HARRIS®

THE HARRIS PRODUCTS GROUP

A GUIDE TO BRAZING & SOLDERING

BRAZING WORKSHOP

Individuals who desire further training in correct soldering, brazing, and welding procedures should consider attending The Harris Products Group brazing workshop. This two-day, comprehensive course conducted by The Harris Products Group Technical Staff covers fundamentals of torch brazing. The course combines classroom discussion with hands-on metal joining experience including basic metallurgy, base metals, filler metals, equipment, technique, and safety.

WHO SHOULD ATTEND?

Supervisors, foremen, quality control, service technicians, and others involved with supervision, instruction, or production of brazed assemblies should attend. Participants are encouraged to share their application problems for class discussion. For more information and course outline, contact The Harris Products Group Technical Services Department, 4501 Quality Place, Mason,OH 45040-1971.

The J.W. Harris Company was founded in 1914 by Joseph W. Harris, Sr., who was involved primarily in the distribution and repair of specialized parts for automotive and farm implement vehicles. In 1937, Mr. Harris formulated Stay-Clean soldering flux, followed by the development of Stay-Brite, a tin-silver solder, in 1956.

In late 1976, the Company entered the welding supply industry by adding a completely new product line of filler metals including stainless steel, aluminum, and copper-based alloys for most welding applications.

Autobraze Inc., a division of J.W. Harris, was established in early 1993 and operates in Cranston, Rhode Island. Autobraze specializes in the manufacture of precision brazing rings for automated brazing systems.

In 2000, the Company built new world headquarters in Mason, Ohio. The facility incorporates leading edge manufacturing technologies, increased production capabilities and expanded warehouse space.

In 2006, J.W. Harris was merged with Harris Calorific and The Harris Products Group was formed.

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Brazing is a metal joining process utilizing a filler metal which melts above 840º F and below the melting point of the base metals. The filler metal is drawn into the joint by capillary attraction producing a sound, leak-proof connection.

These sentences briefly describe a process which is an integral part of manufacturing, installing, and repairing refrigeration and air conditioning systems. This handbook is designed to assist the serviceman or contractor in making sound brazed joints and selecting the correct filler metal for each application.

WARNING: Protect yourself and others. Read and understand this information. Brazing and soldering alloys and fluxes may produce FUMES AND GASES hazardous to your health.

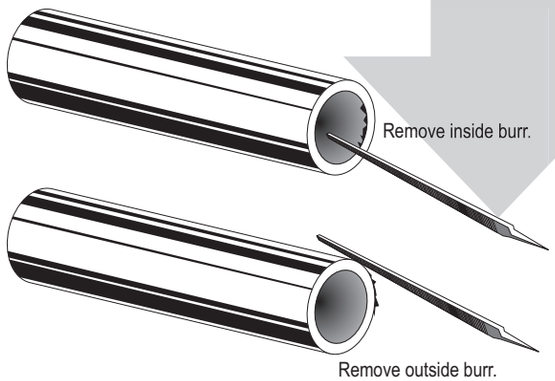
- Before use, read and understand the manufacturer's instructions, Material Safety Data Sheets (MSDS) and your employer's safety practices.
- Keep your head out of the fumes.
- Use enough ventilation or exhaust at the flame to keep fumes and gases from your breathing zone and the general area.
- For maximum safety, be certified for and wear a respirator at all times when welding or brazing.
- Wear correct eye, ear, and body protection.
- Do not touch live electrical parts.
- See American National Standard Z49.1, Safety in Welding, Cutting and Allied Processes, published by the American Welding Society, 550 N.W. LeJeune Rd., Miami Florida 33126; OSHA Safety and Health Standards, 29 CFR 1910, Available from the U.S. Government Printing Office, Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA15250-7954.
- Material Safety Data Sheets are available for all Harris products. Each MSDS contains detailed safety and health information about possible hazards associated with use of a particular product. MSDS are available from your employer or by contacting The Harris Products Group 4501 Quality Place, Mason, OH 45040-1971.

STATEMENT OF LIABILITY

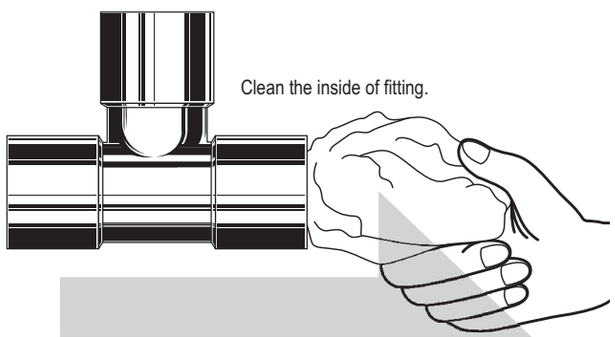
This information and recommendations contained in this publication have been compiled from sources believed to be reliable and to represent the best information on the subject at the time of issue. No warranty, guarantee, or representation is made by The Harris Products Group as to the absolute correctness or sufficiency of any representation contained in this and other publications; The Harris Products Group assumes no responsibility in connection herewith; nor can it be assumed that all acceptable safety measures are contained in this (and other) publications, or that other or additional measures may not be required under particular or exceptional conditions or circumstances.

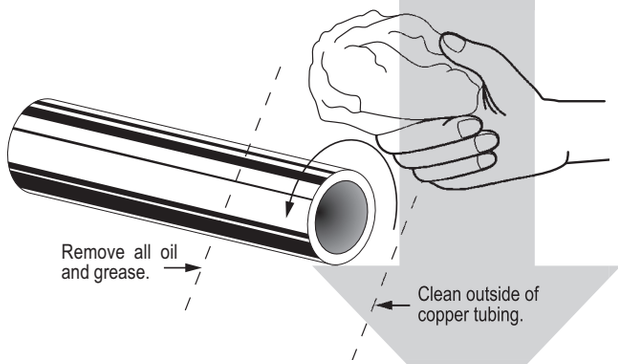
PROCEDURES FOR BRAZING PIPE AND TUBING

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 tube end and inside surface of fitting. 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 or Scotch Brite®. 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 surface MUST be clean.





