INTERNATIONAL STANDARD

ISO 5199

Second edition
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Technical specifications for centrifugal pumps — Class II

Spécifications techniques pour pompes centrifuges — Classe II

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of technical committees is to prepare International Standards. 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.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 5199 was prepared by Technical Committee ISO/TC 115, *Pumps*, Subcommittee SC 1, *Dimensions and technical specifications of pumps*.

This second edition cancels and replaces the first edition (ISO 5199:1986), which has been technically revised.

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

Introduction

This International Standard is one of a set dealing with technical specifications of centrifugal pumps; they are designated as Classes I, II and III. Class I comprises the most severe and Class III the least severe requirements.

The selection of the class to be used is in accordance with the technical requirements for the application for which the pump is intended. The class chosen should be agreed between the purchaser and supplier. Furthermore, additional safety requirements concerning the field of application should 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 to the different requirements of the pump application. So it may happen that pumps built in accordance with Classes I, II and III may work beside one another in the one plant.

Further requirements covering specific applications or industries may be dealt with in separate standards.

Criteria for the selection of the required class of a pump for a certain application may include

— reliability,

— required operating life,

— operating conditions,

— environmental conditions, and

— local ambient conditions.

Cross-references in boldface and the checklist in annex H indicate where a decision may be required by the purchaser, or where agreement is required between the purchaser and the manufacturer/supplier.

Technical specifications for centrifugal pumps — Class II

1 Scope

1.1 This International Standard specifies the requirements for Class II centrifugal pumps of single-stage, multistage, horizontal or vertical construction, with any drive and any installation for general application. Pumps used in the chemical process industries (e.g. those conforming to ISO 2858) are typical of those covered by this International Standard.

1.2 This International Standard includes design features concerned with installation, maintenance and safety for these pumps including baseplate, couplings and auxiliary piping, but it does not specify any requirements for the driver other than those related to its rated power output.

1.3 Where application of this International Standard has been called for 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.

Pumps not complying with all the requirements of this International Standard may be offered for consideration provided that all deviations are stated.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 76, *Rolling bearings — Static load ratings*

ISO 281-1, *Rolling bearings — Dynamic load ratings and rating life — Part 1: Calculation methods*

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

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

ISO 3274, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Nominal characteristics of contact (stylus) instruments*

ISO 3661, *End-suction centrifugal pumps — Baseplate and installation dimensions*

ISO 3744, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Engineering method in an essentially free field over a reflecting plane*

ISO 3746, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Survey method using an enveloping measurement surface over a reflecting plane*

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

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

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

ISO 9906, *Rotodynamic pumps — Hydraulic performance acceptance tests — Grades 1 and 2*

ISO 9614-1, *Acoustics — Determination of sound power levels of noise sources using sound intensity — Part 1: Measurement at discrete points*

ISO 9614-2, *Acoustics — Determination of sound power levels of noise sources using sound intensity — Part 2: Measurement by scanning*

3 Terms and definitions

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

3.1
operating conditions
all parameters (e.g. operating temperature, operating pressure) determined by a given application and pumped liquid

NOTE These parameters will influence the type of construction and construction materials.

3.2
allowable operating range
range of flows or heads at the specified operating conditions of the pump supplied as limited by cavitation, heating, vibration, noise, shaft deflection and other similar criteria

NOTE The upper and lower limits of the range are denoted by maximum and minimum continuous flow.

