

# Orca PT 1000 Micro-Bulk Delivery System



### DRIVER'S OPERATION MANUAL Keep with Orca PT

Chart Industries, Inc. Storage Systems Division 407 Seventh Street Northwest New Prague, MN 56071-1000 USA Phone: (952) 758-4484 Fax: (952) 758-8255 Website: <u>www.chart-ind.com</u> **Manual # 12987316** 



Section 1 - Overview	3
Service	3
Addresses	3
Design Modification	3
Additional Copies	3
Section 2 - Introduction	4
About this Manual	4
Terms	4
Section 3 - Safety	5
Safety Summary	5
General	5
Safety Bulletins	7
Oxygen Deficient Atmospheres	8
Oxygen Cleaning	8
Oxygen Enriched Atmospheres	9
Nitrogen and Argon Asphyxiates	9
Section 4 - Theory of Operation	10
Flow Meter	20
Differential Pressure Transmitter	20
RTD - Resistance Temperature Device	22
Control Panel	21
Dispensing Circuit	22
Section 5 - Operation of the ORCA PT System	23
Filling the ORCA PT	23
ORCA - Initial Fill or Warm Tank Procedures	25
Purging Procedures	25
Purging the Fill Line	23
What is Cold Liquid	17
Reasons for Cold Liquid	18
How to Maintain Cold Liquid	18
Know Your Current Saturation	18
Section 6 - Plumbing	25
ArrivalConditions.	27
Operation	29
Printing a Ticket	48

### **Section 1 - Overview**

#### Service

The ORCA PT cryogenic system has been designed for years of safe and dependable operation. In the event service is required, contact Chart Industries, Inc. at  $1-800-400-46_{M}8_{v}3_{E}$ .

#### Addresses

The ORCA Micro-Bulk Delivery System is designed and manufactured by:

Chart Industries, Inc. Storage Systems Division 407 Seventh Street Northwest New Prague, MN 56071-1000 USA

#### **Design Modification**

**DO NOT** use this product in any manner not consistent with the instructions outlined in this manual!

**NEVER** alter the design, or perform service that is not consistent with the instructions outlined in this manual without the prior written approval of Chart Industries, Inc.!

#### **Additional Copies**

Additional copies of this manual are available by contacting Chart Industries, Inc. New Prague (address listed on cover page).

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## Section 2 - Introduction

#### About this Manual

This operating manual is designed to be used for the ORCA PT 1000 and contains information regarding the safe operation and handling of liquid nitrogen, oxygen, and argon. It should be thoroughly read and understood by anyone that operates or is exposed to this equipment.

This manual is intended to provide the cryogenic service employee with the necessary information needed to operate and maintain the ORCA systems.

The schematics and parts lists refer to reference numbers for each component. The reference numbers will be used throughout this manual to draw specific attention to a component while describing its function, operation, or repair. The manual is generic in content and made specific to your actual version in areas where the detail is required.

#### WARNING!

Fatal or severe injury, fire, explosion, or suffocation may result depending on type of liquid used in this system if operating personnel fail to observe safety precautions.

#### Terms

Throughout this manual, safety precautions will be designated as follows:

#### WARNING!

Description of a condition that can result in personal injury or death.

### **CAUTION**

Description of a condition that can result in equipment or component damage.

Text in a box refers to oxygen service only.

**Note:** A statement that contains information that is important enough to emphasize or repeat.

### **IMPORTANT!**

Highlights information that may otherwise be misunderstood or completed incorrectly.

## Section 3 - Safety

### Safety Summary

While every possible safety precaution has been taken to ensure safe operation and maintenance of the ORCA PT Vessel, it is imperative that all persons having contact with the ORCA PT Delivery Vessel become thoroughly familiar with all maintenance, safety precautions, and procedures contained in this manual. If for any reason any part or parts of this manual become confusing or the information provided is not completely understood contact a technical service representative at Chart Industries, Inc. 1-800-400-46<sub>M</sub>8<sub>v</sub>3<sub>E</sub> before proceeding with the operation or repair of the vessel.

#### General

The ORCA PT tank consists of an inner pressure vessel encased within an outer carbon steel vacuum shell. The container operates under low to medium pressure, and is protected from over-pressurization by use of a safety relief valve system. Safety relief devices are used to protect the inner vessel and vacuum casing, sized and manufactured in accordance with ASME and other standards.