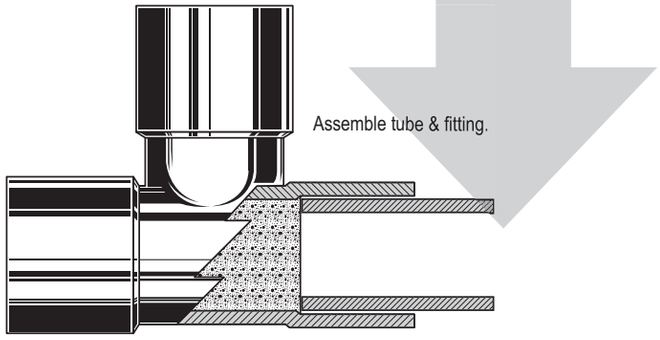
Select Brazing Alloy. Refer to the chart 12 on pg.30-31 for recommended brazing Filler Metal selection. When brazing copper to copper, alloys such as Dynaflow, Stay-Silv 5, or Stay-Silv 15 are recommended. These alloys contain phosphorus and are self- fluxing on copper. When brazing brass or bronze fittings, Stay-Silv white flux is required with these alloys. When brazing iron, steel or other ferrous metals, select one of the Stay-Silv brazing alloys such as Safety-Silv 45 or Safety-Silv 56 with Safety-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 Chart 1 on page 13.

Proper Fluxing is 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. Insert the tube into the fitting and, if possible, revolve the fitting once or twice on the tube to ensure uniform coverage. Stay-Silv white brazing flux is available in 7 oz, 1/4 lb, 1/2 lb, 1 lb, 5 lb jars, 25 lb and 60 lb pails.

Assemble tube and fittings.

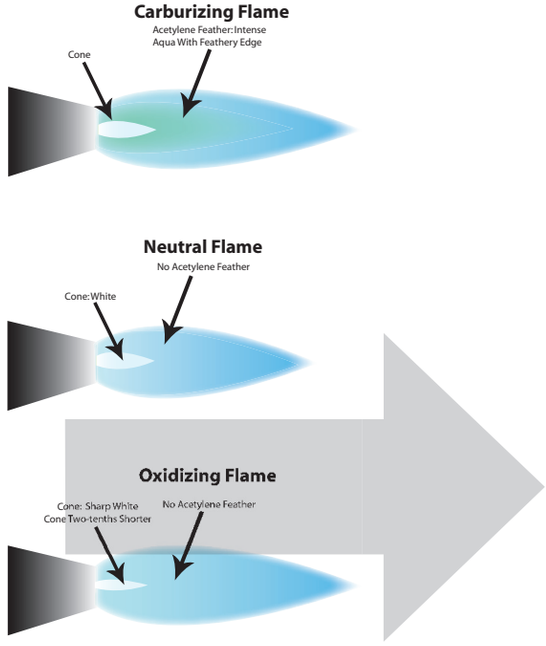
Insert the fluxed tube end into the fitting. Maintain support to ensure the proper alignment until the brazing alloy solidifies. After brazing maintain support for a few seconds (or more) depending upon the size of the joint area.

The assembly is now ready to braze, using brazing alloy in rod, wire, or in coil form manually fed into the joint.



Adjust torch flame.

Oxygen/Acetylene. For most brazing jobs using oxygen-acetylene gases, a carburizing or neutral flame should be used. The neutral flame has a well defined inner cone. See diagram. *Avoid an oxidizing flame.* Excess acetylene removes surface oxides from the copper. The copper will appear bright rather than having a dull or blackened surface due to an improper oxidizing flame.



Adjust torch flame.

Air/acetylene using swirl combustion tips.

Brazing with air/ acetylene torches is a popular alternative to oxygen mixed fuel gas. The fuel gas flow aspirates air into a mixer that contains an internal vane that spins the gas to improve combustion and increase flame temperature.

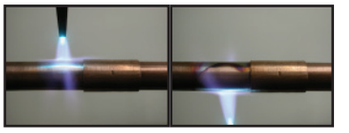
If the tank has a delivery pressure gauge set the delivery pressure at 14-15 psi. If the tank has only a contents gauge delivery pressure is preset at the factory so open the regulator adjusting screw all the way by turning it clockwise until it “bottoms”.

Open the torch value. Opening about 3/4 of a turn will provide sufficient fuel gas delivery. Do not try to meter pressure, (reducing the flame), by using the torch handle valve. If a higher or lower flame is required change to a different tip size.

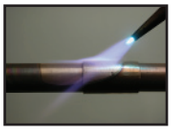
Heating the joint area.

Always keep the torch in short motion. Then...

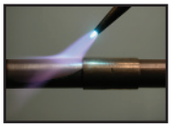
1. Start heating the tube, first applying flame at a point just adjacent to the fitting. Work the flame alternately around the tube and fitting until both reach brazing temperature before applying the brazing filler metal.



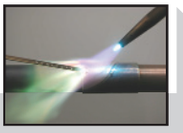
2. When a flux is used, it will be a good temperature guide. Continue heating the tube until the flux passes the “bubbling” temperature range and becomes quiet, completely fluid and transparent and has the appearance of clear water.



3. Direct the flame from the tube to the flange-base of the fitting and heat until the flux that remains in the fitting is also completely fluid.

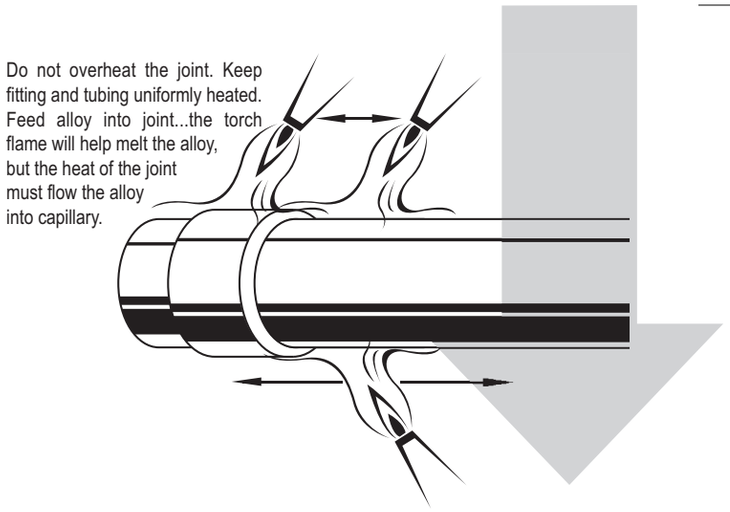


4. Sweep the flame back and forth along the axis of the assembled joint, tube, and fitting to get and then maintain uniform heat in both part.



Apply the brazing alloy.

