
**Cryogenic vessels — Large transportable
vacuum-insulated vessels —**

Part 2:
Operational requirements

*Réipients cryogéniques — Grands réipients transportables, isolés,
sous vide —*

Partie 2: Exigences de fonctionnement

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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.

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 20421-2 was prepared by Technical Committee ISO/TC 220, *Cryogenic vessels*.

ISO 20421 consists of the following parts, under the general title *Cryogenic vessels — Large transportable vacuum-insulated vessels*:

- *Part 1: Design, fabrication, inspection and tests*
- *Part 2: Operational requirements*

Introduction

Elements of this part of ISO 20421 support the requirements of the UN-Recommendations on the Transport of Dangerous Goods and other international, national or local requirements.

Large transportable cryogenic vessels are often partly equipped by the manufacturer, but may be installed or re-installed by another party, such as the operator or owner. For this reason some of the scope of this part of ISO 20421, which includes putting into service, inspection, filling, maintenance and emergency procedures, overlaps with ISO 20421-1.

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Cryogenic vessels — Large transportable vacuum-insulated vessels —

Part 2: Operational requirements

1 Scope

This part of ISO 20421 specifies operational requirements for large transportable vacuum-insulated cryogenic vessels of more than 1 000 l volume.

The scope includes putting into service, filling, withdrawal, transport within the location, storage, maintenance, periodic inspection and emergency procedures.

For the transport of these vessels by public road, rail, waterway, sea and air, additional requirements may apply; these are defined in specific regulations.

This part of ISO 20421 applies to vessels for cryogenic fluids as specified in ISO 20421-1. The additional requirements for flammable fluids are detailed in Clause 16.

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 20421-1, *Cryogenic vessels — Large transportable vacuum-insulated vessels — Part 1: Design, fabrication, inspection and tests*¹⁾

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

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

3 Terms and definitions

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

3.1

putting into service

operation by which a new vessel being used for the first time or an existing vessel being returned to service is prepared for use

1) To be published.

3.2 filling
operation by which a transportable vessel undergoes a prefill check, filling with a cryogenic fluid and an after-fill check

3.3 withdrawal
operation by which the product is taken from a vessel connected to the supply system

3.4 outdoor location
location outside of any building or structure and not enclosed by more than two walls or one wall if a roof is also present

3.5 underground location
area or room whose ground or floor is on all sides significantly lower than the adjacent ground surfaces

3.6 vessels
large transportable cryogenic vessel as defined in ISO 20421-1

3.7 competent person
trained and qualified person for the purpose mentioned in this document

3.8 enterprise
any person or company that has a legal duty of care

3.9 filler
any enterprise which loads cryogenic fluids into a cryogenic vessel

3.10 owner
enterprise that legally owns the cryogenic vessel

3.11 operator
any enterprise for filling, storage, transport and withdrawal of cryogenic product

4 Preliminaries before putting into service

4.1 General

Before putting into service, verification shall take place to ensure that the vessel is suitable for the intended service and that the marking, labelling and handover documents are complete.

4.2 Marking and labelling

4.2.1 Marking

Marking shall be in accordance with ISO 20421-1.

4.2.2 Labelling

For labelling the following shall be affixed:

- a) a flow sheet denoting operation;
- b) an unshortened identification of the fluid which is transported in accordance with the transport and substance regulations and its net mass in accordance with the documentation;
- c) danger labels in accordance with transport regulations;
- d) risk and safety phrases associated with the gas content;
- e) name of the owner;
- f) name of the operator;
- g) actual holding time for gases being transported;
- h) maximum permissible gross mass;
- i) unladen (tare) mass.

4.3 Handover documents

In addition to the manufacturer's documentation, where necessary the cryogenic vessel shall be accompanied by vessel specific documents and instructions for all items supplied covering the

- operation;
- auxiliary equipment;
- inspection records.

These documents shall be retained by the owner of the vessel.

The operator shall have appropriate instructions available. Such instructions may be attached to the vessel in a permanent manner, or carried by or available to the operator.

