INTERNATIONAL STANDARD

ISO 9908

First edition
1993-11-01

Technical specifications for centrifugal pumps — Class III

Spécifications techniques pour pompes centrifuges — Classe III

Reference number
ISO 9908:1993(E)

Contents

International Organization for Standardization
Case Postale 56 • CH-1211 Genève 20 • Switzerland

Printed in Switzerland

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 9908 was prepared by Technical Committee ISO/TC 115, *Pumps*, Sub-Committee SC 1, *Dimensions and technical specifications of pumps*.

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

Introduction

This International Standard is the third of a set dealing with technical specifications of centrifugal pumps; they are designated as Classes I, II and III. Class I (see ISO 9905) comprises the most severe and Class III (this International Standard) 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. It may happen that pumps built in accordance with Classes I, II and III may work beside each other in one plant.

Further text covering specific applications or industry requirements are dealt with later in separate standards.

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

— reliability,

— operating conditions,

— environmental conditions.

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

Technical specifications for centrifugal pumps — Class III

1 Scope

1.1 This International Standard covers Class III requirements for centrifugal pumps of single stage, multistage, horizontal or vertical construction (coupled or close-coupled) with any drive and any installation for general application.

1.2 This International Standard includes design features concerned with installation, maintenance and safety of such pumps including baseplate, coupling and auxiliary piping but excluding the driver, if it is not an integral part of the pump.

1.3 Where the application of this International Standard 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 76:1987, *Rolling bearings — Static load ratings.*

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

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

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 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.*

ISO 9905:—[1], *Technical specifications for centrifugal pumps — Class I.*

1) To be published.

3 Definitions

For the purposes of this International Standard, the definitions given in ISO 9905 and the following definitions apply.

3.1 rated conditions: Conditions (driver excluded) that define the (guarantee) point necessary to meet all defined operating conditions, taking into account any necessary margins.

NOTE 1 This definition differs slightly from that given in ISO 9905.

3.2 rated driver output: The maximum permissible driver power output under site operating conditions.

3.3 pressure-temperature rating: Relationship between pressure and temperature given in the form of a graph (see figure 1).

4 Design

4.1 General

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

a) purchase order (or enquiry if no order is placed) (see annex B);

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).

4.1.1 Characteristic curve

The characteristic curve shall indicate the allowable operating range of the pump.

4.1.2 Net positive suction head (NPSH)

The NPSHR shall be based on cold water as specified in ISO 2548 and ISO 3555. The NPSHA must exceed NPSHR by a margin of at least 0,5 m. The basis for use in performance curves is that NPSH corresponding to a drop of 3 % of the total head of the first stage of the pump (NPSH3).

4.1.3 Installation

The pumps should preferably be suitable for outdoor installation under normal environmental conditions. If they are suitable only for indoor installation this information shall be clearly stated in the manufacturer/supplier's documentation.

For outdoor installation, the range of environmental conditions shall be specified by the purchaser.

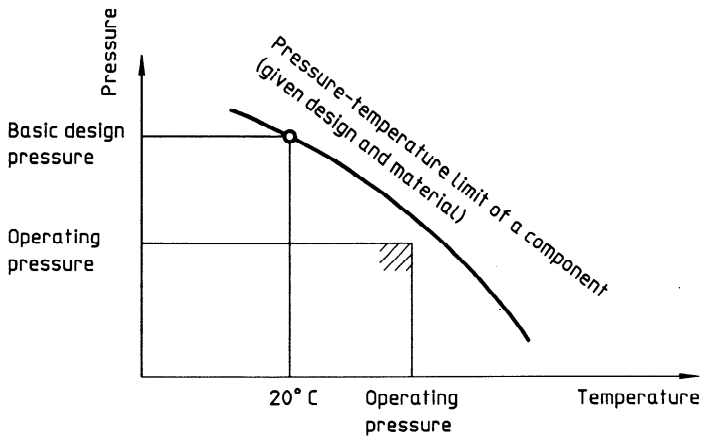

Figure 1 — Relationship between temperature and pressure

4.2 Prime movers

4.2.1 Defined operating conditions

Prime movers required as driver for coupled pumps shall have power output ratings at least equal to the percentage of rated pump power input given in figure 2 for the range of 1 kW to 100 kW. **For pump power input outside this range, the percentage is to be agreed upon between manufacturer/supplier and purchaser.** Where the prime mover has an output rating covering the power requirements at any operating conditions of the impeller diameter installed, no extra margins are required.

4.2.2 Undefined operating conditions

Prime movers as drivers for close-coupled pumps shall have power output ratings covering the power requirements at any operating conditions of the impeller diameter installed. These conditions eliminate the need for extra margins.