3.3
rated conditions
conditions (driver excluded) that define the guarantee values necessary to meet all defined operating conditions, taking into account any necessary margins

3.4
driver rated power output
greatest continuous driver power output permitted under defined conditions

3.5
basic design pressure
pressure derived from the permitted stresses at 20 °C of the material used for the pressure-containing parts

3.6
maximum allowable working pressure
pressure for a component on the basis of materials used and on the basis of calculation rules at the specified operating temperature

3.7
rated inlet pressure
inlet pressure of the operating conditions at the guarantee point

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
pressure/temperature limit
limiting pressure and temperature of a component at given design and material (see Figure 1)

3.10
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 at the most severe operating conditions

3.11
maximum allowable continuous speed
highest speed at which the manufacturer will permit continuous operation

3.12
trip speed
speed at which the independent emergency overspeed devices operate to shut down a prime mover

3.13
first critical speed
speed of rotation at which the first (lowest) lateral natural frequency of vibration of the rotating parts corresponds to the frequency of rotation

3.14
design radial load
radial load of the pump rotor for which the bearing system is selected

3.15
maximum radial load
greatest radial load of the pump rotor resulting from operating the pump at any condition within its allowable operating range

3.16
shaft runout
total radial deviation indicated by a device measuring the shaft position in relation to the bearing housing, as the shaft is rotated manually in its bearings with the shaft in the horizontal position

3.17
face runout
total axial deviation indicated at the outer radial face of the shaft seal casing by a device attached to and rotated with the shaft when the shaft is rotated manually in its bearings in the horizontal position

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

3.18
shaft deflection
displacement of a shaft from its geometric centre in response to the radial hydraulic forces acting on the impeller

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

3.19
seal flush
circulation
return of pumped liquid from high pressure area to seal cavity

NOTE This can be by external piping or internal passage and is used 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. In some cases it may be desirable to circulate from the seal cavity to a lower pressure area (e.g. the inlet).

3.20
injection flush
introduction of an appropriate (clean, compatible, etc.) liquid into the seal cavity from an external source and then into the pumped liquid

NOTE Injection flush is used for the same purpose as circulation and also to provide an improved working environment for the seal.

3.21
quenching
continuous or intermittent introduction of an appropriate (clean, compatible, etc.) fluid at lower than seal chamber pressure on the atmospheric side of the main shaft seal

NOTE It is used to exclude air or moisture, to prevent or clear deposits (including ice), lubricate an auxiliary seal, snuff out fire, dilute, heat or cool leakage.

3.22
barrier fluid
fluid which is introduced between dual mechanical seals to completely isolate the pump process liquid from the environment

NOTE The pressure of the barrier fluid is always higher than the process pressure being sealed.

3.23
buffer fluid
fluid used as a lubricant or buffer between dual mechanical seals

NOTE The fluid is always at a pressure lower than the pump process pressure being sealed.