5 Personnel training

Only persons trained for the specific task shall be allowed to put into service, fill, handle, operate or maintain the vessel.

The training programme shall include

- normal procedures;
- product and hazard identification;
- safe operating limits;
- emergency procedures;
- physical and chemical properties of the vessel's content and their effects on the human body;
- personal protection;
- confined spaces entry, if applicable.

Training shall be repeated as necessary to ensure that personnel remain competent. A record should be maintained which details the training personnel have received.

6 General safety requirements

6.1 General

Before any operation the operator should ensure that all equipment is free from any obvious damage or defect which could affect its safe operation.

Marking and labelling shall not be removed or defaced.

Consideration should be given to the product properties and the use of appropriate personal protective equipment.

Parts under pressure shall be disconnected only if they have been previously depressurized.

Leaking valves or connections should be depressurized before rectification. When this is not possible, leaking valves under pressure shall be tightened using suitable tools and procedures.

Direct flame or direct intense heat shall never be used to raise the pressure or de-ice frozen components.

All surfaces which may come in contact with the product shall be clean for the intended service. For cleanliness requirements, see ISO 23208.

Outlets, seals and transfer hoses shall be checked to be clean, dry and free from contaminants and visible defects before connection.

Vessels and transfer hoses shall not be modified without proper authorization. It is recommended that the couplings be attached to the vessels and/or hoses in a manner that prevents unauthorized removal of the product couplings.

Operating valves should be opened and closed slowly.

6.2 Safety considerations

In all operations and training, the following safety considerations shall be taken into account.

- Small amounts of cryogenic fluids will produce large volumes of vaporized gas. Spillage of oxygen can result in an oxygen-enriched atmosphere, spillage of other cryogenic fluids can result in an oxygen-deficient atmosphere. Appropriate measures shall be taken for all these cases, e.g. ventilation.
- Because of the possibility of cold embrittlement, cryogenic fluids shall only be used in product systems with components which are suitable for low temperatures.
- Vaporizing cryogenic fluids produce gases that are heavier than air and can accumulate in lower areas (e.g. pits, trenches).
- Because of their extremely low temperatures, cryogenic fluids will produce cold burns when coming into contact with the skin. Cold burns can also be produced from contact with uninsulated equipment and piping.
- Oxygen enrichment due to liquefaction of ambient air can occur on the cold surfaces of uninsulated equipment which contains a fluid with a boiling point lower than that of oxygen.
- Consideration should be given to establishing proper safety distances during parking or product transfer.

7 Putting into service

This operation shall follow a written procedure and the results of the steps involved should be recorded (e.g. in a check list). Such lists should be retained by the operating company.

Vessels and accessories shall be visually checked for damage.

The following shall be verified.

- The vessel and accessories are appropriate for the intended service, comply with the flow-sheet and are appropriately marked and labelled; all labels shall be clearly displayed and appropriate for the product.
- A relief device with a set pressure not higher than the maximum allowable working pressure of the vessel is fitted. Pressure, size and installation shall comply with the documentation. Devices requiring approval shall be correctly stamped and matching certificates shall be available.
- All valves are operable.
- All required checks and tests have been carried out.

Ensure that the vessel and accessories are clean and compatible for the intended service; see ISO 23208 and ISO 21010.

The vessel should be purged with an appropriate gas until the gas emerging from the vessel is sufficiently dry and pure for the intended service.

The vessel shall be cooled down according to the manufacturer's recommendations. Steps shall be taken to avoid uncontrolled pressure rise due to rapid liquid vaporization. The cool-down gas chosen shall take into account the risk of solidification.

Measuring and controlling devices (level gauge, pressure gauge, etc.) shall be checked for correct operation and setting.

8 Location

The requirements listed in this clause are valid for storage and parking, as well as for other activities such as filling and withdrawal.

