

Manufacture and Assembly of Metallic Structures

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.

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CONTEC

Comissão de Normalização
Técnica

SC - 04

Civil Construction

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.

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Foreword

This Standard is the English version (issued in 04/2014) of PETROBRAS N-293 REV. H 08/2010. 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 conditions required for the fabrication and assembly of conventional metallic structures in onshore units, metallic structures of modules and auxiliary metallic structures for fixed production platforms, floating production platforms, FSOs, FPSOs, SS and TLP.

1.2 The application of this Standard is limited to carbon steel and carbon-manganese steel structures.

1.3 This Standard applies to designs started as of their date of issuance.

1.4 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-13](#) - Requisitos Técnicos para Serviços de Pintura;

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

PETROBRAS [N-134](#) - Chumbadores para Concreto;

PETROBRAS [N-279](#) - Projeto de Estruturas Metálicas;

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-1644](#) - Construção de Fundações e de Estruturas de Concreto Armado;

PETROBRAS [N-1812](#) - Estruturas Oceânicas;

PETROBRAS [N-1852](#) - Estruturas Oceânicas - Fabricação e Montagem de Unidades Fixas;

PETROBRAS [N-1930](#) - Avaliação da Integridade Operacional de Guindaste "Offshore";

PETROBRAS [N-1965](#) - Movimentação de Carga Inspeção, Manutenção e Operação de Equipamentos Terrestres;

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

PETROBRAS [N-2719](#) - Estocagem de Tubo em Área Descoberta;

ABNT [NBR 5426](#) - Planos de Amostragem e Procedimentos na Inspeção por Atributos;

ABNT [NBR 6118](#) - Projeto de Estruturas de Concreto;

ABNT [NBR 6122](#) - Projeto e Execução de Fundações;

ABNT [NBR 8400](#) - Cálculo de Equipamento para Levantamento e Movimentação de Cargas;

ABNT [NBR 8800](#) - Projeto de Estruturas de Aço e de Estruturas Mistas de Aço e Concreto de Edifícios;

ABNT [NBR 9062](#) - Projeto e Execução de Estruturas de Concreto Pré-Moldado;

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

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

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

AISC [348](#) - Specification for Structural Joints using ASTM A325 or A490 Bolts;

API [Spec 2B](#) - Specification for the Fabrication of Structural Steel Pipe;

ASME [B1.1](#) - Unified Inch Screw Threads (UN and UNR Thread Form);

ASME [B18.2.1](#) - Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series);

ASME [B18.2.2](#) - Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series);

ASTM [A143/A143M](#) - Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement;

ASTM [A500/A500M](#) - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes;

ASTM [A501](#) - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing;

AWS [D1.1/D1.1M](#) - Structural Welding Code.

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 indicated in PETROBRAS [N-1812](#) are adopted, complemented by the following items.

3.1 components

any structural element used as part of a set or subset

3.2 conventional metallic structures

industrial metallic structures that may be installed onshore or on production platforms, which directly support equipment and systems and enable the access to them. They are subdivided into two types, as described in 3.2.1 and 3.2.2

3.2.1**supporting metallic structures**

industrial metallic structures, installed onshore or in platforms, which directly support loads, equipment or systems, such as: piping supports, pressure vessel equipment supports, metallic sheds, flare stacks in industrial units, and fixed production platforms, floating production platforms, FSOs, FPSOs, SS and TLP housings

3.2.2**conventional accessibility structures**

metallic structures, installed onshore or in platforms, which enable the access to equipment and systems, such as: stairways, guard rails, hand rails, access platforms, operation platforms, and accessories of production platforms

3.3**metallic structures of module for platforms**

metallic structures responsible for the integrity of the module and which are supported on the decks of production platforms

3.4**auxiliary metallic structures for platforms**

metallic structures that are independent from the deck or complementary thereto, such as: flare boom, crane pedestal structure, work-over production rigs, helipad, mooring buoys, single-point mooring systems, monorails, and pull-in / pull-out structures

3.5**naval structures**

metallic structures integrating hulls and decks of ships, platforms FPSO, FSO, SS types self-hoisting, as well as buoys and single point moorings

3.6**steel-deck slabs**

Mixed slabs in which the steel formwork is incorporated into the load supporting system

4 Symbols or Acronyms

ABNT	- Associação Brasileira de Normas Técnicas;
AISC	- "American Institute of Steel Construction";
API	- "American Petroleum Institute";
ASME	- "American Society of Mechanical Engineers";
ASTM	- "American Society for Testing and Materials";
AWS	- "American Welding Society";
NDT	- Non-Destructive Testing;
FPSO	- "Floating Production Storage and Offloading Systems";
FSO	- "Floating Storage and Offloading Systems";
IEIS	- Instrução de Execução e Inspeção de Soldagens;
JAPT	- Full-Penetration Fillet Joint;
JASA	- Fillet Joint with Fillet Weld;
JTPT	- Full Penetration Butt Joint;
SS	- Semi-Submersible;
TLP	- "Tensile Leg Platform".

