

**CONTEC**

Comissão de Normalização  
Técnica

**SC-15**

Cathodic Protection

**Design of Galvanic Cathodic Protection  
System - Subsea Pipeline**

Revalidation

Revalidated in 02/2016.

## Design of Galvanic Cathodic Protection System - Subsea Pipeline

### 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 10/2014) of PETROBRAS N-1935 REV. D 12/2010 including its Amendment - 09/2013. 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 determines the additional requirements to ISO 15589-2 to be adopted in the design and installation of galvanic cathodic protection systems for subsea rigid pipelines.

1.2 The acceptance of the design is conditioned to the compliance with this Standard and ISO 15589-2.

1.3 This Standard applies to procedures started from its issue date.

1.4 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;

ISO 15589-2 - Petroleum and Natural Gas Industries - Cathodic Protection of Pipeline Transportation System - Part 2: Offshore Pipelines;

ASTM D 1248 - Standard Specification for Octyl Ortho-Phthalate Ester Plasticizers;

DNV OS F101 - Submarine Pipeline Systems;

DNV RP F103 - Cathodic Protection of Submarine Pipelines by Galvanic Anodes;

AWS D1.1 - Structural Welding Code - Steel.

**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 following terms and definitions are adopted.

### **3.1**

#### **WD**

Water Depth

### **3.2**

#### **3LPE**

Polyethylene Triple Layer

## 3.3

## 3LPP

Polypropylene Triple Layer

## 4 GENERAL DESIGN CRITERIA

4.1 This section defines the complementary requirements to cathodic protection system general requirements defined in ISO 15589-2.

4.2 It shall be considered possible interconnection of pipelines with land sections and offshore structures, such as piers and platforms, as per ISO 15589-2.

4.3 The dimensioning of the cathodic protection system may be made for the entire pipeline section or for a standard length, as long as the pipeline design is repetitive. **[Recommended Practice]**

4.4 The cathodic protection system shall be sized using bracelet aluminum or zinc alloy anodes. However, anodes made of different materials shall not be used to provide cathodic protection to the same pipeline or electrically connected structures.

## 5 DESIGN PARAMETERS

5.1 This section defines the complementary requirements to design parameters defined in ISO 15589-2.

5.2 The mean current density for submerged and buried sections shall be obtained from Table 1.

**TABLE 1 - CURRENT DENSITY VALUES**

Coating	WD	Value (mA/m <sup>2</sup> )
Submerged pipeline	WD < 100 m	55
	100 m ≤ WD ≤ 300 m	120
	300 m ≤ WD ≤ 1000 m	130
	WD > 1000 m	143
Buried pipeline	WD < 100 m	20
	100 m ≤ WD ≤ 300 m	60
	300 m ≤ WD ≤ 1000 m	60
	WD > 1000 m	66
<p>NOTE 1 Alternatively, the mean current density may be established in relation to the facility site and PETROBRAS' experience. Current density values successfully used in other structures installed in the region may be considered. <b>[Recommended Practice]</b></p> <p>NOTE 2 Values shown on Table 1 shall be deemed as the minimum and be corrected, according to the temperature of internal fluid, as recommended in ISO 15589-2.</p>		

5.3 It shall be adopted the value of current capacity of the anode recommended by the ISO 15589-2, as a function of temperature at the surface thereof.

5.4 The inner diameter of the anode shall be equal to the outer diameter of the pipe plus twice the thickness of the anticorrosive coating, adding the proper upper tolerance margins of outer diameter of the pipe and the coating thickness.

5.5 The zinc anode specific weight shall be adopted as  $7.13 \text{ g/cm}^3$  and the aluminum specific weight as  $2.66 \text{ g/cm}^3$ .

5.6 The calculation of the final dimensions of the anode, which means, at the end of its service life, shall be made considering the final length of the anode equivalent to the initial one, and final thickness reduced considering the utilization factor of anode.

5.7 The final outer area of the anode shall be calculated considering the final length and thickness of the anode, calculated as described in 5.6.

## **6 Anode Fabrication**

6.1 This section defines the complementary requirements to those defined in ISO 15589-2, for fabrication and quality control of galvanic anodes.

