



**SLOVENSKI STANDARD**  
**oSIST prEN ISO 25239-4:2019**  
**01-julij-2019**

---

**Varjenje z gnetenjem - Aluminij - 4. del: Specifikacija in kvalifikacija varilnih postopkov (ISO/DIS 25239-4:2019)**

Friction stir welding - Aluminium - Part 4: Specification and qualification of welding procedures (ISO/DIS 25239-4:2019)

Rührreibschweißen - Aluminium - Teil 4: Anforderung und Qualifizierung von Schweißverfahren (ISO/DIS 25239-4:2019)

Soudage par friction-malaxage - Aluminium - Partie 4: Descriptif et qualification des modes opératoires de soudage (ISO/DIS 25239-4:2019)

**Ta slovenski standard je istoveten z: prEN ISO 25239-4**

---

**ICS:**

25.160.10	Varilni postopki in varjenje	Welding processes
77.120.10	Aluminij in aluminijeve zlitine	Aluminium and aluminium alloys

**oSIST prEN ISO 25239-4:2019**

**en,fr,de**



# DRAFT INTERNATIONAL STANDARD

## ISO/DIS 25239-4

IIW

Secretariat: ISO secretariat

Voting begins on:  
2019-05-22Voting terminates on:  
2019-08-14

### Friction stir welding — Aluminium —

## Part 4: Specification and qualification of welding procedures

*Soudage par friction-malaxage — Aluminium —*

*Partie 4: Descriptif et qualification des modes opératoires de soudage*

ICS: 25.160.10

iTeh STANDARD PREVIEW  
(standards.iteh.ai)

SIST EN ISO 25239-4:2020

<https://standards.iteh.ai/catalog/standards/sist/a5e5fa2d-989e-4fc5-993e-638bf66705c1/sist-en-iso-25239-4-2020>

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

This document is circulated as received from the committee secretariat.

### ISO/CEN PARALLEL PROCESSING

This draft International Standard is submitted to all ISO member bodies for voting, as a standard prepared by an international standardizing body in accordance with Council Resolution 42/1999. The proposer, the International Institute of Welding (IIW), has been recognized by the ISO Council as an international standardizing body for the purpose of Council Resolution 42/1999.

THIS DOCUMENT IS A DRAFT CIRCULATED FOR COMMENT AND APPROVAL. IT IS THEREFORE SUBJECT TO CHANGE AND MAY NOT BE REFERRED TO AS AN INTERNATIONAL STANDARD UNTIL PUBLISHED AS SUCH.

IN ADDITION TO THEIR EVALUATION AS BEING ACCEPTABLE FOR INDUSTRIAL, TECHNOLOGICAL, COMMERCIAL AND USER PURPOSES, DRAFT INTERNATIONAL STANDARDS MAY ON OCCASION HAVE TO BE CONSIDERED IN THE LIGHT OF THEIR POTENTIAL TO BECOME STANDARDS TO WHICH REFERENCE MAY BE MADE IN NATIONAL REGULATIONS.

RECIPIENTS OF THIS DRAFT ARE INVITED TO SUBMIT, WITH THEIR COMMENTS, NOTIFICATION OF ANY RELEVANT PATENT RIGHTS OF WHICH THEY ARE AWARE AND TO PROVIDE SUPPORTING DOCUMENTATION.



Reference number  
ISO/DIS 25239-4:2019(E)

© ISO 2019

iTeh STANDARD PREVIEW  
(standards.iteh.ai)

SIST EN ISO 25239-4:2020

<https://standards.iteh.ai/catalog/standards/sist/a5e5fa2d-989e-4fc5-993e-638bf66705c1/sist-en-iso-25239-4-2020>



**COPYRIGHT PROTECTED DOCUMENT**

© ISO 2019

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](mailto:copyright@iso.org)  
Website: [www.iso.org](http://www.iso.org)

