

CRYOLOR ASIA PACIFIC PVT. LTD.
100 KM milestone, NH 45 (GST Road),
Village Kadmalaiputtur, Post Perumberkandigai
Taluk Madurantakam, 603 310, Tamil Nadu,
INDIA

☎+91-44-37578000

User handbook

Vessel identification	RVTA06 – RVTA77
Serial number	— — — — —
Reference	SC000010_0
Date	March 1st, 2013

1- TABLE OF CONTENTS

1. TABLE OF CONTENTS

2. INTRODUCTION

2.1 Forward - Bibliography

2.2 General

3. SAFETY TIPS

3.1 General

3.2 Specific safety instruction in oxygen use

3.3 Over-oxygenated atmosphere

3.4 Oxygen deficient atmosphere

3.5 Nitrogen and Argon

3.6 Extreme cold

3.7 Pressure hazard

4. DESCRIPTION

4.1 General

4.2 Tank

4.3 Control cabinet

5. TRANSPORT AND INSTALLATION

5.1 Sea and road transporting

5.2 Unloading the vessel

5.3 Inspecting upon reception

5.4 Handling and lifting

5.5 Selecting a implantation site

5.6 Preparing the plinth

5.7 Tank anchoring method

5.8 Connecting to application

6. OPERATION

- 6.1 Check prior to first fill and purging**
- 6.2 Initial vessel cool-down**
- 6.3 Filling while in service**
- 6.4 Feeding the customer's line**
- 6.5 Removal of vessel from service**

7. MAINTENANCE AND REPAIR

- 7.1 General**
- 7.2 Vacuum measuring**
- 7.3 Valves and safety valves repair**
- 7.4 Vessel burst discs (optional)**
- 7.5. Pressure regulator (Optional)**
- 7.6 Pressure - Level instruments**
- 7.7 Painting**

8. TROUBLESHOOTING

- 8.1 Pressure maintaining failure**
- 8.2 Abnormal pressure increase**

9. TECHNICAL DATA**10. TELEMETRY PARAMETER DATA****11. GUARANTEE****12. ANNEX**

- Spare parts**
- Flow diagram**
- Layout drawing**

2 – INTRODUCTION

2.1 Forward

This manual is limited to a proper utilization by personnel directly involved in the installation, operation and maintenance of cryogenic vessels and their annexed equipments manufactured by Cryolor.

When those instructions are followed, the equipment described below can be used safely and with maximum operating efficiency.

The advice and information provided in this manual shall raise your awareness concerning the risks which might occur and might result in material damages, physical injuries or even casualties.

This manual is not a training manual. It is not exhaustive, and you must always put your own experience and manage all situations with discernment and pragmatism.

This manual is to be used as a complement and does not substitute itself with the reference documents accepted by the professionals, nor to the recommendations resulting from your own safety instructions, or to the current international, national or local regulations.

It is responsibility for the purchaser of this equipment to properly inform the user of the precautions to take, and of the proper use of these cryogenic equipments and stored liquified gases. The safety instructions concerning the handling of liquified gases and of these equipments must be publicly displayed.

It is essential to understand and master the different points mentionned in this document.

If the instructions are not clear enough, please get in touch with your supplier for additional information.

It is strictly forbidden for unauthorized and untrained personnel to install or perform repair works on any cryogenic equipment.

CRYOLOR constantly works on improving its equipments, and subsequently reserves the right to alter them at any moment. The drawings as well as the descriptions in this user's manual shall thus not prevail.

This user's manual is available in several different languages.

In the case of a discussion regarding the content of this manual, only the French version will prevail.

The french version will be available upon request.

Bibliography: background documents to be consulted

- **ASME Section VIII Division-1**
- **European standard EN 13458-3 : Cryogenic vessels – Static vacuum insulated vessels**

Part 3 : Operational requirements**Contents:**

- Personnel training
- General safety requirements
- Installation
- Periodic inspection
- Putting into service and filling
- Taking out of service
- Maintenance and repair
- Additional requirements for flammable gases

- **EIGA (European Industrial Gases Association): Doc 127/04**

Bulk liquid oxygen, nitrogen and argon storage systems at production sites**Contents:**

- General properties about gases and requirements
- Installations designing
- Installations access
- Tests
- Use and maintenance
- Training and safety

- **Specification Cryolor : Safety instructions for the use of cryogenic vessels**

Complementary recommendations: booklet available upon request

- **European norm EN 12300 : Cryogenic vessels - Cleanliness**

2.2 General

This handbook was created to be used in conjunction with **Celine** vessels.

Because of the specific nature of the equipments, the products involved and the risk of accidents which may result from their improper use or maintenance, CRYOLOR recommends that this handbook be carefully read and understood by anyone operating the CRYOLOR cryogenic vessel.

However, this handbook assumes that the cryogenic vessel is for use by properly trained personnel, and is therefore not intended to serve as a training guide nor for a document for extensive repairs.

Conducting any repairs which are not detailed in this handbook may be hazardous to the correct functioning of the equipment and may jeopardize the safety of operators and those in contact with the equipment.

For all questions regarding maintenance of the equipment, please contact our customer assistance team at:

Tel N°: (33) 03 87 70 85 50

Fax N°: (33) 03 87 73 96 03

Following are the abbreviations used throughout this handbook:



WARNING: Description of a safety constraint that, if not respected, can result personal injury, death and/or materiel damage.



NOTE: A statement containing information important to remember or repeat.

3 – SAFETY TIPS

3.1 General

The objective of these general tips is to attract attention to the various hazards that are involved in the use of cryogenic equipment.

Certain conditions, such as over or under oxygenated environments, can be created when using the atmospheric gases such as oxygen, nitrogen, or argon, and can result in serious dangers. The main components of the air are, by volume, the following: Oxygen "O₂" 21%, Nitrogen "N₂" 78% and argon "Ar" 1%.

The atmospheric gases are non-toxic, but variations in their relative concentration, especially with oxygen, can have effects on life processes and combustion. In any case : make sure that the areas are ventilated well enough, especially in closed-in premises, use air and breathing safety measure and control accessories.

Once informed of the risks run and the precautions that must be taken, users of this equipment should be able to use these gases in with confidence and security.

3.2 Specific safety instruction in oxygen use

Industrial dust and dirt can be a combustion hazard, that is the reason why all surfaces on equipments must be kept very clean.

Do not install a vessel in oxygen use and its annexed equipment on asphalt or tar grounds. Do not leave any grease or oil stains on concrete plinths near equipments in oxygen use.

Use only cleaning products compatible with oxygen use which will not leave any organic layer on the surfaces cleaned.

All accessories in contact with liquified oxygen must be handled carefully (clean gloves, hands previously washed and oilfree...).

3.3 Over-oxygenated atmosphere

Oxygen reacts in some way with most materials. The rate and intensity of combustion depend in particular on the concentration, pressure and temperature of the elements present.

Sparks, which are of no danger in a normal atmosphere, are enough to ignite a fire. Materials that do not normally burn in air, such as fireproof material, can burn vigorously and spontaneously in an over-oxygenated atmosphere.



WARNING: Oxygen rich atmospheres considerably increase the risk of combustion.

Oils and greases are very dangerous in the presence of oxygen, and can ignite spontaneously and burn vigorously.



WARNING: Never use oils or greases that are not compatible with oxygen to lubricate equipment used in oxygen service.

Oxygen system components, including valve seats, and gaskets, must be degreased cleaned to ensure compatibility with oxygen service.

Easily ignitable materials must be avoided unless they are part of equipment that has been proved suitable by compatibility tests or experience.

The installations must be maintained in perfect clean condition, and only greases compatible with oxygen should be used if necessary.



WARNING: in the presence of an oxygenated environment:

- No smoking.
- No open flames or sparks.
- No combustible materials.

3.4 Oxygen deficient atmosphere

Oxygen is necessary to support life. Care must be taken to ensure that there is adequate ventilation when atmospheric gases are used. Following is a description of the effects on humans exposed to an oxygen deficient atmosphere.

▪ **Atmosphere containing 11 to 14% oxygen :**

Decrease in physical attentiveness and impaired judgment without the being conscious of the effects.

▪ **Atmosphere containing 8 to 11% oxygen :**

Possible unconsciousness after a certain exposure period without warning and without the person realizes.

▪ **Atmosphere containing 6 to 8% oxygen :**

Unconsciousness within a few minutes, resuscitation possible if the person is immediately moved to a normal atmosphere.

▪ **Atmosphere containing less than 6% oxygen :**

Immediate unconsciousness.



WARNING: Oxygen deficiency can quickly lead to reduced attentiveness, impaired judgement and asphyxiation that could cause serious brain lesions.

3.5 Nitrogen and Argon

Nitrogen and argon are inert, non-toxic, non-flammable, colorless, odorless non-corrosive, as asphyxiates on body; they can produce immediate hazards by diluting the concentration of oxygen in the air necessary to support life.



WARNING: Cannot be detected by our senses Nitrogen and argon will be inhaled normally as if they were air and can cause dizziness, nausea, unconsciousness, and even death.

