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Specification and qualification of welding procedures for metallic materials — Welding procedure test —

Part 5: Arc welding of titanium, zirconium and their alloys

*Descriptif et qualification d'un mode opératoire de soudage pour
les matériaux métalliques — Épreuve de qualification d'un mode
opératoire de soudage —*

Partie 5: Soudage à l'arc sur titane, zirconium et leurs alliages

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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 document 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).

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This document was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 10, *Quality management in the field of welding*, 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 15614-5:2004), which has been technically revised.

The main changes are as follows:

- normative references updated;
- [Table 2](#) and [Table 3](#) revised using the same format as ISO 15614-1;
- reference to EN 439 replaced with ISO 14175;
- process numbers updated in accordance with ISO 4063;
- [Annex A](#) updated.

A list of all parts in the ISO 15614 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. Official interpretations of ISO/TC 44 documents, where they exist, are available from this page: <https://committee.iso.org/sites/tc44/home/interpretation.html>.

Introduction

All new welding procedure tests are intended to be carried out in accordance with this document. However, this document does not invalidate previous welding procedure tests made to former national standards or specifications or the previous edition of this document.

Where additional tests have to be carried out to make a qualification technically equivalent, these should be done on a test piece which is made in accordance with this document.

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Specification and qualification of welding procedures for metallic materials — Welding procedure test —

Part 5: Arc welding of titanium, zirconium and their alloys

1 Scope

This document specifies how a preliminary welding procedure specification (pWPS) is qualified by welding procedure tests.

This document specifies the conditions for the execution of welding procedure tests and the qualification range for welding procedures for all practical welding operations within the range of variables listed in [Clause 8](#).

This document specifies the required tests. Additional tests can be required by application standards.

This document applies to the arc welding of titanium, zirconium and their alloys in all product forms. Arc welding is covered by the following processes in accordance with ISO 4063:

131 – metal inert gas welding, MIG welding;

14 – tungsten inert gas welding, TIG welding;

15 – plasma arc welding.

The principles of this document can be applied to other fusion welding processes.

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 3452-1, *Non-destructive testing — Penetrant testing — Part 1: General principles*

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

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

ISO 5817, *Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections*

ISO 6947, *Welding and allied processes — Welding positions*

ISO 9606-5, *Approval testing of welders — Fusion welding — Part 5: Titanium and titanium alloys, zirconium and zirconium alloys*

ISO 14175, *Welding consumables — Gases and gas mixtures for fusion welding and allied processes*

ISO 14732, *Welding personnel — Qualification testing of welding operators and weld setters for mechanized and automatic welding of metallic materials*

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

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ISO 15609-1, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 1: Arc welding*

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

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

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 15607 and ISO/TR 25901 (all parts) apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

4 Preliminary welding procedure specification (pWPS)

A pWPS shall be prepared in accordance with ISO 15609-1.

5 Welding procedure test

The welding and testing of test pieces shall be in accordance with [Clauses 6](#) and [7](#).

A welder or welding operator who undertakes the welding procedure test satisfactorily in accordance with this document shall be considered qualified for the appropriate qualification range in accordance with ISO 9606-5 or ISO 14732, providing that the relevant testing requirements are met.

6 Test pieces

6.1 General

The welded joint to which the welding procedure will relate in production shall be represented by making a standardized test piece or pieces, as specified in [6.2](#). Where the production or joint geometry requirements do not represent the standardized test pieces as shown in this document, ISO 15613 shall be used.

6.2 Shape and dimensions of test pieces

6.2.1 General

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

Additional test pieces, or test pieces longer than the minimum size, may be prepared in order to allow for extra and/or for retesting specimens (see [7.7](#)).

For all test pieces, except branch connections (see [Figure 4](#)) and fillet welds (see [Figure 8](#)), the material thickness, t , shall be the same for both plates or pipes to be welded.

The thickness and/or outside pipe diameter of the test pieces shall be selected in accordance with [8.3.2.1](#) to [8.3.2.4](#).

The shape and minimum dimensions of the test pieces shall be as given in [6.2.2](#) to [6.2.5](#).

6.2.2 Butt joint in plate with full penetration

The test pieces shall be prepared in accordance with [Figure 1](#).

6.2.3 Butt joint in pipe with full penetration

The test pieces shall be prepared in accordance with [Figure 2](#).

NOTE The word “pipe”, alone or in combination, is used to mean “pipe”, “tube” or “hollow section”, except square or rectangular hollow section.

6.2.4 T-joint

The test pieces shall be prepared in accordance with [Figure 3](#). These can be used for fully penetrated butt welds or fillet welds.

