
**Specification and qualification of
welding procedures for production
welding of steel castings**

*Descriptif et qualification de modes opératoires de soudage pour le
soudage de production des aciers moulés*

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ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

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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 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 on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](http://www.iso.org/foreword)

The committee responsible for this document is ISO/TC 17, *Steel*, Subcommittee SC 11, *Steel castings*.

This second edition cancels and replaces the first edition (ISO 11970:2001), which has been technically revised. In particular, [Figures 1, 2 and 3](http://www.iso.org/standards/iso-11970-2016) have been redrawn to clarify labels.

Introduction

All welding procedure qualifications for production welding of steel castings are intended to be in accordance with this International Standard.

Previous procedure qualifications that conform to the range of qualification of [Clause 8](#) are valid under this International Standard.

Where additional tests have to be carried out to complete the qualification, it is only necessary to perform the additional tests to the requirements of [Clauses 6](#) and [7](#).

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Specification and qualification of welding procedures for production welding of steel castings

1 Scope

This International Standard specifies how a welding procedure specification (WPS) for production welding of steel castings is qualified.

It defines the conditions for the execution of welding procedure qualification tests and the limits of validity of a qualified welding procedure for all practical welding operations within the range of essential variables.

Tests are intended to be carried out in accordance with this International Standard unless additional tests are specified by the purchaser or by agreement between the contracting parties.

This International Standard applies to the arc welding of steel castings. The principles of this International Standard can be applied to other fusion welding processes subject to agreement between the contracting parties.

In the case of specific service, material or manufacturing conditions, tests more comprehensive than those specified by this International Standard can be specified by the purchaser, in order to gain more information, e.g. longitudinal weld tensile tests, bend tests, chemical analyses, ferrite determination in austenitic stainless steels, elongation, Charpy "V" impact tests, and radiography.

2 Normative references

ISO 11970:2016

<https://standards.iteh.ai/catalog/standards/sist/cacbe8c6-2993-4c96-a6e1-9b6819557f51/iso-11970-2016>

The following documents, in whole or in part, are normatively referenced in this document and are indispensable to its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 148-1, *Metallic materials — Charpy pendulum impact test — Part 1: Test method*

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

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

ISO 4969, *Steel — Macroscopic examination by etching with strong mineral acids*

ISO 4986, *Steel castings — Magnetic particle inspection*

ISO 4987, *Steel castings — Liquid penetrant inspection*

ISO 4992-1, *Steel castings — Ultrasonic examination — Part 1: Steel castings for general purposes*

ISO 4992-2, *Steel castings — Ultrasonic examination — Part 2: Steel castings for highly stressed components*

ISO 4993, *Steel and iron castings – Radiographic inspection*

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

ISO 6507-1, *Metallic materials — Vickers hardness test — Part 1: Test method*

ISO 6892-1, *Metallic materials – Tensile testing – Part 1: Method of test at room temperature*

ISO 9016, *Destructive tests on welds in metallic materials — Impact tests — Test specimen location, notch orientation and examination*

ISO 9606-1, *Qualification testing of welders — Fusion welding — Part 1: Steels*

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

ISO 15612, *Specification and qualification of welding procedures for metallic materials — Qualification by adoption of a standard welding procedure*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 857-1 and ISO 15607 and the following apply.

3.1

production welding

any welding carried out during manufacturing before final delivery to the purchaser

3.1.1

joint welding

production welding used to weld cast components together or weld cast components to wrought steels

3.1.2

finishing welding

production welding carried out in order to ensure the agreed quality of the casting

3.2

repair welding

welding carried out after delivery to the end user, i.e. after the casting has been in service

4 Preliminary welding procedure specification (pWPS)

A preliminary welding procedure specification shall be prepared. It shall specify the range of all the relevant parameters in accordance with ISO 15612.

5 Welding procedure qualification

The making and testing of test specimens representing the type and the position of welding used in production shall be in accordance with [Clauses 6](#) and [7](#).

The welder who undertakes the welding procedure test satisfactorily in accordance with this International Standard is qualified for the appropriate range of qualification according to ISO 9606-1. Additional welders shall be qualified in accordance with [7.6](#).