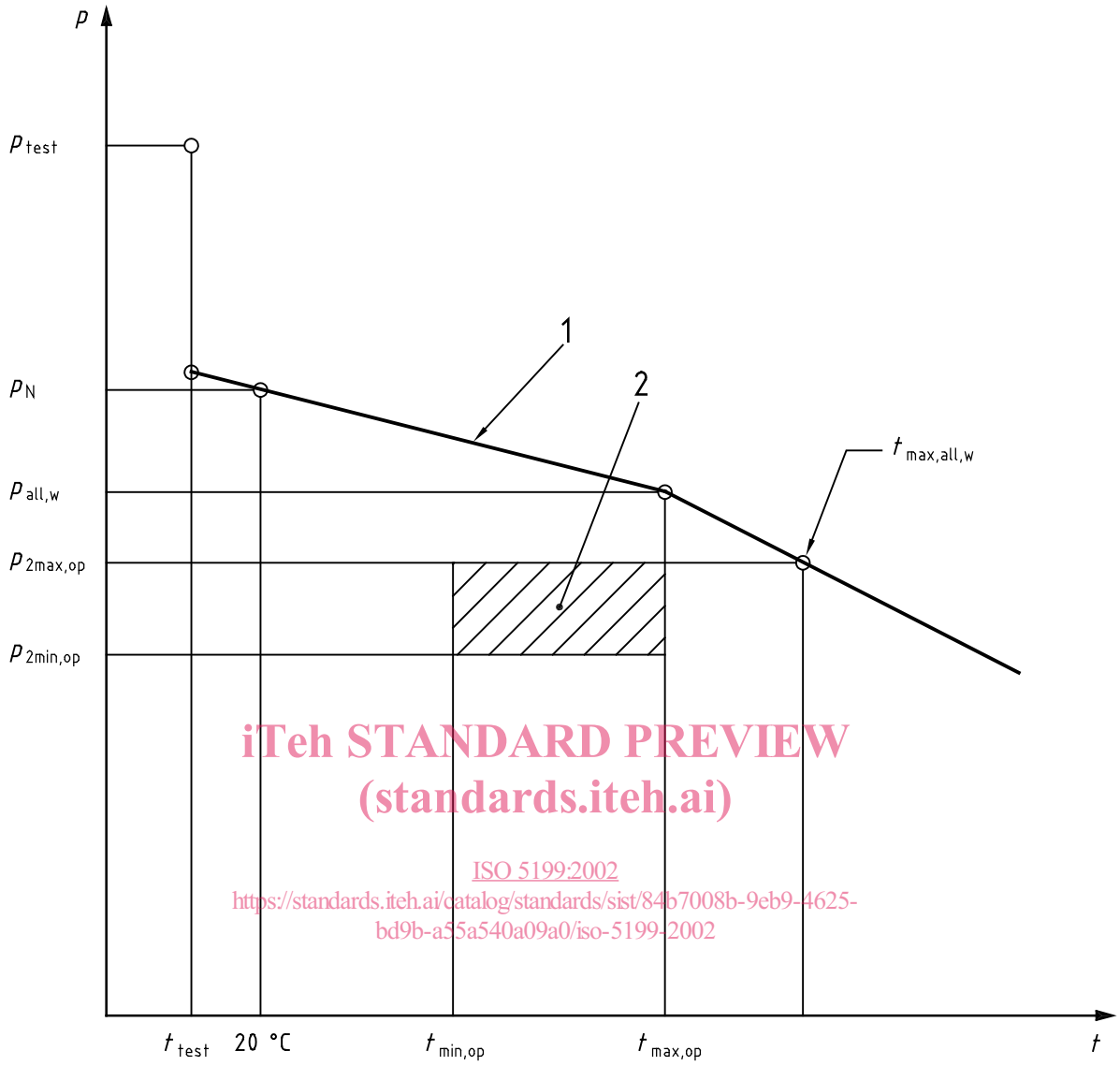
3.24
pump H(Q) curve
pump head capacity curve
pump characteristic curve

relationship between the total head of the pump and the rate of flow at given operating/rated conditions of speed and liquid

3.25
net positive suction head 3 %
NPSH3
net positive suction head required to limit to 3 % the fall in the total head of the first stage of the pump

NOTE It is the basic standard used in performance curves.

See Figure 1.



Key

1 Pressure-temperature limit of a component

2 Fluid operating field including tolerances

p	Pressure	t	Temperature
p_{test}	Hydrostatic test pressure	t_{test}	Hydrostatic test temperature
p_N	Basic design pressure	$t_{min,op}$	Minimum operating temperature
$p_{all,w}$	Maximum allowable working pressure	$t_{max,op}$	Maximum operating temperature
$p_{2max,op}$	Maximum outlet operating pressure	$t_{max,all\ w}$	Maximum allowable working temperature at maximum outlet pressure
$p_{2min,op}$	Minimum outlet operating pressure		

Figure 1 — Pressure–containing part, pressure/temperature rating

4 Design

4.1 General

4.1.1 Documents

Whenever the documents include conflicting technical requirements, they shall be applied 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) the requirements of this International Standard;

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

4.1.2 Pump H(Q) curve (characteristic curve)

The manufacturer/supplier shall make available the characteristic curve which shall indicate the allowable operating range of the pump as supplied. Characteristic curves of the smallest and largest impeller diameter shall be plotted on the performance chart for pumps conforming to ISO 2858 and for other pump types when requested by the purchaser.

Pumps with a stable characteristic curve are preferred.

If specified by the purchaser, it shall be possible for pumps that are to be used with constant speed drives to increase the head by approximately 5 % at rated conditions by installing new, larger or different impeller or impellers.

