GOULD ALLOYS
THE LEADING EDGE IN METALS

Copper and Copper alloys are amongst the most versatile materials available and are used for applications in every type of industry. World consumption of Copper now exceeds 18 million tonnes per annum.
Copper is well known for it's conductivity but it has other properties that have been exploited in a wide range of Copper alloys. These alloys have been developed for a wide variety of applications and numerous fabrication processes employed to produce finished goods.
Fabrication techniques that copper alloys are largely suited to include machining, forming, stamping, joining, polishing and plating.
The exceptional machinability of some Copper alloys means that free machining brass sets the standard of machinability by which all other metals are judged.

DUCTILITY AND MALLEABILITY

The ductility and malleability of Copper and Copper alloys makes them ideally suited to fabrication methods that involve severe deformation such as:

~ Tube forming
~ Wire drawing
~ Spinning
~ Roll forming
~ Deep drawing

These fabrication methods require specialised, heavy equipment and skilled operators. If fabrication by one of these methods is required, more information should be sought independently.

JOINING

Copper and Copper alloys are more readily joined than most other materials used in engineering.
Although 90% of Copper based components are assembled using conventional welding and brazing techniques, they can be successfully joined using every known joining process.
When welding, soldering or brazing Copper the joint must be clean and free of dirt, grease or paint.
Soldering
Soldering can be divided into two methods:
~ Soft soldering using alloys that melt below 350°C
# Hard soldering using stronger, high melting point alloys

In regard to soldering Copper alloys, hard soldering is often referred to as Silver soldering.
Soft soldering normally uses Tin-based solders for joining Copper and Brass when high mechanical strength is not required. The method is commonly used for joining Copper in domestic electrical and plumbing applications.

Brazing
With the exception of alloys containing more than around 10 per cent Aluminium or 3 per cent Lead, brazing can be used to join all Copper alloys.
Brazing is particularly popular for joining Copper components used in building, heating, ventilation, air-conditioning and the manufacturing of electronic products.

Welding
Copper alloys are readily welded using all common welding techniques including:
~ Arc welding
~ Gas-shielded arc welding
~ Tungsten inert gas (TIG) welding
~ Metal inert gas (MIG) welding
~ Plasma arc welding
~ Pulsed-current MIG welding
~ Electron Beam welding
~ Laser welding
~ Friction welding
~ Ultrasonic welding

Bolting and Riveting
Copper and all Copper alloys can be successfully bolted or riveted. However consideration must be given to the material used in the bolts or rivets. As Copper is often chosen for its corrosion resistance, the material used in the bolts and rivets should be made from the same or similar material to that being joined.
For roofing applications, Copper nails are preferred but brass or Stainless Steel can be substituted.
Mechanical joining like bolting and riveting may induce

[1 OF 4] CONTINUED ➲

localised areas of high stress, which could induce failure in the component. Replacing the mechanical joint with adhesive bonding can eliminate this. Adhesive bonding can also be used in conjunction with mechanical bonding.

Adhesive Bonding
With consideration given to joint design so there is an adequate overlap on the joint area, Copper and Copper alloys can be successfully joined using adhesive bonding.
As Copper and Copper alloys form a protective surface oxide layer, the surfaces must be cleaned before the adhesive is applied.

RECYCLING

Copper alloys are highly suited to recycling. Around 40% of the annual consumption of Copper alloys comes from recycled Copper materials. Both process scrap and the component, at the end of its working life, can be readily recycled.
The recycling rate for Free Machining Brass (CZ121/CW614N) is particularly high with clean/dry swarf having a high value, which contributes to the cost-benefit calculations in material selection.

CUTTING

Most Copper alloys are relatively soft and can be readily cut using common hand tools and standard cutting methods.
While the relative softness of Copper makes it easy to cut, it is important to protect the component from unwanted damage during cutting. This damage may include, but not be limited to, bending, denting or scratching.

Tube Cutting
When cutting Copper pipe, a fine toothed hacksaw may be used quite successfully. To ensure the cut is square to the pipe, a tube cutter should be used.
When a pipe cutter is used, it is recommended to grip the Copper tubing with a pipe vice or a similar holding device.
To hold material for cutting with a hacksaw use a mitre box or a jig consisting of a piece of wood containing a notch to hold the tube or pipe in place.
After cutting any burrs need to be removed from the inside and outside of the tube. For this, use a half round file.
NB: For some applications, including medical and refrigeration, is it critical to preserve the internal cleanliness of the tune when cutting or bending.

Cutting Copper Sheet and Plate
The method employed for cutting Copper sheet or plate largely depends on two factors; the thickness of the material and the amount of cutting required.
For thin gauge material where only a minimal amount of cutting is to be done, tin snips or hand shears may be adequate. Thicker material can be cut using a bandsaw or other mechanical saw fitted with a bimetallic blade suited to the cutting of Copper alloys.
For large cutting runs or for thick material it may be necessary to utilise one of the common industrial cutting methods like:
~ Shearing
~ Electrical discharge machining (EDM)
~ Laser cutting
~ Water jet cutting
~ Plasma cutting
~ Slitting
~ Guillotining
~ Abrasive disc cutting

[2 OF 4] CONTINUED

GOULD ALLOYS
THE LEADING EDGE IN METALS

FINISHING

Copper components can be finished in a vast variety of ways. The finish used for any given Copper component is dependent upon function and/or aesthetics. Copper naturally forms a protective oxide layer on exposure to the elements. This layer is normally blue – green and may or may not be desirable.
The blue – green patina develops over time but its development can be enhanced and accelerated by the use of commercially available oxidising agents.
If the tarnished patina of Copper is not desirable, the material can be protected using a lacquer coating. An acrylic coating with benzotriazole as an additive will last several years under most outdoor, abrasion-free conditions.