6 Test piece

6.1 General

The test piece shall be in accordance with those shown in [Figures 1, 2, 3, and 4](#).

Dimensions in the figures are for information only and may be adjusted to meet production and testing requirements.

6.2 Shape and dimensions of test piece

Additional test pieces, or longer test pieces than the minimum size may be prepared in order to allow for extra and/or retesting specimens (in accordance with [7.5](#)).

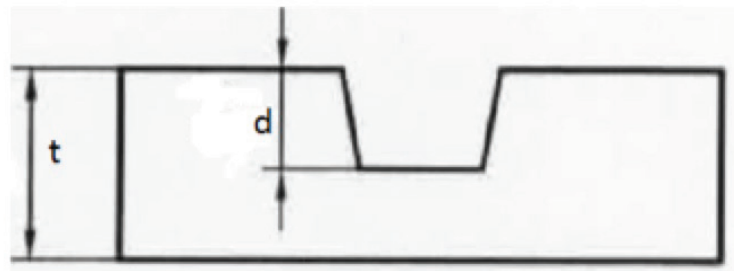
6.3 Welding of sample

The preparation and welding of the sample shall be carried out in accordance with the relevant pWPS. Angular tolerances may be agreed between the contracting parties or by the relevant application standard.

The dimensions and shape of the groove shall be in accordance with [Figures 1, 2, 3, and 4](#).

If tack welds are to be fused into the final joint, they shall be included in the sample.

Unless otherwise specified in the purchase order or contract review, welding and testing of the samples shall be witnessed by an examiner (or test body). When the examiner (or test body) is not specified in the purchase order, the manufacturer may appoint a suitable examiner.



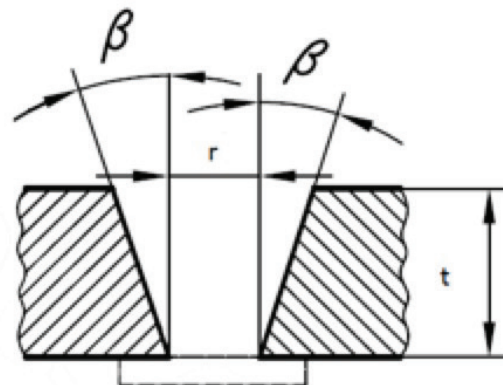
Key

- t base metal thickness > 15 mm
d depth of cavity > 0,5 t. For TIG welding, "d" may be $\leq 0,5 t$

Figure 1 — Weld cross section for weld cavity

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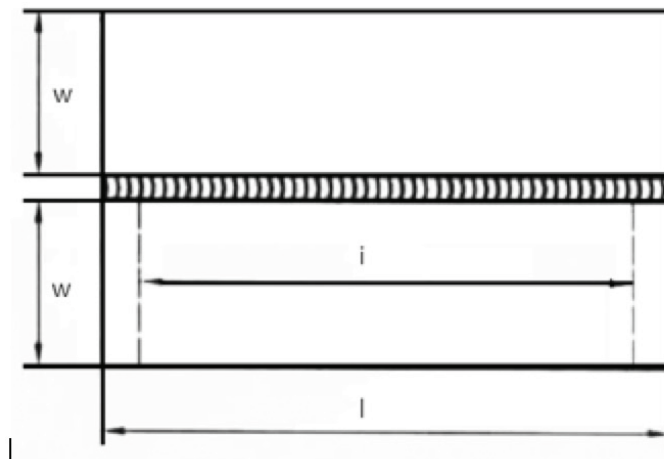
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Key

- t base metal thickness > 15 mm
r root width 15 mm > r > 5 mm
 β groove angle $20^\circ > \beta > 5^\circ$

