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

Part 1:

Diver-welders for hyperbaric wet welding

*Épreuve de qualification des soudeurs pour le soudage sous l'eau —
Partie 1: Scaphandriers soudeurs pour le soudage hyperbare en pleine eau*
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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 15618-1 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 15618-1:2001 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 performance for the fusion welding of steels in a hyperbaric wet environment.

The ability of the diver-welder 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 the diver-welder's competence in the various fields of application. Tests should be carried out in accordance with this standard unless additional tests are specified by the relevant application standard when these should be applied.

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

The diver-welder's skill and job knowledge continue to be approved only if the diver-welder is 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 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 performance for the welding of steels underwater in hyperbaric wet environment. The recommended format for the certificate of approval testing is given in Annex A.

During the approval test the diver-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 B.

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

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

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

However, this standard does not invalidate previous diver-welder 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 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 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

EN 499

Welding consumables – Covered electrodes for manual metal arc welding of non alloy and fine grain steels – Classification

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- 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 particles 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 1435
Non-destructive examination of welds – Radiographic examination of welded joints
- 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 6520:1998)
- 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

3 Terms and definitions

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

3.1

diver-welder

a person who performs the welding under hyperbaric conditions

3.2

hyperbaric wet welding

the process of welding in a hyperbaric wet environment at an elevated pressure with no mechanical barrier around the arc and with the diver-welder working directly in the water

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

| | |
|----------|--------------------------------------|
| <i>a</i> | nominal throat thickness |
| BW | butt weld |
| <i>D</i> | outside diameter of the smaller pipe |
| FW | fillet weld |
| P | plate |
| <i>t</i> | plate or pipe wall thickness |
| T | pipe |
| <i>z</i> | leg length of fillet weld |

4.3 Consumable

| | |
|----|-----------------------|
| R | rutile covering |
| RR | rutile thick covering |
| RB | rutile basic covering |
| fc | flux cored |
| mc | metal cored |

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4.4 Miscellaneous

| | |
|----|----------------------------------------|
| bs | welding from both sides |
| gg | back gouging or back grinding of welds |
| mb | welding with backing material |
| ss | single-side welding |
| wd | water depth |
| sa | salt water |
| fr | fresh water |

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 in these areas. Each criterion is considered to be a significant factor in the approval testing.

The diver-welder 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 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 wet environment.

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- 111 manual metal arc welding (metal arc welding with covered electrode);
- 114 self-shielded tubular-cored arc welding;

- 136 tubular cored metal arc welding with active gas shield;
- 137 tubular cored metal arc welding with inert gas shield.

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 and 8.

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

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

It is assumed that in most approval tests the filler metal will be similar to the parent metal. When a diver-welder's test has been carried out using a filler metal, shielding gas or flux suitable for a certain material group, this test will only confer approval on the diver-welder to use those consumables (filler metal, shielding gas or flux) for other materials from the same material group.

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 wet welding only three of these classifications are applicable. These are

- R rutile covering;
- RR rutile thick covering;
- RB rutile basic covering.

NOTE The covered electrodes for wet application are specially designed electrodes with an additional water protective coating adjusted according to the composition of the alloying elements of the core wire and the flux.

For flux cored arc welding in wet environment special designed wire electrodes are applied. These are of the seamless or the folded type. The internal flux is covered and protected against excessive moisture penetration by the surrounding metal.

5.6 Dimensions

The diver-welder 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 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.

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

Table 1 - Test piece thickness (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 |
| $100 < D \leq 300$ | 0,5 D to 2 D (min. 75 mm) |
| $D > 300$ | $> 0,5 D$ |
| ^a For structural hollow sections " D " is the dimension of the smallest side. | |

5.7 Welding positions

The welding positions shall be taken from EN ISO 6947.

The positions PF and H-L045 are exclusively used for process 114, 136 and 137 (see table 4).

5.8 Hyperbaric environment

The diver-welder approval test shall be carried out under actual or simulated hyperbaric conditions, taking into account:

- diving depth;
- visibility;
- water temperature;
- salinity.

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6 Range of approval

6.1 General

As a general rule, the test piece approves the diver-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 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 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.

6.3 Joint types

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

- a) approval for welds in plates in all relevant positions covers welds on pipes having an outside diameter ≥ 600 mm;
- b) in cases where the production work is predominantly fillet welding, it is recommended that the diver-welder should be approved also by an appropriate fillet welding test, i.e. on plate, pipe or branch connection;
- c) approval of welding from both sides without gouging covers welds from one side with backing and welds from both sides with gouging;
- d) in cases where the production work is either predominantly branch welding or involves a complex branch connection, it is recommended that the diver-welder should receive special training. In some cases a diver-welder approval test on a branch connection including any restricted access may be necessary.

Table 3 - Range of approval for tests (Details of weld type)

| Details of weld type | | | Range of approval | | | | | |
|----------------------|-----------------------------|-------------------|---------------------------|-----------------------------|-----------|----------------|--------------|----------------|
| | | | Butt welds | | Lap welds | | Fillet welds | |
| | | | welded from one side (ss) | welded from both sides (bs) | | | | |
| | | | with backing (mb) | with gouging (gg) | plate | pipe | plate | pipe |
| Butt welds | welded from one side (ss) | with backing (mb) | x | x | x | x ^a | x | x ^a |
| | welded from both sides (bs) | with gouging (gg) | x | x | x | x ^a | x | x ^a |
| Lap welds | plate | | – | – | x | x ^a | x | x ^a |
| | pipe | | – | – | x | x | x | x |
| Fillet welds | plate | | – | – | – | – | x | x ^a |
| | pipe | | – | – | – | – | x | x |

^a See 6.3 a)

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 x indicates those welds for which the welder is approved
 – indicates for what the diver welder is not approved

6.4 Material groups

According to the material group of the test piece, specified in 5.4, the diver-welder is only approved for this special material group. For any steel not covered the diver-welder shall carry out an approval test, which only approves for that steel.

6.5 Consumables

It is not permitted to:

- change the standard or commercial designation of the electrodes and waterprotective coating;
- add or omit the waterprotective coating;
- change the nominal electrode diameter;
- change the nominal composition of the shielding gas.

6.6 Dimensions

The range of approval according to plate thickness or wall thickness of pipe and/or pipe diameter is shown in tables 1 and 2.

6.7 Welding positions

The range of approval for each welding position is given in table 4. The welding positions and codes refer to