#### **Cryogenic Temperatures**

The ORCA system employs cryogenic temperatures to store the product in its liquid state.

### WARNING!

In an oxygen-enriched atmosphere, flammable items burn vigorously and can explode. Excess accumulation of oxygen creates an oxygen-enriched atmosphere (defined by the Compressed Gas Association as an oxygen concentration above 23%). Certain items considered non-combustible in air might burn rapidly in such an environment. Keep all organic materials and other flammable substances away from possible contact with oxygen; particularly oil, grease, kerosene, cloth, wood, paint, tar, coal, dust, and dirt which may contain oil or grease. Do not permit smoking or open flame in any area where oxygen is stored, handled, or used. Failure to comply with this warning may result in serious personal injury including death.

### Warning!

Nitrogen and argon vapors in the air may dilute the concentration necessary to support or sustain life. Exposure to such an oxygen deficient atmosphere can lead to unconsciousness, serious injury, or even death.

#### Warning!

Before removing any parts or loosening of fittings, empty the cryogenic container of liquid contents and release any vapor pressure in a safe manner. External valves and fittings can become extremely cold and may cause painful burns to personnel unless properly protected. Personnel must wear protective gloves and eye protection whenever removing parts or loosening fittings. Failure to do so may result in personal injury due to the extreme cold and tank pressure.

#### WARNING!

Accidental contact of liquid gasses to skin or eyes may cause a freezing injury similar to a burn.

### **IMPORTANT!**

Handle liquid so that it will not splash or spill. Protect your eyes and cover skin where the possibility of contact with liquid, cold pipes, cold equipment, or cold gas exists. Safety goggles and/or a face shield should be worn if liquid ejection, splashing, or cold gas contact is possible. Clean, insulated gloves that can easily be removed and long sleeves are mandatory for arm protection. Cuff-less trousers should be worn over the shoes to shed any spilled liquid.

### IMPORTANT!

If clothing should be splashed with liquid oxygen it will become highly flammable and can easily ignite while concentrated oxygen remains. Such clothing must be removed, aired out immediately, and should not be considered safe for at least **30 minutes**.

### WARNING!

Use only replacement parts that are compatible with liquid oxygen and have been cleaned for oxygen use. **DO NOT** use regulators, fittings, hoses, etc., which have been previously used in a compressed gas air, CO2, or flammable gas environment. **DO NOT** use oxygen equipment for compressed air, CO2, or flammable gas. Failure to comply with these instructions may result in serious personal injury or death, or damage to the container.

### **IMPORTANT!**

Before locating oxygen equipment, become familiar with the National Fire Protection Agency Association (NFPA) standard No. 50, "Bulk Oxygen Systems at Customer Sites", and with all local safety codes. The NFPA standard covers general principals recommended for installing bulk oxygen systems on industrial and institutional consumer premises.

#### Safety Bulletins

Portions of the following information were extracted from Safety Bulletin SB-2 from the Compressed Gas Association (CGA), Inc. Additional information on oxygen, nitrogen, argon, and cryogenics is available from the CGA. Write to: (CGA) Compressed Gas Association, Inc., 1235 Jefferson Davis Highway, Arlington, VA 22202.

#### **IMPORTANT!**

Cryogenic containers stationary or portable, are from time-to-time subjected to assorted environmental conditions of an unforeseen nature. This safety bulletin is intended to call attention to the fact that whenever a cryogenic container is involved in any incident whereby the container or its safety devices are damaged, good safety practices must be followed. The same holds true whenever the integrity or function of a container is suspected of abnormal operation.

Good safety practices dictate that the contents of a damaged or suspected damaged container be carefully emptied as soon as possible. Under no circumstances should a damaged container be left with product in it for an extended period of time. Further, a damaged or suspected damaged container should not be refilled unless the unit has been repaired and recertified.

Incidents which require such practices be followed, include highway accidents, immersion in water, exposure to extreme heat or fire, and exposure to most adverse weather conditions (earthquakes, tornadoes, etc.). As a rule of thumb, whenever a container is suspected of abnormal operation or has sustained actual damage, good safety practices must be followed.

### **CAUTION!**

In the event of known or suspected container vacuum problems (even if an extraordinary circumstance such as those noted above have not occurred), do not continue to use the unit. Continued use of a cryogenic container that has a vacuum problem can lead to carbon steel embrittlement and cracking. Further, the carbon steel jacket could possibly rupture if the unit is exposed to inordinate stress conditions caused by an internal liquid leak.

