Product Manual

Perma-Cyl® MicroBulk Storage Systems

3000 Liter - Horizontal

Designed and Built by:

Chart Inc.

1300 Airport Dr.
Ball Ground, GA 30107 USA
(800) 400-4683

Part Number 20752370 Rev. B

Contents

Revision Log

Revision Level	Date	Description
A	06/02/2014	Original
B	01/05/2016	Update format & add standard manual contents

Preface

General

Chart has created a horizontal version of the very popular Perma-Cyl 3000 HP and VHP MicroBulk Storage System. This new product offering has the same performance as our 3000 HP and VHP, but in a package that is easily delivered on a flatbed truck and short enough to fit under a six foot fence. It also utilizes our new FlexFill™ Piping Option technology.

FlexFill piping is a top and bottom fill circuit that replaces the top float assembly so the driver can control the Perma-Cyl tank pressure during the filling process. This new design maintains the auto shut-off feature with the Orca™ MicroBulk Delivery System for a safe and reliable fill. The FlexFill piping option uses technology adopted from our LNG fueling system which allows for a ventless fill. This patented automatic dispensing system simulates the same process that drivers have used for years to safely fill Perma-Cyl storage tanks with a single hose. The new FlexFill piping feature works with all Orca delivery unit models, both new and existing.

**The FlexFill tank is presently not approved for use with CO_2.*

Product Advantages

- Capacity of 3,000 liters (715 gal)
- Pressures up to 350 psig (24.1 barg) or 500 psig (34.5 barg)
- Gas supply rate up to 2,000 scfh (52.4 Nm^3H)
- All 304 stainless steel construction
- Patented automatic fill shut-off with optional fill box for remote filling from outside the building
- Orca automatically safely stops the fill process when Perma-Cyl is full
- Patented Cyl-Tel® Liquid Level Gauge supports remote alarms or telemetry communications
- Separate pressure build and economizer plumbing circuits
- Outdoor or indoor installation and operation
- Optional VJ withdrawal on HP style tanks
- Forklift access from all sides

Product Manual

This manual contains information regarding the safe operation and maintenance of a Perma-Cyl MicroBulk Horizontal Storage System. It should be thoroughly read and understood by anyone that operates the equipment.

The safety requirements for operating the tank and handling or transporting extremely cold liquid products are shown in the Safety section. Use this safety section as a “Safety Checklist” each time the equipment is being used.

The Introduction section discusses the general features of the tank and the theory of operation. Initial inspection of equipment and gas and liquid withdrawal procedures can also be found in this section.

In the Installation section there are illustrations for how to install the tank.

The Plumbing section contains schematics and detail information to help in identifying various parts of the Perma-Cyl system.

In the Specifications section there is a table that describes the capacities, general specifications and performance of the system along with more schematic drawings.

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.

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

Acronyms / Abbreviations

The following acronyms / abbreviations are used throughout this manual:

ASME	American Society of Mechanical Engineers
Atm	Unit of Atmospheric Pressure
BAR	Pressure (Metric)
CGA	Compressed Gas Association
CO_2	Carbon Dioxide
Kg	Kilogram
LAR	Liquid Argon
LN_2	Liquid Nitrogen
MAWP	Maximum Allowable Working Pressure
MM	Millimeters
Nm^3H	Normal Cubic Meters/Hour
NFPA	National Fire Protection Association
PB	Pressure Builder
PN	Part Number
PSI	Pounds per Square Inch
PSIG	Pounds per Square Inch (Gauge)
SCF	Standard Cubic Feet
SCFH	Standard Cubic Feet/Hour
UFC	Uniform Fire Code

Safety

General

While Chart equipment is designed and built to the most rigid standards, no piece of mechanical equipment can ever be made 100% foolproof. Strict compliance with proper safety and handling practices are necessary when using a cryogenic manifold device or other compressed gas equipment. We recommend that all of our customers re-emphasize safety and safe handling practices to all their employees and customers. While every possible safety feature has been designed into the Perma-Cyl® MicroBulk Horizontal Storage System and safe operations are anticipated, it is essential that the customer carefully read and fully understand all Warning and Caution notes listed below.

Warning! ***The Perma-Cyl cylinder, with its stainless steel support system is designed, manufactured, and tested to function normally for many years of service. It is never safe to drop a liquid cylinder or let it fall over in oxygen or any cryogenic service. In the event a liquid cylinder is inadvertently dropped, tipped over, or abused, slowly raise it to its normal vertical position and immediately open the vent valve to release any excess pressure in a safe manner. As soon as possible, remove the liquid product from the vessel in a safe manner. If the vessel has been used in oxygen service, purge it with an inert gas (nitrogen). If damage is evident or suspected, return the unit to Chart prominently marked "LIQUID CYLINDER DROPPED, INSPECT FOR DAMAGE".***

Warning! ***Any welding that is done on the outside of the Perma-Cyl System can cause loss of vacuum and will VOID any warranty on the unit.***

Warning! ***Before removing cylinder parts or loosening fittings, completely empty the cylinder of liquid and release the entire 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 because of extreme cold and pressure in the cylinder.***

Caution! ***Only use replacement equipment which is compatible with liquid oxygen and has been cleaned for oxygen use. Do not use regulators, fittings, hoses, etc., which have been previously used in compressed air service. Failure to comply with these instructions may result in serious damage to the liquid cylinder and personal injury.***

Caution! ***All valves on an empty Perma-Cyl system should always be kept closed to protect the inner vessel and plumbing from being contaminated.***

Safety Bulletin

Portions of the following information are extracted from Safety Bulletin SB-2 from the Compressed Gas Association, Inc. Additional information on oxygen, nitrogen, argon, and cryogenics is available from the CGA.

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.

Incidents which require that such practices be followed include: highway accidents, immersion of a container in water, exposure to extreme heat or fire, and exposure to most adverse weather conditions (earthquake, tornadoes, etc.). Under no circumstances should a damaged container be left with product in it for an extended period of time.

Prior to reusing a damaged container, the unit must be tested, evaluated, and repaired as necessary. It is highly recommended that any damaged container be returned to Chart for repair and re-certification.

In the event of known or suspected container vacuum problems (even if an extraordinary circumstance such as those noted above has not occurred), do not continue to use the unit. Continued use of a cryogenic container that has a vacuum problem can lead to embrittlement and cracking.

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 gases.

Caution! Before locating oxygen equipment, become familiar with the NFPA standard No. 55 "Compressed Gases and Cryogenic Fluids Code" (www.nfpa.org) and with all local safety codes.

Oxygen Deficient Atmospheres

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

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 to 16%, the flame of ordinary combustible materials, including those commonly used as 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 can be masked by a state of "euphoria," leaving the victim with a false sense of security and well being.

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 an immediate change of environment, or through the gradual depletion of oxygen.

Most individuals working 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 the unconscious partner unless equipped with a portable air supply. Best protection is obtainable by equipping all individuals with a portable supply of respirable air. Life lines are acceptable only if the area is essentially free of obstructions and individuals can assist one another without constraint.

If an oxygen deficient atmosphere is suspected or known to exist:

1. Use the "buddy system." Use more than one "buddy" if necessary to move a fellow worker in an emergency.
2. Both the worker and "buddy" should be equipped with self-contained or airline breathing equipment.

Oxygen Cleaning

When replacing components, only use parts which are considered compatible with liquid oxygen and have been properly cleaned for oxygen service (Refer to CGA Bulletin G-4.1 "Equipment Cleaned for Oxygen Service"). Do not use regulators, fittings, or hoses which were previously used in a compressed air environment on these tanks. Only oxygen compatible sealants or Teflon tape should be used on threaded fittings. All new piping joints should be leak tested with an oxygen compatible leak-test solution.

Oxygen Enriched Atmospheres

An oxygen-enriched atmosphere occurs whenever the normal oxygen content of air is allowed to rise above 23%. While oxygen is nonflammable, ignition of combustible materials can occur more readily in an oxygen-rich atmosphere than in air; and combustion proceeds at a faster rate although no more heat is released.

It is important to locate an oxygen system in a well ventilated location since oxygen-rich atmospheres may collect temporarily in confined areas during the functioning of a safety relief device or leakage from the system.

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 the conditions of temperature and pressure to which the components may be exposed in the containment and use of oxygen. Easily ignitable materials shall be avoided unless they are parts of equipment or systems that are approved, listed, or proven suitable by tests or by past experience.

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 alloy) 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.

Warning! If clothing should be splashed with liquid oxygen it will become highly flammable and easily ignited while concentrated oxygen remains. Such clothing must be aired out immediately, removing the clothing if possible, and should not be considered safe for at least 30 minutes.

Nitrogen and Argon

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.

Nitrogen and argon vapors in 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, or unconsciousness and possibly death. Individuals should be prohibited from entering areas where the oxygen content is below 19% unless equipped with a self-contained breathing apparatus. Unconsciousness and death may occur with virtually no warning if the oxygen concentration is below approximately 8%. Contact with cold nitrogen or argon gas or liquid can cause cryogenic (extreme low temperature) burns and freeze body tissue.

