
**Qualification testing of welders for
underwater welding —**

Part 2:

**Diver-welders and welding operators for
hyperbaric dry welding**

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Épreuve de qualification des soudeurs pour le soudage sous l'eau —

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*Partie 2: Scaphandriers soudeurs et opérateurs soudeurs pour le soudage
hyperbare en caisson*

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Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.ch
Web www.iso.ch

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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 3.

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 part of ISO 15618 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 15618-2 was prepared by the European Committee for Standardization (CEN) in collaboration with Technical Committee ISO/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 document, read "...this European Standard..." to mean "...this International Standard...".

ISO 15618 consists of the following parts, under the general title *Qualification testing of welders for underwater welding*:

- *Part 1: Diver-welders for hyperbaric wet welding*
- *Part 2: Diver-welders and welding operators for hyperbaric dry welding*

Annexes A and B of this part of ISO 15618 are for information only.

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Foreword

The text of EN ISO 15618-2:2001 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 June 2002, and conflicting national standards shall be withdrawn at the latest by June 2002.

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 diver-welder or welding operator performance for the fusion welding of steels in a hyperbaric, dry environment.

The ability of the diver-welder or welding operator to follow verbal or written instructions and testing of his skill are therefore 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.

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

The test weld may be used to approve a welding procedure and a diver-welder or welding operator, provided that all the relevant requirements, e.g. test piece dimensions, are satisfied.

The diver-welder's or welding operator's skill and job knowledge continue to be approved only if the diver-welder or welding operator are working with reasonable continuity on welding work within the extent of approval.

1 Scope

This standard applies to welding processes where the skill of the diver-welder or welding operator has a significant influence on weld quality.

This standard specifies essential requirements, ranges of approval, test conditions, acceptance requirements and certification for the approval testing of diver-welder or welding operator performance for the welding of steels underwater in a hyperbaric dry environment. The recommended format for the certificate of approval testing is given in Annex A.

During the approval test the diver-welder or welding operator 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 B.

This standard is applicable when the diver-welder's or welding operator's approval testing is required by the purchaser, by inspection authorities or by other organisations.

The welding processes referred to in this standard include fusion welding processes which are designated as manual or partly mechanized welding for diver-welders and fully mechanized or automatic welding for operators (see 5.2).

All new approvals are in accordance with this standard from the date of this issue.

However, this standard does not invalidate previous diver-welder or welding operator approvals made to former national standards or specifications, providing the intent of the technical requirements is satisfied and the previous approvals are relevant to the application and production work on which they are to be employed.

Also, where additional tests should be carried out to make the approval technically equivalent it is only necessary to do the additional tests on a test piece which should be made in accordance with this standard. Consideration of previous approvals to former national standards or specifications should be at the time of the enquiry/contract stage and agreed between the contracting parties.

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

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 (including amendments).

EN 288-1

Specification and approval of welding procedures for metallic materials – Part 1: General rules for fusion welding

EN 288-2

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

ISO 15618-2:2001(E)

- EN 499
Welding consumables – Covered electrodes for manual metal arc welding of non alloy and fine grain steels – Classification
- 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 1290,
Non-destructive examination of welds – Magnetic particle examination of welds
- 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 1418
Welding personnel – Approval testing of welding operators for fusion welding and resistance weld setters for fully mechanized and automatic welding of metallic materials
- EN 1435
Non-destructive examination of welds – Radiographic examination of welded joints
- EN 1600
Welding consumables – Covered electrodes for manual metal arc welding of stainless and heat resisting steels – Classification
- EN 1714
Non destructive examination of welds – Ultrasonic examination of welded joints
- EN ISO 4063
Welding and allied processes – Nomenclature of processes and reference numbers (ISO 4063:1998)
- prEN ISO 5817
Welding – Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) – Quality levels for imperfections (ISO/DIS 5817:2000)
- EN ISO 6520-1
Welding and allied processes – Classification of geometric imperfections in metallic materials – Part 1: Fusion welding (ISO 6520-1:1998)
- EN ISO 6947
Welds – Working positions – Definitions of angles of slope and rotation (ISO 6947:1993)
- CR ISO 15608
Welding – Guidelines for a metallic material grouping system (ISO/TR 15608:2000)
- ISO 857-1
Welding and allied processes – Vocabulary – Part 1: Metal welding processes
- ISO 3581
Covered electrodes for manual arc welding of stainless and other similar high alloy steels – Code of symbols for identification

3 Terms and definitions

For the purposes of this standard, the terms and definitions listed below and in EN 288-1 apply.

3.1

diver-welder

a person who performs the welding under hyperbaric conditions

3.2

hyperbaric welding operator

a person who performs fully mechanized or automatic welding in dry hyperbaric conditions (see also EN 1418)

3.3

hyperbaric dry welding

the process of welding in a dry underwater environment wherein the gaseous atmosphere acting on the welding arc and weld is at an elevated pressure the level of which is determined by the depth of water

3.4

habitat

the sealed enclosure surrounding the work area from which the water has been displaced by a gaseous medium to provide a dry environment for performance of the welding operation

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 A).

