
**Petroleum, petrochemical and natural gas
industries — Reciprocating positive
displacement pumps**

*Industries pétrolière, pétrochimique et du gaz naturel — Pompes
volumétriques alternatives*

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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 2.

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 document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 13710 was prepared by Technical Committee ISO/TC 115, *Pumps*, Subcommittee SC 3, *Installation and special application*, in collaboration with ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 6, *Processing equipment and systems*.

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Introduction

This International Standard was developed from API Std 674, 2nd edition, 1995, with the intent that the 3rd edition of API Std 674 will be the same as this International Standard.

Users of this International Standard should be aware that further or differing requirements may be needed for individual applications. This International Standard is not intended to inhibit a vendor from offering, or the purchaser from accepting, alternative equipment or engineering solutions for the individual application. This may be particularly appropriate where there is innovative or developing technology. Where an alternative is offered, the vendor should identify any variations from this International Standard and provide details.

This International Standard requires the purchaser to specify certain details and features.

A bullet (•) at the beginning of a paragraph indicates that either a decision is required or further information is to be provided by the purchaser. This information should be shown on data sheets or stated in the enquiry or purchase order (see examples in Annex D).

In this International Standard, where practical, US Customary (USC) units are included in brackets for information.

Annex A lists typical materials standards used in pumps.

Annex B contains a form in which are listed the vendor drawing and data requirements (VDDR).

Annex C specifies techniques for pulsation and vibration control.

Annex D contains typical data sheets.

Annex E describes pump system interaction and explains the differences between NPIP and NPSH.

Annex F contains an inspector's checklist.

Annex G specifies requirements for the lubrication system.

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Petroleum, petrochemical and natural gas industries — Reciprocating positive displacement pumps

1 Scope

This International Standard specifies requirements for reciprocating positive-displacement pumps and pump units for use in the petroleum, petrochemical and natural gas industries. It is applicable to both direct-acting and power-frame types.

This International Standard is not applicable to controlled-volume pumps and rotary pumps.

NOTE For controlled-volume pumps see API Std 675; for rotary pumps see API Std 676.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 7 (all parts), *Pipe threads where pressure-tight joints are made on the threads*

ISO 228-1, *Pipe threads where pressure-tight joints are not made on the threads — Part 1: Dimensions, tolerances and designation*

ISO 261, *ISO general-purpose metric screw threads — General plan*

ISO 262, *ISO general-purpose metric screw threads — Selected sizes for screws, bolts and nuts*

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

ISO 286-2, *ISO system of limits and fits — Part 2: Tables of standard tolerance grades and limit deviations for holes and shafts*

ISO 724, *ISO general-purpose metric screw threads — Basic dimensions*

ISO 965 (all parts), *ISO general-purpose metric screw threads — Tolerances*

ISO 1328-1, *Cylindrical gears — ISO system of accuracy — Part 1: Definitions and allowable values of deviations relevant to corresponding flanks of gear teeth*

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

ISO 3448, *Industrial liquid lubricants — ISO viscosity classification*

ISO 5753, *Rolling bearings — Radial internal clearance*

ISO 6708, *Pipework components — Definition and selection of DN (nominal size)*

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

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

ISO 8501-1, *Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness — Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings*

ISO 10438 (all parts), *Petroleum and natural gas industries — Lubrication, shaft-sealing and control-oil systems and auxiliaries*

ISO 13707, *Petroleum and natural gas industries — Reciprocating compressors*

ISO 15649, *Petroleum and natural gas industries — Piping*

IEC 60034 (all parts), *Rotating electrical machines*

IEC 60079 (all parts), *Electrical apparatus for explosive gas atmospheres*

EN 287 (all parts), *Qualification test of welders — Fusion welding¹⁾*

EN 288 (all parts), *Specification and approval of welding procedures for metallic materials*

EN 13445 (all parts), *Unfired pressure vessels*

ABMA 7, *Shaft and housing fits for metric radial ball and roller bearings (except tapered roller bearings) conforming to basic boundary plan²⁾*

AGMA 2015-1, *Accuracy classification system — Tangential measurements for cylindrical gears³⁾*

AGMA 6010, *Standard for spur, helical, herringbone, and bevel enclosed drives*

AGMA 6091, *Standard for gearmotor, shaft mounted and screw conveyor drives*

AGMA 9002, *Bores and keyways for flexible couplings (inch series)*

API Std 526, *Flanged steel pressure relief valves⁴⁾*

API Std 541, *Form-wound squirrel cage induction motors — 250 horsepower and larger*

API Std 546, *Brushless synchronous machines — 500 kVA and larger*

API Std 611, *General-purpose steam turbines for petroleum, chemical, and gas industry services*

API Std 677, *General-purpose gear units for petroleum, chemical and gas industry services*

API RP 686, *Machinery installation and installation design*

ASA S2.19, *Mechanical vibration — Balance quality requirements of rigid rotors — Part 1: Determination of permissible residual unbalance, including marine applications⁵⁾*

1) Comité Européen de Normalisation, 36, rue de Stassart, B-1050 Brussels, Belgium.