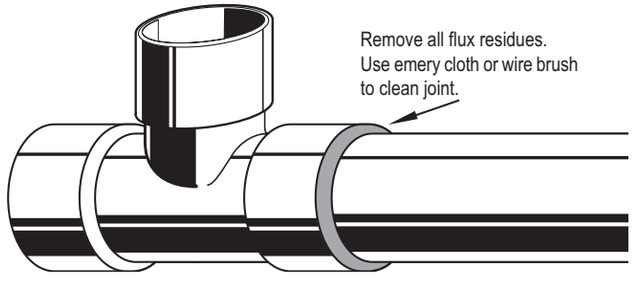
Feed the alloy into the joint between the tube and the fitting. Only after the base metals have been heated to brazing temperatures should the filler metal be added. At that time, the flame may be detected momentarily to the tip of the filler metal to begin the melting process. Always keep both the fitting 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 the dependability of the braze and are a waste of material.



When 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. Keep the flame directed toward the fitting. If the tube is overheated, the brazing alloy may run down the tube rather than into the joint

When 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. 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 fitting are up to temperature.

Clean after brazing. All fluxes 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.



To take a brazing joint apart first flux the visible alloy and all adjacent areas of the tube and fitting. Then, heat the joint (tube and fitting) evenly, especially the flange of the fitting. When brazing apply becomes fluid throughout the joint area, the tube can be easily removed. To re-braze the joint, clean the tube end and the inside of the fitting and proceed as directed for making a new brazed joint.

TROUBLE SHOOTING

In spite of the suggestions and cautions we have noted, the art of brazing is relatively simple, and the rules are common sense rules. Occasionally, however, things do go wrong, and the brazing process fails to do its job satisfactorily. The check lists below have been prepared to assist in such instances. They are intended to give practical tips on what to try and what to look for.

If brazing alloy does not flow into the joint, even though it melts and forms a fillet

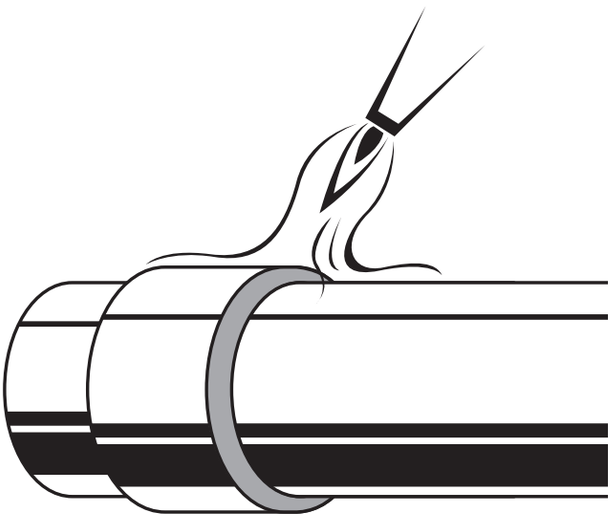
1. The outside of the joint is hot, but the inside is not up to brazing temperature. Review correct heating procedure on page 9. Remember to heat the tube first to conduct heat inside the fitting.
2. There is a flux breakdown due to excessive heat. If overheated, the flux can become saturated with oxides, and the brazing alloy won't flow. Try using a softer flame and/or applying a heavier coating of flux. On thick section where heating is prolonged or on stainless steel, Harris Stay- Silv black flux is recommended.

If brazing alloy does not wet surfaces but balls up instead of running into the joint

1. Review heating technique
   (a) The base metals are not up to brazing temperature, and the alloy has been melted by the torch flame.
   (b) The joint has been over-heated and the flux is no longer active.
2. Base metals have not been properly cleaned.

If brazing alloy flows away from instead of into the joint

1. Make sure fitting is up to temperature and the flame is directed towards the fitting.



If the filler metal cracks after it solidifies

1. When brazing dissimilar metals, the different coefficient of expansion may put the filler metal in tension just below the liquidus temperature during cooling. This sometimes occurs in a copper-into-steel joint. The copper expand and contracts at a greater rate than the steel. Brazing alloys are stronger in compression, so a steel-into-copper assembly would help alleviate the problem.
2. Brazing steel (or other ferrous metals) with an alloy containing phosphorus can lead to formation of a brittle phosphide prone to cracking. Braze ferrous metals with non-phosphorus content alloys.
3. Excessive joint clearance can lead to filler metals cracking under stress or vibration. Make sure clearances are held to .002" - .006" at brazing temperature (depending on alloy).
4. Too rapid quenching can sometime cause cracking. Let joint cool more before washing off flux residue.

If joint leaks in service

90% of "leakers" are due to incorrect brazing technique. The most common causes are:

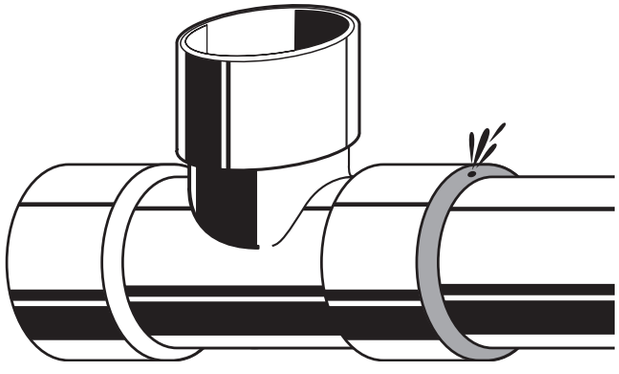
1. Improper (uneven) heating of joint. The effect of this is inadequate or incomplete penetration by the filler metal. Review proper technique on page 10.
2. Over heating, causing volitalization of elements (phosphorus, zinc, etc.)
3. Incorrect torch flame adjustment leading to deposition of carbon or causing excessive oxidation.

REPAIR OF LEAKERS

Pinhole leaks in copper-to-copper joints brazed with phosphorus/copper or phosphorus/copper/silver filler metals can often be repaired using Blockade. If care is taken, you can re-braze the joint with Blockade without remelting the original braze. Be sure to use a carburizing flame.

We DO NOT recommend brazing over joints previously soldered with tin/lead solders. The low melting elements in the solder may prevent proper filler metal/base metal alloying.

Pinhole leaks in joints brazed with either the phosphorus or high silver alloys can usually be repaired with Stay-Brite solder. Clean the joint thoroughly before soldering.



