

Specification for

Approval testing of welding procedures —

**Part 3: Arc welding of tube to tube-plate
joints in metallic materials**

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- Aluminium Federation
- Associated Offices Technical Committee
- Association of Consulting Scientists
- British Constructional Steelwork Association
- British Gas Corporation
- British Railways Board
- Electricity Supply Industry in England and Wales
- Engineering Equipment and Materials Users' Association
- Heating and Ventilating Contractors' Association
- Ministry of Defence
- National Coal Board
- Power Generation Association (BEAMA Ltd.)
- Process Plant Association
- Society of Motor Manufacturers and Traders Limited
- Stainless Steel Fabricators' Association of Great Britain
- United Kingdom Atomic Energy Authority
- Water-tube Boilermakers' Association
- Welding Institute
- Welding Manufacturers' Association (BEAMA Ltd.)
- Coopted member

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Foreword

This Part of BS 4870 has been prepared under the direction of the Welding Standards Committee to cover the particular requirements for the approval testing of welding procedures for tube to tube-plate joints. While there is no limitation on the metallic materials to be used, extra considerations not covered in this standard may need to be taken into account for some materials.

This Part of BS 4870 is one of a series of standards on the approval testing of welders and welding procedures, the latter having a bearing on the former for certain applications. This link has been used as a means of arranging the Parts of the standards for tube to tube-plate joints into:

- a) approval testing of welding procedures;
- b) welder approval when approval of the welding procedure is required (see BS 4871-3).

It should be appreciated that the non-destructive testing acceptance levels given in this standard are for the purposes of approval testing of welding procedures and as such are not necessarily the same as those which might be specified for work on which approved welding procedures will be employed.

Depending upon the emphasis placed on quality control in the production of welded components, the approval of welding procedures covered in this series of standards may be administered in one of several ways which should be stipulated at the enquiry and/or order stage. The alternatives currently employed are the following:

- 1) each individual contractor (or sub-contractor) may have proved, by actual test pieces, every weld form he wishes to use, in every thickness and material; or
- 2) each individual contractor (or sub-contractor) may have proved, by actual test pieces, a set of welds representative on a group basis of all the various thicknesses and materials to be used in production; or
- 3) each individual contractor (or sub-contractor) need not make procedure test pieces provided he can prove by appropriate authentic documentation of an independent nature that he has previously satisfactorily welded the type of joint and material in question.

In respect of 1) and 2) it should be appreciated that once the welding procedure tests have been approved, they need never be repeated unless there is a change in certain variables. As an extension beyond 3), it may be possible by agreement between the contracting parties for fully documented welding procedures, developed independently of the particular contractor, to be employed without the need for further approval tests.

The need for a welding procedure to be approved in accordance with this standard should be specified in the application standard or be agreed between the contracting parties. Although a welding procedure may already have been approved, each manufacturer should accept responsibility for the procedure used on a contract and for the ability of the welders to apply the procedure.

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.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

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

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 12, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This Part of BS 4870 specifies requirements for the approval testing of welding procedures for the arc welding of tube to tube-plate joints in metallic materials by manual, semi-automatic, automatic or mechanized processes.

The welder who successfully completes a welding procedure test in accordance with this Part of BS 4870 is approved to the extent given in clauses 5 and 6 of BS 4871-3:1985 without further testing.

NOTE 1 This Part of BS 4870 does not cover welding processes such as explosive welding, laser welding or electron-beam welding. The parameters to be recorded and the acceptance levels for such processes would, therefore, have to be agreed between the contracting parties, but this Part of BS 4870 may be used as the framework for such agreement.

NOTE 2 The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this Part of BS 4870, the following definitions apply.

2.1

welding procedure

a specific course of action followed in welding, including a list of materials and, where necessary, tools to be used¹⁾

2.2

welding procedure test

the making and testing of a welded joint, representative of that to be used in production, in order to prove the feasibility of a welding procedure

NOTE This term is not usually applied to any tests that may have been made during the development of a welding procedure.

2.3

approved welding procedure

a documented welding procedure that has been approved by an inspecting authority either by means of a welding procedure test or as a result of authentic documented experience gained with the welding of joints similar to that to which the welding procedure applies

2.4

test piece

components welded together in accordance with a specified welding procedure

2.5

test specimen

a portion detached from a test piece and prepared as required for testing

2.6

inspecting authority

that competent independent body or association which verifies compliance with this standard

3 Items in a welding procedure test

3.1 General

The items listed in 3.2 and the items in 3.3 relevant to the particular welding process shall be recorded for each welding procedure test.

