



DPC: 25/30480942 DC

BSI Group Headquarters

389 Chiswick High Road London W4 4AL

Tel: +44 (0)20 8996 9000

Fax: +44 (0)20 8996 7400

www.bsigroup.com

Date: 15 April 2025

Origin: European

Latest date for receipt of comments: 08 June 2025

Project No. 2023/02305

Responsible committee: MCE/6 Pumps and pump testing

Interested committees:

Title: Draft BS EN ISO 15783 BS ISO 15783 Seal-less rotodynamic pumps. Class II. Specification.

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Responsible Committee Secretary: Ms Katherine Imbert (BSI)
Direct tel: 0208 996 6450
E-mail: katherine.imbert@bsigroup.com

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

Submission of Comments

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- All comments should be submitted online at <https://standardsdevelopment.bsigroup.com/>. You will need to register in order to comment.

Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



DRAFT International Standard

ISO/DIS 15783

Seal-less rotodynamic pumps — Class II — Specification

*Pompes rotodynamiques sans dispositif d'étanchéité d'arbre —
Classe II — Spécifications*

ICS: 23.080

ISO/TC 115/SC 1

Secretariat: **BSI**

Voting begins on:
2025-04-15

Voting terminates on:
2025-07-08

This document is circulated as received from the committee secretariat.

ISO/CEN PARALLEL PROCESSING

Reference number
ISO/DIS 15783:2025(en)

Full document details: 25/30480942 DC

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CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document 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 15783:2002), which has been technically revised.

The main changes compared to the previous edition are as follows:

- Normative references were extensively revised. Some references have been updated.
- Liquid properties were added in [4.2.1](#).
- Definition of rigid support added in Note of [table 1](#).
- The following description added in [6.3.1.2](#)
- [Annex F](#) was extensively revised. Hastelloy alloy was also added to Table F1.
- [4.13.1](#) and [4.13.3](#) paragraphs were added to informative [Annex G](#);
- Bibliography was extensively revised.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This International Standard is the first of a series dealing with technical specifications for seal-less pumps; they correspond to two classes of technical specifications, Classes I and II, of which Class I is the more severe requirements.

Where a decision may be required by the purchaser, or agreement is required between the purchaser and manufacturer/supplier, the relevant text is highlighted with * and is listed in [annex G](#).

Seal-less rotodynamic pumps — Class II — Specification

1 Scope

1.1 This International Standard specifies the requirements for seal-less rotodynamic pumps that are driven with permanent magnet coupling (magnet drive pumps) or with canned motor, and which are mainly used in chemical processes, water treatment and petrochemical industries. Their use can be dictated by space, noise, environment or safety regulations.

Seal-less pumps are pumps where an inner rotor is completely contained in a pressure vessel holding the pumped fluid. The pressure vessel or primary containment device is sealed by static seals such as gaskets or O-rings.

1.2 Pumps will normally to recognized standard specifications (e.g. ISO 5199, explosion protection, electromagnetic compatibility), except where special requirements are specified herein.

1.3 This International Standard includes design features concerned with installation, maintenance and operational safety of the pumps, and defines those items to be agreed upon between the purchaser and manufacturer/supplier.

1.4 Where conformity to this International Standard has been requested and calls for a specific design feature, alternative designs may be offered providing that they satisfy the intent of this International Standard and they are described in detail. Pumps which do not conform with all requirements of this International Standard may also be offered providing that the deviations are fully identified and described.

Whenever documents include contradictory requirements, they should be applied in the following sequence of priority:

- a) purchase order (or inquiry, if no order placed), see [annexes C](#) and [D](#);
- b) data sheet (see [annex A](#)) or technical sheet or specification;
- c) this International Standard;
- d) other standards.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 76, *Rolling bearings — Static load ratings*

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

ISO 3274¹⁾, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Nominal characteristics of contact (stylus) instruments*

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

1) This standard will be replaced by ISO/FDIS 25178-601

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

ISO 5199, *Technical specifications for centrifugal pumps — Class II*

ISO 7005-1, *Pipe flanges — Part 1: Steel flanges for industrial and general service piping systems*

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, 2 and 3*

IEC 60034-1, *Rotating electrical machines — Part 1: Rating and performance*

EN 12162, *Liquid pumps — Safety requirements — Procedure for hydrostatic testing*

3 Terms and definitions

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

3.1

Magnetic drive pump

MDP

pump in which the shaft power of the drive is transferred to the impeller of the pump by means of a permanent magnetic field, which passes through a containment barrier (shell) to an inner rotor having permanent magnets or an induction device.

