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Technical specifications for centrifugal pumps - Class I (ISO 9905:1994)

Technical specifications for centrifugal pumps - Class I (ISO 9905:1994)

Kreiselpumpen technische Anforderungen - Klasse I (ISO 9905:1994)

Spécifications techniques pour pompes centrifuges - Classe I (ISO 9905:1994)

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Spécifications techniques pour pompes centrifuges - Classe I (ISO 9905:1994)

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This European Standard was approved by CEN on 18 September 1997.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

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Foreword

The text of the International Standard from Technical Committee ISO/TC 115 "Pumps" of the International Organization for Standardization (ISO) has been taken over as an European Standard by Technical Committee CEN/TC 197 "Pumps", the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 1998, and conflicting national standards shall be withdrawn at the latest by April 1998.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Endorsement notice

The text of the International Standard ISO 9905:1994 has been approved by CEN as a European Standard without any modification.

NOTE: Normative references to International Standards are listed in annex ZA (normative).

Annex ZA (normative)
Normative references to international publications with their relevant European publications

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

Publication	Year	Title	EN	Year
ISO 544	1989	Filler materials for manual welding - Size requirements	EN 20544	1991
ISO 2858	1975	End-suction centrifugal pumps (rating 16 bar) - Designation, nominal duty point and dimensions	EN 22858	1993
ISO 3744	1994	Acoustics - Determination of sound power levels of noise sources using sound pressure - Engineering method in an essentially free field over a reflecting plane	EN ISO 3744	1995
ISO 3746	1995	Acoustics - Determination of sound power levels of noise sources using sound pressure - Survey method using an enveloping measurement surface over a reflecting plane	EN ISO 3746	1995

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Technical specifications for centrifugal pumps — Class I

Spécifications techniques pour pompes centrifuges — Classe I

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 9905 was prepared by Technical Committee ISO/TC 115, *Pumps*, Subcommittee SC 1, *Dimensions and technical specifications of pumps.*

Annexes A, B, C and D form an integral part of this International Standard. Annexes E, F, G, H, J, K and L are for information only.

Introduction

This International Standard is the second of a set dealing with technical specifications of centrifugal pumps; the specifications are designated as Classes I, II and III. Class I (this International Standard) comprises the most severe and Class III (see ISO 9908) the least severe requirements. For requirements for Class II centrifugal pumps, see ISO 5199.

The selection of the class to be used is made in accordance with the technical requirements for the application for which the pump is intended. **The class chosen is to be agreed between purchaser and manufacturer/supplier.**

The safety requirements of the field of application are furthermore to be taken into account.

However, it is not possible to standardize the class of technical requirements for centrifugal pumps for a certain field of application, because each field of application comprises different requirements. All classes (I, II and III) can be used in accordance with the different requirements of the pump application, e.g. for an oil refinery plant, chemical plant or power plant. It may happen that pumps built in accordance with classes I, II and III may work beside each other in one plant.

Conditions covering specific applications or industrial requirements are dealt with in separate standards.

Criteria for the selection of a pump of the class required for a certain application may be based on:

— reliability,

— operating conditions,

— environmental conditions,

— local ambient conditions.

Throughout this International Standard, text written in bold letters indicates where a decision may be required by purchaser, or where agreement is required between purchaser and manufacturer/supplier.

Technical specifications for centrifugal pumps — Class I

1 Scope

1.1 This International Standard covers the Class I (most severe) requirements for centrifugal pumps used in various industries. It consists of a basic text covering general requirements. The technical requirements refer only to the pump unit.

Storage pumps are not included in this International Standard. A separate standard will be issued by IEC.

1.2 This International Standard includes design features concerned with installation, maintenance and safety of such pumps, including baseplate, coupling and auxiliary piping.

1.3 Where this International Standard specification has been called for:

a) and requires a specific design feature, alternative designs may be offered which meet the intent of this International Standard, provided that the alternative is described in detail;

b) pumps not complying with all requirements of this International Standard may be offered for consideration, provided that all deviations are stated.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 7-1:1982, *Pipe threads where pressure-tight joints are made on the threads — Part 1: Designation, dimensions and tolerances.*

ISO 76:1987, *Rolling bearings — Static load ratings.*

ISO 185:1988, *Grey cast iron — Classification.*

ISO 228-1:1982, *Pipe threads where pressure-tight joints are not made on the threads — Part 1: Designation, dimensions and tolerances.*

ISO 281:1990, *Rolling bearings — Dynamic load ratings and rating life.*

ISO 427:1983, *Wrought copper-tin alloys — Chemical composition and forms of wrought products.*

ISO 544:1989, *Filler materials for manual welding — Size requirements.*

ISO 1940-1:1986, *Mechanical vibration — Balance quality requirements of rigid rotors — Part 1: Determination of permissible residual unbalance.*

