TORCH BRAZING

with EASY-FLO, BRAZE and SIL-FOS alloys

SIX FUNDAMENTAL STEPS... *for efficient silver brazing.*

1. GOOD FIT AND PROPER CLEARANCE'

Clearances of .001" - .005" (0.25mm - .13mm) are sufficient. Thin films make the highest strength joints and increase corrosion resistance and electrical conductivity. When joining dissimilar metals, allow for differences in thermal expansion. Make sure tubes are cut square and burrs are removed. Keep filings from inside the tube.

2. CLEAN METAL

All surfaces to be joined must be cleaned. Remove all oils, grease and dirt chemically, then oxides mechanically or chemically. Cleaning should be done reasonably close to brazing.

3. FLUXING

Handy Flux is essential to protect metals from oxidation and dissolve and absorb oxides while heating. Flux all surfaces to be joined and the filler metal alloy too. Normally no flux is necessary when joining copper to copper with **Sil-Fos** or **Fos-Flo** alloys. When brazing small diameter copper refrigeration tubing to steel or brass, assemble the components and brush **Handy Flux** only on the outside of the joint area and use one of the phosphorous-free **Easy-Flo** or **Braze** alloys. It is important **not** to get flux inside refrigeration tubing or medical gases piping to prevent contamination.

4. ASSEMBLING AND SUPPORTING

Joints should be assembled when the flux is still wet. Where the parts are not self-supporting, use a simple jig or fixture to prevent sag and movement of the parts during heating.

5. HEATING AND FLOWING THE ALLOY

Use a neutral or slightly reducing flame. Keep the flame in motion while heating the assembly. Apply heat broadly as quickly as possible to bring the assembly up to uniform brazing temperature range. Avoid overheating. When the assembly reaches brazing temperature range, apply the wire or rod to the joint interface. Allow the parent metals to heat and flow the alloy. Do not impinge the torch flame onto the filler wire or rod.

6. FLUX REMOVAL

After brazing, it is essential to remove flux residue. The easiest way is to quench the joint, after the filler metal has solidified, into hot water. A wet cotton swab may also be used. Light wire brushing in hot water may be required to remove more stubborn flux. If the flux is black or green in colour, either not enough flux was used or the assembly was overheated.

ADVANTAGES OF A SILVER BRAZED JOINT

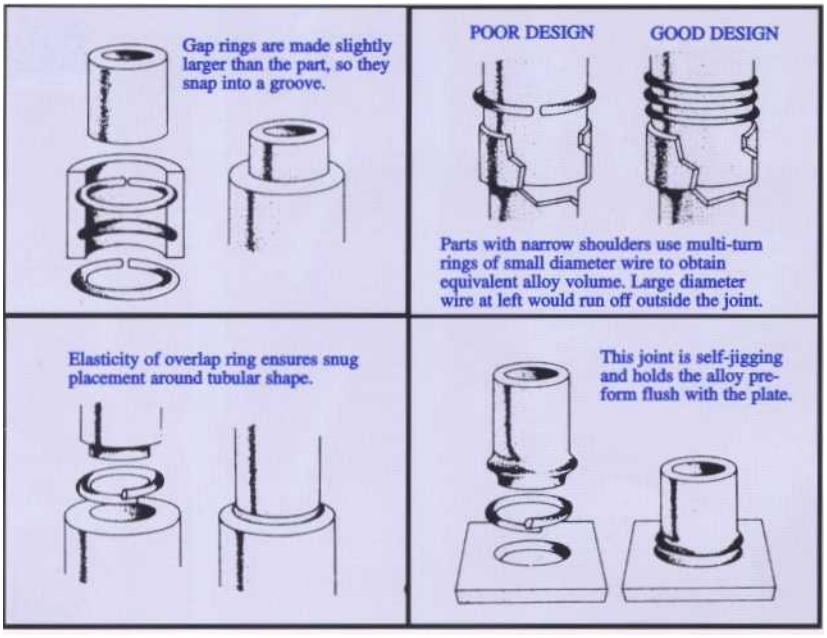
- **LOW COST** With properly designed joints, silver brazing will compare more than favourably with other types of metal joining.
- **VERSATILE** Used on both ferrous and nonferrous metals or combination of these.
- **EASY TO MAKE** Only simple step by step procedures required.
- **LOW TEMPERATURE** Reduces base metals anneal or loss of heat treatment.
- **DUCTILE** Joints will withstand considerable vibration, expansion, contraction or shock.
- **PERMANENT** Joints are metallurgical permanent or can easily be taken apart, if required.
- **NO FINISHING** Silver brazed joints typically require no further grinding, filing or mechanically finishing the joint.
- **ADAPTABLE** Silver brazing is well-adapted to high production methods of heating such as rotary table, conveyor, induction, gas or electric furnace, etc.