Safe liquid nitrogen discharge:

Discharging very cold liquified nitrogen at the bottom of an installation can be very damageable especially for the plinths and the ground on safety lanes. Provision shall be made in order to avoid any damages by, for example, digging an outdoors well filled with clean sand or gravel. The liquified nitrogen will thus be able to evaporate quickly without any risks.

It is recommended to store vessels outside or in a well ventilated area.

Never enter in to an area containing nitrogen or argon without having taken the necessary precautions :

- Emptying of the area and verification of the concentration of the remaining gases.
- Use of respiratory devices.



NOTE: Immediately move asphyxiated persons to a well ventilated area with normal oxygen content.

First aid

If breathing is difficult, give oxygen. If breathing has stopped, call a physician and apply artificial respiration. Keep victim at rest.

3.6 Extreme cold

Cryogenic liquids are extremely cold with temperatures as low as -196°C . At this temperature, cryogenic liquid or cold boil-off gas may result in cryogenic burns similar to frostbite.



WARNING: Avoid all direct contact with cryogenic liquids, cold gas or cold pipework by using adequate protection (Safety goggles, face shield, long sleeved clothing, laced shoes, trousers and gloves). Wearing boots is strictly forbidden.

The extremely cold temperatures of Cryogenic liquids may also make certain materials, such as carbon steel, fragile enough to provoke ruptures.



WARNING: Avoid all impact or irregular disturbances of frosted materiel.

First Aid

If contact with cryogenic liquids or cold boil-off gas results in cryogenic burns, restore tissue to normal body temperature progressively by rinsing or soaking with lukewarm water. Nor should the frozen tissue be rubbed before or after warming. Protect the injured tissue from further damage and infection. If blistering or profound tissue freezing is apparent, promptly call a physician to examine the affected areas.

3.7 Pressure hazard

Cryolor Vertical Thermosiphon Tanks (RVT) can have a service pressure up to 17 bar.

Sudden release of this pressure may cause personal injury by issuing cold gas or liquid, or by expelling parts during servicing.



WARNING: Never modify the control cabinet without CRYOLOR's agreement.

Never perform maintenance or replace component(s) exposed to pressure or cryogenic liquid without first venting the vessel and returning it to ambient temperature. Be wary of projections of liquid near the vessels and especially at the level of safety valves.

Safety distances (in meters) :

Minimal distance from a tank to an equipment which enable to reduce the effects of a predictable incident and to avoid that a minor incident is transformed into a graver incident.

These distances do not guarantee a protection against catastrophic events or against important damages. For that purpose, set up the other appropriate means.

Type of exposure	Inert fluid	Oxidizing fluid Vessel capacity		Flammable fluid	
		<50 t	<200 t	L H ₂	Others
Site limits, carpark areas public highways / railways	3 m	5 m	8 m	8 m	5 m
Area where a bare flame, smoking or ignition sources are allowed	3 m	5 m	8 m	8 m	5 m
Combustible materials, for ex.: wood, including wooden buildings and structures	3 m	5 m	8 m	8 m	5 m
Wells, pipes, drains for day-mater, openings located below ground level	3 m	5 m	8 m	8 m	5 m
Offices, canteens and areas where staff might gather	3 m	5 m	8 m	15 m	5 m
Compressor / fan air inlets	3 m	5 m	8 m	15 m	5 m
Bulk stock of flammable liquids	3 m	5 m	8 m	8 m	5 m
Overhead electric system	-	-	-	10 m	10 m

4 – DESCRIPTION

4.1 General

The RVT (Vertical Thermosiphon Tank), **Celine** type, allow storage and deliverance (in process or in filling station) of liquefied nitrogen, oxygen and argon.

Each RVT appendix called thermosiphon is expected just for one pump feeding with principal subject as minimum lost of gases.



NOTE: In addition, consult also the section 9 « Technical data », the specific drawings of your material and the layout diagram (Section 12 – Annex).

4.2 Tank

The standard **Celine** (RVT) container is supported by three mounting legs made up of a stainless steel inner vessel surrounded by a vacuum evacuated and insulated outer vessel in carbon steel.

Perlite insulation under vacuum is used for **Celine** (RVT) containers. Permanently sealed at our works provides long-term vacuum integrity and longest holding time possible.

The inner vessel support system allows for free shrinkage during the vessel cool down (-196°C).

The inner vessel is thoroughly dehydrated using nitrogen moisture trap, dew point controlled and delivered with 0.3 bar of nitrogen or dry air.

A vacuum measuring and re-evacuation device allows connection of a vacuum gauge or pump. The recommended re-evacuation procedure and materiel are available according to specification N°914CH available upon demand.

Celine (RVT) containers are surface blasted and painted first with an anti-rust protection coat and then with a white finishing coat.

4.3 Control cabinet

Mounted ergonomically at the bottom of the vessel to facilitate operation and maintenance, the control cabinet of **Celine** (RVT) containers is made of the components allowing the main following functions:

- Liquid filling
- Liquid withdrawal for gaseous applications
- Liquid withdrawal for liquid applications
- Protection from over-pressurisation
- Venting
- Pressure maintaining
- Gas economiser
- Level and pressure measurement

Some functions are optional; refer to the flow diagram of your tank.

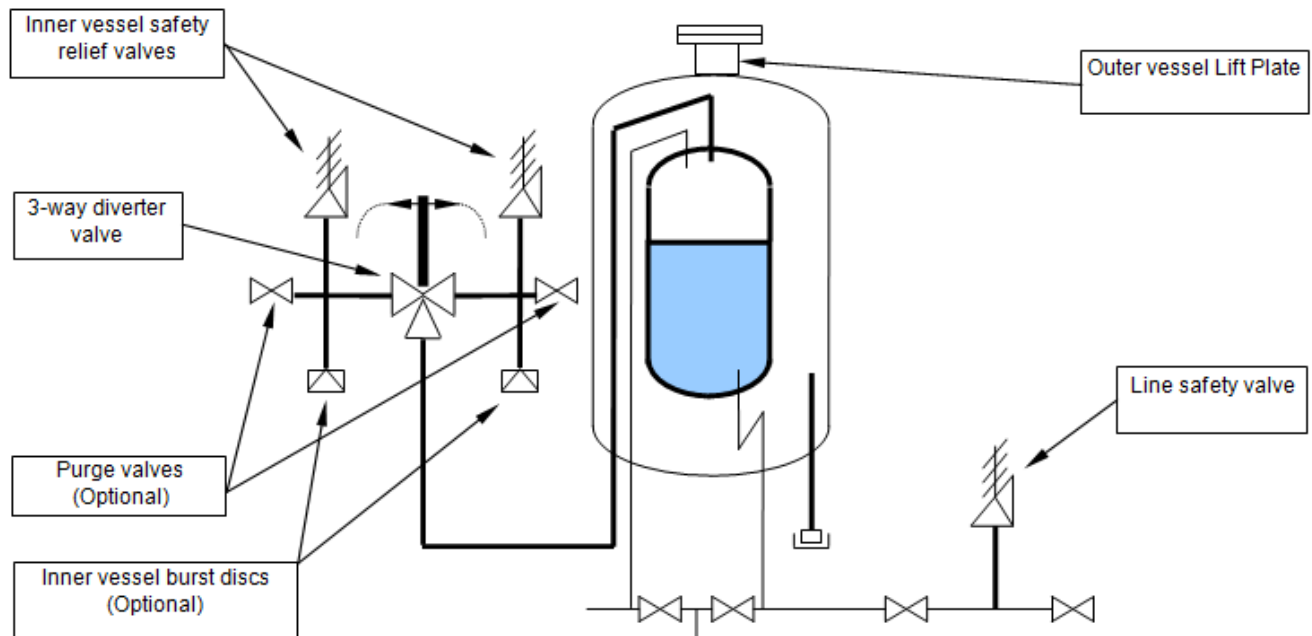


NOTE: The references of the elements which composed devices described below are detailed in the list of spare parts (Section 12 – Annex).

4.3.1 Safety devices

Celine (RVT) tanks are protected from over-pressurisation by several safety devices throughout the vessel.

Diagram – Safety devices



Inner vessel safety devices

Celine (RVT) tanks are protected from over-pressurisation by two safety relief valves, two rupture discs (optional), two purges (optional) and a three way diverter valve.

Depending on the position of the three-way diverter valve, the corresponding safety relief valve(s) and burst disc(s) are in operation (Diagram – Safety devices). The diverter valve also allows easy maintenance without interrupting the application.

When the vessel safety relief valve fails to evacuate the excess pressure and the pressure of the rupture disc setting is reached (optional), it will burst completely to relieve pressure.