### **CAUTION!**

Prior to reusing a damaged container, the unit <u>MUST</u> be tested, evaluated, and repaired as necessary by qualified personnel.

The remainder of this safety bulletin addresses those adverse environments that may be encountered when a cryogenic container has been severely damaged. These are Oxygen Deficient Atmospheres, Oxygen Enriched Atmospheres, and Exposure to Inert Gasses.

#### **Oxygen Deficient Atmospheres**

The normal oxygen content of air is approximately 21%. Depletion of oxygen content in air, either by combustion or by displacement with inert gas, is a potential hazard and users should exercise suitable precautions.

One aspect of this possible hazard is the response of humans when exposed to an atmosphere containing only 8 to 12% oxygen. In this environment, unconsciousness can be immediate with virtually no warning.

When the oxygen content of air is reduced to about 15 or 16%, the flame of ordinary combustible materials, including those commonly used as a fuel for heat or light, may be extinguished. Somewhat below this concentration, an individual breathing the air is mentally incapable of diagnosing the situation because the onset of symptoms such as sleepiness, fatigue, lassitude, loss of coordination, errors in judgment, and confusion.

### WARNING!

Human exposure to atmospheres containing 12% or less oxygen leads to rapid unconsciousness. Unconsciousness can occur so rapidly that the user is rendered essentially helpless. This can occur if the condition is reached by immediate change of environment, or through the gradual depletion of oxygen.

Most individuals in or around oxygen deficient atmospheres rely on the "buddy system" for protection. Obviously, the "buddy" is equally susceptible to asphyxiation if he or she enters the area to assist an unconscious partner unless equipped with a portable air supply. Equipping all individuals with a portable supply of respirable air ensures best protection.

**Important!** Lifelines are acceptable only if the area is essentially free of obstructions and individuals can assist one another without constraint.

## **Oxygen Cleaning**

### **CAUTION!**

When replacing components, even for inert service, only use parts, which are considered compatible with liquid oxygen and have been properly cleaned for oxygen service. (Refer to CGA Bulletin G4.1 "Equipment Cleaned for Oxygen Service"). <u>DO</u> <u>NOT</u> use regulators, fittings, or hoses that were previously used in a compressed air environment on these tanks. Only oxygen compatible sealant or Teflon tape should be used on aluminum threads. All new piping joints should be leak tested with an oxygen compatible leak-test solution. When degreasing, an oxygen compatible solvent should be used.

Once a system has been contaminated through improper or careless parts cleaning or replacement, the vessel may not be returned to Oxygen service without extremely extensive and complex cleaning methods.

If oxygen deficient atmosphere is suspected or known to exist:

Use the "buddy system". Use more than one "buddy" if necessary to remove a fellow worker in an emergency.

Both the worker and "buddy" should be equipped with self-contained breathing equipment.

#### **Oxygen Enriched Atmospheres**

An oxygen-enriched atmosphere occurs whenever the normal oxygen content of air is allowed to rise above 23%. While oxygen is non-flammable, ignition of combustible materials can occur more readily in an oxygen-rich atmosphere than in air; and combustion proceeds at a faster rate.

Oxygen system components, including but not limited to, containers, valves, valve seats, lubricants, fittings, gaskets, and interconnecting equipment including hoses, shall have adequate compatibility with oxygen under conditions of temperature and pressure to which the components may be exposed in the containment and use of oxygen.

Compatibility involves both combustibility and ease of ignition. Materials that burn in air may burn violently in pure oxygen at normal pressure, and explosively in pressurized oxygen. In addition, many materials that do not burn in air may do so in pure oxygen, particularly when under pressure. Metals for containers and piping must be carefully selected, depending on service conditions. The various steels are acceptable for many applications, but some service conditions may call for other materials (usually copper or its alloys) because of their greater resistance to ignition and lower rate of combustion.

Similarly, materials that can be ignited in air have lower ignition energies in oxygen. Many such materials may be ignited by friction at a valve seat or stem packing, or by adiabatic compression produced when oxygen at high pressure is rapidly introduced into a system initially at low pressure.