Persons suffering from lack of oxygen should be immediately moved to areas with normal atmospheres. 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. If cryogenic liquid or cold boil-off gas contacts worker's skin or eyes, the affected tissue should be flooded or soaked with tepid water (105-115ºF or 41-46ºC). DO NOT USE HOT WATER. Cryogenic burns that result in blistering or deeper tissue freezing should be examined promptly by a physician.

Personal Protective Equipment (PPE)

The following personal protective equipment is recommended when working around cryogenic liquid:

- Safety glasses with side shields to prevent cryogenic liquid from splashing into the eyes
- Chemical / Liquid resistant gloves to prevent cryogenic burns on exposed hands
- Long sleeve shirts to protect the arms
- Cuffless trousers worn over closed shoes

Introduction & Operation

General

The new horizontal Perma-Cyl MicroBulk Storage System is another extension of the Perma-Cyl system's innovative design and technology. The horizontal Perma-Cyl system maintains all the features of the existing Perma-Cyl systems with the improved benefit of being horizontal and low profile.

This product was designed with the volume MicroBulk user in mind. Several features include fast fill capability (top and bottom), no loss or low loss fill with automatic fill termination, and extended hold time. The fast fill feature is accomplished with two filling valves, a top and a bottom fill valve which allow for the tank to be filled efficiently without any venting or loss of product (zero losses) under normal conditions.

The cylinder also uses the most advanced pressure building and vaporization technology today. The external process vaporizer is mounted onto the side of the vessel for optimum performance. The external pressure building vaporizers provide quick pressure building and great maintenance of system pressure especially during high liquid draw or high gas usage rate situations. The vaporizers will also maintain the advertized outlet temperatures even at maximum specified flow rates (2000 SCFH). For convenience, a gas use shut off port is located at both the front and the rear of the vessel.

Initial Inspection

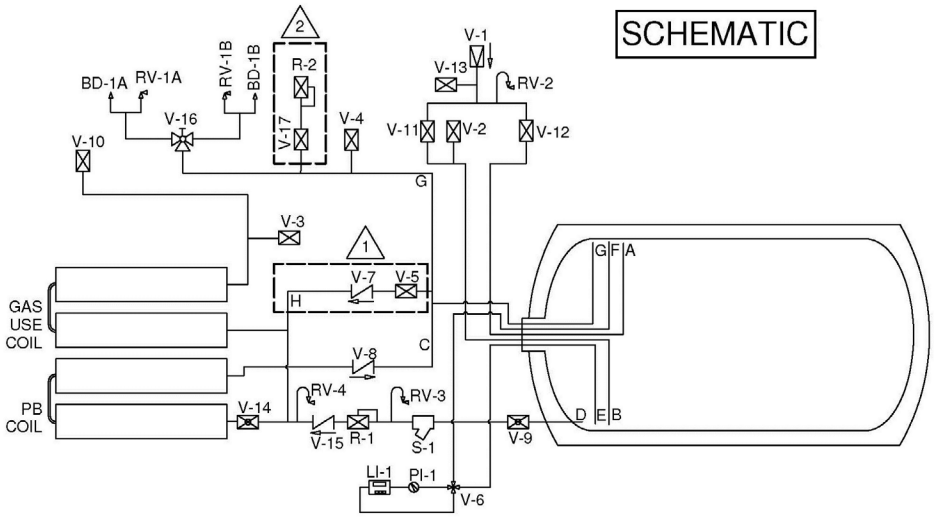
Upon receipt of a Perma-Cyl tank, remove the protective wrapping and inspect for the following:

- Check the outer shell of the tank. There should be no visible signs of damage such as dents or deep scratches.
- Check the piping and external vaporizers on the tank, there should be no visible signs of damage.
- Check that the tank has pressure, normally about 20 psi.
- If the tank passes all the above criteria it is ready for first fill. Follow the First Fill Procedures in the Installation section of this manual.

Operation

The plumbing design for the 3000 liter horizontal Perma-Cyl tank is different from all the vertical models and is addressed in the following section. The horizontal Perma-Cyl tank does not have any internal vaporization or pressure build coils. All pressure building and process vaporization is provided by two external vaporizers.

SCHEMATIC



NOTES:

1. PLUMBING CIRCUIT AVAILABLE ON ### - 03 OPTION KITS ONLY.
2. PLUMBING CIRCUIT AVAILABLE ON ### - 04 OPTION KITS ONLY.

NOMENCLATURE	
V-1	FILL CHECK VALVE
V-2	LIQUID VALVE
V-3	GAS USE VALVE- FRONT
V-4	VENT VALVE
V-5	ECONOMIZER VALVE
V-6	4-WAY VALVE
V-7	ECONOMIZER CHECK VALVE
V-8	PB RETURN CHECK VALVE
V-9	MAIN LINE VALVE
V-10	GAS USE VALVE - REAR
V-11	BOTTOM FILL VALVE
V-12	TOP FILL VALVE
V-13	FILL PURGE VALVE
V-14	PB INLET VALVE
V-15	MAIN LINE CHECK VALVE
V16	RELIEF SELECTOR VALVE
V-17	BACK PRESSURE VALVE
LI-1	LEVEL INDICATOR
PI-1	PRESSURE INDICATOR
R-1	PB REGULATOR
R-2	BACK PRESSURE REGULATOR
RV-1A/B	PRIMARY RELIEF VALVE
RV-2	PIPING RELIEF VALVE
RV-3	PB PIPING RELIEF VALVE #1
RV-4	PB PIPING RELIEF VALVE #2
S-1	STRAINER
BD-1A/B	BURST DISC
PIPING	
A	TOP FILL
B	BOTTOM FILL / LIQUID WITHDRAWAL
C	PRESSURE BUILDING INLET
D	PRESSURE BUILDING OUTLET
E	LIQUID PHASE (HIGH)
F	VAPOR PHASE (LOW)
G	SAFETY CIRCUIT / VENT
H	ECONOMIZER

Primary Plumbing Circuits

(see Flow Schematic on page 7)

Fill

The Perma-Cyl 3000 liter horizontal tank has a top and bottom fill circuit that replaces the top float assembly so the driver can control the tank pressure while filling the Perma-Cyl MicroBulk Storage System. The fill circuit consists of a top fill valve (V-12), a bottom fill valve (V-11), a fill check valve (V-1), and a hose drain valve (V-13). The fill line check valve has a service fitting on the inlet side that provides the sole connection for the liquid delivery vehicle.

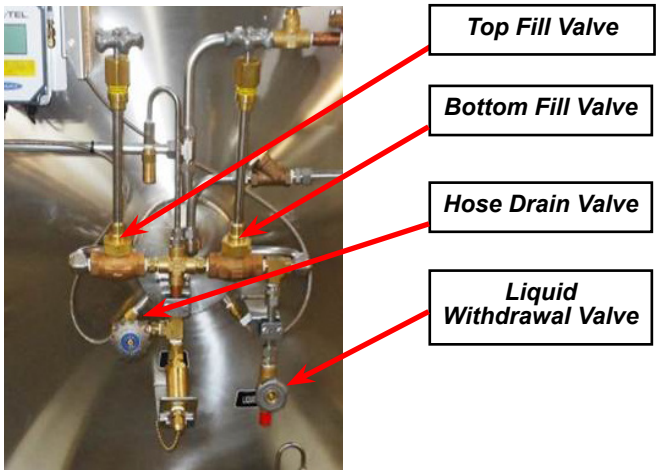


Photo 1 - Top and Bottom Fill Circuit

The hose drain valve (V-13) can be used to both purge the fill hose before filling the tank or to depressurize the fill hose after filling the tank.

The driver controls the pressure in the vessel during the fill process by adjusting the flow through the top and bottom fill valves. Product flowing into the bottom of the tank will raise the pressure and product flowing into the top of the tank will lower the pressure. Adjusting each valve properly will allow the driver to hold a consistent pressure in the tank throughout the entire delivery.

During a first fill, only fill the vessel to 75% full to allow liquid expansion experienced with a new "hot" tank. Each fill there after can be filled to 100% full. Please refer to the Installation section of this manual for detailed filling procedures.

Caution! If liquid can be trapped in the transfer system, a suitable relief valve must be installed to prevent over pressurization.

Caution! Before making a liquid transfer either into or out of this vessel, be sure that protective eyeglasses and gloves are being worn. If the transfer is being made to an open top vessel, the transfer pressure should be as low as possible and a phase separator should be used to eliminate splashing and hose whip.

