

Novolac Epoxy Paint

Specification

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.

CONTEC

Comissão de Normalização
Técnica

SC - 14

Anticorrosive Coating and
Painting

Foreword

This Standard is the English version (issued in 07/2020) of PETROBRAS N-2912 03/2016. 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 specifies the characteristics verifiable in the laboratory required for polyamine-cured novolac epoxy paint, supplied in two containers: one containing the epoxy resin (component A) and the other containing the polyamine curing agent (component B). Three types of paint are specified:

- a) Type I, heat cured or ambient temperature cured;
- b) Type II, solvent free, ambient temperature cured;
- c) Type III, solvent free, ambient temperature cured, pigmented with glass flakes or ceramic fillers.

1.2 This Standard applies to specifications started as of its date of issuance.

1.2 This standard also applies to thermal cured powder Epoxy Novolac paints (Fusion Bonded Epoxy – FBE)

NOTE The FBE coatings, when evaluated as per this standard, only need to attend the requirements established in 4.3 and in Section 5.

1.3 This standard applies to specifications started from its issuance 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-13](#) - Technical Requirements for Paintwork;

PETROBRAS [N-1219](#) - Colors;

ABNT [NBR 12103](#) - Tintas - Determinação de Descaimento;

ABNT [NBR 15442](#) - Pintura Industrial - Inspeção de Recebimento de Recipientes Fechados;

ABNT [NBR 15742](#) - Tintas e Vernizes - Determinação de Vida Útil da Mistura ("Pot-Life");

ABNT [NBR 15877: 2010](#) - Pintura Industrial - Ensaio de Aderência por Tração;

ISO [2808](#) - Paints and Varnishes - Determination of Film Thickness Fourth Edition;

ISO [2812-1](#) - Paints and Varnishes - Determination of Resistance to Liquids - Part 1: Immersion in Liquids Other than Water;

ISO [2812-2](#) - Paints and varnishes - Determination of Resistance to Liquids - Part 2: Water Immersion Method;

ISO 3233-1 - Paints and Varnishes - Determination of the Percentage Volume of Non-Volatile Matter - Part 1: Method Using a Coated Test Panel to Determine Non-Volatile Matter and to Determine Dry Film Density by the Archimedes Principle;

ISO [3251](#) - Paints, Varnishes and Plastics - Determination of Non-Volatile-Matter Content;

ISO 3679 - Determination of Flash No-Flash and Flash Point - Rapid Equilibrium Closed Cup Method;

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 and of Steel Substrates After Overall Removal of Previous Coatings;

ASTM [C 868](#) - Standard Test Method for Chemical Resistance of Protective Linings;

ASTM [D 522/D522M](#) - Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings;

ASTM [D 562](#) - Standard Test Method for Consistency of Paints Measuring Krebs Unit (KU) Viscosity Using a Stormer-Type Viscometer;

ASTM [D 1210](#) - Standard Test Method for Fineness of Dispersion of Pigment-Vehicle Systems by Hegman-Type Gage;

ASTM [D 1475](#) - Standard Test Method for Density of Liquid Coatings, Inks, and Related Products;

ASTM [D 1640/ D1640M](#) - Standard Test Method for Drying, Curing of Film Formation of Organic Coatings at Room Temperature;

ASTM [D 2247](#) - Standard Practice for Testing Water Resistance of Coatings in 100 % Relative Humidity;

ASTM [D 4060](#) - Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser;

ASTM [D 4541:2009](#) - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers;

ASTM [G 8](#) - Standard Test Methods for Cathodic Disbonding of Pipeline Coatings;

NACE [TM 0185](#) - Evaluation of Internal Plastic Coatings for Corrosion Control of Tubular Goods by Autoclave Testing.

3 General Conditions

3.1 Appearance of Components A and B

Components A and B shall be homogeneous and show no skinning and thickening in a freshly-opened can.