NOTE Not all of these items need be included in the approved welding procedure documentation.

3.2 Items for all welding processes

Details relating to the following items shall be recorded for all welding processes:

- a) welding process, or processes when more than one is used in making a complete joint;
- b) tube-plate specification and thickness and details of any cladding and its thickness;
- c) tube specification, thickness and outside diameter;
- d) pitch type (square or triangular) and ligament dimension;
- e) joint geometry and fit-up tolerances (sketch);
- f) cleaning and degreasing;
- g) jiggling or tacking, roller expansion and backing;
- h) tube-plate position (including welding direction for vertical tube-plates);
- i) make, trade name, type and specification of welding consumables;
- j) filler material composition, specification and size (diameter);
- k) pre-heating and interpass temperature, including method of control;
- l) travel speed (mechanized or automatic welding);
- m) approximate number and arrangement of runs and weld dimensions (sketch);
- n) welding sequence;
- o) post-weld heat treatment, including method and control;
- p) when applied, the temperature and time adopted for drying/baking of welding consumables before use;
- q) any special features, including heat input control requirements, any heat sinks or post-weld tube expansion.

¹⁾ This definition is taken from BS 499-1.

3.3 Items for particular welding processes

Details relating to the items given in 3.3 a) to 3.3 d) shall be recorded for these particular processes, in addition to the items in 3.2.

a) *Manual metal-arc welding*

- 1) a.c. or d.c. and polarity;
- 2) current.

b) *MIG and MAG welding, solid wire or cored wire, with or without separate gas shield*

- 1) shielding gas and flow rate;
- 2) nozzle diameter;
- 3) arc voltage;
- 4) wire feed speed or current;
- 5) for pulsed welding, the pulse time and interval, pulse current and background current.

c) *TIG welding*

- 1) tungsten electrode diameter, type and tip included angle;
- 2) shielding gas and flow rate;
- 3) nozzle diameter;
- 4) a.c. or d.c. and polarity;
- 5) current;
- 6) for pulsed welding the pulse time and interval, pulse current and background current;
- 7) whether filler metal is used;
- 8) length of filler metal used per run when dilution is an important factor.

d) *Mechanized or automatic welding*

- 1) all the items in b) or c) above;
- 2) arc length or arc voltage;
- 3) where filler metal is used its rate of addition or wire feed speed;
- 4) other pre-programmed welding variables such as:
 - i) pre- and post-gas purge times;
 - ii) changes in current level;
 - iii) current slope up and down rates;
- 5) welding travel speed and degree of overlap;
- 6) when considering front face welding, the following additional information:
 - i) radius of electrode rotation;
 - ii) electrode angle relative to the tube axis;

7) when considering back face bore welding, the following additional information:

- i) if a flux is used at the back of the joint its type or specification and amount;
- ii) if a shielding gas is used at the back of the joint its composition and flow rate;
- iii) electrode axial position.

Where machine settings are quoted, these shall be backed up with documented calibration that enables the true value of the parameter to be assessed, e.g. wire feed setting shall be related to actual wire feed speed.

4 Changes affecting approval

4.1 For manual or semi-automatic welding, a welding procedure test shall be carried out when any of the following changes are made to an approved welding procedure:

- a) any change in welding process;
- b) any change in parent metal, tube pitch, tube or tube-plate thickness, cladding thickness or tube outside diameter, subject to the extent of approval given in clause 5;
- c) any change in joint geometry that would affect the welding procedure;
- d) any change in type²⁾ or specification of the consumable electrode, filler metal, wire, flux or shielding gas;
- e) any change in type of welding current, e.g. from d.c. to a.c. or change in polarity;
- f) any change in pre-heating temperature except for an increase of not more than 100 °C;
- g) any change in post-weld heat treatment temperature range;
- h) the addition or deletion of filler metal, i.e. a change to or from autogenous welding;
- i) any change in tube-plate position.

4.2 For mechanized or automatic welding, a welding procedure test shall be carried out when there is a change to any of the items recorded in accordance with clause 3, subject to the extent of approval given in clause 5.

4.3 Any change in make, trade name, drying/baking or size [other than as given in 4.1 d) or h)] of filler material or in the shielding or back purging gas shall be reported to the purchaser.

NOTE By agreement between the contracting parties, re-approval of such changes may be waived.

²⁾ In respect of a consumable electrode or filler material, "type" means the compulsory part of the classification according to the standard with which it complies, but a change to a consumable electrode or filler material with a different classification does not necessitate re-approval of the welding procedure if the change is agreed between the contracting parties on the evidence of available mechanical test data.