Pressure Build

The pressure build circuit for the horizontal Perma-Cyl tank is used to build pressure back in the vessel after a delivery or to maintain pressure as liquid is withdrawn from the vessel. The vessel pressure is set by adjusting the PB regulator (R1) shown in photo 2. Standard PB set points found in the 09 plumbing option kits are:

MP - 125-09

HP - 300-09

VHP - 450-09

Note that the liquid which feeds both the PB and the process vaporizers is drawn off the bottom of the tank and split between the two piping circuits. Depicted in photo 2 is where the split occurs. Part of the flow goes to the PB vaporizer and part of the flow goes to the process vaporizer. The vaporized gas off of the PB vaporizer is then returned to the top of the tank. The other portion goes directly to the customer through the gas use valve V-3 or V-10. Closing valve V-14 will shut off the PB circuit.

Note: *Closing valve V-9 will cut off both the PB circuit and any process gas going to the customer through the gas use valve.*

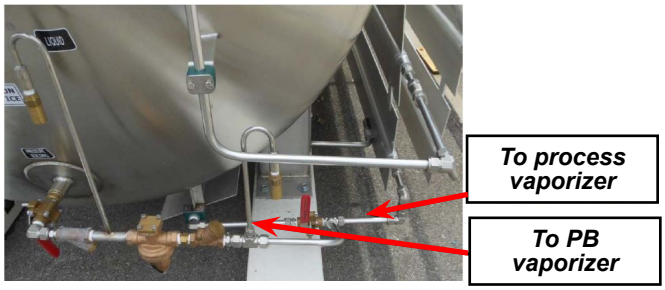


Photo 2 - Flow goes through the single PB regulator and splits to each vaporizer.

Economizer

The economizer circuit allows for the customer to utilize the natural heat leak that occurs in every cryogenic storage vessel. The economizer circuit for the 3000 liter horizontal Perma-Cyl tank is comprised of a check valve V-7 (see photo 3) which draws gas directly off the top of the tank through the gas use valve. Flow through the 1 psig cracking pressure check valve (V-7) only occurs when regulator R-1 closes. Closing valve V-5 will shut off the economizer circuit.

Photo 3 - Economizer check valve

Liquid Use

The liquid use circuit for 3000 liter horizontal Perma-Cyl tanks is similar to other Perma-Cyl models. This circuit draws liquid directly up the dip tube (B) and out through the liquid use valve (V-2). For high flow gas use applications, the liquid can be piped from the liquid use valve (V-2) (see photo 1) to a stand-alone external vaporizer that is properly sized for the flow rate. In this scenario, the gas use valve on the tank is not used.

Gas Use

The gas use valve on the 3000 liter horizontal Perma-Cyl tank is the primary connection point to supply process gas to the customer. The liquid for the process gas comes directly off the bottom of the tank (D) and travels through the PB regulator (R-1). The liquid then splits between the PB vaporizer and the process vaporizer as shown in photo 2. After exiting the gas use vaporizer the option exists to connect the final line regulator to either gas use valve on the front (V-3) or the back (V-10) of the tank (see photo 5).

Note: *Since all the liquid for both the PB and gas use requirements of this model tank travels through one regulator (R-1), the limiting factor on flow is this regulator. A high flow kit (PN 11905753) is offered for this tank. This kit adds an additional PB regulator in parallel with the existing PB regulator (R-1) allowing for flows up to 3500 SCFH (see photo 4).*

Photo 4 - High Flow Kit

Photo 5 - Gas use valve in the rear of the tank

Other Piping Circuits and Components

Phase Lines and Liquid Level Gauges

The 3000 liter horizontal Perma-Cyl tank is equipped with both a low pressure phase line (F) located on the top of the vessel and a high pressure liquid phase line (E) located on the bottom of the vessel. These lines are connected to a differential pressure (DP) gauge (Ll-1) which is used to indicate the amount of product in the vessel. The standard DP gauge used by Chart is the Cyl-Tel® Liquid Level Gauge. Customers can specify other models as options such as the WIKA Analog DP Gauge (see photos 6 & 7).

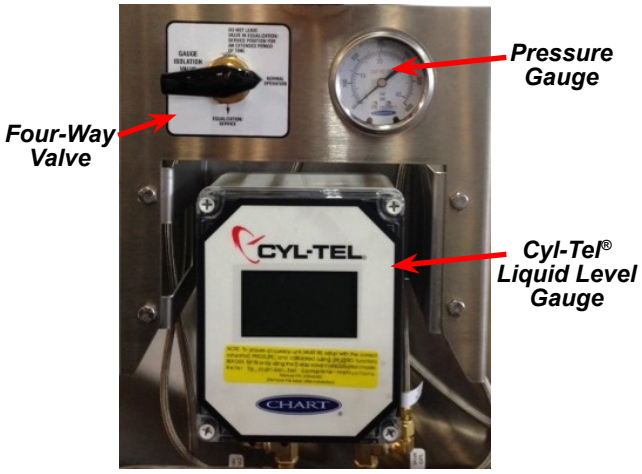


Photo 6 - Cyl-Tel Liquid Level Gauge

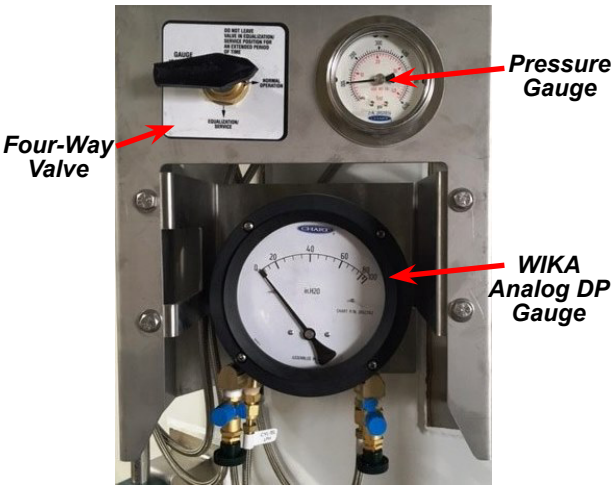


Photo 7 - WIKA Analog DP Gauge

Four-Way Valve *(see photos 6 & 7)*

The four-way valve (V-6) is used as the primary isolation valve between the DP gauge and the phase lines from the tank. This four-way valve also provides an easy method to check the zero on the DP gauge. By turning the valve to the equalization position, the DP gauge can be zeroed and isolated from the tank pressure for removal or replacement.

The four-way valve is used to protect the gauge by applying pressure to both sides of the gauge evenly when it is actuated. Most gauges can be damaged if a high differential pressure is applied to one side of the gauge. The major difference between the four-way and the five-way is that the four-way does not isolate the phase lines on the tank, it connects them. This is turn creates a PB affect and allows liquid to come up the liquid phase line. For this reason **DO NOT** leave the four-way valve in the equalization position for an extended period of time. Additionally, since the valve does not isolate the phase lines, you will need to allow the phase lines to stabilize again after putting the gauge back into service. Basically the liquid which has come up the liquid phase line needs to boil back down.

Checking Zero on Gauge

1. Rotate the four-way valve to the "Equalization/Service" position.
2. Check zero for gauge.
3. Set the gauge zero if needed (follow zeroing instruction in the gauge manual).
4. Rotate the four-way valve to the "Normal Operation" position.

Removing the Gauge from the Tank

1. Rotate the four-way valve to the "Equalization/Service" position.
2. Remove the four mounting bolts for the gauge bracket assembly. This will allow you to drop the bracket down and get access to the two mounting screws on the back of the bracket which hold the gauge.
   a. Four ¼-20 bolts, 7/16" wrench
3. Remove the two mounting screws on the back of the gauge and place the mounting bracket aside.
   a. Machine screws with lock washers, #2 Phillips screwdriver

4. Slowly loosen and remove the liquid phase line from the gauge.
   a. Swagelok fitting, 9/16" wrench
5. Slowly loosen and remove the gas phase line from the gauge.
   a. Swagelok fitting, 9/16" wrench
6. Remove the gauge.

Pressure Gauge (see photos 6 & 7)

A single pressure gauge (PG-7) on the 3000 liter horizontal Perma-Cyl tank is also tied into the low phase line and gives the operator a pressure reading in the gas phase of the vessel. This pressure gauge can also be isolated with the four-way valve.

Installation

General

The horizontal orientation and low profile of this product, and the design of the support base allows for easy and versatile handling by forklifts in all four directions.

The external vaporizer is mounted on one side of the cylinder so care should be taken when transporting the tank via fork lifts on the side with the vaporizer assembly. For optimum performance, the tank should be installed with the vaporizer facing as much sunlight as possible, and away from the building shadow and other obstructions.

Installation Common Codes and Standards

The installer will need to find out what local city ordinances and which rules they are mandated to follow. One of the following standards may apply; Uniform Fire Code (UFC), Compressed Gas Association (CGA), and the National Fire Protection Association (NFPA, for oxygen only).

Note: *Regulations vary in every part of the country. Always consult local codes!*

Caution! Not for CO_2 service. This particular unit contains a ullage within the inner tank.