#### Nitrogen and Argon Asphyxiates

Nitrogen and argon (inert gases) are simple asphyxiates. Neither gas will support or sustain life and can produce immediate hazardous conditions through the displacement of oxygen. Under high pressure these gases may produce narcosis even though an adequate oxygen supply, sufficient for life, is present.

#### WARNING!

Nitrogen and argon vapors in the air dilute the concentration of oxygen necessary to support or sustain life. Inhalation of high concentrations of these gases can cause anoxia, resulting in dizziness, nausea, vomiting, unconsciousness, and possibly death.

Individuals should be prohibited from entering areas where the oxygen concentration is below 19% unless equipped with a self-contained breathing apparatus. Unconsciousness and death may occur <u>WITH VIRTUALLY NO WARNING</u> if the oxygen concentration is below 8%. Contact with cold nitrogen, argon, or argon gas of liquid can cause cryogenic (extreme low temperature) burns and freeze body tissue.

#### **IMPORTANT!**

Persons suffering from lack of oxygen should be immediately moved to areas with normal atmospheres. A SELF-CONTAINED BREATHING APPARATUS MAY BE REQUIRED TO PREVENT ASPHYXIATION OF RESCUE WORKERS. Assisted respiration and supplemental oxygen should be given if the victim is not breathing.

#### **IMPORTANT!**

If cryogenic liquid or cold boil-off gas contacts a worker's skin or eyes, the affected tissues should be promptly flooded or soaked with tepid water (105-115°F; 41/46° C). **DO NOT USE HOT WATER.** Cryogenic burns that result in blistering or deeper tissue freezing should be examined promptly by a physician.

### WARNING!

Do not attempt to remove an individual without utilizing proper rescue equipment or you may also become a casualty.

#### **IMPORTANT!**

If the exposed person is unconscious, obtain assistance and put into effect the established emergency procedures.

### **Section 4 - Theory of Operation**

The Orca PT Delivery System is a high performance transport vessel designed to optimize the filling of Perma-Cyls and small bulk vessels very quickly and economically. Key features of the Orca PT include a "Pressure Transfer/Pulse Technology" design requiring no electrically driven pump translating to less maintenance for the operator.

Furthermore, the ORCA System incorporates "SMART" flow meters that are designed to sense the filling status of Perma-Cyls and shut off automatically when filling is completed. This allows greater operator freedom during the filling process.

The ORCA PT System leverages the principles of cryogenics to minimize losses in delivering gas molecules to the use point. This section of the manual will discuss the theory behind the ORCA System by explaining the principles of cryogenics and provide the user with information necessary to properly understand and identify components and system functions.

Terminology - Cryogenic Principles

## Condensation

Changing gas vapors into liquid by cooling. Liquid can be changed to vapor by warming and vapor can be changed to liquid by cooling.

The ORCA Storage Vessel pressure during normal operation will rise above the saturation pressure of the liquid. This warmer gas will condense to the colder liquid pressure during transit. The liquid splashes into the gas space during normal movement of the truck. The splashing condenses the gas and drops the pressure.

Top filling a Perma-Cyl is possible due to condensing warmer gas to a lower pressure.

### **Cryogenic Temperatures**

ORCA Systems maintain gases efficiently in a cryogenic liquid state.

Cryogenic: A product retaining a temperature of -150° F or colder.

Gases can be most efficiently stored as liquids. For example, liquid nitrogen will expand in volume 750 times when warmed to a gaseous state. Gases may be liquefied by compression or cooling them until they liquefy. In order to be maintained in a liquid state, each gas must be kept at or below their respective boiling temperatures.

-		
Gas	Boiling Temperature (at 0 psig)	
Argon	-302°	
Nitroge	en -320°	
Oxyge	n -297°	
Table	1- Boiling Temperatures	

### **Depressurization Flash Losses**

Dropping the vapor space pressure below the saturation pressure of the liquid causing the liquid to boil. During the venting of the tank below the saturation pressure of the liquid, the liquid temperature will drop, the density will increase, weight of the liquid will decrease, and the saturation pressure will drop.



**Figure 1 - Flash Losses ORCA** 

Figure 2 - Flash Losses Bulk Storage



#### Entrainment

Liquid carried along with venting gas. Can occur during violent depressurization of a tank and during the top filling of a tank with the vent valve open. Large product losses will occur during this event.

### Equilibrium

In a closed vessel the gas and liquid temperatures are the same. If there is a temperature difference between the gas and liquid (with the tank closed), the gas and liquid will change temperatures, until they are <u>equal</u>.

