HARRIS

A LINCOLN ELECTRIC COMPANY

BRAZING AND SOLDERING
Serviceman's Guide

BRAZING WORKSHOP

Individuals who desire further training in correct soldering, brazing, and welding procedures should consider attending The Harris Products Group's brazing workshop. This two-day, comprehensive course, conducted by The Harris Products Group's 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 at 513.754.2000.

As a NATE®, recognized training provider, we offer several courses designed to improve your brazing skills and achieve required continuing education hours. Contact Technical Services for information.

Harris celebrates 100 years in the brazing industry. Harris is the largest manufacturer of welding, brazing and soldering consumable in the world. Our products are used in over 90 countries.

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FOREWORD

Brazing is a metal joining process utilizing a filler metal that 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. The above sentences briefly describe a process that 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 that are 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.
- See American National Standard Z49.1, Safety in Welding, Cutting and Allied Processes, published by the American Welding Society, 8669 NW 36 Street, #130, Miami, Florida 33166-6672;OSHA Safety and Health Standards, 29 CFR 1910, available from the U.S. Government Printing Office, Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954.
- 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 each 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 AND TECHNICAL INFORMATION

CUT TUBE 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.

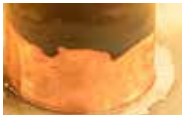
The joint surface areas should be clean and free from oil, grease, or oxide contamination. Surfaces may be properly cleaned for brazing by brushing with a stainless steel wire brush or by a stiff rubbing with emery cloth or Scotch-Brite®*. If oil or grease is present, clean with a commercial solvent. 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 Filler Metal Selection Chart on page 34 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 Safety-Silv® brazing alloys such as Safety-Silv® 45 or Safety-Silv® 56 with Stay-Silv® white flux. Do not use phosphorus bearing alloys as the joint may be brittle. *Scotch-Brite is a trademark of 3M

PERFORM PROPER FLUXING

Proper fluxing is important because the flux absorbs oxides formed during heating and promotes the flow of the 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, rotate the fitting once or twice on the tube to ensure uniform coverage.



Flux at brazing temperature

FLUX APPLICATION

White flux is used for most applications. Black flux is helpful for long heating cycles or localized heating with induction. It is also used when brazing stainless steel.

Flux goes through physical changes during heating and turns clear at about 1100°F / 593°C. This is an indication that parts are close to brazing temperature. Stir flux before use. If flux is dried out add a small amount of water until flux reaches a paste consistency.

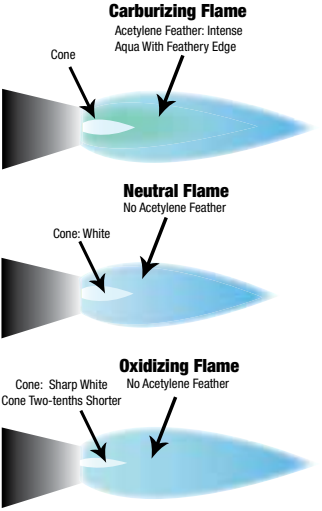
STAY-SILV® WHITE BRAZING FLUX IS AVAILABLE IN THESE CONTAINERS:

- 7 oz.
- 1/4 lb.
- 1/2 lb.
- 1 lb.
- 5 lb.
- 25 lb.
- 60 lb.

ADJUST TORCH FLAME

OXYGEN/ACETYLENE

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



AIR/ACETYLENE USING INFERNO® 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 to 14-15 PSI. If the tank has only a contents gauge delivery pressure is preset at the factory. Open the regulator adjusting screw all the way by turning it clockwise until it bottoms.

OPEN THE TORCH VALVE

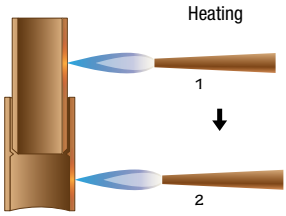
Opening the torch valve about 3/4 of a turn will provide sufficient fuel gas delivery. Do not try to meter pressure (reducing the flame) by using the torch handle valve. If a higher or lower flame is required, change to a different tip size.

OTHER FUEL GASES

Alternate fuel gases such as propane, propylene, and natural gas can be mixed with oxygen for brazing. Refer to the Harris equipment catalog or website for equipment and setting information.

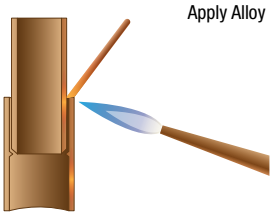
HEATING THE JOINT AREA.