Bolting to Floor

The horizontal Perma-Cyl tank is equipped with two beams along the base with anchor holes at the end of each beam (see photo 8). To ensure a safe environment, the tank ***must*** be bolted to the floor.

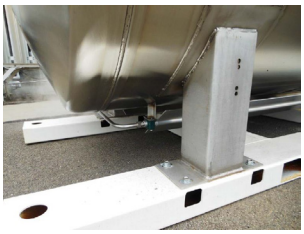


Photo 8 - Anchor Holes

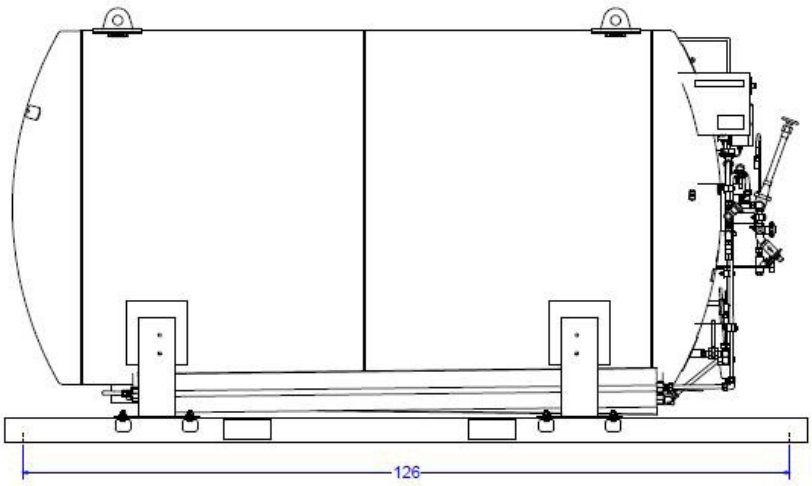
1. Place tank in position with gauges facing toward the front.
2. Mark holes on foundation, move tank.
3. Drill holes using appropriately sized bit.
4. Blow out dust and insert masonry anchors.
5. Move tank back into position over holes and install lag bolts.
6. Tighten bolts.

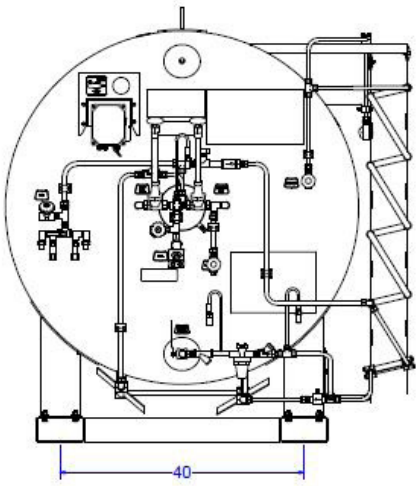
The suggested anchor holes at the four corners of the base requirements are:

Note: *Pad design specifications and anchoring requirements are often specified per local building codes. Use a qualified professional engineer for stamped drawings if required.*

- Bolt: 3/4” dia. (minimum); or 1” dia.
- Concrete: 2500 PSI minimum
- Embedment: 5” minimum (3/4” dia. bolt);
  7” minimum (1” dia. bolt)
- Edge Distance: 7 1/2 minimum (3/4” dia. bolt);
  6” minimum (1” dia. bolt)

Warning! Do not move or store the unit on an angle. Always keep the tank horizontal on its base.





First Fill/Purge Procedure

Note: *The Perma-Cyl tank is shipped with low purity nitrogen gas. Purging is necessary prior to filling. During first fill, only fill the vessel to 75% full to allow for liquid expansion experienced with a new (warm) tank. Each fill thereafter can be filled to 100% full. All valves on an empty Perma-Cyl tank should always be kept closed to prevent the inner vessel and plumbing from being contaminated.*

Purging and First Fill Procedure

1. Attach the source of liquid purge to the fill connection of the Perma-Cyl tank.

2. If the fill hose has not been kept under pressure since the last delivery, it will need to be purged. Purge the fill hose and connector through the purge valve, if so equipped, or by loosening the fill connection until vapor flows from the connection and then retighten. Use the hose drain on the tank piping if equipped as such.

3. If the Perma-Cyl tank is pressurized, open the vent valve and blow down to approximately 5 psi. To prevent drawing atmospheric contaminants back into the tank during the purging operation, a positive pressure of at least 5 psig should be maintained in the tank.

4. Partially fill the Perma-Cyl tank with approximately 5000 standard cubic feet of product (use truck meter to verify amount).

   Let liquid build pressure close to safety setting.

   Leak check all plumbing circuits while the tank is under maximum pressure.

   While vent gas is still warm and tank is under pressure, move the four-way valve to the ‘Equalization’ position and loosen the fittings on either side of the liquid level gauge to allow the gauge lines to purge with gas. Check the gas stream coming out of the fittings for evidence of moisture. Continue to flow the gas until lines have been purged and there is no visible signs of moisture. Tighten fittings to stop the flow of gas. Move the four-way valve to the ‘Normal Operation’ position.

   Vent all product out of the liquid valve and close before pressure drops below 5 psig.

5. Fill Perma-Cyl tank with 5000 standard cubic feet of product. Primarily use the bottom fill on a FlexFill style tank. Make sure some product is also routed through the top fill lines to purge them prior to totally filling the tank.

   Open the PB circuit and set to maximum psi. Ensure liquid is flowing through this circuit as indicated by frosting on the pipes. Let liquid in the tank build pressure close to safety setting. Once desired pressure is reached, open liquid valve. When liquid is out of the tank and pressure is still high, open the vent and gas use valves. If a final line manifold is already connected to the gas use valve, purge through the manifold to insure that there is a flow through the gas use circuit and any moisture is purged out before liquid is introduced into this circuit.

   Once pressure is blown down to 5 psig, close the liquid, vent and gas use valves.

6. Fill the Perma-Cyl tank with 5000 standard cubic feet of product and let the liquid in the tank build pressure close to the safety setting. Insure the product is flowing through and purging the economizer lines. Control the pressure by opening the gas use and vent valves. Once pressure is approximately 5 psig, close the gas use and vent valves.

7. Fill the Perma-Cyl tank with 5000 standard cubic feet of product and let the liquid in the tank build pressure to close to the safety setting. Once the desired psig has been reached, open the gas use and vent valves. Once pressure is approximately 5 psig, close the gas use and vent valves.

Note: *The purge gas should be cooling the tank. If the tank vent line is HOT, always purge until the vent line is cool or even frosted. A new, warm tank should go through a minimum of four or five purge cycles before filling with liquid.*

Filling the Tank After the Cool Down Process is Complete

1. If equipped with a bottom fill valve, the bottom fill valve and the tank vent valve are the valves to be used to fill a warm tank.

2. Have the driver start the pump and slowly deliver the liquid into the tank. Observe the tank pressure and control the pressure by venting the tank down or by using the top fill valve to control the pressure.