2) American Bearing Manufacturers Association, 2025 M Street, NW, Suite 800, Washington, DC 20036, USA.

3) American Gear Manufacturers Association, 1500 King Street, Suite 201, Alexandria, VA 22314, USA.

4) American Petroleum Institute, 1220 L Street NW, Washington, DC 20005-4070, USA.

5) Acoustical Society of America, 35 Pinelawn Road, Suite 114 East, Melville, NY 11747, USA.

ASME Boiler and pressure vessel code, Section V, *Non-destructive examination*⁶⁾

ASME Boiler and pressure vessel code, Section VIII, *Rules for construction of pressure vessels, division 1*

ASME Boiler and pressure vessel code, Section IX, *Welding and brazing qualifications*

ASME B1.1, *Unified inch screw threads, UN and UNR thread form*

ASME B16.1, *Cast iron pipe flanges and flanged fittings classes 25, 125 and 250*

ASME B16.5, *Pipe flanges and flanged fittings NPS 1/2 through NPS 24*

ASME B16.11, *Forged fittings socket welding and threaded*

ASME B16.42, *Ductile iron pipe flanges and flanged fittings classes 150 and 300*

ASME B16.47, *Large diameter steel flanges NPS 26 through NPS 60*

AWS D1.1, *Structural welding code — Steel*⁷⁾

DIN 910, *Heavy-duty hexagon head screw plugs*⁸⁾

HI 6.6, *Reciprocating pump tests*⁹⁾

HI 8.1-8.5, *Direct acting (steam) pumps — Nomenclature, definitions, applications, and operation*

IEEE 841, *Standard for the petroleum and chemical industry — Severe duty totally enclosed fan-cooled (TEFC) squirrel cage induction motors — up to and including 370 kW (500 hp)*¹⁰⁾

NACE MR0175, *Sulfide stress cracking resistant metallic materials for oilfield equipment*¹¹⁾

NFPA 70:2002, *National Electrical Code*¹²⁾

SSPC SP 6, *Surface preparation specification*¹³⁾

6) American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990, USA.

7) American Welding Society, 550 North LeJeune Road, Miami, FL 33136, USA.

8) Deutsches Institut für Normung E.V., Burggrafenstrasse 6, 10787 Berlin, Germany.

9) Hydraulics Institute, 9 Sylvan Way, Parsippany, NJ 07054, USA.

10) Institute of Electrical & Electronics Engineers, 445 Hoes Lane, Piscataway, NJ 08855-1331, USA.

11) National Association of Corrosion Engineers, 1440 South Creek Drive, Houston, TX 77084-4906, USA.

12) National Fire Protection Association, 1 Battery March Park, Quincy, MA 02269-9101, USA.

13) Society for Protective Coatings, 40 24th Street, 6th Floor, Pittsburgh, PA 15222-4643, USA.

3 Terms and definitions

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

**3.1
acoustical simulation**
process whereby the acoustical characteristics of fluids and the reciprocating-pump dynamic flow influence are modelled

**3.2
alarm point**
preset value of a measured parameter at which an alarm is activated to warn of a condition that requires corrective action

**3.3
anchor bolt**
bolt used to attach the mounting plate to the support structure

NOTE The support structure is usually a concrete foundation or steel structure.

cf. **hold-down bolt** (3.6)

**3.4
direct-acting pump**
reciprocating pump consisting of a piston-powered drive end connected directly to a liquid end to which power is directly transmitted by the action of the motive fluid on the piston

NOTE A direct-acting pump can use steam, air, or gas as the motive fluid.

**3.5
flammable liquid**
liquid that has a closed-cup flash point below 37,8 °C (100 °F), as determined by recommended test procedures and apparatus

NOTE Suitable test procedures are e.g. those set forth in NFPA 30.

**3.6
hold-down bolt
mounting bolt**
bolt that holds the equipment to the mounting plate

**3.7
inlet reference point**
position, upstream of any pulsation suppression device, at which the purchaser's connection is made

NOTE At the inlet reference point the specified inlet conditions, such as inlet pressure, inlet temperature and NPIP, apply.

