

## Internal Coating of Pipes

### 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 non-mandatory 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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### CONTEC

Comissão de Normalização  
Técnica

### SC - 14

Painting and Anticorrosive  
Coatings

### 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 10/2020) of PETROBRAS [N-2843](#) REV. C of 07/2020. 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 minimum requirements for selection, application and qualification, in factory, of the procedure for application of liquid paint based coating, in the inner surface of steel pipes, intended to onshore and offshore facilities, and onshore and submarine pipelines.

NOTE 1 For diameters less than 3 inch, PETROBRAS shall be consulted.

NOTE 2 The coating shall be selected to attend the operation temperature specified in the conditions 1, 2 and 3 of this standard.

NOTE 3 This standard does not apply to procedures intended to internal coating of valves, connectors, "*Drill Pipe*" and DPRs ("*Drill Pipe Risers*").

1.2 This standard aims to establish conditions for application of a coating with anticorrosive protection and friction reduction functions and to minimize possible contaminations of the fluid to be transported.

1.3 This standard applies to the coating production process, since the material and bare pipes reception up to the approval of production "*data book*".

1.4 An Application Procedure (PA) and an Inspection and Test Plan (PIT) shall be done and submitted to PETROBRAS approval, according to Annex A.

1.5 The qualification of the coating application procedure shall be performed in accordance with Annex B.

1.6 This standard does not contains requirements to the verification of steel pipes integrity.

1.7 This Standard applies to procedures beginning with its date of issuance.

1.8 This Standard only contains Technical Requirements.

## 2 Normative References

The following documents are cited in the text in such a way that their contents, total or partial, are requirements for this document. For dated references, only the mentioned editions apply. For undated references, the most recent editions of that document (including amendments) apply.

PETROBRAS [N-9](#) - Tratamento de Superfícies de Aço com Jato Abrasivo e Hidrojateamento;

PETROBRAS [N-13](#) - Requisitos Técnicos para Serviços de Pintura;

PETROBRAS [N-2785](#) - Monitorização, Interpretação e Controle da Corrosão Interna em Dutos;

PETROBRAS [N-2912](#) - Tinta Epóxi "Novolac";

ABNT [NBR 10443](#) - Tintas e Vernizes - Determinação da Espessura da Película Seca sobre Superfícies Rugosas - Método de Ensaio;

ABNT [NBR 14847](#) - Inspeção de Serviços de Pintura em Superfícies Metálicas;

ABNT [NBR 15158](#) - Limpeza de Superfície de Aço por Produtos Químicos;

ABNT [NBR 16212](#) - Tubos - Estocagem em área descoberta;

ABNT [NBR 16267](#) - Pintura industrial - Determinação de granulometria de abrasivos para jateamento;

ASTM [D4940](#) - Standard Test Method for Conductimetric Analysis of Water Soluble Ionic Contamination of Blasting Abrasives;

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;

ISO [8501-3](#) - Preparation of Steel Substrates before Application of Paints and Related Products - Visual Assessment of Surface Cleanliness - Part 3: Preparation Grades of Welds, Edges and other Areas With Surface Imperfections;

ISO [8502-3](#) - Preparation of Steel Substrates before Application of Paints and Related Products - Tests for the Assessment of Surface Cleanliness - Part 3: Assessment of Dust on Steel Surfaces Prepared for Painting (Pressure-Sensitive Tape Method);

ISO [8502-6](#) - Preparation of Steel Substrates before Application of Paints and Related Products - Tests for the Assessment of Surface Cleanliness - Part 6: Extraction of water soluble contaminants for analysis (Bresle method);

ISO [8502-9](#) - Preparation of Steel Substrates before Application of Paints and Related Products - Tests for the Assessment of Surface Cleanliness - Part 9: Field Method for the Conductometric Determination of Water-Soluble Salts;

ISO [8503-4](#) - Preparation of Steel Substrates before Application of Paints and Related Products - Surface Roughness Characteristics of Blast-Cleaned Steel Substrates - Part 4: Method for the Calibration of ISO Surface Profile Comparators and for the Determination of Surface Profile - Stylus Instrument Procedure;

ISO [8503-5](#) - Preparation of Steel Substrates before Application of Paints and Related Products - Surface Roughness Characteristics of Blast-Cleaned Steel Substrates - Part 5: Replica Tape Method for the Determination of the Surface Profile;

ISO [21809-2](#) - Petroleum and Natural Gas Industries - External Coatings for Buried or Submerged Pipelines Used in Pipelines Transportation Systems - Part 2: Single Layer Fusion-Bonded Epoxy Coatings;

SSPC [Guide 15](#) - Field Methods for Extraction and Analysis of Soluble Salts on Steel and Other Nonporous Substrates.