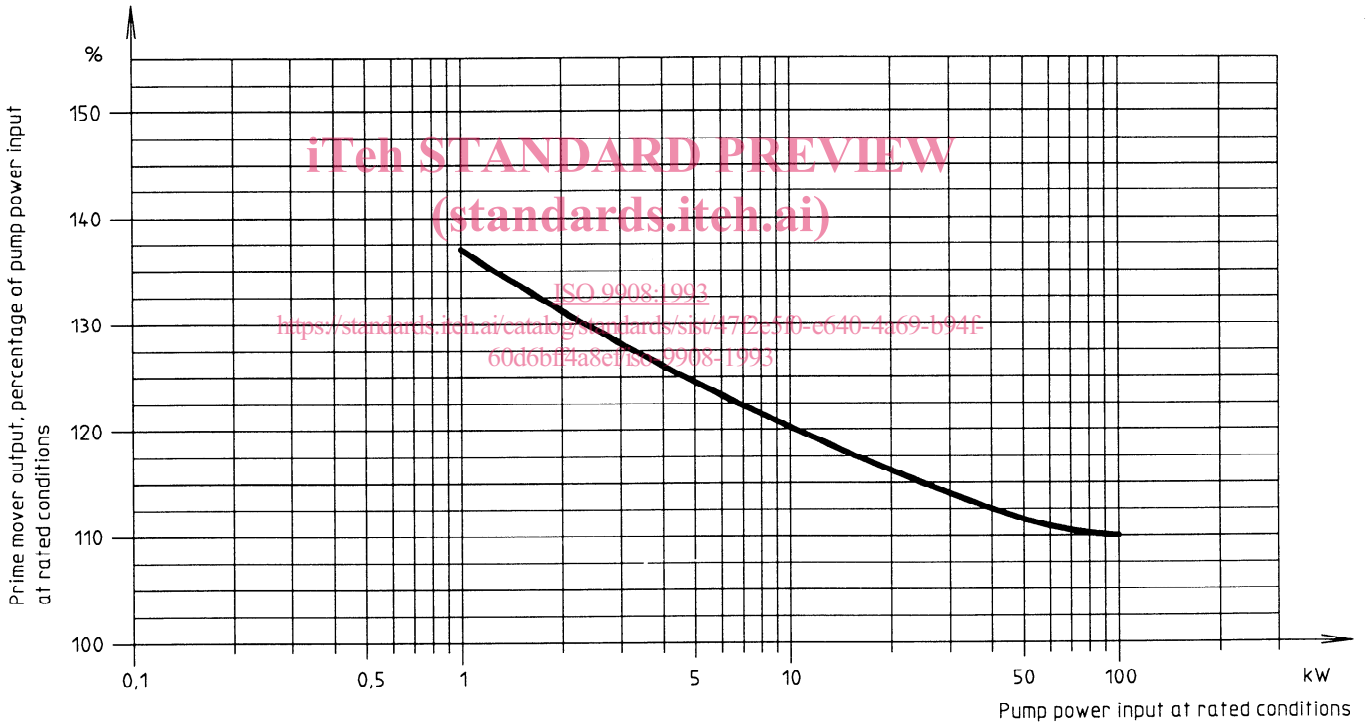

Figure 2 — Driver output percentage of rated pump power required in the range 1 kW to 100 kW

4.3 Critical speed, balance and vibration

4.3.1 Critical speed

Under operating conditions, the actual first lateral critical speed of the rotor when coupled to the drive agreed upon shall be at least 10 % above the maximum allowable continuous speed including the trip speed of a turbine-driven pump. For vertical lineshaft pumps, a flexible shaft is permitted.

4.3.2 Balance and vibration

4.3.2.1 Horizontal pumps

Unfiltered vibration shall not exceed the vibration severity limits given in table 1 when measured on the manufacturer/supplier's test facilities. These values are measured radially at the bearing housing at a single operating point at rated speed (± 5 %) and rated flow (± 5 %) when operating without cavitation.

Pumps with a special impeller, for example a single channel impeller, may exceed the limits given in table 1. In such case the pump manufacturer/supplier should indicate this in his offer.

4.3.2.2 Vertical lineshaft pumps

a) Vibration readings shall be taken on the top flange of the driver mount on vertical lineshaft pumps with rigid couplings and near to the top pump bearing on vertical pumps with flexible couplings.

b) Vibration limits for both rolling and sleeve bearing pumps shall not exceed a velocity of 7,1 mm/s rms during shop test at rated speed (± 5 %), and rated flow (± 5 %) operating without cavitation.

