

---

---

**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*



This document is a preview generated by EKO



**COPYRIGHT PROTECTED DOCUMENT**

© ISO 2020

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  
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>iv</b>
<b>Introduction</b>	<b>v</b>
<b>1 Scope</b>	<b>1</b>
<b>2 Normative references</b>	<b>1</b>
<b>3 Terms and definitions</b>	<b>1</b>
<b>4 Development and qualification of welding procedures</b>	<b>2</b>
4.1 General	2
4.2 Technical content of a pWPS	2
<b>5 Qualification based on a welding procedure test</b>	<b>4</b>
5.1 General	4
5.2 Test pieces	4
5.2.1 Shape and dimensions of test pieces	4
5.2.2 Welding of test pieces	6
5.3 Examination and testing of test pieces	6
5.3.1 Extent of testing	6
5.3.2 Visual testing and acceptance levels	7
5.3.3 Destructive tests	7
5.3.4 Re-testing	12
5.4 Range of qualification	12
5.4.1 General	12
5.4.2 Related to the fabricator	12
5.4.3 Other variables	12
5.5 Welding procedure qualification record	12
<b>6 Qualification based on pre-production welding test</b>	<b>13</b>
6.1 General	13
6.2 Test pieces	13
6.3 Examination and testing of test pieces	13
6.4 Range of qualification	13
6.5 Welding procedure qualification record	13
<b>Annex A (informative) Example of a 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) Example welding procedure qualification record form (WPQR)</b>	<b>18</b>
<b>Bibliography</b>	<b>22</b>

## 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*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 121, *Welding and allied processes*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

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

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

- alternative process control methods (e.g. temperature control) have been included;
- the wording of the paragraph on thermal management and heat treatments has been improved;
- the definition for the extraction of test specimens has been modified for all test pieces and the figures have been revised accordingly;
- the requirement for testing transverse test specimens with as welded surfaces has been deleted;
- in [Table 3](#), a new requirement on the minimum joint efficiency has been added for heat treatable alloys below 5 mm;
- the pWPS is now to be qualified in accordance with the defined acceptance levels included in ISO 25239-5;
- acceptance levels have been included in the WPQR form in [Annex D](#).

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).

## 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 4: Specification and qualification of welding procedures

### 1 Scope

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

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

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

ISO 15607:2019, *Specification and qualification of welding procedures for metallic materials — General rules*

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

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

ISO/TR 25901 (all parts), *Welding and allied processes — Vocabulary*

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 25239-1 and ISO/TR 25901 (all parts) 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/>