
**Friction stir spot welding —
Aluminium —**

**Part 3:
Qualification of welding personnel**

*Soudage par friction-malaxage par points — Aluminium —
Partie 3: Qualification du personnel en soudage*



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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 the IIW, *International Institute of Welding*, Commission III, *Resistance welding, solid state welding and allied joining processes*.

Any feedback, question or request for official interpretation related to any aspect of this document should be directed to IIW via your national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

A list of all parts in the ISO 18785 series can be found on the ISO website.

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, friction stir welding (FSW), which is carried out entirely in the solid phase (no melting), was invented.

Friction stir spot welding (FSSW) processes are spot-like variants of the FSW process. Unlike FSW, there is minimal or no traverse motion of the tool. In basic FSSW, the joint is created by plunging a rotating tool into the work piece and retracting the tool out of the overlapping sheets. Other FSSW variants include additional tool movements. Frictional heat is generated from the contact between the tool and the material to be welded resulting in softening of this material. The softened material is stirred to form a metallurgical connection which is aided by the forge action applied by the tool shoulder contacting the upper sheet surface.

The increasing use of FSSW has created the need for a FSSW standard 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. The ISO 18785 series focuses on the FSSW of aluminium because, at the time this document was developed, the majority of commercial applications for FSW involved aluminium. Examples include railway cars, consumer products, food processing equipment, automotive components, aerospace structures, and marine vessels.

To be effective, welded structures should be free from serious problems in production and in service. To achieve that goal, it is necessary to provide controls from the design phase through material selection, fabrication, and inspection. For example, poor design can create serious and costly difficulties in the workshop, on site, or in service. Incorrect material selection can result in welding problems such as cracking. Welding procedures need to be correctly formulated and approved to avoid imperfections. To ensure the fabrication of a quality product, management needs to understand the sources of potential trouble and introduce appropriate quality and inspection procedures, and supervision should be implemented to ensure that the specified quality is achieved.

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Friction stir spot welding — Aluminium —

Part 3: Qualification of welding personnel

1 Scope

This document specifies the requirements for the qualification of welding personnel for friction stir spot welding (FSSW) of aluminium.

In this document, the term "aluminium" refers to aluminium and its alloys.

This document does not apply to personnel exclusively performing loading or unloading of the automatic welding unit.

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 17636 (all parts), *Non-destructive testing of welds — Radiographic testing*

ISO 17640, *Non-destructive testing of welds — Ultrasonic examination of welded joints*

ISO 18785-1, *Friction stir spot welding — Aluminium — Part 1: Vocabulary*

ISO 18785-4, *Friction stir spot welding — Aluminium — Part 4: Specification and qualification of welding procedures*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 18785-1 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 Qualification

4.1 General

Weld setters for FSSW shall be qualified in accordance with this document.

Welding operators shall, as a minimum, undergo training on the operation of the FSSW equipment, including safety, related issues, for the parts to be welded.

NOTE Personnel performing exclusively loading/unloading the welding unit do not need to be qualified.

4.2 FSSW weld setter qualification

Weld setters shall be qualified by setting up and performing at least one of the following tests:

- qualification based on standard welding test (see [4.4.1](#));
- qualification based on welding procedure test (see [4.4.2](#));
- qualification based on pre-production welding test or production tests (see [4.4.3](#));
- qualification based on production sample testing (see [4.4.4](#)).

Additionally, a weld setter shall pass a functional knowledge test. An example of such a test is described in [Annex A](#).

The essential variables and the range of qualification are specified in [4.3](#) and the validity in [Clause 5](#).

4.3 Essential variables and the ranges of qualification

4.3.1 General

Weld setter qualification is based on essential variables as specified in [4.3.2](#) to [4.3.6](#). For each essential variable, a range of qualification shall be defined. If the weld setter is required to work outside the range of qualification, then a new qualification test is required.

4.3.2 Friction stir spot welding variant

A weld setter qualification test made using one FSSW variant qualifies only for that variant. This clause applies to FSSW variants included in ISO 18785-1 and specified in the preliminary welding procedure specification (pWPS) or welding procedure specification (WPS) used for that qualification test.

4.3.3 Welding equipment

The following changes require a new qualification:

- change from one type or model of welding machine to another type or model of welding machine that requires additional training to operate;
- addition, deletion, or change of control system that requires additional training to operate;
- change or removal of jigs and fixtures, feeding units, and other auxiliary equipment that requires additional training.

4.3.4 Parent materials

- a test weld made in any aluminium alloy qualifies for all aluminium alloys;
- a test weld of any parent material thickness qualifies all parent material thicknesses;
- a test weld of any parent material form (including, but not limited to sheet, tube, castings, forgings, or extrusions) qualifies for all parent material forms and for all tube diameters.

4.3.5 Weld joint geometry

A test weld made in any weld joint geometry qualifies all weld joint geometries.

4.3.6 Range of qualification

The weld setter's range of qualification is unlimited provided that:

- a qualified welding procedure specification (WPS) is followed; and
- the type or model of welding unit or the FSSW variant are not changed.

4.4 Qualification methods

4.4.1 Qualification based on a standard welding test

A weld setter who has successfully completed the standard welding test in accordance with 4.5 shall be considered qualified for the method and type or model of welding unit used.

4.4.2 Qualification based on a welding procedure test

A weld setter having successfully completed a welding procedure test in accordance with ISO 18785-4, shall be considered qualified for that type or model of unit used.

