International Standard

ISO 21012

Cryogenic vessels — Hoses

Récipients cryogéniques — Tuyaux flexibles

Third edition
2024-08

Reference number
ISO 21012:2024(en)

ISO copyright office
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

Contents

Page

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).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

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

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 220, *Cryogenic vessels*. in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 268, *Cryogenic vessels,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 21012:2018), which has been technically revised.

The main changes are as follows:

— Modification of the Scope;

— Modification of the normative references;

— Improvement of the link between requirements of materials (4.2) and addition of a new Annex E for materials;

— Explanations provided for austenitic stainless steel in pressure test (subclause 5.2.4).

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.

Cryogenic vessels — Hoses

1 Scope

This document specifies design, construction, type and production testing, and marking requirements for both non-insulated cryogenic flexible hoses and insulated vacuum jacketed hoses used for the transfer of cryogenic fluids within the following range of operating conditions:

— working temperature range: from −270 °C to +65 °C;

— nominal size (DN): from 10 to 100.

End fittings for mounting of any couplings are within the scope of this document, but the couplings are subject to 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 7369, *Pipework — Metal hoses and hose assemblies — Vocabulary*

ISO 10806, *Pipework — Fittings for corrugated metal hoses*

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

ISO 21028-1, *Cryogenic vessels — Toughness requirements for materials at cryogenic temperature — Part 1: Temperatures below -80 degrees °C*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 7369 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— IEC Electropedia: available at https://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

3.1
hose
flexible leak-tight inner tube of either corrugated metal, elastomer or plastic

3.2
braid
layer, or layers, of cylindrically woven wires covering the *hose* (3.1) and permanently attached to the flexible *hose assembly* (3.5) *end fitting* (3.4) with a ferrule, serving the function of restraining the flexible hose against elongation

3.3
protection coil
protection cover
outer coil or cover fitted to protect the main *hose* (3.1) and *braid* (3.2) against damage and abrasion

3.4
end fitting
fitting (of material compatible with material and product transferred) attached to each end of the *hose* (3.1) and *braid* (3.2) (when fitted)

3.5
hose assembly
hose (3.1) with end fittings (3.5) attached, complete with either *braid* (3.2) or other covering, or both, ready for service

3.6
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 that is indirectly related to the physical size, in millimetres, of the bore or outside diameter of the end connections.

[SOURCE: ISO 6708:1995, 2.1, modified — The second part of the definition was moved into a Note 1 to entry. The original Note 1 to entry was deleted.]

3.7
rated pressure
P_R
<of a hose> (3.1) lowest maximum allowable working pressure (MAWP) of any component of the hose at 20 °C

Note 1 to entry: See also 4.1.

3.8
rated minimum temperature
lowest temperature to which the *hose assembly* (3.5) is rated by the manufacturer and which is intended to be used for the transfer

3.9
working temperature range
highest and lowest temperature to which the *hose assembly* (3.5) is to be subjected

3.10
cyclic life
minimum number of complete cycles which, at the test conditions, the *hose assembly* (3.5) is designed to withstand without failure

4 General requirements

4.1 Design and construction

The test pressure used during tests (see Clause 5) shall be greater than or equal to 1,5 × the PR specified. In addition, the PR shall not be less than the maximum allowable pressure (PS) of the equipment to which it is to be used. A hose is typically made from corrugated metal, from strip steel. The corrugation may be parallel or helical. The maximum pressure in service shall be lower than or equal to the (PR), which is stamped on the hose assembly.

If elastomers or composites are used, additional requirements shall be applied in accordance with 5.3.2.2.

A braid is commonly fitted over the hose. This generally consists of woven wire in one or two layers in stainless steel, or a high strength copper alloy. It may have a cover that shall be compatible with the surroundings and with the conveyed fluid.

The design shall ensure that pressurization, or corrosion, between the inner tube and the outer braid or sheath is prevented.

End fittings shall be designed as a rigid seal to the ends of a hose to ensure:

— a tight fit to the hose;

— a strong joint between the braid, hose and end fitting to stabilize the hose against elongation at PR.