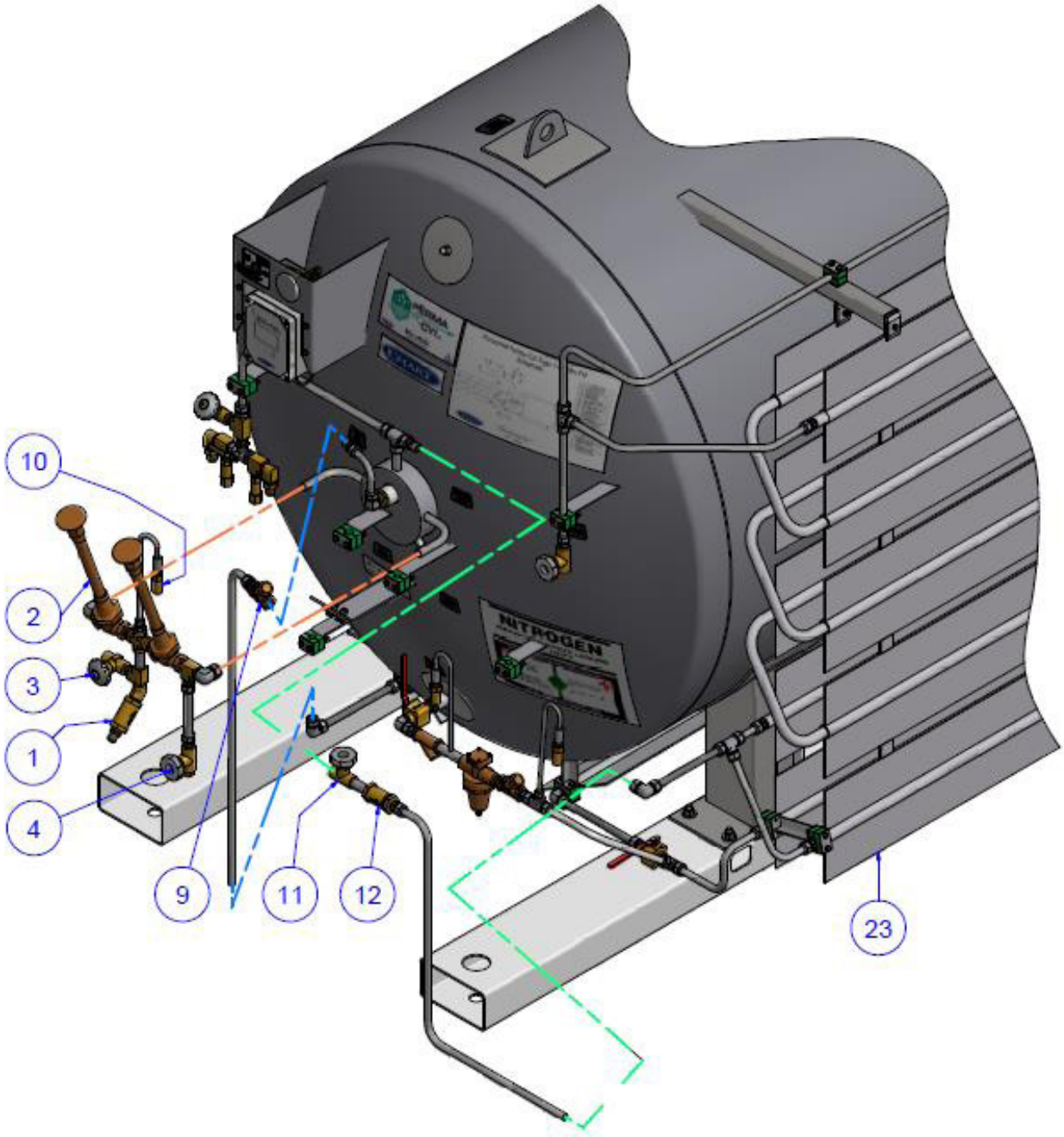
3. As the filling proceeds and the tank gets cooler, you should be able to pinch off and, in some cases, close the vent valve. We recommend that you do not fill the tank to the full trycock on the first fill. Fill to 75% in order to allow for liquid expansion as the tank contents absorb heat while the metal continues to cool down over time.

Plumbing

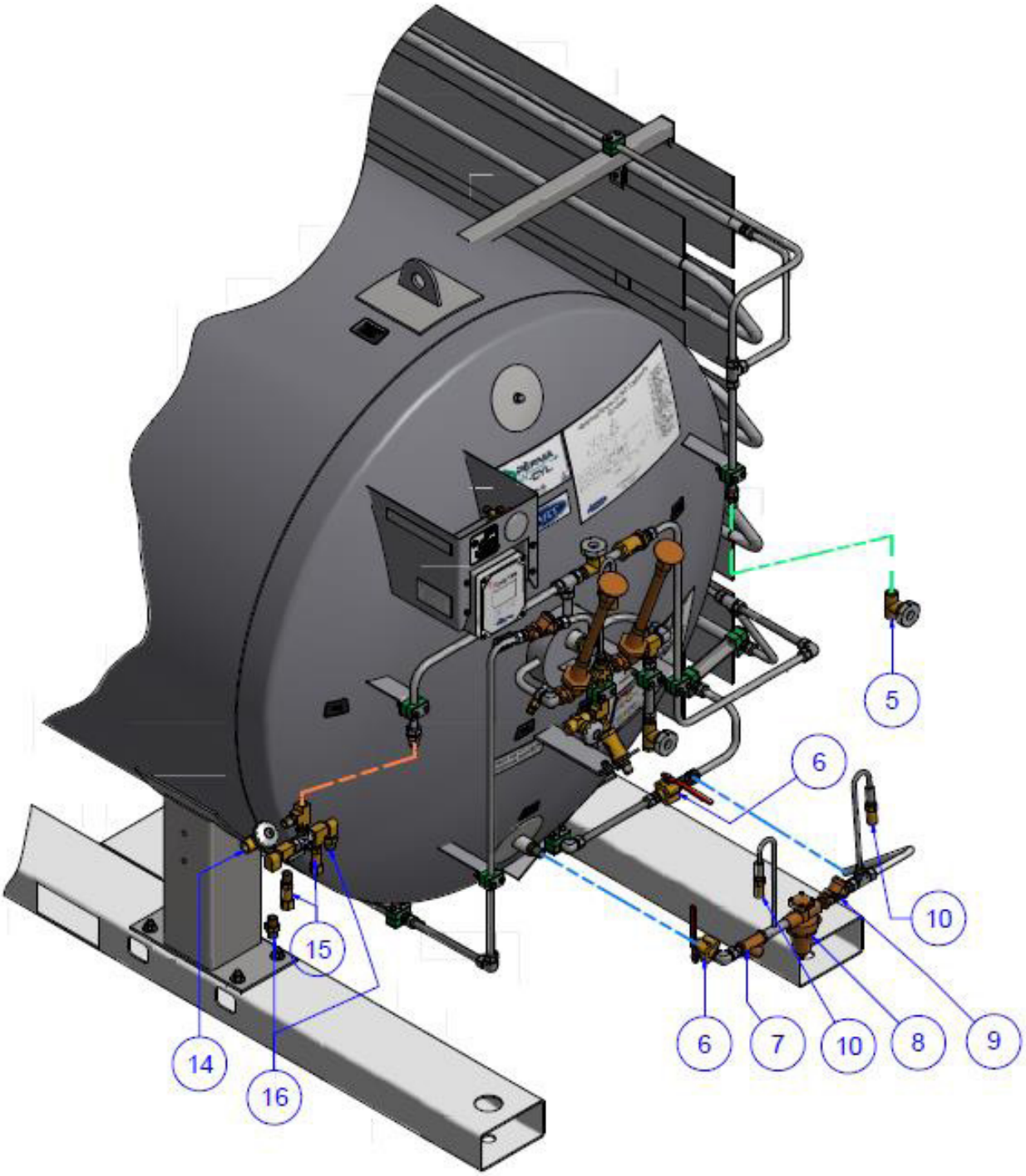
Plumbing Details

Item #	P&ID #	Chart PN	Total Qty	Part Detail	Description
1	V-1	11051090	1	FILL CHECK VALVE	VALVE CHECK BRS 1/2FPTX1/2FPT
2	V-11	10615790	2	BOTTOM FILL VALVE	VALVE GLOBE BRS 1/2NPT SCRD
	V-12			TOP FILL VALVE	
3	V-13	1905999	1	FILL PURGE VALVE	VALVE SHUTOFF 1/4FPT
4	V-2	11555482	1	LIQUID VALVE (###-03 OPTIONS)	VALVE BRS SH 1/2FPTX1/2FPT
5	V-3	11555482	2	GAS USE VALVE-FRONT	VALVE BRS SH 1/2 FPTX1/2FPT
	V-10			GAS USE VALVE-REAR	
6	V-9	1712202	2	MAIN LINE VALVE	VALVE BALL BRS 1/2FPT
	V-14			PB INLET VALVE	
7	S-1	11529090	1	STRAINER	STRAINER .500NPT BRZ BODY
8	R-1	11635511	1	PB REGULATOR	REGULATOR .500NPT @ 450 PSI
		11690211			REGULATOR .500NPT @ 300 PSI
		11779806			REGULATOR .500NPT @ 125 PSI
9	V-8	13462175	2	PB RETURN CHECK VALVE	KIT CHECK VALVE NIBCO 1/2”FPT
	V-15			MAIN LINE CHECK VALVE	
10	RV-2	1812702	3	PIPING RELIEF VALVE	RV BRS 1/4MPT 550PSI
	RV-3			PB PIPING RELIEF VALVE #1	
	RV-4			PB PIPING RELIEF VALVE #2	
	RV-2	1810462	3	PIPING RELIEF VALVE	RV BRS 1/4MPT 350PSI
	RV-3			PB PIPING RELIEF VALVE #1	
	RV-4			PB PIPING RELIEF VALVE #2	
11	V-5	11555482	1	ECONOMIZER VALVE	VALVE BRS SH 1/2FPTX1/2FPT
12	V-7	13620233	1	ECONOMIZER CHECK VALVE	VALVE CHECK BRS 1/2FPTX1/2FPT
13	V-2	1712202	1	LIQUID VALVE (###-04 OPTIONS)	VALVE BALL BRS 1/2FPT
14	V-4	10502848	1	VENT VALVE	VALVE SHUTOFF BRZ 1/2FPT SHORT
15	RV-1A/B	11385111	2	PRIMARY RELIEF VALVE	RV BRS 1/2MPT 500PSI
		11488591			RV BRS 1/2MPT 350PSI
16	BD-1A/B	11526622	2	BURST DISC	RPD ASSY INLINE 1/2MPT 700PSI
		11526569			RPD ASSY INLINE 1/2MPT 525PSI
17	V-16	11773885	1	RELIEF SELECTOR VALVE	VALVE BALL DIV SS 1/2NPT
18	R-2	11696795	1	BACK PRESSURE REGULATOR (###-04 OPTIONS)	REGULATOR .250NPT @ 35PSI
19	V-17	11550631	1	BACK PRESSURE VALVE (###-04 OPTIONS)	VALVE ISOLATION 1/4MPTX1/4FPT
20	LI-1	20786601	1	LEVEL INDICATOR	CYL-TEL 0-200”H2O
21	V-6	20683719	1	4-WAY VALVE	VALVE 4-WAY BRS 1/8FPT SWGLK
22	PI-1	13909811	1	PRESSURE INDICATOR	PG 2-1/2” 0-600PSI/BAR 1/8MPT
23	N/A	20640763	1	GAS USE COIL	VAPORIZER ASSEMBLY
24	N/A	20802238	1	PB COIL	VAPORIZER PB FIN ASSEMBLY

