

Cathodic Protection for Floating/Fixed Maritime facilities and Subsea Equipment

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.

"This Standard is exclusive property of Petróleo Brasileiro S. A. - PETROBRAS, internal application and PETROBRAS Subsidiaries and shall be used by its suppliers of goods and services under contracts or similar under the conditions established in Bidding, Contract, Agreement or similar.

The use of this Standard by other companies / organizations / government agencies and individuals is the sole responsibility of the users.."

CONTEC

Comissão de Normalização
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SC - 15

Cathodic Protection

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.

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Foreword

This Standard is the English version (issued in 10/2015) of PETROBRAS N-2838 REV. B 12/2014. 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 establishes the additional requirements to DNV-RP-B401 to be adopted during the design, manufacture, assembly and pre-operation of the cathodic protection system for the structures listed below:

1.1.1 Fixed maritime platforms for oil production.

1.1.2 Subsea equipment like:

- WCT (Wet Christmas Tree);
- Manifolds;
- PLEM (Pipeline End Manifold);
- PLET (Pipeline End Termination);
- SCM (Subsea Control Module);
- PAB (Production Adapter Base).

1.2 This Standard establishes the additional requirements to DNV-RP-B101 to be adopted during the design, manufacture, assembly and pre-operation of the cathodic protection system for the structures listed below:

1.2.1 Floating maritime facilities like:

- semi-submersible platforms (SS);
- floating, storage and offloading platforms (FSO);
- floating, production, storage and offloading platforms (FPSO);
- tankers;
- buoys and monobuoys.

1.2.2 Ballast tanks, storage tanks, slop tanks, and spaces that could be immersed in sea water.

1.3 DNV-RP-B401 and DNV-RP-B101 paragraphs not mentioned in this Standard are considered as fully applicable.

1.4 This Standard is applicable to procedures issued from emission of this document.

1.5 This Standard contains Technical Requirements and Recommended Practices.

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.

PETROBRAS N-133 - Soldagem;

PETROBRAS N-381 - Execution of Drawing and other General Technical Documents

PETROBRAS [N-1710](#) - Coding of Technical Engineering Documents;

PETROBRAS [N-1814](#) - Inspeção Submarina - Medição de Potencial Eletroquímico;

PETROBRAS [N-2064](#) - Issuance and Revision of Design Documents;

PETROBRAS [N-2608](#) - Rectifiers for Cathodic Protection;

ABNT [NBR 7403](#) - Proteção Catódica Galvânica da Carena, Caixas de Mar, Tanques de Lastro, de Carga/Lastro e de Porões Alagáveis em Embarcações de Aço;

ABNT [NBR 9358](#) - Anodos de Liga de Zinco para Proteção Catódica;

ABNT [NBR 10387](#) - Anodos de Liga de Alumínio para Proteção Catódica;

ISO [8501-1](#) - Preparation of Steel Substrates Before Application of Paints and Related Products - Visual Assessment of Surface Cleanliness - Part 1: Rust Grades and Preparation Grades of Uncoated Steel Substrates and of Steel Substrates After Overall Removal of Previous Coatings;

DNV-[RP-B101](#) - Corrosion Protection of Floating Production and Storage Units;

DNV-[RP-B401](#) - Cathodic Protection Design;

MIL [DTL 18001 L](#) - Anodes, Sacrificial Zinc Alloy - Revision L.

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

For the purposes of this document, the symbols for the cathodic protection project from DNV-[RP-B401](#) and subsequent are applied.

3.1

vessels

SS, FSO, FPSO platforms and ships are considered as vessels

3.2

CPS

Cathodic Protection System

3.3

coating efficiency (E)

fraction of the surface effectively protected by the anti-corrosive coating of a structure, which causes a percentage reduction of the protection current necessary for the coated surface polarization in comparison to a non-coated surface

3.4

initial current (I_i)

intensity of the current needed to polarize a structure under cathodic protection

3.5

average current (I_m)

intensity of the current needed to polarization maintenance for a structure throughout the useful life of the cathodic protection system

3.6**final current (I_f)**

intensity of the current needed to protect a structure during the end of its useful life to the cathodic protection system

3.7**tests on sea**

checking tests for CPS functioning from the floating maritime facility in an area near to the shipyard

3.8**tests on site**

CPS pre-operation tests performed in the site of the floating maritime facility area

3.9**cofferdam**

waterproof compartment installed below the water level of a vessel, which allows the electric interconnection of anodes and electrodes regarding electric cables inside the vessel, restricting the sea water entrance in it

