
British Standard Specification for
**Flash welding of steel tubes for
pressure applications**

Soudage par étincelage des tubes en acier pour utilisations sous pression

Abbrennstumpfschweißen von druckbeanspruchten Stahlrohren

Foreword

This revision of BS 4204 has been carried out under the direction of the Welding Standards Policy Committee. It deals with the production of welds made by the flash welding process and is one of a series of British Standards concerned with the welding of pipework. It relates to the welding of steel pipes, tubes, and pipe fittings for pressure applications. For the automatic flash welding of ferrous metal sections other than these, reference should be made to BS 6944.

This British Standard follows the general pattern set by others in the series and is of the 'process' type. It embodies the currently accepted practice of initial procedure approval tests followed by periodical production control tests.

The standard also details the various parameters specific to the flash welding process which are required to be determined in establishing the procedure. In appendix B, a list is given of the typical information to appear on a welding procedure sheet together with a typical test record sheet.

As the acceptance level of certain aspects, e.g. the contour and form of the weld profile, is related to the service conditions of the joint, reference should be made, for these details, to the appropriate application standard, where such a standard exists. Where such guidance is not given, these aspects should be a matter of agreement between the manufacturer and the purchaser.

For the purposes of this standard, no difference is intended in the meaning 'pipe' and 'tube', though idiomatic use prefers sometimes the one and sometimes the other.

It has been assumed in the drafting of this British Standard that the execution of its provisions is entrusted to appropriately qualified and experienced people.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

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Specification

1 Scope

This British Standard specifies requirements for the automatic flash welding of steel tubes, pipes or pipe fittings for pressure applications.

In addition to the definitive requirements, it also requires the items detailed in clause 3 to be documented. For compliance with this standard, both the definitive requirements and the documented items have to be satisfied.

NOTE 1. The phrase 'pressure applications' in this context applies to designs incorporating pressure and/or temperature requirements.

NOTE 2. For sections other than those covered by this standard, see BS 6944.

NOTE 3. The titles of the publications referred to in this standard are listed on page 17.

2 Definitions

For the purposes of this British Standard, the following definitions apply. For other relevant terms the definitions are as given in BS 499 : Part 1.

2.1 Formier gas. A gas mixture nominally of composition 90 % nitrogen and 10 % hydrogen.

2.2 manufacturer. The user of the welding equipment for the purposes of manufacturing welded tube products.

2.3 automatic flash welding machine. A flash welding machine that has an automatic sequence of events.

2.4 inspecting authority. The competent independent body or association that, where required, verifies compliance with this standard.

2.5 upset current time. The time after the commencement of upsetting during which the current flows.

2.6 preheating (flash welding). The resistance heating of workpieces to facilitate the onset of flashing by a series of current pulses with a cool time in between each pulse. The pulsing is achieved by moving the work pieces together and apart (see appendix C).

3 Items for agreement between the manufacturer and the purchaser

The following items to be agreed between the contracting parties, which are specified in the clauses referred to, shall be fully documented. Both the definitive requirements specified throughout the standard and the following documented items shall be satisfied before a claim of compliance with this standard can be made and verified:

- (a) the specification of the parent metal to be used (see clause 4);
- (b) whether a backing gas is to be used and the type of gas (see clause 8);
- (c) details of the post-weld heat treatment (see clause 11 and 12.4);

(d) the type and extent of procedure approval tests and the necessary details, including acceptance criteria (see 12.1);

(e) frequency of production control tests (see 13.1);

(f) whether production test specimens are to be retained for examination by the purchaser or his representative (see 13.2);

(g) the procedure to be followed for batch inspection in the event of failure of repeat production test pieces (see 13.3);

(h) the service conditions of the weld and the number and title of the particular application standard for determining the acceptability of the weld profile (see clause 14);

(i) the extent of dressing of the production welds (see clause 16);

(j) if non-destructive testing of production welds is required (see clause 17).

4 Parent metal

The materials to be flash welded in accordance with the requirements of this standard shall comply with the requirements of BS 3059, BS 3601, BS 3602, BS 3603, BS 3604, BS 3605 and BS 3606. The use of equivalent alternative steels to those complying with the requirements of the above standards is permitted. It shall be determined by the procedure approval tests (see clause 12) that the steel, or combination of steels, dimensions and wall thickness can be satisfactorily flash welded.