Outer vessel safety devices

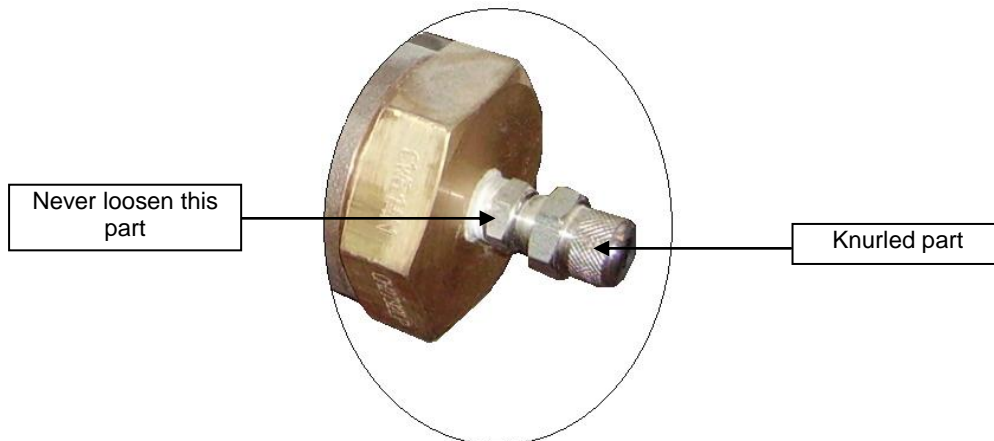
Celine (RVT) vacuum space is protected by one Lift Plate to prevent over pressurisation in the annular space in the case of leakage of cryogenic liquid (Diagram – Safety devices).



WARNING: To open the valves (optional), manually unscrew the thumbscrew (knurled part).

If difficulties, use two spanners.

Never loosen the screw in the three way diverter valve!



Safety Caution for LIFT PLATE :-



1. DO NOT TIGHTEN THE NUTS IN THE LIFT PLATE.
2. TIGHTENING OF THE NUT IN LIFT PLATE LEADS TO MALFUNCTIONING OF THE SAME WHICH MAY CAUSE A FATAL ACCIDENT..

Line safety valves

The pipes of the control cabinet of the **Celine** (RVT) tanks are protected from over-pressurisation by line safety relief valves as a result of liquid evaporation enclosed between two valves or check-valves (Diagram – Safety devices).

4.3.2 Pressure regulator line

The pressure regulator line (optional) has two automatic functions:

- To maintain the vessel working pressure.

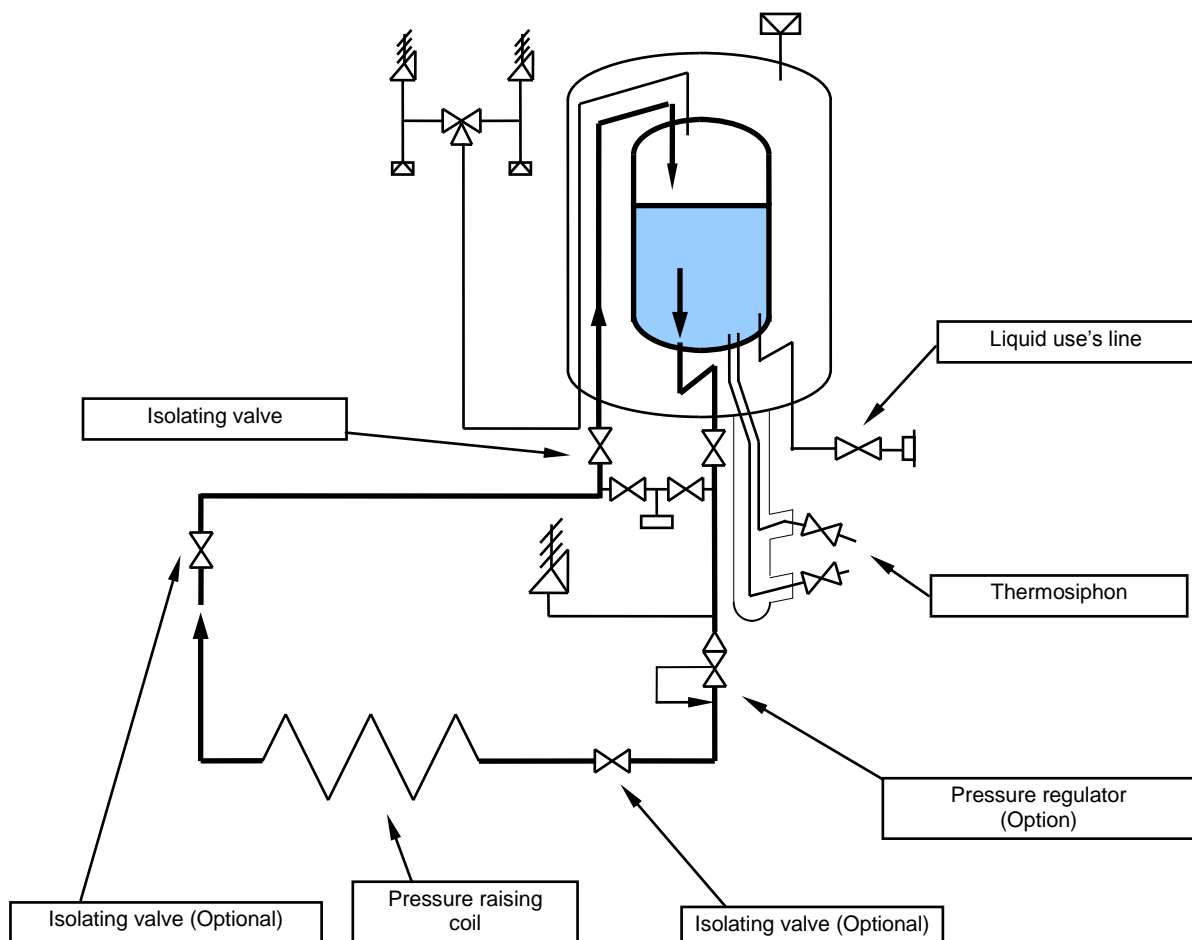
4.3.2.1 Pressure maintaining function

The first function of the regulator economiser is to ensure sufficient driving pressure during high withdrawal periods by controlling the liquid flow from the liquid phase (Diagram – Pressure maintaining function).

When the pressure vessel falls below the regulator setting, liquid is automatically supplied from the inner vessel to the pressure raising coil and vaporised. The expanding gas is fed back into the gaseous phase at the upper part of the vessel.

When the gas phase pressure returns to the regulator economiser setting, the unit automatically closes.

Diagram – Pressure maintaining function



4.3.2.2 Thermosiphon and liquid withdrawal line

The standard RVT (Diagram – Thermosiphon and liquid withdrawal line) is supplied with :

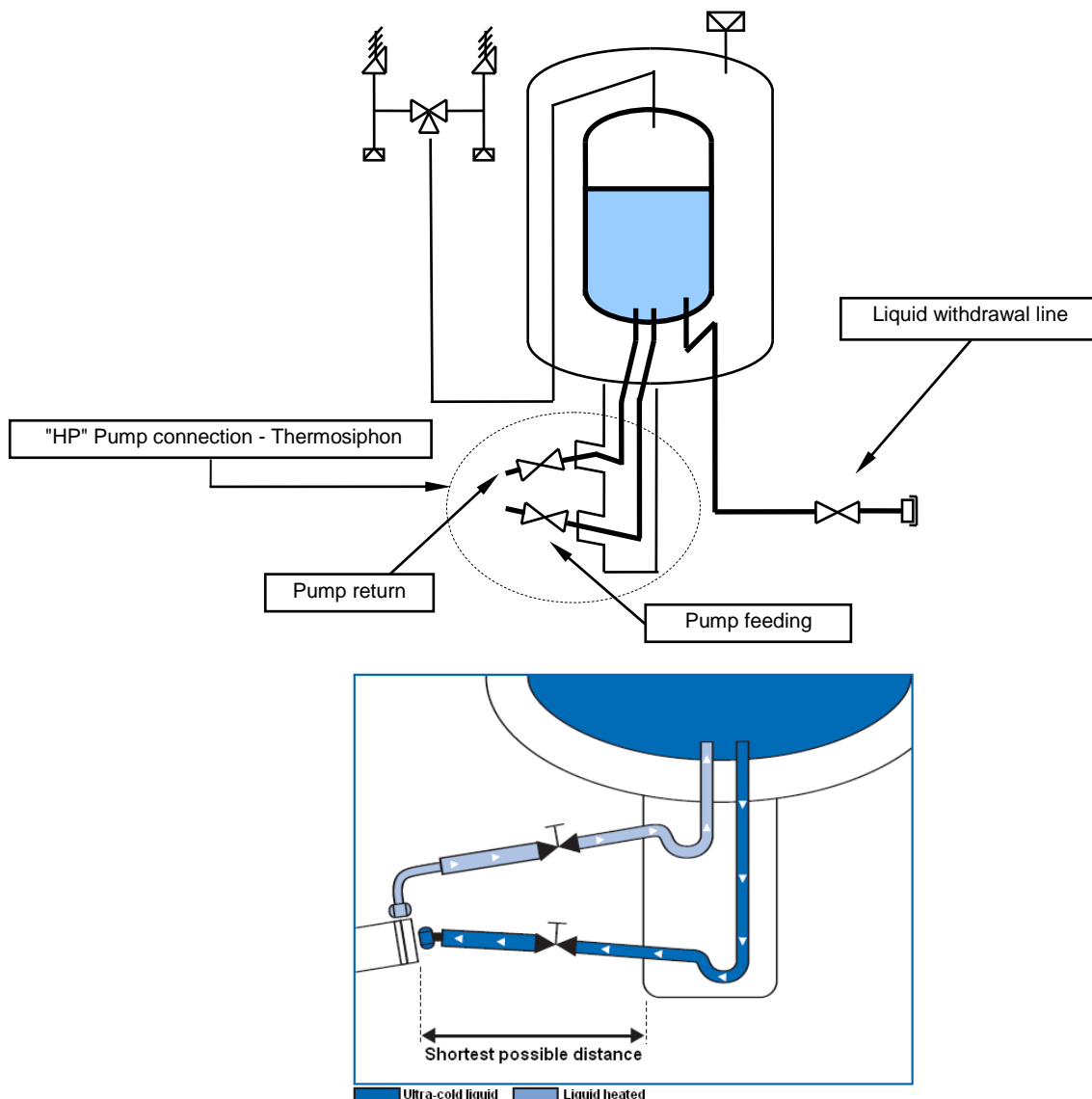
- A thermosiphon system which is connected to a High Pressure cryogenic pump in order to ensure optimal feeding for a cylinder filling unit. The thermosiphon system helps reduce thermal loss and guarantees optimal « HP » pump feeding.