- Vessels shall be located in a suitable area such as in the open air or in a sufficiently ventilated enclosed area, away from sources of heat (welding source, open fire, etc.). Hot work shall be subject to appropriate safety measures. The area shall be kept appropriately clean and suitable access shall be provided.
- Adequate ventilation shall be provided. In locations at or above ground level, natural ventilation is generally sufficient, provided that the room is large enough or that the outdoor area is not closely surrounded by walls. In other circumstances, forced ventilation or other precautions shall be provided.
- Vessels should not be located underground. However, where this is unavoidable, relief device outlet(s) should be piped to a safe external venting point and the underground location shall have sufficient continuous ventilation to deal with product releases arising from normal operation.
- The floor of the designated trans-shipment area shall be level and strong enough to take the mass of the full transport unit. The vessel shall be located at a sufficient distance from the normal paths used by people or vehicles. Water accumulation in the vicinity of the vessel shall be avoided.
- For filling and withdrawing oxidizing liquids and cryogenic liquids colder than liquid nitrogen, the connections shall be located over a non-combustible surface, like concrete.
- Vessels and their components shall be protected against mechanical damage.

- In case of emergency, adequate means of escape shall be provided. Emergency exits shall be kept clear at all times.
- All doors/gates should be preferably outward opening and wide enough to provide an easy access and exit route for personnel.
- A vessel should only be left parked unattended in a location such that operation of the vessel relief devices will not constitute a hazard.
- The operating area should be clearly marked with appropriate warning signs. These may be displayed on the vessel.
- If vessels are indoors for extended periods (e.g. overnight or at weekends), appropriate ventilation or pressure-relief device outlets should be piped to a safe place. The vent pipe-work shall be designed in such a way as to ensure proper pressure relief of the vessel. The vent will also prevent the accumulation or blockage of rainwater by airborne material.
- Operation by unauthorized persons should be prevented, e.g. by locking the valve cabinet.

When large transportable vessels are temporarily used as static vessels, the requirements defined for static vessels shall be considered.

9 Transport

This clause refers to the transport of filled vessels. Additional requirements may apply for transport by public road, rail, waterway, sea and air.

Before transport, the vessels shall be examined for signs of damage or leaks, and valves shall be checked to ensure that they are operational and in the correct position.

Cryogenic vessels shall never be subjected to impacts or falls; these could damage the outer jacket or the suspension system of the inner vessel, causing loss of insulating properties. If any vessel is known to have been subjected to accidental impact or fall, this shall be reported to an appropriate competent person before further use.

Vehicles used for transport shall have well-ventilated cargo areas and shall have separate cargo and passenger compartments. Vessels should be transported in their correct position and shall be securely fixed by appropriate means.

The vessels shall be handled only by those means for which they are designed and equipped.

10 Filling

10.1 General

The following operations shall be carried out in accordance with a written procedure.

10.2 Prefill checks

Prior to filling, the filler shall examine the condition of the vessel as indicated in Table 1.

Table 1 — Prefill checks

	Acceptance criteria for filling
Data plate	Present, legible and in accordance with 4.2
Inspection date	Within required period
Product identification labels	Fitted, legible and for the correct product
Vessel, accessories, framework	No obvious signs of damage, corrosion, contamination, oil or grease; no unusual ice, which would indicate a defect
Valves	Operable
Safety relief devices	In place, free from ice and other visible obstructions
Filling couplings and transfer hoses	<ul style="list-style-type: none"> — Correct connection fitted for product, identified by the product identification label, and cap-fitted if required — Check for leakage and damage of hoses
Pressure gauge	Positive pressure in vessel

10.3 Preparations

The vehicle carrying the vessel shall be immobilized by an appropriate device.

Depending on the type of the cryogenic vessel, it may be filled to capacity either by volume or by mass, taking into account product density to the level for which the vessel is designed. The necessary measuring equipment shall be in good working order and within the calibration period, where required.

If there is no residual pressure in the vessel prior to filling, it should be purged to remove possible contaminants. For carbon dioxide vessels, only gaseous carbon dioxide should be used for purging.

If the vessel is warm, it should be cooled down according to the manufacturer's recommendations. Carbon dioxide vessels shall be pressurized to at least 5 bar with gaseous carbon dioxide before introducing liquid CO₂.