Always keep the torch in short motion.

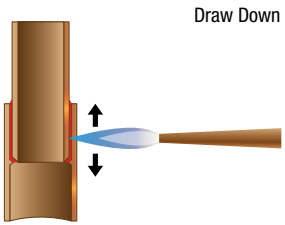


1. Start heating the tube, by first applying the flame to a point just adjacent to the fitting. Work the flame alternately around the tube and fitting until both reach brazing temperature, before applying the brazing filler metal.

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. Watch for this on both sides of the joint to ensure even heating.



3. Direct the flame from the tube to the fitting. When alloy is applied it should quickly melt and flow into the joint.



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

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 deflected 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.

CLEAN AFTER BRAZING

All flux residue 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 residue. Use emery cloth or a wire brush, if necessary.

TO SEPARATE A BRAZING JOINT

First clean the joint thoroughly, then flux the visible alloy and all adjacent areas of the tube and fitting. Next, heat the joint (tube and fitting) evenly, especially the flange of the fitting. When brazing alloy 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 to make a new brazed joint.

NITROGEN PURGE

During braze heating, oxide scale forms on the inside of the copper tube. These dark scales flake off and are carried by refrigerant and can potentially clog small orifices.

For HVAC/R and medical gas installations flow nitrogen through the tube during brazing to prevent internal scale formation. Use a low flow rate to avoid excess pressure inside the tube. A small hole at the line end will allow the nitrogen to escape.

BRAZING PIPE AND TUBING

The art of brazing is relatively simple, and the rules of common sense apply. 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 provide practical tips on what to what to look for and steps to correct them.

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 sections where heating is prolonged, or on stainless steel, Harris Stay-Silv® black flux is recommended.

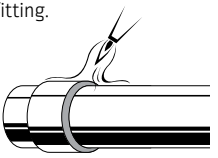
IF BRAZING ALLOY DOES NOT WET SURFACES BUT BALLS UP INSTEAD OF RUNNING INTO THE JOINT

1. Review heating techniques:
   (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 overheated 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-to-steel joint. The copper expands and contracts at a greater rate than the steel. Brazing alloys are stronger in compression, so a steel-to-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, that is 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 sometimes cause cracking. Let joint cool more before washing off flux residue.

IF JOINT LEAKS IN SERVICE

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

1. Improper or uneven heating of joint. The effect of this is inadequate or incomplete penetration by the filler metal. Review proper techniques on page 9.

2. Overheating, causing volatilization of elements (phosphorus, zinc, etc.).

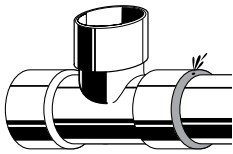
3. Incorrect torch flame adjustment, leading to deposition of carbon or causing excessive oxidation.

REPAIR OF LEAKS

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 re-melting the original braze. Clean thoroughly before brazing.

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 and use Stay-Clean® liquid flux.

STAY-BRITE® - SILVER-BEARING SOLDERS

Extremely versatile, Stay-Brite® silver-bearing solders are widely used through-out 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 temperature eliminates the weakening of the base metals caused by annealment from high brazing heat. The result is a stronger, more economical joint.

Stay-Brite® silver bearing solders have the same excellent affinity as Safety-Silv® alloys for bonding with most of the ferrous and nonferrous alloys (including stainless steel, nickel, copper, brass, etc.) It provides 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® solder eliminates oxide scale formed from brazing heat. No nitrogen purge is required for HVAC/R tubes. They are cadmium free and nontoxic.

Stay-Brite® is a eutectic alloy with a single melting point of 430° F (221° C).

Stay-Brite® 8 has a solidus of 430° F (221° C) and a liquidus of 535° F (279°C). This melting range provides the ability to fill wider clearance parts.

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.

RoHS COMPLIANT

ASTM B32

NSF Certified to NSF/ANSI 61,372 & 51

STAY-BRITE® JOINT vs. BRAZING JOINT

Stay-Brite® offers these important advantages over silver brazing:

- Lower material costs up to 66%
- Lowers temperature up to 60%
- Speeds production up to 400%
- Faster post cleaning with little metal discoloration
- Elimination of base metal distortion
- Elimination of base metal annealment
- Elimination of oxide scale formed by heat
- Cadmium-free and nontoxic
- No internal oxide scale, so nitrogen purge is unnecessary

STAY-BRITE® & STAY-BRITE® 8

Certified to ANSI/NSF 61 and NSF/ANSI 372 for drinking water systems. Conforms to lead-free content requirements of the U.S. Safe Drinking Water Act. Certified to ANSI/NSF 51- Food Equipment Materials.

