

General Purpose Steam Turbines

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.

"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."

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Machines

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 04/2014) of PETROBRAS N-2648 REV. C 04/2014. In case of doubt, the Portuguese version, which is the valid document for all intents and purposes, shall be used.

This Standard is based on API [STD 611:2008](#), 5th edition, march 2008.

1 Scope

1.1 This Standard establishes the minimum conditions required for steam turbine drivers and their auxiliary equipment or systems, to be supplied in accordance with API [STD 611:2008](#).

1.2 The requirements of this Standard are additions to, or modifications of the API [STD 611:2008](#), which is an integral part of this Standard.

1.3 Except for new clauses, item numbers referred in parentheses in this Standard are the same API [STD 611:2008](#), paragraph ones.

1.4 General Purpose Steam Turbines shall be in accordance with API [STD 611:2008](#), plus the following changes, as noted in parenthesis for each clause, according to the definitions stated below. The information of each clause shall be read as follows, whenever starting with:

- addition: continuation of that particular API [STD 611:2008](#) paragraph;
- modification: replacement of part of that affected API [STD 611:2008](#) paragraph;
- substitution: replacement of that API [STD 611:2008](#) paragraph in its entirety;
- new: insertion of a requirement not found in API [STD 611:2008](#);
- exclusion: removal of that particular API [STD 611:2008](#) paragraph;
- comment: clarification or interpretation on that API [STD 611:2008](#) paragraph.

1.5 PETROBRAS considers all items of API [STD 611:2008](#), other than those mentioned herein, as valid to this PETROBRAS Standard.

1.6 This Standard applies to design starting from its issue date.

1.7 This Standard only contains 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.

API [STD 611:2008](#) - General-purpose Steam Turbines for Petroleum, Chemical, and Gas Industry Services;

API [STD 670](#) - Machinery Protection Systems;

ASME [B16.5](#) - Pipe Flanges and Flanged Fittings;

ASME [B16.42](#) - Ductile Iron Pipe Flanges and Flanged Fittings Classes 150 and 300.

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.

unit responsibility - substitution (3.42 of API STD 611:2008)

unit responsibility refers to the technical responsibility for coordinating the general arrangement of the whole train to be supplied (driver and driven equipment-including gears, clutches and couplings, as applicable to each case), as well as power, torque and speed requirements, direction of rotation, and so forth; for analyzing noise, lateral and torsional vibration data; for designing, laying out and supplying piping and appurtenances, controls and instrumentation, cooling, heating, lubrication and sealing systems and for supervising and coordinating all required tests and material reports, preparation for shipment, shipment and field assembly, pre-commissioning, commissioning, start up, pre operation and field acceptance test of all equipment within the scope of this Standard, as required by the contracted scope of supply. Usually, steam turbine supplier/manufacturer is not considered by PETROBRAS as the main equipment vendor (mostly assigned to the supplier of driven equipment) and thus the scope of responsibility defined above shall only apply to those orders where steam turbine manufacturer is referred to as the vendor. When referred to as supplier of manufacturer, its scope of responsibility shall be considered as agreed and stated on the contract with main equipment vendor.

4 Requirements - Exclusion (5.3 of API STD 611:2008)

Removed from API STD 611:2008.

5 Basic Design (Section 6 of API STD 611:2008)

5.1 Modification [6.1.4 b) of API STD 611:2008]

Replace the second paragraph by: The driven rated power shall be achieved with no hand valves open, under normal steam conditions. The turbine rated power can be achieved by using a hand valve or valves under normal steam conditions and an additional hand valve or valves under minimum inlet and maximum exhaust steam conditions.

5.2 Substitution (6.1.6 of API STD 611:2008)

Turbines shall be suitable for immediate (automatic) start-up (from zero RPM) to full load without a preliminary warm-up period. Turbine acceleration time at loaded and unloaded conditions shall be informed in proposal. PETROBRAS shall be permitted for proper drainage of the inlet piping, turbine casing, steam chest, and packing glands. PETROBRAS shall also keep exhaust steam piping pressurized, heated, and drained while turbine is in standby condition. Turbine supplier/vendor shall include a detailed description of additional construction features that may be needed to comply with this requirement and any recommendations of special procedures that PETROBRAS should implement.

5.3 Addition (6.1.9 of API STD 611:2008)

Turbine components that are very similar among each other (such as wheels, shafts, seals and seal glands, sleeves, nozzle rings, stationary blades and casings) shall be indelibly identified with the order of assembly and to which sub-set they belong (e.g.: stage/wheel number, coupling end etc.). Lifting lugs or eyebolts shall be provided for any equipment or component that weighs more than 30 kg (66 lb).

5.4 Addition (6.1.11 of API STD 611:2008)

Tubes shall have, as minimum, an outside diameter of 16 mm (5/8 inch). Number of tubes shall be established according to velocity criterion, and quality material of the tubes.

5.5 Substitution (6.1.12 of API STD 611:2008)

Unless otherwise specified, the whole train furnished by the vendor (driven, driver, gear and auxiliary equipment) shall conform to the maximum allowable sound pressure level of 85 dB(A), slow-response, measured at 1 m (3,28 ft) from the equipment surfaces. Bidder/vendor shall inform in his proposal the expected maximum sound pressure and sound power level data per octave band for the quoted equipment and including copies of noise level test certificates performed on similar equipment.

5.6 New (6.1.17)

Turbine supplier/vendor shall include in installation and maintenance manuals the procedures and diagrams for hot and cold alignment of shafts, couplings and flanges. Allowances and tolerances shall be included as well.