5 Sizes of tube

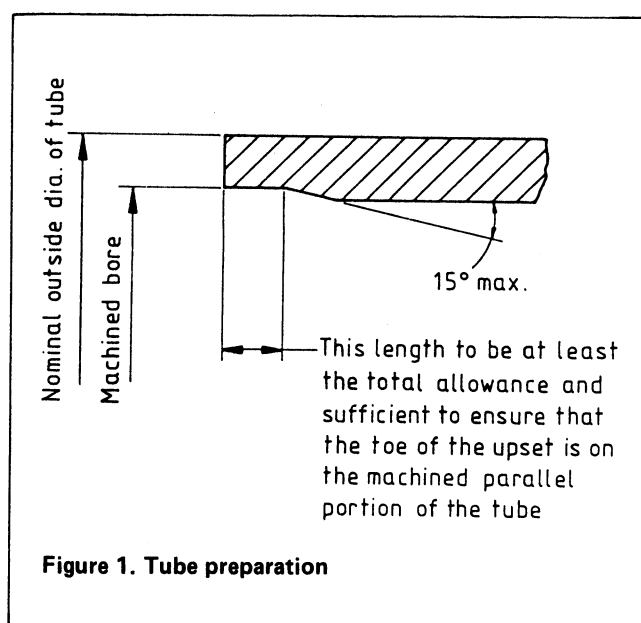
The diameter, thickness and length of tube which can be flash welded depends on the capacity of the machine to be used, and it shall be determined by the procedure approval tests that the tubes come within this machine capacity (see clause 12).

6 Tube preparation

The procedure for tube preparation shall be established during the procedure approval tests. The end of each tube to be welded shall be so cut that the end edge or surface lies in a plane at right angles to the axis of the tube.

NOTE. It is desirable that the face areas to be in contact when welding should be approximately equal, the external diameters of the tubes being nominally equal.

Where machining of each tube is necessary, boring shall be concentric with the outside circumference of the tube, and the machining shall run out smoothly into the bore (see figure 1). Machining shall not reduce the tube wall thickness below the specified design thickness.



7 Cleanliness

Areas of electrical contact on tube and machine shall be cleaned prior to welding.

NOTE 1. The purpose of cleaning the contact area on the tube before welding is to ensure a uniform current in the welding circuit.

Loose matter and free moisture in the bore of the tube shall be removed.

NOTE 2. Cleaning by hand externally with emery cloth is generally sufficient, although mechanical cleaning (linishing, shot blasting) may be necessary for heavily scaled tubes. Internal cleaning may be necessary for scaled tubes as established at the procedure approval test stage (see clause 12).

8 Backing gas

Where backing gases are used, the type of gas and the pressure at which it is to function depends on the type of material and dimensions of the tube to be welded. Nitrogen, Formier or an inert gas shall be used unless otherwise agreed between the purchaser and the manufacturer.

The pressure shall be set at such a value that a positive pressure is maintained during the welding cycle. The pressure to be used shall be determined during the procedure approval tests. An effective purging period prior to the start of welding shall be used to ensure that the tubes are completely filled with the backing gas, and that the gas is present at the weld interface on commencement of welding. Where welds are made to bifurcations, backing gas shall be applied to the ends of the bifurcation to eliminate air entrainment.

9 Welding equipment

All welding shall be done on an automatic flash welding machine.

NOTE. Guidance on the choice of equipment is given in appendix A.

Where flash welding guards are used, they shall be placed at such a distance from the clamped components as to minimize the possibility of particles, thrown off during the flashing period, ricocheting into the weld.

10 Welding sequence

10.1 Overhang

The tubes shall be so clamped that the temperature gradients at the interface are balanced.

10.2 Clamping force

The clamping force exerted on the tubes shall be sufficient to prevent the tubes sliding in the clamps during the welding cycle. This force shall not deform the tubes.

10.3 Alignment

The outside diameter of the tubes to be welded shall be in alignment when clamped in the machine.

10.4 Initial tube end squaring

Where a flashing operation is used for initial tube end squaring, the heat generated shall not cause the tube to collapse during pre-heating.

10.5 Preheating

Preheating is normally accomplished and resistance heating obtained by bringing the tubes into contact and separating them while the current is switched on. This operation shall continue until the temperature of the end of the tubes reaches a value where flashing can commence.

10.6 Flashing

The speed of advance of the moving platen and the value of the welding current shall be regulated to ensure that the flashing is continuous throughout the sequence.