5 General Conditions

5.1 Documentation

5.1.1 Procedures for Receipt, Identification and Storage of Materials and Components

It shall contain at least:

- a) scope;
- b) applicable standards;
- c) definitions;
- d) criteria for verification of manufacturing documents: manufacturing certificates for components, quality certificates for materials, NDT reports and dimensional examinations;
- e) method and extent for receipt inspection, including the following items: identification, general condition of surface, dimensional examination, and protection of parts and components;
- f) identification system and marking method;
- g) definition of storage conditions, division of storage areas and storage and preservation method for all used components and materials;
- h) methods for handling materials and components;
- i) safety in storage of flammable products.

5.1.2 Manufacturing Procedure

It shall contain at least:

- a) scope;
- b) applicable standard and manufacturing design documents;
- c) definitions;
- d) forming processes, including requirements for controlling the degree of forming, in the case of hot forming, the range of allowable temperatures and method used for controlling temperatures;
- e) component welding sequence and deformation control and correction method;
- f) method used for coupling, adjustment and pre-attachment of components;
- g) pre-assembly;
- h) dimensional control (tolerances, preliminary study of post-welding contractions, temperature variations, equipment, methods, references, acceptable settling of supports and inspection plan containing the execution phases).

5.1.3 Assembly Procedure

It shall contain at least:

- a) scope;
- b) applicable standard and manufacturing design documents;
- c) definitions;
- d) types of temporary and permanent bases and supports, swivel saddles and pivoted supports;
- e) method used for alignment and leveling of structure supports;
- f) preparation and testing of land;
- g) method used for coupling, adjustment and pre-attachment of components to structure:
 - relative position of components (method and equipment for checking, measurements and areas for performing measurements);
 - adjustment and pre-attachment devices (types, application, quantity, clearance and dimensions);

- h) types of scaffolds, stairways, ladders and elevators (installation, inspection and maintenance plan);
- i) general precautions to be taken for welding;
- j) deformation control and correction method;
- k) dimensional control (tolerances, previous study of post-welding contractions, temperature variations, acceptable settling of supports, deformations before, during and after assembly, pre-deformation, axes of sections and inspection plan containing the execution phases).

5.1.4 Load Moving Procedure

It shall be in accordance with PETROBRAS [N-1930 and 1965](#), and hoisting devices shall comply with the provisions of ABNT [NBR 8400](#).

It shall contain at least:

- a) scope;
- b) applicable standards;
- c) definitions;
- d) general conditions:
 - machines available;
 - catalogs and tables;
 - accessories used;
 - inspection of machines and accessories;
- e) load moving (rigging) plan;
 - calculation notes;
 - descriptive memorandum covering all phases of load moving.

5.1.5 Dimensional Control Procedure

It shall contain at least:

- a) scope;
- b) applicable standards;
- c) definitions;
- d) components to be inspected;
- e) equipment used and gauges;
- f) method for dimensional examinations of components;
- g) method for dimensional examinations of subsets;
- h) methods for dimensional examinations of structure, covering at least the following points:
 - columns;
 - wind bracing;
 - main beams;
 - trussed beams;
 - lattice girders;
 - floors, bulkheads and other hard panels;
 - stairways and walkways;
 - structural walls;
 - elevations and geometries;
- i) utilization methods of topography equipment;
- j) tolerances;
- k) reports.

5.1.6 Procedure for Receiving, Treating, Preserving and Handling Welding Consumables

It shall contain at least:

- a) scope;
- b) applicable standards;
- c) definitions;
- d) control system for distribution of consumables for welders and welding operators;
- e) requirements from PETROBRAS [N-133](#).

5.1.7 Heat Treatment Procedure

It shall contain at least:

- a) scope;
- b) applicable standards;
- c) definitions;
- d) specifications and/or features of heating equipment used: dimensions and capacity;
- e) physical layout of parts under treatment;
- f) method for fixation and removal of thermocouples and area inspection after removal;
- g) quantity and location of thermocouples of component; drawings with quantity and location of thermocouples, as well as their position regarding the heating and isolating elements between thermocouples - thermocouple/heating elements;
- h) features and materials of thermocouples;
- i) region to be heated and isolated;
- j) method for heat isolation;
- k) method for preparation of parts: locking, supports and removal of heat isolation;
- l) parameters of heat treatments;
- m) records and reports with the results.

