



Product Manual

Perma-Cyl® MicroBulk Storage Systems 230/265/450/700/1000/1500/2000/3000



Designed and Built by:

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Revision Log

Revision Level	Date	Description
A	06/20/2001	Correct part number on pages 20 and 21, item number 8 from 10746447 to 11488591
B	04/02/2002	Updated Perma-Cyl line for configured to order
C	10/01/2003	General Update
D	10/31/2005	Replace 5-way valve 11627651 with 11939013 per ECO#12252
E	05/26/2015	Combine Operation and Installation Manuals into one Product Manual. Also include PN 11630833, 14422722 and 11869772 in this Product Manual.
F	08/14/2015	Remove obsolete part numbers from Illustrations and Parts Listing section, add PPE information to Safety section.
G	08/21/2018	Updated Specification table, remove 300 information



Preface

General

The Perma-Cyl® MicroBulk Storage System allows users to enjoy the benefits of on-site gas delivery. Gone are the hassles, waste, and expense of full-for-empty gas cylinders. Using Perma-Cyl tanks, there are no cylinders to change, no residual gas losses, no back, hand or foot injuries from handling cylinders, and no lost or damaged cylinders.

The Perma-Cyl tank is reliable, efficient, and more economical than comparable transportable cylinders. Designed for a higher level of thermal efficiency, they can hold their gas contents longer with lower pressure rise than other similar vessels. Their extraordinary thermal quality limits product losses during extended periods of little gas use.

The innovative Perma-Cyl storage system incorporates a top fill float designed to allow single-hose filling without losses. It automatically shuts off the Orca™ MicroBulk Delivery System for a safe and reliable fill.

Product Benefits

- The first “fill-at-site solution” for packaged or cylinder gas users
- Fast filling capable
- Single hose no-loss filling
- Automatic fill shutoff when used with an Orca delivery system
- Extended holding times
- Telemetry ready with Cyl-Tel® Liquid Level Gauge

Product Advantages

- Sizes, pressures and configurations to meet most applications
- Capacities from 230 liters to 3,000 liters (60.8 gal to 715 gal)
- Pressures from 235 psig to 500 psig (16.2 bar to 34.5 bar)
- Patented automatic fill shut-off feature with optional fill box allows for remote filling from outside the building or compound when a Perma-Cyl tank is installed indoors
- The Orca delivery system automatically safely stops the fill process when Perma-Cyl tank is full

- Patented Cyl-Tel liquid level gauge supports remote alarms or telemetry communications
- High-pressure high flow models for laser assist applications
- Combination pressure control regulators with micrometer adjustment knob or screw
- Outdoor or indoor installation and operation

Product Manual

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

The schematics, piping illustrations, and parts list show a reference number for each component used on the tank. The reference numbers may refer to the same functional component between the various models. The reference numbers will be used throughout this manual to draw specific attention to a component while describing its function, operation, or repair.

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.

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

The remaining sections describe the specific tank models covered by this manual. They contain warranty information, troubleshooting help, technical specifications/illustrations, and parts lists. They should be reviewed first and referred to as the rest of the manual is read.

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:

Ar	Argon
ASME	American Society of Mechanical Engineers
BAR	Pressure (Metric)
CGA	Compressed Gas Association
CO ₂	Carbon Dioxide
DOT	Department of Transportation
FPT	Female Pipe Thread
Kg	Kilogram
LAR	Liquid Argon
LIN	Liquid Nitrogen
MAWP	Maximum Allowable Working Pressure
N ₂	Nitrogen
Nm ³	Normal Cubic Meters
NER	Normal Evaporation Rate
NFPA	National Fire Protection Association
NPT	National Pipe Tapered Thread
O ₂	Oxygen
PB	Pressure Builder
PN	Part Number
PSI	Pounds per Square Inch
PSIG	Pounds per Square Inch (Gauge)
RV	Relief Valve
SCF	Standard Cubic Feet
SCFH	Standard Cubic Feet/Hour
SCM	Standard Cubic Meters
UFC	Uniform Fire Code

Safety

General

While the Perma-Cyl® MicroBulk Storage System 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. It is essential that the customer carefully read and fully understand all Warning and Caution notes listed below.



Warning! Only Perma-Cyl 230L and 450L models are suitable to transport full of liquid.

For over-the-road transportation of tanks other than 230L and 450L, the tank pressure must be reduced to no more than 22 psig.



Warning! The Perma-Cyl tank, 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 tank or let it fall over in oxygen or any cryogenic service. In the event a tank 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 tank in a safe manner. If the tank 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 tank parts or loosening fittings, completely empty the tank 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 tank.



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 tank 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 circumstances 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 atmosphere 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.



Caution! Failure to comply with these instructions may result in serious damage to the system and personal injury.

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 (105-115°F or 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.

Carbon Dioxide

The system described in this manual has the ability to hold and dispense carbon dioxide (CO₂) gas under pressure.



Warning! *Asphyxiation hazard. Carbon dioxide gas can cause serious injury or death. Do not breathe CO₂ gas. Avoid entering tank area if a leak is suspected and thoroughly ventilate area.*

CO₂ gas is a colorless, odorless, tasteless gas that displaces oxygen and in certain percentages does not support life. The gas is difficult to detect without the assistance of special equipment. Avoid breathing or contacting CO₂ in gas, liquid or solid form.

Exposure to concentrations of less than 5% for less than 15 minutes can cause physical symptoms including unconsciousness, injuries or death. Even low concentrations of CO₂ can cause:

- Dizziness, headaches, nausea or disorientation
- Increased respiration or heart rate
- Shortness of breath or rapid suffocation

It is important to note that unlike nitrogen and argon, exposure to high concentrations of CO₂ can be deadly even when normal percentages of oxygen are present in the surrounding atmosphere.

CO₂ is heavier than air and can collect in low areas such as basements, stairwells, and confined spaces. Avoid entry into areas where CO₂ leaks or high concentrations of CO₂ are suspected. Enter those areas with caution only after they have been thoroughly ventilated.

Whenever the vessel is inside a building it's safety relief circuit must be connected to an outdoor vent typically in the fill box. The fill box and/or vent must never be located in or above any below-ground spaces or stairwells. The vessel must not block emergency exits, aisles, fire suppression

equipment or utility boxes or accesses. CO₂ lines or hoses must be located away from traffic areas and heat sources and must be protected from potential causes or damage. All connections, lines, and components must be leak-free.

This equipment should be installed and serviced only by professional agents who are qualified to work with CO₂ and the mini-bulk liquid CO₂ storage vessels. They should be familiar with all pertinent safety procedures.

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 Perma-Cyl® MicroBulk Storage System is designed to store and deliver liquid oxygen, nitrogen or argon as a cryogenic liquid. A standard Perma-Cyl tank can also be configured to store CO₂. The Perma-Cyl tank can build and maintain pressure from the automatically regulated pressure building circuit. A continuous liquid or gas flow can be provided from these cylinders. Regardless of size, all Perma-Cyl tank models operate on the same principals of operation.



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. Failure to comply with these instructions may result in serious damage to the system and personal injury.

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 on the tank, there should be no visible signs of damage.
- Check that the tank has pressure, normally about 20 psi.
- If tank passes all the above criteria it is ready to first fill. Following the First Fill Procedures in the Installation section of this manual.

Primary Plumbing Circuits

Fill

The liquid fill valve is used to top fill the Perma-Cyl tank using the patented PERMA float device (see Figure 1). The fill line has a check valve (V-1) and service fitting that provide the sole pressure connection for the delivery vehicle.