Fittings for corrugated metal hose assemblies may conform to ISO 10806 or other recognized standards.

An area for marking shall be provided on one of the end fittings or on an attachment.

All joining methods used in corrugated hose assemblies shall be qualified. Manual welds shall be in accordance with applicable standards.

A typical cryogenic hose assembly is shown in Annex A.

4.2 Materials

All materials shall be compatible with the fluid conveyed and shall be controlled by the manufacturer of the hose assembly by a specification ensuring control of chemical content and physical properties, and quality at least equivalent to an internationally recognized standard. Materials for the manufacture of corrugated metal hose assemblies shall be selected on the basis of their suitability for fabrication, e.g. cold forming and welding and for the conditions under which they shall be used. In addition, the following requirements shall be met:

— end connections and couplings shall be made of materials compatible with the other materials of the hose assembly;

— a material is compatible when it does not lead to any violent reaction (e.g. ignition) or any slow reaction with the conveyed gases, and permeability shall be appropriate for intended use;

— a test certificate providing the chemical content and physical property test results shall be provided with the hose assembly.

The materials used in a cryogenic hose assembly shall:

a) maintain sufficient ductility at the rated minimum temperature (as specified in ISO 21028-1);

b) be oxygen compatible, if specified for oxygen or nitrous oxide service (as specified in ISO 21010);

c) be solution annealed after formation for any austenitic stainless-steel hoses used in hydrogen service;

d) contain less than 65 % copper, in the alloy as well as the soldering materials, if it is specified for mixtures containing acetylene.

A list of acceptable materials is given in Annex E (Table E.1 for European materials, Table E.2 for non-European materials).

4.3 Cleanliness

Hose assemblies specified for all cryogenic fluids shall be cleaned in accordance with ISO 23208 to remove hydrocarbons, moisture, particles or other contaminations from inside the hose assembly.

4.4 Mechanical properties

4.4.1 Burst pressure

The burst pressure shall be at least three times the PR at ambient temperature. Failure shall occur only in the body of the hose and braid and not in their connections. See 5.3.3 for burst test.

4.4.2 Pressure cycles

Hose assemblies shall have a minimum cyclic life of 10 000 cycles when repeatedly pressurized from <1 bar to their PR in accordance with 5.3.1.

4.4.3 Bending test

Hose assemblies shall have a minimum cyclic life of 10 000 cycles when repeatedly flexed at their PR in accordance with 5.3.2.

This test is only required if the flexible hose is subject to multiple wide/significant moves when under pressure.

NOTE Actual life cycle of hose depends on actual operating conditions.

When it comes to bending tests, the test shall be done under specified operating conditions.

4.4.4 Resistance to abuse

Hose assemblies shall withstand a crushing test, simulating a person stepping on the hose assembly, in accordance with 5.2.6.

Hose assemblies shall have sufficient resistance to visible deterioration of the braid, such as broken braids and exposed hose, when they are dragged on the ground. For additional protection of the braid, a coil can be used.

4.4.5 Low temperature resistance

All components of the hose assemblies, which become cold during operation, shall retain their toughness at the lowest design temperature.

4.4.6 Leak tightness

Hose assemblies shall be leak-tight in accordance with 5.2.5.

4.4.7 Electrical properties

Hose assemblies specified for flammable products shall be electrically conducting from one end to the other (electric resistance less than 25 Ω).

5 Hose sample tests

5.1 General

The hose test samples shall be representative of production. In case of a connection breaking pre-programmed system, testing will be performed on flexible hoses without these connections. The hose sample test procedures shall include:

a) inspection and non-destructive tests:

— inspection: dimensions, cleanliness, material identification and marking;

— tests: pressure test, leak and crushing tests;

b) destructive tests:

— pressure cycling, bursting test, rolling bend cycling and examination of sectional cut.

The tests shall be recorded in a written report which shall be retained for 10 years after the last hose has been placed on the market.

Four sample hose assemblies (A, B, C and D) are necessary to perform the tests.

The tests and order of tests are summarized in Table 1. The numbers 1 to 5 give the order of the tests.