ESTIMATING AMOUNTS OF BRAZING ALLOYS REQUIRED

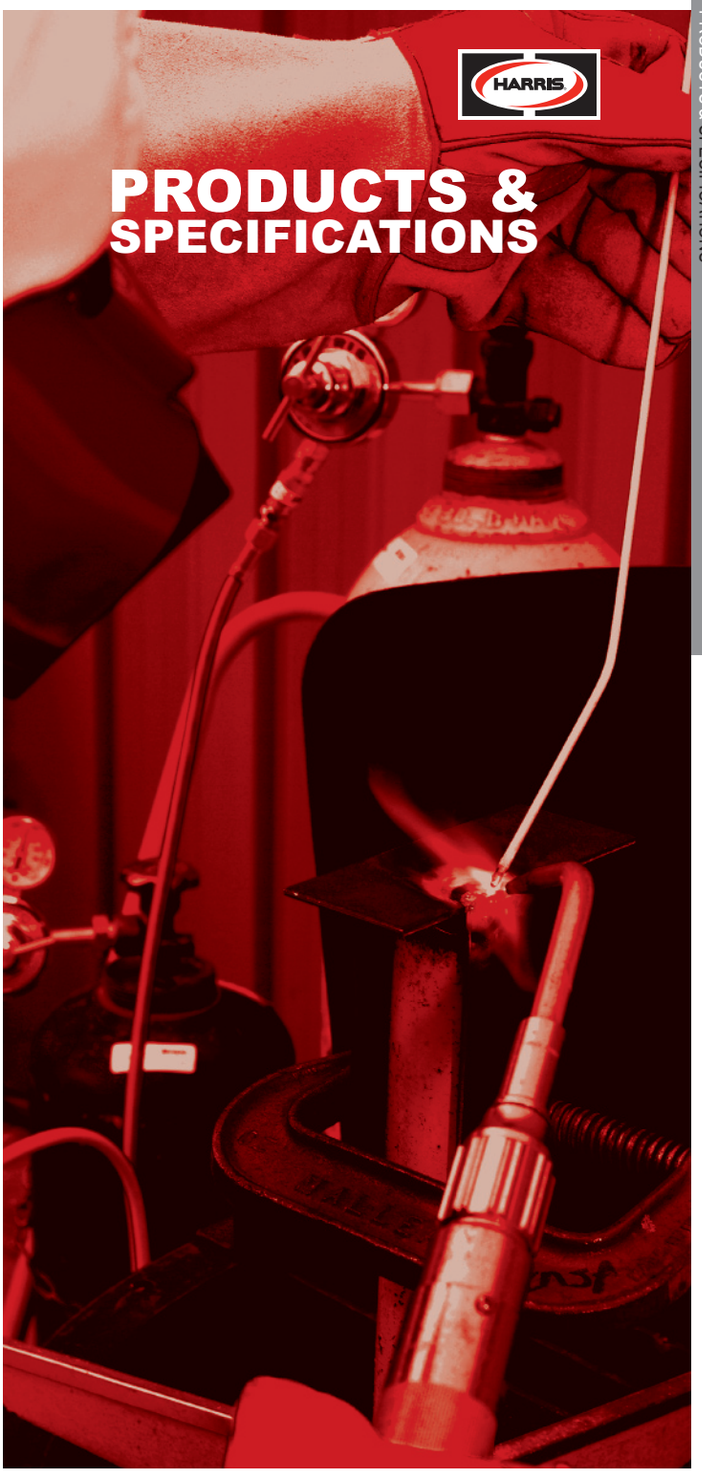
1. Locate the tube diameter to be joined and the wire size to be used. Where the row and the column intersect is the approximate length (in inches) of alloy required per joint.
2. Multiply the length of the alloy needed per joint by the total number of joints.
3. To convert the total length to pounds or troy ounces, divide by the inches of alloy/lb in row A or the inches of alloy/troy oz in row B.

Chart 1 Estimating Brazing Alloy Amounts

Tube Diameter	3/64" Wire	1/16" Wire	3/32" Wire	.050"x 1/8" Rod	Tip Size	Estimated Acetylene Use(C.F.H.)
1/4"	1 1/4"	3/4"			4	6-14
3/8"	1 1/2"	1"			4	6-14
1/2"	2"	1 1/2"	3/4"	7/8"	5	8-18
3/4"	3"	2"	1"	1 1/8"	5	8-18
1"		3"	1 1/2"	1 5/8"	6	10-20
1 1/4"		4"	2"	2 1/2"	6	10-20
1 1/2"			2 1/2"	2 3/4"	7	13-25
2"			3 3/4"	4 1/2"	8	16-32
2 1/2"			6"	7 1/2"	8	16-32
3"			10"	11 1/2"	9	20-37
3 1/2"			12"	13 3/4"	9	20-37
4"			14"	16"	10	24-42
6"			21"	23 3/4"	10	24-42
A	**1900"**	**1068"**	**475"**	**513"**	**in. of alloy/lb**	
B	**118"**	**67"**	**29"**		**in. of alloy/troy oz**	

A- Phos/copper/silver alloys. Dynaflow, Harris 15, etc.
B- Silver Brazing alloys, Safety-Silv 45, 56, etc.
The above figures are approximate and will vary depending on joint clearance, depth, and operator technique.

NOTES



PHOS-COPPER BRAZING ALLOYS

Phos/copper and silver/phos/copper alloys are used to braze copper to copper and copper to brass. The phosphorus content in these alloys makes them self-fluxing on copper. When brazing brass or copper to brass, use Stay-Silv white brazing flux. These alloys are not recommended for brazing steel or other ferrous metals.

The amount of phosphorus in the phosphorus/copper filler metals (AWS BCuP series) is the critical factor that determines the melting range of the alloys and thus, how they perform. The Harris Products Group is the brazing industries forerunner in developing the technology to control phosphorus content. This controls alloy melting temperatures so exactly, that brazing operators no longer need to make temperature adjustments from one batch of filler metals to the next. Operators know that with Harris alloys, the result will be the same with every batch, every time.

Its technology is so exacting The Harris Products Group guarantees users a Liquidus temperature variation of no more then plus or minus 6˚F, a much tighter standard than industry requires. Every package of Harris brazing alloy is clearly marked with the alloy's liquidus temperature, and all Harris brazing rods are marked with alloy identification.

Over the decades many things have changed in our industry. But our dedication to making the world's purest and most consistent brazing alloys has *not* changed; we are committed to giving you the best tool to do your job.

Harris 0® Low-cost alloy for many copper-to-copper applications where good fit-up can be maintained and brazing temperature is not critical.