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.

Fill isolation valves can be ordered as an option kit in addition to the standard check valve.



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 tank, be sure that protective eyeglasses and gloves are being worn. If the transfer is being made to an open top tank, the transfer pressure should be as low as possible and a phase separator should be used to eliminate splashing and hose whip.

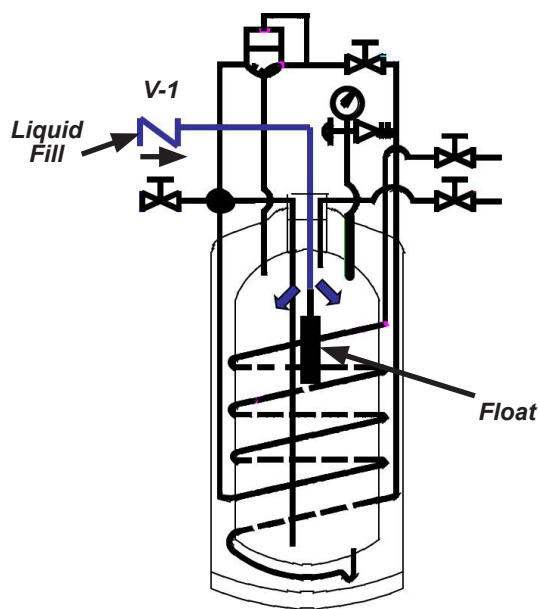


Figure 1

Pressure Build

The pressure build circuit is used to build pressure back in the tank after a delivery or to maintain pressure as liquid is withdrawn from the vessel. The tank pressure is set by adjusting the PB/Economizer combination regulator (R1). Standard PB set points are:

MP - 125 psig

HP - 300 psig

VHP - 450 psig

As the tank pressure drops below the PB set point, the regulator opens and allows liquid to flow off the bottom of the tank, through the internal PB vaporization coils, through the R-1 and back into the gas phase of the tank as depicted in Figure 2. The pressure build circuit can be shut off by closing valve V-5.

Some models of Perma-Cyl tanks can be equipped with external pressure build vaporizers which allows for much quicker recoveries after the tank has been blown down to fill it or for high flow applications.

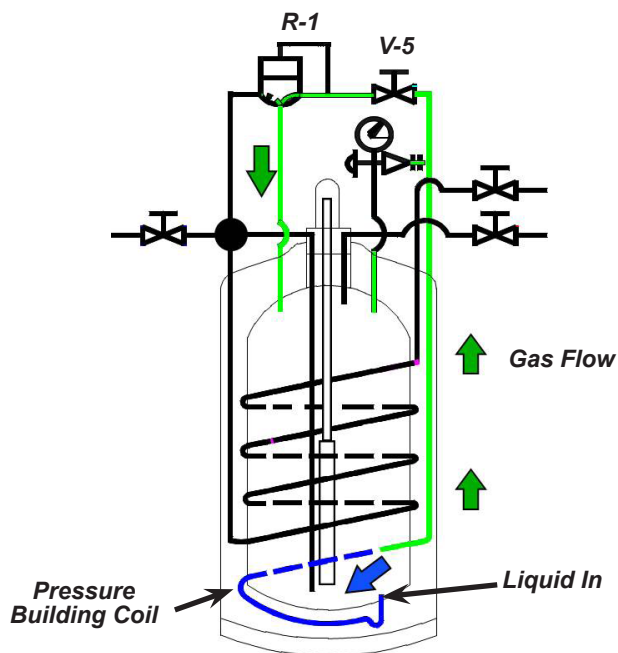


Figure 2

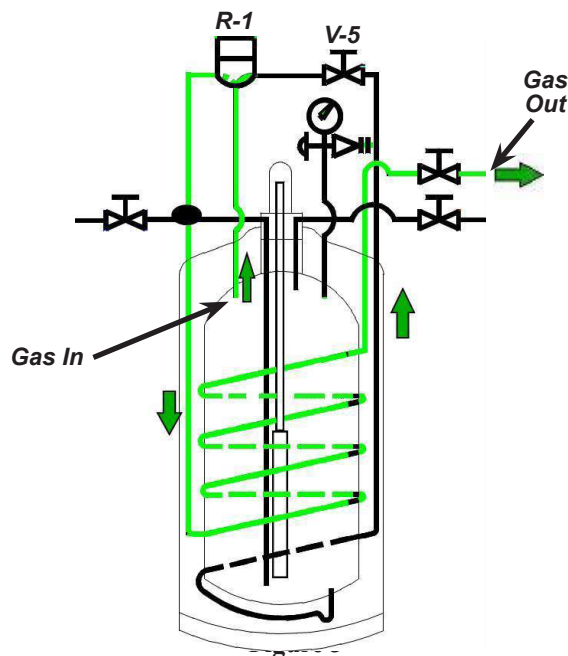
Economizer

The economizer circuit allows for the customer to utilize the natural heat leak that occurs in every cryogenic storage tank. When the pressure is above the setpoint of the pressure build/economizer regulator, the pressure build portion of the regulator closes and the economizer port opens. This allows gas to be withdrawn directly off the headspace of the tank and travel through the internal vaporization coils, in order to warm the cold gas, and out the gas use valve as depicted in Figure 3. This will result in lowering the pressure of the tank.



Note: The economizer circuit will only work if the customer is using product out of the tank.

Tanks can also be equipped with stand alone economizers regulators when higher flowrates through the economizer are required.



Liquid Use

The liquid use circuit can be used for both a liquid application or a high flow gas use application. This circuit draws liquid directly up the dip tube as depicted in Figure 4, and out through the liquid use valve (V-2). The liquid use valve is a blue handled globe valve or a red handled ball valve. For high flow gas use applications, the liquid can be piped through a stand alone external process vaporizer. This can more than double the standard flow rates that can be achieved through the internal vaporization coils.

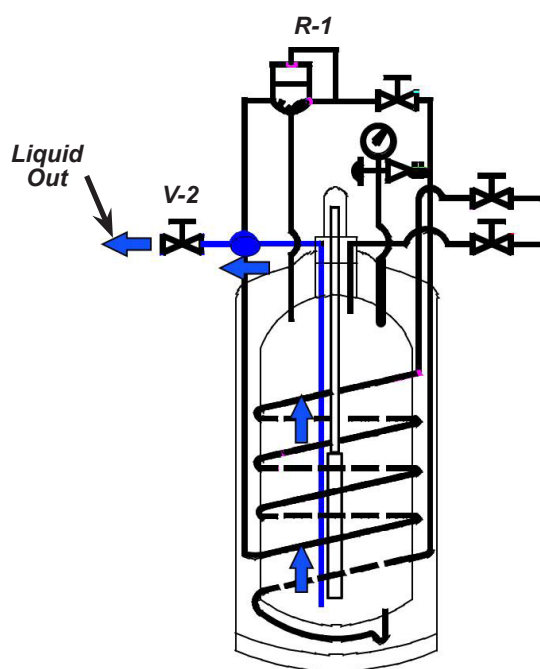


Figure 4

Gas Use

The gas use valve leverages the internal vaporizer on the Perma-Cyl system to supply gaseous product to the end user.



Note: In Figure 5 the liquid is drawn up the dip tube, through the top knuckle and back down through the internal vaporization coil before exiting out the gas use valve.

