

## Non-Destructive Testing - Liquid Penetrant

### 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  
Técnica

### SC - 27

Non-Destructive Testing

### 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 11/2013) of PETROBRAS N-1596 REV. H 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 sets out the conditions to be followed for non-destructive testing by means of liquid penetrant, complementing national and foreign standards.

1.2 This Standard is applied to inspection of non-porous, metallic and non-metallic materials.

1.3 This Standard is applied to non-destructive testing by means of liquid penetrant performed after its issue date.

1.4 This Standard only contains Technical Requirements.

## 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.

INMETRO [VIM:2012](#) - Vocabulário Internacional de Metrologia (Primeira Edição Luso-Brasileira);

PETROBRAS [N-2370](#) - Penetrant Materials;

ABNT [NBR NM 327:2011](#) - Ensaios Não Destrutivos - Líquido Penetrante - Terminologia;

ABNT [NBR NM 334:2012](#) - Ensaios Não Destrutivos - Líquidos Penetrantes - Detecção de Descontinuidades;

ABNT [NBR NM ISO 9712:2007](#) - Ensaio Não Destrutivo - Qualificação e Certificação de Pessoal;

ISO [3452-1:2008](#) - Non-Destructive Testing - Penetrant Inspection - Part 1: General Principles;

ISO [3452-2:2006](#) - Non-Destructive Testing - Penetrant Testing - Part 2: Testing of Penetrant Materials;

ISO [3452-3:1998](#) - Non-Destructive Testing - Penetrant Testing - Part 3: Reference Test Blocks;

ISO [9712:2012](#) - Non-Destructive Testing - Qualification and Certification of Personnel;

ISO IEC [17024:2012](#) - Conformity Assessment - General Requirements for Bodies Operating Certification of Persons;

ASME [BPVC - Section V:2010](#) - Nondestructive Examination;

ASTM [E 165:2012](#) - Standard Practice for Liquid Penetrant Examination for General Industry;

DNV-OS-F101:2012 - Submarine Pipeline Systems.

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 terms and definitions of INMETRO [VIM:2012](#), ABNT NBR [NM 327:2011](#) and those below are adopted.

#### 3.1

##### **addition**

addition of a new paragraph or of a text to a paragraph

#### 3.2

##### **alteration**

replacement of an entire paragraph or modification of part of it

#### 3.3

##### **suppression**

deletion of the paragraph or of part of it

#### 3.4

##### **base standard**

assembly, construction, manufacturing and design standards relating to the inspected equipment item, and complementary standards mentioned by them

### 4 General Conditions

4.1 The liquid penetrant testing shall be performed as recommended in design, manufacture, construction and assembly specifications or standards relating to the inspected equipment item, except for any changes, additions and deletions mentioned under specific conditions.

4.2 When a standard referenced to in Section 2 is not mentioned in specific conditions, it shall be fully applied in its items related to non-destructive testing by means of liquid penetrant.

4.3 For the base standards in Section 2 regarding Personnel Qualification and Procedure Qualification, it is necessary to add 5.1 and 5.2 of this Standard, in order to complement them about the requirements specified therein for liquid penetrant testing.

4.4 In testing nickel, austenitic stainless steel duplex, superduplex and titanium base alloys, penetrant materials shall be tested regarding the content of contaminating elements. In case of titanium, austenitic stainless steel, and duplex or superduplex steel, the maximum content of halogens (Cl + F) allowed is 1 %; for nickel alloys, the maximum content of sulfur (S) is 1 %. In both cases, the analysis is done as a function of the obtained residue, as per ASME [BPVC Section V:2010](#) article 6 appendix II.

4.5 The maximum content of chlorides allowed in water shall be less than 50 ppm when the surface to be tested is made of titanium, austenitic stainless steels, duplex or superduplex steels.