### Liquid Growth

As liquid warms to higher saturation pressures the volume increases. Warm liquid is less dense. Less dense liquid takes up more volume. Liquid growth is a safety concern if the liquid is allowed to grow until it fills the storage vessel. This condition is called liquid full or hydraulically full. During this condition the pressure rises rapidly, the safeties will relieve, and the tank will vent liquid. Figure 3 illustrates the growth of liquid at the molecular level.

### **Figure 3- Liquid Growth**



#### **Pressure Drop**

Pressure lost due to the flow of liquid. The faster liquid flows through the piping circuit, the higher the pressure drop.

#### Saturation

In a closed container, a state where the liquid and gas phases coexists at temperature (in equilibrium).

### **Liquid Saturation**

Liquid density, temperature, and equilibrium pressure change with the saturation level of the liquid.

Saturation can also be described as an energy state. Liquid molecules at a higher energy state (warmer) take up more space. Figure 4 depicts liquid nitrogen at 50psig saturation and 15psig saturation.

### **Figure 4-Liquid Saturation**



#### **Saturation Pressure**

Pressure (usually in psi) that is used to describe the current condition of a liquid and gas within a closed container.

#### **States of Matter (see figure 5)**

Matter can exist as a gas, liquid, or a solid. Two phase liquid is a liquid with gas bubbles or slugs of gas, due to lack of pressure to maintain equilibrium. Gas and liquid can exist at a range of temperatures. Temperature is a measure of the amount of energy within the solid, liquid, or gas.

Gas is molecules in random motion, liquid is molecules in confined motion, and solid is molecules with no motion.



Figure 5 - States of Matter (Gas, Liquid, and Solid)

#### Stratification

Warm liquid is less dense. In a tall vertical tank this less dense liquid will find its way to the top of the tank. Colder more dense liquid will remain at the bottom. The change of temperature from top to bottom is called Stratification.

#### **Two-Phase Liquid**

The mix of liquid and gas due to the pressure dropping below the saturation pressure of the liquid. Figure 6 illustrates two-phase liquid.

### Figure 6-Two Phase Liquid



#### **Vapor Pressure**

Pressure of the vapor space. Measured by reading the tank pressure gauge.

#### Vaporization

Changing liquid into vapor by warming the liquid for the purpose of sub-cooling or for gas use.

### Maintaining Cold Liquid

#### What is Cold Liquid

Cold liquid is liquid saturated at 15 psi or less.

Saturation Pressure	Liquid Nitrogen Temperature	Liquid Oxygen Temperature	Liquid Argon Temperature
psi	deg F	deg F	deg F
0	-320	-297	-303
10	-311	-288	-293
15	-308	-284	-289

#### **Reasons for Cold Liquid**

- 1. Cold liquid is denser. Denser liquid has more cubic feet of gas per gallon of liquid.
- 2. Filling low pressure cylinders (22 psi) with warm liquid (above 22 psi) results in the main safety venting for extended periods of time after the fill is complete.
- 3. Colder liquid (10 psi or less) is essential in filling open Dewars. Cold liquid will minimize vent losses, optimize fill times, and improve safety.
- 4. Collapsing of vapor space in receiving vessel.

#### How to Maintain Cold Liquid

The ORCA PT is supplied with a secondary relief system (Road Relief Circuit). This secondary relief system will maintain the liquid at a specified saturation by the setting of the Road Relief Regulator to approximately 15 PSI. It is recommended to set the secondary relief system to 10 psi if open Dewars or low-pressure cylinders are to be filled.

After filling the ORCA PT storage vessel, vent the contents to your desired pressure. During daily operation, **keep the road relief valve open during transit, closing them during delivery of product.** 

#### **Know Your Current Saturation**

Upon arriving at your delivery site, the vessel pressure will indicate the current saturation pressure. This is due to the fact that, during travel the liquid splashes condensing the warmer vapor. This is referred to as "Shake Down". During normal delivery operations the vessel pressure will rise. This is **not** an increase in your saturation but an increase in your sub-cool. During normal deliveries your saturation pressure will remain the same as at arrival.

### **System Components/Terms**

#### Annulus

The Annulus volume of space is between the outer and inner cylinders that minimize the transfer of heat from the outer cylinder to the inner cylinder where the product is stored.

