
**Friction stir spot
welding — Aluminium —**

**Part 4:
Specification and qualification of
welding procedures**

iTeh STANDARD PREVIEW
Soudage par friction-malaxage par points — Aluminium —
(standards.iteh.ai) Partie 4: Descriptif et qualification des modes opératoires de soudage

[ISO 18785-4:2018](https://standards.iteh.ai/catalog/standards/sist/1197df9d-0578-49ed-a9be-0ce0aa4715c3/iso-18785-4-2018)

<https://standards.iteh.ai/catalog/standards/sist/1197df9d-0578-49ed-a9be-0ce0aa4715c3/iso-18785-4-2018>



iTeh STANDARD PREVIEW (standards.iteh.ai)

ISO 18785-4:2018

<https://standards.iteh.ai/catalog/standards/sist/1197df9d-0578-49ed-a9be-0ce0aa4715c3/iso-18785-4-2018>



COPYRIGHT PROTECTED DOCUMENT

© ISO 2018

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

	Page
Foreword	iv
Introduction	v
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Development and qualification of welding procedures	2
4.1 General.....	2
4.2 Technical content of a pWPS.....	2
4.2.1 Manufacturer information.....	2
4.2.2 Composition of parent material.....	2
4.2.3 Dimensions of material.....	2
4.2.4 Welding method.....	2
4.2.5 Machine specifications.....	3
4.2.6 Tool identification.....	3
4.2.7 Clamping processes and conditions.....	3
4.2.8 Joint design.....	3
4.2.9 Joint preparation and cleaning methods.....	3
4.2.10 Welding technique.....	3
4.2.11 Post-weld processing.....	3
5 Qualification based on a welding procedure test	4
5.1 General.....	4
5.2 Standardized test piece.....	4
5.3 Welding of components, subscale test components or test specimens.....	4
6 Examination and testing	4
6.1 Visual testing.....	4
6.1.1 General.....	4
6.1.2 Re-testing.....	4
6.2 Destructive testing.....	4
6.2.1 General.....	4
6.2.2 Re-testing.....	4
6.3 Macrosection.....	5
6.4 Range of qualification.....	5
6.4.1 General.....	5
6.4.2 Related to the manufacturer.....	5
6.4.3 Related to the material.....	5
6.4.4 Common to all welding procedures.....	5
6.4.5 Other variables.....	6
7 Qualification based on pre-production welding test	6
7.1 General.....	6
7.2 Test pieces.....	6
7.3 Examination and testing of test pieces.....	6
7.4 Range of qualification.....	6
7.5 Welding procedure qualification record.....	6
Annex A (informative) Example format for a welding procedure specification	7
Annex B (informative) Additional variables to be considered in WPS's for FSSW variants	8
Annex C (informative) Example welding procedure qualification record forms	9
Bibliography	12

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.

The International Organization for Standardization (ISO) draws attention to the fact that it is claimed that compliance with this document may involve the use of patents concerning friction stir welding given in [Clauses 5 to 7](#).

ISO takes no position concerning the evidence, validity and scope of this patent right. The holders of this patent right have assured ISO that they are willing to negotiate licenses under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holder of this patent right is registered with ISO. Further information may be obtained from:

ISO 18785-4:2018(E)

Helmholtz-Zentrum Geesthacht Zentrum
für Material- und Küstenforschung GmbH
Max-Planck-Str. 1
21502 GEESTHACHT
GERMANY

Tel.: +49 (0) 4152 87-1713
Fax: +49 (0) 4152 87-1618
E-mail: christina.geisler@hzg.de

KAWASAKI JUKOGYO KABUSHIKI KAISHA
(Kawasaki Heavy Industries, Ltd.)
1-1, Kawasaki-cho
Akashi-shi, HYOGO
673-8666 JAPAN

Tel.: +81-78-921-1612
Fax: +81-78-921-1763
E-mail: fukuoka_ma@khi.co.jp

Mazda Motor Corporation
3-1 Shinchi
Fuchu-cho
Aki-gun, HIROSHIMA
730-8670 JAPAN

Tel.: +81-82-287-5726
Fax: +81-82-287-5119
E-mail: attention@mail.mazda.co.jp

UACJ Corporation
Tokyo Sankei Bldg.
1-7-2, Otemachi
Chiyoda-ku, TOKYO
100-0004 JAPAN

Tel.: +81-3-6202-3346
Fax: +81-3-6202-2042
E-mail: uacj-chizai@ml.uacj.co.jp

iTeh STANDARD PREVIEW (standards.iteh.ai)

ISO 18785-4:2018

<https://standards.iteh.ai/catalog/standards/sist/1197df9d-0578-49ed-a9be-0ce0aa4715c3/iso-18785-4-2018>

Friction stir spot welding — Aluminium —

Part 4: Specification and qualification of welding procedures

1 Scope

This document specifies the requirements for the content of welding procedure specifications for the Friction Stir Spot welding (FSSW) of aluminium.