3.2

Canned motor pump

CMP

pump in which the stator of an electric motor is separated from the rotor by a sealed containment barrier (liner).

Note 1 to entry: The rotor runs in the liquid being pumped or in another liquid.

Note 2 to entry: The shaft power is transmitted by means of an electromagnetic field.

3.3

Seal-less rotodynamic pump

<general> pump design in which the impeller shaft also carries the rotor of either a canned induction motor or a synchronous or an asynchronous magnetic drive.

Note 1 to entry: The design does not use a dynamic shaft seal as a primary containment device. Static seals are the means used for containing the fluid.

3.3.1

Hydraulic end

that end of the pump which transfers mechanical energy into the liquid being pumped.

3.3.2

Power drive end

that end of the pump containing the magnetic coupling (MDP) or the motor (CMP) which provides the mechanical energy necessary for the operation of the hydraulic end.

3.3.3

Lubrication and cooling flow

flow necessary in a magnetic drive in the area between the inner magnet and the containment shell, or in a canned motor between the rotor and the sleeve, for dissipation of the heat due to inherent eddy current losses in metallic containment shells and frictional heat generation from bearings, and for lubrication.

Note 1 to entry: Internal pump bearings are lubricated and cooled by the pumped fluid or an external, compatible flushing fluid.

3.3.4

Close coupled

<MDP> coupling arrangement in which the motor is supplied with a flange adapter which mounts directly onto the casing or body of the pump and in which the outer magnet ring is mounted onto the motor shaft.

3.3.5

Separately coupled

<MDP> arrangement in which the motor and pump have separate mounting arrangements with the outer magnet ring mounted on its own shaft, supported by rolling bearings, and connected to the motor shaft by means of a flexible coupling.

3.3.6

Air gap

<MDP> radial distance between the inner diameter (ID) of the outer magnet assembly and the outer diameter (OD) of the containment shell.

3.3.7

liquid gap

<MDP> radial distance between the ID of the shell and the OD of the rotor sheath.

3.3.8

liquid gap

<CMP> radial distance between the ID of the liner and the OD of the rotor sheath.

3.3.9

total gap

magnetic gap

>MDP< radial distance between the ID of the outer magnets and the OD of the inner magnets/torque ring.

3.3.10

total gap

Canned motor pump

<CMP> total distance between the ID of the stator laminations and the OD of the rotor lamination.

3.3.11

radial load

<MDP and CMP> load perpendicular to the pump shaft and drive shaft due to unbalanced hydraulic loading on the impeller, mechanical and magnetic rotor unbalance, rotor assembly weight, and forces of the fluid circulating through the drive.

3.3.12

axial load

<MDP> load in line with the pump shaft caused by hydraulic forces acting on the impeller shrouds and inner magnet assembly.

3.3.13

axial load

<CMP> load in line with the pump shaft caused by hydraulic forces acting on the impeller shrouds and rotor.

3.3.14

hydraulic load balance

axial load equalization by means of an impeller design, impeller balance holes or vanes, or by balancing through variable orifices in the drive section and hydraulics.

3.4

starting torque

maximum net torque transmitted to the driven components during a hard (full voltage) start-up of the unit.

Note 1 to entry: It is affected by the inertia of the pump and motor rotors, the starting torque capacity of the motor and the power versus speed requirements of the liquid end.

3.5

break-out torque

torque load applied to the drive shaft with the rotor locked at the point at which magnetic decoupling occurs.

3.6

locked rotor torque

maximum torque that a motor will develop when prevented from turning.

3.7

magnetic coupling

device which transmits torque through the use of magnet(s) attached to the drive and driven shafts.

3.8

inner magnet ring

rows of magnets operating within the containment shell, driven by the outer magnet ring.

Note 1 to entry: The inner magnet ring is mounted on the same rotating element as the pump impeller.

3.9

outer magnet ring

rows of permanent magnets securely fixed to a carrier, evenly spaced to provide a uniform magnetic field.

Note 1 to entry: outer magnet ring, while rotating, transmits power through a containment shell, driving the inner magnet ring or torque ring.

3.10

Eddy currents

3.10.1

eddy current drive

asynchronous magnetic coupling consisting of a permanent outer magnet ring and an inner torque ring containing a network of conductive rods supported on a mild steel core.