Figure 2 — Weld joint

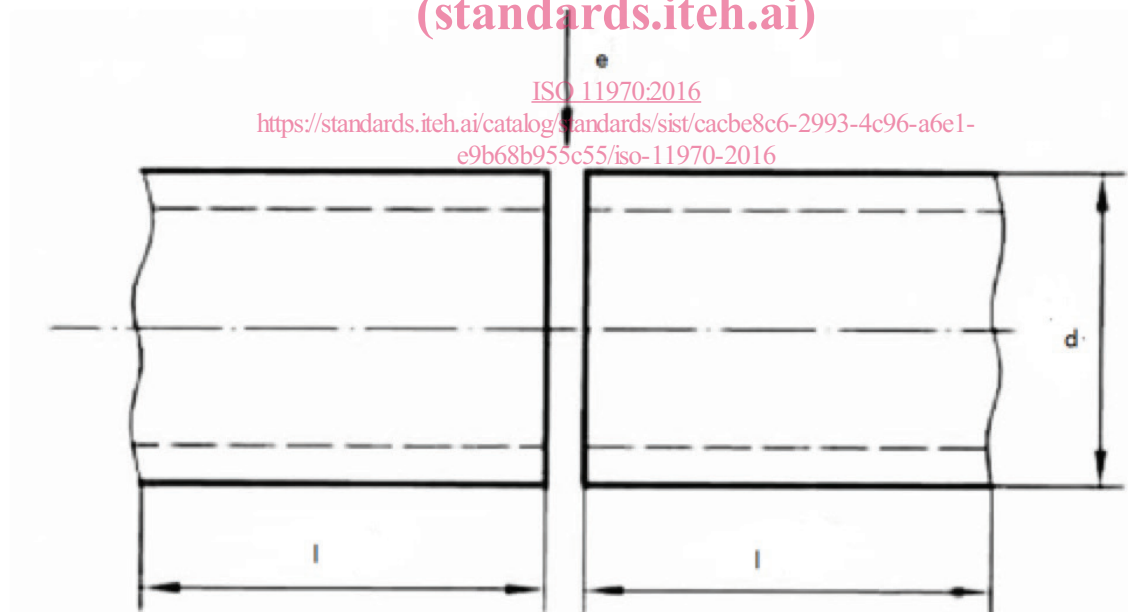


Key

- w width of weld base material ($w = 3t$ or ≥ 50 mm whichever is greater)
- l length of weld ($l = 6t$ or ≥ 350 mm whichever is greater)
- i inspection length ($i = l$ less 50 mm from each end)

Figure 3 — Weld sample (Plate)

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Key

- l length of tube section ($l \geq 150$ mm)
- d outside diameter of the tube
- e edge preparation and fit up as detailed in the preliminary Weld Procedure Specification (pWPS)

Figure 4 — Weld sample (Tube)

7 Examination and testing

7.1 Extent of testing

The examination and testing includes both non-destructive testing (NDT) and destructive testing (DT) which shall be in accordance with the requirements given in [Table 1](#).

Table 1 — Examination and testing of the test pieces

Type of test	Extent
Visual	100 %
Radiographic or ultrasonic	100 %
Surface crack detection	100 %
Transverse tensile test	1 specimen
Impact test ^a	2 sets
Hardness test	if required by the purchase order or by the relevant application standard
Macrostructure-examination	if required by the purchase order or by the relevant application standard
Microstructure-examination	if required by the purchase order or by the relevant application standard
Bend tests	if required by the purchase order or by the relevant application standard
Corrosion tests	if required by the purchase order or by the relevant application standard
Additional tests	if required by the purchase order or by the relevant application standard
^a Impact V-notch tests are only required when the parent metal requires impact testing. The same number of tests is required in the weld metal and HAZ.	

All tests shall be carried out after any required post-weld heat treatment.
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7.2 Location and cutting of test specimens

Location of test specimens shall be in accordance with [Figures 5](#) and [6](#).

Test specimens shall be taken after non-destructive testing (NDT) has given satisfactory results.

7.3 Non-destructive testing

The quality requirements of the HAZ shall be in accordance with the requirements for the parent metal.

The acceptance requirements of the weld deposit shall comply with level C of ISO 5817 except for excess weld metal and excessive convexity for which level D shall apply. Standards for acceptance criteria relating to NDT methods shall be used for the evaluation of imperfections.