**3.8
local**
<of a device> mounted on the equipment mounting plate

**3.9
maximum allowable speed**
highest speed at which the manufacturer's design permits continuous operation

cf. **speed** (3.40)

3.10**maximum allowable temperature**

maximum continuous liquid temperature permitted by the manufacturer's design when handling the specified liquid at the specified maximum operating pressure

3.11**maximum allowable working pressure****MAWP**

maximum continuous pressure permitted by the manufacturer's design when handling the specified liquid at the specified maximum operating temperature

3.12**maximum continuous speed**

highest speed at which the machine, as built and tested, is capable of continuous operation with the specified liquid at any of the specified operating conditions

cf. **speed** (3.40)

3.13**minimum allowable liquid temperature**

lowest liquid temperature permitted by the manufacturer's design

3.14**minimum allowable speed**

lowest operating speed at which the manufacturer's design permits continuous operation

cf. **speed** (3.40)

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3.15**mounting plate**

baseplate, skid or soleplate on which the equipment is mounted

NOTE See 7.4 for [mounting plate specifications](https://standards.iteh.ai/catalog/standards/sist/a11c692b-92fb-4de7-a0f5-14402bb62042/iso-13710-2004).

3.16**net positive inlet pressure****NPIP**

minimum instantaneous pressure determined at the pump inlet reference point during pulsating pressure, minus the vapour pressure of the liquid at the maximum operating temperature

3.17**net positive inlet pressure available****NPIPA**

NPIP determined by the vendor from the NPSHA and system data

3.18**net positive inlet pressure required****NPIPR**

minimum NPIP required by the pump to achieve the required performance with the specified liquid

3.19**NPIPR test**

running test conducted to validate the NPIPR

3.20**net positive suction head****NPSH**

total absolute suction pressure, determined at the underside of the mounting plate, minus the vapour pressure of the liquid

NOTE It is expressed as head of water, in metres (feet).

3.21

net positive suction head available

NPSHA

minimum value of NPSH determined to be available under any specified operating condition at the underside of the mounting plate, based on steady-state flow

NOTE NPSHA is a value provided by the purchaser which can be used by the supplier to calculate the NPIPA (see 3.17). NPSHA is a function only of the system upstream of the pump and the operating conditions, and is independent of pump design.

3.22

observed inspection [test]

inspection [test] for which the purchaser is notified of the timing, and the inspection [test] is performed as scheduled irrespective of whether the purchaser or purchaser's representative is present

3.23

panel

enclosure used to mount, display and protect gauges, switches and other instruments

3.24

performance test

running test conducted to confirm the pump's mechanical and volumetric efficiency

3.25

piston pump

reciprocating pump having a seal attached to the piston and moving within a cylinder

3.26

piston load

plunger load

force acting on one piston or plunger during any portion of the pumping cycle

3.27

plunger pump

reciprocating pump having a uniform-section plunger that moves in a static seal

3.28

power pump

reciprocating pump consisting of a power end and a liquid end connected by a frame or distance piece

NOTE 1 The power end of a power pump transmits energy from a rotating shaft to pistons or plungers by means of a crankshaft, connecting rods and crossheads.

NOTE 2 The liquid end of a power pump consists of the cylinders, the pistons or plungers, and the valves.

3.29

preliminary anticipated system acceleration head

estimated pressure change due to changes in fluid velocity in the piping system

NOTE This is an important factor in the application of reciprocating pumps because of the pulsating nature of the flow in the pump suction line. For additional information on acceleration heads, see Annex E.

3.30

pressure-containing part

part that acts as a barrier between process or motive liquid and the atmosphere

EXAMPLES Liquid cylinder, discharge manifold, suction manifold, stuffing box, cylinder plugs and covers (if in contact with process fluid), valve seats (if a portion is in contact with the atmosphere), power cylinder, gas cylinder head, valve chest, valve chest cover and heads.

3.31**pressure-limiting valve accumulation pressure**

pressure at which a pressure-limiting valve discharges the pump-rated flow

3.32**pressure-limiting valve set pressure**

pressure at which a pressure-limiting valve starts to release pressure

3.33**pressure-retaining part**

part whose failure would allow process or motive fluid to escape to the atmosphere

EXAMPLES Pressure-containing parts (3.30) and liquid and gas cylinder bolting, stuffing box bolting, gland bolting, glands, and covers that constrain plugs and valve stops, but not parts such as packing, gaskets, pistons, plungers, piston rings, rods, valves, seats (if completely surrounded by pressure-containing parts), and internal bolting.

3.34**pump efficiency****pump mechanical efficiency**

ratio of the pump's hydraulic power to its power input

3.35**purchaser**

issuer of the order and specification to the vendor

NOTE The purchaser can be the owner of the plant in which the equipment is to be installed or the owner's appointed agent.

