

Anticorrosive Coating of Industrial 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.

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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-2](#) REV. N 06/2020. In case of doubt, the Portuguese version, which is the valid document for all intents and purposes, shall be used.

1 Scope

1.1 The objective of this Standard is to establish the procedure for selection of the internal and external anticorrosive paint system of onshore and offshore industrial equipment.

NOTE 1 Anticorrosive paint systems for internal and external areas of tanks, spheres and storage cylinder shall be according PETROBRAS [N-2913](#).

NOTE 2 Maintenance painting of offshore installations shall be according PETROBRAS [N-1374](#).

1.2 This Standard is applied to procedures started after its date of issuance.

1.3 This Standard contains Technical Requirements and Recommended Practices.

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-1374](#) - Revestimentos Anticorrosivos para Manutenção de Unidades Marítimas de Exploração de Produção;

PETROBRAS [N-1514](#) - Tinta Indicadora de Alta Temperatura;

PETROBRAS [N-2231](#) - Tinta de Etil - Silicato de Zinco - Alumínio;

PETROBRAS [N-2288](#) - Tinta de Fundo Epóxi Pigmentada com Alumínio;

PETROBRAS [N-2630](#) - Tinta Epóxi - Fosfato de Zinco de Alta Espessura;

PETROBRAS [N-2677](#) - Tinta de Poliuretano Acrílico;

PETROBRAS [N-2680](#) - Tinta Epóxi, sem Solventes, Tolerante A Superfícies Molhadas;

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

PETROBRAS [N-2913](#) - Revestimentos Anticorrosivos para Tanque, Esfera e Cilindro de Armazenamento;

PETROBRAS [N-2943](#) - Revestimentos Anticorrosivos;

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

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

ABNT [NBR 15185](#) - Inspeção de Superfícies para Pintura Industrial;

ABNT [NBR 15488](#) - Pintura Industrial - Superfície Metálica para Aplicação de Tinta - Determinação do Perfil de Rugosidade;

ABNT [NBR 16172](#) - Revestimentos Anticorrosivos - Determinação de Descontinuidades em Revestimentos Anticorrosivos Aplicados sobre Substratos Metálicos;

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 [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;

ASTM [D610](#) - Standard Test Method for Evaluating Degree of Rusting on Painted Steel Surfaces;

ASTM [D2485](#) - Standard Test Methods for Evaluating Coatings for High Temperature Service;

ASTM [D4541](#) - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers;

NACE [WAB-2/SSPC-SP 10 \(WAB\)](#) - Near-White Metal Wet Abrasive Blast Cleaning;

NACE [WJ-2/SSPC-SP WJ 2](#) - Joint Surface Preparation Standard Waterjet Cleaning of Metals-Very Thorough Cleaning (WJ-2);

SSPC [SP 11](#) - Power Tool Cleaning to Bare Metal;

SSPC [VIS-4/NACE VIS 7](#) - Guide and Reference Photographs for Steel Surfaces Prepared by Waterjetting.

3 Application

For the purposes of application of this Standard, the following equipment items are considered:

- a) loading arms;
- b) boilers;
- c) stacks;
- d) desalters;
- e) incinerators;
- f) fired heaters;
- g) heat exchangers;
- h) reactors;
- i) regenerators;
- j) flares;
- k) process towers;
- l) pressure vessels.

NOTE For internal and external anticorrosive coatings of spheres and storage cylinders, PETROBRAS [N-2913](#) shall be followed.

4 General Conditions

4.1 The paint systems standardized herein are established considering the specific conditions to which they are subject, whether or not there is thermal insulation, and the operating temperature.

4.2 Any promotional painting or shop primer applied, if any, shall be removed just before the application of the paint systems specified in this Standard.

4.3 For touching up existing painting, the original system shall be repeated. In case that it is not possible to carry out abrasive blasting, duly justified and accepted by PETROBRAS, the surface preparation shall be performed by means of mechanical rotary tools type "wire bristle impact" or "rotary flap" according to SSPC-SP11. In the case of touchups to maintenance paint jobs, "aluminum pigmented epoxy primer" as per PETROBRAS N-2288 shall be used, excepting for the conditions 2, 3, 6 and 8, where shall be used to touching up the specified paint in the original paint scheme.

NOTE When performing touch-ups, attention shall be given to the compatibility aspects between the paint to be applied and the existing ones, as well as making sure that the paint used in the touch-up meets the operating temperatures described in the conditions of this standard.

4.3.1 In the case of touch-ups or minor repairs in interior painting maintenance services, the surface preparation described in 4.3 shall not be performed and shall be maintained the original painting scheme.