10.7 Upsetting

The upset or forging force required to weld different steels depends on the temperature gradient in the plastic zone and the compressive strength of the steel at high temperature. The upset shall be sufficient to ensure that all voids are closed and oxide and molten metal are removed from the weld. It shall not be such as to cause distortion of the work or excessive protrusion. The current shall be maintained from flashing until after upset has commenced.

11 Post-weld heat treatment

The post-weld heat treatment of flash welds shall be done in accordance with BS 2633 or BS 4677 for the steels specified in these standards unless an appropriate application standard specifies different requirements or an alternative treatment has been agreed between the manufacturer and the purchaser. For other steels post-weld heat treatment shall be by agreement between the manufacturer and the purchaser.

The proposed heat treatment shall be stated in the welding procedure.

If post-weld heat treatment is carried out for a limited time in the flash welding machine by means of further resistance heating, the procedure shall be the subject of agreement between the purchaser and the manufacturer.

12 Procedure approval tests

12.1 General

A procedure shall be established for each machine, size of tube and material or combination of steels to be used. The record of the procedure shall be based on the appropriate items from the information given in appendix B.

NOTE. It is recommended that the procedure approval tests carried out in accordance with this British Standard and approved by a purchaser or his representative should be accepted by other purchasers, or their representatives, provided that all the requirements of this standard have been fulfilled.

12.2 Number of tests

When the manufacturer is satisfied that appropriate machine settings have been obtained, a minimum of three test welds (see 12.5) shall be produced using actual materials to be used in production.

Where shaped components are to be used in production, e.g. return bends or spirally finned tubes, these shall be used for the tests.

12.3 Changes affecting approval

A procedure shall remain approved indefinitely unless there are consistent failures attributable to the procedure in production tests (see clause 13) or there is a change in any of the following:

- (a) the nominal tube diameter;
- (b) the nominal tube thickness;
- (c) the tube material specification;

NOTE. It is recommended that materials used in successful procedure tests should not only give approval for the relevant material specification but also to equivalent material specifications.

- (d) the joint preparation, including the cleaning method;
- (e) the machine components, such that any of the machine characteristics are altered;
- (f) welding parameters outside the changes allowed by 13.4.

NOTE. If necessary, the machine settings may be altered to maintain the welding parameters.

12.4 Heat treatment

If a specific heat treatment and finished condition is required for production welds, it shall be carried out on the test welds except in the case of macro-examination (see 12.8) where additional samples shall be taken in the as-welded condition.

If heat treatment is not required for production welds, no heat treatment shall be carried out on the bend test specimens except in those cases where the bend test specimen does not follow the profile of the former, in which case test specimens shall be given an approved heat treatment (see clause 11) to reduce the hardness and thus permit a uniform bend in the weld area.

12.5 Test specimens

One test weld shall be completely segmented round the circumference to give:

- (a) one tensile test specimen in accordance with the dimensions given in 12.9;
- (b) one specimen for macro-examination and hardness tests;
- (c) an even number of bend test specimens in accordance with the dimensions given in 12.6.

The remaining two test welds shall be completely sectioned round the circumference to give a number of bend test specimens in accordance with the dimensions in 12.6. Where the diameter of the tube is less than or equal to 35 mm, a whole tube shall be used for the tensile test. In this case a total of four test welds shall be produced, one for tensile testing, and three for bend testing and a macro-examination sample.

12.6 Dimensions of bend test specimens

Each bend test specimen shall consist of a strip cut radially from the welded tube (see figure 2) so that the test weld is disposed approximately at the centre. The minimum width of each specimen shall be as follows:

- (a) for tubes of outside diameter less than 60 mm:

$$t + \frac{D}{10}$$

- (b) for tubes of outside diameter equal to or greater than 60 mm:

$$t + \frac{D}{20}$$

where, for (a) and (b),

t is the thickness of the tube. In tubes of dissimilar bore, t is the thickness of the thinner tube.

D is the outside diameter of the tube.

When the width:thickness ratio of the bend test specimens is less than 2:1 the manufacturer shall be permitted the option of taking parallel sided bend test specimens rather than radially cut, trapezium shaped bend test specimens. If this is done, the weld shall be completely segmented around its circumference to give an even number of test specimens. The wedge shaped sections from between adjacent test specimens shall be discarded. The test weld