
**Approval testing of welders — Fusion
welding —**

Part 5:

**Titanium and titanium alloys, zirconium and
zirconium alloys**

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*Épreuve de qualification des soudeurs — Soudage par fusion —
Partie 5: Titane et ses alliages, zirconium et ses alliages*

ISO 9606-5:2000

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to member bodies for voting. Publication as an International Standard requires approval by at least 75 % of member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this part of ISO 9606 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 9606-5 was prepared by the European Committee for Standardization (CEN) in collaboration with ISO Technical Committee TC 44, *Welding and allied processes*, Subcommittee SC 11, *Approval requirements for welding and allied processes personnel*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Throughout the text of this standard, read ".this European Standard." to mean "...this International Standard...".

ISO 9606 consists of the following parts, under the general title *Approval testing of welders — Fusion welding:*

- *Part 1: Steels* <https://standards.iteh.ai/catalog/standards/sist/02cdcd36-dd56-4063-bd5e-6a8e8944d2c6/iso-9606-5-2000>
- *Part 2: Aluminium and aluminium alloys*
- *Part 3: Copper and copper alloys*
- *Part 4: Nickel and nickel alloys*
- *Part 5: Titanium and titanium alloys, zirconium and zirconium alloys*
- *Part 6: Magnesium and magnesium alloys*

Annexes A and ZA of this part of ISO 9606 are for information only.

Annex ZA provides a list of corresponding International and European Standards for which equivalents are not given in the text.

For the purposes of this part of ISO 9606, the CEN annex regarding fulfilment of European Council Directives has been removed.

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Foreword

The text of EN ISO 9606-5:2000 has been prepared by Technical Committee CEN/TC 121 "Welding", the secretariat of which is held by DS, in collaboration with Technical Committee ISO/TC 44 "Welding and allied processes".

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by August 2000, and conflicting national standards shall be withdrawn at the latest by August 2000.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

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Introduction

This standard covers the principles to be observed in the approval testing of welder performance for the fusion welding of titanium, zirconium and their weldable alloys.

The ability of the welder to follow verbal or written instructions and testing of his skill are important factors in ensuring the quality of the welded product.

Testing of skill to this standard depends on welding methods in which uniform rules and test conditions are complied with, and standard test pieces are used.

The test weld can be used to approve a welding procedure and a welder provided that all the relevant requirements, e.g. test piece dimensions, are satisfied (see EN 288-2).

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1 Scope

This standard specifies essential requirements, ranges of approval, test conditions, acceptance requirements and certification for the approval testing of welder performance for the welding of titanium and zirconium.

This standard applies to the approval testing of welders for the fusion welding of titanium and zirconium.

This standard is intended to provide the basis for the mutual recognition by examining bodies for approval relating to welders' competence in the various fields of application. Tests will be carried out in accordance with this standard unless more severe tests are specified by the relevant application standard when these are applied.

During the approval test the welder should be required to show adequate practical experience and job knowledge (test non mandatory) of the welding processes, materials and safety requirements for which he is to be approved. Information on these aspects is given in Annex A.

This standard is applicable when the welder's approval testing is required by the purchaser, by inspection authorities or by other organizations.

The welding processes referred to in this standard include those fusion welding processes which are designated as manual or partly mechanized welding. It does not cover fully mechanized and automatic processes (see 5.2).

This standard covers approval testing of welders for work on semi-finished and finished products made from wrought, forged or cast material types listed in 5.4.

The certificate of approval testing is issued under the sole responsibility of the examiner or examining body.

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2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 287-1 : 1992

Approval testing of welders – Fusion welding – Part 1: Steels

EN 288-2 : 1992

Specification and approval of welding procedures for metallic materials – Part 2: Welding procedure specification for arc welding

EN 571-1

Non destructive testing – Penetrant testing – Part 1: General principles

EN 910

Destructive tests on welds in metallic materials – Bend tests

EN 970

Non-destructive examination of fusion welds – Visual examination

EN 1289

Non-destructive examination of welds – Penetrant testing of welds – Acceptance levels

EN 1320

Destructive tests on welds in metallic materials – Fracture test

EN 1321

Destructive tests on welds in metallic materials – Macroscopic and microscopic examination of welds

EN 1435

Non-destructive examination of welds – Radiographic examination of welded joints

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EN ISO 4063

Welding and allied processes – Nomenclature of processes and reference numbers (ISO 4063 : 1998)

EN ISO 6520-1

Welding and applied processes - Classification of geometric imperfections in metallic materials - Part 1: Fusion welding (ISO 6520-1:1998)

EN 25817

Arc-welded joints in steel – Guidance on quality levels for imperfections (ISO 5817 : 1992)

EN ISO 6947

Welds – Working positions – Definitions of angles of slope and rotation (ISO 6947 : 1993)

CR 12187

Welding – Guidelines for a grouping system of materials for welding purposes

ISO 857

Welding, brazing and soldering processes – Vocabulary

3 Terms and definitions

For the purposes of this standard, the terms and definitions given in EN 287-1 apply.

4 Symbols and abbreviations

4.1 General

Where the full wording is not used, the following symbols and abbreviations shall be used when completing the test certificate (see Annex B of EN 287-1 : 1992).

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4.2 Test piece

a nominal throat thickness;
BW butt weld;
D outside diameter of pipe;
FW fillet weld;
P plate;
t plate or pipe wall thickness;
T pipe;
z leg length of fillet weld.

4.3 Consumables

nm no filler metal;
wm with filler metal.