Lap length required for optimum joint strength in a silver brazed joint is as follows

Tensile strength of weakest member	Lap length = factor x W (W is the thickness of weakest member)
35,000 psi	2 x W
60,000 psi	3 x W
100,000 psi	5 x W
130,000 psi	6 x W
175,000 psi	8 x W

BRAZING ALLOY PERFORMS

for economy and even distribution of the filler metal



HANDY HINTS

- Highly polished metal surfaces tend to restrict filler metal flow.
- Minimum electrical resistively is obtained by keeping joint tolerances as close as possible.
- The joint area should be self-venting to allow gases and fluxes to escape.
- To maximize corrosion resistance, keep joint tolerances close and filler metal fillets to a minimum.
- To distribute stress in the joint, you may use a heavier fillet to spread joint stress.
- Do not use phosphorous content alloys on hip steam lines nor on joints subject to free sulphur containing atmospheres.
- As a general rule, don't skimp on flux. It's your assurance against oxidation during heating.
- Use **Handy-Flux** as a temperature indicator.
- Use simple and lightweight jigs or fixtures to hold parts for brazing. Use pin-point or knife edge fixture design to reduce contact with the base metal to a minimum.
- Try to use jig or fixture metals that are poor heat conductors, such as stainless steel, innocent or ceramics.
- Sharp corners in joint design impede capillary action.
- Good thermal conducting metals (i.e.. copper) require more heating than poor (i.e.. carbon steel).
- Molten filler metals tend to flow towards areas of higher temperatures.
- Highly oxidizing pickles, such as bright dips containing nitric acid, should be used with caution as they attack the silver filler metal.

Brazing Filler Metals

Filler Metal Name	Typical Applications	* Heating Methods	Solidus (Melt Pt.) °F	Solidus (Melt Pt.) °C	Liquidus (Flow Pt.) °F	Liquidus (Flow Pt.) °C	Max. Recom. Brazing Temp °F	Nominal Composition, % Ag	Cu	Zn	Others
EASY-FLO 45	Joining ferrous, nonferrous and dissimilar metals and alloys with close joint clearances.	TFIR	1125	605	1145	620	1350	45	15	16	24Cd
EASY-FLO 35	Similar to **Easy-Flo 45,** but used where joint clearances are large and fillets are desired.	TFI	1125	605	1295	700	1400	35	26	21	18Cd
EASY-FLO 3	For 300 series stainless steel, for joining tungsten carbide, beryllium copper and aluminum bronze to steel	TI	1170	630	1270	690	1400	50	15.5	15.5	16Cd, 3Ni
BRAZE 560	Low melting filler metal, cadmium-free alloy, free flow. For food handling equipment.	TFIR	1145	620	1205	650	1400	56	22	17	5Sn
BRAZE 505	For tungsten carbides, and 300 series stainless steel food handling equipment allowing no cadmium.	TFI	1220	660	1305	705	1500	50	20	28	2Ni
BRAZE 452	**Braze 452** is a free-flowing, low temperature filler metal commonly used to replace cadmium-bearing filler metals of similar silver content.	TFI	1190	640	1260	680	1500	45	27	25	3Sn
BRAZE 450	Intermediate temperature filler metal for use with ferrous and nonferrous materials.	TFI	1225	665	1370	745	1550	45	30	25	
BRAZE 380	Economical, free-flowing, cadmium-free filler metal used with ferrous and nonferrous base metals. Similar to **Easy-Flo 35.**	TFI	1200	650	1330	720	1500	38	32	28	2Sn
Silver-Copper-Phosphorus Alloys (See note below)											
SIL-FOS	For use where close fit-ups cannot be maintained and joint ductility is important. Recommended joint clearance: .001" to .005". Slow flow.	TFIR	1190	645	1475 (1300)	800 (705)	1500	15	80		5P
SIL-FOS 5	Designed primarily for those applications where close fit-ups cannot be maintained. It has ability to fill gaps and form fillets without adversely affecting joint strength. Recommended joint clearance .003" to .005". Slow flow.	TFIR	1190	645	1495 (1325)	815 (720)	1500	5	89		6P
SIL-FOS 2	A filler metal with comparable characteristics to **Fos-Flo 7.** Medium flow. Recommended joint clearance: .001" - .005".	TFIR	1190	645	1450 (1325)	785 (720)	1500	2	91		7P
Copper-Phosphorus Alloys (See note below)											
FOS-FLO 7	An economical, very fluid medium temperature filler metal for use with copper, brass, and bronze. Withstands moderate vibration. Recommended joint clearance: .001" - .003". Fast flow.	TFIR	1310	710	1460 (1350)	795 (730)	1550		92.75		7.25P

