

Methods of testing

Fusion welds in aluminium and aluminium alloys

ICS 25.160.40

UDC 669.716:621.791.05:620.17

NO COPYING WITHOUT BSI PERMISSION EXCEPT AS PERMITTED BY COPYRIGHT LAW



Document Sharing Hub

Co-operating organizations

The Welding Industry Standards Committee, under whose supervision this British Standard was prepared, consists of representatives from the following Government departments and scientific and industrial organizations:

- Aluminium Federation*
- Associated Offices Technical Committee*
- Association of Consulting Engineers
- British Constructional Steelwork Association*
- British Railways Board
- British Steel Industry*
- Crown Agents for Oversea Governments and Administrations
- Department of Employment*
- Department of Trade and Industry*
- Department of Trade and Industry — National Engineering Laboratory
- Institution of Civil Engineers
- Institution of Electrical Engineers
- Institution of Mechanical Engineers*
- Institution of Production Engineers
- Institution of Structural Engineers*
- Lloyd's Register of Shipping*
- London Transport Executive*
- Ministry of Defence
- Ministry of Defence, Army Department*
- Ministry of Defence, Navy Department*
- Process Plant Association*
- Shipbuilders' and Repairers' National Association*
- Society of British Aerospace Companies Limited*
- Welding Institute*
- Welding Manufacturers Association*

The Government departments and scientific and industrial organizations marked with an asterisk in the above list, together with the following were directly represented on the committee entrusted with the preparation of this British Standard:

- British Compressed Gases Association
- British Non-ferrous Metals Research Association
- Electricity Council, the Central Electricity Generating Board and the Area Boards in England and Wales
- Engineering Employers Federation
- National Physical Laboratory (Department of Trade and Industry)

This British Standard, having been approved by the Welding Industry Standards Committee, was published under the authority of the Executive Board on 22 October, 1973

© BSI 02-1999

First published, January 1962
First revision, October 1973

The following BSI references relate to the work on this standard:
Committee reference WEE/2
WEE/2/4
Draft for comment 71/43525

ISBN 0 580 07724 1

Amendments issued since publication

Amd. No.	Date of issue	Comments
3669	October 1981	
8910	December 1995	
9145	August 1996	
9377	March 1997	Indicated by a sideline in the margin

Contents

	Page
Co-operating organizations	Inside front cover
Foreword	ii
1 General	1
1.1 Scope	1
1.2 Definitions	1
1.3 Recommended non-destructive tests	1
1.4 Recommended destructive tests	1
2 Non-destructive tests	1
2.1 Visual examination	1
2.2 Radiographic examination	1
3 Destructive tests	4
3.1 Separation of test specimens	4
3.2 Transverse tensile test	4
3.3 Macroscopic examination	4
3.4 Side bend test (for material of thickness 10 mm and over)	4
3.5 Transverse and longitudinal bend tests	4
3.6 Fracture test (for material of thickness 2 mm and over)	4
3.7 Fillet weld fracture test (for material of thickness 3 mm and over)	4
Appendix A Metallurgical aspects of testing welds in aluminium	6
Appendix B Suggested method of preparing etched specimens	8
Figure 1 — Maximum X-ray tube voltage	3
Figure 2 — <i>Figure deleted</i>	4
Figure 3 — <i>Figure deleted</i>	4
Figure 4 — <i>Figure deleted</i>	4
Figure 5 — <i>Figure deleted</i>	4
Figure 6 — <i>Figure deleted</i>	4
Figure 7 — <i>Figure deleted</i>	4
Figure 8 — <i>Figure deleted</i>	4
Figure 9 — <i>Figure deleted</i>	4
Figure 10 — <i>Figure deleted</i>	4
Figure 11 — <i>Figure deleted</i>	4
Figure 12 — <i>Figure deleted</i>	4
Figure 13 — Alternative forms of fillet weld fracture test specimen	5
Figure 14 — Weld zones in non-heat-treatable alloys	7
Figure 15 — Weld zones in heat-treatable alloys	8
Table 1 — <i>Table deleted</i>	4
Table 2 — <i>Table deleted</i>	4
Table 3 — <i>Table deleted</i>	4
Publications referred to	Inside back cover

Foreword

The revision of this standard was undertaken to incorporate the developments in testing techniques that have occurred since the first edition was published in 1962 and to align the presentation of its contents with the style adopted for companion standards on the testing of welds in other materials.