Note 1 to entry: The rotating outer magnet ring generates eddy currents in the copper rods which convert the core to an electromagnet. The electromagnet follows the rotating outer magnet ring but at a slightly slower speed due to slip.

3.10.2

eddy current loss

power loss resulting from eddy currents.

Note 1 to entry: The energy in these eddy currents is normally dissipated as heat due to the electrical resistance of the material.

3.10.3

torque ring

laminations and conductors mounted on the rotor in which electric currents are induced in an eddy current drive.

3.10.4
decouple

failure of a synchronous magnetic coupling to rotate synchronously, or the stall condition of an eddy current drive.

3.10.5
slip

speed differential between the torque ring and outer magnet ring in an eddy current drive pump or between the running speed and the synchronous speed in a CMP.

3.10.6
demagnetization

permanent loss of magnetic attraction due to temperature or modification of the field.

3.11
Containment

3.11.1
sheath

thin-walled hermetically sealed enclosure fitted to the inner rotor enclosing the inner magnet ring (MDP) or rotor laminations (CMP).

Note 1 to entry: See [Figures 1](#) and [2](#).

3.11.2
shell

hermetically sealed enclosure fitted within the total-gap between the inner and outer magnet rings of an MDP and which provides for the primary containment of the pumped liquid.

Note 1 to entry: See [Figure 2](#).

3.11.3
liner

hermetically sealed enclosure fitted to the ID of the stator assembly of a CMP and providing for the primary containment of the pumped liquid.

Note 1 to entry: See [Figure 1](#).

3.11.4
secondary containment

backup pressure-containing system using static seals only to contain leakage in the event of failure of the primary containment by shell or by liner, and including provisions to indicate a failure of the containment shell or liner.

3.11.5
drive shaft

<MDP> outer shaft of the magnetic drive coupling.

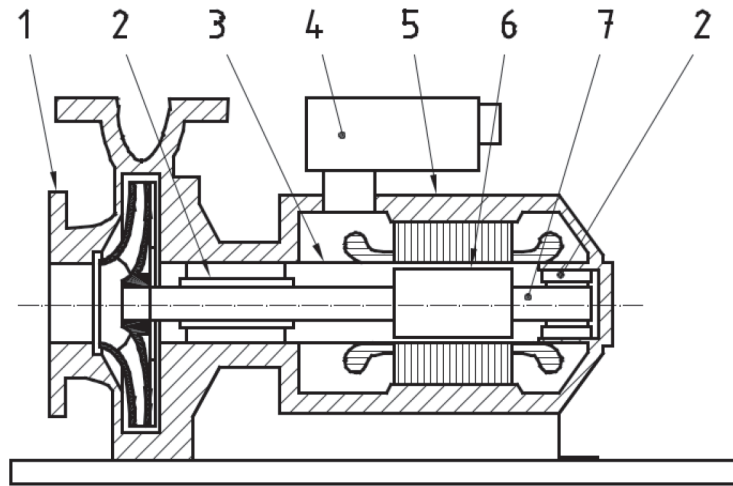
3.11.6
secondary control

minimization of release of pumped liquid in the event of failure of the containment shell or stator liner

3.11.7
secondary control system

combination of devices (including, for example, a secondary pressure casing, a mechanical seal) that, in the event of leakage from the containment shell or stator liner, minimizes and safely directs the release of pumped liquid.

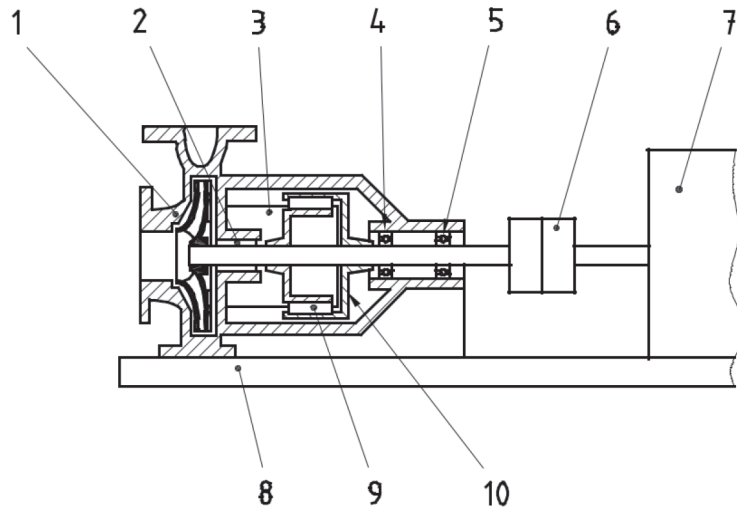
Note 1 to entry: It includes provision(s) to indicate a failure of the containment shell or liner.