4.4 If exceeded the maximum repainting intervals, the recommendations established in PETROBRAS N-13 shall be followed.

4.5 Before preparing the surface to be painted, the entire surface shall be visually inspected, in accordance with ABNT NBR 14847 and ABNT NBR 15185. Identify spots showing traces of oil, grease or fat and other contaminants, the degree of corrosion of the surface (A, B, C or D, in accordance with ISO 8501-1), as well as the points where the painting, if any, is damaged. For painted surfaces, identify the areas that present painting defects or flaws in accordance with the requirements of ASTM D 610.

4.6 In any of the paint systems specified in this Standard, the surface to be painted shall undergo a physical-chemical cleaning process as per ABNT NBR 15158, only in the regions where traces of oil, grease, or fat and other contaminants are found during the inspection.

4.7 The surface shall be treated according to Table 1 using abrasive blasting or water jetting.

NOTE Water jetting shall only be used in maintenance services. For new construction, the water jetting is permitted only if combined with abrasives.

Table 1 - Surface Treatment Method

| Specific conditions | Procedure for surface treatment | Finish grade for abrasive blasting (ISO 8501-1) | Finish grade for wet abrasive blasting (NACE WAB-2/SSPC-SP 10 (WAB)) | Finish grade for water jetting (NACE WJ-2/SSPC-SP WJ 2) | Roughness profile (ISO 8503-4 or ISO 8503-5 or ABNT NBR 15488) (Note 3) |
|---|---|---|--|---|---|
| 1, 2 (alternative), 3, 4, 5, 6, 7 (alternative) and 8 and 9 | According to PETROBRAS N-9 | Sa 2 1/2 (minimum) | WAB-2 (minimum) | WJ2 (minimum) | 50 µm to 100 µm (external areas) |
| 2 | | | - | - | 70 µm to 100 µm (internal areas) |
| | NOTE 1 In case of water jetting, shall be considered the use of paint compatible with substrate state after this treatment. Applications shall be executed over surfaces presenting light flash rust. NOTE 2 The visual standards for water jetting are established at SSPC VIS-4/NACE VIS 7. NOTE 3 Utilized Replica Tape method according to ISO 8503-5 or needle type roughness profile gauge according to ABNT NBR 15488 or stylus method according to ISO 8503-4 and, in this case, considering the parameter Rz DIN or Rv5 and have angular nature. | | | | |

4.8 On the basis of the equipment with fire proofing coating, the metallic surface shall be blasted by means of dry abrasive blasting to grade Sa 2 ½, or wet abrasive blasting to grade WAB-2, or water jetting, and a coat of 150 µm of surface tolerant solvent free epoxy paint for wet surfaces, PETROBRAS N-2680, shall be applied. The time interval for applying the fire proofing coating shall be the same as required for repainting of the anticorrosive coating PETROBRAS N-2680.

NOTE After abrasive blasting (dry or wet) and water jetting, the surface roughness profile shall be inspected, which shall meet the requirements of Table 1.

4.9 For application of paint systems and quality control, the recommendations of PETROBRAS N-13 shall be followed.

4.10 On weld fillets, complex geometry parts, sharp edges and cavities, the primer shall be applied by brush, except in the case of paint of ethyl-silicate or zinc-aluminum, PETROBRAS N-2231.

4.11 For equipment having operating temperatures below 80 °C, but for which steam-out is expected to be carried out, the paint system specified in Condition 2 shall be used.

4.12 The pull-off test shall be performed after the paint application has been completed and the curing time has elapsed. The execution of the test shall be carried out as defined in PETROBRAS N-13, taking into account the acceptance criterion in Table A.1.

5 Specific Conditions

5.1 External Coating

5.1.1 Equipment Without Thermal Insulation

5.1.1.1 Condition 1

Environment: dry or humid, with or without salinity, containing or not containing gases derived from sulfur. Operating temperature: from 0°C up to 80 °C.

5.1.1.1.1 Primer

Apply a coat of high-thickness primer epoxy paint, PETROBRAS N-2630, by means of a brush or airless spray gun. The minimum dry film thickness shall be 100 µm. The time interval for application of the finish paint shall be, at least, 16 hours, but not more than 48 hours.

NOTE As an alternative, apply one coat of Surface Tolerant Solvent Free Epoxy Paint for Wet Surfaces as specified in PETROBRAS N-2680 with a minimum dry film thickness of 100 µm. The time interval for application of the finish paint shall be, at least, 12 hours, but not more than 120 hours.