4.4 Miscellaneous

bs welding from both sides;
gg back grinding or back milling of welds;
mb welding with backing;
nb welding without backing;
ng no back grinding or back milling of welds;
ss single-side welding.

5 Essential variables for approval testing

5.1 General

The criteria specified in this clause shall be examined in order to identify the ability of the welder in these areas. Each criterion is considered to be a significant factor in the approval testing.

The welder's approval test shall be carried out on test pieces and is independent of the type of construction.

5.2 Welding processes

Welding processes are defined in accordance with ISO 857 and reference numbers of welding processes for symbolic representation are listed in accordance with EN ISO 4063.

This standard covers the following welding processes:

- 131 – metal-arc inert gas welding (MIG welding);
- 141 – tungsten inert gas arc welding (TIG welding);
- 15 – plasma arc welding;

Other fusion welding processes by agreement.

5.3 Joint types (butt and fillet welds)

Test pieces shall be produced for butt weld (BW) and fillet weld (FW) in plates (P) or pipes¹⁾ (T) for approval tests in accordance with 7.2.

5.4 Material groups

An approval test carried out on any material in groups 51, 52, 53 or 54 according to CR 12187 or 61 or 62 according to CR 12187 covers all materials within these groups. In cases where the production work is predominantly zirconium welding, the welder shall carry out the approval test on zirconium.

5.5 Consumables

In the approval test, the filler metal and the shielding gas, including plasma gas, shall be compatible with the parent metal and the process used in accordance with the relevant pWPS or WPS (see EN 288-2).

5.6 Dimensions

The welder approval test should be based on the thickness of the material (i.e. plate thickness or wall thickness of pipe) and pipe diameters which the welder will use in production. A test is listed for each of the ranges of plate thickness and pipe wall thickness or pipe diameter as specified in tables 1 and 2.

Table 1 - Test piece thickness (plate or pipe) and range of approval

Test piece thickness t mm	Range approval
$t \leq 3$	t to $2,5 t$
$t > 3$	> 3

¹⁾ The word "pipe" alone or in combination, is used to mean "pipe", "tube" or "hollow section".

Table 2 - Test piece diameter and range of approval

Test piece diameter <i>D</i> mm	Range approval
$D \leq 25$	D to $2D$
> 25	$\geq 0,5 D$ (25 mm min.)

5.7 Number of test pieces

Plate: One test piece per position.

Pipe: A minimum weld length of 150 mm is required, but not more than three test pieces.

5.8 Welding positions

The welding positions shall be taken from EN ISO 6947.

The test pieces shall be welded in accordance with the nominal angles of the positions according to EN ISO 6947.

6 Range of approval for the welder

6.1 General

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As a general rule, the test piece approves the welder not only for the conditions used in the test, but also for all joints which are considered easier to weld. The range of approval for each type of test is given in the relevant sub-clauses and tables. In these tables the range of approval is indicated in the same horizontal line.

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6.2 Welding process

Each test normally approves one process. A change of process requires a new approval test. However, it is possible for a welder to be approved for more than one welding process by a single test or by two separate approval tests to be used to cover a multi-process joint. For example in a case where approval is required for a single-side butt joint with the root to be welded by TIG (141) without backing and to be filled by MIG (131), the welder can be approved by either of the following routes:

- a) a successful completion of an approval test simulating the multi-process joint, i. e. the root run welded by TIG (141) without backing, subsequent runs or layers welded by MIG (131) within the limits of the range of approval for each welding process;
- b) successful completion of separate relevant approval tests one for TIG (141) without backing for the root run and a separate test for the fill by MIG (131) with backing or welded from both sides with or without back grinding or milling.

6.3 Joint types

Depending on the test piece, the range of welds for which the welder is approved is shown in table 3. The following criteria are applicable:

- a) approval for butt welds in pipes, diameter > 25 mm, includes butt welds in plates;
- b) approval for butt welds in plates in all relevant positions covers butt welds on pipes having an outside diameter ≥ 500 mm, except item c) also applies;
- c) approval for butt joints in plates welded in the flat (PA) or horizontal (PC) position shall include approval for butt joints in pipes of outside diameter ≥ 150 mm welded in similar positions according to table 6;
- d) butt welds approve fillet welds. In cases where the majority of production work is fillet welding, the welder shall be approved also by an appropriate fillet welding test;
- e) approval for butt welds in pipes without backing includes approval for branch connections within the same range of approval as in tables 3 to 6. For a branch weld the range of approval is based on the diameter of the branch;
- f) in cases where the majority of production work is predominantly branch welding or involves a complex branch connection, the welder should receive special training. In some cases a welder approval test on a branch connection can be necessary.

Table 3 - Range of approval for tests on butt joints (Details of the weld type)

Details of the weld type				Range of approval					
				Butt welds in plate				Butt welds in pipe	
				welded from one side ss		welded from both sides bs		welded from one side ss	
				with baking mb	no baking nb	with grinding gg	no grinding ng	with baking mb	no baking nb
Butt weld in plate	welded from one side ss	with baking	mb	★	—	×	—	¹⁾	—
		no baking	nb	×	★	×	×	¹⁾	¹⁾
	welded from both sides bs	with grinding	gg	×	—	★	—	¹⁾	—
								¹⁾	—
Butt weld in pipe	welded from one side ss	with baking	mb	×	—	×	—	★	—
		no baking	nb	×	×	×	×		★

¹⁾ See 6.3b), and 6.3c)

★ indicates the weld for which the welder is approved in the approval test
 × indicates those welds for which the welder is also approved
 — indicates those welds for which the welder is not approved