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

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 10447, *Resistance welding — Testing of welds — Peel and chisel testing of resistance spot and projection welds*

ISO 14270, *Resistance welding — Destructive testing of welds — Specimen dimensions and procedure for mechanized peel testing resistance spot, seam and embossed projection welds*

ISO 14271, *Resistance welding — Vickers hardness testing (low force and microhardness) of resistance spot, projection, and seam welds*

ISO 14272, *Resistance welding — Destructive testing of welds — Specimen dimensions and procedure for cross tension testing of resistance spot and embossed projection welds*

ISO 14273, *Resistance welding — Destructive testing of welds — Specimen dimensions and procedure for tensile shear testing resistance spot and embossed projection welds*

ISO 17653, *Resistance welding — Destructive tests on welds in metallic materials — Torsion test of resistance spot welds*

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

ISO 18785-5, *Friction stir spot 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 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 Development and qualification of welding procedures

4.1 General

Qualification of welding procedures shall be performed prior to production welding.

The manufacturer shall prepare a preliminary welding procedure specification (pWPS) and shall ensure that it is applicable for production using experience from previous production jobs and/or the general fund of knowledge of welding technology.

A pWPS shall be used as the basis for the establishment of a welding procedure qualification record (WPQR). The pWPS shall be tested in accordance with one of the methods listed in [Clause 5](#) (welding procedure test), or [Clause 7](#) (pre-production welding test). [Clause 5](#) shall be used when the production part or joint geometry is accurately represented by a standardized test piece or pieces, as specified in [5.2](#). However, [Clause 5](#) shall be used when the production part or joint geometry is not accurately represented by the standardized test pieces, as specified in [5.2](#). The information required in a pWPS is given in [4.2](#).

For some applications, it may be necessary to supplement or reduce the list. All relevant information shall be specified in the WPS.

Once a pWPS has been qualified, the manufacturer shall prepare a Welding Procedure Specification (WPS) covering a range of parent material thicknesses, including tolerances, as well as a range of aluminium alloys.

An example of a pWPS form is shown in [Annex A](#).

4.2 Technical content of a pWPS

The following information, as a minimum, shall be included in a pWPS.

<https://standards.iteh.ai/catalog/standards/sist/1197df9d-0578-49ed-a9be-0ce0aa4715c3/iso-18785-4-2018>

4.2.1 Manufacturer information

- identification of manufacturer;
- identification of pWPS.

4.2.2 Composition of parent material

- designation of the material(s) and reference standard(s);
- when coatings are applied the following may include: type, thickness, number of faces, control document.

4.2.3 Dimensions of material

- thickness of materials comprising the welded joint.

4.2.4 Welding method

Process parameters are unique to each process variant (see corresponding annexes for details).

- basic (includes probe-less) FSSW (see [Annex A](#));
- refill FSSW (see [Annex A](#) and [Annex B](#));
- swing FSSW (see [Annex A](#) and [Annex B](#));
- swept FSSW (see [Annex A](#) and [Annex B](#));

- stitch FSSW (see [Annex A](#) and [Annex B](#)).

4.2.5 Machine specifications

- type or model;
- manufacturer;
- auxiliary equipment.

4.2.6 Tool identification

- material;
- drawing or drawing number or identification number.

4.2.7 Clamping processes and conditions

- method and type of jiggling, fixtures, rollers and backing support (dimensions and material);
- tool and fixture heating/cooling (internal, external, cooling medium), if applicable;
- tacking arrangement.

4.2.8 Joint design

- overlap;
- edge distance;
- joint stack-up;
- sealant and/or adhesive (type, grade, location, dimension);
- tool plunge side.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO 18785-4:2018

<https://standards.iteh.ai/catalog/standards/sist/1197df9d-0578-49ed-a9be->

(Grade 4, Location 18785-4:2018)

NOTE A sketch of the welded joint can be used to show the joint design/configuration.