3.2 Packaging

3.2.1 Containers shall be straight circular cylindrical in shape.

3.2.2 For sealing packaging, material likely to cause degradation or contamination of the paint shall not be used.

3.3 Conditions and Filling of Containers

3.3.1 The containers with the paint components shall be in a good state of repair, duly labeled or marked on the side surface, in accordance with the requirements of this Standard and ABNT NBR 15442.

3.3.2 Containers shall contain at least the quantity indicated thereon.

3.4 Stability During Storage

3.4.1 Components A and B shall display stability during storage in a closed container at a temperature below 40 °C, ensuring their use for at least 12 months after the date of manufacture.

3.4.2 This period of use may be renewed for two additional periods of 6 months through repetition and prior approval of the tests performed at the time of supply, in accordance with PETROBRAS [N-13](#).
[Recommended Practice]

3.5 Dilution

3.5.1 When necessary, to facilitate its application, Type I novolac epoxy paint may be diluted according to the manufacturer's instructions.

3.5.2 Solvent-free novolac epoxy paints (Type II and Type III) shall not be diluted.

3.6 Marking

3.6.1 Containers shall bear at least the following information on the label or on their body, but not on the lid:

- a) PETROBRAS standard N-2912;
- b) Type I, Type II or Type III novolac epoxy paint;
- c) Identification of components: A and B;
- d) diluents to be used; (only for Type I);
- e) amount contained in container in liters and in kg;
- f) manufacturer's name and address;
- g) number or signal identifying manufacturing lot;
- h) product expiration date;
- i) mass and volume mixing ratio.

3.6.2 Besides the information described in 3.6.1, the containers of hot-cured Type I paints shall also bear on their label or on their bodies the parameters for the curing process such as temperature and time.

3.7 Color

Novolac epoxy paints shall be supplied in white (0095), light gray (0065) or pastel green (3582), according to PETROBRAS [N-1219](#), and the film may be darkened after application.

NOTE This paint may be supplied in other colors, when specified in the proper technical documentation.

4 Specific Conditions

4.1 Requirement of Components A and B

4.1.1 Components A and B, when examined for settling, may present some deposit provided they can be easily homogenized (manually).

4.1.2 The resins of Component A shall be identified by vibrational spectroscopy in the infrared region. The spectra obtained after evaporation of the solvents shall present the characteristic streaks of the novolac epoxy resin, free of contaminants and in accordance with the spectrum of Annex A.

4.2 Requirements of Ready- to -Apply Product

4.2.1 Type I

The requirements of Type I paint (ready for application), after mixing components A and B, are indicated in Table 1.

Table 1 - Requirements for Paint Type I (Ready for Application)

Tests	Requirements		Standards to be used
	Min.	Max.	
Solids by mass, %	80	-	ISO 3251
Solids by volume, %	75	-	ISO 3233-1
Density, g/cm ³	-	1,50	ASTM D 1475
Consistency, UK	-	110	ASTM D 562
Sagging, µm	200		ABNT NBR 12103
Fineness of grind, µm	-	50	ASTM D 1210
Pot life, min (see Note)	30	-	ABNT NBR 15742
Tack-free time, h	-	12	ASTM D1640/D1640M
Hard Dry time, h	-	24	ASTM D1640/D1640M
Overcoating interval, h	-	24	ASTM D1640/D1640M
NOTE If heat curing is necessary, curing conditions shall be indicated by the paint manufacturer.			

4.2.2 Type II

The requirements of Type II paint (ready for application), after mixing components A and B, are indicated in Table 2.

Table 2 - Requirements for Type II Paint (Ready for Application)

Tests	Requirements		Standards to be used
	Min.	Max.	
Solids by mass, %	97,0	-	ISO 3251
Solids by volume, %	95,0		ISO 3233-1
Density, g/cm ³	-	1,50	ASTM D 1475
Consistency, UK	-	140	ASTM D 562
Sagging, µm	300	-	ABNT NBR 12103
Flash point, °C, comp. A	100	-	ISO 3679
Flash point, °C, comp. B	66	-	ISO 3679
Fineness of Grind, µm	-	50	ASTM D 1210
Pot life, min	30	-	ABNT NBR 15742
Tack-free time, h	-	12	ASTM D 1640
Hard Dry time, h	-	24	ASTM D 1640
Overcoating interval, h	-	24	ASTM D 1640

4.2.3 Type III

The requirements for Type III paint (ready for application), after mixing components A and B, are indicated in Table 3.