Stay-Silv®5 and Stay-Silv®6 Medium-range alloys; Stay-Silv 5 is useful primarily where fit-up cannot be tightly controlled. Stay-Silv 6 is slightly more fluid and can be used where closer tolerances are available. Both alloys are somewhat more ductile than Harris 0.

Dynaflow® Premium, medium-range silver alloy, formulated to even tighter specifications than the Stay-Silv alloys to mirror the performance characteristics of the 15% silver brazing filler metals. Excellent for brazing both tight and poorly-fitted connections, Dynaflow's proven reliability and acceptance by field service engineers has made it the leading choice of brazing operators.

Stay-Silv®15 The industry standard for air conditioning / refrigeration applications. Still widely used but now often replaced by Dynaflow in many ACR applications.

Blockade® Brazing Alloys. Silicon brazing alloys offer significant advantages over phos/copper and silver/phos/copper (BCuP) brazing alloys and present important differences in the brazing of copper and its alloys. The addition of silicon affects such noticeable changes as:

- Outstanding ability to form a large shoulder, or cap, at the braze connection
- Distinct, favorable color changes in the finished braze alloy
- Improved ductility over non-silver-bearing BCuP-2 braze alloys
- Easily brazes brass and brass alloys without the addition of silver
- Significantly reduces brazing temperatures compared to BCuP braze alloys

SILVER BRAZING ALLOYS

The Harris Products Group manufactures their complete line of cadmium-free, high silver brazing alloys with the same attention to quality found in their phos/copper products. Only the purest metals are used, and precision production procedures ensure consistency in product quality and performance.

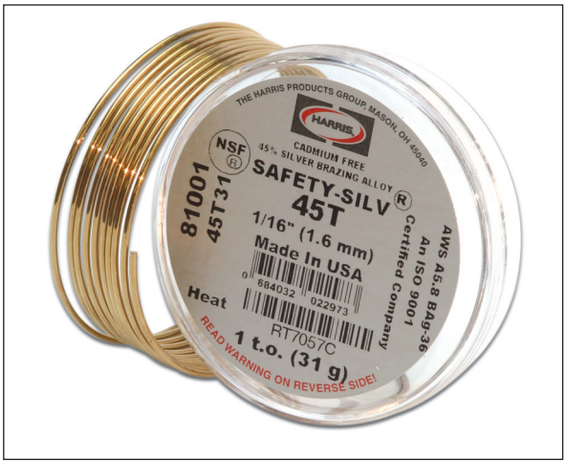
The Harris Products Group does not manufacture alloys containing cadmium. Cadmium-bearing alloys, when molten, emit cadmium oxide fumes which are highly toxic and can cause illness or death. Safety-Silv alloys are strongly recommended as replacements for all cadmium-bearing alloys.

Safety-Silv®56 This high silver (56%) content alloy makes first quality brazes. It is free flowing with unequaled capillary attraction and deep penetration. Ductility is high, corrosion resistance suitable for all but strong chemical applications offers highest elongation of silver brazing alloys. Suitable for use in the food processing industry. The silver color is an excellent match for stainless steel and silverware applications.

Safety-Silv®40 Ductile, free-flowing alloy offers economy, good penetration into tight connections, and medium temperature. Silver to light yellow color as in polished brass.

Safety-Silv®45 Excellent general purpose non-toxic brazing alloy. Often specified in governmental use. Good ductility and capillary flow. Color is silver to light yellow as in polished brass.

Safety-Silv®45T Performs like a 45% silver, cadmium-bearing alloy. Lower melting temperature than Safety-Silv 45. Excellent fillet forming qualities. Produces high-strength, ductile joints.



STAY-BRITE®
SILVER-BEARING SOLDERS

Certified to NSF/ANSI 61

Stay-Brite silver bearing solders were introduced to the air conditioning industry more than 40 years ago. Today Stay-Brite is the most used of all solders.

Extremely versatile, Stay-Brite silver-bearing solders are widely used throughout the industry as a better-than-brazing method in many situations.

The important advantage of Stay-Brite solders is the greater strength of the overall component. After joining its lower working temperatures eliminate the weakening of the base metals caused by annealment from high brazing heat. The result is stronger, more economical system.

Stay-Brite silver-bearing solders have the same excellent affinity as Safety-Silv to bond with most of the ferrous and nonferrous alloys (including stainless steel, nickel, copper, brass, etc.) and a considerably higher than necessary elongation for sound dissimilar metal joints and vibration applications. Stay-Brite alloys range in temperature from 430˚F to 535˚F.

Stay-Brite offers these important advantages over silver brazing:

1. Lower material cost up to 66%
2. Lowers temperature up to 66%
3. Speeds production up to 400%
4. Faster post cleaning, little metal discoloration
5. Elimination of base metal distortion
6. Elimination of base metal annealment
7. Elimination of oxide scale formed by heat
8. Cadmium-free and non-toxic

Stay-Brite® - Certified By The National Sanitation Foundation For Use In The Food Processing Industry, NSF C2.

Failure occurred adjacent to higher temperature braze due to weakened copper.

Chart 2- Stay-Brite® Joint Vs. Brazing Joint

Properties	Stay-Brite®	Brazed Joint
Tube burst strength (before heating; type M-1")	3,800 PSI	3,800 PSI
Tube burst strength (after joining)	3,800 PSI	1,800 PSI
Oxide scale	None	Heavy
Annealment	None	Heavy

LEAD-FREE SOLDER DEVELOPED SPECIFICALLY FOR POTABLE WATER SYSTEMS

Bridgit® Meets ASTM B32. A patented, high-performance, lead-free solder developed by The Harris Products Group in response to the Federal ban on the use of lead solders in drinking water systems. The lead-free solder is specially formulated to fill both tight and loose-fitting connections. The nickel content in Bridgit solder creates joints that are substantially stronger than those joints soldered with 50/50, 95/5 or common lead-free solders. Bridgit has the ability to fill large gaps and "cap" joints with ease.

Extensive laboratory and field tests show that Bridgit eliminates the problems associated with 95/5, and Bridgit begins to melt at 460˚ F, only 40˚ higher than 50/50. A 1 pound spool provides 20% more wire than a roll of 1/8" diameter 50/50, resulting in 75 more soldered joints per roll.

Bridgit® Paste Flux Bridgit flux is burn resistant, reducing black carbon formations which can cause leaks. This flux is unexcelled for use in soldering, copper, brass, bronze, galvanized, and other pluming fittings. Works equally well with other solders.