5.1.1.1.2 Finish Paint

Apply a coat of polyurethane acrylic paint, PETROBRAS N-2677, by means of a brush or airless spray gun, with a minimum dry film thickness of 70 µm.

5.1.1.2 Condition 2

Environment: dry or humid, with or without salinity, containing or not containing gases derived from sulfur. Operating temperature: above 80 °C and up to 500 °C or when the operation temperature is lower than 80 °C, but a steam-out will carry out.

Apply a single coating of ethyl silicate of zinc-aluminum paint, PETROBRAS N-2231, by means of a airless spray gun (with mechanical agitation) with a minimum dry film thickness of 75 µm.

NOTE For operating temperatures above 80 °C and up to 200 °C it is recommended the application of one coat of Novolac Epoxy Paint (Type I) as specified in PETROBRAS N-2912, by means of airless spray gun, with a minimum dry film thickness of 200 µm. **[Recommended Practice]**

5.1.1.3 Condition 3

Equipment made of carbon steel, with refractory lining and/or internal insulation. Operating temperature: above 200 °C.

Apply two coats of high-temperature indicating paint, PETROBRAS N-1514, by means of airless gun, with a minimum dry film thickness of 15 µm per coat. The maximum time interval between coats shall be 24 hours for type I and 16 hours for type II. For operating temperatures between 200 °C and 290 °C use type II. For operating temperatures above 290 °C use type I.

5.1.1.4 Condition 4

Equipment located along the seashore or on a pier and industrial areas with high humidity and aggressive atmosphere. Operating temperature: from 0°C up to 80 °C.

NOTE Applicable in particularly aggressive atmospheres located up to 500 m from beach or in areas where there is predominantly strong conditions caused by winds in the presence of high salinity of air (salt spray). The surface shall be cleaned with fresh water at a pressure of 3 000 psi between coats.

5.1.1.4.1 Primer

Apply one coat of Novolac Epoxy Paint (Type II) as specified in PETROBRAS N-2912, by means of airless spray gun, with a minimum dry film thickness of 300 µm.

NOTE As an alternative, apply two coats of Surface Tolerant Solvent Free Epoxy Paint for Wet Surfaces as specified in PETROBRAS [N-2680](#) with a minimum dry film thickness of 150 µm. The time interval for application of the second coat shall be dry to touch, since operationally possible, but not more than 120 hours.

5.1.1.4.2 Finish Paint

Apply a coat of acrylic polyurethane paint, as specified in PETROBRAS [N-2677](#), by means of conventional or airless gun, with a minimum dry film thickness of 70 µm.

5.1.2 Equipment With Thermal Insulation

5.1.2.1 Condition 5

Environment: dry or humid, with or without salinity, containing or not containing gases derived from sulfur. Operating temperature: from -45 °C up to 15 °C.

Apply two coats of surface tolerant solvent free epoxy paint for wet surfaces, PETROBRAS [N-2680](#), by means of a airless gun, with minimum dry film thickness of 150 µm, per coat.

5.1.2.2 Condition 6

Environment: dry or humid, with or without salinity, containing or not containing gases derived from sulfur. Operating temperature: above 15 °C up to 150 °C.

Apply one coat of Novolac Epoxy Paint (Type I), as specified in PETROBRAS [N-2912](#), by means of airless gun. The minimum dry film thickness shall be 200 µm

5.1.2.3 Condition 7

Environment: dry or humid, with or without salinity, containing or not containing gases derived from sulfur, in continuous duty. Operating temperature: above 150 °C up to 500 °C. In this case, the equipment shall not be painted.

5.1.2.4 Condition 8

Environment: dry or humid, with or without salinity, containing or not containing gases derived from sulfur, in intermittent or cyclical services. Operating temperature: above 150 °C up to 500 °C, considering the possibility of occurring corrosion under insulation

Apply 02 coats of paint for high temperature and corrosion under insulation, as specified in Annex E of PETROBRAS [N-2943](#), by means of airless gun. The minimum dry film thickness shall be 150 µm per coat.

5.2 Internal Coating

5.2.2 Condition 9

Equipment subject to corrosion with a high wear rate (above 0,1 mm/year). Operating temperature: above - 15 °C and up to 150 °C.

Apply, in all internal surface of equipment, a single coating with minimum dry film thickness of 400 μm of the type III coating, specified by PETROBRAS [N-2912](#), mandatorily by means of an airless gun, except for products applied by spatula.

NOTE 1 Film shall be checked against discontinuity using a holiday detector in accordance with PETROBRAS [N-13](#) and ABNT [NBR 16172](#).