The internal vaporizer can support specific flow rates. The gas use valve used is a green handled globe valve. In inert service, the gas use connection can be made using Kitec tubing. Kitec tubing should be used at pressures below 200 psi and for gas at temperatures above 10° F. At conditions other than those outlined previously, the Kitec tubing can burst. For applications other than those outlined above, copper tubing or stainless steel braided hose should be used. The line size for the gas use should be sized properly for the pressure and flow rate that is desired.

The Perma-Cyl tank will deliver gas at various flow rates and temperatures for different applications. The equipment that is being supplied gas from the Perma-Cyl tank controls the flow rate. Higher flow rates may provide very cold gas that could damage the equipment to which they are attached. To supply gaseous product, follow this step by step procedure.

1. Connect the proper regulator/regulating manifold to the liquid cylinder's gas use outlet.

2. Connect the proper piping between the final line regulator and the receiving equipment.
3. Open the pressure building valve.
4. Allow pressure to build to the operating pressure (refer to gauge).
5. Open the gas use valve.
6. Adjust the gas use regulator for the proper delivery pressure.



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

The operator should review the safety precautions found in the Safety section before conducting a gas or liquid withdrawal operation. Protective eyeglasses and gloves should always be worn.

At low flow rates, the Perma-Cyl tank is capable of delivering warm gas through the line regulator. As the flow rate increases, the temperature of the gas decreases. If the cold temperature becomes a problem at a desired flow rate, an external vaporizer can be added. Attach this vaporizer directly in series with the gas use connection and place the line regulator at the exit of the vaporizer.

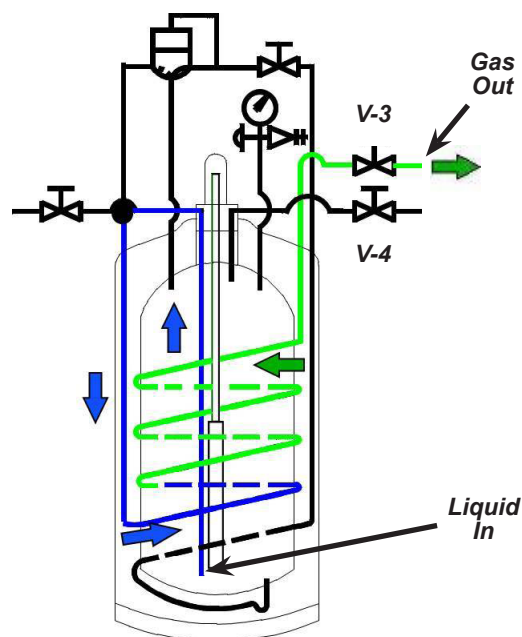


Figure 5

Safety Circuit

Most Perma-Cyl tanks are equipped with both a spring operated relief valve and a burst disc. These devices are used to automatically relieve excess pressure in the tank and cannot be isolated by the use of a valve. Replacement of these relief devices should only be on a "like for like" basis. Substitutes should be avoided unless approved by the manufacturer. An optional dual relief and rupture disc with a diverter valve can also be ordered. This allows for changing out safety relief devices without the need to empty the tank. For CO₂ applications, the rupture disks are often replaced by a secondary relief valve or a back pressure regulator.

Vent/Full Trycock

The vent valve is used to relieve excess pressure in the tank. On Perma-Cyl systems the vent valve is a gray handled globe valve (see Figure 5 V-4). When installed indoors, the vent line should be piped outdoors using 1/2" nominal copper or the equivalent stainless steel hose. The vent valve also serves as the full trycock during filling operations. When the Perma-Cyl tank is filled by trucks other than Orca™ MicroBulk Delivery System trucks, the full trycock must be used to fill the tank. When liquid starts to spit out of this valve while being filled, the filling process should be terminated.

Other Piping Circuits and Components

Phase Lines and Liquid Level Gauges

The Perma-Cyl tank is equipped with both a low pressure phase line located on the top of the tank and a high pressure liquid phase line located on the bottom of the tank. These lines are connected to a differential pressure gauge which is used to indicate the amount of product in the tank. The standard DP gauge used by Chart is the Cyl-Tel® Liquid Level Gauge. Customers can specify other models as options.

Four-Way Valve

The four-way valve 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.

Pressure Gauge

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

2000 and 3000 VHP Operation

The plumbing design for the 2000 and 3000 VHP Perma-Cyl system is different from all the other models. These models do not contain internal vaporization or pressure build coils. All pressure building and process vaporization is provided by two external vaporizers. This plumbing configuration is commonly referred to as Option 09 or the ZX package.

2000 and 3000 VHP Primary Plumbing Circuits

Fill

The fill plumbing circuit is exactly the same as all the other Perma-Cyl models (refer to page 7).

Pressure Build

The pressure build circuit for the 2000 and 3000 VHP Perma-Cyl models is used to build pressure back in the tank after a delivery or to maintain pressure as liquid is withdrawn from the tank. The tank pressure is set by adjusting the PB Regulator (R1) shown in Figure 6 on the next page. Standard PB set points found in the 09 plumbing option kits are:

MP - 125-09

HP - 300-09

VHP - 450-09

Liquid is drawn off the bottom of the tank, runs through the PB regulator, then is vaporized by running through both the PB vaporizer and the gas use vaporizer. The vaporized gas then splits and a portion flows through check valve V-7 and back to the headspace of the tank. The other portion goes directly to the customer through the gas use valve V-3. Liquid serving both the PB and gas use can be shut off by closing valve V-9.