Table 3 - Requirements for Type III Paint (Ready for Application)

Tests	Requirements		Standards to be used
	Min.	Max.	
Solids by mass, %	97	-	ISO 3251
Solids by volume, %	95	-	ISO 3233-1
Density, g/cm ³	-	1,60	ASTM D 1475
Sagging, µm	400	-	ABNT NBR 12103
Flash point, °C comp. A	100	-	ISO 3679
Flash point, °C comp. B	66	-	ISO 3679
Pot life, min.	30	-	ABNT NBR 15742
Tack-free time, h	-	12	ASTM D1640/D1640M
Hard Dry time, h	-	24	ASTM D1640/D1640M
Overcoating time, h	-	24	ASTM D1640/D1640M

4.2.4 The final product obtained after mixing together both paint components shall present a uniform consistency.

4.3 Dry Film Characteristics

4.3.1 The dry film characteristics of Type I, II, and III paints are specified in Table 4 and in 4.3.2 to 4.3.6. In Table 4, the tests required for Type I, II and III paints are marked by letter X, and the minimum thicknesses for testing are marked within parentheses in the respective columns.

Table 4 - Dry Film Characteristics

Tests	Type I (300 µm)	Type II (450 µm)	Type III (800 µm)	Requirements		Standards to be used
				Min.	Ma.	
Atlas cell @ 40 °C, h (see Note 1)	X			2 000	-	ASTM C 868
Atlas cell @ 60 °C, h (see Note 1)		X		2 000	-	ASTM C 868
Atlas cell @ 80 °C, h (see Note 1)			X	2 000	-	ASTM C 868
Autoclave @ 150 °C, h (see Notes 1 and 2)	X			1 000	-	NACE TM 0185
Autoclave @ 150 °C, h (see Notes 1 and 2)			X	2 000	-	NACE TM 0185
Abrasion resistance, mg/1 000 cycles (see Note 3)	X	X	X	-	70.0	ASTM D 4060
Cathodic disbonding, mm (see 5.2.3.7)	X	X	X	-	10,0	ASTM G 8
Pull-off strength, MPa	X	X	X	15,0	-	ABNT NBR 15877:2010, Annex A.2 or ASTM D 4541:2009, Method D - Equipment Type IV
Resistance to 100 % relative humidity, h	X	X	X	2 000	-	ASTM D 2247
Resistance to distilled water @ 40 °C, h	X	X	X	2 000	-	ISO 2812-2
Resistance to NaOH 30%, h	X	X	X	2 000	-	ISO 2812-1
Resistance to H ₂ SO ₄ 40%, h	X	X	X	2 000	-	ISO 2812-1
Resistance to xylene, h	X	X	X	2 000	-	ISO 2812-1
Resistance to coke naphtha, h	X	X	X	2 000	-	ISO 2812-1
Resistance to fuel ethanol, h	X	X	X	2 000	-	ISO 2812-1
Flexure over conic mandrel - Elongation (%)	X			7	-	ASTM D522/D522M
NOTE 1 The solution to be used shall have the following composition: 70 000 ppm of chloride ions, 21,0 g/L of sodium acetate trihydrate, initial pH of 5,0, adjusted with hydrochloric acid.						
NOTE 2 The gas phase shall be comprised of 96 % of CO ₂ and 4 % of H ₂ S and, during the test, its pressure shall be kept sufficiently above the water vapor pressure at 150 °C to prevent the solution from boiling.						
NOTE 3 The abrasion resistance test shall be performed using a CS-17 abrasive wheel with a load of 1 kg.						

