

Centrifugal Pumps for Medium Services

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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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 10/2013) of PETROBRAS N-906 REV. D 10/2013. 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 minimum requirements for horizontal centrifugal pumps applied in chemical, petrochemical, and other medium-duty services, i. e., services not handling hazardous liquids (hazardous services) and not exceeding any of the conditions below:

- a) discharge pressure (gauge) of 1 900 kPa;
- b) suction pressure (gauge) of 500 kPa;
- c) pumping temperature of 150 °C for non-hydrocarbon and of 50 °C for hydrocarbon;
- d) rotative speed of 3 600 rpm;
- e) rated total head of 120 m;
- f) impeller diameter of 330 mm, overhung pumps.

NOTE Regardless of the conditions mentioned above, pumps for fire fighting and cooling tower services shall comply with this Standard.

1.2 Pumps shall comply with ASME [B73.1](#) or ISO [5199](#), according to purchaser definition, and meet the additional requirements and modifications described in this Standard.

NOTE Fire fighting pumps shall also comply with NFPA [20](#).

1.3 The end user is responsible to decide whether to apply this Standard, complementing it with specific technical requirements for each service.

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

1.5 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.

PETROBRAS [N-2919](#) - Motores Elétricos Trifásicos de Indução ou Síncronos.

ANSI/HI [1.4](#) - Rotodynamic (Centrifugal) Pumps for Manuals Describing Installation, Operation and Maintenance;

ANSI/HI [9.6.4](#) - Rotodynamic Pumps for Vibration Measurements and Allowable Values;

ANSI/HI [14.6](#) - Rotodynamic Pumps for Hydraulic Performance Acceptance Tests;

API [682](#) - Pumps Shaft Sealing Systems for Centrifugal and Rotary Pumps;

ASME [B1.20.1](#) - Pipe Threads, General Purpose (Inch) Revision and Redesignation of ASME/ANSI B2.1-1968;

ASME [B16.1](#) - Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250;

ASME [B16.5](#) - Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard;

ASME [B16.47](#) - Large Diameter Steel Flanges NPS 26 Through NPS 60 Metric/Inch Standard;

ASME [B73.1](#) - Specification for Horizontal End Suction Centrifugal Pumps for Chemical Process;

ASTM [A216](#) - Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service;

ASTM [A278](#) - Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 650°F (350°C);

ASTM [A395](#) - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures;

ASTM [A487](#) - Standard Specification for Steel Castings Suitable for Pressure Service;

ASTM [A743](#) - Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application;

ASTM [A890](#) - Standard Specification for Castings, Iron-Chromium-Nickel-Molybdenum Corrosion- Resistant, Duplex (Austenitic/Ferritic) for General Application;

ASTM [A995](#) - Standard Specification for Castings, Austenitic-Ferritic (Duplex) Stainless Steel, for Pressure-Containing Parts;

ISO [5199](#) - Technical Specifications for Centrifugal Pumps - Class II;

NFPA [20](#) - Standard for the Installation of Stationary Pumps for Fire Protection;

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

BB

between bearings, axially split, one stage double suction, foot mounted pump.

3.2

BEP

best efficiency point.

3.3

DN (Nominal Diameter)

designation usually followed by a number which represents the approximate size of the outer diameter of a pipe in millimeters.

3.4**hazardous service**

refers to the service where pumped liquid presents any of the characteristics below:

- a) H₂S (Hydrogen Sulphide) concentrations above 500 ppm (mass);
- b) hydrocarbons with hydrogen at a partial pressure above 700 kPa (abs);
- c) hydrocarbons at pumping temperatures above their auto-ignition temperatures;
- d) other toxic and lethal substances, which can result in death or permanent personal injury through inhalation, exposition, or contact, to be specified and defined in the proposal phase.

3.5**labyrinth "L" type**

shaft seal applied in bearing housing which design contemplate only one deflector that allows air circulation through the bearing housing.

3.6**labyrinth "U" type**

shaft seal applied in bearing housing which design contemplate two deflectors (internal and external) that obstruct air movement through the bearing housing.

3.7**Material Requisition (RM)**

document that aims to establish the scope of supply, technical requirements and additional instructions required to acquisition of materials, systems and equipment.

3.8**maximum discharge pressure**

maximum suction pressure plus the maximum differential pressure that the pump is able to develop (head at shutoff including all tolerances described in Table 3 of this Standard) when operating with the furnished impeller at the rated speed and maximum specified liquid relative density.

3.9**minimum continuous stable flow**

lowest flow at which the pump can operate continuously, defined by pump manufacturer on the data sheet. This flow is usually limited by recirculation, vibration, noise, shaft deflection or other parameter established by pump manufacturer.

3.10**normal point**

the most frequent operating point.

3.11**NPS (Nominal Pipe Size)**

designation usually followed by a number which represents the approximate size of the outer diameter of a pipe in inches.

3.12**OH**

overhung, single stage, foot mounted pump.

3.13**rated point**

operating point for which the pump is selected and its performance is guaranteed.

4 Design**4.1 Hydraulic Requirements****4.1.1 Hydraulic Requirements Applied To All Pumps**

4.1.1.1 Pumps shall have stable curves (continuous head rise to shutoff). Pumps with unstable curves shall be submitted to PETROBRAS previous approval.

4.1.1.2 In case of parallel operation, the shutoff head shall be at least 110 % of the head in rated point. The use of orifice plates shall be approved by PETROBRAS.