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

COMMON WIRE SOLDERS FOR TIN-LEAD

TIN-LEAD 50/50, 40/60, 60/40

Meets ASTM B32. With some exceptions, the tin-lead solders can be used to solder copper to most copper, lead, high-nickel and steel alloys.

Tin-lead solders are not recommended for use in high stress or vibration joints in the cooling industry due to lack of sufficient elongation properties. Heat sources for use with solder 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.

Harris 95/5 is certified to ANSI/NSF 61 and NSF/ANSI 372 for drinking water systems. Conforms to lead-free content requirements of the U.S. Safe Drinking Water Act.

FLUX SELECTION FOR TIN-LEAD, AND TIN-ANTIMONY SOLDERS

Both Stay-Clean® paste and liquid soldering fluxes are recommended, except in electrical or electronic applications that require the use of a non-corrosive flux.

TIN / LEAD SOLDERS

COMPOSITION/ PROPERTIES

Solder	Tin	Lead	Antimony	Solidus	Liquidus
*40/60	40	60	-	360˚F (182˚C)	460˚F (238˚C)
*60/40	60	40	-	360˚F (182˚C)	375˚F (191˚C)
*50/50	50	50	-	360˚F (182˚C)	420˚F (216˚C)
95/5	95	-	5	452˚F (233˚C)	464˚F (240˚C)

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

BRIDGIT®

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. This 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. Meets ASTM B32.

Extensive laboratory and field tests show that Bridgit® eliminates the problems associated with 95/5. Bridgit® begins to melt at 460°F, only 40° higher than 50/50. Bridgit® flux in a one 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 and Bridgit® water soluble flux are certified to ANSI/NSF 61 and NSF/ANSI 372 for drinking water systems. Conforms to lead-free content requirements of the U.S. Safe Drinking Water Act. Certified to ANSI/NSF 51-Food Equipment Materials.

BRIDGIT® PASTE FLUX

Bridgit® flux is burn resistant, reducing black carbon formations that can cause leaks. This flux is unmatched for use in soldering copper, brass, bronze, galvanized, and other plumbing 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.

STERLING® LEAD-FREE SOLDER

Meets highest product standards NSF 61 certification for safe use in potable water applications it's 100% environmentally safe and completely free of antimony or nickel

SAFETY-SILV®

The Harris Products Group manufactures its complete line of cadmium-free, high silver brazing alloys with the same attention to quality found in their phosphorus / copper products. Only the purest metals are used. Precision production procedures ensure consistency in product quality and performance. Safety-Silv® alloys are strongly recommended as replacements for all cadmium-bearing brazing filler metals.

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 and corrosion resistance is suitable for all but strong chemical applications. NSF 51 listed for use with food equipment materials. The silver color is an excellent match to stainless steel and silverware applications.

NSF RoHS COMPLIANT

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. Listed with NSF 51 listed for use with food equipment materials.

NSF RoHS COMPLIANT

SAFETY-SILV®45

Excellent general purpose nontoxic brazing alloy. Good ductility and capillary flow. Color is silver to light yellow matches polished brass.

RoHS COMPLIANT

SAFETY-SILV®40

Ductile, free-flowing alloy offers economy, good penetration into tight connections, and medium temperature. Silver to light yellow color matches polished brass.

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.

ESTIMATING BRAZING ALLOY AMOUNTS

TUBE DIAMETER	3/64" WIRE	1/16" WIRE	3/32" WIRE	.050"x1/8" 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® 40, 45, 45T, 56
The above figures are approximate and will vary depending on joint clearance, depth, and operator technique.

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 and refrigeration applications. Still widely used, but now often replaced by Dynaflow® in many HVAC/R applications.

BLOCKADE®

Blockade's® unique silicon addition offers significant advantages over phos/copper and silver/phos/copper, (BCuP), brazing alloys. Among the benefits are: bright alloy color during cooling that allows visual verification of a good braze joint, improved ductility over BCuP-2 alloy, reduced brazing temperature, and reduced material costs. It is often used with Stay-Silv® white brazing flux as a replacement for high silver alloys when brazing brass.