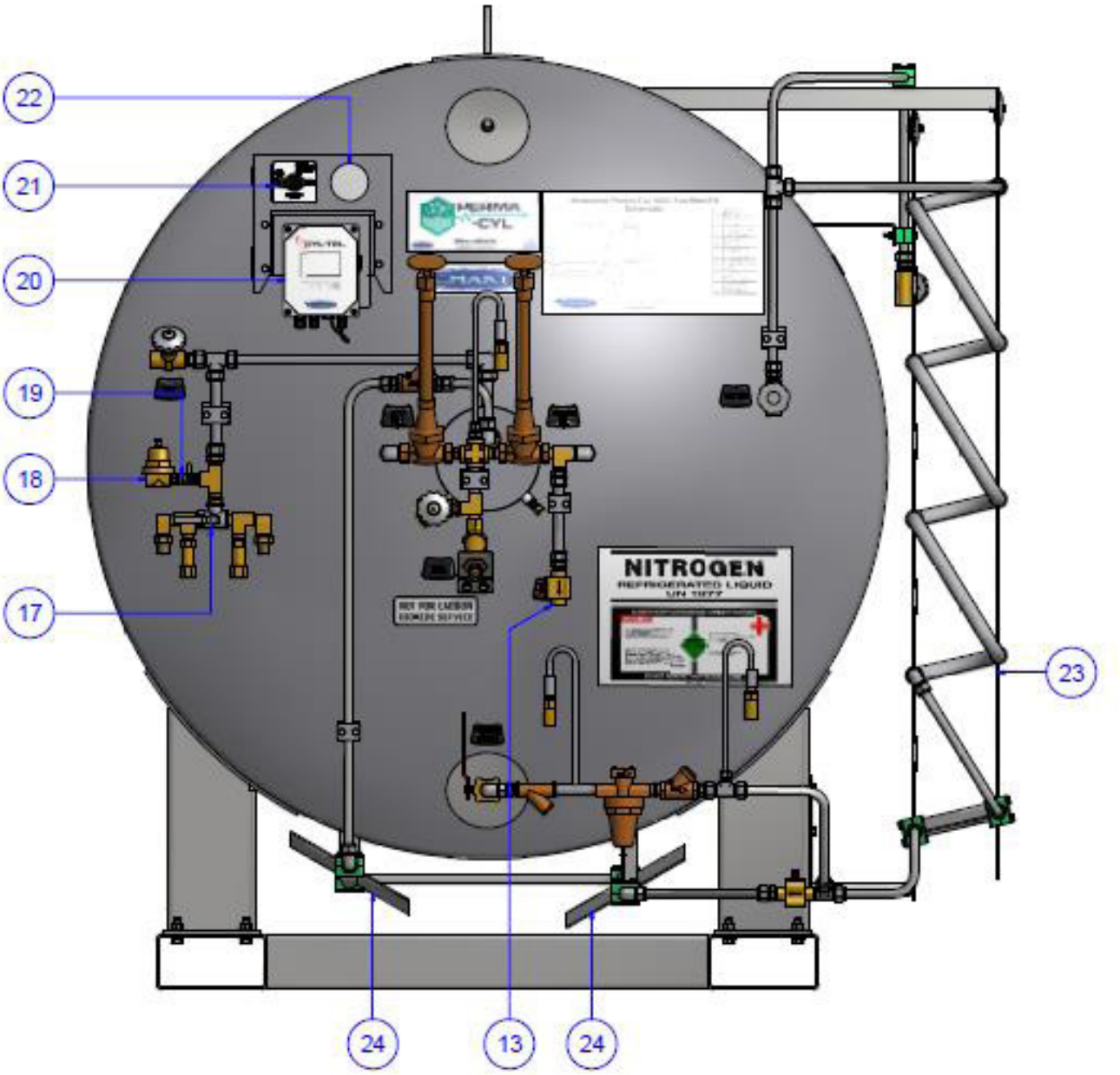
Plumbing Diagram (###-03 Option Kits)



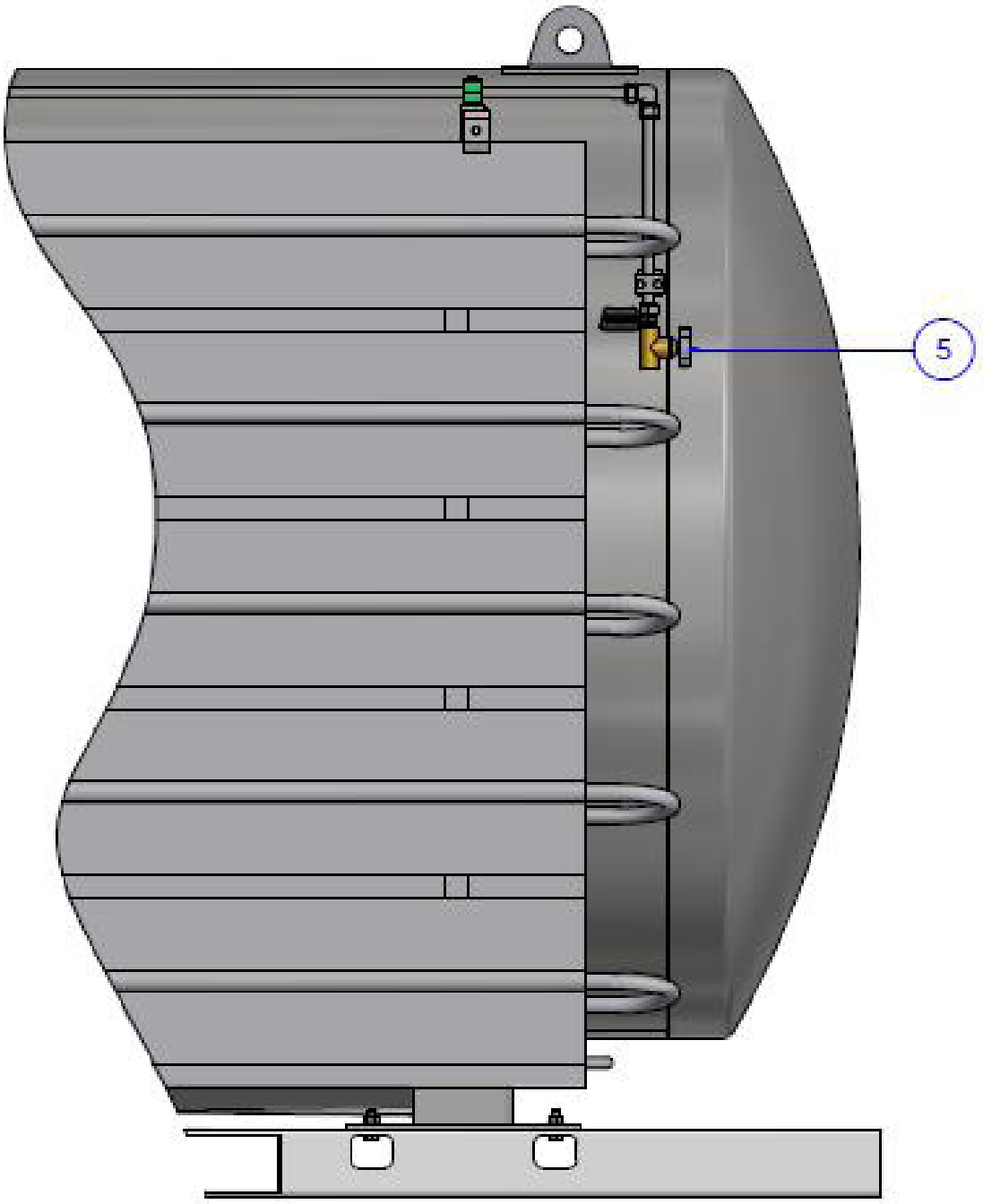
Plumbing Diagram (###-03 Option Kits)



Plumbing Diagram (###-04 Option Kits)



Plumbing Diagram



Troubleshooting

The following table is arranged in a Trouble/Probable Cause/Remedy format. The probable causes for specific problems are listed in descending order of significance. That is, check out the first cause listed before proceeding to the next.

