

Additional Requirements for Pressure Vessels for Hydrogen Service

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 - 02

Tanks and Pressure Vessels

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 05/2014) of PETROBRAS N-1704 REV. D 05/2013. 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 establishes additional requirements for the design, fabrication and erection of carbon steel pressure vessels, with or without clad, for H₂ Service.

1.2 Pressure vessels for hydrogen service shall comply with all of the requirements set forth in standards PETROBRAS [N-253](#), [N-268](#), [N-269](#), [N-466](#) e [N-1707](#), besides the criteria established in this Standard. In case of conflict, the criteria in this Standard shall prevail.

1.3 This Standard shall be used with the standard API [RP 941](#), and, in case of conflict, the requirements of this Standard shall prevail.

1.4 For pressure vessels fabricated in materials different from carbon steel, the requirements of basic design specific documents mentioned in RM of the pressure vessel and the General Requirements described in Section 7 of this Standard shall be followed.

1.5 This Standard applies to pressure retaining parts of pressure vessel in contact with fluid, resulting in the characterization of "H₂ Service".

1.6 In heat exchangers, when only one of the circulating fluids fits in the "H₂ Service" classification, the requirements of this Standard shall only apply to parts in contact with such fluid.

1.7 This Standard applies to pressure vessel designs started as of its date of issuance.

1.8 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-76](#) - Materiais de Tubulação para Instalações de Refino e Transporte;

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

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

PETROBRAS [N-268](#) - Fabricação de Vaso de Pressão;

PETROBRAS [N-269](#) - Montagem de Vaso de Pressão;

PETROBRAS [N-466](#) - Projeto de Trocador de Calor Casco e Tubo;

PETROBRAS [N-1593](#) - Ensaio não Destrutivo - Estanqueidade;

PETROBRAS [N-1594](#) - Ensaio não Destrutivo - Ultrassom em Solda;

PETROBRAS [N-1595](#) - Ensaio não Destrutivo - Radiografia;

PETROBRAS [N-1596](#) - Ensaio não Destrutivo - Líquido Penetrante;

PETROBRAS [N-1597](#) - Ensaio não Destrutivo - Visual;

PETROBRAS [N-1598](#) - Ensaio não Destrutivo - Partículas Magnéticas;

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

PETROBRAS [N-1859](#) - Qualificação de Consumíveis de Soldagem;

PETROBRAS [N-2301](#) - Elaboração da Documentação Técnica de Soldagem;

API [RP 941](#) - Steels for Hydrogen Service at Elevated Temperatures and Pressures in Petroleum Refineries and Petrochemical Plants;

ASME [BPVC Section II - Part A-1](#) - Boiler and Pressure Vessel Code - Section II - Ferrous Material Specifications (Beginning to SA-450) Materials;

ASME [BPVC Section II - Part A-2](#) - Boiler and Pressure Vessel Code - Section II - Ferrous Material Specifications (SA-451 to End) Materials;

ASME [BPVC Section II - Part A - SA-105/SA-105M](#) - Standard Specification for Carbon Steel Forgings for Piping Applications;

ASME [BPVC Section II - Part A - SA-106/SA-106M](#) - Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service;

ASME [BPVC Section II - Part A - SA-234/SA-234M](#) - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service;

ASME [BPVC Section II - Part A - SA-266/SA-266M](#) - Standard Specification for Carbon Steel Forgings for Pressure Vessel Components;

ASME [BPVC Section II - Part A - SA-388/SA-388M](#) - Standard Practice for Ultrasonic Examination of Steel Forgings;

ASME [BPVC Section II - Part A - SA-516/SA-516M](#) - Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service;

ASME [BPVC Section II - Part A - SA-578/SA-578M](#) - Specification for Straight-Beam Ultrasonic Examination of Plain and Clad Steel Plates for Special Applications;

ASME [BPVC Section II - Part C](#) - Specifications for Welding Rods, Electrodes, and Filler Metals - Materials;

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

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

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

ASME [BPVC Section IX](#) - Boiler and Pressure Vessel Code - Section XI - Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators Welding and Brazing Qualifications;

ASTM [A262](#) - Standard Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels;

ASTM [A833](#) - Standard Practice for Indentation Hardness of Metallic Materials by Comparison Hardness Testers;

ASTM [A1038](#) - Standard Test Method for Portable Hardness Testing by the Ultrasonic Contact Impedance Method;

ASTM [E10](#) - Standard Test Method for Brinell Hardness of Metallic Materials;

ASTM [E384](#) - Standard Test Method for Knoop and Vickers Hardness of Materials;

BS [EN 10160](#) - Ultrasonic Testing of Steel Flat Product of Thickness Equal or Greater than 6 mm (Reflection Method).

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 are applicable.

3.1

minimum PWHT

Specified heat treatment, considering all fabrication heat treatments provided in construction and assembly phases of pressure vessel, including the final PWHT

3.2

maximum PWHT

Specified heat treatment, considering all fabrication heat treatments provided in construction and assembly phases of pressure vessel, including the final PWHT and, at least, an additional PWHT, for further use of PETROBRAS

NOTE It is recommended the provision of a PWHT for repair during fabrication. **[Recommended Practice]**

3.3

simulated PWHT

Heat treatment performed on test specimens to check on the influence of PWHTs performed in the raw material acquisition, welding procedure qualification, manufacturing, erection, maintenance phases, on the mechanical properties of base metals, consumables and welds

4 Symbols or Acronyms

CE	- Carbon Equivalent;
NDT	- Non-destructive Test;
WPS	- Welding Procedure Specification;
RT	- Radiographic Test;
HB	- Brinell Hardness;
HV	- Vickers Hardness;
PT	- Penetrant Test;
INMETRO	- Instituto Nacional de Metrologia, Qualidade e Tecnologia;
OAC	- Conformity Assessment Body;
OCP	- Product Certification Body;
MT	- Magnetic Particle Test;
RM	- Material Requisition;
WPQR	- Welding Procedure Qualification Record;
SBAC	- Sistema Brasileiro de Avaliação de Conformidade;