

MAXITRAK & STEAM TECHNOLOGY

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**Welded boiler information  
& test procedure**

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### **A look at new methods and materials in boiler construction.**

Over the last 100 years of model boiler making the only real change in construction methods has been the change over from rivets and caulking to silver solder for boiler plate joining.

We have been pioneering the next change, to fully welded boilers where all the boiler plates are joined with the parent material. This is common in steel boilers but is relatively rare in copper. Boilers using this type of construction have now been sold by us for a number of years, with the boilers themselves giving every satisfaction. These notes are intended to give some guidance to boiler testers encountering these boilers for the first time, with some pointers on what to look out for.

#### **Welded copper boilers.**

The most important item to consider in the construction of these boilers is the specification of the copper. It must be all C106, other grades will be likely to give localized cracking near the welded joint. Only C106 will avoid this. For this reason it is not practical to do welded boiler repairs on an existing boiler, or to construct a boiler from a kit of parts of unknown origin.

The correct filler wire and gas is also vital, for this reason we would not recommend this as a home construction method. Like larger steel boilers there needs to be full specification on the boiler materials and a coded welder to do the job. The CE certificate of conformity on professional boilers will assure you these aspects are correct.

Construction methods are the same as a welded steel boiler, there is no flanging on boiler plates. A small gap is left between plates to allow full weld penetration with extra weld added to build up a good fillet, taking the place of the flange. This extra weld is visible all round the boiler except in the firebox where the weld is inside the water jacket.

We do not use ordinary commercial rivets for boiler stays as they are of unknown material, the stays are made from solid rod with the heads built up with weld. We usually change girder stays to rod stays on the firebox top as the weld does not penetrate between the plates like silver solder. Rod stays are usually considered to be the more modern method aiding water circulation over the firebox. All copper to copper joints are welded avoiding problems with differential expansion or electrolytic action between the boiler plates and stays. In order to get a good weld the boiler tubes are a little thicker than normal with a minimum of 18 swg wall thickness. The weld on each end also forms an extra thickness to prevent wear from hot gasses and ash.

The bushes are not copper so need to be silver soldered in after welding, we also usually run silver solder round the fire door ring to keep it looking tidy. This is actually welded on the inside so the solder is cosmetic, a weld here would be difficult to clean up for a good fit on the firebox door.

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Like all welded boilers it is not possible to check plate thicknesses other than by using a thickness tester or drilling and measuring in traditional full size manner. A look at the drawings will tell you what should be there. Some older designs call for thinner firebox plates than the rest of the boiler shell, *we always use the same thickness throughout the boiler*. Any changes to published designs need to be recorded in the manufacturer's boiler paperwork. The certificate of conformity is the start of your paper trail for all information on a particular boiler, drawings, material spec, calculations, coding etc.

We like to weld in the longitudinal stays from front to back of the boiler, however the thick wall tube for the blower pipe is of indeterminate parentage so this needs to be silver soldered in or screwed both ends in traditional manner. My favorite is to have all solid stays and run a blower pipe down the outside the boiler and into the smoke box.

### **Welded steel boilers**

Welded steel boilers have been around in model engineering for many years, the construction methods are well known. The new development here is in the materials now available, as used in modern high pressure water tube boilers etc. We can take advantage of the new spec tube P265-GH has a high carbon content, this has far superior corrosion resistance compared to the older boiler plate. Our suppliers are amazed that model boiler makers still order the old type as the new tube has about three times the life expectancy. This tube is not available in the smaller sizes so boiler tubes are usually copper expanded in for ease of replacement.

### **Fabrication**

For the fabrication and welding of all boilers "Steam Technology" complies with the following classification and welding standards.

**EN 13445 (BS 5500)**

**EN 12952 (BS 1113)**

**EN 12953 (BS 2790)**

**EN 13480 (806)**

**Welding Procedures Qualification BS EN 288 and ASME IX**

**Welding Qualification (Code) BS EN 287 and ASME IX.**

\*\*To obtain the above qualification the welding procedures have to be witnessed and approved by a Independent body, we use ZURICH insurance.