The purity of the residual product in the vessel shall be analysed and recorded where required by specification. Where the purity of the residual product is outside specification, the vessel should be purged until it meets specification.

The fill hose should be securely connected, purged and cooled down.

Where it is necessary, the pressure shall be reduced by venting to facilitate safe filling. For carbon dioxide the pressure shall not drop below 5 bar. Measures shall be taken to ensure that there is no unwanted backflow between the vessel and supply vessel.

10.4 After-fill check

The vessel mass or level of contents and pressure shall be checked and, where necessary, the vessel should be vented or drained to reach the values required by specification.

Where required by specification, the vessel contents shall be analysed and recorded.

The filler should check that all valves are in the correct position (open or closed) according to the instructions, that no unusual cold spots have developed and that valves, piping and fittings are free from leaks.

Where required (e.g. for portable tanks), the vessel shall be labelled with the holding time.

11 Product withdrawal

The operator shall check that the product and the pressure in the vessel are compatible with the supply system, that the correct hose couplings are fitted and that the nominal pressure of the withdrawal line is greater than the pressure developed by the withdrawal system, e.g. pumping system.

Before connecting the vessel for withdrawal, the operator shall check that no unwanted backflow from the vessel is possible and also that the liquid cannot become trapped without adequate pressure relief.

The vehicle carrying the vessel shall be immobilized by an appropriate device before connecting the hose.

Operating valves shall be returned to the appropriate position for transport unless otherwise instructed.

12 Change of service

Change of service shall only be authorized by the owner. This operation shall follow a written procedure and the results of the steps involved should be recorded. Such records should be retained. The procedure shall include the following.

- Check that the vessel, the pump, soft goods (i.e. seals, gaskets, etc.) and the accessories are designed for the intended service. Special attention shall be given to this point if the vessel is intended for oxidizing fluids.
- Depressurization, emptying and disconnecting the vessel shall be performed in accordance with Clause 13.
- Where it is suspected that the vessel may have been contaminated, it shall be cleaned by using a suitable cleaning procedure. Special attention shall be given to this point if the vessel is intended for oxidizing fluids.
- The vessel labelling, couplings and transfer hoses shall be changed appropriate to the new product.

If the vessel is intended for oxidizing fluids, the following additional requirements shall be considered.

- The vessel and all piping and accessories shall be purged with inert gas until the outlet temperature is at least close to ambient temperature. The purge gas inlet temperature shall never exceed the maximum operating temperature of 50 °C.
- It shall be verified by suitable methods that the vessel and all piping and accessories are clean for the intended service, see ISO 23208.
- Before the vessel is filled with an oxidizing fluid, a competent person shall verify that the procedure has been carried out correctly.

Thereafter, follow the procedure in Clause 7 before filling the vessel.

13 Taking out of service

This operation shall follow a written procedure and the results of the steps involved should be recorded. If the vessel is intended for further service, such records should be retained by the owner company.

The procedure shall include the following.

- Emptying of the vessel and depressurizing to a positive pressure no greater than 2 bar.
- Monitoring pressure and level gauge/mass, if necessary; verifying that no line is obstructed.
- Taking into account the properties of the product involved (e.g. solidification of CO₂).

If the vessel is intended to be taken into service again later, the following additional requirements shall be considered.

- Purging of the vessel and accessories with inert gas.
- If the vessel may be used for oxidizing fluids at a later time, the cleaning and hydrocarbon checking steps outlined in Clause 12 (necessary) should be applied when the vessel is taken out of service.
- If the vessel is to be transported or stored/parked, protective caps should be fitted on all transfer couplings.
- When in store, a slight positive pressure of dry inert gas should be maintained in the vessel and the vessel shall be labelled accordingly.

If the vessel is to be scrapped, it shall be purged necessarily with inert gas and labelled accordingly, product identification labels shall be removed and nameplates rendered unusable.

