
**Cryogenic vessels — Pumps for
cryogenic service**

Réipients cryogéniques — Pompes pour service cryogénique

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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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](#)

The committee responsible for this document is ISO/TC 220, *Cryogenic vessels*.

This second edition cancels and replaces the first edition (ISO 24490:2005), which has been technically revised.

Cryogenic vessels — Pumps for cryogenic service

1 Scope

This International Standard specifies the minimum requirements for the design, manufacture and testing of pumps for cryogenic service.

This International Standard is applicable to centrifugal pumps. However, it can be applied to other types of cryogenic pumps (e.g. reciprocating pumps), where applicable.

This International Standard also gives guidance on the design of installations (see Annex A).

It does not specify requirements for operation or maintenance.

NOTE For cryogenic fluids, see ISO 21029-1, ISO 20421-1 and/or ISO 21009-1.

2 Normative references

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

ISO 5198, *Centrifugal, mixed flow and axial pumps — Code for hydraulic performance tests — Precision grade*

ISO 21010, *Cryogenic vessels — Gas/materials compatibility*

ISO 21028-1, *Cryogenic vessels — Toughness requirements for materials at cryogenic temperature — Part 1: Temperatures below $-80\text{ }^{\circ}\text{C}$*

ISO 21028-2, *Cryogenic vessels — Toughness requirements for materials at cryogenic temperature — Part 2: Temperatures between $-80\text{ }^{\circ}\text{C}$ and $-20\text{ }^{\circ}\text{C}$*

ISO 23208, *Cryogenic vessels — Cleanliness for cryogenic service*

3 Terms and definitions

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

3.1

nominal size

DN

alphanumeric designation of size for components of a pipework system, which is used for reference purposes

Note 1 to entry: It comprises the letters DN followed by a dimensionless whole number which is indirectly related to the physical size, in millimetres, of the bore or outside diameter of the end connections.

Note 2 to entry: The number following the letters DN does not represent a measurable value and is not to be used for calculation purposes except where specified in the relevant standard.

Note 3 to entry: In those standards which use the DN designation system, any relationship between DN and component dimensions is given, e.g. DN/OD or DN/ID.

[SOURCE: ISO 6708:1995, 2.1, modified]

3.2
nominal pressure
PN

alphanumeric designation used for reference purposes related to a combination of mechanical and dimensional characteristics of a component of a pipework system

Note 1 to entry: It comprises the letters PN followed by a dimensionless number equal to at least the maximum allowable pressure in bar.

Note 2 to entry: For a pump, PN can be different for inlet and outlet.

Note 3 to entry: For Europe, PN equals the design pressure (PS) as defined in the Pressure Equipment Directive (2014/68/EU).

3.3
specified minimum temperature
lowest temperature for which the pump is specified

3.4
duty point
performance point defined by pressure or head and volume or mass flow rate

3.5
net positive suction head
NPSH

inlet total head increased by the head (in flowing liquid) corresponding to the atmospheric pressure at the test location and decreased by the sum of the head corresponding to the vapour pressure of the pump liquid at the inlet temperature and the inlet impeller height

Note 1 to entry: See also ISO 5198:1987, Table 1.

4 Requirements for pumps

4.1 General

Cryogenic centrifugal pumps shall comply with appropriate general standards. The appropriate general standard(s) shall be subject to the particular circumstances and applicable regulations and should be agreed between the manufacturer and the purchaser.

NOTE Commonly used standards are, e.g. ISO 5199, ISO 13709 (ANSI/API 610) or EN 809.

In the event of conflict, the requirements of this International Standard shall take precedence over the general standards.

4.2 Materials

4.2.1 General

Materials of construction shall be selected taking into consideration that cryogenic pumps operate at low temperature, often in a damp environment, and at times with liquid oxygen or flammable fluids.

The minimum requirements given in [4.2.2](#), [4.2.3](#) and [4.2.4](#) shall apply.

4.2.2 Mechanical properties at low temperature

Metallic materials which are under stress at low temperature and which exhibit a ductile/brittle transition (such as ferritic steels) shall have minimum toughness values in accordance with ISO 21028-1 or ISO 21028-2 as appropriate.

Metallic materials which can be shown to have no ductile/brittle transition do not require impact testing.

Non-metallic materials are generally used only for seals or heat barriers. If such materials are to be used for structural parts, the stress levels and material impact values shall be shown to be acceptable for the intended use.

4.2.3 Corrosion resistance

Materials should be resistant to, or protected from, atmospheric corrosion. Where this is not achievable, a suitable corrosion allowance shall be considered.

4.2.4 Oxygen and oxidizing fluids compatibility

If the specified minimum service temperature is equal to or less than the boiling point of air or the pump is intended for oxygen service, the materials which are, or are likely to come, in contact with oxygen or oxygen-enriched air shall be oxygen-compatible in accordance with ISO 21010.

If the pump is employed for oxidizing cryogenic fluids, e.g. nitrous oxide, the requirements for oxygen compatibility should be taken into consideration.

In the case of nitrous oxide, the risk of decomposition shall also be considered.

Materials should be selected that minimize the potential for ignition and inhibit sustained combustion.

Suitable material properties are

- high ignition temperature,
- high thermal conductivity, and
- low heat of combustion.

[Table B.1](#) lists materials found through testing and operating experience to be particularly suitable for centrifugal cryogenic pumps in oxygen service. Materials other than those identified in [Table B.1](#) may be used but their selection shall be justified by specific testing or long-term experience in this application.

For (any) parts of the pump which are, or are likely to come, in contact with oxygen and which could be exposed to energy sources such as friction, aluminium or aluminium alloy including aluminium bronzes containing more than 2,5 % aluminium shall not be used. The use of aluminium or aluminium alloy for any other parts shall only be adopted after careful consideration.

Stainless steel shall not be used for exposed thin components. Exceptions allowed are seal bellows, trapped shims or gaskets and screw-locking devices of stationary parts where knowledge of past satisfactory performance is available. However, suitable alternative materials, e.g. nickel or nickel alloy, Monel^{®1)} and Inconel^{®1)}, should be considered.

NOTE Tin bronze has been found to be most suitable for the main “wetted” pump components. The most common aluminium bronzes, which typically contain between 6 % and 11 % aluminium, have relatively high heats of combustion and, if combustion occurs, are practically impossible to extinguish in an oxygen environment.

1) Monel[®] and Inconel[®] are the trademarks of products supplied by Special Metals Corporation, New Hartford, New York, U.S.A. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results.