5.1.8 Preheating Procedure

It shall be in accordance with PETROBRAS [N-133](#) and shall contain at least the following:

- a) scope;
- b) applicable standards;
- c) definitions;
- d) methods and equipment to be used;
- e) type and composition of fuels and comburent;
- f) method and extent of verification and measurement of the maximum and minimum temperature limits.

5.1.9 Procedure for Visual and Dimensional Inspection of Welds

This procedure shall contain at least:

- a) scope;
- b) reference standards;
- c) test method;
- d) available condition of surface;
- e) surface preparation method;
- f) surface condition required for testing;
- g) required illuminance;
- h) instruments;
- i) inspection (regarding discontinuities, irregularities to be examined and/or observations to be done);

- j) test sequence;
- k) additional requirements;
- l) methodology of result recording.

5.1.10 Procedure for Additional Filling, Weld Repair and Base Metal

It shall comply with PETROBRAS [N-333](#) and contain, at least:

- a) scope;
- b) applicable standards;
- c) definitions;
- d) methods and equipment for additional filling;
- e) method for removal of defects:
 - inspection and non-destructive testing phases;
 - limits regarding dimensions of defects to be repaired, type of defects, positions, finishings;
 - methods to remove metal from the defect region;
- f) welding procedure of the executing company, if applicable;
- g) final inspections (non-destructive tests);
- h) maximum number of repairs in the same location.

5.2 Foundations for Assembly of Structures

5.2.1 The design of foundations for the assembly stages shall be in accordance with ABNT [NBR 6118](#), [NBR 6122](#) and [NBR 9062](#).

5.2.2 Land preparation and the construction of reinforced concrete foundations and structures (blocks and loading strips) shall be in accordance with PETROBRAS [N-1644](#).

5.2.3 Provision shall be made for a settling control and compensation system during assembly.

5.3 Definitive Foundations

5.3.1 Land preparation and the construction of reinforced concrete foundations and structures shall be in accordance with PETROBRAS [N-1644](#), ABNT [NBR 6118](#) and ABNT [NBR 6122](#).

NOTE Base dimensions shall be in accordance with the structure foundation drawing and be recorded on the base conformity certificate as per 5.3.6.

5.3.2 Anchor bolts shall be in accordance with PETROBRAS [N-134](#) and the following tolerances:

- a) diameter: see ASME code [B1.1](#);
- b) thread length: shall not be shorter than that specified in the foundation design;
- c) thread condition: shall not present cracks and dents or corrosion preventing nut movement;
- d) temporary corrosion protection shall be provided for anchor bolts after their installation.

5.3.3 The relative position of anchor bolts on the base shall comply with the tolerances specified in PETROBRAS [N-134](#) and [N-1644](#).

5.3.4 Marking of axes and elevations on bases shall be made.

5.3.5 Base leveling shall be performed by placement of shims. Shims shall be sized and spaced in such a way as to support the structure, according to the following requirements:

- a) a tolerance of approximately ± 1 mm relative to the design elevation shall be adopted for the elevation;
- b) shims shall be totally contained within the support area;
- c) the maximum height of the shim (metal plus mortar) shall be 5 mm above the height specified in the design;
- d) the minimum width of the shim shall be 50 mm;
- e) the minimum length of the shim shall be 100 mm;
- f) after placing the base plate of the structure and shims, there shall be enough space for grouting.

5.3.6 The base conformity certificate shall contain records of:

- a) coordinates;
- b) elevation;
- c) dimension;
- d) relative position between anchor bolts and base;
- e) leveling.

5.3.7 Grouting shall be performed in accordance with the conditions established in PETROBRAS [N-1644](#).

NOTE Grouting of bases shall only be performed after correcting the plumb line and column alignment and after final tightness of bolts.

5.4 Receiving, Identification and Storage

5.4.1 The materials and structural components delivered at the work sites shall be received by dimensional control inspectors, specialized in boilermaking, and qualified as per ABNT [NBR 15523](#).

5.4.2 Structural components and materials shall be inspected according to the following requirements:

- a) all materials and components shall be checked in accordance with 5.8.4;
- b) all plates, profiles and pipes shall be in accordance with 5.8.4 and 5.8.5;
- c) components received shall be subjected to a dimensional inspection in accordance with 5.10;
- c) chamfers received shall be subjected to a visual dimensional inspection in accordance with 5.8.7;
- e) factory welded joints shall be subjected to a visual-dimensional inspection in accordance with 5.8.9 and to verification of reports of applicable inspections;
- f) it shall be checked whether the components were subjected to the NDTs expected to be performed.

5.4.3 The plates, profiles or pipes shall not present dents, burrs or knurling or cracking edges.