Key

- | | | | |
|---|---------------|---|-----------------|
| 1 | hydraulic end | 5 | stator assembly |
| 2 | bearing | 6 | rotor sheath |
| 3 | liner | 7 | rotor |
| 4 | terminal box | | |

Figure 1 — Example of a canned motor pump (CMP)



Key

- | | | | |
|---|-----------------|----|---------------------------|
| 1 | hydraulic end | 6 | coupling |
| 2 | bearing | 7 | prime mover |
| 3 | shell | 8 | baseplate |
| 4 | bearing housing | 9 | sheath: inner magnet ring |
| 5 | rolling bearing | 10 | outer magnet ring |

Figure 2 — Example of a magnetic drive pump (MDP)

4 Design

4.1 General

4.1.1 Characteristic curve

The characteristic curve shall indicate the permitted operating range of the pump. Pumps should have a stable characteristic curve. In addition, the characteristic curves for the smallest and largest impeller diameters shall also be shown.

Minimum and maximum continuous stable flows at which the pump can operate without exceeding the noise, vibration and temperature limits imposed by this International Standard shall clearly be stated by the manufacturer/supplier.

4.1.2 Net Positive Suction Head (NPSH)

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

The manufacturer/supplier shall make available a typical curve as a function of flow for water. NPSHR curves shall be based upon a head drop of 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 not 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 or inlet velocity;
- the pumped liquid and temperature;
- the cavitation erosion resistance of the construction materials.

4.1.3 Outdoor installation

The pumps shall be suitable for outdoor installation under normal ambient conditions.

* Local regulations or extraordinary ambient conditions, such as high or low temperatures, corrosive environment, sandstorms, for which the pump is required to be suitable shall be specified by the purchaser.

4.2 Prime movers

4.2.1 General

The following shall be considered when determining the power/speed requirements of the pump.

- a) The application and method of operation of the pump. For example, in an installation intended for parallel operation, the possible performance range with only one pump in operation, taking into account the system characteristic.
- b) The position of the operating point on the pump characteristic curve.
- c) The circulation flow for lubrication of bearings and removal of heat losses (especially for pumps with low rates of flow).
- d) Properties of the pumped liquid (viscosity, solids content, density, specific heat, vapour pressure).

- e) Power loss, including slip loss through transmission (only magnet drive pumps).
- f) Atmospheric conditions at the pump site.
- g) Starting method of the pump:
 - if a pump (e.g., a stand-by pump) is started automatically then consideration shall be given to whether the pump may start against a closed valve, or whether the pump may start against an open valve or be pumping into an empty pipeline; i.e. operates within a pumping system in which the pump pressure is provided only for pipeline friction losses.
- h) For variable speed arrangements the minimum continuous speed shall be indicated by the manufacturer/supplier to ensure proper cooling and lubrication of the bearings.

Prime movers required as drivers for seal-less pumps covered by this International Standard shall have power output ratings at least equal to the percentage of rated power input given in [Figure 3](#), 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.

4.2.2 Magnetic drive pumps

When determining the permanent magnetic drive to be used, the following points shall be taken into consideration in addition to the points a) to h) listed under [4.2.1](#).

- a) The magnetic drive shall be selected for the allowed operating range with the selected impeller diameter at operating temperature and taking into consideration the characteristics of the liquid to be pumped.

* If the density of the liquid of the normal operation is below 1 000 kg/m³ special agreements between the manufacturer/supplier and purchaser for testing and cleaning shall be made.

- b) Heat generated by eddy current losses, power losses in the shell, power losses in the bearings and power losses due to liquid circulation shall be removed by pumped liquid or by supply of external cooling fluid.
- c) The magnetic material temperature shall be maintained at or below rated values for the material used. Magnetic materials should not be subject to irreversible losses.
- d) The irreversible magnetic losses at operating temperatures of the magnetic drive shall be considered.

Fluids containing magnetically attracted particles should be avoided unless such particles can be effectively removed.

Special arrangements may be provided to avoid formation of ice in air gaps when pumping cold liquids.

