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

Part 10:
Hyperbaric dry welding

*Descriptif et qualification d'un mode opératoire de soudage pour les
matériaux métalliques — Épreuve de qualification d'un mode
opératoire de soudage —
Partie 10: Soudage hyperbare en caisson*



Reference number
ISO 15614-10:2005(E)

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Contents

Page

Foreword	iv
Introduction	v
1 Scope	1
2 Normative references	1
3 Terms and definitions	2
4 Preliminary welding procedure specification (pWPS)	2
5 Welding procedure test	3
6 Test piece	3
6.1 General	3
6.2 Shape and dimensions of test pieces	3
6.3 Welding of test pieces	3
7 Examination and testing	4
7.1 Extent of testing	4
7.2 Location and cutting of test specimens	4
7.3 Non-destructive testing	4
7.4 Destructive tests	4
7.5 Re-testing	4
8 Range of qualification	4
8.1 General	4
8.2 Related to the manufacturer	5
8.3 Related to the parent material	5
8.4 Common to all welding procedures	5
8.5 Specific to processes	7
8.6 Specific to hyperbaric environment	7
9 Welding procedure qualification record (WPQR)	8

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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

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.

ISO 15614-10 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*.

ISO 15614 consists of the following parts, under the general title *Specification and qualification of welding procedures for metallic materials — Welding procedure test*:

- *Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys*
- *Part 2: Arc welding of aluminium and its alloys*
- *Part 3: Arc welding of cast iron*
- *Part 4: Finishing welding of aluminium castings*
- *Part 5: Arc welding of titanium, zirconium and their alloys*
- *Part 6: Arc welding of copper and its alloys*
- *Part 7: Overlay welding*
- *Part 8: Welding of tubes to tube-plate joints*
- *Part 9: Arc underwater hyperbaric wet welding*
- *Part 10: Hyperbaric dry welding:*
- *Part 11: Electron and laser beam welding*
- *Part 12: Spot, seam and projection welding*
- *Part 13: Resistance butt and flash welding*

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Introduction

All new welding procedure qualifications are to be carried out in accordance with this part of ISO 15614 from the date of publication.

This part of ISO 15614 does not invalidate previously qualified welding procedures in accordance with other standards or specifications, providing the technical requirements are satisfied and the previous qualifications are relevant to the application and production work on which they are to be employed.

Where additional tests have to be carried out to make the qualification technically equivalent, it is only necessary to do the additional tests in accordance with this part of ISO 15614.

Requested for official interpretations of any aspect of this standard should be directed to the Secretariat of ISO/TC 44 via your national standards body, a complete listing of which can be found at www.iso.org.

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

Part 10: Hyperbaric dry welding

1 Scope

This part of ISO 15614 specifies how to qualify welding procedure specifications for welding in hyperbaric dry environments.

It also specifies the minimum testing requirements necessary for qualification of welding procedures.

This part of ISO 15614 may be used to qualify welding procedures using mechanized and automated welding.

NOTE This part of ISO 15614 is part of a series of standards, details of this series are given in ISO 15607:2003, Annex A.

2 Normative references

The following referenced documents are indispensable for the application 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 4063, *Welding and allied processes — Nomenclature of processes and reference numbers*

ISO 6947, *Welds — Working positions — Definitions of angles of slope and rotation*

ISO 14175, *Welding consumables — Shielding gases for arc welding and cutting*

ISO 15607:2003, *Specification and qualification of welding procedures for metallic materials — General rules*

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

ISO 15618-2, *Qualification testing of welders for underwater welding — Part 2: Diver-welders and welding operators for hyperbaric dry welding*

EN 288-9, *Specification and approval of welding procedures for metallic materials — Part 9: Welding procedure test for pipeline welding on land and offshore site butt welding of transmission pipelines*

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3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 15607 and ISO 15618-2, and the following, apply.

3.1

repair

any operation which involves welding to rectify the weld, outside the normal welding cycle

3.2

full penetration repair

weld repair through the whole thickness of the qualification joint

3.3

internal repair

weld applied to rectify a weld from the inside surface or the root side of a weld, after excavation and re-preparation, using either a single or a multi-pass weld deposition sequence

3.4

make

specific trade or brand name of the consumable, but not its designation

3.5

examiner

person who has been appointed to verify compliance with the applicable standard

NOTE In certain cases, an external independent examiner may be required.

[ISO 15607:2003, definition 3.24¹⁾]

3.6

examining body

organization that has been appointed to verify compliance with the applicable standard

NOTE In certain cases, an external independent examining body may be required.

[ISO 15607:2003, definition 3.25¹⁾]

4 Preliminary welding procedure specification (pWPS)

The preliminary welding procedure specification shall be prepared in accordance with ISO 15609-1. It shall specify all relevant parameters and tolerances, including the following additional items if applicable:

- water depth at which welding is to be carried out;
- gas composition in the hyperbaric chamber or habitat;
- partial pressure of oxygen;
- temperature range in the hyperbaric chamber or habitat;
- relative humidity;
- method of measuring heat input and/or weld deposition rate;

1) This term and definition have been reproduced for clarity.

