

Underwater Welding

Procedure

This Standard replaces and cancels its previous revision.

The CONTEC - Authoring Subcommittee provides guidance on the interpretation of this Standard when questions arise regarding its contents. The Department of PETROBRAS that uses this Standard is responsible for adopting and applying the sections, subsections and enumerates thereof.

Technical Requirement: A provision established as the most adequate and which shall be used strictly in accordance with this Standard. If a decision is taken not to follow the requirement ("non-conformity" to this Standard) it shall be based on well-founded economic and management reasons, and be approved and registered by the Department of PETROBRAS that uses this Standard. It is characterized by imperative nature.

Recommended Practice: A provision that may be adopted under the conditions of this Standard, but which admits (and draws attention to) the possibility of there being a more adequate alternative (not written in this Standard) to the particular application. The alternative adopted shall be approved and registered by the Department of PETROBRAS that uses this Standard. It is characterized by verbs of a nonmandatory nature. It is indicated by the expression: **[Recommended Practice]**.

Copies of the registered "non-conformities" to this Standard that may contribute to the improvement thereof shall be submitted to the CONTEC - Authoring Subcommittee.

Proposed revisions to this Standard shall be submitted to the CONTEC - Authoring Subcommittee, indicating the alphanumeric identification and revision of the Standard, the section, subsection and enumerate to be revised, the proposed text, and technical/economic justification for revision. The proposals are evaluated during the work for alteration of this Standard.

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Introduction

PETROBRAS Technical Standards are prepared by Working Groups - WG (consisting specialized of Technical Collaborators from Company and its Subsidiaries), are commented by Company Units and its Subsidiaries, are approved by the Authoring Subcommittees - SCs (consisting of technicians from the same specialty, representing the various Company Units and its Subsidiaries), and ratified by the Executive Nucleus (consisting of representatives of the Company Units and its Subsidiaries). A PETROBRAS Technical Standard is subject to revision at any time by its Authoring Subcommittee and shall be reviewed every 5 years to be revalidated, revised or cancelled. PETROBRAS Technical Standards are prepared in accordance with PETROBRAS Technical Standard [N-1](#). For complete information about PETROBRAS Technical Standards see PETROBRAS Technical Standards Catalog.

Foreword

This Standard is the English version (issued in 09/2012) of PETROBRAS N-2036 REV. F 06/2011. In case of doubt, the Portuguese version, which is the valid document for all intents and purposes, shall be used.

1 Scope

1.1 This Standard rules the required conditions for Underwater Welding aiming the application in metal structures and ducts.

1.2 This Standard applies to procedures started as from the date of its edition.

1.3 This Standard includes only Technical Requirements.

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 applies.

Norma Regulamentadora nº 15 (NR-15) - [Anexo 6](#) - Trabalho sob Pressões Hiperbáricas;

PETROBRAS [N-1438](#) - Terminologia de Soldagem;

PETROBRAS [N-1792](#) - Inspeção Subaquática - Partícula Magnética;

AWS [D 3.6M:2010](#) - Specification for Underwater Welding;

DNV [OS F101:2010](#) - Submarine Pipeline Systems;

IMCA [D 045](#) - Code of Practice for the Safe Use of Electricity Underwater.

NOTE For documents referred in this Standard and for which only the Portuguese version is available, the PETROBRAS department that uses this Standard should be consulted for any information required for the specific application.

3 Terms and Definitions

Terms and definitions set out in PETROBRAS [N-1438](#) apply to this document, as well as the following.

3.1

submarine welding methods

basic submarine welding techniques are described in 3.1.1 and 3.1.2

3.1.1

welding in hyperbaric chamber

welding in an open bottom pressurized chamber where water is moved out and the diver/ welder works in an environment where he can breath

3.1.2**wet welding**

welding carried out directly under water

3.2**sealing mixture**

gas serving to exclude water, but it is not necessarily intended to protect the electric arc, may or may not be breathable and shall not be flammable and / or explosive

3.3**weld types**

Quality levels of submarine welding, checked through non-destructive tests, mechanical and metallographic tests, specified according to properties required by the structure or the equipment design

NOTE 1 The required weld type must be established previously according to the application intended for the welding, such as fastening anodes, repairing structures, repairing ducts and according to operational and safety aspects.

NOTE 2 Acceptance standards for the different welding types (A, B, and O) are set out in [AWS D 3.6M:2010](#).

NOTE 3 Other levels of quality (welding type) related to the acceptance standards set out in other norms can be used, after PETROBRAS approval.