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

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4.3 Consumable

nm no filler metal

wm with filler metal (solid wire)

B basic covering

S other coating types

fc flux cored

mc metal cored

4.4 Miscellaneous

bs welding from both sides

gb welding with gas backing

gg back gouging or back grinding of welds

mb welding with backing material

nb welding without backing

ng no back gouging or no back grinding

ss single-side welding

wd water depth

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 diver-welder or welding operator in these areas. Each criterion is considered to be a significant factor in the approval testing.

The diver-welder or welding operator shall be tested separately. The approval test shall be carried out on test pieces and is independent of the type of construction.

Approval of a diver welder according to this standard does not approve a welding operator and vice versa.

5.2 Welding processes

Welding processes are defined in ISO 857-1 and reference numbers of welding processes for symbolic representation are listed in EN ISO 4063.

This standard covers the following welding processes applicable in hyperbaric dry environment.

- 111 manual metal arc welding (metal arc welding with covered electrode);
- 114 self-shielded tubular-cored arc welding;
- 131 metal inert gas welding, MIG welding;
- 135 metal active gas welding, MAG 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, 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 7.3.

5.4 Material groups

The designation of steel groups of material, as defined in CR ISO 15608 shall apply.

This standard applies to the following material groups according to CR ISO 15608: 1, 2, 3, 7, 8 and 10.

In general, diver-welder's or welding operator's approval test shall involve depositing weld metal having a chemical composition and mechanical strength compatible with any of the steels in the parent metal group(s).

When welding parent metals from two different groups which do not give approval to each other, an approval for the combination as a separate group is required.

When the filler metal is dissimilar to the parent metal group, an approval for that combination of parent metal group and filler metal is needed.

5.5 Consumables

5.5.1 General

Only consumables for the intended hyperbaric application shall be used, e. g. by the welding procedure test.

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

5.5.2 Metal-arc welding with covered electrodes

Covered electrode groups are classified with respect to the most important characteristics according to EN 499 as given in 4.3. In the case of hyperbaric dry welding only two of these classifications are applicable. These are

- B basic covering;
- S other covering.

NOTE: For further details on covered electrodes reference should be made to EN 499, EN 1600 or ISO 3581 according to the steel in question.

5.6 Dimensions

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

It is not intended that thicknesses or diameters should be measured precisely but rather the general philosophy behind the values given in Tables 1 and 2 should be applied.

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

Test piece thickness t mm	Range of approval
$t \leq 6$	$\geq t$ (max. 6 mm)
$t > 6$	$0,5 t$ to $2 t$ (min. 6 mm)

Table 2 - Test piece diameter and range of approval

Test piece diameter D^a mm	Range of approval
$D \leq 100$	$0,7 D$ to $2 D$
$100 < D \leq 300^b$	$0,5 D$ to $2 D$ (min. 75 mm)
$D > 300$	$\geq 0,5 D$

^a For structural hollow sections, "D" is the dimension of the smallest side.
^b See also 6.3 a).

5.7 Welding positions

The welding positions shall be taken from EN ISO 6947.

Angles of slope and rotation for straight welds in the welding positions shall be in accordance with EN ISO 6947.

5.8 Hyperbaric environment

The diver-welder or welding operator approval test shall be carried out under actual or simulated hyperbaric conditions at the appropriate water depth.

6 Range of approval

6.1 General

As a general rule, the test piece approves the diver-welder or welding operator 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 subclauses and tables. In these tables the range of approval is indicated in the same horizontal line.

6.2 Welding process

Each test approves one welding process. A change of welding process requires a new approval test. However, it is possible for a diver-welder or welding operator to be approved for more than one welding process by a single test or by several 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 metal-arc welding with covered electrode (111), the diver-welder or welding operator may be approved by either of the following routes:

- 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 metal-arc welding with covered electrode (111) 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 metal-arc welding with covered electrode (111) with backing or welded from both sides with or without gouging.

6.3 Joint types

Depending on the test piece, the range of welds for which the diver-welder or welding operator is approved is shown in Table 3; the following additional criteria are applicable:

- a) approval for butt welds in pipes with diameter > 300 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 ≥ 600 mm;
- c) welding from one side without backing approves welds from one side with backing and welds from both sides with and without gouging;
- d) welding in plates or pipes with backing approves welds made from both sides, but not for welds without backing;
- e) butt welds approve fillet welds for similar welding conditions;
- f) in cases where the production work is predominantly fillet welding, it is recommended that the diver-welder or welding operator should be approved also by an appropriate fillet welding test, i.e. on plate, pipe or branch connection (see EN 288-3).
- g) welding from both sides without gouging approves welds from one side with backing and welds from both sides with gouging;
- h) approval for butt welds in pipes without backing includes approval for branch connections within the same range of approval as in Tables 3 and 4. For a branch weld the range of approval is based on the diameter of the branch;
- i) in cases where the production work is either branch welding or involves a complex branch connection a special training and testing is necessary.

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