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

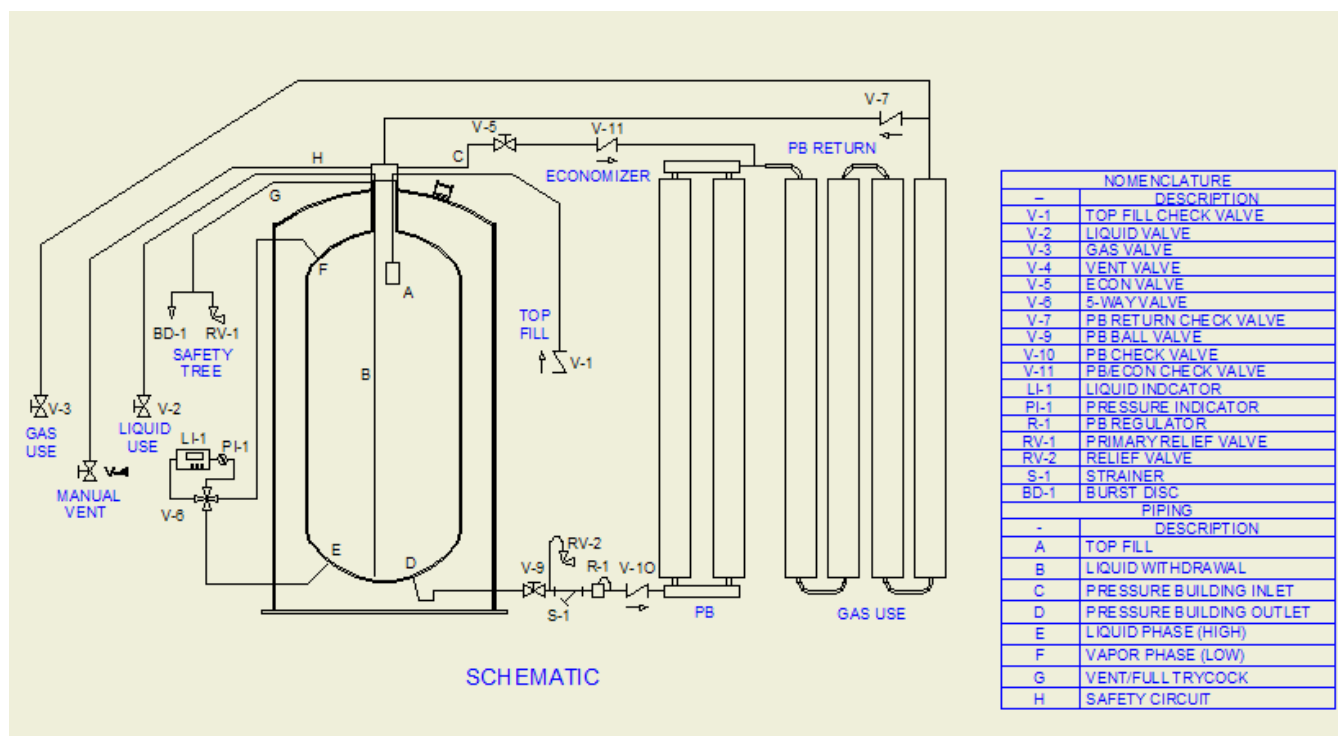


Figure 6

Economizer

The economizer circuit allows for the customer to utilize the natural heat leak that occurs in every cryogenic storage tank. The economizer circuit for the 2000 and 3000 VHP models is comprised of a check valve (V-11) which draws gas directly off the top of the tank and sends it through the gas use vaporizer in order to warm up the cold vapor prior to exiting the tank through the gas use valve. Flow through the 1 psig cracking pressure check valve (V-11) only occurs when regulator R-1 closes.

Liquid Use

The liquid use circuit for both the 2000 and 3000 VHP models is exactly the same as 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) to a stand-alone external vaporizer that is properly sized for the flowrate. In this scenario, the gas use valve on the tank is not used so the PB and gas use external vaporizers on the tank become dedicated to pressure building only.

Gas Use

The gas use valve on the 2000 and 3000 VHP Perma-Cyl models is the primary connection point to supply process gas to the customer. Unlike the other Perma-Cyl models, the liquid for the process gas comes directly off the bottom of the tank (D) and travels through the PB regulator (R-1). The unique design of this model allows for both the PB vaporizer and the gas use vaporizer to be utilized for process gas vaporization. After exiting the gas use vaporizer, the gas splits and supplies both the pressure build and the gas use as explained in the pressure build explanation for this particular model of tank.



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 is offered for the 2000 and 3000 VHP tanks. 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 on next page).



All other plumbing circuits that are covered on page 10 of this manual also apply to the 2000 and 3000 VHP Perma-Cyl models. These include the safety circuit, vent/full trycock, high/low phase lines, liquid level gauges and pressure gauges.

Installation

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).



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

Conducting a Site Evaluation

Before a Perma-Cyl System is installed a site evaluation should be conducted. This trip to the customer's site will help identify any special needs that each site invariably has. While on site, note what application the Perma-Cyl System will be used for and what service it will be in. Decide whether the installation will be inside or outside. Proximity to the Orca™ MicroBulk Delivery System fill point and the user's equipment should be taken into account in making this decision. When the placement has been set, take measurements of how much and where the piping will be run.

Installation Tools and Supplies

Installation of the Perma-Cyl System requires that certain tools and supplies are available. For simple and economical installations, the following supplies and tools should be maintained, however, not all installations will require them.

Supplies

- Silicone Sealant (clear and white)
- PVC Cement
- 1/4" Plastic Screw Anchors
- Self-tapping Screws
- 9" Cable Ties
- Duct Tape
- Teflon Tape
- Chalk or Marker
- Leak Check Solution

Tools

Electric Hammer Drill:

Used for drilling holes and chiseling brick. Some accessories include:

- 3/4" x 21" Scaling Chisel
- 2-1/2" Core Bit
- 1" x 21" Drill Bit (Masonry)
- 1/4" x 13" Masonry Bit
- 1/2" Masonry Bit

7-1/4" Builder's Circular Saw:

Used for scoring brick and cutting wood exteriors. Some accessories include:

- Masonry Cutoff Wheel
- Combination Blade

Reciprocating Saw:

Used for cutting through wood walls. Some accessories include:

- 1/4" and 3/8" Masonry Bits
- Set of Twist Drills
- 2-1/2" Hole Saw

Oxy-Acetylene Torch:

Used for cutting rebar in poured concrete walls and floors.



Warning! When using the above mentioned tools, suitable eye and ear protection must be worn. Failure to do so could result in serious personal injury.

Additional Required Supplies

- Hand Truck with Strapping Attachment
- Torpedo Level
- Carpenter Square
- Extension Cord
- Oetiker Clamp Pliers
- Step Ladder
- Caulk Gun
- Assorted Hand Tools
- Flashlight

Indoor Installations

(Inert: Any Size / Oxygen: 230-700L)

Required:

- Room size - Air volume must allow oxygen level to stay between 18% to 25%
- Increased ventilation
- Valves vented outside (including mobile tanks)
- CO₂ monitors required for all CO₂ installations
- Oxygen monitors recommended for LAR and LN₂

Preferred:

- Sealed off away from other work areas
- Ground level next to outside wall

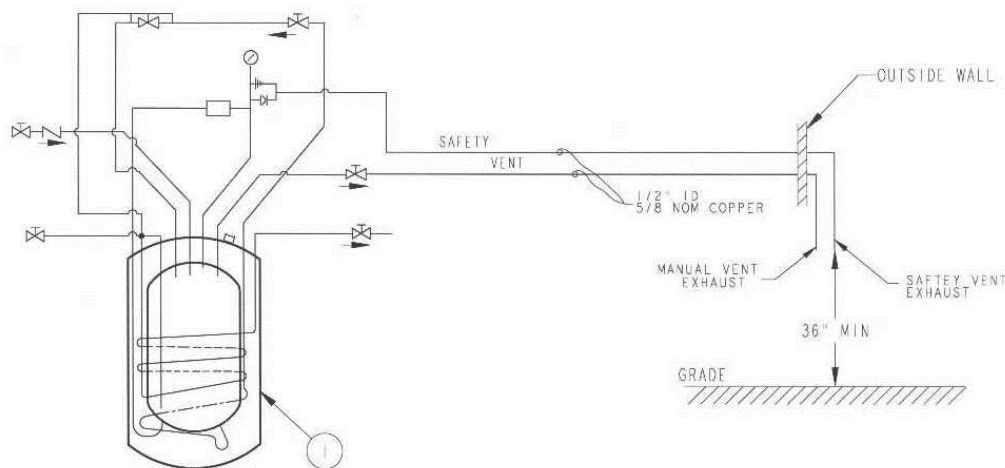


Internally Sited / Filled Indoors / Pipe Out Safeties

Some indoor installations allow for direct filling of the tank because of a close proximity to a doorway. These installations do not require the use of a wall box but still need to have safeties vented outside. A drain valve should be included in the safety line. This valve should be operated periodically to prevent moisture build-up in the line causing blockage. A 1/2" nominal copper should be used for both lines. Once through the wall, both lines should be directed downward and kept a minimum of 36" above the grade.

Wall Box

Indoor installations allow the tank to be positioned in very close proximity to the end user's equipment. This can be accomplished very easily using a Perma-Cyl Wall Box. The wall box contains a vent valve, fill line, pressure gauge and safety pipe out. All connections on the wall box are 1/2" FPT.