Bridgit® Water Soluble Flux This flux is formulated so water flushing will remove flux residue from copper tube runs. Water soluble flux conforms to ASTM B813-93, and meets state and local regulations for use in potable water systems.

Stay-Clean® Liquid Soldering Flux Highly recommended for use with Stay-Brite silver-bearing solders, tin-lead and tin-antimony solders, and any other solder with a liquidus temperature below 700˚F. Stay-Clean can also be used with lead-free solders such as Bridgit.

Stay-Clean® Paste Soldering Flux Excellent flux in paste form for joining copper to copper and copper to brass. Not recommended for electrical or electronic applications. Meets Commercial Spec. A-A-51145C.

COMMON WIRE SOLDERS-TIN/LEAD

Tin-lead 50/50, 40/60, 60/40 meet ASTM B32. With some exceptions, the tin-lead solders can be used to solder copper and most copper alloys, lead, high-nickel alloys, and steel.

Tin-lead solders are not recommended in high stress or vibration joints in the cooling industry due to lack of sufficient elongation properties. Heat sources include soldering guns, irons, and torch applications.

Tin-antimony 95/5 meets ASTM B32. The 95/5 tin-antimony solder is useful for applications where moderately elevated temperature is a factor. It has a higher electrical conductivity and is sometimes used where lead contamination must be avoided. The tin-antimony solders are not recommended for use on brass.

Flux, tin-lead, and tin-antimony solders. Both Stay-Clean Paste and Liquid soldering flux is recommended except on electrical or electronic applications which require the use of a non-corrosive flux.

Chart 3- Tin/Lead Solders

Composition/ Properties					
Solder	Tin	Lead	Antimony	Solidus	Liquidus
*40/60	40	60	-	360˚F	460˚F
*60/40	60	40	-	360˚F	375˚F
*50/50	50	50	-	360˚F	420˚F
95/5	95	-	5	452˚F	464˚F

* 40/60, 60/40, 50/50 solders are available in solid wire or with rosin or acid core.

BRAZING AND SOLDERING ALUMINUM

Aluminum can be soldered or brazed if correct procedure is followed. Precleaning is essential to break up the tough aluminum oxide film. Thorough brushing with a stainless steel wire brush is recommended.

Most common aluminum alloys such as 1100 and 3003 can be readily soldered or brazed. It should be noted some alloys are difficult to join.

Soldering or brazed aluminum to copper or brass is not recommended because:

A) Brazed joints may be brittle
B) Combination of base metals creates a high potential for galvanic corrosion

ALUMINUM ALLOYS

Alcor® aluminum alloy with non-corrosive flux inside the wire; no external flux required. Very good fluidity with good capillary attraction. Post-braze cleaning unnecessary. Better than tin-zinc and aluminum silicon alloys for aluminum coil repair.

Alsolder 500® forms excellent corrosion-resistant joints on the tough-to-solder aluminum alloys. Joints all solderable aluminum alloys to each other and to dissimilar metals, both ferrous and non-ferrous. Also beneficial as a high-temperature solder on most other metals.

Al-braze® is a superior brazing alloy for the joining of aluminum to aluminum. Not recommended for brazing aluminum directly to non-aluminum alloys, as the joint may be brittle. Al-Braze is free flowing with unequaled capillary attraction, ductility and penetration. Excellent corrosion resistance.

Chart 4 Aluminum Alloys

Part #	Description	Chemical Composition	Solidus	Liquidus	Typical Application
Al200RC (10015)	Alcor Flux-Cored Aluminum Alloy	Zn Al	824˚ F 440˚ C	824˚ F 440˚ C	A new approach to joining aluminum. A low temperature, free flowing, flux-cored solder for aluminum joining or repair.
500K (10022)	Alsolder 500 Aluminum Solder Kit	15% Zn 85% Sn	391˚ F 199˚ C	482˚ F 250˚ C	Forms excellent corrosion-resistant joints on the tough-to-solder aluminum alloys. Use for for copper to aluminum connections.
1070K (10023)	Al-Braze 1070 Aluminum Brazing Kit	88% Al 12% Si	1070˚ F 577˚ C	1080˚ F 582˚ C	Superior brazing alloy for joining aluminum to aluminum. Excellent capillary attraction.

Chart 5 Safety-Silv® 45

Part #	Description	Chemical Composition	Specifications	Solidus	Liquidus	Typical Application
45318LMPOP	Safety-Silv® 45 1/16"x 18" Mini Pak	45% Ag 30% Cu 25% Zn	AWS A5.8 BAg-5	1225°F 663°C	1370°F 743°C	General purpose filler for steel and copper alloys. Melting range useful for wide clearances.
45518LMPOP	Safety-Silv® 45 3/32"x 18" Mini Pak					
45F318MPOP	Safety-Silv® 45 1/16"x 18" Flux Coated					
45KPOP	Safety-Silv® 45 1/16" Brazing Kit					

Chart 6 Safety-Silv® 56

Part #	Description	Chemical Composition	Specifications	Solidus	Liquidus	Typical Application
56318LMPOP	Safety-Silv® 56 1/16" x 18" Mini Pak	56% Ag 22% Cu 17% Zn 5% Sn	AWS A5.8 BAg-5 NSF 51	1145°F 618°C	1205°F 652°C	For ferrous and nonferrous alloys. Often used to braze stainless steel for food service.
56F318MPOP	Safety-Silv® 56 1/16" x 18" Flux Coated					
56KPOP	Safety-Silv® 56 1/16 Brazing Kit					

Chart 7 Stay-Brite® - Production packs available. Contact customer service.

Part #	Description	Chemical Composition	Specifications	Solidus	Liquidus	Typical Application
SB61/2POP	Stay-Brite® Solder 1/8" 8 oz Spool	4% Ag 96% Sn	ASTM B32 Sn 96 NSF 51 J-STD-006 Sn 96 Ag 04A	430°F 221°C	430°F 221°F	Use for all metals with the exception of aluminum. Low temperature solder used in HVAC.
SBSKPOP	Stay-Brite ® Solder Kit with Flux				----------	

Chart 8 Solders - Production packs available. Contact customer service.