- A liquid withdrawal line for liquid applications.

Connection thermosiphon / High Pressure pump:

- Angle: always keep a downward slope for feeding and an upwards slope for return.
- Connections: they must be the shortest possible to limit heat input.

Diagram – Thermosiphon and liquid withdrawal line



5 – TRANSPORT AND INSTALLATION

This section describes the correct procedures to employ upon receiving, unloading, inspecting and installing the **Celine** (RVT) tanks.



WARNING: All operations described in this section should be supervised by trained personnel.

Consult the layout drawing assigned to your tank to get the dimensions, weight, definition of connections, anchorages, strains with wind and earthquake and the limits of supply...

Ensure that this drawing is properly assigned to the vessel by checking the references. Additional copies of this drawing may be requested from CRYOLOR.

The installation of a tank is the responsibility of the customer. As part of an installation, the European standard EN 13458-3 is to be consulted.

Ensure free access for any inspection, monitoring and maintenance of the vessel. All safety devices must be operated easily.

The tank is embedded in a horizontal position and rests on his feet in stainless steel. Remove all packaging before handle the vessel.

Ensure that the foundations and concrete slab used to install the tank are designed to resist loads and weight of the tank filled and its facilities as well as external forces (wind, earthquake...).

Refer to local codes and studies of soil (soil type, presence of groundwater...) to validate the ability to install the tank at a particular location.

Employ experienced staff to handle, move and install the tank.

Ensure the compatibility of lifting equipment (cranes, lifting equipment, slings, hooks, shackles...) compared to the regulations and costs involved.



WARNING: The tank must be always handled empty and with an inner vessel at room temperature.



WARNING: During the different operations of handling, do not put the tank on any ground (furnish, wet ...) other than the plinth, in reinforced concrete, which has to receive it. Indeed, because of the weight, the tank can sink into the ground, be unbalanced and fall over. This recommendation is valid in horizontal or vertical position

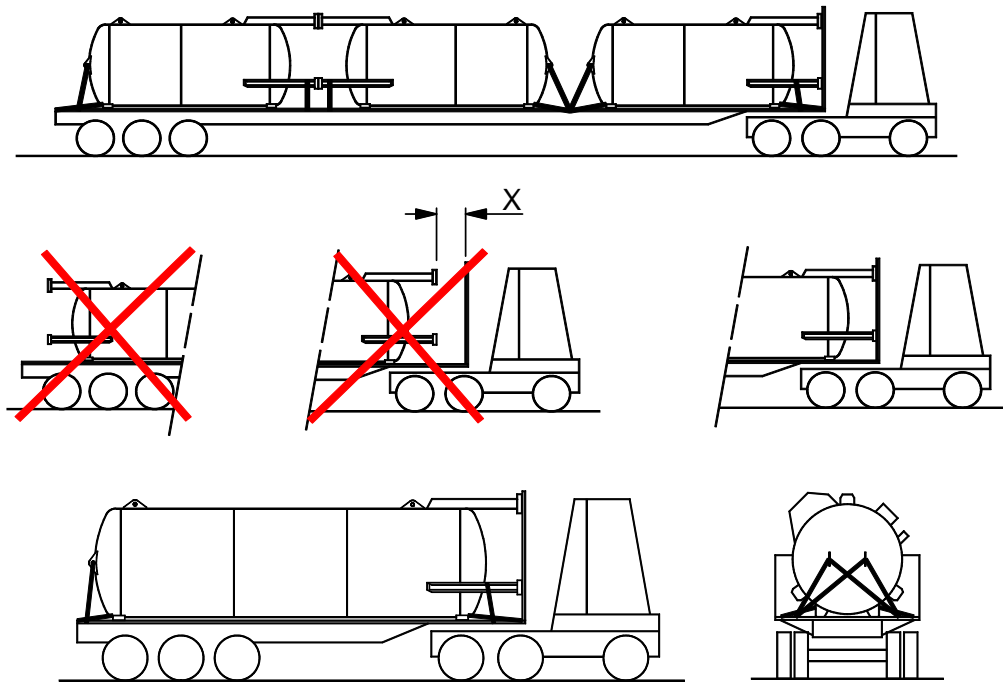
5.1 Sea and road transporting

Whichever means of transport is used, **Celine** (RVT) containers undergo considerable stress. It is therefore very important to ensure the equipment is securely fastened in order to prevent any possible damage (Diagram – Stowage).

When transporting, **Celine** (RVT) containers rest horizontally on built-in stainless steel transport legs.

1. Place cross straps / shackles as indicated on diagram – Stowage.
2. Place wedges against vessel on each side of the cradles.
3. When possible, the vessel legs should be facing the truck cabin as shown in the diagram (to avoid the crash of the outer vessel during braking rough).

Diagram – Stowage



5.2 Unloading the vessel

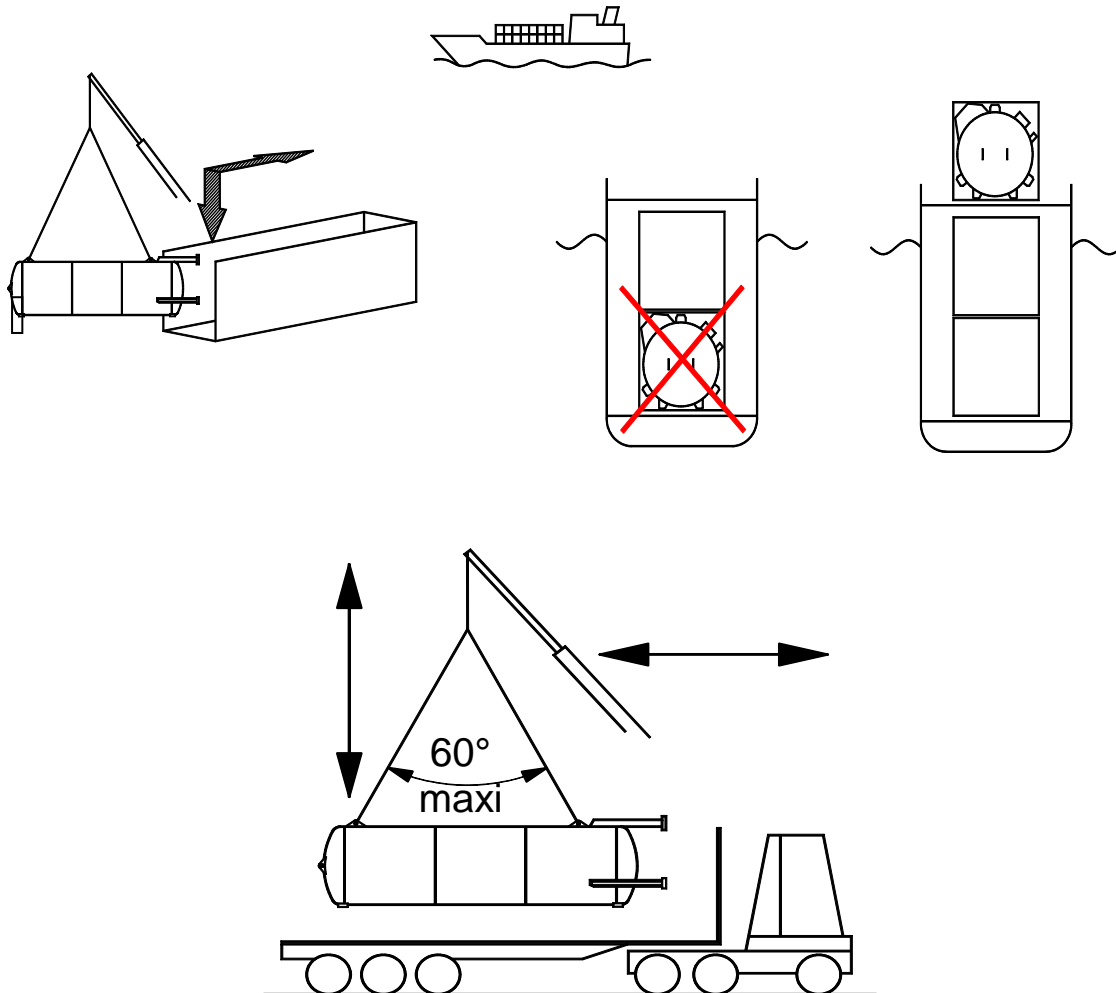
During maritime transport, vessels can be shipped in a 20' or 40' container type "Open Top" or in a special packaging or in a flat container.