3.10**turret**

asymmetrical structure internally or externally incorporated to the vessel shell through one bearing or more, which allows the free rotation of the vessel around the structure axle, providing the full alignment of the vessel together with the environmental conditions, this structure is anchored on seabed

3.11**speed factor**

correction factor of the protection current due to relative speed between the electrolyte and the structure to be protected

3.12**jacket**

structural part of a fixed platform from its base to a little part above the sea level, in which the deck and/or modules are installed

3.13**mudmat**

wood or steel panel used to support a structure under the sea. Regarding the jackets, the support is provisory up to the definitive staking

3.14**shall**

indicates a mandatory requirement

3.15**should**

indicates a preferred course of action

3.16**may**

indicates a permissible course of action

4 General Considerations on the Cathodic Protection Design

4.1 General

4.1.1 Choosing a type of cathodic protection system, impressed current or galvanic current shall take into account the economic and technical aspects as the design life premises, maintenance accessibility, reliability, availability, etc.

4.2 Electrochemical Potentials

4.2.1 The range of potentials to be adopted as the criterion related to cathodic protection for carbon steel structures shall be between -800 mV to -1150 mV, measured to the silver-silver chloride (Ag/AgCl)_{sea water} reference electrode, or between +250 mV and -100 mV, measured to the Zinc (Zn) reference electrode.

4.3 Anodes

4.3.1 Impressed current design shall use inert anodes of titanium with a mixed metals oxide coating (MMO). Specifications of other types of anode shall be previously submitted to PETROBRAS approval.

4.3.2 Galvanic anodes of aluminum or zinc alloys acquired in Brazil shall be specified as per ABNT [NBR 10387](#) and ABNT [NBR 9358](#), respectively.

4.3.3 Galvanic anodes of aluminum or zinc alloys acquired abroad shall be specified as per DNV-RP-B401 or MIL [DTL 18001 L](#).

4.3.4 It is recommended the use of galvanic anodes manufactured with the same material or alloy intended to the same cathodic protection system. **[Recommended Practice]**

4.3.5 In case of use of anodes hanging from the platform, the electric cable shall not bear the weight of the system.

4.3.6 Guidances for Specification of Galvanic and Inert Anodes

4.3.6.1 Flush mounted anodes shall be used in places subject to hydrodynamic efforts (maritime current) as sea chests and hull of tankers. Slender stand-off anodes are recommended for the remaining locations, as jacket structure, lower part of tanks and subsea equipment.

4.3.6.2 Different shapes and installation types of anodes can be specified according to the project demand.

4.3.7 The connection of anodes to structures should be welded, following the project requirements for piping or subsea structure. Anodes may be fixed by bolts, in this case all nuts, washers and bolts shall be made of stainless steel AISI 316.

4.4 Reference Electrodes

4.4.1 Permanent reference electrodes shall be made of zinc as per ABNT [NBR 9358](#) and MIL 18001 L.

4.5 Rectifiers

4.5.1 The minimal conditions required to supplying, inspecting and performing tests for manual and automatic control rectifiers (air- and oil-cooled) used in cathodic protection systems (vessels and platforms) shall be in compliance with PETROBRAS [N-2608](#).

4.5.2 It is recommended to use identical rectifiers for the same facility. **[Recommended Practice]**

4.6 Vessels

4.6.1 Vessels with total length above 150 m shall have at least two impressed current systems, each one with at least two inert anodes and two reference electrodes.

4.6.2 The entire underwater area in the maximum draught of the operation that holds the electrical continuity between it and the vessel hull in CPS dimensioning for vessels shall be considered. Regarding transportation vessels, besides the items foreseen in DNV-[RP-B101](#), both propeller and rudder shall be considered.

4.6.3 A provisory CPS installation for vessel hull shall be assessed before the definitive CPS is in operation.

4.6.4 Projects shall comply with safety premises by noting the hazardous area classification plan.

4.7 Buoys and Monobuoys

4.7.1 For CPS dimensioning the entire underwater area shall be considered, including steel cable, mooring and accessories that are electrically connected to the area to be protected by CPS .

NOTE For mooring and/or steel cables, please consider an area correspondent to their metallic extension, limited to 300 m.

4.8 Jackets and Accessories of Fixed Platforms

4.8.1 The entire areas of underwater parts, buried parts and transition zones shall be considered during the dimensioning.

4.8.2 It's shall be considered as buried surfaces the areas correspondent to well coatings, piles and provisory mud mats shall be considered.

4.8.3 Conductors and other accessories shall be electrically interconnected to the jacket.