

Fabrication of Pressure Vessel

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.."

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

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Tanks and Pressure Vessels

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Foreword

This Standard is the English version (issued in 12/2014) of PETROBRAS N-268 REV. C 03/2012. 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 establishes the requirements for the fabrication of pressure vessels of any type, used in petroleum and petrochemical industrial facilities.

1.2 Pressure vessel is understood to mean the equipment defined in standard PETROBRAS [N-253](#), such as: vessel, tower, heat exchanger and sphere.

1.3 This Standard is based on ASME BPVC [Section VIII](#) and presents the supplementary requirements to be complied with when fabricating pressure vessels for PETROBRAS.

1.4 When the design is done according to a standard or code different from ASME BPVC [Section VIII](#), the fabrication shall be fully performed in accordance with the adopted standard or code, and this Standard shall be used only to supplement the adopted standard or code.

1.5 For equipment with special services, the technical requirements of respective Standards and Technical Specifications prevail, for example, H₂ service, H₂S service, equipment with controlled toughness requirements etc.

1.6 This Standard applies to fabrication of pressure vessel starting from its issue date.

1.7 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.

Norma Regulamentadora nº 13 ([NR-13](#)) - Caldeiras e Vasos de Pressão;

PETROBRAS [N-133](#) - Welding;

PETROBRAS [N-253](#) - Projeto de Vaso de Pressão;

PETROBRAS [N-266](#) - Presentation of Pressure Vessel Design;

PETROBRAS [N-466](#) - Design of Shell-And-Tube Heat Exchanger;

PETROBRAS [N-1592](#) - Non-Destructive Testing - Identification of Materials;

PETROBRAS [N-1593](#) - Non-Destructive Testing - Leak Testing;

PETROBRAS [N-1594](#) - Non-Destructive Test - Ultrasonic;

PETROBRAS [N-1595](#) - Non-Destructive Testing - Radiography;

PETROBRAS [N-1596](#) - Non-Destructive Testing - Liquid Penetrant;

PETROBRAS [N-1597](#) - Non-Destructive Testing Visual Inspection;

PETROBRAS [N-1598](#) - Non-Destructive Testing - Magnetic Particles;

PETROBRAS [N-1707](#) - Projeto de Vaso de Pressão com Revestimento Metálico;

PETROBRAS [N-1738](#) - Descontinuidades em Juntas Soldadas, Fundidos, Forjados e Laminados;

PETROBRAS [N-2301](#) - Preparation of The Welding Technical Documentation;

PETROBRAS [N-2913](#) - Anticorrosive Coating for Tank, Sphere and Storage Cylinder;

ABNT [NBR 14842](#) - Critérios para a Qualificação e Certificação de Inspetores de Soldagem;

ABNT [NBR 15523](#) - Qualificação e Certificação de Inspetor de Controle Dimensional;

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;

ASME Boiler and Pressure Vessel Code - Section VIII, [Division 1](#) - Rules for Construction of Pressure Vessels;

ASME Boiler and Pressure Vessel Code - Section VIII, [Division 2](#) - Rules for Construction of Pressure Vessels - Alternative Rules;

ASME [PCC-1](#) - Guidelines for Pressure Boundary Bolted Flange Joint Assembly;

ASTM [A 380](#) - Standard Practice for Cleaning, Descaling and Passivation of Stainless Steel Parts, Equipment and Systems;

ASTM [E 384](#) - Standard Test Method for Knoop Vickers Hardness of Materials;

[TEMA](#) - Standards of the Tubular Exchanger Manufacturers Association;

WRC Bulletin 452 - Recommended Practices for Local Heating of Welds in Pressure Vessels.

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 following terms and definitions apply.

3.1

fabrication

all activities developed in factory regarding the construction of pressure vessel

3.2

manufacturer

company, firm or organization responsible for the complete or partial fabrication of the vessel, in those cases in which fabrication is completed at the job site

3.3**map of repaired defects**

register indicating all welded repairs in plates. This register shall allow the precise location of repaired areas in the equipment

3.4**quality certificate**

document issued by the material manufacturer showing its compliance with the standardized specification of material and which allows its traceability

3.5**Welding Procedure Specification - WPS**

written document issued by the service executing firm, based on specifications of designer, consumables, and base metals, providing the welding variables required for production of welded joints with the same properties and characteristics of joint tested in qualification. See PETROBRAS [N-2301](#).

