PETROBRAS | N-2820 | REV. A | ENGLISH | 02 / 2011

# Non-Destructive Tests - Industrial Radiography - Thickness Measurement in Piping and Accessories Using Computed Radiography

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.



**CONTEC**
Comissão de Normalização Técnica

**SC - 27**
Non-Destructive Tests

## *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 08/2012) of PETROBRAS N-2820 REV. A 02/2011. 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 non-destructive test method for computed radiography applied to the thickness measurement in piping and accessories, using gamma rays or X-rays.

1.2 Results yielded by this technique can be used as a tool for corrosion inspection.

1.3 This Standard applies to non-destructive tests using X-rays and gamma rays from the date of its edition.

1.4 This Standard contains only 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:2008 - Vocabulário Internacional de Metrologia (First Brazilian Edition of VIM 2008);

ABNT NBR 15783:2009 - Ensaios não Destrutivos - Radiografia Industrial - Medição de Espessura em Serviço de Tubulações e Acessórios com Uso de Radiografia Computadorizada.

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 effects of this document, the INMETRO VIM:2008, and ABN NBR 15783:2009 terms and definitions apply, as well as the following:

**3.1**
**addition**
insertion of a new paragraph or insertion of text within a paragraph

**3.2**
**modification**
replacement of a paragraph or a partial change within a paragraph

**3.3**
**suppression**
exclusion of a paragraph or any part of it

**3.4**
**base standard**
design, manufacturing, construction and assembly standards related to the inspected equipment and supplementary standards mentioned by these.

## 4 Specific Conditions

### 4.1 Modification, Addition and Suppression of ABNT NBR 15783:2009

#### 4.1.1 Item 4.2 - Qualification of Personnel - Modification

Additionally, professionals involved with computed radiography should have specific training in the computed system used, with certification issued by a Radiographic Level 3 professional of the Company.

#### 4.1.2 Item 5 - Written Procedure - Modification

The radiographic test should be performed according to the written procedure, which should include at least the requirements listed in Table 1 and Item 5.2.

#### 4.1.3 Item 14.2.8 - Density Difference Radiographic Technique - Suppress

Suppress Item 14.2.8 and Figure 7.

#### 4.1.4 Table 6 - Image Quality Pointers - Suppress

Suppress columns “essential hole” in Table 6.

#### 4.1.5 Item 20.1 - Source Detector Distance - Addition

NOTE In the case of double wall double image technique, consider “d” as distance and “e” as thickness the external diameter of the pipe, with or without the distance between the detector and the nearest side of the object.

#### 4.1.6 Item 21 - Radiography Identification - Addition

**Item 21.5 -** The contractor shall provide, with no charge for PETROBRAS, at least one copy of the original installation program for processing and visualization of radiographic images, updated and compatible with the operational systems used by the Company, with their respective licenses and license keys and their users’ manuals.

#### 4.1.7 Item 28 - Exposition Time Calculation - Addition

When using isotopes as a source, the following equation can be used to calculate the exposition time:

$$E_T = 2{,}4.10^{-4}.E_0.\exp(\mu.e_{tot})\frac{Dfd^2}{A}$$

Where:

$E_T$ is the time of exposition in seconds for the “e” penetration thickness;

$E_0$ it is needed exposition to reach the $SNR_N$ required value with direct exposition on the phosphor imaging plate (with no sample), in Ci.min @ 500 mm;

A is the source activity in Ci;

Dfd is the source-detector distance in mm;

μ is the effective attenuation coefficient of the material (0,04 mm for Ir 192 and 0,08 /mm for Se 75);

$e_{tot}$ is the total steel penetrated thickness, including any product inside the equipment or pipe.

NOTE 1 If $E_0$ exposition is expressed in GBq.s @ 1 000 mm, the equation constant will be equal to $2.7.10^{-8}$.

NOTE 2 If there is any liquid inside the equipment or pipe to be inspected, the following correction should be used for the etot calculation:

a) water: add to the depth of penetration a factor corresponding to the internal diameter divided by 9;

b) oil: add to the depth of penetration a factor corresponding to the internal diameter divided by 11 (800kg/$m^3$ density).

| INDEX OF REVISIONS | |
|---|---|
| | |
| | |
| **REV. A** | |
| **Affected Parts** | **Description of Alteration** |
| All | Revised |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |