SIX FUNDAMENTAL STEPS... for efficient silver brazing.

1. GOOD FIT AND PROPER CLEARANCE
Clearances of .001” to .005” (0.25mm to .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.

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 resistivity 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**

<table>
<thead>
<tr>
<th>Filler Metal Name</th>
<th>Typical Applications</th>
<th><em>Recom. Heating Methods</em></th>
<th>Solidus (Melt Pt.)</th>
<th>Liquidus (Flow Pt.)</th>
<th>Max. Recom. Brazing Temp. ℉</th>
<th>Nominal Composition, %</th>
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</thead>
<tbody>
<tr>
<td><strong>EASY-FLO 45</strong></td>
<td>Joining ferrous, nonferrous and dissimilar metals and alloys with close joint clearances.</td>
<td>TFIR</td>
<td>1125 605</td>
<td>1145 620</td>
<td>1350</td>
<td>45 15 16 24Cd</td>
</tr>
<tr>
<td><strong>EASY-FLO 35</strong></td>
<td>Similar to Easy-Flo 45, but used where joint clearances are large and fillets are desired.</td>
<td>TF</td>
<td>1125 605</td>
<td>1295 700</td>
<td>1400</td>
<td>35 26 21 18Cd</td>
</tr>
<tr>
<td><strong>EASY-FLO 3</strong></td>
<td>For 300 series stainless steel, for joining tungsten carbide, beryllium copper and aluminum bronze to steel.</td>
<td>TI</td>
<td>1170 630</td>
<td>1270 690</td>
<td>1400</td>
<td>50 15.5 15.5 16Cd, 3Ni</td>
</tr>
<tr>
<td><strong>BRAZE 500</strong></td>
<td>Low melting filler metal, cadmium-free alloy, free flow. For food handling equipment.</td>
<td>TFIR</td>
<td>1145 620</td>
<td>1205 650</td>
<td>1400</td>
<td>56 22 17 5Sn</td>
</tr>
<tr>
<td><strong>BRAZE 505</strong></td>
<td>For tungsten carbides, and 300 series stainless steel food handling equipment allowing no cadmium.</td>
<td>TF</td>
<td>1220 660</td>
<td>1305 705</td>
<td>1500</td>
<td>50 20 28 2Ni</td>
</tr>
<tr>
<td><strong>BRAZE 452</strong></td>
<td><strong>Braze 452</strong> is a free-flowing, low temperature filler metal commonly used to replace cadmium-bearing filler metals of similar silver content.</td>
<td>TF</td>
<td>1190 640</td>
<td>1260 680</td>
<td>1500</td>
<td>45 27 25 3Sn</td>
</tr>
<tr>
<td><strong>BRAZE 450</strong></td>
<td>Intermediate temperature filler metal for use with ferrous and nonferrous materials.</td>
<td>TF</td>
<td>1225 665</td>
<td>1370 745</td>
<td>1550</td>
<td>45 30 25 2Sn</td>
</tr>
<tr>
<td><strong>BRAZE 390</strong></td>
<td>Economical, free-flowing, cadmium-free filler metal used with ferrous and nonferrous base metals. Similar to Easy-Flo 35.</td>
<td>TF</td>
<td>1200 650</td>
<td>1330 720</td>
<td>1500</td>
<td>38 32 28 2Sn</td>
</tr>
</tbody>
</table>

**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 the ability to fill gaps and form fillets without adversely affecting joint strength. Recommended joint clearance: .005" to .007". Slow flow. | TF | 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" to .003". Fast flow. | TF | 1190 645 | 1450 (1325) | 785 (720) | 1500 | 2 91 7P |

**FOS-FLO 7**

| **FOS-FLO 7**     | A economical, very fluid medium temperature filler metal for use with copper, brass, and bronze. Withstands moderate vibration. Recommended joint clearance: .001" to .003". Fast flow. | TF | 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.

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

<table>
<thead>
<tr>
<th>Temp. (°F)</th>
<th>Appearance of flux</th>
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<tbody>
<tr>
<td>212°F (100°C)</td>
<td>Water boils off</td>
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<tr>
<td>600°F (315°C)</td>
<td>Flux become white and slightly puffy, and starts to “work”</td>
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<tr>
<td>800°F (425°C)</td>
<td>Flux lies against surface and has a milky appearance</td>
</tr>
<tr>
<td>1100°F (595°C)</td>
<td>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.</td>
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**Safety in Brazing**

- **Apply heat only to base metal, not to filler metal. (Direct flame on filler metal causes overheating and fuming.)**
- **Know your base metals.** A cadmium coating on a base metal will volatilize and produce toxic fumes 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.
- **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.
- **Ventilate confined areas.** Use ventilating fans and exhaust hoods to carry all fumes and gases away from work. Use air supplied respirators as required.
- **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.
- **Use sufficient flux.** Flux protects base metals and filler metal during the heating cycle. Full flux cover reduces fuming.
- **Heat metals broadly.** Heat the base metals broadly and uniformly. Intense localized heating uses up flux, increases danger of fuming.