4.1.1.3 Pumps for parallel operation shall have equal shutoff head, considering the criteria established in Table 3 of this Standard.

4.1.1.4 The maximum pump discharge pressure (shutoff condition) shall not exceed design pressure for downstream piping and equipment.

4.1.1.5 The flow at BEP, for furnished impeller, shall be preferably between normal and rated flows.

4.1.1.6 At rated flow, the NPSH available shall exceed the NPSH required by at least 0,8 m and the NPSH ratio ($NPSH_a / NPSH_r$) shall be at least 1,15. Nevertheless, some services may require larger NPSH margins to be either specified on the data sheets or recommended by vendor.

NOTE For cooling tower services, the NPSH ratio ($NPSH_a / NPSH_r$) shall be at least 1,3 at rated flow.

4.1.2 Specific OH Pumps Hydraulic Requirements

4.1.2.1 The suction specific speed shall not exceed 12 000 when calculated in English units (or 233 in SI units).

4.1.2.2 For pumps with discharge nozzle greater than or equal to DN 100 (NPS 4), the rated flow point shall be between 70 % and 120 % of the flow at BEP.

NOTE For all other cases, the rated flow point shall be between the minimum continuous stable flow and 120 % of the flow at BEP.

4.1.2.3 The use of inductor shall be approved by PETROBRAS and if adopted shall be considered in suction specific speed.

4.1.3 Specific BB pumps hydraulic requirements

4.1.3.1 The suction specific speed shall not exceed 11 000 when calculated in English units (or 213 in SI units), except for cooling tower pumps in which the suction specific speed shall not exceed 9 000 when calculated in English units (or 175 in SI units).

4.1.3.2 The rated flow point shall be between 70 % and 120 % of the flow at BEP.

4.2 Mechanical Requirements

4.2.1 Mechanical Requirements Applied To All Pumps

4.2.1.1 Suction and discharge nozzles with diameter greater than or equal to DN 50 (NPS 2) shall be flanged according to ASME B16.1 for cast iron and ASME B16.5 or ASME B16.47 (Series A) for steel.

4.2.1.2 Suction and discharge nozzles with diameter less than DN 50 (NPS 2) and auxiliary connections can be threaded according to ASME B1.20.1 - NPT type, in services where the pumped liquid is water. Other services, only with PETROBRAS approval.

4.2.1.3 The use of welded impellers shall be approved by PETROBRAS.

4.2.1.4 Bilabial retainer for bearing housing sealing can only be used for shafts diameter up to 30 mm in sealing region. Above this limit, "U" type labyrinth shall be applied. "L" type labyrinth is not acceptable, except for BB type pumps.

4.2.1.5 For pumps with driver power greater than 30 kW, the thrust bearing shall be double row angular contact ball bearing type 3 000 series or duplex single row angular contact ball bearing type 7 000 series, back-to-back mounted.

4.2.1.6 Bearing cages of 3 000 series shall be metallic. Bearing cages of 7 000 series shall be brass or bronze.

4.2.1.7 Pumps shall be sealed with mechanical seal according to API 682, category 1, except in cases where the pumped liquid is water and the shaft has a diameter less than 40 mm in sealing region where can be applied a manufacturer's standard mechanical seal.

NOTE When packing is applicable, and the use is approved by PETROBRAS, it shall be carbon fiber type.

4.2.1.8 The coupling shall be stainless steel flexible element type for pumps with driver power greater than 5 kW.

4.2.1.9 The coupling guard shall be made of a carbon steel solid sheet and withstand 900 N load in any direction, in order to protect all rotating parts between driver and driven equipment, preventing unintentional personnel access.

NOTE 1 For shaft diameters equal to or larger than 40 mm in hub region, an opening shall be provided in order to allow coupling visual inspection without coupling guard removal (e.g. inspection window).

NOTE 2 Despite the design requirements described in 4.2.1.9 are acceptable, providing the coupling guard as Patent PETROBRAS is preferable.

4.2.2 Specific OH Pumps Mechanical Requirement

If the pump has closed impeller, at least the casing shall have wear ring.

4.2.3 Specific BB Pumps Mechanical Requirements

4.2.3.1 Hydrodynamic bearings shall be applied to shaft diameter greater than or equal to 80 mm in bearing region.

4.2.3.2 Pumps shall have casing and impeller wear rings.

4.3 Drivers

4.3.1 Electric motors shall have nameplate power ratings, excluding the service factor, at least equal to the percentages of power at pump rated conditions given in Table 1.

Table 1 - Power Ratings for Electric Motor Drives

Electric Motor (nameplate rating power)		Percentage of rated pump power
kW	hp	%
< 22	< 30	125
22 to 55	30 to 75	115
> 55	> 75	110

4.3.2 Unless otherwise specified by PETROBRAS, steam turbine drivers shall be sized to deliver continuously a minimum power of 110 % of the pump rated power at normal steam conditions.

4.3.3 Drivers for fire fighting pumps shall be sized according to NFPA 20.

4.4 Materials

4.4.1 Table 2 is a guide to material selection of the main pump parts. This table presents six (6) material classes to be applied considering the severity of the pumping service.

4.4.2 For services which require materials other than shown in Table 2, these materials shall be specified by PETROBRAS on the data sheet, and the manufacturer shall comment the proposed material according to its experience.