5.7 New (6.1.18)

Only well-proven machinery, sturdy designs shall be proposed. Prototypes or undersized equipment (e.g., equipment or components that, in order to comply with specified transient service conditions, might come to operate close to design limitations) are not acceptable. Refurbished equipment or parts are not acceptable.

5.8 Substitution (6.3.10 of API STD 611:2008)

On condensing turbines, if required by the orientation of the exhaust nozzle or piping, an automatic drain system shall be provided by the vendor.

5.9 Addition (6.5.6 of API STD 611:2008)

Threaded openings shall not be used unless specifically approved by the purchaser.

5.10 Substitution [6.5.10 g) of API STD 611:2008]

For the purpose of manufacturing mating parts, the vendor shall supply equipment flange details to the purchaser if connections larger than those covered by ASME B16.5 or ASME B16.42 are supplied. These mating parts shall be furnished by the vendor.

5.11 New [6.5.10 h)]

Whenever nonstandard flanges are approved by PETROBRAS, their respective companions shall be furnished as well.

5.12 Substitution (6.7.2.4 of API STD 611:2008)

Shafts shall be protected by corrosion-resistant material under carbon ring packing for casing glands. Chromium-plated electrolyte processes are preferred, thermal spray asperion processes shall not be used. Any other alternate method shall be submitted by vendor for PETROBRAS approval. The chosen application method, the coating material used, and the finished thickness shall be stated on the data sheets.

5.13 Substitution (6.8.3 of API STD 611:2008)

Turbine shaft seals may be carbon ring or labyrinth type packing. Non-contacting (gas face) seals shall not be used.

5.14 Substitution (6.8.5 of API STD 611:2008)

If labyrinth type packing is adopted, a separate vacuum device system shall be furnished by vendor for connection to the glands to reduce external steam leakage.

5.15 Substitution (6.9.3.1 of API STD 611:2008)

For units including gears, units comprising three or more coupled machines (excluding any gears), or two coupled machines with power above 500 kW, the vendor having unit responsibility shall ensure that a torsional vibration analysis of the complete coupled train is carried out and shall be responsible for directing any modifications necessary to meet the requirements of API STD 611:2008 Annex B.

5.16 Substitution (6.10.4.2.2 of API STD 611:2008)

The vendor shall submit bearing isolation seals design for purchaser approval.

5.17 Substitution (6.10.4.4.3 of API STD 611:2008)

Bearing housings shall be prepared for seismic vibration transducers in accordance with API STD 670. The spotface and drilling are to be per Figure 3 of API STD 611:2008 and located on the top of each bearing housing. The thread size is to be agreed upon between the customer and vendor.

5.18 Substitution (6.11.5 of API STD 611:2008)

For rapid-starting, according to 6.1.6 of API STD 611:2008 (5.2 of this Standard), or if a wide-speed-range is specified, the turbine vendor shall verify that adequate lubrication is available to the turbine.

6 Accessories (Section 7 of API STD 611:2008)**6.1 Substitution (7.2.1 of API STD 611:2008)**

Unless otherwise specified, flexible element spacer couplings and guards between horizontal turbines and driven equipment shall be supplied by the manufacturer with unit responsibility. The driver half of the coupling shall be mounted by the turbine manufacturer. For vertical turbines, a rigid non-spacer coupling between the turbine and driven equipment shall be supplied by the manufacturer with unit responsibility.

6.2 Substitution (7.3.2.9 of API STD 611:2008)

Alignment positioning screws shall be provided, regardless of the weight of any train component, to facilitate longitudinal and transverse horizontal adjustments. Horizontal jackscrews shall be same size of or larger than the vertical screws. The lugs holding these jackscrews shall be attached to the mounting plates so that they do not interfere with the installation or removal of the equipment.

6.3 Modification (7.4.2.1.5 of API STD 611:2008)

Replace first sentence by: For turbines above 300 kW or if remote control is specified, an electronic governor with pneumatic actuator shall be supplied.

6.4 Substitution (7.4.4.7.2 of API STD 611:2008)

All gauges shall be liquid-filled type.

6.5 Substitution (7.4.4.9.1 of API STD 611:2008)

The vendor shall furnish the relief valves that are to be installed on equipment or piping that the vendor is supplying. The exhaust steam relief valve to protect the turbine outer casing shall be furnished by the turbine vendor. The vendor's quotation shall list all relief valves and shall clearly state that these valves shall be furnished by the vendor.

6.6 Substitution (7.4.5.2 of API STD 611:2008)

A sentinel warning valve shall not be supplied.

7 Inspection, Testing and Preparation for Shipment (Section 8 of API STD 611:2008)**7.1 New (8.2.3.3)**

Hydrodynamic bearings shall be inspected during manufacturing and turbine assembling. The actual contact area among each journal/collar and its corresponding bearing, checked by blueing, shall be at least 70 % of the design contact area. Blueing is not required for radial tilting pads type bearing.

7.2 Exclusion (8.3.1.2 of API STD 611:2008)

Removed from API STD 611:2008.

7.3 Addition (8.3.2.2 of API STD 611:2008)

The hydrostatic test liquid shall include a wetting agent to reduce surface tension.

7.4 Addition (8.3.2.4 of API STD 611:2008)

Polytetrafluoroethylene (PTFE) tape or any threaded compounds shall not be used in order to help prevent leakage of threaded plugs and connections during hydrostatic tests.

7.5 New (8.3.2.5)

Vises or any other devices for clamp pressing of nozzle flanges shall not be used during hydrostatic tests.