3.6**screening test**

sample receiving test performed in welding consumables

3.7**Welding Execution and Inspection Instruction (IEIS)**

written document based on qualified WPS, detailing the suitable welding parameters for each joint or service, as well as the applicable non-destructive tests and respective extensions. See PETROBRAS [N-2301](#).

3.8**Welding Procedure Qualification Record - RQPS**

document issued by the service executing firm, where the real values of welding operation parameters of test piece and qualification tests are recorded; it shall also have the certificates required in PETROBRAS [N-2301](#) and other supplementary test certificates required in technical specifications

3.9**Inspection and Test Plan (PIT)**

document prepared by the supplier, contained in its Quality Plan, following the standards established by ISO standards of quality management. PIT is intended to ensure the compatibility of the equipment to be supplied with the design, procedures and contract documentation

3.10**Positive Material Identification - PMI**

examination performed to confirm the employed material through analysis of its chemical composition

3.11**equipment "Class A"**

nomenclature adopted in this Standard to designate pressure vessels not categorized in Class B

3.12**equipment "Class B"**

nomenclature adopted in this Standard to designate pressure vessels without special requirements

4 Classification of Vessels for Fabrication

The equipment shall be classified in accordance with items 4.1 and 4.2.

4.1 Class A

Equipment subjected to all applicable requirements from this Standard.

4.2 Class B

Equipment with less complex service and that has **all** the following characteristics:

- a) fluid: hydrocarbon with flash point higher than 60 °C at ambient temperature and design temperature between atmospheric and 196 kPa (2 kgf/cm² gauge), water not contaminated by toxic substances, compressed air or non-flammable fluid;
- b) is not classified as equipment with Special Service such as, for example, H₂ service, H₂S service, toxic service, etc.;
- c) does not have controlled toughness requirements;
- d) is made of carbon steel and without metallic internal lining, example: clad;
- e) is designed in accordance with ASME BPVC Section VIII [Division 1](#) and its fabrication does not require stress relief heat treatment or full radiography;
- f) in case of heat exchanger, be [TEMA](#)-type class C or B.

NOTE Silos, flare stacks and cyclones for FCC units are categorized in class B of this Standard.

5 General Conditions

5.1 Manufacturer's Responsibility

5.1.1 Fabrication shall conform to the requirements in the Material Requisition or in the contract, and shall be done in accordance with the approved fabrication drawings. Any omissions or mistakes found by the manufacturer in any of the documents provided by PETROBRAS shall be referred to PETROBRAS for a proper solution, so that the manufacturer remains fully responsible for the fabrication of the equipment.

5.1.2 The vessel fabrication documentation shall comply with [NR-13](#).

5.2 Fabrication Documents

The fabrication of pressure vessels shall conform to the fabrication documents prepared by the manufacturer and submitted for PETROBRAS' approval.

5.2.1 Fabrication documents involve, at least, the following items (when applicable):

- a) PIT (see 5.2.2);
- b) technical specification of acquisition of welding consumables and materials;
- c) identification and marking transfer procedure for materials;
- d) WPS, RQPS, IEIS, welding plans according to PETROBRAS [N-2301](#);
- e) screening test procedure, when required in other technical document or contract;
- f) production test plans, according to PETROBRAS [N-2301](#);
- g) non-destructive testing procedures;
- h) PMI procedure;
- i) torquing procedure;

- j) expanding procedure;
- k) sealing (tightness) test procedure
- l) pneumatic test procedure;
- m) ferrite content examination procedure;
- n) hardness examination procedure;
- o) refractory isolation procedure;
- p) internal lining application procedure;
- q) procedure for performance of other required tests, including equipment to be used;
- r) repair procedure, including type of removal of defect, type of repair and types of examinations to be made after the repair is done;
- s) protocol for dimensional inspection, indicating tolerances;
- t) heat treatment procedure;
- u) hydrostatic test procedure;
- v) drainage, clean-up and drying procedure for the vessel after the hydrostatic test;
- w) external coating application procedures (painting, etc.);
- x) procedure for pickling, passivation and inertization;
- y) transport and storage procedure.