14 Maintenance and repair

Maintenance is required to ensure that the vessel remains in a safe, serviceable condition. The responsibility for its maintenance and repair shall be established between the contracting parties (e.g. owner and filler). Following maintenance, the vessel shall comply with the current approval documentation.

Maintenance generally comprises the following:

- checking the condition of the vessel, accessories and the external supporting structure;
- checking the operability of valves;
- minor repairs, e.g. changing of seals;
- cleaning external surfaces.

Maintenance operations shall only be carried out by personnel trained for the task.

IMPORTANT Before entering the inner vessel, all hazards related to confined spaces (e.g. oxygen enrichment/deficiency or flammability) shall have been considered and documented.

Equipment shall not be removed until the directly connected system has been depressurized or adequately isolated and depressurized.

Modifications in design, materials and equipment or repairs shall be approved by a competent person and the documentation updated accordingly (see ISO 20421-1).

Any leakage shall be rectified promptly and in a safe manner. Original approved spare parts should preferably be used. The suitability of the spare part shall be approved by a competent person.

Hot work (welding, soldering, heating, etc.) shall be carried out to an equivalent procedure (fabrication, qualification of personnel, testing, certification, etc.) as during manufacture. If at any time it is necessary to break the seal for adjustment of a pressure-relief valve, the valve shall be removed from service until it has been reset and sealed. Any adjustment of spring-loaded pressure-relief devices shall be made by the manufacturer or other companies having competent personnel and adequate facilities for the repair, adjustment, replacement and testing of such devices. Replacement of pressure-relief devices shall be carried out by trained personnel.

The organization making such adjustment shall attach a permanent tag with the setting, capacity and date to the pressure-relief valve.

Vessels shall be internally clean, dry and free from particulate matter, and vessels for oxidizing fluids shall be free from oil and grease (see ISO 20421-1).

15 Periodic inspection

The inspection shall be performed at intervals defined by the relevant regulation for transport by public road, rail, waterway, sea or air.

The following activities shall be performed.

- a) Equipment and safety device check. Reclosable pressure-relief devices shall be lift tested either in situ or off the vessel. Non-reclosable pressure-relief devices, where fitted, shall be checked for correct installation and rating. If satisfactory, they do not require replacement.
- b) Visual internal inspection. The visual internal inspection is not required. The vessel integrity may be checked by a leak test [(see d)] and measurement of the vacuum, if appropriate. Vacuum measurement should only be performed when the thermal performance is deficient as noted by vessel operation.
- c) Visual external inspection. Check for signs of damage or corrosion which may affect the integrity. Check content and legibility of data plate (see 4.2) and other markings.
- d) Leak test. A gas-leak test using an inert gas or the working medium at minimum of 25 % of the allowable working pressure shall be carried out.
- e) All other equipment shall be checked for satisfactory functioning.
- f) Traceability of inspection shall be ensured.(see ISO 20421-1).

NOTE For periodic inspection of cryogenic flexible hoses, see ISO 21012.

16 Additional requirements for flammable gases

16.1 General safety requirements (see also Clause 6)

16.1.1 General

Precautions shall be taken when approaching a leak as the product may ignite and produce a flame. Products such as hydrogen require specific care as the flame is invisible.

Care should be taken in the choice of personnel clothing, to protect as much as practical against static charges and flames. Electrically conductive footwear should be worn.

Fill/withdrawal connections shall be capped when not in use.

Spillage of flammable fluids can result in the risk of fire or explosion.

16.1.2 Electrical equipment

All product system and ancillary electrical equipment shall be in accordance with the requirements of the hazardous area classification in which it is being used.

In the classified area personnel shall not be permitted to carry sources of flame, or non-approved electrical equipment. Consideration shall be given to all electrical equipment, e.g. mobile phones and radio transmitters.

16.1.3 Grounding (earthing) system

All parts of the installation shall be bonded to ensure electrical continuity.

Major items of equipment (e.g. the vessel) shall be bonded directly to the earth point and shall not rely upon the piping as a means to earth during filling, discharging and maintenance.

For transfilling processes, equalization of the electrical potentials is necessary (resistance < 10 Ω).