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Friction stir welding — Aluminium —

Part 3:
Qualification of welding operators

Soudage par friction-malaxage — Aluminium —

Partie 3: Qualification des opérateurs soudeurs

Member bodies are requested to consult relevant national interests in ISO/TC 44/SC 10 before casting their ballot to the e-Balloting application.

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by IIW, *International Institute of Welding*, Commission III, *Resistance Welding, Solid State Welding and Allied Joining Process*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 121, *Welding*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 25239-3:2011), which has been technically revised.

The main changes compared to the previous edition are as follows:

— the qualification of the welding operator has been changed for reference to the acceptance levels of ISO 25239-5;

— the definitions for testing and acceptance levels of test welds have been updated;

— NDT is no longer accepted as an alternative to bend test to qualify welding operator;

— the period of welding operator qualification has been extended to three years with possible prolongation for another three years;

— Annex A has been reworded to focus on the knowledge of the welding unit and its operation;

— Annex B has been reworded to focus on the knowledge of the welding technology;

— Annex C has been modified to fit to the extended validity of the qualification.

A list of all parts in the ISO 25239 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Welding processes are widely used in the fabrication of engineered structures. During the second half of the twentieth century, fusion welding processes, wherein fusion is obtained by the melting of parent material and usually a filler metal, dominated the welding of large structures. In 1991, Wayne Thomas at TWI invented friction stir welding (FSW), which is carried out entirely in the solid phase (no melting).

The increasing use of FSW has created the need for this document in order to ensure that welding is carried out in the most effective way and that appropriate control is exercised over all aspects of the operation. This document focuses on the FSW of aluminium because, at the time of publication, the majority of commercial applications for FSW involved aluminium. Examples include railway carriages, consumer products, food processing equipment, aerospace structures, and marine vessels.

Friction stir welding — Aluminium —

Part 3:
Qualification of welding operators

1 Scope

This document specifies requirements for the qualification of welding operators for friction stir welding (FSW) of aluminium. In this document, the term "aluminium" refers to aluminium and its alloys.

This document does not apply to "operators" as defined in ISO 25239-1.

This document does not apply to friction stir spot welding which is covered by the ISO 18785 series.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 25239-1, *Friction stir welding — Aluminium — Part 1: Vocabulary*

ISO 25239-4:2020, *Friction stir welding — Aluminium — Part 4: Specification and qualification of welding procedures*

ISO 25239-5:2020, *Friction stir welding — Aluminium — Part 5: Quality and inspection requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 25239-1 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

4 Requirements

4.1 Welding operator qualification

Welding operators shall be qualified by one of the following tests, as detailed in 4.3:

— standard welding test, see 4.3.1;

— welding procedure test, see 4.3.2;

— pre-production welding test or production welding test, see 4.3.3;

— production welding sample test, see 4.3.4.

In addition, the welding operator's knowledge of the welding unit to be used for the qualification test and the knowledge of the welding technology shall be tested and documented as shown in Annexes A and B.

The essential variables and ranges of qualification are specified in 4.2 and the validity is specified in Clause 5. Provided that the welding operator works in accordance with a welding procedure specification (WPS), the range of qualification shall be limited only as specified in 4.2.

A suggested form for the welding operator's qualification certificate is shown in Annex C.

4.2 Essential variables and ranges of qualification

4.2.1 General

The qualification of welding operators is based on essential variables, as specified in 4.2.2 to 4.2.5. For each essential variable, a range of qualification is defined. If a welding operator is required to weld outside the range of qualification, then a new qualification test is required.

NOTE Friction stir welding is a mechanized process. However, because it is also a solid-state welding process, the essential variables are different from those applicable to fusion welding processes.

4.2.2 Friction stir welding methods

A successful welding operator qualification test made with any type of FSW method qualifies an operator only for that welding method. This subclause applies to FSW methods that include, but are not limited to, robotic, single spindle, multiple spindle, bobbin tool, adjustable tool probe, or any other FSW method defined in the WPS used for that qualification test.

4.2.3 Welding equipment

The following changes require a new qualification:

— a change from welding with a joint sensor to welding without, although welding without a joint sensor also qualifies an operator to weld with a joint sensor (i.e. location, height mismatch, ...);

— a change from one type of welding machine to another type of welding machine that requires additional training to operate;

— a test made with any type of machine qualifies only that type of machine, although the addition or removal of jigs and fixtures, feeding units and other ancillary equipment does not change the type of machine;

— addition, removal or change of control system.

4.2.4 Parent materials

A successful test weld made in any aluminium alloy qualifies an operator for all aluminium alloys.

A successful test weld of any parent material thickness qualifies an operator for all parent material thicknesses.

A successful test weld of any parent material form (including, but not limited to, sheet, tube, castings, forgings or extrusions) qualifies an operator for all parent material forms and for all tube diameters.

4.2.5 Weld joint geometry

A successful test weld made in any weld joint geometry qualifies an operator for all weld joint geometries.

