



# CORED SOLDER WIRES FOR ALUMINIUM

## ALU-SOL®

- Easier and more reliable soldering of aluminium and aluminium alloys
- Greatly improved resistance to electrolytic corrosion (Tin/Zinc solder is poor in comparison)
- Excellent flow on aluminium, most aluminium alloys and other metals. Good penetration
- Contains 4 cores of unique flux. No separate flux required
- Compatible with standard solders
- Solders virtually all other metals including stainless steel
- Range of alloys possible with various melting temperatures
- Flux permits direct flame heating at soldering point. Gas heated iron also suitable. Thinner gauge sheet and wires solderable directly with electric soldering iron, hot plate, oven, induction, infra-red and resistance heating

vary somewhat in price, the more expensive alloys being of lower melting temperature and therefore easier to work. Alu-Sol 45D has been chosen as a general purpose aluminium solder offering the best balance between price and ease of working, but enquiries are invited for other alloys in the corrosion-resistant range, which can be made to suit users' requirements if sufficient quantity is ordered. For the soldering side contact joints on lamp bulbs that will be used in dry warm sockets, electrolytic corrosion is not so much of a problem and so for this specific application Multicore Solders are able to offer more economical alloys Alu-Sol 4D and Alu-Sol 31D.

### APPLICATION

Soft-soldering offers the possibility of joining aluminium or its alloys with less distortion (due to thermal expansion or local stress relief) than may occur with hard soldering or welding since the temperatures required are not so high. For the same reason, strength changes in the aluminium joint members may also be less than with hard soldering or welding. Hitherto, the problems of soldering aluminium and its alloys; (slow wetting, poor fluidity of the solder, and low corrosion resistance of the joint) have limited the applications of aluminium soldering to a few special cases involving pure aluminium. The tin-zinc solder commonly used, because of its zinc content formed a strong oxide skin when melted and this skin, together with that on the aluminium itself, required the use of very corrosive fluxes to allow the solder to flow.

The Research Laboratories of Multicore Solders Limited therefore turned their attention to removing these limitations. The result is Alu-Sol 45DH, a unique combination of a highly-developed flux permitting wetting of many of the more difficult aluminium alloys, with a solder having better penetration and greatly improved resistance to electrolytic corrosion. Alu-Sol 45D is only one of a complete patented range of tin/lead/silver alloys of a special grade. The alloys

### SOLDERABILITY OF VARIOUS METALS AND ALLOYS USING ALU-SOL "D" FLUX

Wrought aluminium alloys:	
"Pure" aluminium (up to 1% impurities) Aluminium-manganese	Excellent
Aluminium + up to 3% magnesium Aluminium + up to 1.5% each magnesium and silicon Aluminium copper	Good
Aluminium + over 3% magnesium	Poor

Cast aluminium alloys:	
"Pure" aluminium (up to 0.5% impurities)Aluminium-copper	Good if rough cast surface is first machined off
Aluminium-silicon	Unsolderable

Other aluminium finishes:	
Anodised surfaces	Not solderable without first removing the anodising**
Aluminium-silicon coatings	Unsolderable

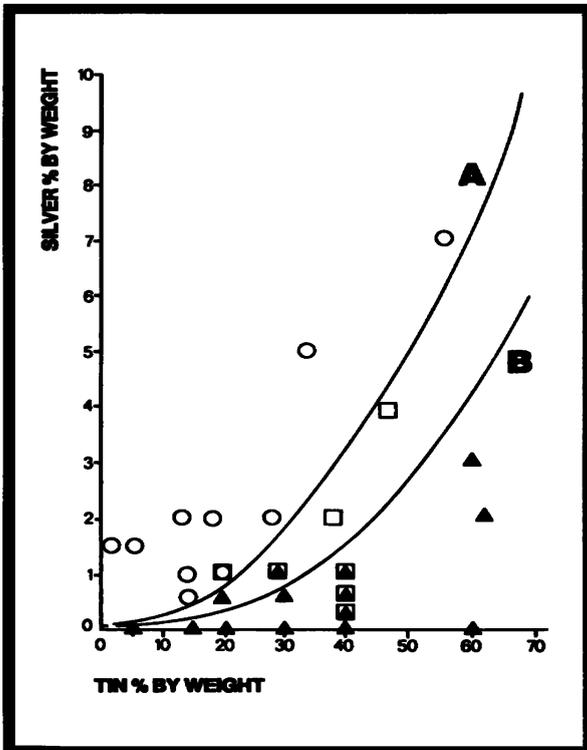
\*\* Anodising cannot be applied over solder.