Trouble	*Probable Cause*	*Remedy*
No gas to gas-use equipment. OR Insufficient pressure to gas-use equipment	Perma-Cyl tank empty.	1. Switch to emergency gas supply. 2. Call gas supplier for delivery.
	Gas-use valve to final line regulator is closed or other valves downstream are closed.	1. Open valve or valves, as needed. 2. Insure there is no obstruction in the line or valve.
	Pressure builder is not building sufficient pressure.	1. Open pressure building regulator isolation valve and allow pressure to build. 2. Adjust setting on regulator to a higher pressure. 3. If tank pressure fails to rise, see section on low tank pressure.
	Final line pressure regulator set too low or malfunctioning.	1. Insure gas use valve is open and tank pressure is at least 25 psi higher than desired working pressure of final regulator. 2. Call service technician.
	Inappropriate type of regulator (high-pressure or 2-stage or too small) installed as final line regulator and is not able to supply sufficient gas flow.	1. Insure gas use valve is open and tank pressure is at least 25 psi higher than desired working pressure of final regulator. 2. Inspect final line regulator or its specifications to determine if it has a suitable flow capacity for the required inlet and outlet pressures. 3. Call appropriate equipment supplier or service technician.
	Gas supply line, hose, or network contains excessive pressure drop.	1. Check line for sufficient diameter. 2. Remove all unnecessary bends, elbows, reducers, and small diameter valves. 3. Check for leaks in the gas supply line.
	Unknown	1. Call service technician
Ice on external vaporizers and/or plumbing	Normal condition during and following gas use, liquid use or filling.	1. None 2. User to check tank for frost / leaks before use.
	Tank is being used for continuous flow application and is not receiving sufficient ambient heat to melt the frost or ice. (Tank may have heavy ice build-up during continuous use or low ambient temperature.)	1. Move tank to a warmer location. 2. Add additional environmental heat and / or warm airflow to warm outer piping, components and vaporizers. Steam clean vaporizers. 3. Add additional vaporization.
	Leak in gas supply lines, gas-use equipment, or tank plumbing. (Frost is present on tank even after an extended period with no gas or liquid use.)	1. Evacuate and ventilate room. 2. If possible, locate and correct leak, 3. User to check tank for frost / leaks each morning before starting gas use. 4. Call appropriate equipment service technician.

Trouble	Probable Cause	Remedy
Frost or ice on sides, bottom, top-center and / or plumbing of tank. (continued)	Weak vacuum or failed vacuum.	1. Check if tank pressure is routinely high even during gas use and / or if tank has cold or ice spots even when not in operation as sign of vacuum problem. 2. Condensation or sweating is seen over the entire outer shell as a sign of vacuum problem. 3. Call gas service agent.
	Unknown.	1. Call gas service agent.
Routinely low pressure in tank.	PB shut-off valve is closed. (If PB is not operating, no frost will appear on external PB vaporizer during gas use.)	1. Open pressure building regulator isolation valve and allow pressure to build. 2. Call service agent to repair, replace or adjust regulator.
	Pressure builder setting is too low. (If PB is not operating, no frost will appear on external PB vaporizer during gas use.)	1. Adjust regulator to higher pressure and allow pressure to build. 2. Call service agent to repair, replace or adjust regulator.
	Economizer check valve is flowing.	1. Only flows when PB regulator is closed. 2. Check PB regulator.
	Relief valve(s) stuck open.	1. Evacuate and ventilate the room. 2. Check exhaust of relief valve to see if gas is flowing at a pressure below the pressure stamped on the valve. 3. Tap lightly on the side of the relief valve to attempt to dislodge any obstruction holding valve open. Repeat several times, if needed. 4. If equipped with dual relief valves and a diverter valve, switch diverter to second set of relief valves. 5. Call gas service technician to replace relief valve, if necessary.
	Large gas leak from tank plumbing or from gas use system.	1. Evacuate and ventilate the room. 2. If possible, locate and repair leak or call gas equipment service technician.
	Gas or liquid withdrawal rate exceeds the tank specifications.	1. Excess usage will cause tank pressure to decrease as PB is unable to maintain pressure. Decrease withdrawal rate to within design specifications. 2. Increase pressure setting on PB regulator. 3. If withdrawing gas, consider: (a) withdrawing liquid and using external vaporizer, (b) installing larger tank, (c) installing additional tank(s), or (d) splitting application. 4. If withdrawing liquid, consider: (a) installing larger tank, (b) splitting application or (c) installing additional tank(s). 5. Call gas service agent.
	Unknown	1. Switch to emergency gas cylinder. 2. Call gas service technician.
Gas supply to gas-use equipment is too cold.	Ambient temperature surrounding the Perma-Cyl is too cold.	1. Move tank to warmer location. 2. Install freestanding ambient vaporizer on gas supply line in warmer location or install in-line gas heater.

Trouble	*Probable Cause*	*Remedy*
Gas supply to gas-use equipment is too cold. (continued)	Gas withdrawal rate from Perma-Cyl exceeds the capacity of tank's ambient vaporizer.	1. Reduce gas withdrawal rate to within specified parameters. 2. Install freestanding ambient vaporizer on gas supply line in warm location or install in-line heated vaporizer on gas supply circuit. 3. Install larger tank with greater withdrawal rate capacity.
Routinely high tank pressure.	Normal when little or no gas has been used for several days.	1. None - Routine use of gas will automatically reduce the tank pressure. 2. Gas usage must exceed NER of tank, if not, contact gas supplier for different tank model.
	Economizer function on regulator is malfunctioning.	1. Call gas service technician to clean, repair, or replace regulator.
	Tank is over-filled	1. If tank is filled to or beyond proper fill level, pressure builds very rapidly and relief valve may open. 2. Use gas or liquid as soon as possible to reduce tank contents. 3. Vent tank until no liquid is coming out the vent valve.
	Pressure building function on regulator is set too high or regulator is malfunctioning.	1. Reduce pressure setting by turning adjustment knob counter-clockwise to the desired pressure setting and continuing normal gas use until pressure drops. 2. Close PB isolation valve and carefully observe pressure to ensure tank pressure does not drop too low during use. 3. Call gas service technician to adjust PB regulator.
	Weak or failed vacuum.	1. Observe if condensation and / or frost are present even during periods of non-use as possible sign of vacuum problem. 2. Call gas service technician.
	Unknown.	1. Call gas service technician.
Hissing sounds or evidence of gas leaking near tank, gas lines, or gas-use equipment.	Normal for short periods of time from some regulators and relief valves.	1. Evacuate and ventilate room or area, if necessary. 2. If possible, observe leak. If leak is not large, does not last long, does not occur frequently and is in well-ventilated area, no action may be needed. If in doubt, call appropriate equipment service technician. 3. If above combined conditions do not exist, call equipment service technician and observe "Safety" precautions.
Hissing sounds or evidence of gas leaking near tank, gas lines, or gas-use equipment. (continued)	Large leaks, leaks from elsewhere in the system, sustained leaks, or frequent leaks (not normal).	1. Evacuate all personnel from affected areas. Ventilate room / area. 2. If possible, locate the leak and repair it or call gas service or gas-use equipment service technician.

Trouble	Probable Cause	Remedy
High gas usage.	Unrecognized increase in actual gas use.	1. None for Perma-Cyl tank or gas supplier 2. Gas user to determine reason for increase in gas use.
	Leak in gas supply line or network or in gas-use equipment or tank plumbing, e.g. relief valve.	1. Evacuate and ventilate room, if necessary. 2. If possible, locate and repair leak or call gas-use equipment service agent. 3. User to check tank for frost / leaks before operations.
	Tank pressure routinely too high and venting.	1. See troubleshooting section on routinely high tank pressure.
	High flash or vaporization losses in liquid use application due to high pressure / temperature liquid in tank.	1. Vent tank to approximately 25 psi. Follow safety procedures. 2. In future only refill the Perma-Cyl tank with low-pressure cryogenic product.
	Error in gas delivery or supplier invoice.	1. Check gas usage history / pattern against supplier invoices. 2. Call gas supplier, if necessary.
Perma-Cyl tank cannot be filled.	Perma-Cyl tank is full.	1. None
	Fill line is blocked or inoperative.	1. Check for obstructions in the fill line. Clear if necessary. 2. Gently tap on check valve to assure proper operation. 3. Ensure top & bottom fill valves are open. 4. Call gas service technician.
	Orca™ MicroBulk Delivery System is not functioning properly.	1. Refer to Orca system Troubleshooting.
	Transfer hose is obstructed, e.g. hose is bent excessively, crimped or plugged.	1. Clean obstruction, inspect hose for damage, and, if everything is satisfactory, continue the filling.
Perma-Cyl tank does not initiate automatic fill shut off properly.	Fill line piping created too much pressure drop.	1. Ensure fill line is piped with 3/4” nominal copper (or equivalent) with minimal 90° bends. 2. Re-route fill piping.
	Improper fill procedure.	1. Review Orca system/Perma-Cyl tank filling procedure. 2. Ensure that all vent and use valves of the tank are closed.
	Only works with Chart Orca MicroBulk delivery vehicle. For other type trucks use full trycock.	N/A
Liquid withdrawal contains high level of gas.	Saturated liquid pressure in Perma-Cyl tank is too high. (Temperature or energy level of contents is too high due to excess pressure.)	1. Ensure PB shut-off valve is closed. 2. Open vent valve to allow excess pressure to vent until desired pressure is obtained. Follow “Safety” guidelines and procedures for venting. 3. Install secondary lower pressure relief valve to reduce saturated pressure of liquid in the future. 4. In future only refill the Perma-Cyl tank with low-pressure cryogenic product.