Table 1 — Limits of vibration severity for horizontal pumps with multivane impellers

Speed of rotation n min^{-1}	Maximum rms values of the vibration velocity for the shaft centreline height h_1 [1) 2)] mm/s	
	$h_1 \leqslant 225$ mm	$h_1 > 225$ mm
$n \leqslant 1\,800$	2,8	4,5
$1\,800 < n \leqslant 4\,500$	4,5	7,1

1) Based on ISO 2372.

2) For horizontal foot-mounted pumps, h_1 is the distance between baseplate area in contact with pump feet and pump shaft centreline.

4.4 Pressure-containing parts

4.4.1 Pressure-temperature rating

The pressure limit (maximum allowable working pressure) of the pump at the most severe operating conditions shall be clearly defined by the manufacturer/supplier. In no case may the rated pressure of the pump (casing and cover, including shaft seal housing and gland follower/end plate) exceed that of the pump flanges.

The basic design pressure of the pump shall be a gauge pressure of at least 6 bar[2] at 20 °C when made of cast iron, ductile iron, carbon steel or stainless steel.

For materials the tensile requirements of which do not permit the 6 bar rating, the pressure-temperature rating shall be adjusted according to the stress-temperature rating for the material and shall be clearly stated by the manufacturer/supplier.

Low head pumps may have a lower pressure-temperature rating if this is clearly stated by the manufacturer/supplier on the nameplate and data sheet.

4.4.2 Wall thickness

Pressure casings including the shaft seal housing and gland end plate shall be of such thickness as will be suitable for containing pressure and limiting distortion under the maximum allowable working pressure at operating temperature.

The casing shall also be suitable for the hydrostatic test pressure (see clause 6) at ambient temperature.

4.4.3 Materials

The materials used for pressure-containing parts shall depend on the liquid pumped and the application of the pump (see clause 5).

4.4.4 Mechanical features

4.4.4.1 Dismantling

The pump should be designed to permit necessary dismantling for spare part replacement without disturbing inlet and outlet connections. If the design is such that dismantling will cause some disturbance, then it should be so stated.

4.4.4.2 Casing gaskets

Casing gaskets shall be of a design suitable for the rated operating conditions and for hydrostatic test conditions at ambient temperature.

4.4.4.3 External bolting

Bolts or studs that connect pressure-containing parts shall be selected to be adequate for the maximum allowable working pressure and for normal tightening procedures.

4.5 Branches (nozzles) and miscellaneous connections

NOTE 2 For the purpose of this International Standard the terms branch and nozzle are synonymous.

4.5.1 Type and size

Type and size of fluid connections shall be stated in the manufacturer/supplier's document.

4.5.2 Closures

Vent, pressure-gauge and drain openings shall be fitted with removable closures adequate to contain the maximum allowable working pressures and of material suitable for the pumped liquid.

4.6 External forces and moments on branches (inlet and outlet)

The manufacturer/supplier shall provide details of allowable external forces and moments on branches on request.

4.7 Branch (nozzle) flanges

If circular flanges are used the flange envelope shall be of a size to enable flanges as specified in ISO 7005-1, ISO 7005-2 and ISO 7005-3 to be used. **If the pump manufacturer/supplier's standard pattern entails a flange thickness and a diameter greater than that of the rating specified, the heavier flange may be supplied if requested by the manufacturer/supplier, but it shall be faced and drilled as specified above.**

Bolt holes shall straddle the centreline.

4.8 Impellers

4.8.1 Impeller design

Impellers of closed, semi-open or open designs may be selected according to the application.

4.8.2 Securing of impellers

Impellers shall be secured against circumferential and axial movement when rotating in the intended direction of rotation. Attention shall be drawn to the secure

2) 1 bar = 0,1 MPa

attachment of impeller in either direction of close-coupled pumps.

4.9 Running clearance

When establishing running clearances between stationary and moving parts, consideration shall be given to operating conditions and properties of the material (such as hardness and gall resistance) used for these parts. Clearances shall be sized to prevent contact under operating conditions, and material combinations selected to minimize the risk of seizure and erosion.

4.10 Shafts and shaft sleeves

4.10.1 General

Shafts shall be of ample size and stiffness to:

a) transmit the prime mover rated power;

b) minimize unsatisfactory packing or seal performance;

c) minimize wear and the risk of seizure;

d) take due consideration of the method of starting and inertia loading involved.

4.10.2 Surface roughness

Surface roughness in the gland sealing area shall be suitable for the satisfactory operation of either mechanical seal or gland packing.

4.10.3 Shaft deflection

The calculated shaft deflection at the radial plane through the outer face of the stuffing box caused by radial loads exerted during operation of the pump shall not exceed 50 µm, within the allowable operating range, as verified by prototype testing.

4.10.4 Diameter

The diameter of the portions of the shaft or shaft sleeves in the seal area shall be in accordance with ISO 3069 where practicable.