* Recommended heating methods: Furnace , Inert atmosphere (e.g.. H, At, He, N) without flux; I= Induction; R= Resistance; T= Torch and Gas-Air Burner; Vacuum .

Note: The **Sil-Fos** and **Fos-Flo** filler metals are for use with copper and copper alloy base metals. Do not use these materials to join ferrous materials as brittle phosphate compounds will be formed at the interface.

HANDY FLUX: All purpose, low temperature flux for use in brazing both ferrous and nonferrous metals and alloys.

HANDY FLUX TYPE B-1: For brazing high chromium stainless steels, tungsten and chromium carbides, and molybdenum alloys.

HANDY FLUX TYPE A-1: For brazing aluminum bronze and other alloys containing small amounts of aluminum and /or titanium.

HANDY FLUX TYPE LT: For applications with long heating cycles, such as many furnace brazing jobs.

HANDY FLUX as a temperature indicator

Temp.	*Appearance of flux*
212°F (100°C)	Water boils off
600°F (315°C)	Flux become white and slightly puffy, and starts to "work"
800°F (425°C)	Flux lies against surface and has a milky appearance
1100°F (595°C)	Flux is completely clear and active, looks like water. Bright metal surface is visible underneath. At this point, test the temperature by touching brazing filler metal to base metal. If brazing alloy melts, assembly is at proper temperature for brazing.

Safety in Brazing

In brazing, there is always the possibility of dangerous fumes and gases arising from base metal coatings, zinc and cadmium-bearing filler metals, and from fluorides in fluxes. The following well-tested precautions should be followed to guard against any hazard from these fumes.

1. Ventilate confined areas. Use ventilating fans and exhaust hoods to carry all fumes and gases away from work. Use air supplied respirators as required.

2. Clean base metals thoroughly. A surface contaminant of unknown composition on base metals may add to fume hazard and may cause a too-rapid breakdown of flux, leading to overheating and fuming.

3.Use sufficient flux. Flux protects base metals and filler metal during the heating cycle. Full flux coverage reduces fuming.

4. Heat metals broadly. Heat the base metals broadly and uniformly. Intense localized heating uses up flux, increases danger of fuming. Apply heat only to base metals, not to filler metal. (Direct flame on filler metal causes overheating and fuming).

5. Know your base metals. A cadmium coating on a base metal will volatilize and produce toxic fume during heating. Zinc coatings (galvanized) will also fume when heated. Learn to recognize these coatings. It is recommended that they be removed before parts are heated for brazing.

6. Know your filler metals. Be especially careful not to overheat assembly when using filler metals that contain cadmium. Consult the Material Safety Data Sheet for maximum recommended brazing temperature of a specific filler metal. The filler metal carries a warning label. Be sure to look for it and follow the instructions carefully.