4.6 For the purpose of evaluation of penetrating materials it is recommended the application of PETROBRAS [N-2370](#). [Recommended Practice]

## 5 Specific Conditions

### 5.1 Personnel Qualification

5.1.1 For services performed in Brazil, the qualification and certification of personnel for testing by means of liquid penetrant shall be made by the “Sistema Brasileiro de Qualificação e Certificação de Pessoal em END – ABENDI”, according to ABNT [NBR NM ISO 9712:2007](#).

5.1.2 For services performed abroad, qualification and certification shall be made as established in 5.1.1 or by independent international entities, accredited by national bodies in their respective countries, which fully meet the requirements of ISO IEC [17024:2012](#), and fully complies with ISO [9712:2012](#).

NOTE Self-certification systems, such as Nondestructive Personnel Qualification and Certification ASNT SNT-TC-1A for inspectors for Levels 1, 2 or 3, in which the certification method is established or enforced by the employer itself, according to its criteria, are not accepted by PETROBRAS, even if they are mentioned in the base standards of this document.

### 5.2 Procedure Qualification

5.2.1 The procedure shall be qualified and certified by a Level 3 inspector.

5.2.2 Objective evidences of the qualification procedure shall be kept, in order to allow its check by PETROBRAS at any time, when requested.

5.2.3 The sensitivity test of penetrant products for procedure qualification shall be performed on 10 µm and 30 µm blocks, according to ISO [3452-3:1998](#), observing the complements in 5.3 of this Standard.

5.2.4 The procedure shall be evaluated, checking its compatibility with its application, this stage being a pre-requisite for qualification.

5.2.5 The level of sensitivity achieved by penetrating product family shall be registered in the procedure according to Table 2 in PETROBRAS N-2370.

5.2.6 The qualification procedure shall be performed before the services are executed, and the qualified procedure shall include, at least, the items described in Table 1. Whenever any of the variables is changed, a revision of the procedure shall be issued. If the variable is essential, the procedure shall be re-qualified.

**Table 1 - Variables of Written Procedure**

| Requirements                                                                                                                                                            | Essential variable | Non essential Variable |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|------------------------|
| Objective                                                                                                                                                               |                    | X                      |
| Reference standards                                                                                                                                                     | X                  |                        |
| Type, form, and manufacturing process of the material to be tested (examples: cast aluminum, forged carbon steel, carbon steel weld, flange)                            | X                  |                        |
| Penetrant materials: the manufacturer, brand, commercial reference of each product, as well as the type of packaging for each one and the family of penetrant materials | X                  |                        |
| Surface preparation method                                                                                                                                              | X                  |                        |
| Drying method and time spent in the previous surface cleanup                                                                                                            |                    | X                      |
| Manner of application of liquid penetrant and penetration time                                                                                                          | X                  |                        |
| The allowable temperature range for the surface being tested and for the liquid penetrant                                                                               | X                  |                        |
| Manner in which excess liquid penetrant is removed                                                                                                                      | X                  |                        |
| Drying method and time before application of developer                                                                                                                  | X                  |                        |
| Manner and maximum time period for application of developer                                                                                                             | X                  |                        |
| Additional requirements                                                                                                                                                 |                    | X                      |
| Application of final cleanup                                                                                                                                            |                    | X                      |
| Systematic procedure adopted for recording results (identification of tested surface and location of indications)                                                       |                    | X                      |
| Safety and environmental requirements                                                                                                                                   |                    | X                      |
| Report of recorded results                                                                                                                                              |                    | X                      |
| Sensibility level of the family of penetrant materials                                                                                                                  | X                  |                        |

### 5.3 Alteration, Addition and Suppression in Base Standards

#### 5.3.1 Alteration, Addition and Suppression of Standard ABNT [NBR NM 334:2012](#)

##### 5.3.1.1 Item 7.2 Receiving of Materials - Add

5.3.1.1.1 The result of the receiving test shall be recorded in a report containing:

- name of issuer;
- numerical identification;
- type of reference block used;
- number and revision of procedure;
- penetrant materials used;
- report, indicating acceptance or rejection;
- date of test;
- identification and signature of the responsible inspector/operator;
- number of lot of penetrant material examined;