

Non-Destructive Testing - Ultrasound in Castings

Specification

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 - 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 09/2012) of PETROBRAS N-2314 REV. D 04/2011. 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 sets out the conditions required for nondestructive testing with ultrasound in carbon steel, low alloy steel and martensitic stainless steel castings with thermal treatment.

1.2 This Standard applies to projects started as of the date of its edition.

1.3 This Standard contains only Technical Requirements.

2 Normative References

The following related documents are crucial to the application of this document. For references with dates, only the editions mentioned apply. For references without a date, the latest editions of the relevant documents apply (including amendments).

INMETRO [VIM:2008](#) - Vocabulário Internacional de Metrologia (Primeira Edição Brasileira do VIM 2008);

ABNT [NBR ISO/IEC 17024:2004](#) - Avaliação de Conformidade - Requisitos Gerais para Organismos que Realizam Certificação de Pessoas;

ABNT [NBR ISO/IEC 17025:2005](#) - Requisitos Gerais para a Competência de Laboratórios de Ensaio e Calibração;

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

ISO [2400:1972](#) - Welds in Steel - Reference Block for the Calibration of Equipment for Ultrasonic Examination;

ISO [7963:2006](#) - Non-destructive Testing Ultrasonic Testing Specification for Calibration Block No. 2;

ISO [9712:2005](#) - Non-Destructive Testing - Qualification and Certification of Personnel;

ISO/IEC [17024:2003](#) - Conformity Assessment - General Requirements for Bodies Operating Certification of Persons;

ASME [BPVC Sec.V:2010](#) - Boiler and Pressure Vessel Code - Section V - Nondestructive Examination;

ASTM [A609/A609M:2007](#) - Standard Practice for Castings, Carbon, Low-Alloy and Martensitic Stainless Steel, Ultrasonic Examination Thereof;

CEN [EN 473:2008](#) - Non-Destructive Testing - Qualification and Certification of NDT Personnel - General Principles;

DNV-OS-[F101:2007](#) - 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 effects of this document, the INMETRO [VIM:2008](#) 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

change

replacement of a paragraph or a partial change within a paragraph

3.3

deletion

exclusion of a paragraph or any part of it

3.4

base standard

project, manufacturing, construction and assembly standards related to the inspected equipment and supplementary standards mentioned by these

4 General terms

4.1 The ultrasound testing shall be performed in accordance to base standards in its project, manufacturing, construction and assembly specifications, related to the inspected equipment, except for those changes, additions and suppressions mentioned in the specific terms.

4.2 In cases where a base standard mentioned in Section 2 is not mentioned in Section 5 of the specific terms, the base standard shall be applied in its entirety to the ultrasound non-destructive testing related items.

4.3 All standards concerning the project, manufacturing, construction and assembly shall be supplemented by 5.1 and 5.2, for additional requirements specified therein for the ultrasound testing.

5 Specific terms

5.1 Qualification of Personnel

5.1.1 For services executed in Brazil, the training and certification of personnel for the ultrasound testing procedure shall be done by the Brazilian System of Qualification and Certification of Personnel for non-Destructive Testing by ABENDI or by any other INMETRO accredited entity, according to ABNT [NBR ISO/IEC 17024:2004](#) and ABNT [NBR NM ISO 9712:2007](#).

5.1.2 For services performed abroad, training and certification shall be according to 5.1.1. or by independent entities in other countries, with certification by national entities in these countries in strict compliance with [ISO/IEC 17024:2003](#), and operating in accordance with ISO [9712:2005](#) or with other standards from normalization entities, as long as they comply with CEN [EN 473:2008](#).

NOTE Self-certification systems, such as "Nondestructive Personnel Qualification and Certification ASNT SNT-TC-1A" for Level 1, 2 or 3 inspectors, in which the certification methodology is established or applied by the employer according to his own criteria, are not allowed by PETROBRAS, even if mentioned in base standards of this document.

5.2 Procedure Qualification

5.2.1 The procedure must be qualified and certified by Level 3 Inspector.

5.2.2 Objective evidence of procedure quality shall be kept to allow their checking by PETROBRAS at any time, when requested.

5.2.3 The procedure qualification shall be done in accordance with the standard set out for the project, manufacturing, construction and assembly.