4.2.9 Joint preparation and cleaning methods

- cleaning procedure (degreasing, wire brushing, chemical etching, etc.);
- pre-weld heat treatment procedure, if applicable.

4.2.10 Welding technique

- mechanized, automatic welding;
- procedures to minimize distortion, indentation, contamination, corrosion, etc.

Operator protection shall be taken into consideration.

4.2.11 Post-weld processing

- stress relieving (or other methods to correct distortion);
- removal of flash, or any other mechanical post weld processing of the weldment;
- post-weld heat-treatment (temperature range and minimum time for post-weld heat treatment or ageing shall be specified or reference shall be made to other standards which specify this information).

5 Qualification based on a welding procedure test

5.1 General

The welded assembly, to which the welding procedure will relate to in production, shall be represented by actual components, subscale test components or by preparing a standardized test piece in accordance with 5.2.

If required by the application standard, the direction of plate rolling shall be marked on the test piece.

5.2 Standardized test piece

The joint geometry and dimensions of standardized test pieces shall be in accordance with the appropriate document: ISO 10447, ISO 14270, ISO 14271, ISO 14272, ISO 14273 or ISO 17653.

5.3 Welding of components, subscale test components or test specimens

Preparation and welding of actual components, subscale test components or standardized test pieces shall be carried out in accordance with a pWPS, and under the general conditions of production welding (parameters, equipment, etc.) which they shall represent.

Welding and testing of the test pieces shall be witnessed by an examiner or examining body and the details of this shall be established before any qualification is undertaken.

6 Examination and testing

iTeh STANDARD PREVIEW
(standards.iteh.ai)

6.1 Visual testing

ISO 18785-4:2018

6.1.1 General

<https://standards.iteh.ai/catalog/standards/sist/1197df9d-0578-49ed-a9be-0ce0aa4715c3/iso-18785-4-2018>

Test pieces shall be visually examined in accordance with ISO 18785-5.

6.1.2 Re-testing

If any test piece fails visual testing, an additional test piece shall be welded, under the same conditions as the original, and subjected to the same examination. If visual testing of the additional test piece fails, the welding procedure test has failed.

6.2 Destructive testing

6.2.1 General

Test specimens shall be cut from the actual components, standardized test pieces, or subscale test components.

Depending on the joint geometry and loading conditions, the shape and dimensions of the test pieces and test specimen and the test procedures shall be in accordance with the appropriate document: ISO 10447, ISO 14270, ISO 14271, ISO 14272, ISO 14273, or ISO 17653.

6.2.2 Re-testing

If any test specimen fails to comply with the requirements for destructive testing, two further test specimens shall be tested for each one that failed.

Additional test specimens shall be taken from the same test piece if there is sufficient material or from a new test piece welded under the same conditions as the original. Each additional test specimen shall

be subjected to the same tests as the initial test specimen that failed. If either of the additional test specimens fails to comply with the requirements, then the welding procedure test has failed.

6.3 Macrosection

Test specimens shall be prepared and etched to produce cross-sections in order to clearly show the stir zone and, if necessary, the weld profile.

6.4 Range of qualification

6.4.1 General

All the conditions of validity stated below shall be met independently of each other.

Additions, deletions or changes outside the ranges specified shall require a new welding procedure test to be performed.

6.4.2 Related to the manufacturer

A qualification of a WPS obtained by a manufacturer is valid for welding in workshops or sites under the same technical and quality control of that manufacturer.

Welding is under the same technical and quality control when the manufacturer who qualified the WPS retains complete responsibility for all welding carried out to it.

6.4.3 Related to the material

All tests shall be carried out with materials that are representative of those used in production. The following characteristics shall be consistent for the production and test materials:

- thickness;
- alloy and temper;
- surface condition and treatments if required.

Any modification shall be established before any qualification is undertaken.

6.4.4 Common to all welding procedures

6.4.4.1 Welding process

The qualification only applies to the welding procedure used in the welding procedure test.

Any variations in the welding parameters shall be within the range of machine performance specified in the WPS.

6.4.4.2 Type of control method

The WPS is only qualified for the type of control method used in the welding procedure qualification.

6.4.4.3 Type of weld equipment

The WPS is only qualified for the weld equipment of the same machine specifications used in the welding procedure qualification (see 4.2.5).