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 industry's forerunner in developing the technology to control phosphorus content. This controls alloy melting temperatures so precisely 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.

Over the decades many things have changed in the industry. However, Harris' dedication to manufacturing the world's purest and most consistent brazing alloys has not changed. Harris is committed to providing the best products every time, all the time, so all jobs are completed successfully.

THE HARRIS PRODUCTS GROUP guarantees users a liquidus temperature variation of no more than plus or minus 6˚ F, a much tighter standard than the industry requires.


ALCoR
FLUX-CORED
ALUMINUM BRAZING ALLOY
2 mm DIA. x 36'
-Solder 50
Al-Braze 1070

BRAZING AND SOLDERING ALUMINUM

Aluminum can be soldered or brazed if the correct procedure is followed. Pre cleaning 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 that some alloys are difficult to join. Dissimilar metal connections may be subject to galvanic corrosion in certain service conditions.

ALCOR®

Aluminum alloy with non-corrosive flux inside the wire, thus no external flux required. Very good fluidity with good capillary attraction. Post-braze cleaning unnecessary. Its low operating temperature often makes it a better choice than aluminum silicon alloys for aluminum coil repair.

AL-SOLDER®

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®

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

ALUMINUM ALLOYS					
PART NUMBER	**DESCRIPTION**	**CHEMICAL COMPOSITION**	**SOLIDUS**	**LIQUIDUS**	**TYPICAL APPLICATION**
Al200RC	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	Al-Solder® 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 with copper-to-aluminum connections.
1070K	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.

SAFETY-SILV® HIGH SILVER BRAZING ALLOYS

SAFETY-SILV® 56				
CHEMICAL COMPOSITION	**SPECIFICATIONS**	**SOLIDUS**	**LIQUIDUS**	**TYPICAL APPLICATION**
56 % Ag 22 % Cu 17 % Zn 5% Sn	AWS A5.8 BAg-7 NSF 51	1145°F 618°C	1205°F 652°C	For ferrous and nonferrous alloys. Often used to braze stainless steel for use with food equipment materials.

SAFETY-SILV® 45				
CHEMICAL COMPOSITION	**SPECIFICATIONS**	**SOLIDUS**	**LIQUIDUS**	**TYPICAL APPLICATION**
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.

SAFETY-SILV® 40				
CHEMICAL COMPOSITION	**SPECIFICATIONS**	**SOLIDUS**	**LIQUIDUS**	**TYPICAL APPLICATION**
40 % Ag 30.5 % Cu 29.5 % Zn	HARRIS INTERNAL	1250°F 677°C	1350°F 732°C	Ductile, free-flowing alloy that offers economy, good penetration into tight connections and medium temperature.

STAY-BRITE® SOLDER				
CHEMICAL COMPOSITION	**SPECIFICATIONS**	**SOLIDUS**	**LIQUIDUS**	**TYPICAL APPLICATION**
4 % Ag 96 % Sn	ASTM B32 Sn96 NSF 51 J-STD-006 Sn96 Ag 04A	430°F 221°C	430°F 221°C	Use with all metals except aluminum. Low temperature solder used in HVAC/R industry.

STERLING®				
CHEMICAL COMPOSITION	**SPECIFICATIONS**	**SOLIDUS**	**LIQUIDUS**	**TYPICAL APPLICATION**
4-5% Cu .04-.2% Se Tin Rem	ASTM B32 NSF61 UPC	410 °F °C	°F °C	Lowest melting temperature: 410° F · Highest tensile strength: 7130 psi · Best flowing lead-free solder available

BRIDGIT®				
CHEMICAL COMPOSITION	**SPECIFICATIONS**	**SOLIDUS**	**LIQUIDUS**	**TYPICAL APPLICATION**
Nickel Bearing	ASTM B32 HB NSF to ANSI NSF61 Conforms to 1986 Safe Drinking Water Act	460°F 238°C	630°F 332°C	Lead-Free solder widely used in plumbing applications. Contains nickel to increase joint strength.