Published in Switzerland

# Contents

	Page
<b>Foreword</b> .....	<b>v</b>
<b>Introduction</b> .....	<b>vi</b>
<b>1 Scope</b> .....	<b>1</b>
<b>2 Normative references</b> .....	<b>1</b>
<b>3 Terms and definitions</b> .....	<b>2</b>
<b>4 Symbols and abbreviated terms</b> .....	<b>2</b>
<b>5 Development and qualification of welding procedures</b> .....	<b>2</b>
5.1 General.....	2
5.2 Technical content of a pWPS.....	2
5.2.1 General.....	2
5.2.2 Fabricator information.....	3
5.2.3 Parent material type(s), temper(s), and reference standard(s).....	3
5.2.4 Parent material dimensions.....	3
5.2.5 Equipment identification.....	3
5.2.6 Tool identification.....	3
5.2.7 Clamping arrangement.....	3
5.2.8 Joint design.....	3
5.2.9 Joint preparation and cleaning methods.....	3
5.2.10 Welding details.....	3
5.2.11 Welding speed.....	4
5.2.12 Welding position.....	4
5.2.13 Thermal management.....	4
5.2.14 Postweld (mechanical) processing.....	4
<b>6 Qualification based on a welding procedure test</b> .....	<b>4</b>
6.1 General.....	4
6.2 Test pieces.....	4
6.2.1 Shape and dimensions of test pieces.....	4
6.2.2 Welding of test pieces.....	6
6.3 Examination and testing of test pieces.....	6
6.3.1 Extent of testing.....	6
6.3.2 Visual testing and acceptance levels.....	7
6.3.3 Destructive tests.....	7
6.3.4 Re-testing.....	12
6.4 Range of qualification.....	12
6.4.1 General.....	12
6.4.2 Related to the fabricator.....	12
6.4.3 Other variables.....	12
6.5 Welding procedure qualification record.....	12
<b>7 Qualification based on pre-production welding test</b> .....	<b>13</b>
7.1 General.....	13
7.2 Test pieces.....	13
7.3 Examination and testing of test pieces.....	13
7.4 Range of qualification.....	13
7.5 Welding procedure qualification record.....	13
<b>Annex A (informative) Form for preliminary welding procedure specification (pWPS) and welding procedure specification (WPS)</b> .....	<b>14</b>
<b>Annex B (informative) Non-destructive testing</b> .....	<b>15</b>
<b>Annex C (informative) Hammer S-bend test of lap welds</b> .....	<b>16</b>
<b>Annex D (informative) Welding procedure qualification record form (WPQR)</b> .....	<b>18</b>

**Bibliography** ..... **23**

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

SIST EN ISO 25239-4:2020

<https://standards.iteh.ai/catalog/standards/sist/a5e5fa2d-989e-4fc5-993e-638bf66705c1/sist-en-iso-25239-4-2020>

## 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](http://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](http://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](http://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*.

This second edition cancels and replaces the first edition (ISO 25239-4:2011), which has been technically revised.

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

- to be entered closer to publication

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](http://www.iso.org/members.html).

## ISO/DIS 25239-4:2019(E)

### 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. Then, 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.

The parts of this document are:

Part 1: Vocabulary, defines terms specific to FSW.

Part 2: Design of weld joints, specifies design requirements for friction stir weld joints in aluminium.

Part 3: Qualification of welding operators, specifies requirements for the qualification of a welding operator for the FSW of aluminium.

Part 4: Specification and qualification of welding procedures, specifies requirements for the specification and qualification of welding procedures for the FSW of aluminium. A welding procedure specification (WPS) is needed to provide a basis for planning welding operations and for quality control during welding. Welding is considered a special process in the terminology of standards for quality systems. Standards for quality systems usually require that special processes be carried out in accordance with written procedure specifications. Metallurgical deviations constitute a special problem. Because non-destructive testing of the mechanical properties is impossible at the present level of technology, this has resulted in the establishment of a set of rules for qualification of the welding procedure prior to the release of the WPS to actual production. ISO 25239-4 defines these rules.

Part 5: Quality and inspection requirements, specifies a method for determining the capability of a fabricator to use the FSW process for the production of aluminium products of the specified quality. It defines specific quality requirements but does not assign those requirements to any specific product group. 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 have to be correctly formulated and qualified to avoid imperfections. To ensure the fabrication of a quality product, management should understand the sources of potential trouble and introduce appropriate quality and inspection procedures. Supervision should be implemented to ensure that the specified quality is achieved.



# Friction stir welding — Aluminium —

## Part 4: Specification and qualification of welding procedures

### 1 Scope

This part of ISO 25239 specifies the requirements for the specification and qualification of welding procedures for the friction stir welding (FSW) of aluminium. In this document, the term “aluminium” refers to aluminium and its alloys.

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

NOTE Service requirements, materials or manufacturing conditions can require more comprehensive testing than is specified in this document.

### 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 209, *Aluminium and aluminium alloys — Chemical composition*

ISO 857-1, *Welding and allied processes — Vocabulary — Part 1: Metal welding processes*

ISO 3134 (all parts), *Light metals and their alloys — Terms and definitions*

ISO 4136, *Destructive tests on welds in metallic materials — Transverse tensile test*

ISO 5173, *Destructive tests on welds in metallic materials — Bend tests*

ISO 6520-1, *Welding and allied processes — Classification of geometric imperfections in metallic materials — Part 1: Fusion welding*

ISO 9017, *Destructive tests on welds in metallic materials — Fracture test*

ISO 10042, *Welding — Arc-welded joints in aluminium and its alloys — Quality levels for imperfections*

ISO 15607:2003, *Specification and qualification of welding procedures for metallic materials — General rules*

ISO 15613, *Specification and qualification of welding procedures for metallic materials — Qualification based on pre-production welding test*

ISO 15614-2, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 2: Arc welding of aluminium and its alloys*

ISO 17637, *Non-destructive testing of welds — Visual testing of fusion-welded joints*