NOTE For Class B, the items described in b), e), f), h), m), n), t) and x) are not mandatory.

5.2.2 The PIT shall have at least:

- a) identification of stages throughout the entire fabrication cycle of equipment, when checks or inspections are performed by the manufacturer and by the client, including those performed in sub-suppliers. It shall identify the types of examinations, tests or checks to be done;
- b) care taken with temporary welds, including method to be used for their removal and future inspection;
- c) indication of qualification/certification of personnel performing the activities of inspection, check and special production processes;
- d) indication of procedures and acceptability standards for all quality characteristics and requirements, including the subjective ones and of sub-supplies;
- e) identification and preparation of quality records, mentioning its various types of records;
- f) indication of devices/equipment, including the required accuracy, in order to obtain quality when checking critical dimensions, operation and performance tests;
- g) equipment classification, as per Section 4 of this Standard.

5.3 Presentation of Technical Documents

Procedures and/or plans specified in item 5.2, as well as the documents specified below, shall be submitted to the inspector for examination before the beginning of the corresponding activity:

- a) mechanical design and fabrication drawings released for execution;
- b) material quality certificates;
- c) consumable quality certificates;
- d) RQPS, according to PETROBRAS [N-2301](#);
- e) record of welders/welding operators qualification, including tack welders, according to PETROBRAS [N-2301](#);
- f) report indicating procedures and inspectors and/or qualified non-destructive testing operators and qualified welding inspectors;
- g) report of welding record, according to PETROBRAS [N-2301](#).

5.4 Technical Fabrication Data Book

In addition to documents mentioned in 5.2, the manufacturer shall furnish a technical fabrication data book in the number of samples required, containing at least the following documents (when applicable):

- a) Purchase and Service Order (PCS);

- b) certified mechanical design and fabrication drawings and documents;
- c) technical specifications;
- d) data sheet;
- e) material quality certificates of pressure parts, internals and equipment supporting parts;
- f) quality certificates of welding consumables, including drying control;
- g) traceability map of materials and welding consumables;
- h) report with record non-destructive examination results;
- i) radiograph location drawing;
- j) map of repaired defects;
- k) PMI examination result;
- l) Production Testing Records (RETP), according to PETROBRAS [N-2301](#);
- m) dimensional examination protocol, informing the dimensions found;
- n) Heat Treatment Record Report (RRTT), including temperature charts and other records regarding heat treatment, according to PETROBRAS [N-2301](#);
- o) sealing (tightness) test report;
- p) pneumatic test report, including charts and/or records;
- q) hardness test report, according to PETROBRAS [N-2301](#);
- r) hydrostatic test certificate, including charts and/or records;
- s) ferrite content examination report;
- t) internal lining inspection report;
- u) external coating inspection report (painting etc.);
- v) refractory lining inspection report;
- w) reports of non-compliances, if any;
- x) Material Release Notification (CLM);
- y) hibernation procedure;
- z) procedure for installation in field;
- aa) recordable non-destructive tests soft copies. Examples: TOFD and Phased Array.

NOTE The assembly documents required to prepare the pressure vessel handbook, as per [NR-13](#), shall be contained in technical documentation data book.

5.5 Files

In addition to documents listed in a) and b), below, the manufacturer shall keep a copy of the technical documentation data book in an organized file for a period of 5 years after the shipping date of equipment, which is to be made available for the examination of PETROBRAS or its authorized representative.

- a) records of qualification of welders and weld operators, including tack welders;
- b) radiographic films: when this test is required and non-destructive test records.

6 Non-Destructive Testing

Non-destructive tests, when required in the equipment design, shall be carried out in accordance with the requirements of this Section.

6.1 Liquid Penetrant

It shall be performed in accordance with PETROBRAS [N-1596](#), the evaluation of results shall be in accordance with code ASME BPVC Section VIII, [Division 1](#) or [Division 2](#).

6.2 Magnetic Particle

It shall be performed in accordance with PETROBRAS [N-1598](#), the evaluation of results shall be in accordance with code ASME BPVC Section VIII, [Division 1](#) or [Division 2](#).