ISO 2372:1974, *Mechanical vibration of machines with operating speeds from 10 to 200 rev/s — Basis for specifying evaluation standards.*

ISO 2548:1973, *Centrifugal, mixed flow and axial pumps — Code for acceptance tests — Class C (It is planned to combine ISO 2548 with ISO 3555 during their next revision to create a new International Standard).*

ISO 2858:1975, *End-suction centrifugal pumps (rating 16 bar) — Designation, nominal duty point and dimensions.*

ISO 3069:1974, *End suction centrifugal pumps — Dimensions of cavities for mechanical seals and for soft packing.*

ISO 3274:1975, *Instruments for the measurement of surface roughness by the profile method — Contact (stylus) instruments of consecutive profile transformation — Contact profile meters, system M.*

ISO 3506:1979, *Corrosion-resistant stainless steel fasteners — Specifications.*

ISO 3555:1977, *Centrifugal, mixed flow and axial pumps — Code for acceptance tests — Class B (It is planned to combine ISO 3555 with ISO 2548 during their next revision to create a new International Standard).*

ISO 3744:1981, *Acoustics — Determination of sound power levels of noise sources — Engineering methods for free-field conditions over a reflecting plane.*

ISO 3746:1979, *Acoustics — Determination of sound power levels of noise sources — Survey method.*

ISO 3755:1991, *Cast carbon steels for general engineering purposes.*

ISO 4863:1984, *Resilient shaft couplings — Information to be supplied by users and manufacturers.*

ISO 7005-1:1992, *Metallic flanges — Part 1: Steel flanges.*

ISO 7005-2:1988, *Metallic flanges — Part 2: Cast iron flanges.*

ISO 7005-3:1988, *Metallic flanges — Part 3: Copper alloy and composite flanges.*

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 normal conditions: Conditions at which usual operation is expected.

3.2 rated conditions: Specified guarantee-point operating conditions, including flowrate, head, power, efficiency, net positive suction head, suction pressure, temperature, density, viscosity and speed.

3.3 operating conditions: All operating parameters (for example temperature, pressure) determined by a given application and pumped liquid.

These parameters will influence the type of construction materials.

3.4 allowable operating range: Flow range, defined by the manufacturer/supplier, at the specified operating conditions using the impeller supplied, as limited by cavitation, heating, vibration, noise, shaft deflection and other similar criteria; range whose upper and lower limits are denoted by maximum and minimum continuous flow, respectively.

3.5 maximum allowable casing working pressure: Greatest outlet pressure at the specified operating temperature for which the pump casing is suitable.

3.6 basic design pressure: Pressure derived from the permitted stress at 20 °C of the material used for the pressure-containing parts.

3.7 maximum outlet working pressure: Sum of the maximum inlet pressure plus maximum differential pressure at rated conditions using the supplied impeller.

3.8 rated outlet pressure: Outlet pressure of the pump at the guarantee point with rated flow, rated speed, rated inlet pressure and density.

3.9 maximum inlet pressure: Highest inlet pressure to which the pump is subjected during operation.

3.10 rated inlet pressure: Inlet pressure for the operating conditions at the guarantee point.

3.11 maximum allowable temperature: Highest allowable continuous temperature for which the equipment (or any part to which the term refers) is suitable when handling the specified operating fluid at the specified operating pressure.

3.12 rated power input: Power required by the pump at the rated conditions.

3.13 maximum dynamic sealing pressure: Highest pressure expected at the shaft seals during any specified operating condition and during startup and shutdown.

NOTE 1 In determining this pressure, consideration should be given to the maximum inlet pressure, circulation or injection (flush) pressure and the effect of internal clearance changes.

3.14 minimum permitted flow

(1) for stable flow: Lowest flowrate at which the pump can operate without exceeding the noise and vibration limits imposed by this International Standard.

(2) for thermal flow: Lowest flowrate at which the pump can operate and still maintain the temperature of the pumped liquid below that at which net positive suction head available equals net positive suction head required.

3.15 corrosion allowance: That portion of the wall thickness of the parts wetted by the pumped liquid in excess of the theoretical thickness required to withstand the pressure limits given in 4.4.2.2 and 4.4.2.4.

3.16 maximum allowable continuous speed: Highest speed at which the manufacturer will permit continuous operation.

3.17 rated speed: Number of revolutions of the pump per unit time required to meet the rated conditions.

NOTE 2 Induction motors will operate at a speed that is a function of the load imposed.

3.18 trip speed: Speed at which the independent emergency overspeed device operates to shut down a prime mover.

3.19 first critical speed: Speed of rotation at which the lowest lateral natural frequency of vibration of the rotating parts corresponds to the frequency of rotation.