#### **Flow Processor**

Figure 7 shows the flow processor and system controller. They are used for calculating, integrating, system controlling, and displaying the mass flow. The push button controls allow the operator to start and stop the delivery, to view audit trail information, initiate the print out of the delivery ticket and to clear the counter.

#### **Figure 7-Flow Processor**



#### **Inner Cylinder**

The inner cylinder is the container in which the liquid product is stored. It is constructed of high quality alloy steel and its exterior is wrapped with a multilayered insulation.

### **Outer Cylinder**

The Outer Vessel houses the Inner Cylinder and serves as the chamber in which a vacuum is drawn to minimize the transfer of heat from the outer cylinder to the inner cylinder where the product is stored.

#### **Pulse Tank**

The Orca PT pulse tank also has a super-insulated inner vessel with a carbon steel outer vessel. The maximum working pressure of the Orca PT pulse tank is 350 PSI.

#### **Flow Meter**

The function of the flow meter (see figure 8) is based on an obstruction in the line that causes a pressure drop. This differential pressure is measured along with the temperature of the liquid to calculate mass flow. It has no moving parts, unlike turbine meters typically found in the industry. This makes it a very low maintenance item, since there are no turbines or moving parts to be damaged by gas.



#### **Figure 8-Cross Section of Flow Meter**

#### **Differential Pressure Transmitter**

Figure 9 is a picture of the Differential Pressure Transmitter used on the ORCA System.

The DP Transmitter measures a change in pressure (pressure drop) across the meter section and relays this information to the meter controller, via an electrical signal.



#### **Figure 9-Differential Pressure Transmitter**

#### **Ticket Printer**

An optional ticket printer (EPSON TM295, see figure 10) can be directly connected to the flow processor via serial data link. The printer requires a 24volt power source. A DC to DC converter is supplied to convert the truck or trailer 12-volt power to 24 volts. The system allows printing in a customized ticket form as well as a standard ticket on a plain sheet of paper. Additionally, it can also be used to print the system's parameter and audit trail information in order to file them.



**Figure 10-Ticket Printer** 

#### **RTD - Resistance Temperature Device**

Also referred to as PT100 (see figure 11). The resistance of the element at the end of the probe varies with temperature. The RTD is used to measure accurately the temperature of the liquid being metered. Based on this temperature a density is assigned. The temperature probes are 4-wire Resistance Temperature Devices (RTD). They are also referred to as PT 100 (Platinum element, 100 ohms is at 32 degrees F). Resistance varies with temperature. Figure 16 are the two versions of temperature device used (actual probe will depend on the ORCA Model ordered).



Figure 11-Resistance Temperature Device (RTD)

#### **Control Panel**

The Control Panel is shown in figure 12. The MAWP of the PT 1000 main storage tank (Fig. 12 Gauge upper Left) is 50 PSI. The main storage liquid level gauge (top center) displays in percent full. The MAWP of the pulse tank (gauge upper right) is 350PSI. The Pressure builder can be viewed and set by the cluster (middle left). A series of three pneumatic override switches can be used to manually operate the Dispense, Pressure Builder, and Pulse tank Vent to Bulk Valves.



### Figure 12-PT 1000 Control Panel

#### **Control Piping Circuit Valves**

The dispense circuit consists of three air actuated control valves; Vent to Storage, Dispense and Pressure Building (P.B.). The dispense circuit also includes five hand operated valves; Main Storage Road Relief, Pulse Tank Road Relief, Main Storage Vent, Pulse Tank Vent, and the Hose Valve.



## Section 5 - Operation of the Orca PT 1000

#### Filling the Orca PT 1000

#### **CAUTION!**

The ORCA is shipped under pressure with a nitrogen atmosphere to keep out moisture. IT MUST BE PURGED PRIOR TO USE.

#### **ORCA PT- Initial Fill or Warm Tank Procedures**

Pre-Cool the tank by blowing cold gas from the source tank into the fill line. Open the Manual Vent Valve, check the temperature of the exit gas. When the exit gas is cold enough to frost the vent assembly stop the flow of gas from the source tank and start the flow of liquid. Cooling the tank down slowly will prevent uneven cooling and uneven contraction. Stainless Steel from ambient to cryogenic temperatures will shrink 1/32" per 12" of length. Uneven shrinking can cause high stresses in supports and attachments, resulting in damage to the vessel.