FLUXES

DESCRIPTION	SPECIFICATION	ACTIVE TEMPERATURE	TYPICAL APPLICATION
STAY-SILV® WHITE BRAZING FLUX 7 oz., 1/4 lb., 1/2 lb.,1 lb., 5 lbs., 25 lbs., 60 lbs.	Meets Federal Spec. (OF499,Type B AWS A5.31) Class FB3-A AMS 3410	1050-1600°F (565 - 870° C)	All-purpose low temperature brazing flux used to braze most ferrous and non-ferrous metal, (exceptions are aluminum bronze, titanium, magnesium, and aluminum).
STAY-SILV® BLACK BRAZING FLUX 1 lb., .5 lbs., 5 lbs., 30 lbs., 60 lbs.	Meets Federal Spec. (OF499,Type B AWS A5.31) Class FB3-C AMS 3411	1050 -1700°F (565 - 926°C)	A boron modified formula designed for use where heating cycles are prolonged or where there is concentrated local heat as with induction brazing. Also effective in brazing stainless steel and tungsten carbide.
STAY-CLEAN® LIQUID SOLDERING FLUX 1 gl., 4 oz., 16 oz., 32 oz., 55 gl.	Meets Commercial Spec. A-A-51145 Type II Form B	300 - 700°F (148 - 371°C)	An active flux for soldering copper, brass, steel, nickel, and stainless steel. It can be used effectively with Stay-Brite® and most other solders. Remove flux residue after soldering.
STAY-CLEAN® PASTE SOLDERING FLUX 4 oz.	Meets CommercialSpec. A-A-51145 Type I Form A	300 - 600° (148 - 315°C)	Excellent flux for joining copper-to-copper and copper-to-brass. Not recommended for electrical or electronic applications.
BRIDGIT® HIGH TEMPERATURE PASTE SOLDERING FLUX 4 oz.	NSF/ANSI 61	300 – 700°F (148 - 371°C)	Designed for lead-free solders. Well suited for use in larger connections where prolonged heating will cause other fluxes to burn.
BRIDGIT® WATER SOLUBLE SOLDERING FLUX 4 oz.	ASTM B813 NSF/ANSI 61	350 - 600°F (176 - 316°C)	This flux is formulated so water flushing will remove flux residue from copper tube runs. The flux meets state and local regulations for use in potable water systems.


STAY-SILV
Stay-Silv
STAY-SILV


STAY-SILV


STAY-CLEAN
STAY-CLEAN


STAY-CLEAN
Stay-Clean


BRIDGIT


BRIDGIT

PHOS-COPPER BRAZING ALLOYS

PHOS-COPPER BRAZING ALLOYS

DESCRIPTION	CHEMICAL COMPOSITION	SPECIFICATIONS
STAY-SILV® 15 	15% Ag 5% P 80% Cu	AWS A5.8 BCuP-5
STAY-SILV® 5 	5% Ag 6% P 89% Cu	AWS A5.8 BCuP-3
DYNAFLOW® 	6% Ag 6% P 88% Cu	--------
HARRIS® 0 	7.2% P 92.8% Cu	AWS A5.8 BCuP-5

LEAD-FREE SOLDER

DESCRIPTION	CHEMICAL COMPOSITION	SPECIFICATIONS
STERLING® SOLDER 	4-5% Cu .04-.2% Se Tin Rem	ASTM B32 NSF61 UPC
STAY-BRITE® SOLDER 	4% Ag 96% Sn	ASTM B32 SN96 NSF 51· J-STD-006 SN96AG04A
BRIDGIT® SOLDER 	-------	ASTM B32 Alloy HB NSF 61
95/5 SOLDER 	95% Sn 5% Sb	ASTM B32 · Sb5 J-STD-006 Sn95Sb05A NSF 61

	SOLIDUS	LIQUIDUS	TYPICAL APPLICATION
	1190°F 643°C	**1475°F 802°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.
	1190°F 643°C	**1500°F 816°C**	Well suited where close fit-up cannot necessarily be maintained.
	1190°F 643°C	**1465°F 796°C**	Designed for copper-to-copper applications, it may also be used on brass. Provides the ability to braze poorly fitted as well as tight connections.
	1310°F 710°C	**1460°F 793°C**	Designed for copper-to-copper. Suitable where tight tolerances can be maintained. Harris®0 has a higher solidus temperature so more heat is required, but alloy is fluid at brazing temperature.