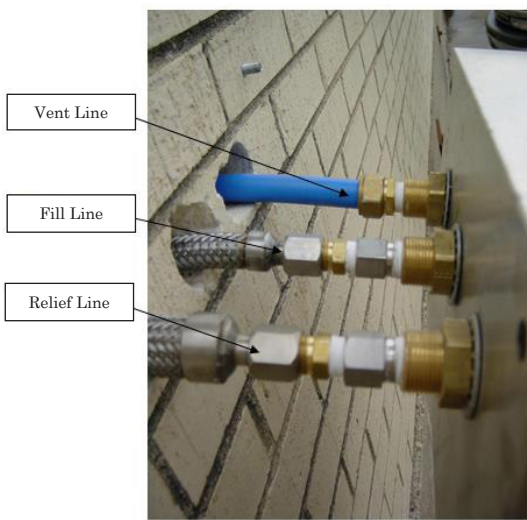


INTERNALLY SITED/FILLED INDOORS/PIPE OUT SAFETIES

Installation of Hoses and Lines

General

Running the liquid fill hose and vent hoses from the fill box to the tank, will most likely be done differently at each location. By following the basic rules and guidelines listed below, the lines can be run easily and as simply as possible. A typical wall box installation is diagrammed below. Note the guidelines for piping to be used.



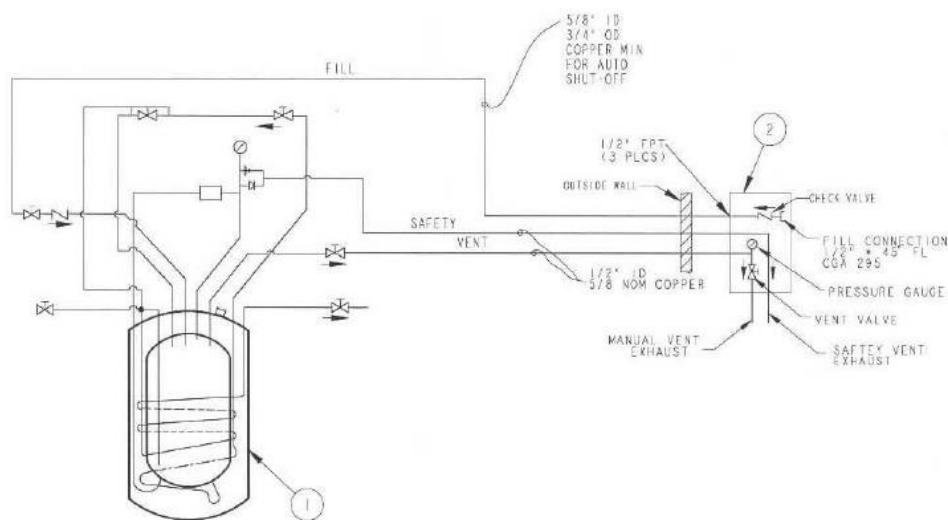
Line Connection to Fill Box Panel

1. Fasten NPT connection on vent hose to the NPT fitting on the back of the control panel.
2. Fasten NPT connection on fill hose to the NPT fitting on the back of the control panel.
3. Fasten NPT connection on safety vent to the NPT connection on the back of the wall box.
4. Feed all lines back into building while pushing panel back into the fill box.
5. Loosely fasten panel into box (it will be removed for pressure checking later).



Connections on the wall box are provided for the vent line, liquid fill and relief line.

- **Liquid Fill Line** - The liquid fill should be piped using a minimum diameter of 3/4" nominal copper. The equivalent size stainless steel braided hose can also be used. The line should be connected from the fill connection in the wall box to the liquid fill check valve on the Perma-Cyl System. When piping this line there are a few guidelines that should be followed.



INTERNALLY SITED/TYPICAL EXTERNAL WALLBOX

- Bends and elbows should be kept at a minimum. When needed they should be made with a wide bend radius. A minimum bend radius of 6" should be observed.
- The length of the line from the tank to the box should be kept to a minimum. Bare copper line can be used for lines. If bare copper is used, it should be insulated using air conditioning foam to keep condensation from dripping off the piping.
- Line size should be a minimum 5/8" ID.
- Vent Line - The vent line should be run using 1/2" nominal copper or the equivalent size stainless steel braided hose. This line should connect the vent valve in the wall box to the vent valve on the Perma-Cyl System.
- Relief Line - The relief line should be run using 1/2" nominal copper. Kitec tubing or braided stainless steel hose can also be used. Relief lines should be no smaller in diameter than the outlet of the relief valve.

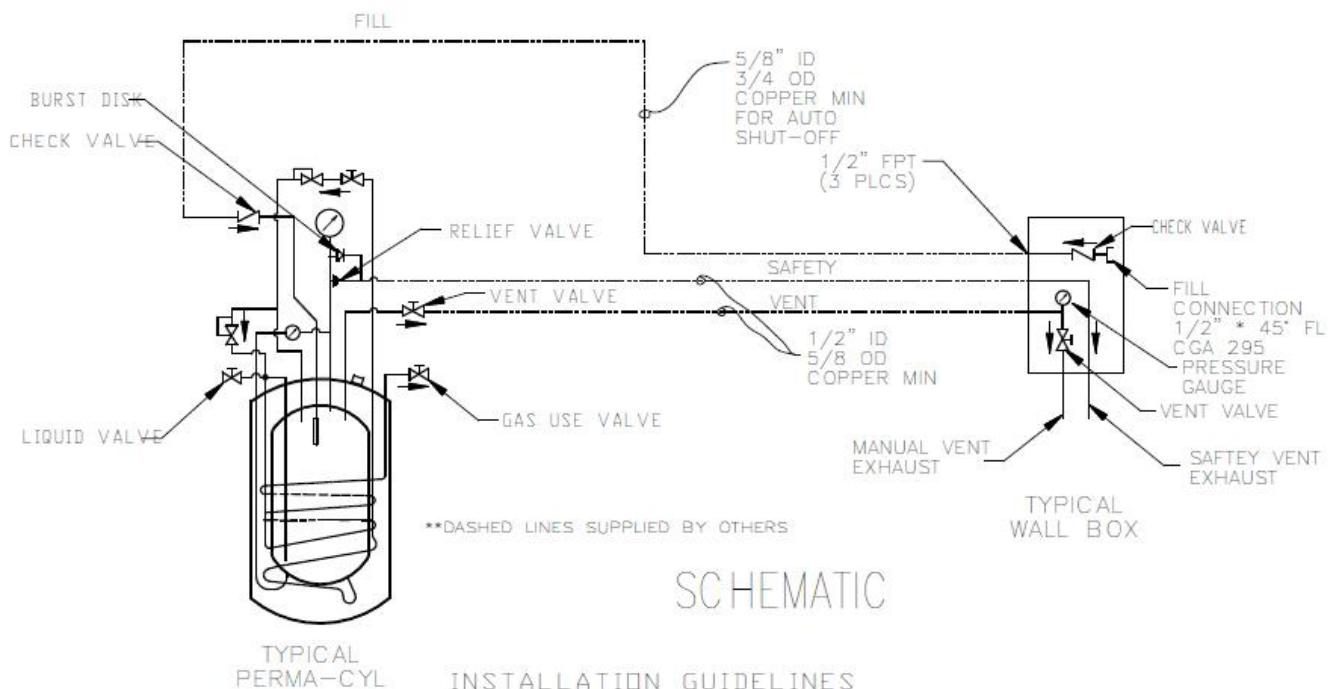


Caution! *Restrictions in the relief valve outlet piping should be avoided to eliminate the possibility of excessive back pressure when the relief valve opens. Restrictions could reduce the required flow rate of the relief valve and pose a potential safety hazard.*

Bolting to Floor

The Perma-Cyl tank is equipped with a flange on the bottom that has four holes for attachment. To ensure a safe environment, the tank should be bolted to the floor.