NOTE 2 For conditions of operating temperature above 150 $^{\circ}\text{C}$, the use of alternatives available on the market shall be evaluated.

Annex A – Table

Table A.1 – Acceptance Criteria for Pull-Off Test

| Condition | Paint scheme | Pull off Strength (MPa) | Acceptance Criteria |
|-----------------|---|-------------------------|--|
| 1 | 1 st coat: N-2630 (100 µm) 2 nd coat: N-2677 (70 µm) | 8 (Minimum) | Allowed fail type B/C |
| | | Above 10 | Allowed failures types B, -/Y, Y ou Y/Z |
| | | Above 20 | Allowed any type of failure |
| 1 (alternativa) | 1 st coat: N-2680 (100 µm) 2 nd coat: N-2677 (70 µm) | 8 (Minimum) | Allowed fail type B/C |
| | | Above 10 | Allowed failures types B, -/Y, Y or Y/Z |
| | | Above 20 | Allowed any type of failure |
| 2 | Single coat: N-2231 (75 µm) | 5 (Minimum) up to 20 | Allowed any type of failure, except type A/B |
| | | Above 20 | Allowed any type of failure |
| 2 (alternative) | Single coat: N-2912 type I (200 µm) | 15 (Minimum) up to 20 | Allowed any type of failure, except type A/B |
| | | Above 20 | Allowed any type of failure |
| 3 | 1 st coat: N-1514 (15 µm) 2 nd coat: N-1514 (15 µm) | 5 (Minimum) up to 20 | Allowed any type of failure, except type A/B |
| | | Above 20 | Allowed any type of failure |
| 4 | 1 st coat: N-2912 type II (300 µm) 2 nd coat: N-2677 (70 µm) | 8 (Minimum) up to 12 | Allowed failures types B/C, -/Y, Y or Y/Z |
| | | Above 12 | Allowed failures types B, -/Y, Y or Y/Z |
| | | Above 20 | Allowed any type of failure |

Annex A – Table (continuation)

Table A.1 – Acceptance Criteria for Pull-Off Test

| Condition | Paint scheme | Pull off Strength (MPa) | Acceptance Criteria |
|-----------------|--|-------------------------|--|
| 4 (alternative) | 1 st coat: N-2680 (150 µm) 2 nd coat: N-2680 (150 µm) 3 th coat: N-2677 (70 µm) | 8 (Minimum) up to 12 | Allowed failures types C/D, –/Y, Y or Y/Z |
| | | Above 12 | Allowed failures types B, C, –/Y, Y or Y/Z |
| | | Above 20 | Allowed any type of failure |
| 5 | 1 st coat: N-2680 (150 µm) 2 nd coat: N-2680 (150 µm) | 12 (Minimum) up to 20 | Allowed any type of failure, except type A/B |
| | | Above 20 | Allowed any type of failure |
| 6 | Single coat: N-2912 (Type I) (200 µm) | 15 (Minimum) up to 20 | Allowed any type of failure, except type A/B |
| | | Above 20 | Allowed any type of failure |
| 7 | The equipment is not painted | | |
| 8 | Single coat: Paint for Corrosion under insulation– Annex E of N-2943 (300 µm) | 2 (Minimum) up to 20 | Allowed any type of failure, except type A/B |
| | | Above 20 | Allowed any type of failure |
| 9 | Single coat: N-2912 tipo III (400 µm) | 15 (Minimum) up to 20 | Allowed any type of failure, except type A/B |
| | | Above 20 | Allowed any type of failure |
| NOTE | Test equipment and adhesive shall be selected to meet at least 20% above the minimum pull off strenght. | | |

| ÍNDICE DE REVISIONS | |
|---------------------------------------|---|
| REV. A, B, C, D, E, F, G and H | |
| There is no index of revisions. | |
| REV. J | |
| Affected Parts | Description of Alteration |
| All items | Revised |
| REV. K | |
| Affected Parts | Description of Alteration |
| All | Revised |
| REV. L | |
| Affected Parts | Description of Alteration |
| 1.4 | Inclusion of Recommended Practice indication |
| 2 | Exclusion of PETROBRAS N-9 |
| Tabela 1 | Revised |
| 4.11 | Revised |
| 5.1.1.5 | Alteration of the temperature from 120° to 500 °C |
| 5.1.2.2 | Revised |
| 5.1.2.3 | Revised |
| 5.2.1 | Notes revised |
| REV. M | |
| Affected Parts | Description of Alteration |
| All | Revised |
| REV. N | |
| Affected Parts | Description of Alteration |
| All | Revised |
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