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- material grade and supply condition;
- number and location of welder-divers (for pipelines);
- partially completed joint;
- type of line-up clamp (for pipelines);
- time of clamp removal (for pipelines);
- preheating procedure;
- post-weld heat-treatment procedure;
- consumables handling and control procedure.

The pWPS should detail the precautions to be taken to prevent damage, corrosion and/or contamination of the consumables due to humidity or other environmental influences.

5 Welding procedure test

Welding shall be performed under simulated or actual site conditions at the appropriate water depth.

The test pieces shall represent the type of welding used in production and shall be prepared and tested in accordance with Clauses 6 and 7.

NOTE The welder-diver or hyperbaric welding operator who undertakes the welding procedure test satisfactorily in accordance with this part of ISO 15614 is qualified for the appropriate range of qualification given in ISO 15618-2.

6 Test piece

6.1 General

The welded assembly, to which the welding procedure will relate to in production, shall be represented by making a standardized test piece or pieces, as specified in 6.2 (see also 8.4.3).

6.2 Shape and dimensions of test pieces

The shape and dimensions for steel test pieces shall be in accordance with ISO 15618-2, except for pipelines where the test welds shall be made between two short sections of pipe (≥ 500 mm).

6.3 Welding of test pieces

Preparation and welding of test pieces shall be carried out in accordance with the pWPS, with removal of line-up clamps, partial completion and recommencement of welding, where applicable. Welds shall be made under the same production conditions which they represent. Welding positions and limitations for the angle of slope 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 as part of the test piece.

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

NOTE In some cases, it may be necessary to carry out a preliminary welding test to provide the information to select the welding conditions for the pWPS.

ISO 15614-10:2005(E)

7 Examination and testing

7.1 Extent of testing

Non-destructive and destructive testing shall be carried out in accordance with ISO 15618-2 for steel structures and EN 288-9 for pipelines.

7.2 Location and cutting of test specimens

The location of test specimens shall be in accordance with ISO 15618-2 for steel structures and EN 288-9 for pipelines.

Test specimens shall be taken only after all non-destructive testing (NDT) has been carried out and which has passed the relevant inspection criteria for the NDT method(s) used. Test specimens may be taken from locations avoiding areas which have imperfections which are within the acceptance limits for the NDT method(s) used (see above).

7.3 Non-destructive testing

7.3.1 Method

All NDT in accordance with 7.1 shall be carried out on the test pieces prior to cutting of the test specimens. Any post-weld heat treatment which is specified shall be completed prior to non-destructive testing.

For materials that are susceptible to hydrogen-induced cracking and where no post-weld heat treatment is specified, non-destructive testing should be delayed for a minimum of 24 h, unless otherwise specified.

7.3.2 Acceptance levels

A welding procedure is qualified if the imperfections in the test piece are within the limits specified in ISO 15618-2 for steel structures and EN 288-9 for pipelines.

7.4 Destructive tests

Destructive testing shall be in accordance with ISO 15618-2 for steel structures and EN 288-9 for pipelines.

7.5 Re-testing

If the test piece fails to comply with any of the requirements for visual examination or non-destructive testing specified in 7.3.2, one further test piece shall be welded and subjected to the same examination. If this additional test piece does not comply with the relevant requirements, the pWPS shall be regarded as not capable of complying with the requirements of this part of ISO 15614 without modification.

If any test specimens fail to comply with the requirements for destructive testing in accordance with 7.4, two further test specimens shall be tested for each one that failed. The extra test specimens can be taken from the same test piece if there is sufficient material or from a new test piece. Each extra test specimen shall be subjected to the same tests as the initial specimen which failed. If either of the extra specimens fails on testing, the pWPS does not comply with this part of ISO 15614.

8 Range of qualification

8.1 General

Each of the conditions given in Clause 8 shall be met in order to comply with this part of ISO 15614.

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Changes outside of the ranges specified shall require a new welding procedure qualification test.

8.2 Related to the manufacturer

A qualified welding procedure specification (WPS) is valid for welding under the same technical conditions and quality control of those who qualified the WPS.

8.3 Related to the parent material

8.3.1 Parent-material grouping

In order to minimize the unnecessary duplication of welding procedure tests, steels shall be grouped in accordance with ISO 15618-2 for steel structures and EN 288-9 for pipelines.

Welds in dissimilar materials require separate qualification.

8.3.2 Parent-metal thickness and pipe diameter

The qualification range for parent-metal thickness and pipe diameter for a welding procedure test shall be in accordance with ISO 15618-2 for steel structures and EN 288-9 for pipelines.

8.4 Common to all welding procedures

8.4.1 Welding process

The qualification is valid only for the welding process or combination of processes used in the welding procedure test. It is not permitted to change a multi-run deposit into a single run (or single run on each side) or vice versa for a given process. In a multi-process procedure, the qualification is only valid for the order of processes used during the qualification test.