4.3.2 After tests are performed on atlas cells, the coating applied on the tested specimens shall be subjected to the pull-off strength test in accordance with ABNT NBR 15877:2010, Annex A.2 or ASTM D 4541:2009, Method D - Equipment Type IV, both in the region that remained immersed during the test and in the one that remained exposed to the vapor phase. The Pull-Off Strength shall not be less than 10 MPa and failure related to adhesion to the substrate (A/B) shall not be accepted.

4.3.3 When observing panels, after the atlas cell, autoclave, water and chemical immersion tests, blistering, corrosion spots, cracks and failures of any nature shall not be observed on the coating.

NOTE It is considered acceptable to change the color of the film at the end of the immersion in coke naphtha.

4.3.4 The minimum pull off strength specified in Table 4 shall be satisfied and failure related to adhesion to the substrate (A/B) are not accepted.

4.3.5 After the xylene, ethanol, and coke naphtha immersion tests, no changes shall be observed in the color of the solvent used in the test.

4.3.6 The fuel ethanol used in the test shall comply with the specifications of the current resolution of the National Petroleum, Natural Gas and Biofuel Agency (ANP) for Hydrated Ethyl Alcohol Fuel.

5 Inspection

5.1 Visual Inspection

Check if the conditions described in 3.1, 3.2, 3.3, and 3.6 have been satisfied and reject supplied items that fail to do so.

5.2 Tests

5.2.1 The liquid paint tests to be performed are those contained in Tables 1 to 3 according to the type of paint to be evaluated (Type I, Type II or Type III).

5.2.2 The dry film tests to be performed are those contained in Table 4.

5.2.3 For the performance of the tests indicated in Tables 1 to 4, the conditions described in 5.2.3.1 to 5.2.3.7 shall be followed.

5.2.3.1 The test panels shall be made of AISI-1020 carbon steel plate measuring 150 mm x 100 mm and 4,6 mm thick. The surface shall be prepared by abrasive blasting to near white metal, grade Sa 2 1/2 of ISO [8501-1](#). The anchor profile shall be from 50 µm to 100 µm.

NOTE For the atlas cell, abrasion resistance and bending tests, the dimension of the test specimen shall be that described in the respective standard. The surface preparation grade as well as the anchor profile shall be those described in this subsection.

5.2.3.2 Three panels shall be prepared for each test.

5.2.3.3 Thickness measurements shall be made in accordance with the proper nondestructive methods specified in ISO [2808](#) (Method 10).

5.2.3.4 Panels should be painted with an airless spray gun. **[Recommended Practice]**

5.2.3.5 The edges and the back of the test panels shall be properly protected so as to prevent premature corrosion from appearing in these parts.

5.2.3.6 The tests described in Table 4 shall be conducted not more than 5 days after the paints are applied on the panels. During this period, panels shall be stored at a temperature of $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$ and a relative humidity of $60\% \pm 5\%$. The paint manufacturer may authorize the beginning of the tests with shorter curing times in order to reduce the product evaluation time. From a practical standpoint, and depending on the results obtained, this may reduce the equipment start up operation.

NOTE For heat-cured Type I paints, the tests indicated in Table 4 may be started 24 hours after the end of the curing process indicated by the respective manufacturer.

5.2.3.7 In the cathodic disbonding test to be performed according to ASTM [G 8](#) (Method B), the test panels shall be subjected to an electrochemical potential range between -1,45 V and -1,55 V, measured in relation to a Cu/CuSO₄ reference electrode, using an impressed current system or a magnesium galvanic sacrifice anode. The test panel and the sacrifice anode shall be immersed in an electrolyte at a temperature between 21 °C and 25 °C and with the following chemical composition: 1 % sodium chloride + 1 % sodium sulfate + 1 % sodium carbonate. A 6,35 mm diameter hole with a depth equivalent to the coating thickness shall be made at the center of the test panel. The test shall last 30 days.