3.20 design radial load: Maximum hydraulic radial forces on the largest impeller (diameter and width) operating within the manufacturer's specified range on its maximum speed curve using the design liquid (normally 1 000 kg/m^3).

3.21 maximum radial load: Maximum hydraulic radial forces on the largest impeller (diameter and width) operating at any point on its maximum speed curve with a maximum liquid density.

3.22 shaft runout: Total radial deviation indicated by a device measuring shaft position in relation to the bearing housing as the shaft is rotated manually in its bearings with the shaft in the horizontal position.

3.23 face runout: Total axial deviation indicated at the outer radial face of the stuffing box by a device attached to and rotated with the shaft when the shaft is rotated manually in its bearings in the horizontal position.

The radial face is that which determines the alignment of a seal component.

3.24 shaft deflection: Displacement of a shaft from its geometric centre in response to the radial hydraulic forces acting on the impeller.

NOTE 3 Shaft deflection does not include shaft movement caused by tilting within the bearing clearances, bending caused by impeller unbalance or shaft runout.

3.25 circulation (flush): Return of pumped liquid from a high pressure area to seal cavity, by external piping or internal passage, to remove heat generated at the seal or to maintain positive pressure in the seal cavity or treated to improve the working environment for the seal.

NOTE 4 In some cases it may be desirable to circulate from the seal cavity to a lower pressure area (for example, the inlet).

3.26 injection (flush): Introduction of an appropriate (clean, compatible, etc.) liquid into the seal cavity from an external source and then into the pumped liquid.

3.27 quenching: Continuous or intermittent introduction of an appropriate (clean, compatible, etc.) fluid on the atmospheric side of the main shaft seal to exclude air or moisture, to prevent or clear deposits (including ice), lubricate an auxiliary seal, snuff out fire, dilute, heat or cool leakage.

3.28 barrier liquid (buffer): An appropriate (clean, compatible, etc.) liquid inserted between two seals (mechanical seal and/or soft packing).

NOTE 5 The barrier liquid pressure depends on the seal arrangement. The barrier liquid may be used to prevent air entering the pump. The barrier liquid is normally easier to seal than the pumped liquid and/or creates less hazard if leakage occurs.

3.29 throttle bush (safety bush): Close-clearance restrictive bush around the shaft (or sleeve) at the outboard end of a mechanical seal to reduce leakage in case of seal failure.

3.30 throat bush: Close-clearance restrictive bush around the shaft (or sleeve) between the seal (or packing) and the impeller.

3.31 pressure casing: Composite of all stationary pressure-containing parts of the unit, including all branches and other attached parts.

3.32 double casing: Type of construction in which the pressure casing is separate and distinct from the pumping elements contained in it.

3.33 barrel casing: Refers specifically to a pump of the double casing type.

3.34 vertical canned pump: Vertical pump inserted in an outer casing (can or caisson) taking its suction from the liquid in the annular space.

3.35 vertical canned motor pump: Glandless pumping set in which the stator of the (electric) motor is sealed by a can against the rotor which runs in the pumped liquid or in any other liquid.

3.36 hydraulic power recovery turbine: Pump operated with reversed flow to deliver mechanical energy at the coupling obtained from the recovery of energy released by the reduction of fluid pressure (and sometimes from the additional energy released by vapour or gas evolution from the fluid).

NOTE 6 For hydraulic power recovery turbine branches, all references in this standard to suction and discharge apply to the outlet and inlet, respectively.

3.37 radial split: Refers to casing joints that are transverse to the shaft centreline.

3.38 axial split: Refers to casing joints that are parallel to the shaft centreline.

3.39 net positive suction head (NPSH): Absolute total inlet head above the head equivalent to the vapour pressure referred to the NPSH datum plane.

NOTE 7 NPSH is referred to the datum plane, whereas inlet total head is referred to the reference plane. The NPSH datum plane is the horizontal plane through the centre of the circle described by the external points of the entrance edges of the impeller blades; in the case of double inlet pumps with vertical or inclined axis, it is the plane through the higher centre. The manufacturer/supplier should indicate the position of this plane with respect to precise reference points on the pump.

3.40 net positive suction head available (NPSHA): NPSH determined by the conditions of the installation for a specified liquid, temperature and rate of flow.

3.41 net positive suction head required (NPSHR): Minimum NPSH for a pump achieving a specified performance at the specified rate of flow and speed (occurrence of visible cavitation, increase of noise due to cavitation, appearance of head or efficiency drop, head or efficiency drop of a given amount, etc.).

3.42 suction specific speed: Parameter relating the rotational speed, the flowrate and the NPSHR, determined at the best efficiency point.

3.43 hydrodynamic bearing: Bearing whose surface is oriented to another surface such that relative motion forms an oil wedge to support the load without metal-to-metal contact.