Other metals and alloys:	
Tin plate, Copper, Brass Nickel and nickel silver	Excellent
Steel, stainless steel and zinc alloy die-castings	Good
Chromium, Titanium	Unsolderable

## CORROSION RESISTANCE

Most joints in aluminium will last for a considerable time if kept dry, whether made with tin/zinc or tin/lead solders. In the presence of moisture, however, particularly if the moisture contains dissolved salts, such joints may fail in a few days. This is due to electrolytic corrosion, which attacks the metal at the aluminium-solder interface, causing complete loss of adhesion. A widely-used accelerated corrosion test is therefore to leave the joint immersed in 3% sodium chloride solution and noting the number of days to failure. At the Multicore Research Laboratories, the sodium chloride solution is replaced by the synthetic sea water specified in BS 2011: Part 2K: 1963.

The results show that, for joints of copper or aluminium to pure aluminium, failure occurs within a few days (rarely more than 21 days) if tin/zinc or tin/lead solders are used; but that, with tin/lead/silver solders of certain compositions, such as Alu-Sol 45D, joints subjected to this accelerated corrosion test have still not failed after 400 days and might therefore be expected to last indefinitely in many environments.



- Less than 25 days endurance (short life)
- Between 25 and 50 days (Intermediate or uncertain life)
- - Over 200 days (long life)

Curves A and B, above, indicate the apparent division between safe and unsafe compositions.

Research has shown that when joints are subjected to accelerated testing as described, tin/lead/silver solders in combination with special Alu-Sol Flux D give long life provided that the silver/tin ratio is above Curve A in the graph above. For an added safety margin, the ratio should be well above Curve A, hence the choice of composition for Alu-Sol 45D.

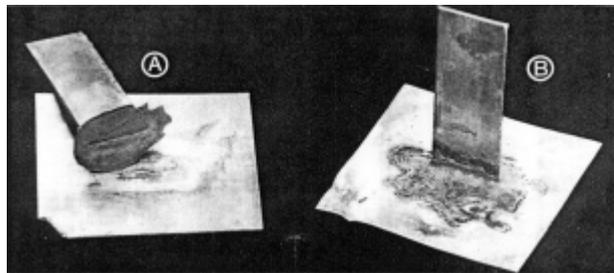
The presence of certain impurities such as bismuth, cadmium or zinc in the solder greatly reduces this expectation, and when making the solder, it is therefore necessary to use special grades of tin, lead

and silver from which such impurities are absent, in order to get the best possible life.

Joints on aluminium alloys of good solderability with Alu-Sol 45D generally withstand over 70 days immersion in sea water and over 400 days if carefully made; but if the alloy is of poor solderability, the corrosion resistance of the joint is reduced. It should be remembered that the contact of solder with aluminium/copper alloys in the presence of moisture can cause blackening and corrosion of the aluminium alloy independently of any corrosion of the joint. The endurance in sea water of a joint in aluminium may be a little less if the second joint member is nickel or steel than if it is copper, brass or aluminium. The test results summarised above were reached by an accelerated testing procedure and can only be taken as an approximate guide to possible behaviour in practice. The user should always test any design under conditions closely related to the expected conditions of service.

## Electrolytic Corrosion Test Results

These aluminium joints were subjected to an accelerated test by immersion in synthetic salt water to BS 2011:Part 2K:1963.