Part #	Description	Chemical Composition	Specifications	Solidus	Liquidus	Typical Application
505061/2POP	50/50 1/8" 8oz Spool	50% Sn 50% Pb	ASTM B32 Sn50 J-STD-006 Sn50pB50a	360°F 182°C	420°F 216°C	This can be used, but with some exceptions, to join copper to most copper, lead, nickel, and steel. Note: Illegal for potable water systems.
60R61/2POP	60/40 1/8" 8oz Spool	60% Sn 40% Pb	ASTM B 32 Sn60	360°F 182°C	375°F 191°C	Similar to 50/50 but flows faster due to narrow melting range. Note: Illegal for potable water systems.
60R31/2POP	60/40 1/16" 8oz Spool					

Chart 9 Fluxes - Production packs available. Contact customer service.

Part #	Description	Specification	Active Temperature	Typical Application
SSWF7POP	Stay-Silv ® White Brazing Flux 6.5 oz	Meets Federal Spec. OF499,Type B AWS A5.31 Class FB3A AMS 3410	Below 1600°F	For use with silver brazing alloys on all metals other than aluminum, magnesium, or titanium.
SCF4POP	Stay-Clean® Paste Flux 4 oz	Meets Commercial Spec. A-A-51145C	Below 700°F	Excellent flux for joining copper to copper and copper to brass. Not recommended for electrical or electronic applications.
BRPF4POP	Bridgit® High Temperature Paste Flux 4 oz	----------	Below 800°F	Designed for lead-free solders and well suited for use in larger connections where prolonged heating will cause other fluxes to burn.

Chart 10 Silver Solders - Production packs available. Contact customer service.

Part #	Description	Chemical Composition	Specifications	Solidus	Liquidus	Typical Application
1520FMPOP	Stay-Silv® 15 .050"x 1/8" Mini Pak	15% Ag 5% P 80% Cu	AWS A5.8 BCuP-5	1190°F 643°C	1475°F 80°C	Designed primarily for copper to copper brazing application, it may also be used in brazing brass with the use of Stay-Silv brazing Flux.
5620FMPOP	Stay-Silv® 5 .050" x1/8" Mini Pak	5% Ag 6% P 89% Cu	AWS A5.8 BCuP-3	1190°F 643°C	1500°F 816°C	Well suited where close fit-up cannot necessarily be maintained.
D620FMPOP	Dynaflow® Mini Pak	6% Ag 6% P 88% Cu	----------	1190°F 643°C	1465°F 796°C	Designed for copper to copper applications, it may also be used on brass. Allows the ability to braze poorly fitted as well as tight connections.
0620FMPOP	Harris 0 Mini Pak	7.2% P 92.8% Cu	AWS A5.8 BCuP-2	1310°F 710°C	1460°F 793°C	Suitable for most copper-to-copper or brass joints where good fit-up exists, and the assemblies are not subject to vibration nor movement.

Chart 11 Lead Free Solder - Production packs available. Contact customer service.

Part #	Description	Chemical Composition	Specifications	Solidus	Liquidus	Typical Application
BRGT61/2POP	Bridgit ® Solder 1/8" 8 oz Spool	------	ASTM B32 HB • NSF to ANSI NSF61 Conforms to 1986 Safe Drinking Act	460°F 238°C	630°F 332°F	Widely used in plumbing applications where lead-bearing solders are prohibited. Contains nickel, making joints tremendously strong. Wide plastic range make Bridgit® an excellent alloy for large diameter fittings and ill-fitted or non-concentric pipes. Fills gaps and caps off easily and effectively.
SB61/2POP	Stay-Brite® Solder 1/8"x 8 oz Spool	4% Ag 96% Sn	ASTM B32 Sn96 NSF 51• J-STD-006 Sn96Ag04A	430°F 221°C	430°F 221°F	Use for all metals with the exception of aluminum. Low temperature solder used in HVAC
95561/2POP	95/5 1/8"x 8oz Spool	95% Sn 5% Sb	ASTM B32 • Sb5 J-STD-006 Sn95Sb05A	452°F 233°C	464°F 240°C	Well suited for applications where moderately-elevated temperature is a factor.

Chart 12 Filler Metals

HARRIS FILLER METAL SELECTION

METALS TO BE JOINED	FILLER METALS: SOLDERS	FILLER METALS: BRAZING FILLER METALS	MELTING RANGE: SOLIDUS °F / °C	MELTING RANGE: LIQUIDUS °F / °C	FLUIDITY RATING*	FLUXES
Copper or Brass To Copper or Brass	Stay-Brite®		430 / 221	430 / 221	10	Stay-Clean® Soldering Flux
	Stay-Brite® 8		430 / 221	535 / 279	8	
	Bridgit®		460 / 238	630 / 332	6	Bridgit® Water Soluble Paste Flux
		Blockade®	1178 / 637	1247 / 674	7	No flux required for copper-to-copper joints with the phosphorus-bearing filler metals.
		Harris 0	1310 / 410	1475 / 802	5	
		Stay-Silv® 5	1190 / 643	1500 / 816	3	
		Dynaflow®	1190 / 643	1465 / 796	3	
		Stay-Silv® 6	1190 / 643	1425 / 774	5	For brass and other alloys of copper, use Stay-Silv® White Brazing Flux.
		Stay-Silv® 15	1190 / 643	1480 / 804	3	
Copper or Brass To Steel or Stainless	Stay-Brite®		430 / 221	430 / 221	10	Stay-Clean® Soldering Flux
	Stay-Brite® 8		430 / 221	535 / 279	8	
		Safety-Silv® 56	1145 / 618	1205 / 652	8	Stay-Silv® White Brazing Flux
		Safety-Silv® 40	1250 / 677	1350 / 732	5	
		Safety-Silv® 45	1225 / 663	1370 / 743	6.5	Stay-Silv® Black Flux for Stainless
		Safety-Silv® 45T	1195 / 646	1265 / 685	7	
Steel or Stainless To Steel or Stainless	Stay-Brite®		430 / 221	430 / 221	10	Stay-Clean® Soldering Flux
	Stay-Brite® 8		430 / 221	535 / 279	8	
		Safety-Silv® 56	1145 / 618	1205 / 652	8	Stay-Silv® White Brazing Flux
		Safety-Silv® 40	1250 / 677	1350 / 732	5	
		Safety-Silv® 40Ni2	1220 / 660	1435 / 779	4.5	
		Safety-Silv® 45	1225 / 663	1370 / 743	6.5	Stay-Silv® Black Flux for Stainless
		Safety-Silv® 45T	1195 / 646	1265 / 685	7	
		Safety-Silv® 50N	1220 / 660	1305 / 707	7	
Steel or Stainless To Carbides	NOT RECOMMENDED					Stay-Silv® White Brazing Flux
		Safety-Silv® 40Ni2	1220 / 660	1435 / 779	4.5	
		Safety-Silv® 50N	1220 / 660	1305 / 707	7	
Aluminum To Aluminum (1)	Alsolder® 500		391 / 199	482 / 250	NOT RATED	Stay-Clean® Aluminum Soldering Flux
Aluminum To Copper Or Brass (2)*	Alcor®			824 / 440	NOT RATED	No Flux Required
Aluminum To Steel Or Stainless (2)*		Albraze® 1070	1070 / 577	1080 / 582	NOT RATED	Albraze® 1070 Flux
* Aluminum dissimilar metal joints may subject to galvanic corrosion.		(1) Can be directly brazed or soldered. (2) Solder directly with Alsolder® 500, or coat steel side with aluminum and solder with Alcor® or Braze with Albraze® 1070				

* The higher the fluidity rating, the faster the alloy flows within the melting range.