\*\* Welders qualifications also have to be witnessed, tested and approve by an independent body, ZURICH again. To get a welders qualification the welds have to be tested in the following ways:

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### **X ray Test.**

### **Vickers or Rockwell Hardness Test**

**DPI** (Deep Paint Inspection. use in non magnetic materials to found undercuts, cracks, porosity and overlaps.)

**NDT** (Non destructive testing)

### **Molecular macro structure examination.**

To obtain the pressure vessels Directive 97/23 EC we have to pass the tests listed above and also give details of the design process, welding preparation, manufacturing and testing procedures including a witnessed pressure test.

CSWIP welding stamp.



### **Boiler Testing Notes**

Boiler testers do not need to know the ins and outs of making a welded boiler, this is covered by the manufacturers. The CE mark and supporting paperwork give you the quality assurance for these boilers. Boiler testers should accept commercial certificates on new boilers, (6.1 in the blue book). Testers can do their own test as well if desired as a double check, but should not refuse a tested and CE marked boiler on account of not knowing how to make one themselves.

Boiler inspectors do not need an ultrasonic or thickness tester when testing copper boilers, welded or soldered.

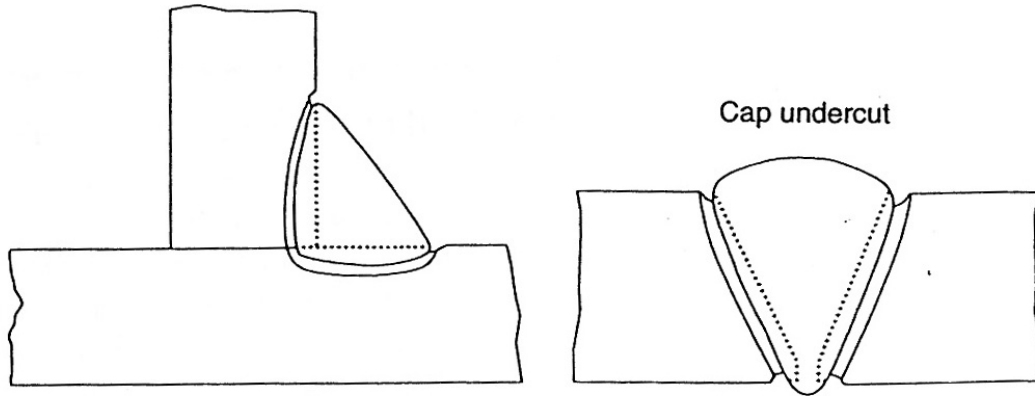
The initial boiler test certificate assures us that:

- Any changes to the published design have been recorded
- The welder is properly certified for the materials involved
- All welding preparations have been done in accordance with the applicable British Standard

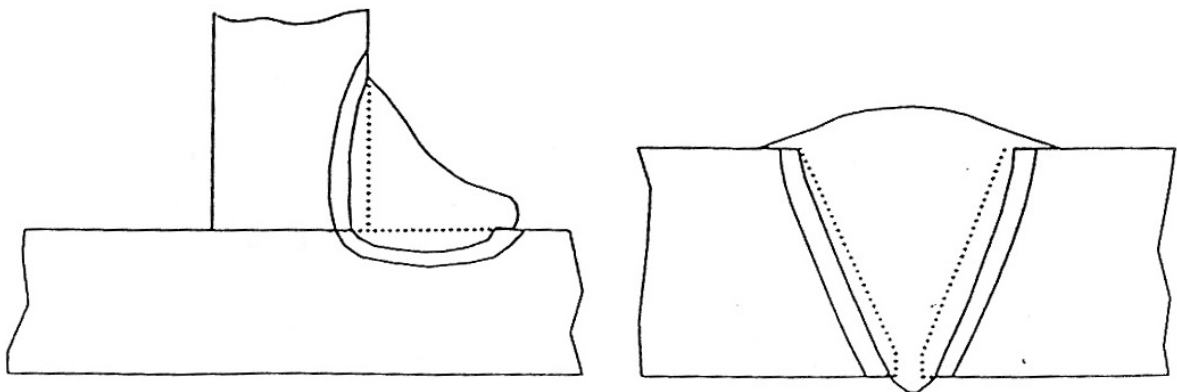
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**This guide to what to look out for when inspecting welded boilers in copper or steel.**  
*(A boiler produced by a coded welder should not have these problems.)*