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



- SOFT COPPER W/6" BEND RADIUS (MIN BENDS).
- 20 FT. MAX BARE PIPE FROM TANK TO WALL BOX (KEEP MINIMUM).
- INSULATE BARE PIPE W/AIR CONDITIONING FOAM.
- FOR RUNS GREATER THAN 20 FT USE PYTHON PIPE.
- 5/8" ID MIN FOR FILL LINE.
- 1/2" ID MIN FOR SAFETY AND VENT.

Outdoor Installations

(Any Size)

Required:

- Open
- Well ventilated
- At or above ground level



Externally Sited / Gas Use Indoors

Outdoor installations can offer better accessibility for the Orca™ MicroBulk Delivery System for filling purposes. Also, lines do not need to be run except from the tank to the user's equipment. Outdoor installations should be made on a concrete pad. Local soil conditions and seismic codes will affect the thickness and reinforcement required for the concrete pad. The Perma-Cyl tank should be bolted to the concrete pad using appropriate sized anchor bolts. Also in outdoor installations, a fence can provide added protection for the Perma-Cyl system and work to eliminate tampering with any plumbing component.

Outdoor Installation Schematic

At a minimum, installation should include a final line regulator and a check valve. A typical piping schematic is depicted in Figure 6.

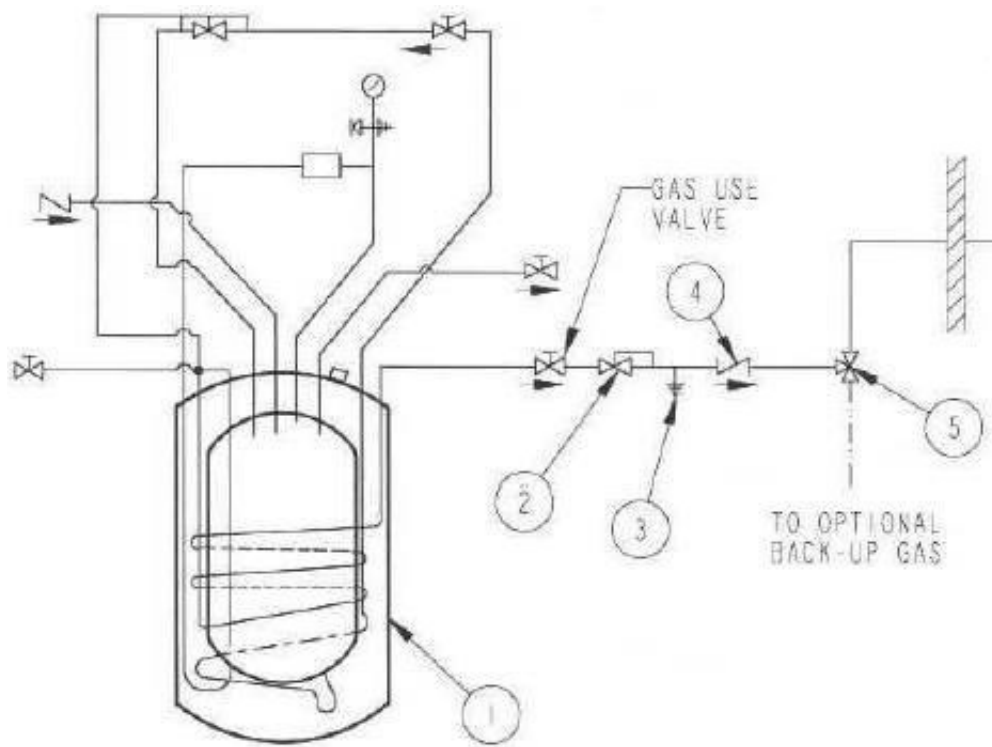


Figure 6
Externally Sited/Gas Use Installation

First Fill/Purge Procedure, ASME:



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 the Tank Prior to Filling

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 >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.

First Fill Procedure

1. Partially fill the Perma-Cyl tank with product according to the table below.

Let liquid build pressure close to safety setting.

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

450 L Perma-Cyl tank	1000 standard cubic feet
1000 L Perma-Cyl tank	2000 standard cubic feet
1500 L Perma-Cyl tank	3000 standard cubic feet
2000 L Perma-Cyl tank	4000 standard cubic feet
3000 L Perma-Cyl tank	5000 standard cubic feet

2. Fill Perma-Cyl tank with product as indicated in the table.

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.

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.

Once pressure is >5 psig, close the liquid, vent and gas use valves.

3. Fill the Perma-Cyl tank with product and let the liquid in the tank build pressure close to the safety setting. Ensure the product is flowing through and purging the economizer lines. Control the pressure by opening the gas use and vent valves. Once pressure is >5 psig, close the gas use and vent valves.
4. Fill the Perma-Cyl tank with product per the table 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 >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.

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.
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 80% in order to allow for liquid expansion as the tank contents absorb heat while the metal continues to cool down over time.

Filling Procedures, DOT:

The Perma-Cyl 230 & 450 tanks are regulated by the Department of Transportation (US DOT) for transporting liquid oxygen, nitrogen, argon, carbon dioxide, and nitrous oxide. The filling of these tanks must be done by product weight. This will allow enough gas space above the liquid to keep the tank from becoming liquid full if its pressure rises to the relief valve setting. The filling weight tables (below and on the next page) indicate the correct product weight for the various relief valve settings. The standard relief settings are 230 psig (15.9 bar), 350 psig (24.1 bar), and 550 psig (37.9 bar).

Filling can be accomplished by either pressure transfer or pump fill. The following procedure is for a pressure transfer fill.

1. Sample the residual gas that is in the tank. Purge the tank if necessary to ensure the proper purity.
2. Place the tank on the filling scale. Record the weight. Compare this weight to the registered tare weight on the data plate. The difference is the weight of the residual gas.
3. Connect the transfer hose to the fill fitting. Record the new weight. The difference between this weight and the initial weight is the weight of the transfer hose.

4. To determine the total filling weight add the tare weight of the tank, the hose weight and proper filling weight from the table. The table indicates the product across the top and the relief valve pressure down the side. Connect the two columns to find the proper weight. Example: Perma-Cyl 230, nitrogen at 350 psig (24.1 bar) has a product weight of 343 pounds.
5. Open the tank's vent and liquid valves. Open the transfer line shut-off valve to begin the flow of product.
6. When the scale reads the calculated total filling weight, turn off the liquid valve on the tank. Close the vent valve.
7. Close the transfer line shut-off valve and relieve the pressure in the transfer line. Remove the transfer line. Remove the tank from the scale.



Note: The Perma-Cyl DOT models can also be filled by the Orca™ MicroBulk Delivery System while on-site. The Orca pump will automatically shut off at the correct fill level. If the Perma-Cyl tank is going to be transferred on a public road at pressures over 25.3, it must be filled on a scale according to weight tables show below. Perma-Cyl tanks transferred at pressures below 25.3 are exempt from DOT regulations.