	SOLIDUS	LIQUIDUS	TYPICAL APPLICATION
	°F °C	**°F °C**	Lowest melting temperature: 410° F · Highest tensile strength: 7130 psi · Best flowing lead-free solder available
	430°F 221°C	**430°F 221°C**	Use for all metals with the exception of aluminum. Low temperature solder often used in residential HVAC. Flows quickly to penetrate tight clearances. Use Stay-Brite® 8 where wider gaps must be filled.
	460°F 238°C	**630°F 332°C**	Widely used in plumbing applications where lead-bearing solders are prohibited. Contains nickel, making joints tremendously strong. Wide plastic range makes Bridgit® an excellent alloy for large diameter fittings and ill-fitted or non-concentric pipes. Fills gaps and caps off easily and effectively.
	452°F 233°C	**464°F 240°C**	Well-suited for applications where moderately elevated temperature is a factor. Requires close part tolerance due to it's narrow melting range.

FILLER METAL SELECTION CHART

METALS TO BE JOINED	SOLDERS	BRAZING FILLER METALS	SOLIDUS
COPPER OR BRASS TO COPPER OR BRASS	Stay-Brite® Stay-Brite® 8 Bridgit® Sterling® Premium Silver		430°F / 221°C 430°F / 221°C 460°F / 238°C 419°F / 215°C 440°F / 227°C
		Blockade® Harris® 0 Stay-Silv® 5 Dynaflow® Stay-Silv® 6 Stay-Silv® 15	1178°F / 637°C 1310°F / 710°C 1190°F / 643°C 1190°F / 643°C 1190°F / 643°C 1190°F / 643°C
COPPER OR BRASS TO STEEL OR STAINLESS STEEL	Stay-Brite® Stay-Brite® 8		430°F / 221°C 430°F / 221°C
		Safety-Silv® 56 Safety-Silv® 38T Safety-Silv® 45 Safety-Silv® 45T	1145°F / 618°C 1120°F / 660°C 1125°F / 663°C 1195°F / 646°C
STEEL OR STAINLESS STEEL TO STEEL OR STAINLESS STEEL	Stay-Brite® Stay-Brite®		430°F / 221°C 430°F / 221°C
		Safety-Silv® 56 Safety-Silv® 38T Safety-Silv® 40Ni2 Safety-Silv® 45 Safety-Silv® 45T Safety-Silv® 50N	1145°F / 618°C 1220°F / 660°C 1220°F / 660°C 1225°F / 663°C 1195°F / 646°C 1220°F / 660°C
STEEL OR STAINLESS STEEL TO CARBIDES	Not Recommended	Safety-Silv® 40Ni2 Safety-Silv® 50N	1220°F / 660°C 1220°F / 660°C
ALUMINUM-TO-ALUMINUM (1) OR ALUMINUM- TO-COPPER OR BRASS (2) OR ALUMINUM-TO-STEEL OR STAINLESS STEEL (2)	Al-Solder® 500 Aluxcor® 78/22 Alcor®		391°F / 199°C 800°F / 427°C – – – – –
		Aluxcor® 78/22 Aluxcor® 4047	800°F / 427°C 1070°F / 577°C

NOTE: ALUMINUM TO DISSIMILAR METAL JOINTS MAY BE SUBJECT TO GALVANIC CORROSION the alloy flows within the melting range

LIQUIDUS	FLUIDITY RATING*	FLUX	TORCHES & FLAMES
430°F / 221°C 535°F / 279°C 630°F / 332°C 660°F / 348°C 640°F / 338°C	10 8 6 6 6	Stay-Clean® soldering fluxes, liquid or paste. Bridgit® paste flux.	Harris Inferno® Air-fuel equipment
1247°F / 674°C 1475°F / 802°C 1500°F / 816°C 1465°F / 796°C 1425°F / 774°C 1480°F / 804°C	7 5 3 3 5 3	No flux required for copper to copper joints with the phosphorus-bearing filler metals. For brass and other copper alloys, use Stay-Silv® white brazing flux.	Harris Inferno® Air-fuel equipment or Harris oxy-acetylene equipment (Neutral flame)
430°F / 221°C 535°F / 279°C	10 8	Stay-Clean® liquid soldering flux.	Harris Inferno® Air-fuel equipment
1205°F / 652°C 1325°F / 718°C 1370°F / 743°C 1265°F / 685°C	8 7 6.5 7	Stay-Silv® white brazing flux. Stay-Silv® black flux for stainless steel.	Harris Inferno® Air-fuel equipment or Harris oxy-acetylene equipment (Slightly reducing flame)
430°F / 221°C 535°F / 279°C	10 8	Stay-Clean® liquid soldering flux.	Harris Inferno® Air-fuel equipment
1205°F / 652°C 1325°F / 718°C 1435°F / 779°C 1370°F / 743°C 1265°F / 685°C 1305°F / 707°C	8 7 4.5 6.5 7 7	Stay-Silv® white brazing flux. Stay-Silv® black flux for stainless steel.	Harris Inferno® Air-fuel equipment or Harris oxy-acetylene equipment (Slightly reducing flame)
1435°F / 779°C 1305°F / 707°C	4.5 7	Stay-Silv® black flux for stainless steel.	Harris oxy-acetylene equipment (Reducing flame)
482°F / 250°C 900°F / 482°C 824°F / 440°C	---- 7 ----	Stay-Clean® aluminum soldering flux. Alcor & Aluxcor 78/22 is Flux Cored - flux is contained inside wire.	Harris Inferno® Air-fuel equipment
900°F / 482°C 1080°F / 582°C	7 9	Aluxcor® 78/22 & Aluxcor 4047 - Flux cored rod - no additional flux required.	Harris Inferno® Air-fuel equipment or Harris Oxy-acetylene equipment (Reducing flame)