Joint made with conventional 80/20 tin-zinc solder failed after 4 days due to electrolytic corrosion

Joint made with Alu-Sol 45D had survived over 400 days when test terminated

## Joint Design

Correct joint design is very important. Many of the advantages of soldering may be lost if the joint design is inadequate.

The area of mating surfaces must be sufficient to provide adequate strength, to give an efficient seal and to provide electrical or thermal conductivity as required. Solders have low tensile and peel strength and joints should be designed so that the solder is subjected only to shear stresses. Joint clearances should be 0.05 - 0.10 mm for best strength and capillary effect.

As aluminium expands with heat more than most metals (including those commonly used for jigs) it is most important that some arrangement of springs, weights or levers is devised for holding joint members while soldering, in such a way that the parts are free to expand and contract. The holding devices should not be removed until the joint is completely cold. The joint should not be artificially cooled in case the cooling is non-uniform, setting up stresses that might tear the joint

## SOLDERING TECHNIQUE

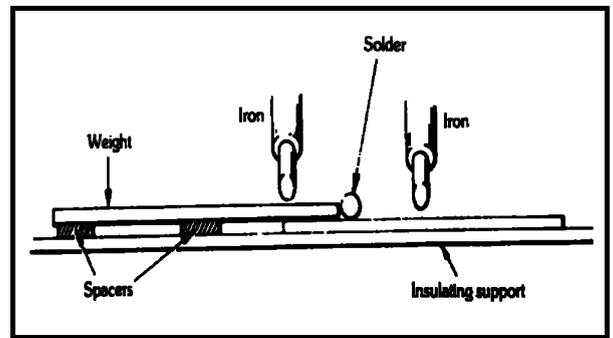
The only treatment necessary for surfaces of wrought aluminium before soldering is to wipe off dirt and grease. Cast surfaces should be machined before soldering. The flux residue is not in itself very corrosive, but it does absorb moisture from the atmosphere and should therefore be washed off with water, in which it is readily and completely soluble. From the earlier explanation of electrolytic corrosion it will be realised that for maximum protection the joint should be carefully made with neat fillets showing a low contact angle.

## HEATING

The thermal conductivities of aluminium and its alloys are only about half that of copper, and in some types of joint it is therefore necessary to ensure that the joint surroundings as well as the joint itself are well heated, to reduce mechanical distortion introduced by the higher thermal expansion of aluminium. Although the thermal capacity of aluminium is about 2½ times that of an equal weight of copper, it is only three-quarters that of an equal volume of copper, owing to the difference in density. Combined with the lower thermal conductivity of aluminium this means that a volume of aluminium should heat more quickly than an equal volume of copper. The opposite impression may be gained because aluminium articles are often made of relatively thick material, and also because the oxide skin on aluminium may have an insulating effect, preventing the absorption of heat.

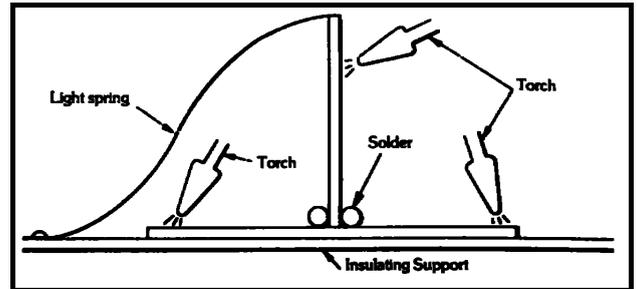
Any of the usual forms of heating may be used, but they should be of sufficient temperature and heat capacity to raise the work to 350°C as quickly as possible. For many jobs a gas-heated iron will be found preferable to an electrically-heated one as it can supply heat more rapidly. Direct flame heating of the work gives excellent results, though with acetylene or hydrogen flames great care must be taken not to overheat the work. Propane and butane are extremely suitable gases. In theory butane has slightly greater heat capacity but it cannot be used in cold weather when the bottle is near or below freezing point, whereas propane bottles can be used down to about -35°C. There is little difference in price between the two gases, but there is a wider choice of burners and ancillary equipment for propane torches, and as propane can be used at higher pressures it is in practice a more versatile and more powerful torch fuel.