NOTE When a system for the procedure qualification is not specified in the project, manufacturing, construction and assembly standards, such qualification shall be done in specimens typical of the inspection to be done, with identical characteristics and in sufficient amount to, during the qualification process, demonstrate that the test is repeatable, there is measurement accuracy and detection probability, compatible with the inspection and criteria adopted in the assessment of discontinuities.

5.2.4 The procedure qualification shall be done before the services and shall include, at a minimum, items set forth in Table 1. Whenever a variable is changed, a procedure revision shall be issued. If the variable is essential, the procedure must be qualified again.

Table 1 - Procedure Requirements

Requirements	Essential variable	Non essential variable
Purpose;	x	
Reference standards;	x	
Requirements for personnel training;		x
Material and configurations, including thickness range and dimensions;	x	
Sketches with dimensional details;		x
Equipment (manufacturer and model);	x	
Probes: type, manufacturer, model, dimensions, angle, frequency, length of near field and thickness to use;	x	
Computerized system for data acquisition, including computer software and its version, when applicable;	x	
Description of scanning system (manual or mechanic), when applicable;	x	
Method and interval for equipment adjustment;		x
Technique to be used (example: direct contact method, pulse-echo method, immersion);	x	
Adjustment technique;	x	
Instrument sensitivity adjustment;	x	
Superficial conditions and preparation technique;		x
Couplant;		x
Scan technique;	x	
Discontinuities sizing method;	x	
Criteria for discontinuities record and acceptance;		x
Record system for results;		x
Results reporting form.		x

5.2.5 Results shall be recorded and a report shall be issued, including, at a minimum:

- a) name of the issuer (PETROBRAS agency or company performing the service);
- b) numerical identification;
- c) number and revision of the procedure;
- d) identification of the part (type and dimensions);
- e) part material specification;
- f) identification, including serial number, of the instruments and probes used;
- g) computerized system for data acquisition, including computer software and its version, when applicable;
- h) scan instrument, when used;
- i) calibration certification of the instruments;
- j) temperature of the tested part;
- k) couplant used;
- l) surface where the test was performed;
- m) identification of the reference block, when applicable;
- n) sensitivity adjustment method;

- o) test duration;
- p) superficial finishing of the inspected area;
- q) sonic attenuation of the material, when applicable;
- r) record of results, including the response level (range) in relation to the adopted reference, the depth and the dimensions of the discontinuities and/or areas with loss of background echo;
- s) standards, including edition/revision, and/or reference values for interpretation of the results;
- t) sketch of the part showing the examined area, the discontinuities and/or areas with loss of background echo;
- u) opinion indicating acceptance, rejection or recommendation for complementary examination;
- v) place and date;
- w) identification, signature and level of the responsible inspector.

5.3 Calibration of the Inspection System Using Ultrasound

5.3.1 The measurement system devices requiring periodical calibration are the ultrasound device, the probe and standard blocks.

5.3.2 The interval of calibration of the ultrasound equipment shall not be greater than 24 months.

NOTE 1 The calibration certificates are issued by accredited laboratories, in accordance with ABNT [NBR ISO/IEC 17025:2005](#). In case there is no accredited laboratory for the magnitude of calibration, laboratories with standards referenced to "Rede Brasileira de Calibração" (RBC) or with a nationally or internationally accredited metrological system can be used.

NOTE 2 Any repair or service in the measurement system requires a recalibration, notwithstanding the programmed interval already set.

5.4 Acceptance Criteria for Discontinuities

The acceptance criterion shall be established by the casting project specification. When not specified in the project, quality Level 1 of ASTM [A609/A609M:2007](#) shall be the standard.

5.5 Change, Addition and Suppression of DNV [OS-F101:2007](#), APPENDIX D

Item E210 - Calibration of amplification and testing procedure - Adjustment of the amplitude and testing procedure - Change

5.5.1 For manual or mechanized scans without a computerized data acquisition system, a minimum of 6dB shall be added to the rectified primary gain. This addition shall be removed when assessing the indications.

5.5.2 For manual or mechanized scan with a computerized data acquisition system, an addition 4dB gain or the gain set out in the procedures qualification shall be added. This new gain shall be called Evaluation Gain (EG).

5.5.3 The method used for detection of loss by transfer shall be specified in the procedure. The loss by transfer cannot be bigger than 6dB. If bigger values are shown, blocks set must be substituted or the part must be reworked.