The position of the duty point in the flow range relative to the best efficiency point should be decided by the purchaser as a function of the specific application and anticipated variation in flow for optimum operation.

4.1.3 Net positive suction head (NPSH)

The NPSH required (NPSHR) shall be based on cold water as determined by testing in accordance with ISO 9906 unless otherwise agreed.

The manufacturer/supplier shall make available the NPSHR curve as a function of flow for water. NPSHR curves shall be net positive suction head 3 % (NPSH3).

Correction factors for hydrocarbons shall not be applied to the NPSHR curves.

Pumps shall be selected such that the minimum NPSH available (NPSHA) in the installation exceeds the NPSHR of the pump by at least the specified safety margin. This safety margin shall be no less than 0,5 m but the manufacturer/supplier may specify a significantly higher margin depending on factors including the following:

— size, type, specific speed, hydraulic geometry or design of the pump;

— operating speed;

— the pumped liquid;

— the cavitation erosion resistance of the construction materials.

4.1.4 Outdoor installation

The pump shall be suitable for outdoor installation under environmental conditions specified by the manufacturer/supplier.

Any different local environmental conditions, such as high or low temperatures, corrosive environment, sand storms, for which the pump must be suitable shall be specified by the purchaser.

4.2 Prime movers

The following shall be considered when determining the rated performance of the drive:

a) application and method of operation of the pump; for instance in the case of parallel operation, the possible performance range with only one pump in operation taking into account the system characteristic shall be considered;

b) position of the operating point on the pump characteristic curve;

c) shaft seal friction loss;

d) circulation flow for the mechanical seal (especially for pumps with low rate of flow);

e) properties of pumped liquid (viscosity, solids content, density);

f) power and slip loss through transmission;

g) atmospheric conditions at pump site;

h) start-up of the pump.

In assessing the required speed-torque characteristic of the driver, consideration shall be given to the system characteristics, in particular whether or not the pump is to be started manually or automatically with an open or closed discharge valve, or is to be used to fill the discharge main.

Prime movers required as drivers for any pumps covered by this International Standard shall have power output ratings at least equal to the percentage of rated pump power input given in Figure 2, this value never being less than 1 kW.

Where it appears that this will lead to unnecessary oversizing of the driver, an alternative proposal shall be submitted for the purchaser's approval.