For the small workshop, where the hire charge for the steel propane cylinders would be too high, butane is the best gas. Cheap and very effective butane torches are available in most hardware shops, and the butane can be bought in disposable tin-plate cartridges, unlike propane, it does not have to be packed in expensive returnable steel cylinders.



**Soldering Iron**

Simple set-up for soldering a lamp joint with an iron or torch. The iron (or torch) is moved from one side of the joint to the other to heat both pieces of metal.



**Gas Torch Soldering**

Typical set-up for soldering a tee joint. The torch is shown in the three positions it will be held to promote even heating.

## TECHNICAL DATA

Alloy 45	
Melting range	178-270°C
Density	10.1g cm <sup>-3</sup>
Composition	18% tin, 1.9% silver, 80.1% lead
Electrical conductivity	8.7% copper
Tensile strength of bulk alloy	3.8 kg mm <sup>-2</sup>

## Cored Solder 45D

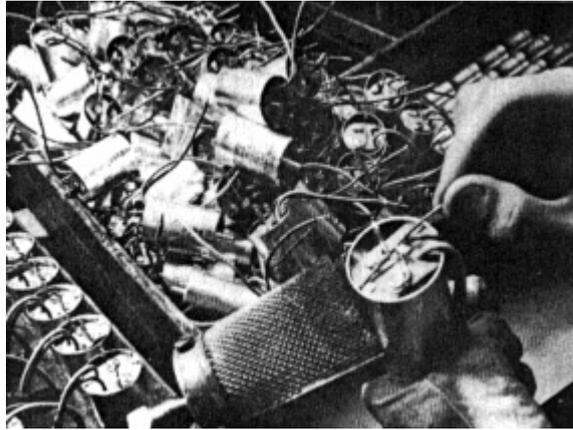
Core construction	4 - Core
Flux content	Approx. 2.3% by weight
Diameter, mm	3.2 2.0 1.8 1.6 1.2 1.0
M/kg	14.1 36.1 44.6 56.4 100 144
F/lb	20.9 53.6 66.1 83.7 149 214

**Note:** The fumes produced by any soldering fluxes, particularly during soldering, can cause discomfort if inhaled; moreover, there is always a slight possibility that some operators may be found to be exceptionally sensitive to particular substances. None of our fluxes is likely to be harmful if the inhalation is only occasional and brief, but it is wise to prevent frequent or prolonged inhalation, even at low concentrations, by providing fume extraction or adequate ventilation at the soldering position. Splashes of Alu-Sol D flux should be washed off with water; the hands should be washed after use and before eating. Alu-Sol solders and fluxes should not be permitted to touch foodstuffs, nor be used in any application where infants could place the soldered objects in their mouths.

The recommendations given in this publication are based on tests carried out in our own laboratories. Owing to the fact that conditions of application are beyond our control the information here given is meant to act solely as a guide. The use of the material is entirely the responsibility of the user, who is advised to undertake their own research to determine the suitability for any specific application. The materials will be replaced without charge if found defective in manufacture. Subject to this, all warranties or conditions, statutory or otherwise, and responsibility for any loss or damage however caused, are excluded.

We particularly emphasise that the improved corrosion resistance of Alu-Sol 45D is due to a combined reaction of the solder and flux in this product. The use of another separate flux is likely to inhibit this corrosion resistance.

The best technique is to heat the area adjacent to the joint and apply Alu-Sol direct to the joint so that it is melted by the surface rather than the heat source itself. When using a soldering iron it is best to use a copper tip for optimum heat transfer because Alu-Sol flux carbonises on iron plated solder tips.



**ALU-SOL 45D being used to join a tinned Copper Foil Tab to the aluminium can of a suppression filter in the Great Yarmouth Factory of ITT Components Group Europe. The speed and reliability achieved by using a gas torch and ALU-SOL is essential for this highly competitive market.**



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**MULTICORE SOLDERS**

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