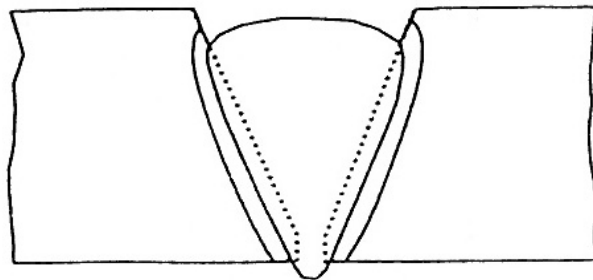
**Undercut** (an irregular groove at the toe of a run in the parent material)



**Overlap** (at the toe of the weld an imperfection caused by metal flowing on to the surface of the parent material without fusing)

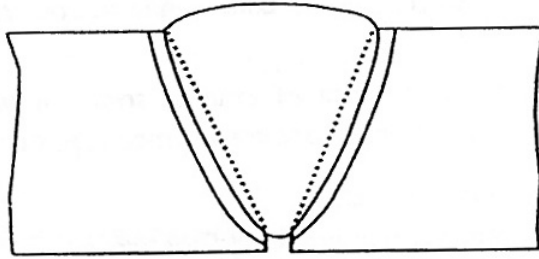


**Under fill** (Channel in the surface of the weld running along it's length due to insufficient weld metal)

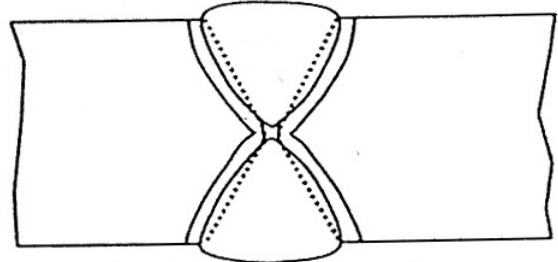


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**Incomplete Join penetration** (failure of metal to extend into the root of a joint)

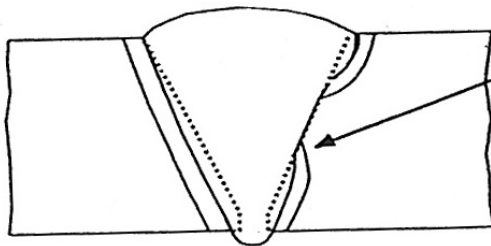


Lack of root penetration



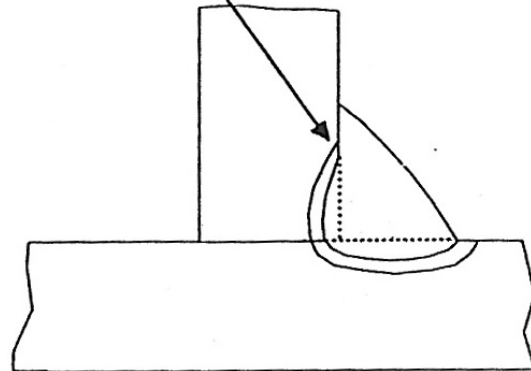
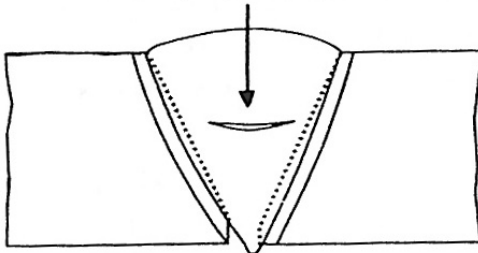
Lack of inter-penetration