4.10.5 Shaft runout

Manufacture and assembly of the shaft and sleeve, if fitted, should ensure that the runout at a radial plane through the outer face of the stuffing box is not greater than 50 µm for nominal outside diameters smaller than 50 mm, not greater than 80 µm for nominal outside diameters 50 mm to 100 mm, and not greater than 100 µm for nominal outside diameters greater than 100 mm.

4.10.6 Axial movement

Axial movement of the rotor permitted by the bearings shall not adversely affect the performance of the mechanical seal.

4.11 Bearings

4.11.1 General

Rolling bearings of standard design are normally to be used.

4.11.2 Rolling bearing life

Rolling bearings shall be selected and rated in accordance with ISO 76 and ISO 281; the "basic rating life (L_{10})" shall be at least 10 000 h when operating within the allowable operating range.

4.11.3 Lubrication

The operating instructions shall include information on the type and amount of lubricant to be used and the frequency of application.

4.11.4 Bearing housing design

The bearing housing shall be designed to prevent the ingress of contaminants and the escape of the lubricant under normal operating conditions.

4.12 Shaft sealing

4.12.1 General

The pump design shaft permit the use of either mechanical seal(s) or soft packing (with the exception of glandless pumps).

The seal cavity dimensions shall be in accordance with ISO 3069 except where the operating conditions dictate otherwise.

4.12.2 Stuffing box

Ample space shall be provided for repacking, including compression of packing material, without removing or dismantling any part other than gland components and guards.

The gland shall withstand forces necessary for compressing the packing material.

4.12.3 Mechanical seals

The mechanical seal shall be suitable to withstand the given operating conditions.

Appropriate material for the seal components shall be chosen to withstand corrosion, erosion, temperature and mechanical stress, etc.

A mechanical seal shall not be subjected to a hydrostatic test pressure exceeding the seal pressure limit.

4.13 Nameplate

Nameplates shall be securely attached to the pump.

The minimum information required on the nameplate shall be name (or trademark) and address of the manufacturer/supplier, identification number of the pump (for example, serial number or product number), type and size.

Further space may be provided for additional information on rate of flow, pump total head and pump speed.

4.14 Direction of rotation

The direction of rotation shall be indicated by a prominently located arrow of durable construction. For portable close-coupled pumps the direction of the starting reaction may be indicated as alternative.

4.15 Couplings

If the driver is not integral with the pump design, the pump shall normally be coupled to the driver by a flexible coupling.

Coupling halves shall be effectively secured against circumferential and axial movement relative to the shafts.

If coupling components are balanced together, the correct assembly position shall be shown by permanent and visible marks.

An appropriate fixed guard shall be provided. Guards shall be designed in accordance with national safety regulations.

4.16 Baseplates for horizontal pumps

4.16.1 General

Baseplates designed for installations without grouting shall be rigid enough for freestanding installation or for installation by bolting on a foundation without grouting.

Baseplates requiring grouting shall be designed to ensure proper grouting (for example trapping of air shall be prevented).

4.16.2 Assembly of pump and driver on baseplate

Provision shall be made for spacers or shims for vertical adjustment of driver alignment to permit compensation for pump, driver and baseplate tolerances.

If the purchaser supplies a driver or coupling, he shall provide the pump manufacturer/supplier with certified installation dimensions of these components.

If the driver is not mounted by the pump manufacturer/supplier, the driver fixing holes shall not be drilled, if not otherwise specified.

5 Materials

The materials shall be selected by the manufacturer/supplier for the intended liquid to be pumped and for the intended application, unless specified by the purchaser.

6 Shop inspection and tests

A hydrostatic test shall be performed for pressure-containing parts of a pump at a test pressure of at least 1,3 times the basic design pressure.

Pumps are normally subject only to such other internal shop tests as may be decided by the manufacturer/supplier. If witnessed or nonwitnessed tests are required, this should be stated on the enquiry or order.

If a hydraulic performance test is required it shall be made in accordance with ISO 2548 and ISO 3555 Class II for clean cold water. For liquids other than clean cold water and for special operating conditions, hydraulic performance is to be calculated by the manufacturer/supplier and the conversion method is to be indicated.

7 Preparation for dispatch

7.1 General

All internal parts shall be drained prior to shipment. Where bearings are oil-lubricated, the bearing housings shall be drained and a label warning that prior to startup filling with oil is required, shall be fitted.

7.2 Securing of rotating parts for transport

In order to avoid damage to bearings caused by vibration during transport, rotating parts shall be secured as required according to mode and distance of transport, mass of rotor and bearings design. In such cases a warning label shall be securely attached.

7.3 Openings

All openings to the pressure chamber shall have weather-resistant closures for transport, substantial enough to withstand accidental damage.