### 3 Terms and Definitions

For this standard the following terms and definitions are applied.

#### 3.1 quality certificate

document issued by the manufacturer, dated and signed, referring to each batch of material supplied, where the tests required in this Standard are reported, with the respective values found

**3.2****collars**

are the extensions of the tubes to be welded, from the face of the "bevel" to the inner lining, located at both ends, which are left free of lining

**3.3****manufacturer**

company that produces the coating materials

**3.4****holiday detector**

equipment used to detect discontinuity in non-conductive anticorrosive coatings applied on metallic substrates

**3.5****batch**

typical amount of production of a specific coating material, defined by its manufacturer

**3.6****coating materials**

coating raw material

**3.7****Rq parameter**

roughness parameter corresponding to the square root of the arithmetic mean of the square of the profile deviations (Yi) from the midline, obtained using the following formula:

$$Rq = \sqrt{\frac{1}{N} \sum_{i=1}^N Y_i^2}$$

Where:

N quantity of measures;

Yi deviation of the midline roughness profile.

**3.8****Rz DIN or Rys parameters**

roughness parameter of a metallic surface, which corresponds to the arithmetic mean of the five partial roughness values (Ry), this being the sum of the absolute values of the ordinates of the points of greatest distance, above and below the midline, existing in a sampling length

$$R_{ys} = \frac{R_{y(1)} + R_{y(2)} + R_{y(3)} + R_{y(4)} + R_{y(5)}}{5}$$

Where:

Ry partial roughness

**3.9****PA**

application procedure

**3.10****restart of Production**

new start of the coating production process after interruption of 1 h or more, maintaining the initial conditions of production

**3.11****coating applicator**

company responsible for applying the coating to the pipe

**3.12****shift**

working journey not exceeding 12 h

**4 General Conditions**

4.1 For applying the internal coating schemes established in this Standard, the recommendations of PETROBRAS [N-13](#) shall be attended.

4.2 For internal surface preparation, the requirements established in PETROBRAS N-9 shall be attended.

**5 Receiving, Handling, Storage and Transport of Pipes****5.1 Handling of Bare and Coated Pipes**

The handling of the pipes shall be done in order to avoid damages that could compromise its integrity.

The contact of the coated inner surface with the pipe handling accessories shall be avoided, however in the event of this occurrence, this surface shall be inspected as described in section 6 and repaired as described in section 8.

**5.2 Storage**

5.2.1 Storage shall be done in a way that avoids any type of damage, contamination or deterioration, which could compromise the coating performance.

5.2. The coating applicator shall present the procedure for storing pipes in factory.

5.2.3 ABNT [NBR 16212](#) shall be used in relation to the stacking of bare and coated tubes on a construction site.

5.2.4 The coated pipes stored at the construction site shall always be protected to the full extent by waterproof tarpaulin, as protection against local weather. The integrity of the coating shall be checked periodically, especially the edges, in order to prevent the spread of corrosion. The storage of the pipes shall ensure that water does not accumulate inside.

5.2.5 When the coated pipes remain in stock for more than 1 year, the coating shall have its original characteristics checked by visual inspection, thickness measurement and adhesion test.

### **5.3 Transportation of Coated Pipes**

5.3.1 The transportation of coated pipes shall be done in a way that avoids damages to the coating.

5.3.2 The coating applicator shall present a procedure for transportation of coated pipes.

## **6 Method for Application of Coating**

To carry out the inspection, there shall be proper lighting (minimum 1 000 lux).

### **6.1 Surface Preparation**

6.1.1 In the case of surface imperfections such as sharp edges and welding defects, ISO [8501-3](#) finishing standards P3 shall be adopted.

6.1.2 The internal surface of the tubes shall be free of contaminants that may interfere with the final quality of the coating. If it occurs, contaminants shall be removed in accordance with ABNT [NBR 15158](#).

6.1.3 Contamination by soluble salts shall be checked according to ISO [8502-6](#) and ISO [8502-9](#), or by the method described in subsection 4.6 of the SSPC [Guide 15](#). The maximum contamination value with soluble salts is 2 µg/cm<sup>2</sup>, measured by electronic instrument.