The magnetic drive shall be designed in such a manner that start-up will not cause the magnet assemblies to decouple.

4.2.3 Canned motor pumps

Canned motors are generally cooled by circulation of pumped liquid or by the use of coolant liquid to remove heat generated by the containment liner, eddy current losses, motor electrical losses and mechanical losses. Stator winding temperatures shall be maintained at or below values established for the grade of insulation used.

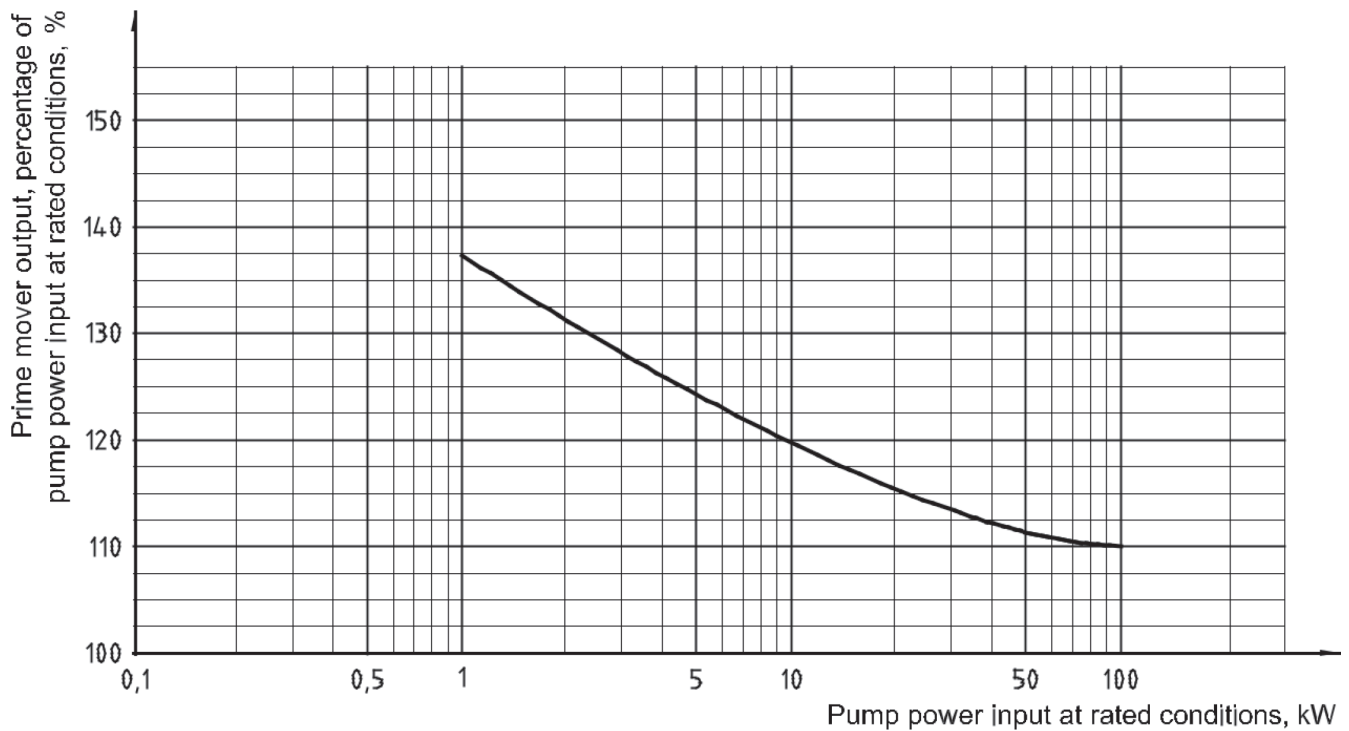


Figure 3 — Prime mover output, percentage of pump power input at rated conditions

When rating a canned motor, the conditions listed below shall be taken into consideration in addition to points a) to h) listed under [4.2.1](#):

- power losses within the canned rotor;
- power losses in the bearings;
- power losses due to liquid circulation;
- explosion protection requirements.

Manufacturers/suppliers shall specify external cooling requirements when required.

Stand-by units may require special arrangements for flushing and/or heating to prevent the settling out of solids, or the formation of ice, or solidification or too low viscosity of the liquid to be pumped.

* The details of such arrangements should be agreed upon between the purchaser and manufacturer/supplier.