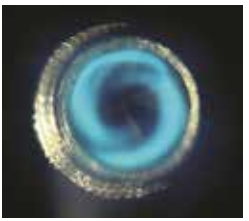
*The higher the fluidity rating the faster

HARRIS INFERNO®

Harris Inferno® air-fuel equipment allows for soldering and brazing of a variety of tube sizes. Equipment attaches to a B (40 cu. ft.) or MC (10 cu. ft.) acetylene cylinder.

The Inferno® tip provides a special swirl combustion approach to increase flame velocity and homogenize the gas mixture.

For air-acetylene, fuel gas delivery pressure should be set at 14-15 PSI. When soldering or brazing different size connections, change tip size rather than reducing flow. The air fuel flame provides a wider heating pattern than oxy-acetylene. This is helpful in soldering or brazing larger tube diameters as heat tends to wrap around the pipe.



SWIRL COMBUSTION TECHNOLOGY

The revolutionary Inferno® tip has a specially designed insert that delivers reliable swirl combustion performance every time. The swirl combustion of the Inferno® tip is unlike anything offered on the market. Contractors get a consistent, hotter flame that will engulf and wrap around the work piece for maximum efficiency.

AIR-FUEL FLAME PATTERN

OXY-FUEL FLAME PATTERN

HSLT604 HD
Part No. 1400356
Trigger Torch Aluminum Cast Body Auto Ignite
Heavy-Duty

HSLT 604
Part No. 1400355
Trigger Torch Aluminum Cast Body Auto Ignite
Medium Duty

HTS99
Part No. 1400359
Swivel Torch, Auto Ignite

HTM 11
Part No. 1400353
Swivel Torch, Manual Ignite

HTM 9
Part No. 1400357
Swivel Torch, Manual Ignite

Model 30
Part No. 1401730
Pencil Flame Torch

HARRIS PORT-A-TORCH®

The Harris Port-A-Torch® contains all the quality equipment needed for cutting, welding and brazing packaged in a rugged, molded plastic carrying case. The outfit is designed to carry one MC acetylene cylinder and one 20 cu. ft. oxygen cylinder. As supplied, the outfit is capable of cutting up to a 1" plate and welding up to a 1/16"plate . The outfit can cut up to a 4" plate and weld up to a 1/2" plate with larger tips and acetylene cylinder.

An oxy-acetylene flame produces the highest flame temperature with a more focused heat zone. Optimum delivery pressure settings for this gas mixture depends on the tip size. Refer to the tip chart for guidance.

23A90 - ACETYLENE WELDING/BRAZING TIPS				
METAL THICKNESS	**SIZE**	**PART NUMBER**	**OXYGEN PSIG**	**ACETYLENE PSIG**
1/64"	0	1600840	1	1
1/32"	1	1600850	1	1
3/64"	2	1600860	2	2
1/16"	3	1600870	3	3
3/32"	4	1600880	4	4
1/8"	5	1600890	5	5
3/16"	6	1600900	6	6
1/4"	7	1600910	7	7
5/16"	8	1600920	8	8
3/8"	9	1600930	9	9
1/2"	10	1600940	10	10

A LINCOLN ELECTRIC COMPANY

The Harris Products Group
4501 Quality Place, Mason, OH 45040-1971
1.800.733.4043
www.harrisproductsgroup.com

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