During road transport **Celine** vessels are loaded on a normal or lowered flat bet truck depending on their size and weight. (Section 9 – Technical data).

Employ the following procedure to remove the vessel (Diagram – Maritime transport and unloading).

1. Remove any chains, straps, or shipping braces.
2. Connect the crane hooks to the vessel lifting lugs.
3. Lift the vessel out of the container or the semi-trailer.

Diagram – Maritime transport and unloading



5.3 Inspecting upon reception

Always carry out a thorough inspection upon reception in order to ensure the soundness of the vessel.

Any damage noticed should be immediately reported before taking possession from the carrier. Warn the CRYOLOR customer assistance.

Check all the accompanying documents and keep them preciously.

Make available this handbook for users of the tank.

Check before unloading

- Check chains, straps, shipping braces, and other supports used to secure the vessel during transport. Any apparent damage will suggest the possibility of improper handling during shipment
- Check the vessel surface and paint condition. There should be no chipping, flaking, etc.
- Check safety assembly-relief valves & rupture (burst) discs (optional).
- Check protected caps of both outer vessel rupture (burst) discs.
- Check welded joints on the control cabinet pipework.
- Check valves and fittings for tightness.
- Check vessel pressure on the pressure gauge. If no pressure is indicated, then extra care must be taken against vessel contamination (moisture) during first filling.

5.4 Handling and lifting

Celine (RVT) containers have been designed to allow handling with a single crane and lifting with two cranes (Diagram – Handling).

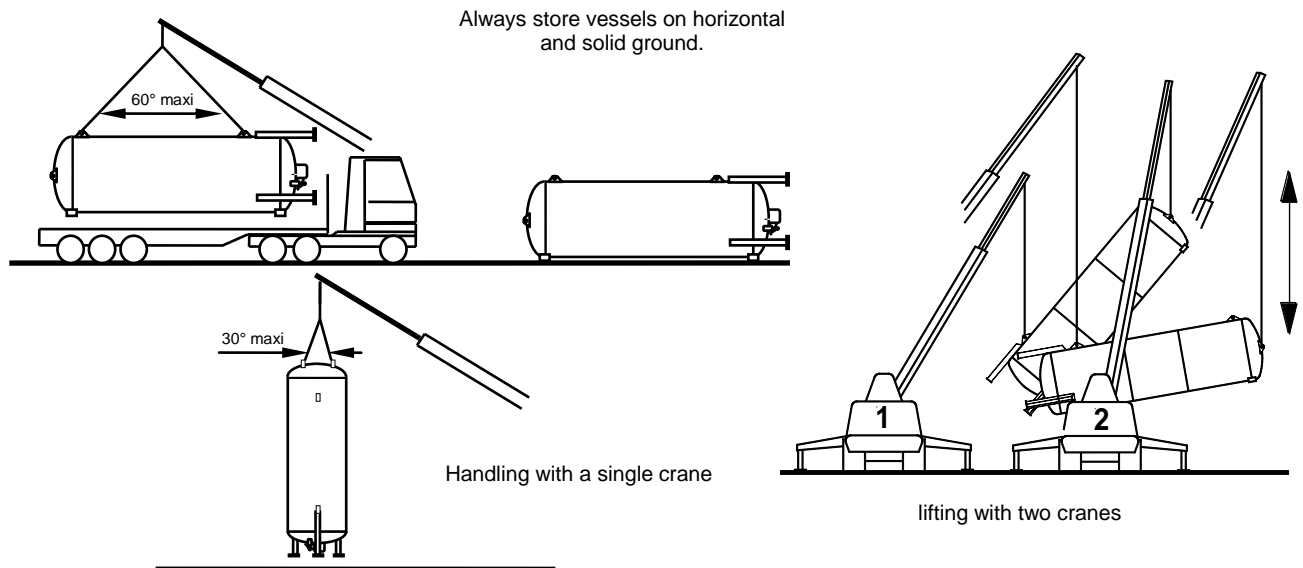
Use the vessel lifting lugs for both vertical and horizontal handling (See implantation diagram, Section 12 – Annex).

During all handling, lifting chains must always be as close to vertical as possible. Make sure that pipework at the bottom of the vessel does not touch the ground.



NOTE: In order to avoid rotation of the vessel and prevent damage to the paint or accessories (valves, instruments control etc.), horizontal handling and lifting should be carried out perpendicularly to the cradles.

Diagram – Handling



5.5 Selecting a implantation site

The following criteria should be taken into consideration prior to the installation of the cryogenic vessel.

- Nature of soil and subsoil (stability, groundwater, ...)
- Ease of access.
- Absence of electrical lines.
- Absence of flammable liquid or gas lines.
- Proximity to the liquid dispense point.
- Accessibility to a supply vehicle using a single flexible hose with a maximum length of 4 meters.



WARNING: Never install the vessel in a pit - escaping nitrogen or argon lowers the oxygen content in the surrounding air.

5.6 Preparing the plinth

Concrete pads are most often used as the base for cryogenic vessel installations, as they are very stable and provide a secure location for the vessel and accessory equipment (vaporisers, etc.).

The foundation must be firm, level, allow proper drainage and should not allow any settling, as this could provoke damage to the installation. The slab should be at least 10 cm above the surrounding ground.

As civil engineering is the customer's responsibility, the minimum characteristics following are required:

Concrete density	350 kg/m ³
Stress compression	350 kg/cm ²

5.7 Tank anchoring method

Celine (RVT) containers are supported by three mounting legs with mounting holes for bolting down the vessel to the installation pad. The three mounting legs are equipped with drilled plates with the following hole diameters.

The distance from the anchoring of the vessel to the edge of the plinth should never be less than 350mm.

Celine (RVT) tanks are designed to resist high winds and earthquakes according to calculation codes refer on layout diagram (Section 12 – Annex).

For the choice of fixation, consult the layout diagram (Section 12 – Annex).

- If fixing by anchor bolts, provide for reservations during the building of the concrete foundation.
- If fixing by mechanical anchor pegs, the implementation will be made by against drilling of the paving stone through the soles of feet.
- **Unless agreed with the order, the anchor and fixation material for the storage (rods, dowels, bolts, ...) is not provided by Cryolor.**



WARNING: Never leave the vessel upright without bolting it down to its foundation. Use the anchoring methods in accordance with these instructions.

To avoid the fall of the tank and face the diverse constraints due to the wind and to the earthquake, it is mandatory to use the totality of the drillings of the base plate of feet to fix correctly the tank to the ground.



NOTE: For all engineering operations, CRYOLOR recommends to see you a lay-out diagram which is supplied with your vessel. Get closer also to a competent professional in the domain for the respect for the standards and for the rules of the art.

5.8 Connecting to application

Prior to connecting the **Celine** (RVT) containers, carefully clean the coupling faces with acetone. After increasing pressure up to the maximum service pressure of the vessel with dry nitrogen, carry out a test with a soapy solution compatible with oxygen to verify that there are no leaks at the connections.

Complete installation realized by the customer

Designing a cryogenic installation safe and effective requires a lot of experience and skills.

For all cyogenic installation (tank, vaporizer, pipe, regulation unit, environnement, access, protection ...), it is mandatory to seek the necessary skills. All equipments must be cleaned for use of oxygen.

Provide protection devices to prevent overpressure in equipment connected downstream of the exit of the tank.

Choose the right material for all the installation according to the used temperature (avoid the embrittlement of materials), taking into account the risk of flooding of cryogenic liquid.



WARNING: Add safety valve on piping where liquid could be imprisoned: between two valves or equipments like regulator, economiser or check valve. The purpose of the safety valve is to evacuate the overpressure generated by the expansion of the warmed liquid which is transformed into gas: a small quantity of cryogenic liquid produces a big volume of vaporized gas !

6 – OPERATION

This section describes the different operational procedures of the **Celine** (RVT) containers and serves to prepare operators for purging, the initial vessel cool-down, filling and withdrawal.

To guarantee on the long term the safety of the operations relative to the cryogenic storages, it is strongly recommended to follow scrupulously the instructions supplied with the reservoir.

It is important to identify and to remember the position of the elements of the device before executing the operations described in this chapter.

Consult the flow diagram of the tank to know how to identify the location and the function of all the components of the cryogenic storage.

Labels and identification plates have to be neither removed nor degraded.

The instructions which follow are to be realized by experimented operators and which know security measures to be applied.

Before using the storage, make sure that all the applicable measures determined in the section of installation were respected.



WARNING: During the different operations of storage using, ensure that:

- Keep, especially during the operations of purge, a positive pressure in the reservoir to avoid the entrance of atmospheric contaminants.
- Do not place directly at the output pipe, open the valves with care and beware of the residual liquid which may be in the tank
- Do not touch the cold with bare hands



WARNING: During the filling, make sure that the quantity of liquid introduced into the storage does not exceed the volume recommended for the vessel.

Overpressure generated is a danger to property and persons.

