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Friction stir spot welding — Aluminium —

Part 5: Quality and inspection requirements

Soudage par friction-malaxage par points — Aluminium —

Partie 5: Exigences de qualité et de contrôle

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Foreword

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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.

Friction stir spot welding — Aluminium —

Part 5: Quality and inspection requirements

1 Scope

This document specifies a method to determine the capability of a manufacturer to use friction stir spot welding (FSSW) for production of products of the specified quality.

It specifies quality requirements, but does not assign those requirements to any specific product group.

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 3452 (all parts), *Non-destructive testing — Penetrant testing*

ISO 9015-1, *Destructive tests on welds in metallic materials — Hardness testing — Part 1: Hardness test on arc welded joints*

ISO 9015-2, *Destructive tests on welds in metallic materials — Hardness testing — Part 2: Microhardness testing of welded joints*

ISO 9712, *Non-destructive testing — Qualification and certification of NDT personnel*

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

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

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

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

ISO 18785-3, *Friction stir spot welding — Aluminium — Part 3: Qualification of welding personnel*

ISO 20807, *Non-destructive testing — Qualification of personnel for limited application of non-destructive testing*

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 Quality requirements

4.1 General

These requirements relate only to those aspects of product quality that may be influenced by FSSW.

4.2 Welding personnel

4.2.1 General

Manufacturers shall have at their disposal sufficient and competent personnel for the planning, performing and supervising of FSSW production operations in accordance with specified requirements.

4.2.2 Weld setter and welding operator

Weld setters and welding operators shall be qualified in accordance with ISO 18785-3. Qualification records shall be kept up to date.

4.3 Inspection and testing personnel

4.3.1 General

The manufacturer shall have sufficient and competent personnel for the planning, performing, and supervising of inspecting and testing operations during FSSW production operations in accordance with specified requirements.

4.3.2 Personnel performing non-destructive testing and visual testing

Non-destructive and visual testing personnel shall be qualified in accordance with ISO 9712 or ISO 20807 or equivalent. When the use of an examination method not presently incorporated in these ISO standards is specified, the manufacturer shall be responsible for developing the training program, written practice, examination, and practical demonstrations equivalent to the requirements of these ISO standard(s). These shall establish the capability of the personnel performing the required examination.

4.3.3 Destructive testing personnel

Personnel performing destructive testing shall be trained for those test methods.

4.4 Equipment

4.4.1 Suitability of equipment

The equipment shall be adequate for the application concerned.

Welding equipment (for example, welding equipment and FSSW tools) shall be capable of producing welds that do not exhibit any of the imperfections given in Annex A. Acceptance levels shall be defined prior to commencing welding.

Welding equipment shall be maintained in good condition and shall be repaired or adjusted when a weld setter, welding operator, inspector, or welding coordinator is concerned about the capability of the equipment to operate satisfactorily.

4.4.2 Equipment acquisition

After installation of new or refurbished equipment, tests shall be performed as agreed between the equipment manufacturer/supplier and user of the equipment. Such tests shall verify the equipment functions correctly.

4.4.3 Validation tests for qualified machine welding settings

Reproducibility tests shall be performed to demonstrate that the welding equipment can repeatedly produce welds that meet the acceptance levels. Acceptance levels shall be within the specified limit of the relevant requirements or the design specification. Validation tests shall be carried out when any of the following occurs:

— an event occurs that changes the functionality of the machine;

— repair or preventative maintenance of the machine that changes the functionality of the machine;

— equipment is upgraded or modified;

— equipment is dislodged or moved in a manner for which it was not designed;

— stationary equipment is moved from one location to another.

The reproducibility test shall be performed in accordance with a WPS that is used in production for that machine.

A representative number of acceptable welds, at least three, shall be made and found satisfactory.

4.4.4 Equipment maintenance

The manufacturer shall have a documented plan for equipment maintenance. The plan shall ensure that maintenance checks are performed on the equipment that controls variables listed in the relevant WPS(s). The maintenance plan may be limited to those items that are essential for producing welds that meet the quality requirements of this document.

Examples of these items are as follows:

— condition of guides and mechanised fixtures;

— condition of meters and gages that are used for the operation of the welding equipment;

— condition of cables, hoses, and connectors;

— condition of the control systems in mechanised and/or automatic welding equipment;

— condition of thermocouples and other temperature measurement instruments;

— condition of clamps, jigs, and fixtures.

Before welding, clamps, jigs, and fixtures that contact the work pieces shall be sufficiently free of contaminants (for example, oil, grease, and dirt) that can have a detrimental effect on the weld.

4.5 Welding procedure specification (WPS)

The welding coordinator, or the person responsible designated by the manufacturing organization shall ensure the WPS is used correctly in production.

4.6 Friction stir spot welding tool

4.6.1 Identification

The FSSW tool that is used in production shall be permanently marked with its drawing or part number.

4.6.2 FSSW tool inspection

Before welding, the FSSW tool shall be sufficiently free of contaminants (e.g. oil, grease or dirt) that can have a detrimental effect on weld quality. The correct tool geometry is critical for producing a