4.4.3 Qualification based on a pre-production test or production test

A weld setter having successfully completed a pre-production welding test in accordance with ISO 18785-4 or a production test shall be considered qualified for that type or model of welding unit used. The testing of these pre-production or production articles is to be done in accordance with the requirements of 4.5 or the requirements of the contracting parties, whichever is more stringent.

4.4.4 Qualification based on a production welding sample test

A weld setter having successfully welded a production part shall be considered qualified if representative samples of the items that are produced are qualified by the examiner or the examining body. This testing of production samples is to be done in accordance with the requirements of 4.5 or the requirements of the contracting parties, whichever is more stringent.

4.5 Test welds

4.5.1 General

Welding tests shall be made in accordance with a qualified WPS, except when 4.4.2 applies. The performance and testing of test pieces shall be witnessed by the examiner or the examining body.

If the qualification is based on pre-production tests, production tests, or production sample tests, and the product used has insufficient number of spots or size, then the number of products tested shall be such that the required number of spots is met.

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

The examiner or examining body may stop the test if the welding conditions are not correct or if it appears the weld setter/operator does not have the skill to fulfil the requirements of this document.

4.5.2 Testing of welds

4.5.2.1 Visual testing and acceptance levels

Visual testing shall be carried out in accordance with ISO 18785-5. Visual inspection of spot welds is performed with an "unaided eye" inspection and shall be performed on all spots.

Types of imperfections:

- sheet separation;
- surface imperfections (cracking, lack of consolidation);
- excessive flash.

The as-welded surface shall be generally consistent and uniform in appearance and free of cracks or surface-breaking voids. The spot weld shall not show any variations due to insufficient tool pressure.

4.5.2.2 Mechanical testing

4.5.2.2.1 Extent of testing

Mechanical testing shall be the primary means of establishing setter/operator qualification. Testing shall be carried out in accordance with ISO 18785-4. At least one mechanical testing method shall be used, with a minimum of three coupons per method (the test lot).

4.5.2.2.2 Macroscopic examination (optional)

One macroscopic examination shall be carried out in accordance with ISO 18785-4 or 100 % tested with an appropriate non-destructive, volumetric testing method (radiography, Eddy current or ultrasonic). Testing shall be done in accordance with ISO 17636 (all parts) or ISO 17640 (radiography and ultrasonic, respectively).

4.5.3 Re-testing

If one or more of the test welds fails to meet the requirements of [4.5.1](#) and [4.5.2](#), then the test shall be rejected. A duplicate test lot may be welded using the same procedure and subjected to examination. But if the second test lot fails to meet the requirements, then corrective action (modification of the pWPS, verification of machine and materials, etc.) shall be taken before a new test is made.

4.6 Test record

The results of all testing shall be documented and retained until re-qualification or for a minimum of two years. The format of the documentation shall be decided by the manufacturer.

NOTE The documentation can be on paper or electronic media.

5 Certificate

5.1 General

It shall be verified and documented that the weld setter passed the qualification test. All essential variables shall be recorded on the certificate. If the test piece(s) fail(s) any of the required tests, no certificate shall be issued.

Certificates shall be issued under the sole responsibility of the examiner or examining body. A recommended format is given in [Annex B](#). If another welder setter qualification certificate format is used, it shall contain at least all of the information given in [Annex B](#).

5.2 Period of validity

5.2.1 Initial qualification

The weld setter qualification is valid from the date of welding of the test pieces; provided that the required tests have been carried out and acceptable test results are available.

The weld setter qualification test certificate is valid for a period of 2 years, the period of validity ending on the last day of the month.

5.2.2 Confirmation of the validity

The welding coordinator (see ISO 14731), or the person responsible from the employer, shall confirm that the weld setter has been working within the initial range of qualification. This shall be confirmed every 6 months. If such a confirmation is not given and the qualification expires, the weld setter/operator shall be required to pass a new qualification test before resuming welding.

5.2.3 Prolongation of the validity

A weld setter's qualification may be extended indefinitely, provided an auditable record is maintained from the date of the initial qualification that verifies the weld setter has used the process within the previous six-month period.

Annex A **(informative)**

Functional knowledge of the welding unit

A.1 General

This annex specifies the knowledge of the welding unit required by a weld setter to ensure that procedures and common practices are followed. Testing of functional knowledge can be accomplished by any of the following methods or combinations of these methods:

- written objective tests (multiple choice). This test may be given on paper or on a computer;
- oral questioning following a set of written questions;
- oral questioning following a practical demonstration (skills test).

A.2 Welding sequences/procedures

The setter shall understand welding procedure requirements and the influence of welding parameters on the weld, in particular:

- a) joint preparation and weld representation:
 - 1) conformity to the WPS for joint preparation;
 - 2) cleanliness of the surfaces to be welded;
- b) weld imperfections:
 - 1) identification of weld imperfections;
- c) welding operator qualification, including its range;
- d) process operation:
 - 1) knowledge of programming the welding unit (if relevant);
 - 2) knowledge of operation of the welding unit;
 - 3) operation of auxiliary equipment;
 - 4) adjustment of jigs, fixtures, and set-up;
 - 5) setting and adjustment of parameters within the WPS;
 - 6) applications of safety regulations and precautions;
 - 7) initiation of start and stop procedures.