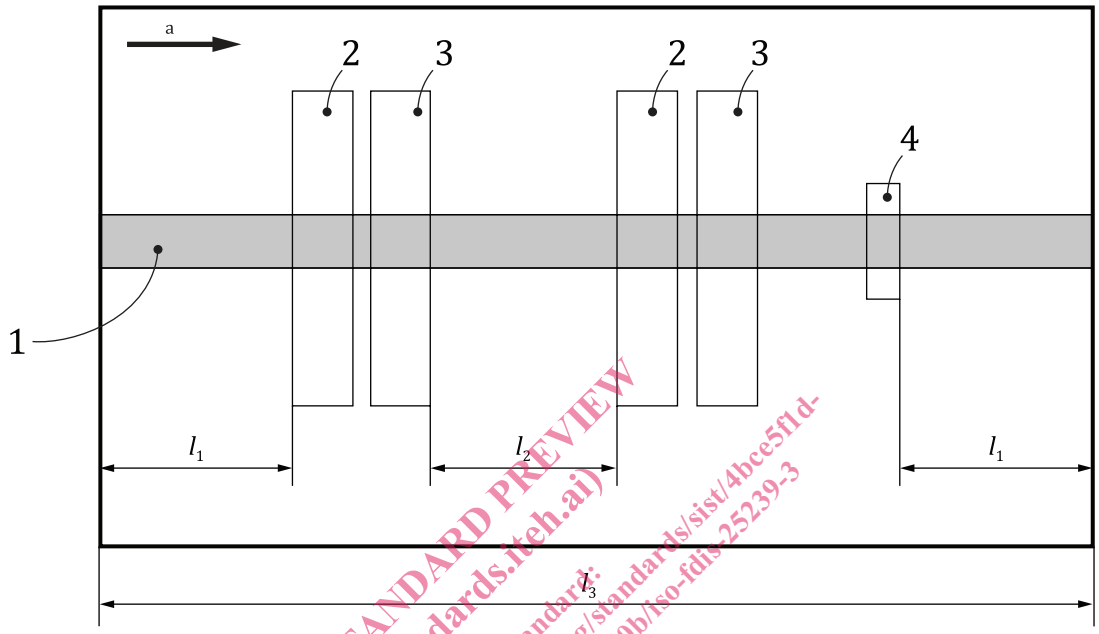
4.2.6 Quality acceptance levels

The qualification of a welding operator to one weld quality acceptance level in accordance with ISO 25239-5:2020, Annex A, shall qualify for all acceptance levels.

4.3 Qualification methods

4.3.1 Qualification based on standard welding test

The test piece shown in Figure 1 shall be used for the standard welding test. A welding operator who has successfully completed the welding test in accordance with 4.4 shall be considered qualified for the method and type of welding machine used for the test.



Key

1	weld	l_1	minimum 50 mm or three times the weld penetration whichever is greater
2	area for root bend test specimen	l_2	minimum 50 mm
3	area for face bend test specimen	l_3	minimum 500 mm
4	area for test specimen for macroscopic examination	a	Weld direction.

The width of the test piece shall be sufficient for extracting the bend test specimens.

NOTE Not to scale. Start and stop of the weld are not shown in this figure.

Figure 1 — Location of destructive test specimens

4.3.2 Qualification based on welding procedure test

A welding operator shall have successfully completed a welding procedure test in accordance with ISO 25239-4:2020, Clause 6, to be considered qualified for the method and type of welding machine used.

4.3.3 Qualification based on pre-production welding test

A welding operator shall have successfully completed a pre-production welding test in accordance with ISO 25239-4:2020, Clause 7, to be considered qualified for the FSW method and type of welding machine used for the test.

4.3.4 Qualification based on production sample welding test

A welding operator having successfully set up a production part shall be considered qualified if representative samples of the items that are produced are approved by the examiner or the examining

body. This testing of production samples shall be in accordance with the requirements of 4.4 or the requirements of the contracting parties, whichever is more stringent.

4.4 Test welds

4.4.1 General

Test welds shall be made in accordance with a WPS, except when 4.3.2 or 4.3.3 applies. The welding and testing of test pieces shall be witnessed by the examiner.

The test welds used for qualification of a welding operator shall have a length of at least 500 mm. If the qualification is based on pre-production tests, production tests or production sample tests and the product used has a shorter weld length than 500 mm, then the number of products tested shall be such that the required weld length is met. However, no more than three products shall be tested.

The test piece and test specimens shall be marked with the identification of the examiner or the examining body and the welding operator before welding starts.

The examiner may stop the test if the welding conditions are not correct or if it appears that the welding operator does not have the skill to fulfil the requirements of this part of ISO 25239.

4.4.2 Testing and acceptance levels of test welds

4.4.2.1 General

The acceptance levels for the test welds shall be the same as those used to qualify the WPS.

The following tests, as a minimum, shall be performed:

— visual testing 100 %;

— macroscopic examination;

— bend tests (only applies to a qualification based on a standard welding test in accordance with 4.3.1).

4.4.2.2 Visual testing

Visual testing shall be carried out in accordance with ISO 25239-4:2020, 6.3.2, except in the case of 4.4.1 where, if the length of weld is less than 500 mm, the length of weld to be tested shall be specified in the WPS.

4.4.2.3 Macroscopic examination

Macroscopic examination shall be carried out in accordance with ISO 25239-4:2020, 6.3.3.5. The location of the test specimen blank shall be in accordance with Figure 1.

4.4.2.4 Bend test

Bend testing shall be performed in accordance with ISO 25239-4:2020, 6.3.3.4. The location of the test specimen blanks shall be in accordance with Figure 1.

If a partial penetration weld is specified in the WPS, the specimen shall be machined from the root side to a thickness equal to the specified minimum weld penetration before testing.

4.4.3 Re-testing

If the welded assembly fails to meet the requirements of 4.4.1 and 4.4.2, then the test shall be rejected. A duplicate assembly may be welded using the same procedure and subjected to examination. If the