Table 1 — Testing scope and sequence

Tests	Hose sample			
	A	B	C	D
1) Non-destructive tests				
Documentation of materials	1	1	1	1
Dimensional check	1	1	1	1
Cleanliness check	1	1	1	1
Pressure test	1	1	1	1
Leak test	2	4	3	2
Crushing test		2	—	
2) Destructive tests				
Hydraulic pressure cycling	3	—	—	—
Rolling bend cycling (required if flexible hose is subject to multiple wide/significant moves when under pressure)	—	3	2	—
Hydraulic bursting test	4	5	—	3
Examination of a sectional cut	—	—	4	—

The hydraulic bursting test shall be carried out to qualify all DN hose assemblies.

When a hose assembly with a given DN and a given rated pressure, P_R, has been successfully sample tested, any hose assembly of the same type, having:

— a rated pressure P_R;

and

— a nominal diameter up to 1,25 DN

can be considered as approved, except each DN hose assembly shall be hydraulic burst tested.

A hose assembly is said to be of the same type when the design and its characteristics are similar to the tested hose. "Similar" is defined as having the same

— materials;

— welding method;

— type of corrugation (shape and method of manufacturing);

— method of joining (hose and end fitting);

— braid (type of braiding, i.e. calculated, according to diameters to obtain the same maximum tensile stress in each wire, same materials, same welding method).

Bend radius and minimum hose length for sample hose assemblies are defined in Annexes B and C.

Hose assemblies used for the crushing and destructive tests shall not be placed on the market.

5.2 Non-destructive tests and inspection

5.2.1 Documentation of materials

The materials, assembly methods, weld procedures and welder qualification for the manufacture of the hose assemblies shall be identified and recorded.

5.2.2 Dimensional check

The outside diameter and total length of hose assemblies shall be measured, as delivered, to check conformity with the drawings.

5.2.3 Cleanliness check

The hose assembly shall satisfy the requirements of ISO 23208.

5.2.4 Pressure test

All flexible hose assemblies shall be subjected to a hydraulic pressure test, at room temperature (20 ± 10) °C, equal to 1,5 × the PR. The pressure shall be held for a minimum of 3 min. There shall be no leaks. Under pressure, the overall length shall not increase by more than 3 %.

Where austenitic stainless steel comes into contact with water, the chloride content of the water and time of exposure shall be controlled so as to avoid stress corrosion cracking.

As an alternative to the hydraulic test, it is also permissible to perform a pneumatic test, at the same pressure, provided that the necessary safety precautions are met (e.g. perform the test in a cage).

5.2.5 Leak test

The hose assembly shall be leak tested by immersion in water and pressurized with gaseous nitrogen or air to the PR.

The pressure shall be maintained for a minimum of 5 min. There shall be no leaks detected (i.e. no release of bubbles of gas in water). This corresponds approximately to a leak rate of less than 10^{-4} Pa m^3/s.

Table 2 — Conversion factors

Pa m^3/s or Pa m^3 s^{-1}	mbar l/s or mbar l s^{-1}	mm Hg l/s or mm Hg l s^{-1} or Torr l/s or Torr l s^{-1}	µm Hg l/s or µm Hg l s^{-1}	atm STP atm cm^3/s or STP cm^3 s^{-1}	at cm^3/s or at cm^3 s^{-1} ft^3 (STP)/h	atm STP STP ft^3/h or STP ft^3 h^{-1}
10^{-4}	10^{-3}	$7{,}501 \times 10^{-4}$	$7{,}501 \times 10^{-1}$	$9{,}869 \times 10^{-4}$	$1{,}020 \times 10^{-3}$	$1{,}255 \times 10^{-4}$

Other methods of equivalent or greater accuracy may be used for standard hose assemblies. Hose assemblies specified for more stringent applications may have more stringent leak requirements (e.g. helium leak testing under pressure) when specified by the customer.

5.2.6 Crushing test

This test is only carried out for hose assemblies made without corrugated stainless steel.

This test shall be performed on hose assemblies to simulate risks of damage when walking on a hose. The hose assembly shall be held between two 200 mm × 200 mm rigid plates and a force of 1 000 N shall be applied 10 times at the same location in the middle of each flexible hose.