6.3 Ultrasound

It shall be performed in accordance with PETROBRAS [N-1594](#), the evaluation of results shall be in accordance with code ASME BPVC Section VIII, [Division 1](#) or [Division 2](#).

NOTE If present in specific service standard of vessel, adopt a prescription stricter than the one mentioned in this item.

6.4 Radiography

It shall be performed in accordance with PETROBRAS [N-1595](#), the evaluation of results shall be in accordance with code ASME BPVC Section VIII, [Division 1](#) or [Division 2](#).

6.5 Visual

It shall be performed in accordance with standard PETROBRAS [N-1597](#), the evaluation of results shall be in accordance with code ASME BPVC Section VIII, [Division 1](#) or [Division 2](#).

6.6 Dimensional

It shall be performed in accordance with applicable code ASME BPVC [Section VIII](#) and with tolerances of Figure A.1 and [TEMA](#).

6.7 PMI

It shall be performed in accordance with PETROBRAS [N-1592](#).

6.8 Tightness

6.8.1 For stiffening plate, a bubble formation test with positive pressure shall be performed in accordance with PETROBRAS [N-1593](#). No leak is allowed.

6.8.2 When it is specified a seal welding for tube to tubesheet connection, the tightness test shall be performed in accordance with PETROBRAS [N-466](#).

6.8.3 When it is specified a strength welding for tube to tubesheet connection, the tightness test shall be performed with helium gas before the hydrostatic test. The test pressure shall be 0,5kgf/cm² and shall be kept for at least 3 hours. Leak above 1x10⁻⁴ cm³/s is not acceptable.

6.9 Hardness

6.9.1 In welding procedure qualification and in production testing, the hardness measurement shall be performed with bench instrument, according to ASTM [E 384](#).

6.9.2 When measuring hardness in equipment, a portable instrument shall be used, according to requirements described in 6.9.2.1 to 6.9.2.5.

6.9.2.1 The suitability of the portable instrument shall be showed by comparison settlement in hardness measurements obtained by the portable instrument and those obtained by the bench instrument. The comparison results shall be previously submitted to PETROBRAS for approval.

6.9.2.2 The demonstration shall be performed in a welded joint of material of same applicable specification (ASTM, ASME and PETROBRAS) of equipment material to be tested, using the outline of hardness measurements for bevel similar to the equipment, defined in PETROBRAS [N-133](#). Measurements performed with bench instrument, Vickers method, as per ASTM [E 384](#), hardness HV 5 or HV 10, shall be similar to those obtained in adjacent positions with portable instrument, being considered the maximum range of +10 % as acceptable. For equipment which may be subjected to corrosion under stress condition, the maximum range shall be +5 %. Negative ranges are not acceptable.

6.9.2.3 The comparison of measurements performed in standard blocks to decide for suitability of portable instrument device for hardness measurement is not allowed.

6.9.2.4 To measure the hardness in heat affected area (ZAC), ultrasonic-type portable instruments shall be used. For this measurement, it is required to perform the chemical attack of the joint so that the ZAC region is revealed.

6.9.2.5 Portable instruments based on Leeb (rebound) method and Poldi or Telebrineller-type portable instruments may not be used.

7 Material Identification, Control and Inspection

7.1 Material supply shall be as specified in the Material Requisition and in design documentation approved by PETROBRAS.

7.2 Certificates of Quality

7.2.1 For pressure parts (including parts welded to those and flanged connections) and supporting parts made of plates and pipes (example: skirt and columns), materials certificates shall be checked to verify compliance with their respective specifications.

7.2.2 The certificates of quality shall have: the specification the material meets, the heat number, the treatment to which the material was subjected, results of chemical analyses and mechanical tests, as well as results of complementary tests.

7.2.3 When certificate of quality of sub-suppliers are required and they do not have the original certificates of quality available, the manufacturer shall perform tests and analyses and issue a certificate, listing the results of tests and analyses.

7.2.4 For piping accessories, studs/bolts and flanges fabricated according to an approved standard, certificates of quality are required, even if they are identified with mark required by code ASME BPVC [Section VIII](#).

7.3 The materials used shall be perfectly identified and traceable to their respective certificates of quality.