#### Purging

The ORCA PT system is designed to be used for liquid nitrogen, argon, or oxygen service. Chart (and the Compressed Gas Association) does not encourage unnecessary and frequent changing of service to the vessel. However, if it is necessary to make a service change, to ensure product purity, or to remove any moisture or foreign material from the tank and tank lines, the ORCA® vessel must be purged.

**Note:** To prevent drawing atmospheric contaminates back into the tank, a positive pressure of at least 5 PSIG must be maintained in the tank.

#### **CAUTION!**

While purging through the various lines, observe the tank pressure-indicating gauge. Make sure that the tank pressure does not go below 5 PSIG.

#### Top Filling the ORCA PT Vessel

The PT piping has a Top Fill circuit Filling the ORCA with liquid saturated at pressure at or above the tank pressure rating (50psig), will require venting. Lowering the saturation pressure of a liquid will require the liquid to boil. Cold gas is heavy! Minimize venting during filling. Try to use as cold a source of

liquid as possible. **Note:** Either pressure transfer or pump fill can accomplish Filling the ORCA PT system.

## **CAUTION!**

Whenever possible, the truck should be on a level surface when filling. If the vehicle is not level, instrument readings as well as the full trycock points may not be accurate.

The best results will be obtained when the pressure in the supply unit is at least 25 pounds more than the receiving unit. As pressure fluctuates, adjusting the vent valve (V-5) on the ORCA vessel and the fill/drain valve on the supply unit may regulate the pressure.

#### WARNING!

Wear gloves and protective goggles when working with any cryogenic material. Contact with cryogenic materials can result in severe frostbite and injuries similar to burns.

### **CAUTION!**

Make sure that the Road Relief Valves (V-70 and V-2) are closed prior to filling the ORCA Vessel.

#### **Purging the Fill Line**

- 1. Connect the fill hose from the supply vessel to the truck fill CGA fitting.
- 2. Open the Fill drain valve.
- 3. Crack open the Fill valve on the supply tank.
- 4. Run product through the line to thoroughly purge the line until frost is visible at vent.

#### Filling the ORCA PT Vessel

The Fill valve on the ORCA PT Vessel has a spray header that will splash the incoming cold liquid onto the somewhat warmer gas in the tank. The cold liquid will condense the warmer gas reducing the vessel pressure.

- 1. Open Main Storage Vent (V-5).
- 2. Open the Fill Valve.
- 3. Monitor the Main Storage Tank Pressure Gauge During filling to ensure pressure does not exceed Maximum tank pressure (50 P.S.I).
- 4. When the liquid level in the tank is at the halfway point, open the Full Trycock Valve two turns.

- 5. When the tank is full, liquid will vent through the Full Trycock Valve to the Main Vent.
- 6. When the tank is full, shut the liquid supply tank fill and drain valves. Open the Fill Drain Valve.
- 7. Shut the Full Trycock and allow the hose to drain into the truck.
- 8. Shut the Fill Valve on the truck.
- 7. When the hose indicates no pressure, remove the hose from the CGA fitting on the truck.
- 8. Replace the CGA cover onto the fitting and stow the hose.
- 9. Open Road Relief Valves (V-70 and V-2).
- 10. Close the back doors.

## Plumbing - Road side



Plumbing – Curb side



## **Arrival Conditions**

Upon arrival all control valves are closed and the hand valves for road relief are open. If pressure is above road relief set point, gas will be venting. The Pulse tank will be at or near the 100 % level if Auto Refill Mode was initiated



## Step #1 Control Panel - At Arrival

- Upon Arrival, turn on Flowcom S8
- Turn on work lights to display Main Tank Liquid Level.



## **Gauge Panel**

Main storage tank pressure at arrival will be below 25psig.

Main Storage Tank liquid level is displayed in % full.

Pulse tank pressure will be within 5psig of the Main Storage Tank pressure.

### **Flow Meter**

0.0 will be displayed in the totalizer if the last delivery was cleared.

"-S-" in the status display means stand by or ready.

All valves should bein the manual off (auto) position.



## Step #3 - Attach Hose

• Attach Hose to fill connection of receiving tank.

- Hose valve should remain closed.
- Determine if the receiving tank is "Cold" (has liquid).



## Step #4 - Level Check

- 70 flowcom s8 100 -L-Status Field Totalizer Field
- Press the "Start Button to display the Pulse Tank Liquid Level and change Status field from "-S-" to "-L-".