6.1 Check prior to first fill and purging

Celine (RVT) vessels are delivered slightly pressurised with 0.3 bar of nitrogen or of dry without oil gas to prevent moisture from entering the vessel.

- Check that all valves are closed except for high and low level valves.
- Open and close right away valve W41 to check that the vessel is under pressure. If not the case, vessel must be purged with dry nitrogen as described in the following procedure :
 1. Disconnect the liquid withdrawal valve connection.
 2. Remove the blind flange from the filling coupling.
 3. Connect the dry nitrogen for the purge to the filling coupling.
 4. Open the bottom and top fill valves and raise the vessel pressure to 3 bar.
 5. Remove the product supply source and close bottom and top fill valves.
 6. Purge the pipes instrument valves of the gas and liquid phase by loosening the valves coupling.
 7. Purge until pipework is lightly frosted, in the following order: bottom fill, withdrawal, top fill, full trycock and vent valve. Then, close the valves.
 8. Replace the blind flange of the coupling.
 9. Test the degree of residual moisture by checking the dewpoint.

If the measurement of dew point is not satisfactory resume operations described above.

6.2 Initial vessel cool-down

After purging and before filling the vessel:

- Make sure protected box for outer vessel burst discs located at top and bottom of the vessel are intact and the presence of the vacuum line cover at the bottom of the vessel.
- Make sure that the support bracket of the pressure raising coil is loosened so that it can freely contract and expand during each cool down.



REQUIREMENT: Follow the Cryolor instructions regarding the initial cooling down of the vessel before the first filling.

Take the necessary time for this delicate operation

As long as the reservoir rises in pressure (evaporation of the liquid introduces), it means that the reservoir is still warm: pursue the stake in cold.

Make too quickly the initial cooling down create important and dangerous strains (deformations of the vessel, breaking pipes, the internal noises...).



NOTE: To have an indication of the level gauge in compliance with expectations, ensure the adequacy of the calibration parameters compared with ground (gas properties, environment, and nature of installation).

Filling procedure



WARNING: The transfer for the initial cool down is done using the pressure transfer of the supply vehicle. Do not use his pump.

1. Purge the supply hose of the supply tanker, remove the blind flange from the filling coupling and connect the hose.
2. Open top fill valve, and slowly open withdrawal valve of the supply tanker. Fill the vessel to one-eighth capacity.
3. Open the bottom fill valve for a few seconds in order to cool down the pipework, and then close.
4. Check the vessel pressure. If the pressure during transfer approaches the safety relief valve pressure setting, discontinue transfer and vent the vessel through the trycock or vent.
5. Close withdrawal valve of the liquid supply tanker and then the top fill valve. Purge then disconnect filling hose at filling coupling.
6. Cool down pipework until lightly frosted by opening the following valves: full trycock and vent valve, relief valves and withdrawal. Vent the vessel by opening the top fill valve.
7. Close valves when the pressure has returned to "0". Replace the blind flange of the filling coupling, after having verified the seal.



NOTE: After the initial vessel cool down and the components have returned to ambient temperature, make sure to re-tighten all the various valves and couplings.

6.3 Filling while in service

The same cautions should be taken for filling vessels in service as when filling them for the first time.



NOTE: Correct filling procedures should allow the vessel to be filled without interrupting the application.

Vessels in service must be refilled through both the bottom and top fill valves.

Filling only through the bottom fill valve will increase vessel pressure as the warm vapour above the liquid is compressed. On the other hand, filling only through the top fill valve will lower vessel pressure as this warm vapour above the liquid is cooled down and re-liquefied.

There are two different methods that can be used to transfer liquid product from the liquid supply tanker to **Celine** (RVT) container.

The method most frequently used to fill the cryogenic vessel is with the cryogenic pump transfer. This method is used when the operating pressure of the vessel is the same as or more than those of the liquid supply tanker.



WARNING: Ensure during a transfer with a pump not to exceed the working pressure of the tank to fill. Reduce in particular the flow of the pump at the end of filling.

Another method used is a pressure transfer. This method is used when no transfer pump system is available and when the liquid supply tanker is able to provide a higher pressure than the working pressure of the cryogenic vessel.

Prerequisites for filling by pressure transfer:

- Make sure full trycock valve, vent valve, top and bottom fill valves are closed.
- Make sure pressure build-up valve and economiser regulator isolating valves are open.
- Make sure liquid withdrawal valve is open (only on vessel in service).

Filling procedure

1. Purge the liquid supply hose of the tanker.
2. Remove the blind flange from the filling coupling and connect the supply hose to the vessel.
3. Cryogenic Pump Transfer: Cool down the pump and flow meter of the supply vehicle.
4. Pressure Transfer: Raise the pressure of the liquid supply tanker higher the working pressure of the tank.
5. Open the bottom fill valve of the vessel and slowly open withdrawal valve of the liquid supply tanker.
6. Observe the vessel pressure on the pressure/level instrument during transfer.
7. Keep the cold converter pressure stable by alternating the opening and closing of the bottom and top fill valves.
8. Observe pressure/level instrument. When the cold converter is filled to approximately seven-eighths capacity, open the full trycock valve and close the filling valve.
9. When liquid splashes through the full trycock, close withdrawal valve of the liquid supply tanker.
10. Close bottom fill valve and full trycock.
11. Purge and replace the filling blind flange, checking the gasket carefully.
12. Replace the filling coupling, checking the gasket carefully.

NOTE: In the case irregular pressure increase causes the safety valves to blow:

- **Decrease pressure by opening trycock valve.**
- **Close pressure raising coil isolating valve.**
- **Should this not be sufficient, remove the blind flange from the filling coupling and open the top fill valve.**
- **Inform as soon as possible the person responsible for vessel maintenance.**

6.4 Feeding the customer's line

Celine (RVT) vessels may be used for both gas and liquid service with nitrogen, oxygen and argon.

Gas application withdrawal procedure

1. Allow the vessel pressure by opening the pressure raising coil isolating valves.
2. When the desired withdrawal pressure has been reached, slowly open liquid withdrawal valve.

If the liquid withdrawal is connected to an atmospheric vaporiser, the liquid will be vaporised and gas automatically supplied.

After long stop withdrawal, the regulator economiser will discharge the excess pressure of the gaseous phase into the withdrawal line, and the vessel will function normally.

Liquid application withdrawal procedure

Celine (RVT) tanks can have an additional dedicated liquid line for withdrawal of the product in a liquid state for low pressure liquid applications. This dedicated liquid line is easily available as an optional component. (Valves and coupling).

It is not necessary to put the vessel under pressure in order to proceed a punctual liquid withdrawal. The withdrawal is carrying out simple by gravity.

It is necessary to put the vessel under pressure in order to proceed at important liquid withdrawal. (High flow rate and pressure required).

1. Put the vessel under pressure by opening the isolating valves of the regulator-economiser.
2. When the pressure wanted is reached, open the withdrawal valve.

6.5. Removal of vessel from service

If possible, match stop working storage when the liquid level is low. If there is a large quantity of liquid in the tank, drain and transfer liquid to a semi-trailer or another safe place (other storage site...). Small quantities of liquid can be sprayed using the pressure raising coil and then evacuated by the purge pipe (trycock) of the control cabinet.

For short-term stops, keep the remaining liquid in the tank and close all valves except those of the level indicator / pressure.

Stops for a long time, according to the fluid, follow the following recommendations.

Oxygen tanks used

- Remove the liquid from the tank. Open the purge valve (trycock) to reduce storage at atmospheric pressure and then close the valve.
- Connect to the filling flange of the tank a nitrogen cylinder banks hot and clean (no presence of hydrocarbons) to conduct a sweep of the reservoir. Bringing the nitrogen into the tank by opening the filling valves, let pressure (about 0.5 bar) and then open the trycock valve to clear warm nitrogen. Close and open the trycock valve several times to switch rise and fall of pressure of nitrogen in the container.
- Ensure that the tank contains no more oxygen. The output of the purge valve (trycock), to check the gas out with a nitrogen analyzer (see userbook of the equipment). Continue scanning nitrogen until being sure that there is no more oxygen in the storage.
- Close the valves after leaving a positive pressure (0.3 bar) of dry nitrogen oiling into the tank and avoid contamination from the outside and the humidity.
- Dismantle the nitrogen cylinder banks.
- The tank at room temperature can be moved towards a new site.

Nitrogen / Argon tanks used

- Remove the liquid from the tank. Open the purge valve (trycock) to degas the storage up to keep a positive residual value (0.3 bar) and then close the valve.
- The tank at room temperature can be moved towards a new site.

7 – MAINTENANCE AND REPAIR

7.1 General

This section describes the various maintenance operations including checking and adjustments procedures of **Celine** (RVT) containers.



It is imperative to respect national or local regulations for the maintenance and periodic inspection of our cryogenic storage.

For repair works, parts-list or any problems not described below concerning the use of your **Celine** (RVT) container, please contact:

CRYOLOR customer assistance department

Tel N°: (33) 03 87 70 85 50

Fax N°: (33) 03 87 73 96 03



NOTE: It is highly recommended to replace damaged components with CRYOLOR approved parts.