Annex A - Figure

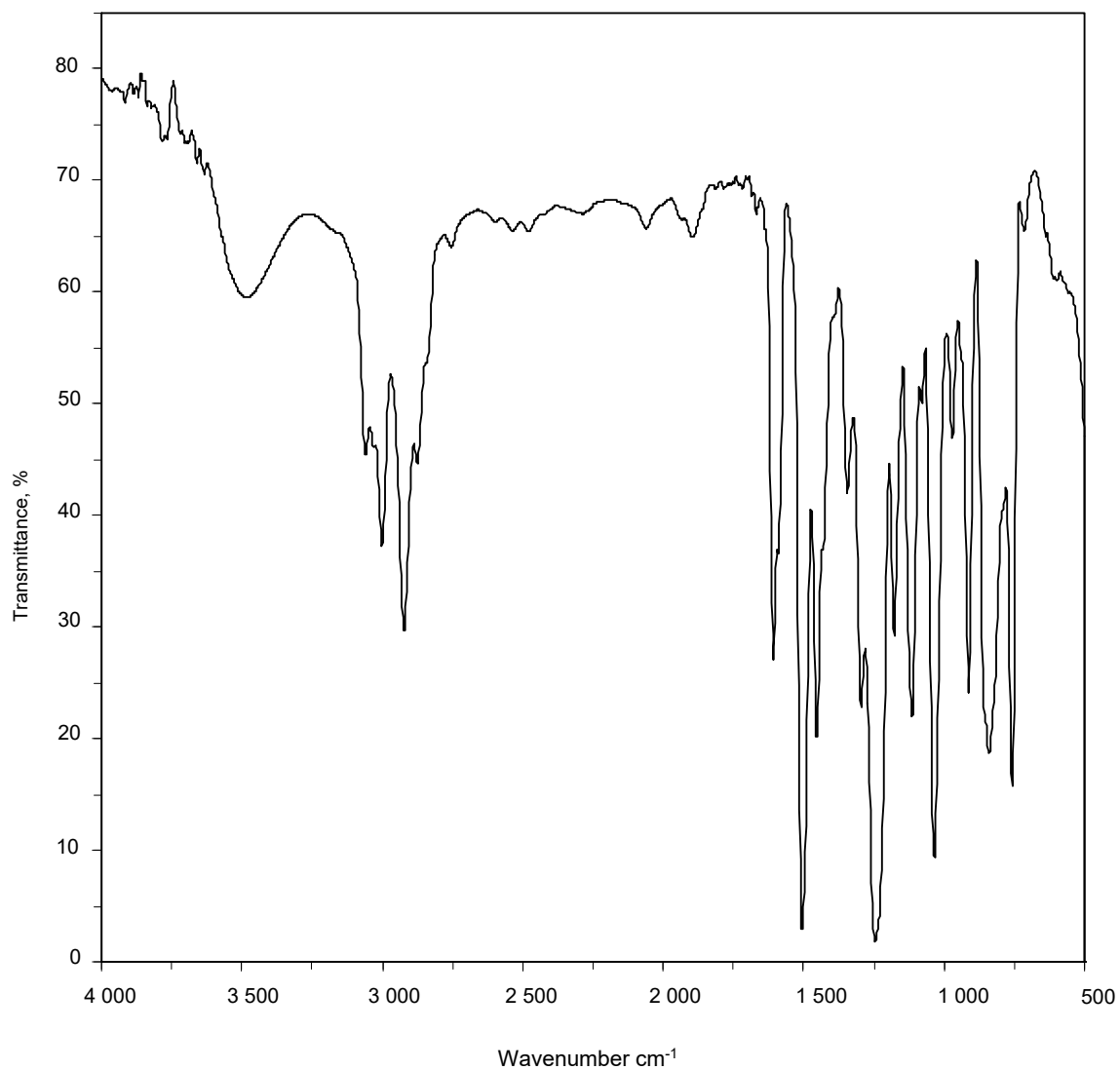


Figure A.1 - Vibrational Spectrum in Infrared Region of Novolac Epoxy Resin

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