ıe

• If the level is low use the Auto Refill or Fast Fill procedure to fill the pulse tank.

## <u>Step #5 – Fast Fill Procedure</u>



• Turn the Pulse Tank Liquid Lever switch on.

- Open Pulse Tank Vent Valve
- Monitor liquid level in flowcom Totalizer field.
- Close Pulse Tank Vent Valve to stop liquid flow to Pulse Tank.

Pulse Tank Vent Valve

## <u>Step #6 – Check receiving tank Pressure and check P.B set point</u>



## <u>Step #7 – Adjust P.B. set point</u>



## **Step #8 - Start Pressure Building**

#### **Pressure Build**

- Press the "Start" button to open the P.B. valve.
- Observe Control Panel to verify start of Pressure Building.

The light above the PB valve on the active schematic will illuminate when valve is open.

The pulse tank pressure gauge will increase. The Pulse Tank Pressure will also be displayed in the "Totalizer" field and –P- will be displayed in the "Status" field during the pressure rise





### **Step #10 Determine when system is ready to start**



### **Step #11 - Start Delivery**



## **During Delivery**

•The dispense valve and pressure building valve are open during the delivery.



## **During Delivery**

•The receiving tank pressure and the pulse tank pressure both drop during the delivery.

•The cold liquid drops the receiving tank pressure and the pulse tank pressure drops due to the high delivery flow rates.



## **During Delivery**

•The flow rate drops off from the initial 40+ gallons per minute to approximately 20 gallons per minute at the end of the 300 liters.

•A 50 psi pressure difference between the pulse tank and the cylinder will result in approximately a 20 gallon per minute flow rate.



## **Step #12 The Delivery Termination (Operator Controlled)**

• The flow may need to be stopped before the level reaches the float. The operator can close the hose valve, or press the "Stop" button.



## **Step #13 The Delivery Termination (System Controlled)**

•The flow is restricted by the float. The controller senses this restriction and closes the delivery hose and the pressure building valve.



# **Step # 14 End of Delivery**

### **End of Flow**

•The pulse tank will be below P.B. set point.

•The delivery total is displayed in the "Totalizer" field.

•"-S-" will be displayed in the status field if the fill was terminated due to the float restriction, or hose valve being manually closed.



# **Step #15 - Disconnect Hose**

•Close hose valve.

•Disconnect the hose and stow.



## **Step #16 - End Delivery**



## End Delivery

•Press and hold the "Stop" until the "-E-" is displayed in the "Status" field.

## Step # 17 Printing a job ticket (Optional printer)

Upon completion of the delivery, information relating to the delivery of product can be printed onto a standard or custom Job Ticket.

The standard delivery contain the following information: Transaction Number, Product, and Quantity.



**Power Switch(on side of printer)** 

# Printing a Job Ticket

#### Φ

- 1. Switch the printer power "ON".
- 2. Press the Printer "RELEASE" button.
- 3. Insert the ticket.
- 4. Press the printer "FORWARD" button to lock ticket in place.
- 5. Press and hold the "STOP" button until "-E-" appears in the status window.
- 6. Press the "START" button to print the ticket.
- 7. Press the printer "RELEASE" button to remove the ticket.
- 8. Additional tickets (duplicate) can be printed by repeating the steps above.
- **9.** To erase the transaction and/or error messages, press and hold the **"STOP"** button for 5 seconds.

## **Step #18 - Print Ticket**



•A duplicate ticket can be printed by pressing the "Start" button a second time.

# Step #19 - Clear Total



### **Clear the Total**

•Press and hold the Stop button to clear the total.

• -S- will be displayed in the Status field.

## Step #20 - Auto Refill Pulse Tank



•With the total cleared and -Sin the status field. Press and hold the "Auto Re-fill" button.

•The Vent to Storage valve will open. The pulse tank pressure will drop and the storage pressure will increase.

## Step #21- Manual Vent

•Open manual vent to drop the pressure to near 25 psig.



## Step #22 - Open Road Valves

•At 25 psi close the manual vent and open the road relief valves.

•Close the cabinet doors.

•Proceed to next stop.



## **Manual Fill Termination**

• Auto Vent valve closes when the pulse tank is full.

•Check valve close when the pulse tank pressure rises.

•The pulse tank road relief circuit maintains the pulse tank below road pressures.