#### **6.1.2 Abrasive Blasting**

6.1.2.1 Before blasting, if necessary, the pipe shall be preheated to remove moisture. The surface of the tube (pipe) shall be kept at a temperature of at least 3 °C above the dew point, but below 100 °C and the relative humidity must be less than 85%, according to PETROBRAS [N-9](#).

6.1.2.2 The surface to be coated shall be subjected to dry abrasive blasting, according to PETROBRAS [N-9](#), minimum standard Sa 2 1/2 of ISO [8501-1](#).

6.1.2.3 The roughness profile shall be 70 µm to 100 µm, measured by the method "Replica Tape" as per ISO [8503-5](#) or by the method "Stylus" as per ISO [8503-4](#) and, in that case, considering the parameter Rz DIN or Ry5 and have angular nature. Three measurements shall be carried out in each end, evenly separated by 120°.

6.1.2.4 The pipe's blasted surface shall be free from contamination by dust, which shall not exceed the standard of Figure 2, according to ISO [8502-3](#).

6.1.2.5 Blasted, clean and accepted pipes for coating shall be coated within a period not exceeding 2 hours and kept in a controlled environment. In addition, the pipe surface shall be maintained at a temperature of at least 3 °C above the dew point. When there is oxidation, or any other contamination, the tube shall be blasted again.

#### 6.1.2.6 Inspection of abrasive

- a) Contamination by oil and grease shall be checked by collecting a sample of the abrasive mix from the jet equipment. This sample, approximately 100 g, shall be placed in a clean glass container, which must be filled with distilled water. After 3 min, the presence of oil or fat stains on the water surface shall be checked;
- b) For the evaluation of ionic contamination in the abrasive, the conductivity shall be measured according to ASTM [D4940](#). The maximum allowable value is 1000  $\mu\text{mho/cm}$ ;
- c) The abrasive must be free of visible signs of impurities;
- d) The abrasive must be free of oxidation;
- e) The granulometry of the new abrasive must meet that specified in ABNT NBR [16267](#).

### 6.2 Application of Coating

6.2.1 In the case of flanged spools, it is prohibited to cover the sealing face of the flanges, including the groove.

6.2.2 The cutback (non coated end) shall be 30 mm  $\pm$  3 mm, or another dimension agreed between the parties.

#### 6.2.3 Condition 1

Coating intended to decrease the friction and to pipes for construction of gas pipelines in non corrosive natural gas transportation. The field joints shall not be coated internally.

The coating must be applied over an operating temperature range of -30 ° C to 90 ° C.

Apply a single layer of epoxy paint "Novolac", PETROBRAS [N-2912](#), type I, by means of air less gun. The minimum thickness of dry film shall be 250  $\mu\text{m}$ .

NOTE 1 The specification of non corrosive natural gas shall attend the parameters defined for low corrosion grade fluids by means of analyses of fluids and wastes of PETROBRAS [N-2785](#).

#### 6.2.4 Condition 2

Coating intended to minimize potential contaminations of the transported product, resulting from corrosion processes, and to pipes for construction of oil pipelines construction in transportation of products such as: Aviation fuels, ethanol and ethylene glycol. The field joints shall not be coated internally.

The coating must be applied over an operating temperature range of -30 ° C to 90 ° C.

Apply a single layer of epoxy paint "Novolac", PETROBRAS [N-2912](#), type I, by means of air-less gun. The minimum thickness of dry film shall be 300  $\mu\text{m}$ .

#### 6.2.5 Condition 3

Coating with anticorrosive function and intend to pipes for the construction of pipelines (oil pipelines, gas pipelines or aqueducts) and industrial piping, where specified in the project.

The coating must be applied over an operating temperature range of -30 ° C to 150 ° C.

Apply a single layer of epoxy paint "Novolac", PETROBRAS [N-2912](#), type I, by means of air less gun. The minimum thickness of dry film shall be 400 µm.

**NOTE** This condition has an anti-corrosion nature and it is also necessary to protect the field joints and piping accessories.

## 7 Inspection and Manufacture Tests

The inspections shall be performed by qualified painting inspectors and they shall be certified by organisms accepted by PETROBRAS.

Defects, described in PETROBRAS [N-13](#), that compromise the integrity of the film shall not be accepted.

### 7.1 Inspection of Paints

The paints shall be inspected according to PETROBRAS [N-13](#). Nonconformity paints shall be rejected.