Trouble	*Probable Cause*	*Remedy*
Vacuum pump-out port and / or vacuum plug are open or damaged.	Pump-out plug or port have been damaged or tampered with.	1. If possible, transfer any remaining contents to another tank. 2. Call gas service technician to replace and repair tank.
	Inner vacuum space leak has dislodged safety pump-out plug.	1. If possible, transfer any remaining contents to another tank. 2. Cover pump out port to keep moisture from getting into the annular space. 3. Call gas service technician to replace and repair tank.

Warning! Use only parts which are cleaned and approved for oxygen service. Chart recommends the use of only Chart approved parts.

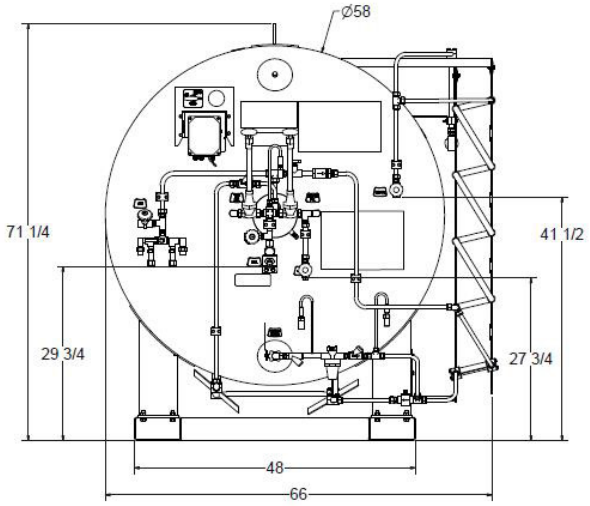
Specifications

Capacities	***3000 HP - Horizontal***		***3000 VHP - Horizontal***	
Gross Volume	770 gal	2911 liters	770 gal	2911 liters
Net Volume	715 gal	2707 liters	715 gal	2707 liters
Gas Storage Capacity (@ 1 Atm & 68° F / 20° C)*				
Oxygen	82,239 scf	2161 Nm^3	82,239 scf	2161 Nm^3
Nitrogen	66,592 scf	1750 Nm^3	66,592 scf	1750 Nm^3
Argon	80,425 scf	2115 Nm^3	80,425 scf	2115 Nm^3
General Specifications				
Relief Valve Setting / MAWP	350 psi	24.1 bar	500 psi	34.5 bar
Overall Height w/Piping & Base	71 in	1803 mm	71 in	1803 mm
Width w/Piping & Base	68 in	1727 mm	68 in	1727 mm
Length w/Piping	124 in	3150 mm	124 in	3150 mm
Length w/Base	132 in	3353 mm	132 in	3353 mm
Tank Diameter	59 in	1499 mm	59 in	1499 mm
Tare Weight	3800 lbs	1724 kg	4250 lbs	1928 kg
Performance				
Normal Evaporation Rate (% per day)**				
Nitrogen	1%	1%	1%	1%
Oxygen & Argon	0.62%	0.62%	0.62%	0.62%
Gas Supply Rate	2000 scfh	52.4 Nm^3H	2000 scfh	52.4 Nm^3H
Construction				
Design & Manufacturing Code	ASME Sec. VIII Div. 1		ASME Sec. VIII Div. 1	
Outer Vessel	Type 304 SS		Type 304 SS	
Multi-Function Vaporizer (Standard)	Ambient Side-Mounted Aluminum		Ambient Side-Mounted Aluminum	

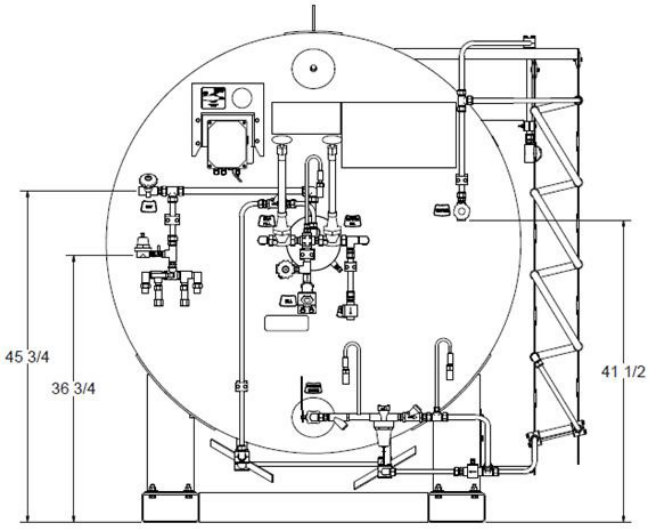
All specifications are subject to change without prior notice.
Patents: 6,128,908 • 5,954,101 • 6,799,429
**Values are based on net capacity at 0 psig (0 barg). See Chart's Microbulk System Product Catalog for conversion densities.*
***Values are based on gross volume.*

Component Location and Overall Dimension

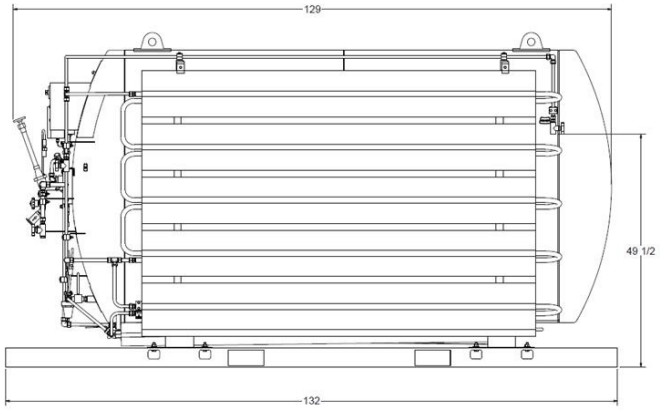
Perma-Cyl 3000 VHP, HP, HP-VJ



Front View (###-03 Option Kits)

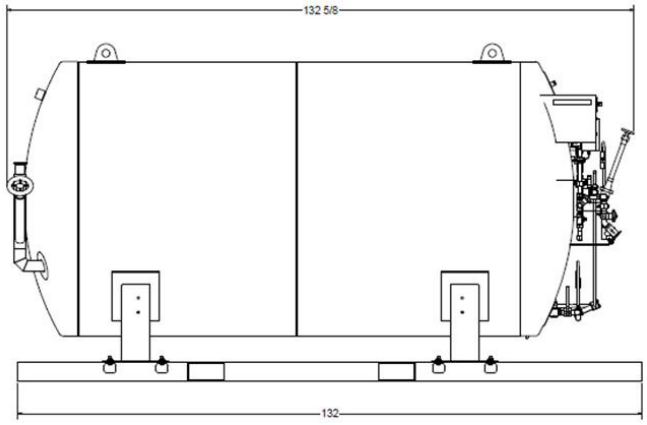


Front View (###-04 Option Kits)



Side View Vaporizer

Perma-Cyl 3000 HP-VJ



Side View

Warranty

Chart Packaged Gas Products Warranty Policy

Warranty only applies to original purchaser of Chart equipment and does not transfer to any other party.

Materials, components and workmanship are warranted to be free of defects for 90 days from date of invoice.

Vacuum integrity as measured by conformance to Chart NER (Normal Evaporation Rate) specifications is warranted as follows:

- Perma-Cyl, Mega-Cyl™ or Laser-Cyl™ liquid cylinders - 5 years from date of invoice.
- All Chart repaired liquid cylinders - 2 years from date of invoice.

Damage or abuse caused by purchaser voids Chart warranty obligations.

Freight damage incurred during shipment from Chart to purchaser must be reported immediately to Chart, and before placing equipment into service.

In the event of a valid warranty claim, Chart reserves the right to repair, replace or refund the value of the equipment at its discretion. The warranty applies only to the purchased Chart equipment and in no case is Chart obligated to reimburse the purchaser for consequential damages resulting from the operation of Chart equipment.