The regular inspections of the tank were recommended before use, the periodic regulatory controls, as well as the abnormalities met during the operations of exploitation of the storage, bring to light the necessity of maintaining the equipment.

The typical observations are for example:

- A pressure exceptionally high or low in the tank or in a section of pipe.
- Leaks at accessories (valves, regulators, connections...).
- An excessive functioning of safety valves.



The actions of preventive or corrective maintenance should be IMMEDIATELY to ensure a right working of the storages and installations as well as a level of maximum safety for the goods and the persons.

- It is important to keep all of the various inspection reports, records of performance and vacuum repairs performed. This helps to assess the quality of the maintenance program.
- For all your maintenance operations, observe the safety instructions given in this manual and in your reference documents.
- Before working on the tank or installations, isolate the section to be repaired, bring to room temperature and depressurize before disconnecting the component.
- Maintenance on cryogenic equipment must be carried out only by trained and authorized personnel. Know the normal procedures and emergency procedures.
- Measuring instruments level / pressure and various electrical or pneumatic accessories should be repaired by a qualified person. Apply the rules and respect the regulations.
- Refer to section 8 - Troubleshooting - this manual contains a list of anomalies that can be met and the solutions for them.

Damaged equipment

Large impacts :

- Remove the vessel from service.
- Check vacuum level (vacuum measuring procedure refer to § 7.2).
- Contact customer assistance department.

Total loss of vacuum:

WARNING: The operators have to show an extreme vigilance for the signs of a loss of vacuum, because of the consequences of the penetration of wet air.

- The emergence of a « sweat » or frost on the external tank.
- An unexpected increase in pressure.

In case of loss of vacuum, the tank must be removed from service and it is necessary to identify and correct the cause of loss of vacuum (e.g. presence of leaks to the right vacuum fittings, etc...).

It must then restore the vacuum after first fully heated and dried the tank. In case of escape of vapor or perlite by the disks of break of the outer vessel, a leak of liquid in the inter wall must be suspected.

In this case, the storage must be **IMMEDIATELY** taken out of service, we must lower the pressure on and make a careful emptying the tank.

For lack of a depressurization and of the emptying of the vessel, there is a significant risk of rupture of the outer vessel caused by the weakening of carbon steel in contact with the cold liquid. This embrittlement is to be taken into account for components of the facility attached to the cryogenic storage.

In a global way, for a complete cryogenic installation (cryogenic tank and components of the installation), to watch to have no block of ice generally and in particular on the organs of safety: valves, beadings, line of pumping of vacuum...

- Check integrity of outer vessel burst discs.
- Remove the vessel from service.
- Immediately relieve vessel pressure.
- Carefully emptied the vessel from liquid.
- Contact our customer assistance department.



WARNING: Damaged equipment must be carefully emptied, removed from service and should not be refilled unless the equipment has been repaired and tested.

Replacing components

**To replace any components exposed to pressure (e.g. Valves) :
IT IS NECESSARY TO REMOVE THE VESSEL FROM SERVICE**

1. Carefully empty the liquid from the vessel.
2. Vent the vessel and reduce to '0' pressure.
3. Remove components to be replaced.
4. Plug pipe ends to protect the vessel from contamination.
5. Mount replacement components.
6. Check the tightness of the seal.

Components not exposed to pressure (e.g. régulator-economiser, safety valves and inner vessel bursting discs): it is not necessary to remove the vessel from service.

1. Isolate component to be replaced using the appropriate isolation valves.
2. Remove components to be replaced.
3. Plug pipe ends to protect the vessel from contamination.
4. Mount replacement components.
5. Check the tightness of the seal.



WARNING: Components must be replaced with an identical model and thoroughly cleaned and degreased and oxygen compatible.

In a general way and by safety, all the components in contact with the cryogenic liquid or the gaseous product, whatever it is, must be cleaned and streamlined for conditions of service with oxygen. Make the degreasing by using the compatible products and the adequate procedures. Components cleaned for the use oxygen will be packed to prevent contamination.

7.2 Vacuum measuring

All **Celine** (RVT) tanks are equipped with a vacuum evacuation connection allowing vacuum measuring and/or a vacuum pump. Addition of a vacuum isolation valve / gauge allows the vacuum to be quickly read (Consult spare parts to know references, section 12 – Annex).

If you notice on the outer vessel, the appearance of the following symptoms:

- Frost, cold spots or considerable condensation
- Irregular pressure build-up,

A deterioration or a loss of vacuum can be suspected.

In this case, the storage must be immediately taken out of service.

Contact our customer assistance department.



WARNING: Any repair involving the vacuum must be carried out by trained and authorized personnel in conformity with the Cryolor procedure N° 914-CH “Vacuum maintenance and measuring device”.

7.3 Valves and safety valves repair

Make sure to have an adequate supply of Cryogenic vessel spare parts in stock.

Extended valves

Except for the level isolating valve and the 3 way diverter valve all the valves are extended valves and were Teflon coated disc type with a metallic seat.

The valves are of very sturdy make and require minimum maintenance when used under normal operating conditions.

In case of a leak through the packing, make sure that the valve is closed and first tighten the packing nut to see if the leakage stops before removing the valve.

But, if a valve is suspected to be defective, remove complete valve head or repair the assembly as described in this section.

Removing valves and replacing components

Depending on the condition, carry out the procedures described in § 7.1 (Replacing Components).

1. Disassemble the valve body and inspect all components.
2. Remove the valve seat assembly. During normal operation, the surface of the seat should not be scratched.
3. Clean metal components with an oxygen compatible solvent. All other components should be cleaned in warm soap solution. Rinse thoroughly with cold water.
4. Replace damaged components.
5. Reassemble the valve making sure the surfaces are clean and properly seated in order to prevent moisture from getting into the valve.

Instrument level valves

This valve is a 3-way manifold type. In case of a defective valve, replace it with a similar valve.

Way diverter valve

The diverter valve is a quarter-turn ball type with three positions or slide valve type. If the diverter leaks, it is recommended to completely replace it.

Safety relief valves

The safety relief valves open to prevent excessive inner vessel pressure. The valves have a disc and generally require no particular maintenance except a periodic check-up of the safety relief valve's opening at the set pressure. The checks depend on the regulations in force in each country.

Safety relief valves cannot be repaired. Immediately replace any valves when leaking or malfunctioning occurs.

Replacing the safety relief valves

1. Turn the three way diverter valve a half turn to isolate the safety relief valve.
2. Remove and replace the defective safety relief valve without breaking its seal.

Check that the new valve is identical to that of replacement: pressure calibration, the same type, same manufacturer, supplier and technical features (flow, connections and materials).

7.4 Vessel burst discs (optional)

Burst discs are additional safety relief devices that will rupture completely to protect the vessel from over-pressurisation.

Replacing the burst discs

1. Open trycock valve or vent valve to reduce vessel pressure.
2. Isolate disc to be replaced by turning the three way diverter valve a half turn.
3. Make sure that the new disc has the same set pressure.
4. Remove and replace the defective burst disc.
5. Refit the gaskets using oxygen compatible thread sealant or Teflon tape to prevent leaking.

7.5 Pressure regulator (optional)

The Regulator valve setting of is carried out at the CRYOLOR works, although it may also be adjusted. The economiser valve does not require any particular maintenance.

In case of malfunction or damage (e.g. ruptured diaphragm) checks and repairs should be carried out only by trained and authorized personnel. In any case, it is highly recommended to return the regulator to the CRYOLOR works for replacement.

The type of regulator should be specified when ordering (refer to spare parts).

In order to find out the exact pressure setting and the possible adjusting range of your regulator, consult the parts list (Section 12 – Annex) and the equipment user handbook.

Increasing or decreasing set pressure

Slowly loosen (to decrease) or tighten (to increase) the adjusting screw of the regulator until the desired pressure is stabilised.



NOTE: It is recommended to adjust the pressure regulator setting during withdrawal.

Removal of the regulator

1. Close the isolating valves located on each side of the regulator.
2. Slightly loosen the outlet connection of the pressure regulator, so that the pressure decreases from the escaping gas.
3. Allow the regulator to return to ambient temperature before removing.
4. Remove the regulator by unscrewing the couplings upstream, downstream, outlet.

7.6 Pressure – level instruments

The pressure-level instrument requires no particular maintenance, except checking that the connections are tight.

If, however, the instrument malfunctions, several checks that can be made before replacing it:

- Make sure the connections are tight and that there is no leakage in the gauge line or the instrument valves.
- Make sure the gauge lines are not blocked (Ice plug).

- If the previous adjustments do not correct the problem, CRYOLOR recommends replacing it with new cells.

Removal of the pressure – level instruments

Prior to adjusting or replacing the pressure/level instrument:

1. Make sure make sure to close instrument shut-off valves

Prior to replacing the liquid isolation valve:

2. Make sure the vessel is drained.

Prior to replacing the gas isolation valve:

3. Make sure the vessel is completely vented.



NOTE: To have an indication of the level gauge in compliance with expectations, ensure the adequacy of the calibration parameters compared with ground (gas properties, environment, and nature of installation).

7.7 Painting

If it is necessary to perform painting work on the outer vessel, ensure that the procedure implemented for the application is correct and that the components used are compatible.