### 7.2 Inspection and Testing During the Coating Production

7.2.1 Inspections and testing shall be carried out according to specified in Table 1.

7.2.2 In the event that any test in Table 1 and Table 2 fails, all production shall be stopped immediately. Two additional tests must be carried out on the same sample and both shall be approved for the production process to be restarted.

If any of these tests fail, an investigative process must be initiated immediately by the coating applicator by running tests on the pipes before and after the occurrence, always in duplicate quantity, and all tests must always be approved. All pipes with a failed test must be segregated and the investigative process must identify the cause of the occurrence and the correction before restarting production.

**Table 1 - Inspection and Tests During the Coating Production**

Inspection	Acceptance Criteria/item	Frequency/sampling
Surface condition before abrasive blasting	6.1.1.2	All pipes
Contamination by soluble salts before abrasive blasting	6.1.1.3	At the beginning of each work shift
Inspection of abrasive	6.1.2.6	At the beginning of each work shift and each 4 h
Environmental conditions	6.1.2.1 and PETROBRAS <a href="#">N-13</a>	At the beginning of each work shift and each 4 h
Finish Grade of Blasted Surfaces	6.1.2.2	In the start or restart of each production and each 1 hour
Roughness profile	6.1.2.3	In the start or restart of each production and each 1 hour



Inspection	Acceptance Criteria/item	Frequency/sampling
Contamination by dust	6.1.2.4	In the start or restart of each production and each 1 hour
Appearance of the coating	7	All pipes
Thickness of wet film	PETROBRAS N-13	All pipes
Thickness of dry film	6.2.1 up to 6.2.3	All pipes
Identification of the painted pipes	9	All pipes
Adhesion "Pull Off"	Table 2	Three tests at the beginning of the work shift and after process change
Discontinuities (Holiday Detector)	Table 2	All pipes

### 7.3 Inspection and Testing in the Coating

#### 7.3.1 Coating Requirements

The inspections and testing carried out in the coating and in test panels fixed in the interior of the pipes shall attend to Table 2.

**Table 2 - Inspection and Testing in the Coating System**

Inspection	Acceptance Criterion/item	Testing method
Visual inspection of the coating	Item 7	ABNT NBR 14847
Thickness of dry film	Item 6.2	ABNT NBR 10443
Roughness of the dry film (Rq parameter) (see note 1)	Máx. 7 µm	(See Note 5)
Discontinuity test	(see note 2)	PETROBRAS N-13
Bending to 2.5 °PDL at 23 °C ± 2 °C Note: Test to be carried out for both extremes of allowable thickness	No cracks	ISO 21809-2
Adhesion (Pull off Test)	15 MPa	PETROBRAS N-13
<p>NOTE 1 Test carried out for Condition 1.</p> <p>NOTE 2 If up to two specific discontinuities are detected, the coating shall be repaired, according to the approved application procedure. The test can be carried out by wet or dry methods according to PETROBRAS N-13. Up to 2 specific discontinuities are accepted per inspected pipe, as long as it is not a systemic / repetitive occurrence. After the repair, a new test shall be performed. The test speed must not exceed 18m/min.</p> <p>NOTE 3 The test will be considered approved if the conditions below are met:            –The value of the minimum tensile stress (15 MPa), without presenting a type A / B failure;            –To present type B, - / Y, Y or Y / Z faults for stresses ranging from 15 MPa to 20 MPa;            –To present any type of failure for stresses greater than 20 MPa.</p> <p>NOTE 4 Equipment and adhesive must be selected to meet at least 20% above the minimum tensile stress.</p> <p>NOTE 5 Three measurements shall be made at each end, 120 ° out of phase.</p>		

## **8 Repairs in the Coating Applied**

8.1 The only repairs to the coating that can be performed are those resulting from specific defects detected in the discontinuity test (Holiday Detector). Other defects shall not be repaired and defective pipes shall be segregated.

8.2 The repairing procedure shall be done by the coating applicator and shall be approved by PETROBRAS.

8.3 The areas where the panels for tests were fixed shall be repaired.

## **9 Identification of Coated Pipes**

The identification in the pipes shall be done externally, in location previously agreed by PETROBRAS and the company that applies the coating. The identification shall contain the following information:

- a) logo or name of the applier company;
- b) type of coating;
- c) date of the application of the coating;
- d) traceability code.

**NOTE** The original inner identification made by the pipe manufacturer shall be transferred to the external surface of the pipe. If during the process of application of the inner coating the external identification is damaged it shall be remade.