3.36**rated flow**

total volume of liquid actually delivered per unit time at rated operating conditions, normalised to inlet conditions

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NOTE Rated flow includes liquid and any dissolved or entrained gases or solids specified.

3.37**remote**

<(of a control device)> located away from the equipment or console, typically in a control room

3.38**shutdown set point**

pre-set value of a measured parameter at which automatic or manual shutdown of the system or equipment is required

3.39**special tool**

tool that is not commercially available, e.g. from a catalogue

3.40**speed**

<(power pump)> number of revolutions of the crankshaft in a given unit of time.

NOTE It is expressed in revolutions per minute.

3.41**speed**

<(direct-acting pump)> number of strokes of the piston in a given unit of time.

NOTE It is expressed in strokes per minute.

**3.42
unit responsibility**

responsibility for coordinating the delivery and technical aspects of the equipment and all auxiliary systems included in the scope of the order

NOTE The technical aspects to be considered include but are not limited to such factors as the power requirements, speed, rotation, general arrangement, couplings, dynamics, noise, lubrication, sealing system, material test reports, instrumentation, piping, conformance to specifications and testing of components.

**3.43
vendor
supplier**

manufacturer or manufacturer's agent that is contractually responsible for the supply of the equipment

**3.44
volumetric efficiency**

ratio of the pump rated flow to the total piston or plunger displacements per unit time

NOTE Volumetric efficiency is normally expressed as a percentage.

**3.45
witnessed inspection [test]**

inspection [test] for which the purchaser is notified of the timing of the inspection [test] and a hold is placed on the inspection [test] until the purchaser or his representative is in attendance

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4 General

4.1 Units of measurement

Drawings and maintenance dimensions of pumps shall be in SI units or US Customary (USC) units. Use of SI units on the data sheets indicates that SI units shall be used. Use of USC units on the data sheets indicates that USC units shall be used. See Annex D for typical data sheets.

4.2 Subvendor control

The vendor who has unit responsibility shall ensure that all subvendors comply with the requirements of this International Standard.

5 Statutory requirements

The purchaser and the vendor shall mutually determine the measures that must be taken to comply with any governmental codes, regulations, ordinances or rules that are applicable to the equipment.

6 Basic design

6.1 General

6.1.1 The equipment (including auxiliaries, but excluding parts listed in Table 1, which are subject to wear and maintenance) covered by this International Standard shall be designed and constructed for a minimum service life of 20 years and at least 3 years of uninterrupted operation.

It is recognised that these requirements are design criteria, and that service or duty severity, misoperation or improper maintenance can result in a machine failing to meet these criteria.

The term “design” shall apply solely to parameters or features of the equipment supplied by the manufacturer. The term “design” should not be used in the purchaser's enquiry or specifications because it can create confusion in understanding the order.

Table 1 — Maintenance items

Item	Life (months)
Packings	4 to 12
Valves	9 to 24
Valve seats	9 to 24
Plungers	12 to 36
NOTE The actual life of these parts will depend on the liquid, the service conditions and the installation method.	

6.1.2 The vendor shall assume unit responsibility for all equipment and all auxiliary systems included in the scope of the order.

- **6.1.3** The purchaser shall specify the normal operating point and all other required operating points.

6.1.4 Equipment driven by fixed-speed induction motors shall be rated at the actual motor speed for the rated load condition.

- **6.1.5** Control of the sound pressure level (SPL) of all equipment supplied shall be a joint effort of the purchaser and the vendor having unit responsibility. The equipment supplied by the vendor shall conform to the maximum allowable sound pressure level specified. In order to determine compliance, the vendor shall provide both maximum sound pressure and sound power level data per octave band for the equipment.

6.1.6 Unless otherwise specified, the cooling water system or systems shall be designed for the conditions given in Table 2.

6.1.7 Provision shall be made for complete venting and draining of the pump and systems provided by the vendor.

6.1.8 Equipment shall be selected to run to the pressure-limiting valve accumulation pressure without suffering damage.

NOTE There might be insufficient driver power to operate under these conditions.

6.1.9 For direct-driven equipment, the equipment's maximum continuous operating speed shall be not less than 105 % of the rated speed for variable speed machines, and shall be equal to the rated speed for constant-speed drives.

6.1.10 For gear-driven equipment, the gearbox input shaft maximum continuous operating speed shall be not less than 105 % of the rated speed for variable speed machines and shall be equal to the rated speed for constant-speed drives.

6.1.11 The arrangement of the equipment, including piping and auxiliaries, shall be developed jointly by the purchaser and the vendor. The arrangement shall provide adequate clearance areas and safe access for operation and maintenance.