3.4**welding system**

All equipment, devices, tools, accessories and consumables used for welding works in accordance with a specific procedure

4 General conditions**4.1 Base metals**

The base metals included in the scope of this Standard are steels used in the construction of maritime structures and submarine ducts.

4.2 Welding Processes

The main welding processes included in the Scope of this Standard are: coated electrode, MIG/MAG, TIG, tubular wire, aluminothermic process and friction stir welding. Other processes can be used, upon PETROBRAS approval.

4.3 Welding Procedure

4.3.1 Welding shall be performed in accordance with a previously qualified welding procedure, as per [AWS D 3.6M:2010](#).

4.3.2 The welding procedure must be qualified according to the depth, as per [AWS D 3.6M:2010](#). For class A wet welding, the depth of repair shall be 5 m beyond the specified depth, at a maximum.

4.3.3 When aluminothermic process is used, the welding procedure shall also meet the requirements established by [DNV OS F101:2010](#).

4.4 Production Test

4.4.1 Beyond the submarine welding procedure qualification, before the beginning of the production welding, a production test shall be performed for evidence that the submarine welding system is free of issues where the service is to be executed.

4.4.2 The production test must be in accordance with the qualified procedure, as per [AWS D 3.6M:2010](#).

4.5 Welding monitoring and control

During the execution of the production welding the following shall be monitored and be registered, when applicable:

- a) current;
- b) voltage;
- c) protection gas outflow;
- d) preheating, interpass and after-heating temperatures;
- e) time for pass deposition;
- f) pass length;
- g) atmosphere inside the hyperbaric chamber.

4.6 Qualification of Welders

Welding operations shall be performed by welders qualified according to [AWS D 3.6M:2010](#) requirements. Other Standards can apply, at PETROBRAS discretion.

4.6.1 For wet welding, the welders' qualification shall be valid for 3 years at a maximum, renewable for 3 additional years after a simplified test. Within this period, in case the welder has not performed this activity for a period of 3 months, he shall take a new production test, as per 4.4.

4.6.2 For wet welding operations, the welder shall remain qualified as long as he meets the visual test requirements for angle welding and the radiographic test for butt weld, according to the welding type acceptance criteria as per [AWS D 3.6M:2010](#).

4.7 Preparation of the Welded Joint

4.7.1 The surface to be welded and the adjacent surface, in a 25 mm range from each margin of the joint, shall be prepared for welding: there shall be no scale, paint, sea organisms or corrosion.

4.7.2 Any discontinuity in the base metal surface caused by open arc shall be eliminated by grinding. The area shall be examined with magnetic particles, as per PETROBRAS [N-1792](#), with checking for the elimination of discontinuities.

4.7.3 In case a welding repair is needed to eliminate any superficial discontinuity, the procedure shall be qualified according with 4.3.

4.8 Temporary Welding

Any provisory welding performed to help in the assembly shall be done according to the same production welding requirements, and its location on the structure or equipment shall be checked and included in the repair procedure.

4.9 Security and Health of the Welder

4.9.1 The Regulatory Standard Number 15 (NR-15) - [Annex VI](#) and IMCA [D 045](#) shall be met, aiming the safety and health of the diver/welder.

4.9.2 The contractor shall include a specific clause regarding measures to ensure the safety and protection of welders in its procedures.

4.10 Essential Variables

4.10.1 The Essential Variables shall be as per AWS [D 3.6M:2010](#).

4.10.2 The sealing mixture is considered an essential variable. When the diver/welder must work in the environment, the sealing mix shall be breathable, and in no case it shall be flammable and/or explosive.

4.11 Acceptance Standards

Acceptance standards for the welding types A, B, and O are set out in AWS [D 3.6M:2010](#).

5 Specific Conditions

5.1 Welding in hyperbaric chamber [Recommended Practice]

5.1.1 The welding procedure shall include the hyperbaric chamber design.

5.1.2 The hyperbaric chamber design shall meet the requirements set out in 5.1.2.1 to 5.1.2.11.

5.1.2.1 Enough inner space to allow the free movement and comfort of the welder during the welding operation.

5.1.2.2 Easy access, to ensure the free entry and exit of divers and materials.

5.1.2.3 Fastening and sealing methods.

5.1.2.4 Port holes to allow the external monitoring of the operation.

5.1.2.5 Relief valve installed at the highest point of the chamber, to eliminate the build up of toxic and fuel fumes produced by the welding.