Brazing with silver-containing filler metals
Brazing with a silver-containing filler metal is one of the most versatile methods of metal joining used, for a number of reasons:

- It is cost-effective and very little braze alloy is required to produce a brazed joint. With properly designed joints, brazing will compare favourably to any other metal joining method;
- The joints produced are strong. Strength data are typically close to, and on occasions exceed the typical strength of the base materials brazed;
- Joints produced are ductile, able to withstand considerable shock and vibration;
- The joints are generally produced easily and quickly;
- Brazing is excellent for dissimilar joining. You can easily join metals with widely different melting points;
- It can join metals with different cross sections. For example, joining 0.1 mm. thick copper foil to a 2.5 mm. thick steel plate is relatively easy to braze. It is almost impossible to weld;
- Joints have excellent stress distribution and heat transfer. The braze fillet formed is ideally shaped to resist fatigue;
- The process is highly suitable for automation. Typical automation methods include torch, furnace, induction and resistance heating;
- After brazing there is seldom any need for grinding, filling or mechanical finishing after the joint is completed. This is cost-reducing and particularly beneficial for assemblies to be plated;
- The joints virtually make themselves by capillary action, complex geometries are as easy to join as simple ones;
- Brazing is done at relatively low temperature ranges, excellent for heat input sensitive materials and workpieces subject to hot cracking.

The process
Silver brazing uses a silver-containing alloy with a melting temperature above 450ºC but below the melting point of the metals to be joined. In brazing, the base metals are heated, usually to a point slightly above the liquidus (flow point) of the filler metal, causing it to melt. The filler metal then flows into the parallel joint clearance between the two base materials by capillary attraction and bonds to their surfaces through atomic attraction and diffusion. Unlike other methods of metal joining, in brazing we are interested in the alloy flowing between closely fitted members. For successful brazing you need to understand the fundamentals of brazing. When the following brazing fundamentals are understood, problem solving becomes a simple matter:

- **Good fit and proper clearance**
- **Clean base metals**
- **Proper fixturing**
- **Proper fluxing/atmosphere**
- **Heating the assembly**
- **Cleaning the brazed assembly**

Good fit and proper clearance
Any braze alloy relies on capillary action to distribute the brazing filler metal throughout the joint interface. Capillary action is the force that pulls a liquid through two parallel surfaces. In brazing, the clearance at which capillary action is most effective is in the 0.03 to 0.10 mm. range. Joint clearance also has a profound impact on joint strength. Upon brazing stainless steel the strongest joint (930 MPa) is achieved with a joint clearance of 0.038 mm. In every day practice any slip fit will give you a perfectly adequate brazed joint between two tubular parts. If you are joining two flat parts, you can simply rest one on top of the other. The clearance provided by the average "mill finish" is usually adequate to create capillary paths for the flow of molten filler metal.

Cleaning the metals
Capillary action will work properly only when the surfaces of the metals are clean. Contaminants, such as oil, grease, rust, scale or dirt, must be removed. If they remain, they will form a barrier between the base metal surfaces and the brazing materials. Start by getting rid of oil and grease, usually done by dipping the part into a degreasing solvent, or by vapour degreasing, alkaline or aqueous cleaning. If the metal surfaces are coated with oxide or scale, remove these chemically or mechanically. For chemical removal, used an acid pickle treatment. Mechanical removal calls for abrasive cleaning. Particularly in repair brazing, where parts can be very dirty or rusted, you can speed the cleaning process by using emery cloth, a grinding wheel, a file or metallic shot blast.
Once the parts are thoroughly clean, it is recommended to flux and braze as soon as possible. This way, there is the least chance for recontamination of surfaces.

Fluxing the parts
Flux is a chemical compound applied to the joint surfaces before brazing. Its use is essential for brazing as the coating of flux on the joint area will shield the surfaces from the air, preventing oxide formation. The flux will also dissolve and absorb any oxides that form during heating or those not completely removed during the cleaning process. HILCO brazing fluxes conventionally come in powder form, which is made into a paste by stirring in water. Flux the assembly just before brazing, if possible.
Fluxing is usually an essential step in the brazing operation. There are a couple of exceptions to this rule. You can join copper to copper without flux by using a brazing filler metal specially formulated for the job, such as silver-copper-phosphorus alloys (L-Ag2P, L-Ag5P, L-Ag15P). The P content in these alloys acts as a fluxing agent on copper.

Proper fixturing
If the shape and weight of the part permit, the simplest way to hold them together is by gravity. If you have a number of assemblies to braze it may be a good idea to use a brazing support fixture. If you need to fixture close to the joint use a non-wetting material for the fixture, such as titanium.

Heating the assembly
This step brazes the joint. It involves heating the joint to brazing temperature and flowing the filler metal through the joint. Both metals in the assembly should be heated as uniformly as possible to reach brazing temperature at the same time. Therefore, when joining a thick section to a thin section, more heat should be applied to the thick section. Or, when joining a good conductor of heat to a poor conductor, such as copper to stainless steel, more heat will have to be applied to the good conductor (copper). The flux is used as an indicator for even heating.
In manual brazing, when the assembly reaches brazing temperature, hold the brazing rod carefully against the joint area. Do not heat the brazing rod directly. The heated assembly will melt off a portion of the brazing rod, which will instantly be drawn by capillary action throughout the entire joint area. We recommend that you heat the side of the assembly opposite the point where you are going to feed the filler metal.
If using preforms (slugs, washers, shims or special shapes of filler metal) preplace them in the joint before applying heat to the assembly.

Cleaning the brazed assembly
Post cleaning of brazed assemblies is done primarily to remove flux residue. Flux removal is a simple, but essential, operation to prevent flux residue attacking the base metal, thereby possibly weakening the joint. Most fluxes are soluble in water. The easiest way to remove them is to submerse the assembly in hot water.