

Specification for

Friction welding of joints in metals

Committees responsible for this British Standard

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- Associated Offices Technical Committee
- Association of Manufacturers Allied to the Electrical and Electronic Industry (BEAMA Ltd.)
- British Gas plc
- British Steel Industry
- Imperial Chemical Industries Ltd.
- Society of British Aerospace Companies Ltd.
- Society of Motor Manufacturers and Traders Ltd.
- The Welding Institute

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Publication(s) referred to	Inside back cover

Foreword

This British Standard, which has been prepared under the direction of the Welding Standards Policy Committee, supersedes BS 6223:1982 which is withdrawn. It concerns the friction welding of metallic components for duties in which failure could lead to serious personal injury or damage to equipment. It is not directed towards any specific industry or application and it is intended to cover processes in which the heat required to effect welding is produced by friction. A classification of these processes is made within the standard, based upon the method of supplying energy and the form of relative movement.

The standard is written on the basis of weld quality, specifying initial procedure approval tests, and a quality control system to check production welds. As readily available non-destructive testing techniques cannot find, with certainty, all the types of imperfection which may exist in a friction weld, such techniques are generally confined to the detection of surface defects, and reliance for quality control is placed on one, or a combination, of the following methods:

- a) destructive testing of sample production weldments or representative test pieces;
- b) proof load testing of production weldments;
- c) monitoring the operation of the welding machine.

Regarding method (c), the particular characteristics of friction welding permit the use of monitoring techniques that give a clear indication of weld quality.

Additional information considered to be useful for the comprehension of this standard's requirements is included in the appendices.

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 to iv, pages 1 to 20, 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 British Standard specifies requirements for the friction welding of components manufactured from metals. It specifies initial procedure approval tests and a quality control system to check production welds.

Whilst the standard deals primarily with components of circular cross section it does not preclude the joining of other component shapes.

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.

Appendix A gives information on machines suitable for carrying out the work.

NOTE 1 It is strongly recommended that the equipment should be in accordance with Appendix A.

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

2 Definitions

For the purposes of this British Standard, the following definitions apply. For other terms the definitions given in BS 499-1 apply.

2.1

friction welding

a method for making welds in which one component is moved relative to and in pressure contact with the mating component to produce heat at the faying surfaces, the weld being completed by the application of a forge force during or after the cessation of relative motion

NOTE There are several forms of supplying energy and various forms of relative movement; these are given in Figure 1.

2.2

faying surface

a surface of one component that is intended to be in contact with a surface of another component to form a joint

2.3

pressure contact area

the initial surface contact area of the components through which the force is transmitted

2.4

interface

the contact area developed between faying surfaces after completion of the welding operation

2.5

friction force

the force applied normal to the faying surfaces during the time that there is relative movement between the components

NOTE This force may be varied during the friction time.

2.6

forge force

the force applied normal to the faying surfaces at the time when relative movement between the components is ceasing or has ceased

2.7

burn-off length

the overall length loss of the components during the application of the friction force

2.8

forge length

the amount by which the overall length of the components is reduced during the application of the forge force

2.9

total length loss

the loss of length that occurs as a result of friction welding, i.e. the sum of the burn-off length and the forge length

2.10

burn-off rate

the rate of shortening of the components during application of the friction force

2.11

forge rate

the rate of shortening of the components during the application of forge force

2.12

welding cycle

the succession of operations effected by the machine for making a weldment and the return to the initial position (excluding component-handling operations)

2.13

friction pressure

the pressure (force per unit area) on the faying surfaces resulting from the friction force

2.14

forge pressure

the pressure (force per unit area) on the faying surfaces resulting from the forge force

**2.15
overhang**

the distance a component projects from the die, clamp, or chuck in the direction of the mating component

**2.16
upset metal**

parent metal proud of the normal surfaces of the weldment as a result of friction welding

**2.17
friction speed**

the rate of relative movement of the components

**2.18
forge speed**

the friction speed at which the forge force is initiated

**2.19
stopping time**

the time required by the moving component to decelerate from friction speed to zero speed

**2.20
friction time**

the time during which relative movement between the components takes place at friction speed and under application of the friction force

**2.21
forge time**

the time for which the forge force is applied to the components

**2.22
stopping phase**

in the friction welding cycle the interval in which the relative motion of the components is decelerated to zero

**2.23
friction phase**

in the friction welding cycle the interval in which the heat necessary for making a weld is generated by relative motion and the friction force between the components, i.e. from contact of components to the start of deceleration

**2.24
forge phase**

in the friction welding cycle the interval in which the forge force takes effect on the faying surfaces

**2.25
component**

a single item before welding

**2.26
weldment**

two or more components joined by welding

**2.27
rotating inertia**

the inertia of rotating parts of the machine and component that supply energy to the weld

**2.28
swash**

the angular deviation from axial alignment

3 Information and requirements to be agreed and to be documented**3.1 Information to be supplied by the purchaser**

The following information to be supplied by the purchaser 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 the standard can be made and verified:

- a) whether heat treatment of production welds or upset removal is required (10.4);
- b) where relevant, the level of loads expected in service, in order to carry out proof testing (11.2.3.3).

3.2 Requirements to be agreed

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 the standard can be made and verified:

- a) any variations in the preparation of the faying surfaces (clause 6);
- b) for procedure approval:
 - 1) items to appear on the procedure record for the approval test sample results (10.1);
 - 2) details of test simulation, where relevant (10.2);
 - 3) alternative test to bend testing, where relevant (10.5);
 - 4) additional tests to be carried out (10.5 and Appendix D);
 - 5) alternative test procedure, where relevant, when specimens are of insufficient thickness for preparation of bend test specimens (10.6.1.2);
 - 6) preparation of hollow specimens (10.6.2.1 and 10.6.2.2);