Filling Weight Tables

Perma-Cyl 230 MP DOT (230 psig max. RV)

Perma-Cyl 230 HP DOT (350 psig max. RV)

Gross Capacity = 240 liters

Relief Valve Setting psig	Argon lbs	Nitrogen lbs	Oxygen lbs	Carbon Dioxide lbs	Nitrous Oxide lbs
0 to 45	702	401	570	-	-
46 to 75	686	390	554	-	-
76 to 105	670	380	543	570	549
106 to 170	644	369	528	554	533
**171 to 230	628	364	517	549	522
231 to 295	607	359	506	538	512
**296 to 360	596	343	491	528	501

**Normal Factory Setting

Perma-Cyl 265 MP DOT (230 psig max. RV)

Perma-Cyl 265 HP DOT (350 psig max. RV)

Gross Capacity = 276 liters

Relief Valve Setting psig	Argon lbs	Nitrogen lbs	Oxygen lbs	Carbon Dioxide lbs	Nitrous Oxide lbs
0 to 45	807	461	655	-	-
46 to 75	789	449	637	-	-
76 to 105	771	437	625	655	631
106 to 170	740	425	607	637	613
**171 to 230	722	418	595	631	601
231 to 295	698	412	582	619	588
**296 to 360	686	394	564	607	576

**Normal Factory Setting

Perma-Cyl 450 HP DOT (350 psig max. RV)

Gross Capacity = 450 liters

Relief Valve Setting psig	Argon lbs	Nitrogen lbs	Oxygen lbs	Carbon Dioxide lbs	Nitrous Oxide lbs
0 to 45	1316	752	1069	-	-
46 to 75	1287	732	1039	-	-
76 to 105	1257	712	1019	1069	1029
106 to 170	1207	693	990	1039	1000
**171 to 230	1178	683	970	1029	980
231 to 295	1138	673	950	1009	960
**296 to 360	1118	643	921	990	941

**Normal Factory Setting

Perma-Cyl 450 VHP DOT (450 psig max. RV)

Gross Capacity = 450 liters

Relief Valve Setting psig	Argon lbs	Nitrogen lbs	Oxygen lbs	Carbon Dioxide lbs	Nitrous Oxide lbs
0 to 45	1316	752	1069	--	--
46 to 75	1287	732	1039	--	--
76 to 105	1257	712	1019	1069	1029
106 to 170	1207	693	990	1039	1000
171 to 230	1178	683	970	1029	980
231 to 295	1138	673	950	1009	960
296 to 360	1118	643	921	990	941
361 to 450	1099	603	900	970	920
**451 to 540	1059	574	871	910	861

**Normal Factory Setting



Note: Filling weights are shown as the maximum weight allowed by code. Their related volumes may vary with product density.

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.

<i>Trouble</i>	<i>Probable Cause</i>	<i>Remedy</i>
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. Ensure there is no obstruction in the line or valve.
	Pressure builder is not building sufficient pressure.	1. Open pressure building regulator control 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. Ensure 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. Ensure 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
Frost or ice on sides, bottom, top-center and / or plumbing of tank.	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 continuous ice or frost.)	1. Move tank to a warmer location. 2. Add additional environmental heat and / or warm airflow to warm outer piping, components and sides of the tank. 3. Add switchover system to allow tank to rest and warm up when not in use.
	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.	<ol style="list-style-type: none"> 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.	<ol style="list-style-type: none"> 1. Call gas service agent.
Routinely low pressure in tank.	PB shut-off valve is closed. (If PB is not operating, no frost ring will appear at the bottom of the tank during gas use.)	<ol style="list-style-type: none"> 1. Open pressure building regulator control 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 ring will appear at the bottom of the tank during gas use.)	<ol style="list-style-type: none"> 1. Adjust regulator to higher pressure and allow pressure to build. 2. Call service agent to repair, replace or adjust regulator.
	Relief valve(s) stuck open.	<ol style="list-style-type: none"> 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. Call gas service technician to replace relief valve, if necessary.
	Large gas leak from tank plumbing or from gas use system.	<ol style="list-style-type: none"> 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.	<ol style="list-style-type: none"> 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	<ol style="list-style-type: none"> 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 tank is too cold.	<ol style="list-style-type: none"> 1. Move tank to warmer location. 2. Install freestanding ambient vaporizer on gas supply line in warmer location or install in-line gas heater.

<i>Trouble</i>	<i>Probable Cause</i>	<i>Remedy</i>
Gas supply to gas-use equipment is too cold. (continued)	Gas withdrawal rate from Perma-Cyl tank exceeds the capacity of tank's ambient vaporizer.	<ol style="list-style-type: none"> 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.	<ol style="list-style-type: none"> 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.	<ol style="list-style-type: none"> 1. If tank is in a mixer application and the usage is low, consider drawing gas off the vent line, as the economizer will not work completely in non-consistent draws. 2. Call gas service technician to clean, repair, or replace regulator.
	Tank is over-filled	<ol style="list-style-type: none"> 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. 4. Follow liquid withdrawal procedures to transfer excess contents into a second tank and eliminate the over-fill situation. Avoid hazards of contact with cryogenic liquids, excess gas concentrations, or high pressure.
	Pressure building function on regulator is set too high or regulator is malfunctioning.	<ol style="list-style-type: none"> 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.	<ol style="list-style-type: none"> 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.	<ol style="list-style-type: none"> 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.	<ol style="list-style-type: none"> 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.

<i>Trouble</i>	<i>Probable Cause</i>	<i>Remedy</i>
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)	<ol style="list-style-type: none"> 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.
High gas usage.	Unrecognized increase in actual gas use.	<ol style="list-style-type: none"> 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.	<ol style="list-style-type: none"> 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.	<ol style="list-style-type: none"> 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.	<ol style="list-style-type: none"> 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.	<ol style="list-style-type: none"> 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.	<ol style="list-style-type: none"> 1. None
	Fill line is blocked or inoperative.	<ol style="list-style-type: none"> 1. Check for obstructions in the fill line. Clear if necessary. 2. Gently tap on check valve to assure proper operation. 3. Call gas service technician.
	Float is stuck in the up position	<ol style="list-style-type: none"> 1. Gently tap on top knuckle to see if float will drop.
	Orca™ MicroBulk Delivery System is not functioning properly.	<ol style="list-style-type: none"> 1. Refer to Orca Troubleshooting.
	Transfer hose is obstructed, e.g. hose is bent excessively, crimped or plugged.	<ol style="list-style-type: none"> 1. Clean obstruction, inspect hose for damage, and, if everything is satisfactory, continue the filling.
Perma-Cyl tank does not shut off properly.	Fill line piping created too much pressure drop.	<ol style="list-style-type: none"> 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.	<ol style="list-style-type: none"> 1. Review the Orca/Perma-Cyl tank filling procedure. 2. Ensure that all vent and use valves of the tank are closed.
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.)	<ol style="list-style-type: none"> 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.

<i>Trouble</i>	<i>Probable Cause</i>	<i>Remedy</i>
Vacuum pump-out port and / or vacuum plug are open or damaged.	Pump-out plug or port have been damaged or tampered with.	<ol style="list-style-type: none"> 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.	<ol style="list-style-type: none"> 1. If possible, transfer any remaining contents to another tank. 2. 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.*

The following manuals are available for reference on related topics. All manuals are available on the MicroBulk Toolkit CD.