4.3 Critical speed, balancing and vibrations

4.3.1 Critical speed

The critical speed shall be calculated with liquid.

* 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 to the critical speed when the pump is to be driven at variable speed.

4.3.2 Balancing 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's/supplier's test facilities²⁾. These values are measured radially at the bearing housing at a single operating point at rated speed ($\pm 5\%$) and rated flow ($\pm 5\%$) when operating without cavitation.

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 This can normally be achieved by balancing in accordance with a minimum of class G6.3 of ISO 21940-11

**Table 1 — Maximum allowable unfiltered vibration values
Values in millimetres per second (r.m.s)**

Pump arrangement	Pump type and criterion	
	Canned motor pump	Magnetic drive pump
Pump with rigid support centre-line height ≤ 225 mm	2,3	3,0
Pump with rigid support centre-line height > 225 mm	3,0	4,5
Pump with flexible support	3,0	4,5
NOTE 1 The values of vibration velocity filtered for rotating frequency and blade passing frequency can be expected to be lower than given in the table.		
NOTE 2 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.		

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](#) during shop test at rated speed ($\pm 5\%$) and rated flow ($\pm 5\%$) operating without cavitation³⁾.

4.4 Pressure-containing parts

4.4.1 Primary containment

Containment of the pumped liquid shall be by means able to withstand the stresses derived from the maximum allowable working pressure and any dynamic effects of operation. The wetted materials shall be compatible with each other and the pumped liquid, and shall be dimensioned to give an adequate working life.

It is recognized that several effective methods are suitable for the design of pressure-containing parts. These may be based upon recognized national codes or upon other proven methods. To satisfy the acceptance criteria, each design method shall

— be a written procedure,

2) For *in situ* acceptance limits refer to ISO 20816-3.

3) For *in situ* acceptance limits refer to ISO 20816-3.

- recognize limits of material stresses,
- incorporate a checking stage,
- have been proven empirically or experimentally.

4.4.2 Secondary containment

Where containment of any leakage is considered to be desirable, the pump shall be provided with a secondary containment.

The secondary containment shall be designed to allow installation of a sensor by the purchaser to indicate change in status and either to shut-down the pump or to warn that attention and rectification is required. The secondary containment shall sustain this condition when exposed to the pumped liquid for a minimum of 48 h. It shall be capable of containment under the maximum allowable working pressure, temperature and any dynamic effects from operation.

4.4.3 Secondary control

Where the liquid is less hazardous, but uncontrolled leakage is unacceptable for environmental or personal comfort reasons, the pump shall be provided with a means to control leakage from the primary containment.

Secondary control shall provide a safe means to collect leakage from the primary containment and present it in a manner that will allow its safe disposal. The manufacturer/supplier shall define the maximum allowable working pressure and provide a disposal connection capable of discharging 20 % of the pump flow rate without this pressure being exceeded.

4.4.4 Pressure-temperature rating

The maximum allowable working pressure of the pump at the most severe operating conditions shall be clearly stated by the manufacturer/supplier. In no case shall the maximum allowable working pressure of the pump exceed the flange rating.

The basic design pressure of the pump shall be at least a gauge pressure of 16 bar at 20 °C when the tensile requirements of the material permit.

In the case of materials whose strength does not permit the basic design pressure for 16 bar rating at 20 °C, or where the pump is to be used at temperatures other than 20 °C, the pressure rating shall be adjusted according to the stress-temperature characteristics of the material and shall be clearly stated by the manufacturer/supplier.

The containment shell/liner shall be resistant to a pressure of 0,1 bar absolute and designed for a gauge pressure of 16 bar at 250 °C in the case of metallic materials, and to a vacuum of 0,5 bar absolute and a gauge pressure of 16 bar at 20 °C in the case of non-metallic materials.

4.4.5 Wall thickness

4.4.5.1 General

Pressure-containing parts, including containment shell/liner, shall be dimensioned so that they are capable of withstanding the allowable working pressure at working temperature without deformation which interferes with the safe operation of the pump. The test pressure shall not cause any permanent deformation in accordance with [6.3.1](#). The casing shall also be suitable for the hydrostatic test pressure (see [6.3.1](#)) at ambient temperature.

* The corrosion allowance for all pressure-containing parts, excluding the shell/liner, shall be agreed upon between the purchaser and manufacturer/supplier by consideration of corrosion rates for the liquids and materials involved.