Painting

In most instances Copper and Copper alloys do not require painting. The inherent properties of Copper resist corrosion and biofouling. Painting of Copper is occasionally done for aesthetic reasons. It is also done to reduce the incidence of metal to metal contact of bimetallic couples where galvanic corrosion might be a problem.
Before painting Copper, the surface of the material should be roughened by grit or sand blasting. Other specific procedures will depend upon the type of paint being used. Please consult the paint manufacturer for details.

Cleaning and Polishing Copper

The cleanliness of Copper and Copper alloys is best achieved by regular maintenance.
Where possible, decorative items should be kept clean and free of dust. Many decorative Copper items are coated with lacquer to protect the finish. Other than dusting, for these items occasional washing with lukewarm, soapy water may be required. They should never be polished as this may remove the protective lacquer.
To remove tarnish from Copper cookware, simply rub with lemon halves dipped in salt.
Tarnish can be removed from Copper in industrial applications using commercial Copper polishes. These polishes should be applied following the manufacturer's instructions.
To apply a brushed finish Stainless Steel brushes must be used.

Descaling

The surface oxide films that form on Copper alloys can prove to be quite tenacious. Often these films need to be removed before some fabrication processes can be performed.
Very fine abrasive belts or discs can be used to remove oxides and discolouration adjacent to welds.
Pickling might be necessary by using a hot 5-10% sulphuric acid solution containing 0.35g/l potassium dichromate. Before commencing pickling, oxides can be broken up by a grit blast. Components that have been pickled should be rinsed thoroughly in hot, fresh water and finally dried in hot air.

CASTING

Copper and many Copper alloys are ideally suited to fabrication of components by casting.
The most flexible casting technique utilises sand moulds. Sand moulds can be used for production runs from simple one-off items to long casting runs. These items can also range in size from a few grams to many tonnes.
The other popular casting technique uses iron moulds and is called die casting. Die casting is suited to long casting runs.
Both die casting and sand casting can be used for the low cost production of complex near net-shape components. This minimises expensive post casting machining.
Bars, sections and hollows that require tight dimensional control are often produced by continuous casting.
Rings, discs and other symmetrical shapes tend to be produced using centrifugal casting.

HANDLING AND STORAGE

The procedures for the handling and storage of Copper and Copper alloys are very similar to those used for Aluminium and Stainless Steel. It should be noted that the products are heavy, but relatively soft and can thus be easily damaged through poor or inappropriate handling.
The most important factor is cleanliness. Contaminated Copper can be the cause of cracking or porosity during heat treatment or welding. Corrosion resistance can also be adversely affected. Tooling and work surfaces should be dedicated to use with Copper materials or thoroughly cleaned before use. If this rule is not adhered to, cross contamination can occur.
Copper sheets should remain in their packaging until required and should be kept separated by protective material to avoid abrasion between the sheets.
Equally, the products must be protected from water, dampness and condensation.
Where practical, plates and sheets should be stored vertically in covered racks.
Copper and copper alloy products should never be walked upon.

GOULD ALLOYS
THE LEADING EDGE IN METALS

MACHINABILITY

All Coppers and Copper alloys can be machined accurately, cheaply, with a good tolerance standard and good surface finish. Some Copper alloys are specifically formulated to have excellent machinability.
If machinability is the paramount consideration for the material, the material of choice is high speed machining brass.
The relative machinability of metals is demonstrated by a percentage rating. This rating system is based on the original free machining brass (CZ121 / CW614N) which has a rating of 100.

BENDING

Tube Bending
Most Copper tube can be readily bent and two main methods are employed. The first uses bending springs and the second, a pipe bending machine.
The simplest tool for bending pipe is the bending spring. Bending springs are normally used for thinner walls where the pipe can be bent by hand. Two types of spring are used: internal and external. Both types of spring serve the same function; to prevent the wall of the pipe from collapsing during bending.
External springs are used for smaller diameter copper piping (6 to 10mm external diameter). As the name suggests, the spring is fitted over the tube during the bending operation. Internal springs are placed inside the pipe during bending.
Each pipe size requires its own specific size of spring.
All bending machines are different but the principal is the same.
The bending machine is fitted with a bending roller and a former matched to the size of the pipe. The pipe is secured at one end and the lever handle of the machine moved to bend the pipe around the former.
NB: For some applications, including medical and refrigeration, is it critical to preserve the internal cleanliness of the tune when cutting or bending.

Bar and Flat Bar Bending
Copper and Copper alloy bar can be bent using standard bending methods.
As a general rule, the minimum bending radius for copper bar is equal to the thickness of the bar.

CONTACT

Address:	Gould Alloys Ltd Markham Lane Markham Vale Chesterfield S44 5HS United Kingdom
Tel:	+44 (0) 1246 263300
Email:	sales@gouldalloys.co.uk
Web:	www.gouldalloys.co.uk

REVISION HISTORY

Datasheet Updated	13 November 2018

DISCLAIMER