**Lack of fusion** (lack of union in the weld)



Lack of sidewall fusion

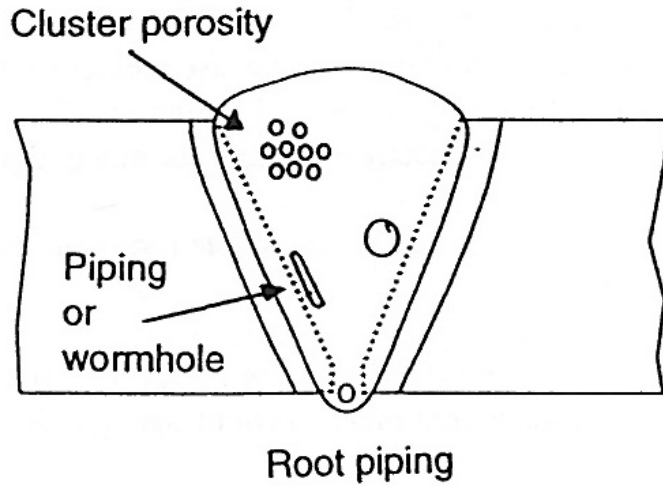
Lack of inter-run fusion



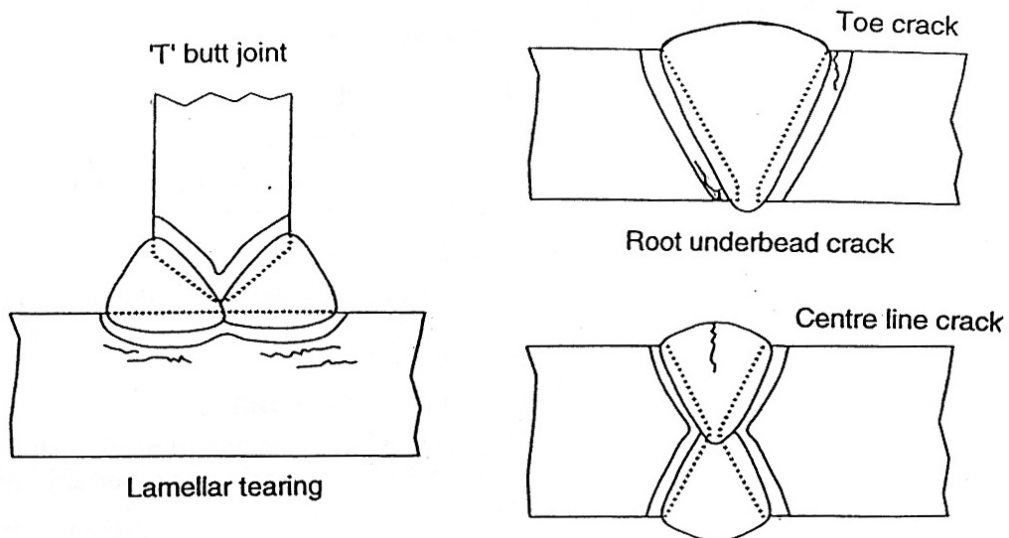
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**Porosity** (gas pore or hole formed by entrapped gas during the solidification of molten metal)

**Worm Hole** (Piping, elongated tubular cavity)



**Cracking** (liner discontinuity produced by fracture)



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- All these defects can be inspected with a simple visual test, on either copper or carbon steel boilers.
- All other aspects of boiler testing are the same as silver soldering, leaks or boiler plate movement are tested in the same manner.
- As it is not easily possible for a Club boiler tester to verify the welding preparation of the joints (undercuts, overlaps, etc) we have to assume that the coding of the welder has complied with the appropriate standards – by him signing for it we have to assume that the standards have been met
- visual inspection of the welded joints – general lack of smooth ‘puddles’ of molten filler would make me suspicious – this should never be a problem with an experienced welder of the parent metal and is only a visual indication.
- As far as deterioration in service is concerned, we can ignore corrosion of the copper (so thickness measurements are not required), however local cracking should be recognised, it should be negligible and should not propagate beyond the heat affected zone (due to the ductility of copper). Any leaks will be seen on a hydraulic test. This should be looked for on any repeat hydraulic test that there is no sign of weepage near any of the welded joints.
- Boiler Inspectors checks on silver soldered joints (fitting of bronze bushes, etc) are no different to checking a silver soldered boiler.
- As with a silver soldered boiler any “unexpected event”, ie boiler running dry or accident damage should involve a hydraulic retest before further use.

If you or your boiler tester have any questions about the welding, testing, usage or care of your boiler please contact us on 0044 (0)1580 893030, fax 0044(0)1580 891505