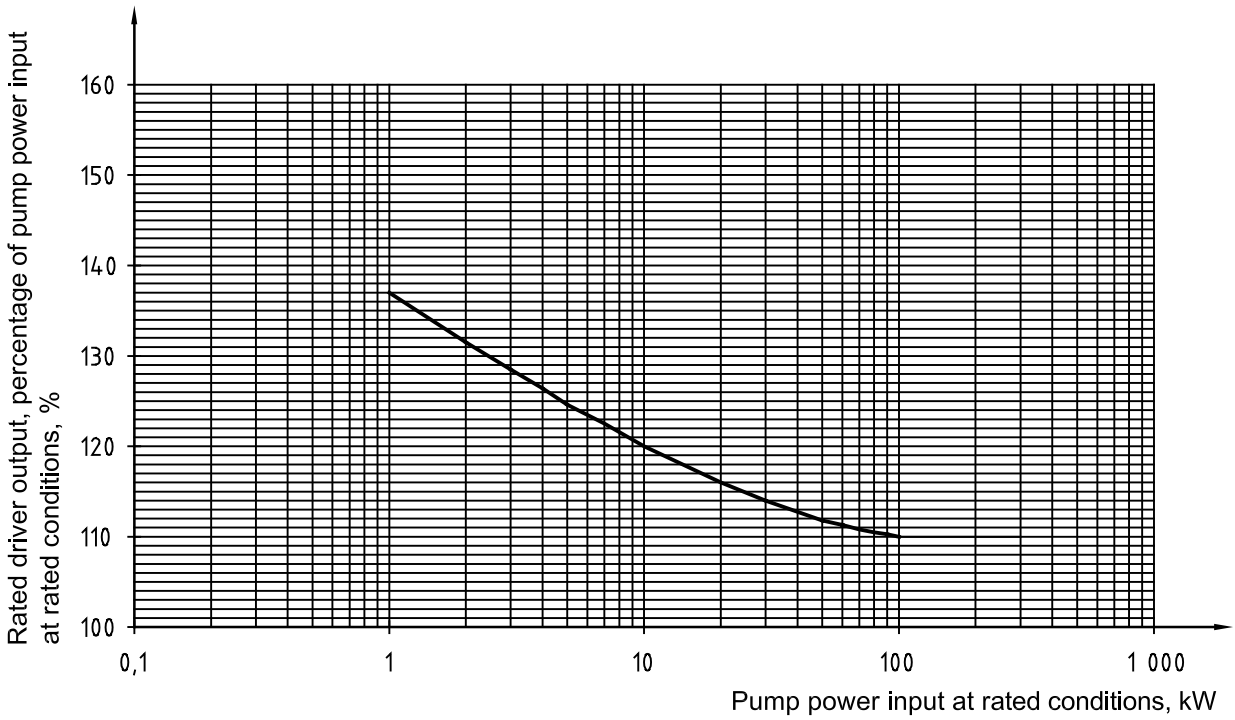


Figure 2 — Rated driver output, percentage of pump power input at rated conditions

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 some pump types (e.g. vertical line shaft and horizontal multistage), the first critical speed may be below the operating speed when agreed between the purchaser and manufacturer/supplier. Particular attention shall be paid when the pump is to be driven at variable speeds.

4.3.2 Balance and vibration

4.3.2.1 General

All major rotating components shall be balanced.

4.3.2.2 Horizontal pumps

Unfiltered vibration shall not exceed the vibration severity limits as given in Table 1 when measured on the manufacturer/suppliers test facilities.[1)] 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.

1) Refer to ISO 10816-3 for *in situ* tests only.

Table 1 — Maximum allowable vibration severity

Pump arrangement	Pump type	Maximum values of r.m.s. vibration velocity, mm/s	
		$h \leqslant 225$	$h > 225$
Pump with rigid support	horizontal pumps	3,0	4,5
Pump with flexible support	horizontal pumps	4,5	7,1
All	vertical pumps	7,1	

In Table 1, h is the centreline height of the pump, and a rigid support is one where the lowest natural frequency of the combined machine and support system in the direction of measurement is at least 25 % higher than the rotational frequency. Any other support is considered flexible.

The manufacturer/supplier shall determine the grade of balancing required in order to achieve acceptable vibration levels within the limits specified in this International Standard.

NOTE For information, this can normally be achieved by balancing in accordance with grade G6.3 of ISO 1940-1.

The filtered values for rotating frequency and blade passing frequency may be expected to be lower than given in Table 1.

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

4.3.2.3 Vertical pumps

Vibration readings shall be taken on the top flange of the driver mounting on vertical pumps with rigid couplings, and near to the top pump bearing on vertical pumps with flexible couplings.

Vibration limits for both rolling and sleeve bearing pumps shall not exceed the vibration severity limits as given in Table 1 when measured on the manufacturer/suppliers test facilities at rated speed (± 5 %) and rated flow (± 5 %) operating without cavitation.

4.4 Pressure-containing parts

4.4.1 Pressure/temperature rating

The maximum allowable working pressure of the pump at the most severe operating conditions shall be clearly defined by the manufacturer. In no case shall the maximum allowable working pressure of the pump (casing and cover including shaft seal housing and gland follower/end plate) exceed that of the pump flanges (also see 4.5.2).

For pumps complying to ISO 2858 the following shall apply:

a) the basic design pressure of the pump shall be at least a gauge pressure of 16 bar at 20 °C when made of cast iron, ductile iron, carbon steel or stainless steel;

b) for materials the tensile requirements of which do not permit the 16 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.

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 pressure at the operating temperature.