5.6 Change, Addition and Suppression, ASTM [A609/A609 M:2007](#)

The ultrasound test in casts must be done in accordance with ASTM [A609/A609M:2007](#), "A" procedure and S1 supplementary requirement.

5.6.1 Item 4.2 - Search Units - Probes - Addition

Dead zones in monocrystal probes shall be as small as possible, for example, 10 % of material thickness, or 15 mm, whatever is smaller.

5.6.2 Item 8 - Procedure - Addition

5.6.2.1 The Screen Height Linearity and Range Linearity checks shall be performed immediately before each period of extended use (or every three months, whatever is lesser). Records shall be available upon demand.

5.6.2.2 For scale range and beam adjustments IIW or ISO (V1-V2) calibration blocks shall be used, according to ISO [2400:1972](#) or ISO [7963:2006](#) standards. These calibration blocks shall have, inasmuch as possible, the same acoustic properties of the material being tested. Alternatively, the adjustment of the scale range may be done in a defect-free area with known thickness of the material under test. Two background echoes (reflections) shall be present on the screen, whenever the adjustment of the scale is performed.

5.6.2.3 Different frequencies, types, angles and probe diameters must be used to get additional information on the detected indications.

5.6.2.4 A complementary examination with angular beam must be carried out in casting or casting area where the background echo cannot be kept during the straight beam check or when the angle between the previous and posterior surface of the casting is more than 15 degrees.

5.6.2.5 The method used for detection of loss by transfer shall be specified in the procedure. The loss by transfer cannot be bigger than 6dB. If bigger values are shown, blocks set must be substituted or the part must be reworked.

5.6.3 Item 8.4 - Addition

In intervals of approximately four hours and at the completion of the test, the scale range, probe angles and primary gain shall be checked and corrected. These checks shall be done whenever a system parameter is modified or there is reason to believe that these parameters have changed. If a deviation bigger than 2 % is found in the scale range, a 3 dB in the primary gain adjustment or 2° in the nominal angle of the probe are found, tests done with the measurement system in the previous period of time shall be repeated.

5.6.4 Item 8.4 - Note 3 - Change

5.6.4.1 For manual or mechanized scans without a computerized data acquisition system: A minimum of 6dB shall be added to the corrected primary gain in scans. This addition shall be removed when assessing the indications.

5.6.4.2 For manual or mechanized scan with a computerized data acquisition system, an addition 4dB gain or the gain set out in the procedures qualification shall be added. This new gain shall be called Evaluation Gain (EG).

5.6.5 Item 8.5 - Change

During the examination of parallel wall casting areas, areas showing a 50 % reflection loss or more of back-wall echo shall be checked, to determine if this is due to a faulty contact, insufficient couplant, discontinuities with no defined form etc. If the reason for the absence of back-wall echo is not determined, consider investigating the area. The method used to investigate these areas shall be described.

5.6.6 Item 9.1.1 - Report - Change

The total number of readings equal to or higher than 50 % of the DAC curve in the casting, range and area shall be reported, and possible its limits shall be indicated.

5.7 Change, Addition and Suppression, ASME [BPVC Sec.V:2010](#)

Whenever ASME [BPVC Sec.V:2010](#) refers to ASTM [A609/A609 M:2007](#), 5.6 of this Standard applies.

INDEX OF REVISIONS	
REV. A and B	
There is no index of revisions.	
REV. C	
Affected Parts	Description of Alteration
1.1	Revised
2 and 3	Revised
3.1	Revised
3.2	Included
3.3 to 3.5	Revised and Renumbered
3.6 to 3.10	Included
4	Revised
4.1 to 4.3	Revised
4.4 to 4.5	Included
6.1	Revised
6.2.3	Revised
6.2.4	Included
6.3.3	Revised
6.4 to 6.5	Revised
7.1	Revised
7.2.1 to 7.2.3	Revised
8.1 and 8.2	Revised
8.1.5	Included
8.2.2 to 8.2.4	Revised
8.2.5	Included
8.3.1 to 8.3.4	Revised
8.3.5	Included
10.2	Revised
10.6	Revised
10.20 to 10.22	Revised
11.1 and 11.3	Revised and Renumbered
12	Revised
14	Excluded



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REV. D

[illegible]