Consult Cryolor for a definition of products to be used.

Precautions to take when painting operations

Paints contain volatile solvents, especially petroleum distillates, alcohols and xylene. The usual precautions for flammable substances must be observed and the storage must be grounded prior to painting. In general, ensure respect for rules to prevent the dangers inherent in the work of painting (inhalation, absorption through the skin, steam ...). Wear protective clothing and appropriate.

The operations must be performed by a competent person. Respect good practice, including thorough washing of hands before eating or smoking.

8 – TROUBLESHOOTING

The following section is presented as two columns - possible problems / possible solutions, with the most likely causes and solution listed first. The solution procedures will be found in the chapters according to the reference for liquid refill.

If needed, refer to the vessel diagram to identify the various vessel components mentioned in this section.

8.1 Pressure maintaining failure

Regulator economiser does not function correctly. Pressure raising coil is not frosted and vessel pressure is lower than the required vessel operating pressure.	
Possible problems	Possible solutions
Isolating valves are closed. Regulator setting is too low. Regulator is not opening properly. Low liquid level less than 25%. Excessive withdrawal rate. Plugged filter inside the regulator. Ice plug on the circuit.	Open the isolation valves Re-adjust regulator setting (§ 7.5). Replace Regulator (§ 7.5). Refill the vessel with liquid (§ 6.3). Decrease rate, action on withdrawal valve. Remove the filter, clean it with acetone and blow it prior to refitting (to dismantle the regulator § 7.5). The plug will blow after draining with dry and warm gaseous nitrogen in order to eliminate any trace of moisture (§ 6.1).
The vessel pressure will not increase or the vessel pressure suddenly drops.	
Ruptured vessel burst disc.	Replace the defective disc (§ 7.4).
Vessel safety relief valve not functioning, leaking or frozen open.	
Damaged valve seat or disc. Ice or dirt under valve disc.	Replace defective valve (§ 7.3). Remove, clean and blow defective valve in order to prevent moisture. (§ 7.3).

8.2 Abnormal pressure increase

Regulator not functioning.	
Possible problems	Possible solutions
Regulator does not close	Replace regulator (§ 7.5).
Regulator setting is too high	Re-adjust regulator setting (§ 7.5).
Vacuum and insulation Problems. Measure vacuum at vacuum connection (§ 7.2).	
<p>1. Ruptured outer vessel / vacuum line rupture disc (Corrosion and/or fatigue).</p> <p>Inner vessel pipework leak and burst disc rupture with escape in particular of vapor or perlite.</p> <p>REMINDER: it does not have to have of block of icegenerally and particularly on the organs of safetythere such as beadings, valves, line of pumping of the space.</p>	<p>Empty vessel and contact our customer assistance department.</p> <p>In this case, the storage must be <u>IMMEDIATELY</u> taken out of service, we must lower the pressure on and make a careful emptying the tank.</p> <p>For lack of a depressurization and of the emptying of the vessel, there is a significant risk of rupture of the outer vessel caused by the weakening of carbon steel in contact with the cold liquid.</p>
<p>2. Appearance on the outside in particular, of the following symptoms:</p> <ul style="list-style-type: none"> ▪ Frost, cold or condensation ▪ Abnormal pressure raising ▪ Unexpected request of the economiser line (it can show itself by a remarkable increase of the quantity of ice on the pipings close to the economiser) 	<p>A deterioration or loss of vacuum may be suspected.</p> <p>The storage must be <u>immediately</u> taken out of service, contact our customer assistance department to identify and correct the cause of loss of vacuum.</p>

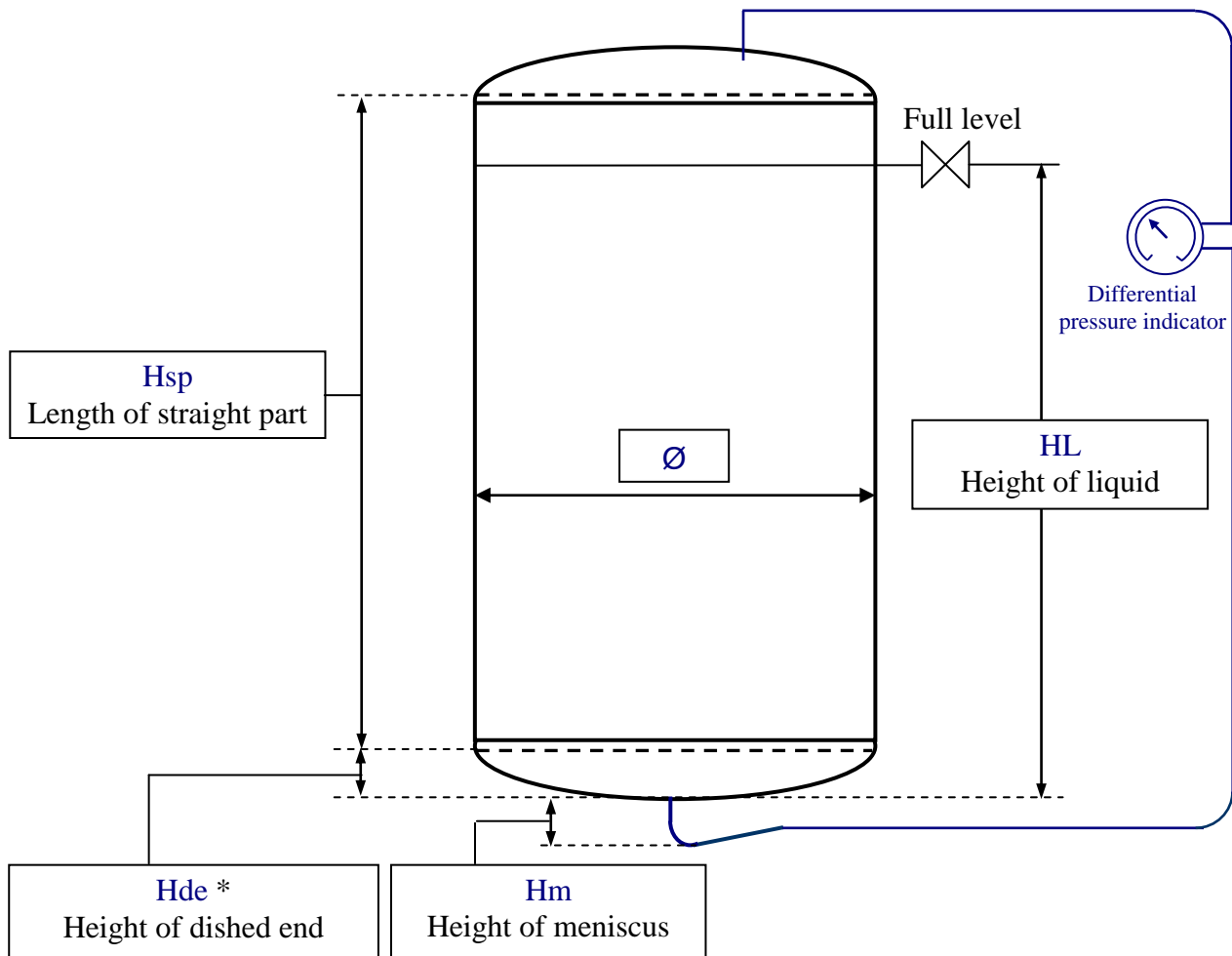
9 – TECHNICAL DATA

Refer Annex 12

Flow Diagram for Dimensions

Technical Datasheet for Weight & Volume Parameters..

10 – TELEMETRY PARAMETER DATA



* Torispherical head 2:1 (with $R = 0,8 \times Da$ and $r = 0,154 \times Da$ Da = Outer diameter)

Ø (mm)	Hsp (mm)	Hde (mm)	Hm (mm)	HL (mm)
1 906	6 925	466	58	7 573

Values in working temperature (-196°C). Contraction parameter : 3mm/m for ΔT of 216°C.

11 – GUARANTEE



NOTE: To have all the warranty applicable to your Cryolor cryogenic storage, consult the General Conditions (or SCS) of Sale and Certificate of Guarantee attached to your tank.

These documents contain clauses relating to the duration of the guarantee, the guaranteed benefits, exclusions, conditions to benefit...



WARNING:

The warranty does not cover normal wear and tear resulting from the use or damage which may be the consequence of excessive or improper use of equipment, in light of the type of container and / or conditions (flow, pressure, temperature...) specified in the order.

The guarantee will be withdrawn at any material that has been altered without prior agreement of Cryolor or where parts delivered by Cryolor have been replaced with another origin.

Revisions and maintenance requirements or intervention on the equipment provided in maintenance documentation submitted at the time of delivery make the application of the guarantee and must be conducted under the responsibility of the buyer. The person will verify that these documents are in his possession.

12 – ANNEX

- Spare parts



WARNING: Accessories replacement should always be identical to the original, compatible and degreased oxygen.

Refer to the schematic drawing of the tank to identify the landmarks of the part to replace

Accessories are to be replaced in accordance with good engineering and safety applies.

Closer to Cryolor to get the records of accessories and installation specifications (torque, welding, setting...).

- Flow diagram

- Layout diagram

- Technical Data Sheet