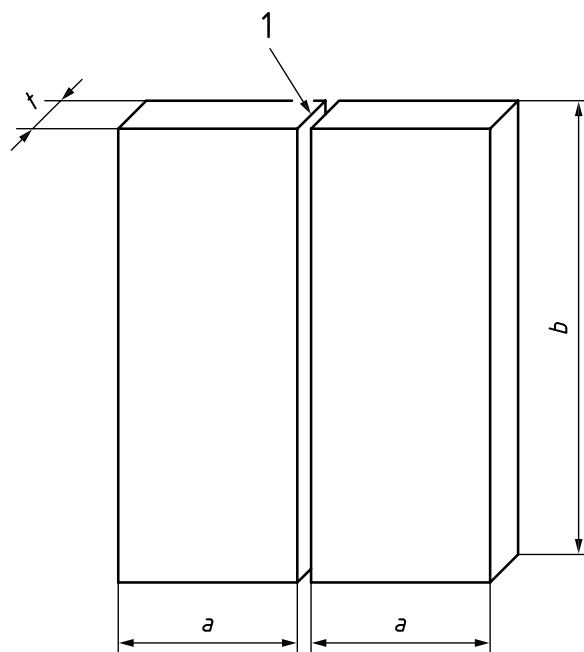
6.2.5 Branch connection

The test pieces shall be in accordance with [Figure 4](#). The angle α is the minimum to be used in production. These can be used for fully penetrated joints (set-on or set-in or set-through joint) and for fillet welds.

6.3 Welding of test pieces

Preparation and welding of test pieces shall be carried out in accordance with the pWPS and under the general conditions of welding in production which they shall represent. Welding positions and limitations for the angle of slope and rotation of the test piece shall be in accordance with ISO 6947. If tack welds are to be fused into the final joint, they shall be included in the test piece.

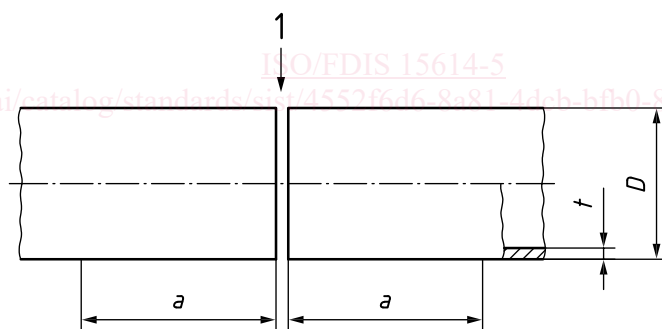
Welding and testing of the test pieces shall be witnessed by an examiner or examining body.



Key

- 1 joint preparation and fit-up as detailed in the pWPS
- a minimum value 150 mm
- b minimum value 300 mm
- t material thickness

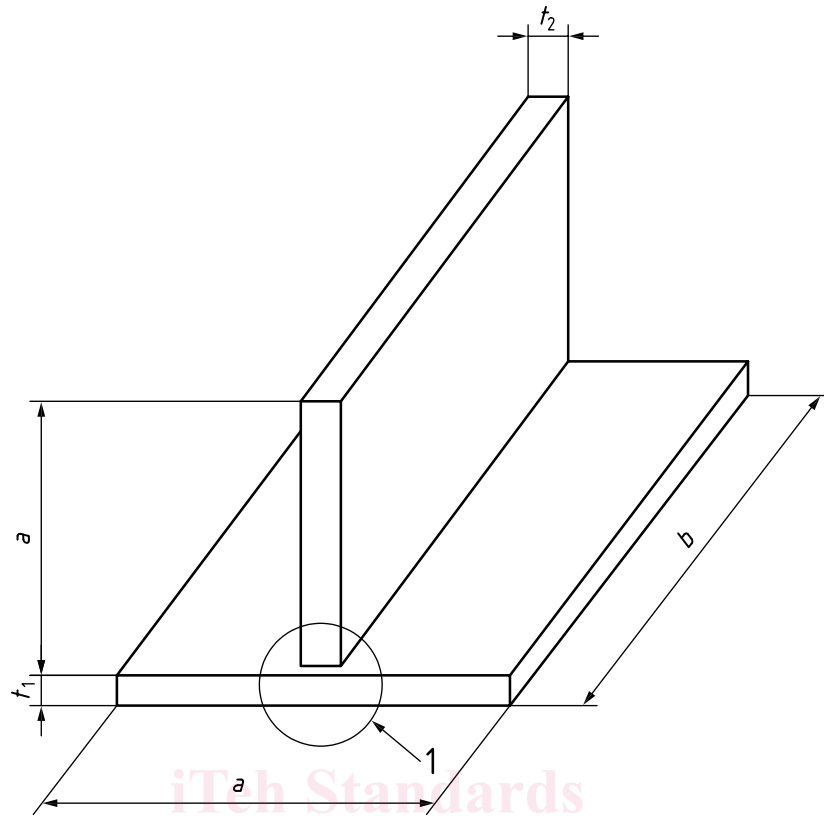
Figure 1 — Test piece for a butt joint in plate with full penetration



Key

- 1 joint preparation and fit-up as detailed in the pWPS
- a minimum value 150 mm
- D outside pipe diameter
- t material thickness

Figure 2 — Test piece for a butt joint in pipe with full penetration

**Key**

- 1 joint preparation and fit-up as detailed in the pWPS
- a minimum value 150 mm
- b minimum value 350 mm
- t_1, t_2 material thickness

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Figure 3 — Test piece for a T-joint