** For best results and strong leak proof bonds, filler metals should be applied to the joint area only after the parts are heated to the proper brazing or soldering temperature. Oxy-Acetylene torches may be substituted for air-fuel but may require care to prevent overheating of the base metal/flux with the higher temperature flame.

EQUIPMENT: 2345 Murphy Blvd., Gainesville, GA 30504 U.S.A. Tel: 770-536-8801 Fax: 770-535-8358
CONSUMABLES: 4501 Quality Place, Mason OH 45040 U.S.A. Tel: 513-754-2000 Fax: 513-754-8778
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HARRIS FILLER METAL SELECTION CHART

FILLER METALS		MELTING RANGE				
SOLDERS	**BRAZING FILLER METALS**	**SOLIDUS °F / °C**	**LIQUIDUS °F / °C**	**FLUIDITY RATING***	**FLUXES**	**TORCHES & FLAMES****
Stay-Brite®		430 / 221	430 / 221	10	Stay-Clean® Soldering Flux	Harris Powertorch® Air - Fuel Equipment
Stay-Brite® 8		430 / 221	535 / 279	8		
Bridgit®		460 / 238	630 / 332	6	Bridgit® Water Soluble Paste Flux	Harris Powertorch® Air - Fuel Equipment
	Blockade®	1178 / 637	1247 / 674	7	No flux required for copper-to-copper joints with the phosphorus-bearing filler metals. For brass and other alloys of copper, use Stay-Silv® White Brazing Flux.	Harris Powertorch® or Classic Oxy-Acetylene Equipment (neutral flame)
	Harris 0	1310 / 410	1475 / 802	5		
	Stay-Silv® 5	1190 / 643	1500 / 816	3		
	Dynaflow®	1190 / 643	1465 / 796	3		
	Stay-Silv® 6	1190 / 643	1425 / 774	5		
	Stay-Silv® 15	1190 / 643	1480 / 804	3		
Stay-Brite®		430 / 221	430 / 221	10	Stay-Clean® Soldering Flux	Harris Powertorch® Air - Fuel Equipment
Stay-Brite® 8		430 / 221	535 / 279	8		
	Safety-Silv® 56	1145 / 618	1205 / 652	8	Stay-Silv® White Brazing Flux Stay-Silv® Black Flux for Stainless	Harris Powertorch® or Classic Oxy-Acetylene Equipment (slightly reducing flame)
	Safety-Silv® 40	1250 / 677	1350 / 732	5		
	Safety-Silv® 45	1225 / 663	1370 / 743	6.5		
	Safety-Silv® 45T	1195 / 646	1265 / 685	7		
Stay-Brite®		430 / 221	430 / 221	10	Stay-Clean® Soldering Flux	Harris Powertorch® Air - Fuel Equipment
Stay-Brite® 8		430 / 221	535 / 279	8		
	Safety-Silv® 56	1145 / 618	1205 / 652	8	Stay-Silv® White Brazing Flux Stay-Silv® Black Flux for Stainless	Harris Powertorch® or Classic Oxy-Acetylene Equipment (slightly reducing flame)
	Safety-Silv® 40	1250 / 677	1350 / 732	5		
	Safety-Silv® 40Ni2	1220 / 660	1435 / 779	4.5		
	Safety-Silv® 45	1225 / 663	1370 / 743	6.5		
	Safety-Silv® 45T	1195 / 646	1265 / 685	7		
	Safety-Silv® 50N	1220 / 660	1305 / 707	7		
NOT RECOMMENDED					Stay-Silv® White Brazing Flux	Harris Powertorch® or Classic Oxy-Acetylene Equipment (reducing flame)
	Safety-Silv® 40Ni2	1220 / 660	1435 / 779	4.5		
	Safety-Silv® 50N	1220 / 660	1305 / 707	7		
Alsolder® 500		391 / 199	482 / 250	NOT RATED	Stay-Clean® Aluminum Soldering Flux	Harris Powertorch® Air - Fuel Equipment
Alcor®			824 / 440	NOT RATED	No Flux Required	Harris Powertorch® Air - Fuel Equipment
	Albraze® 1070	1070 / 577	1080 / 582	NOT RATED	Albraze® 1070 Flux	Harris Powertorch® Air - Fuel Equipment or Classic Oxy-Acetylene Equipment (reducing flame)
	(1) Can be directly brazed or soldered. (2) Solder directly with Alsolder® 500, or coat steel side with aluminum and solder with Alcor® or Braze with Albraze® 1070					

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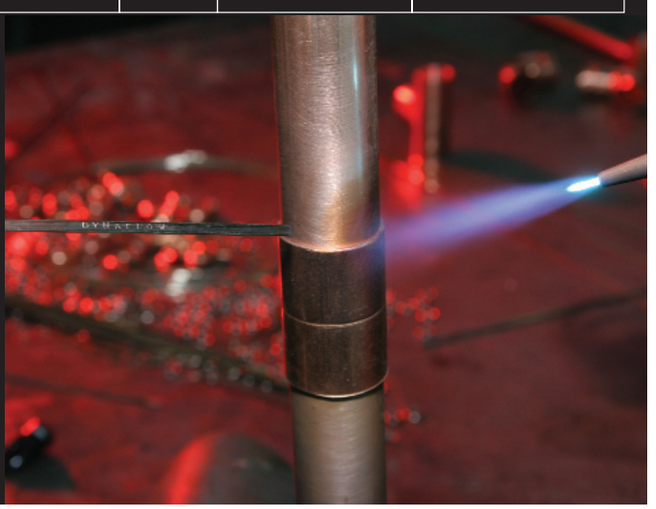

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