6.2 At least 1 complete anode shall be fabricated and used in pre-production tests, and it shall comply with the quality control criteria for galvanic anodes shown in ISO 15589-2.

6.3 For the pre-production tests, the samples to determine the chemical composition shall be taken from the anode itself, being one sample for each anode half-shell.

6.4 For destructive testing, during pre-production testing or fabrication, each half-shell shall be cut transversally in the average length point of the anode and on the metal core area, and longitudinally on the average point of its circumference.

6.5 In case of failures in fabrication tests, the criteria established in DNV RP F103 shall be met.

6.6 Anodes reproofed on tests must not be repaired or reused.

## **7 Receipt, Storage and Handling**

7.1 The receiving body shall compare the material being received to the Material Requisition (RM), including with regards to the documentation that shall accompany the material.

7.2 Galvanic anodes shall have no damage and be stored in clean locations, protected from weather, away from the ground and placed on wood pallets, and may be piled up.

7.3 Monoblock insulation joints shall be stored away from the ground and protected against mechanical damage.

7.4 All components intended for the cathodic protection system shall be handled carefully, avoiding shocks, breaks, dents or general damage.

7.5 Anodes shall not be handled by the electrical connection metal bars or by their power cables. Those cables shall be handled with utmost care in order to avoid damage to their coating.

## **8 ANODE DISTRIBUTION**

8.1 Anodes selected for pipelines shall be evenly distributed, so that the maximum spacing between anodes complies with the requirements defined in design. The spacing between anodes shall never be above 300 m.

8.2 For the case of "risers" or pipe string in directional drilling, where the spacing between anodes smaller than 300 m is not feasible, the extent of cathodic protection shall be checked by calculating the attenuation of current according to ISO 15589-2. When prompted by PETROBRAS, the calculation of attenuation of the current must be validated by numerical simulation. Both the calculation of attenuation of current as the numerical simulation must be submitted to approval of PETROBRAS.

8.3 1 additional anode shall be provided at each end of the pipeline where there is a flange connection.

## **9 INSTALLATION OF ANODES**

9.1 Before starting the work of installation of anodes, a procedure for mounting the anode and electric welding (electrical connection) shall be prepared, qualified according to AWS D1.1. The qualification of welding personnel (welders, welding operators, inspectors, supervisors and foremen) and the required documentation shall be in accordance with AWS D1.1.

9.2 Anodes shall be mounted so that there is no relative movement between the parts under any stresses from the installation and from operation of the pipeline. When requested by PETROBRAS, tests shall be conducted to prove this requirement.

9.3 In the case of electrical connection made by electric cables, they shall be isolated and have outer casing made of high molecular weight polyethylene.

9.4 In welding regions of pads and electrical cables to the pipe, the anticorrosive coating shall be removed. The area of coating removed shall be as small as possible. In both cases, the surface cleanliness standard shall comply with the welding procedure.

9.5 The electrical connection shall be tested and it shall be enough to withstand the loads from the pipeline installation and also those generated during its service life.

9.6 After welding, the coating in the weld area shall be repaired. The material used to repair the coating in the electrical connection region shall be approved by PETROBRAS.

9.7 The region between the anode and the concrete coating (if any), shall be filled with polyurethane (density of 900 kg/m<sup>3</sup> or above) or non-reinforced concrete. The region between the anode half-shells shall be filled with polyurethane, and the electrical interconnect cable shall be enclosed by protective material.

9.8 In the case of using anodes with electric cables on pipes without concrete coating, adhesive tapes shall be used to secure the electrical cables to the pipe, thus avoiding their interference with other structures during the pipeline laying. Those adhesive tapes shall be submitted to PETROBRAS for approval.

9.9 If anode groups are used, they shall be electrically connected to the pipeline through independent connections.

9.10 Anodes shall be preferentially allocated at the midpoint of the pipe.

## ÍNDICE DE REVISÕES

**REV. A**

There is no index of revisions.

**REV. B**

Affected Parts	Description of Alteration
	Revalidacion

## REV. C

Affected Parts	Description of Alteration
All	Revised

## REV. D

[illegible]