ISO 17639, *Destructive tests on welds in metallic materials — Macroscopic and microscopic examination of welds*

ISO/TR 17671-1, *Welding — Recommendations for welding of metallic materials — Part 1: General guidance for arc welding*

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

## ISO/DIS 25239-4:2019(E)

ISO 25239-5:2011, *Friction stir welding — Aluminium — Part 5: Quality and inspection requirements*

ISO 80000-1:2009, *Quantities and units — Part 1: General*

### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 209, ISO 857-1, ISO 3134, ISO 6520-1, ISO 10042, ISO 15607, ISO 15613, ISO 15614-2, ISO/TR 17671-1, and 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 Symbols and abbreviated terms

For the purposes of qualification of welding procedures, the abbreviations listed in ISO 15607:2003, Table 1, apply.

### 5 Development and qualification of welding procedures

#### 5.1 General

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

The fabricator shall prepare a preliminary welding procedure specification (pWPS) and shall ensure that it is applicable for production using experience from previous production jobs and 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 6](#) (welding procedure test) or [Clause 7](#) (pre-production welding test). [Clause 6](#) shall be used when the production part or joint geometry is accurately represented by a standardized test piece or pieces, as shown in [6.2](#). [Clause 7](#) shall be used when the production part or joint geometry is not accurately represented by the standardized test pieces, as shown in [6.2](#). The information required in a pWPS is given in [5.2](#).

NOTE For some applications, it can be necessary to supplement or reduce the content of the pWPS given in [5.2](#).

A welding procedure specification (WPS) covers a certain range of parent material thicknesses as well as a range of aluminium alloys.

Ranges and tolerances in accordance with the relevant International Standard (see [Clause 2](#)) and the fabricator's experience shall be specified when appropriate.

An example of a pWPS form for force and position controlled friction stir welding is shown in [Annex A](#).

Alternative process control methods can be used such as temperature control. Essential variables of the alternative process control method need to be documented in the pWPS.

#### 5.2 Technical content of a pWPS

##### 5.2.1 General

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

### 5.2.2 Fabricator information

- identification of the fabricator
- identification of the pWPS

### 5.2.3 Parent material type(s), temper(s), and reference standard(s)

### 5.2.4 Parent material dimensions

- thickness of the members comprising the welded joint
- outside diameter of tube

### 5.2.5 Equipment identification

- model
- serial number
- Equipment manufacturer

### 5.2.6 Tool identification

- material
- drawing or drawing number

### 5.2.7 Clamping arrangement

- method and type of jiggling, fixtures, rollers, and backing (dimensions and material)
- tack welding process and conditions, when required — the pWPS shall indicate any required tack welding or prohibited tack welding
- assembly requirements (i.e. welding gap, misalignment)

### 5.2.8 Joint design

- sketch of the welded joint design and dimensions
- weld run sequence and direction
- run-on and run-off plates, material type, reference standard, dimensions and method of attachment (if required)
- placement of exit hole

### 5.2.9 Joint preparation and cleaning methods

### 5.2.10 Welding details

- tool motion (e.g. rotation in either the clockwise or anticlockwise direction, rotation speed including downward and upward motion)
- tool position (e.g. heel plunge depth) or axial force, as applicable
- tool cooling (internal, external, cooling medium), if applicable
- tilt angle

**ISO/DIS 25239-4:2019(E)**

- side tilt angle, lateral offset
- dwell time at start of weld
- dwell time at end of weld
- joint configuration
- weld overlap area (WOA) for a butt joint or lap joint in tube
- lap joint: advancing or retreating side near the upper sheet edge, direction of welding, depth of probe penetration in lower sheet

**5.2.11 Welding speed**

- welding speed, including details of any changes during welding
- ramp-up/ramp-down or upslope/downslope speeds when applied

**5.2.12 Welding position**

- applicable welding positions

**5.2.13 Thermal management**

- details of any pre-weld heat treatment, if applicable
- details of the preheating temperature, preheat maintenance temperature and/or interpass temperature for the base materials or the friction stir welding tool, if applicable (use of ISO 13916 is recommended)
- details of any postweld heat treatment (solution heat treatment, ageing, stress relieving...), if applicable
- details of any methods for managing the cooling rates (gas flows, liquid environments...) applied prior, during or after welding, if applicable

**5.2.14 Postweld (mechanical) processing**

- - methods to correct distortion and straighten parts, removal of toe flash or any other postweld processing of the weldment

**6 Qualification based on a welding procedure test****6.1 General**

The preparation, welding, and testing of test pieces shall be in accordance with [6.2](#) and [6.3](#).

Fulfilment of the requirements of this part of ISO 25239 can also serve to qualify the welding operator (see ISO 25239-3).

**6.2 Test pieces****6.2.1 Shape and dimensions of test pieces****6.2.1.1 General**

The length or number of test pieces shall be sufficient to allow all required tests to be performed.