3.44 hydrodynamic radial bearing: Bearing of sleeve-journal or tilting-shoe type construction.

3.45 hydrodynamic thrust bearing: Bearing of multiple-segment or tilting-shoe type construction.

3.46 design values: Values used in the design of a pump for the purpose of determining the performance, the minimum permissible wall thickness and physical characteristics of the different parts of the pump.

NOTE 8 Use of the word design in any term (such as design pressure, design power, design temperature or design speed) should be avoided in the purchaser's specifications. This terminology should be used only by the equipment designer and manufacturer/supplier.

3.47 coupling service factor: A factor k, by which is multiplied the nominal torque T_N of the driver in order to obtain the rated torque $T_K = kT_N$, which makes due allowance for cycle torque fluctuations from the pump and/or its driver, and therefore ensures satisfactory coupling life.

4 Design

4.1 General

Whenever the documents include contradicting technical requirements, they shall apply in the following sequence:

a) purchase order (or enquiry, if no order is placed) (see annexes C and D);

b) data sheet (see annex A);

c) this International Standard;

d) other standards to which reference is made in the order (or enquiry, if no order is placed).

The applicability of any national and local codes, regulations, ordinances or rules shall be mutually agreed upon by the purchaser and the manufacturer/supplier.

4.1.1 Characteristic curve

4.1.1.1 The characteristic curve for the supplied impeller shall show the head, efficiency, NPSHR and the power input, plotted against flowrate. It shall also show the allowable operating range of the pump. Head/flowrate curves (on the basis of calculation or test) for the largest and smallest impeller diameters shall be plotted for single stage pumps, and for multistage pumps when requested.

4.1.1.2 Pumps that have stable head/flowrate curves which continuously rise to shutoff are preferred for most applications and are required when parallel operation is specified by the purchaser. Unstable head/flowrate curves or curves with dips (such as propeller pump curves) can be offered providing the application is suitable and the curve shape deviations are shown. When service conditions are such that a stable curve is technically impossible, other means of ensuring the desired flow(s) must be used. When parallel operation is specified, the rise of the head at rated flowrate shall have sufficient slope to avoid instability of flow.

4.1.1.3 The best efficiency point for the supplied impeller should preferably be between the rated point and the normal point (see 3.1).

4.1.1.4 When the pump design permits a constant-speed driver, the pump shall be capable of approximately a 5 % head increase at rated conditions by installing a new larger impeller or impellers.

4.1.1.5 Pumps that handle Newtonian liquids more viscous than water shall have their performance corrected in accordance with the conversion factors to be agreed between purchaser and manufacturer/supplier. Non-Newtonian liquids require special consideration.

4.1.2 Net positive suction head (NPSH)

NPSHR shall be based on cold water according to ISO 2548 and/or ISO 3555[1)] unless otherwise agreed.

The NPSHR curve as a function of flow for water shall be provided.

NPSHA must exceed NPSHR by a 10 % margin but in each case by not less than 0,5 m. The basis for use in performance curves is the NPSH corresponding to a drop of 3 % of the total head of the first stage of the pump (NPSH3).

Should the pump manufacturer/supplier consider that, because of the construction material and liquid pumped, a greater NPSH is required, this should be stated in the proposal and the appropriate curve provided.

The manufacturer/supplier shall specify on the data sheet the net positive suction head required (NPSHR) when the pump is operated with water at the rated flowrate and rated speed.

Hydrocarbon reduction or correction shall not be applied.

For NPSH tests, see 6.3.5.

4.1.3 Pump design

4.1.3.1 Pumping units may be of single-stage or multistage design. When the rated inlet gauge pressure is positive or the differential pressure is more than 3,5 bar, the pump should be designed to minimize the pressure on the shaft seals unless thrust balance requirements dictate otherwise. On single-stage overhang designs this can be accomplished with rings or pumping vanes on the back of the impeller. On multistage pumps this can be accomplished either by a back-to-back impeller arrangement combined with a close clearance throttle bush, or by an in-line impeller arrangement using balance drums or discs.

Other means can be used after agreement between purchaser and manufacturer/supplier.

4.1.3.2 High-energy pumps (head greater than 200 m per stage and power more than 225 kW per stage) require special consideration to ensure that the radial distance between the volute tongue (including double volute casing) or diffuser vane and the impeller periphery is so dimensioned to avoid undue vibrations and noise (blade-passing frequency and low frequency at reduced flowrates).

4.1.3.3 Vertical pumps with threaded line shaft coupling that could be damaged by reverse rotation shall be provided with a non-reverse ratchet or other approved means.

1) A combination of ISO 2548 and ISO 3555 and their simultaneous revision in a new International Standard is foreseen.