## **10 Production Documentation (Databook)**

The coating applicator shall present a production databook contend, at least:

- a) coating materials specification.
- b) quality certificate of coating materials.
- c) coating application procedure;
- d) list of production equipment;
- e) list of measurement calibrated instruments and its certificates;
- f) approved inspection and tests plans;
- g) record of inspections and tests performed during coating materials receiving;
- h) record of inspections and tests performed during the production process, informing the companies which performed the tests;
- i) record of repairs performed;
- j) record of non-conformities;
- k) record of concession requests.

## **Annex A - Procedure for Application of the Coating**

### **A.1 Purpose**

Establish a description of all activities of the coating production process containing an Application Procedure (PA) and an Inspection and Test Plan (PIT).

### **A.2 Application Procedure (PA)**

The coating applicator shall prepare, for approval by PETROBRAS, a Procedure for Application (PA) including, at least, the following items:

- a) plant identification;
- b) technical documents and standards on which the PA was based;
- c) PA scope;
- d) type of coating, its materials and certificates;
- e) list of measurement instruments, due calibrated and their calibration certificate numbers;
- f) list of equipment to be used;
- g) receiving, preservation, storage and transportation plan for the coating materials and bare pipes;
- h) procedure for application of the coating, comprising:
  - cleaning of pipes;
  - blasting of inner surface, providing preparation grade, equipment and material used;
  - method for application of the coating;
  - cure method;
  - method for preparation of the ends of the pipe.
- i) procedure for performing the repairs on the applied coating;
- j) identification system of coated pipes;
- k) handle and storage plan of coated pipes;
- l) plan for protection of bares and coated pipes ends;
- m) company responsible for the tests;

### **A.3 Inspection and Test Plan (PIT)**

The coating applicator shall present the PIT, to be approved by PETROBRAS, which shall contains, at least, the following items:

- a) size of pipes (diameter and thickness);
- b) inspections and tests methods, as per indicated in this standard, during the receiving of coating materials, at the production and in the coating applied, containing:
  - frequency of carrying out the inspection;
  - acceptance criteria;
  - inspection level;
  - quantity of test bodies;
- c) method for performing the repairs on the applied coating.

## **Annex B - Qualification of the Procedure for Application of the Coating**

B.1 The procedure qualification process shall be detailed in a Qualification Plan, prepared by the applier of the coating, which shall contain, at a minimum, the following information:

- a) the application procedure;
- b) the paints quality certificates;
- c) the dimension and amount of specimens;
- d) the acceptance and rejection criteria;
- e) the site and schedule for the qualification testing.

B.2 The procedure qualification shall be carried out and concluded by the coating applicator, at its expenses and followed-up by a third part, before the beginning of the activities of coating production in factory.

B.3 The third party representative shall witness and issue a report of all the qualification tests and inspections carried out on the coatings, during the qualification in the factory and after the applied coating.

B.4 The application procedure qualification shall be stopped if any testing or inspection present unacceptable results and the whole process shall be restarted. The procedure shall be considered qualified when all the tests and inspections are in accordance with the requirements established in this Standard.

B.5 The paint to be used shall attend the requirements of PETROBRAS [N-2912](#).

B.6 At the application procedure qualification stage, 5 pipes shall be wholly painted, in accordance to the application procedure and, in each one of them, all tests and inspections specified in tables 1 and 2 of this standard shall be carried out and registered, regardless the frequencies established in their relevant tables.

B.7 The qualification tests specified in Tables 1 and 2, shall be remade on another 5 pipes, by the coating applicator, whenever any of the following parameters is changed:

- a) commercial name of the paint;
- b) surface preparation grade;
- c) internal diameter of pipe;
- d) blasted pipe roughness profile;
- e) changing of coating application equipment.

B.8 Being the procedure qualification working concluded, the coating applicator shall submit, for PETROBRAS approval and before the beginning of the production activities, a Qualification Report, in digital format, properly identified and including, at a minimum, the following information and/or documents:

- a) suppliers of the paints;
- b) specification of the paints;
- c) paints quality certificate;
- d) procedure for application of the coating;
- e) application process measurement equipment and instrumentation (with the relevant calibration certificates in force);
- f) thickness of dry film;

- g) surface preparation grade;
- h) roughness profile of blasted pipe;
- i) roughness profile of coating (only for condition 1);
- i) records of the inspections and tests carried out during the qualification process, including results and the respective entities that carried out the tests.

NOTE The updating and maintenance of the Databook is the responsibility of the coating applicator, and shall be maintained for a minimum period of 5 years.