8.4.2 Welding positions

The qualification range for welding positions shall be in accordance with ISO 15618-2 for structures and EN 288-9 for pipelines.

8.4.3 Joint type

The joint type to be used in the welding procedure test shall be representative of the joint to be welded in production.

Any change in joint configuration outside the tolerances specified in ISO15618-2 for steel structures and EN 288-9 for pipelines requires requalification of the welding procedure.

8.4.4 Consumables

The range of qualification for covered electrodes and flux-cored consumables is restricted to the same make as that used for the welding procedure test.

Any changes in underwater transportation procedure, storage (including change from internally pressurized to unpressurized containers), addition or deletion of supplementary coatings and an increase in exposure time of the filler metal in the qualified atmosphere shall require requalification of the WPS.

The qualification is restricted to the nominal shielding gas composition used in the welding procedure test.

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8.4.5 Type of current

The qualification is valid for the type of current (alternating current, direct current, pulsed current) and the polarity used in the welding procedure test.

8.4.6 Heat input

This clause only applies when the control of heat input is specified.

When impact requirements apply, the upper limit of heat input qualified is 15 % greater than that used in welding the test piece.

When hardness requirements apply, the lower limit of heat input qualified is 15 % lower than that used in welding the test piece.

8.4.7 Preheat temperature

The lower limit of qualification is the preheat temperature used in the welding procedure test.

8.4.8 Interpass temperature

The upper limit of qualification is the highest recorded interpass temperature used in the welding procedure test.

8.4.9 Post-heating for hydrogen release

The temperature and duration of post heating for hydrogen release may not be less than those reached in the welding procedure test. Post heating may not be omitted, but may be added.

8.4.10 Post-weld heat treatment

Addition or deletion of post-weld heat treatment is not permitted.

The temperature range qualified is the holding temperature used for the welding procedure test $\pm 20\text{ }^{\circ}\text{C}$, unless otherwise specified. Where required, heating rates, cooling rates and holding time shall be related to the production assembly.

The holding time at the heat-treatment temperature shall be that used for qualification of the WPS $\pm 25\text{ }\%$.

8.4.11 Removal of line-up clamp(s)

The line-up clamp(s) shall not be removed when the length of weld (in % of circumference) or number of runs is less than that recorded in the welding procedure test.

8.4.12 Number of welder-divers

The qualification given is restricted to the minimum number of welder-divers used in the welding procedure test for pipelines.

8.4.13 Partially completed joint

The qualification given is restricted to welds which have at least as many runs deposited before cooling below preheat temperature as recorded in the welding procedure test.

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8.5 Specific to processes²⁾

8.5.1 Processes 111, 114, 131, 135, 136, 137, 141 and 15

The qualification given is for the diameter of electrode/consumables used in the welding procedure test.

8.5.2 Processes 15, 131, 135, 136, 137 and 141

The qualification is for the shielding gas and backing gas in accordance with ISO 14175 used for the weld procedure test using the same nozzle diameter and nominal flow rate ($\pm 15\%$).

The qualification given to the face and/or back shielding gas is restricted to the type of gas (nominal composition) used in the welding procedure test.

Table 1 — Process numbers in accordance with ISO 4063

Process number	Definition in accordance with ISO 4063
15	Plasma arc welding
111	Manual metal arc welding
114	Self-shielded tubular-cored arc welding
131	Metal inert gas welding
135	Metal active gas welding
136	Tubular cored metal arc welding with active gas shield
137	Tubular cored metal arc welding with inert gas shield
141	Tungsten inert gas welding

8.6 Specific to hyperbaric environment

The qualification range for water depth is given in Table 2.

Table 2 — Water depth qualification range

Type of welding	Water depth W_D m	Range of qualification
Manual, mechanized, automatic	$W_D \leq 200$	+ 20 % or + 10 m whichever is greater ^a
Manual, automatic	$200 < W_D \leq 300$	$\pm 15\%$
	$300 < W_D \leq 500$	$\pm 10\%$
^a A decrease in depth shall not require requalification.		

For water depth ≤ 200 m, a change from an argon or heliox environment to an air or nitrox environment shall require a new procedure test. The converse shall not require a new procedure test. For water depth > 200 m, no change shall be permitted.

An increase of the relative humidity of more than 10 % shall require a new procedure test.

2) Process numbers in accordance with ISO 4063 (see Table 1).

ISO 15614-10:2005(E)

9 Welding procedure qualification record (WPQR)

The welding procedure qualification record (WPQR) provides documented evidence of the results of each test piece, including retests for each weld procedure test. All variables listed in the welding procedure specification (WPS) in accordance with ISO 15609-1 shall be included in the WPQR, as well as all results of testing in accordance with Clause 7. If all test results are within the limits defined in accordance with this part of ISO 15614, the WPQR is approved and shall be signed and dated by an examiner or an examining body."

A standard WPQR format shall be used to record details for the welding procedure and the test results, in order to facilitate uniform presentation and assessment of the data.

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