Standards relating to welded construction in various branches of engineering generally include requirements for certain welding tests to be conducted. There is seldom any technical reason for divergence in the procedures followed for such welding tests and there are both practical and economic advantages to be gained in their standardization. The main purpose of this standard is to recommend test procedures and test specimens that should be quoted, or incorporated, in engineering application standards that deal with welded constructions of aluminium or aluminium alloy. Where differences exist between application standards, the methods of test given in this standard are to be preferred.

A general indication is given of the purpose served by each of the different tests, but the standard does not purport to lay down when any particular test should or should not be used; again it does not state the number of specimens to be tested, the repeat tests to be allowed in the event of failure or acceptance requirements. Such requirements are matters to be dealt with in the particular application standard, e.g. BS 5500, "Unfired fusion welded pressure vessels" and CP 118, "The structural use of aluminium", or are to be agreed between the contracting parties.

Tests for fusion welds in aluminium and aluminium alloys should be selected on their own merits, there being no value in making comparisons with other materials and experience in testing other materials is not necessarily valid. It should also be appreciated that variations in welding procedure and the quality of preparation of test specimens can give rise to variations in the test results.

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 8, 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. General

1.1 Scope

This British Standard deals with methods for the testing of fusion welds in aluminium and aluminium alloys in all forms of material including pipes and castings.

Requirements for test plates, number of test specimens, mechanical test requirements and acceptance levels are not included. These are either covered in the appropriate application standard or to be agreed between the manufacturer and the purchaser.

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

1.2 Definitions

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

1.3 Recommended non-destructive tests

The recommended non-destructive tests are:

- 1) visual examination aided by dye or fluorescent penetrant methods;
- 2) radiography.

NOTE Although no British Standard exists for the method, ultrasonic examination is sometimes applicable to aluminium and aluminium alloy welds. Under optimum conditions it can detect defects such as lack of fusion which are not always revealed by radiography, but interpretation can be complicated by the effect of the metallurgical structure. It is useful where radiography is not sufficiently sensitive because of thickness or joint configuration.

1.4 Recommended destructive tests

The recommended destructive tests are:

Butt welds

- 1) Transverse tensile test
- 2) Macroscopic examination
- 3) Side bend test
- 4) Transverse and longitudinal bend tests (under certain circumstances)
- 5) Fracture test (under certain circumstances)

Fillet welds

- 1) Macroscopic examination
- 2) Fracture test (under certain circumstances)

2. Non-destructive tests

2.1 Visual examination

2.1.1 Object. The object of visual examination is to check the contour and soundness of the surface of the weld zone. The use of penetrant methods (see BS 4416) is an aid to detecting flaws that would not be apparent under normal vision.

Visual examination is the primary method of weld examination and should always precede any other non-destructive or destructive testing.

2.1.2 Preparation. The weld shall be examined in the as-welded condition except that the surface to be examined shall be clean and free from any residues from the welding process.

2.1.3 Examination. The surface of the weld zone shall be examined visually with or without the use of a low power magnifier.

As a further aid to visual examination, one of the following types of penetrant methods (see BS 4416) may be used:

- 1) a coloured dye which indicates flaws after treating the weld with developer;
- 2) a fluorescent penetrant which reveals its presence under a beam of ultraviolet radiation; treatment with a developer may or may not be used. This is less suitable than 1) for site inspection and requires particularly careful interpretation.

All residues from penetrant testing shall be removed to avoid contamination when further welding or repair welding is required.

2.1.4 Reporting of results. The appearance and contour of the weld zone shall be described in the report, together with the nature and location of all flaws found. The use of any aid to examination shall be indicated in the report.

2.2 Radiographic examination

2.2.1 Object. The object of radiographic examination is to detect flaws which are not apparent during visual examination. It is useful for detecting "volume" defects such as porosity, cavities and tungsten or flux inclusions. It cannot always be relied upon to detect narrow planar defects such as cracks, oxide films, lack of fusion and incomplete root penetration.

2.2.2 Preparation. The surfaces of welded joints which are to be radiographically examined need not be chipped or ground to a smooth surface so long as the contours of the welds do not interfere with the interpretation of the radiograph.