<i>Description</i>	<i>Part Number</i>
Cyl-Tel® Quick Start Guide	20664277
Cyl-Tel 2 Operation	11761841
Cyl-Tel Product Manual	20544482
OnSite Telemetry Cellular Quick Start Guide	20817822

All manuals are available free of charge by contacting Chart Inc. Customer Service at (800) 400-4683.



Specifications

Model	230L MP/LCCM Sq/Rnd Base w/Casters	230L HP/LCCM Sq/Rnd Base w/Casters	265L MP/LCCM Sq/Rnd Base w/Casters	265L HP/LCCM Sq/Rnd Base w/Casters	450L HP Plate Base	450L MP Plate Base	450L VHP Plate Base	700L HP Plate Base	1000L HP/VHP Plate Base	1500L HP/VHP Pallet Base	2000L HP/VHP Pallet Base	3000L HP/VHP Pallet Base	3000L HP/VHP Horizontal Forklift Base
CAPACITY (Liters)													
Gross	240	240	276	276	450	450	450	688	1056	1550	2042	2911	2911
Net	230	230	265	265	420	420	420	645	950	1455	1945	2707	2707
CAPACITY (Gallons)													
Gross	63.4	63.4	72.9	72.9	118.9	118.9	118.9	181.8	279.0	409.5	539.5	770	770
Net	60.8	60.8	70.0	70.0	111.0	111.0	111.0	170.4	251.0	384.4	513.9	715	715
MAWP													
psig	230	350	230	350	350	250	500	350	350/500	350/500	350/500	350/500	350/500
barg	15.9	24.1	15.9	24.1	24.1	17.2	34.5	24.1	24.1/34.5	24.1/34.5	24.1/34.5	24.1/34.5	24.1/34.5
PRE-SET OPERATING PRESSURE													
psig	125	300	125	300	300	125	450	300	300/450	300/450	300/450	300/450	300/450
barg	8.6	20.7	8.6	20.7	20.7	8.6	31.0	20.7	20.7/31.0	20.7/31.0	20.7/31.0	20.7/31.0	20.7/31.0
DESIGN SPECIFICATIONS													
DOT/ASME	DOT	DOT	DOT	DOT	DOT/ASME	ASME	DOT/ASME	ASME	ASME	ASME	ASME	ASME	ASME
STORAGE CAPACITY ⁽¹⁾													
Nitrogen SCF	5024	4734	5769	5769	8875/10332	10332	7922/10332	15860	24350	35790	47847	66592	66592
	Nm ³	142	134	152	271/272	272	271/272	449	686	1013	1257	1750	1750
Oxygen SCF	6244	5930	7186	7186	11124/12760	12760	11124/12760	19600	30070	44220	59089	82239	82239
	Nm ³	177	168	189	315/336	336	315/336	554	850	1250	1553	2161	2161
Argon SCF	6073	5763	6982	6983	10812/12478	12478	10812/12478	19160	29400	43220	57786	80425	80425
	Nm ³	172	163	183	306/328	328	306/328	542	832	1223	1519	2115	2115
CO₂ SCF	N/A	4615	N/A	5306	8312/8200	N/A	8312/8200	12608	19960	29340	38048	52954	N/A
	Nm ³	N/A	130.7	N/A	235/232	N/A	235/232	357	564	830	1000	1390	N/A
	Lbs	N/A	528	N/A	951/938	N/A	951/938	1442	2283	3356	4352	6058	N/A
THERMAL PERFORMANCE ⁽²⁾ (NER%/Day)													
N ₂	1.8%	1.8%	2%	2%	1.9%/1.6%	1.6%	1.9%/1.6%	1%	1%	1%	1%	1%	1%
O ₂ -Ar	1.12%	1.12%	1.4%	1.4%	1.2%/1%	1%	1.2%/1%	.62%	.62%	.62%	.62%	.62%	.62%
CO ₂	N/A	.6%	N/A	.7%	.6%/5%	N/A	.6%/5%	.3%	.3%	.3%	.3%	.3%	N/A
GAS DELIVERY RATE (LIN/LAR/LOX)													
SCF/H	400	400	400	400	575	575	575	660	960	1350	1350.2000 ⁽³⁾	1350.2000 ⁽³⁾	2000
Nm ³ /h	10.5	10.5	10.5	10.5	15.1	15.1	15.1	18.6	25.2	35.4	35.4/52.4	35.4/52.4	52.4
GAS DELIVERY RATE (CO₂)													
SCF/H	N/A	133	N/A	133	192	N/A	192	220	320	450	450/667 ⁽³⁾	450/667 ⁽³⁾	N/A
Nm ³ /h	N/A	3.8	N/A	3.8	5.4	N/A	5.4	6.2	9.0	12.7	12.7/17.5	12.7/17.5	N/A
Lbs/H	N/A	22	N/A	22	22	N/A	22	25	36	51	51/76	51/76	N/A
DIMENSIONS													
Diameter	in	26	26	26	30	30	30	42	42	48	48	58	58
	mm	660	660	660	762	762	762	1067	1067	1219	1219	1473	1473
Height	in	61.8/62	61.8/62	64.6/64.8	64.6/64.8	69	69	69	82	92/91	118.5/119.5	122/122.25	71
	mm	1570/1575	1570/1575	1641/1646	1641/1646	1753	1753	1753	2083	2337/2311	3010/3037	3099/3105	1803
Tare Weight	lbs	300	340	340	340	688*	605*	812*	1250*	1500/1750*	2200/2500**	2600/2950**	3300/4500**
	kg	136	154	154	154	312	274	368	567	680/794	998/1134	1179/1338	1497/2045

All specifications are subject to change without prior notice.

1) Values are based on net capacity at 0 psig (0 barg) for ASME vessels. CO₂ vessels are based on net capacity at 300 psig (20.7 barg). DOT vessels are per code.

2) Values are based on gross capacity.

3) Optional 3,500 SCF/H (92 Nm³/h) flow kit available.

Patents: 5,954,101 • 6,542,848 - Other Patents Pending

DOT - Department of Transportation, 4L Code

ASME - American Society of Mechanical Engineers, Section VIII, Division 1

Contact Factory for Canadian Approvals.

*Weights do not include lab base option. (265 lbs)**Weights include lab bases.

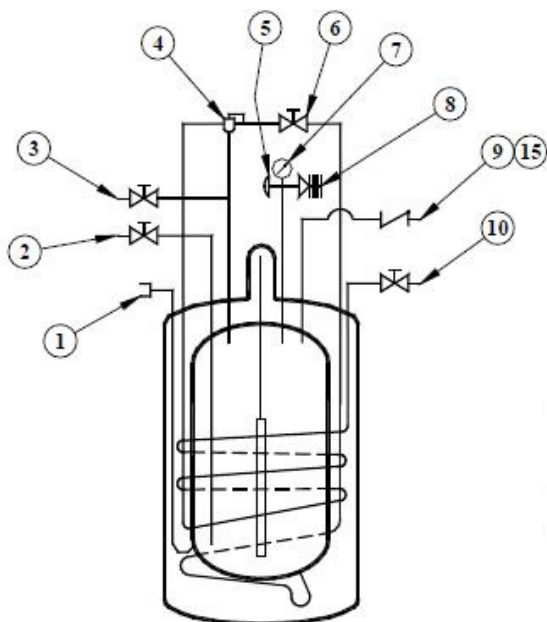
All dimensions are measured from the floor to the top of the highest plumbing component.



Illustrations & Parts Listing

Perma-Cyl 230/265 LCCM Schematics

Side View

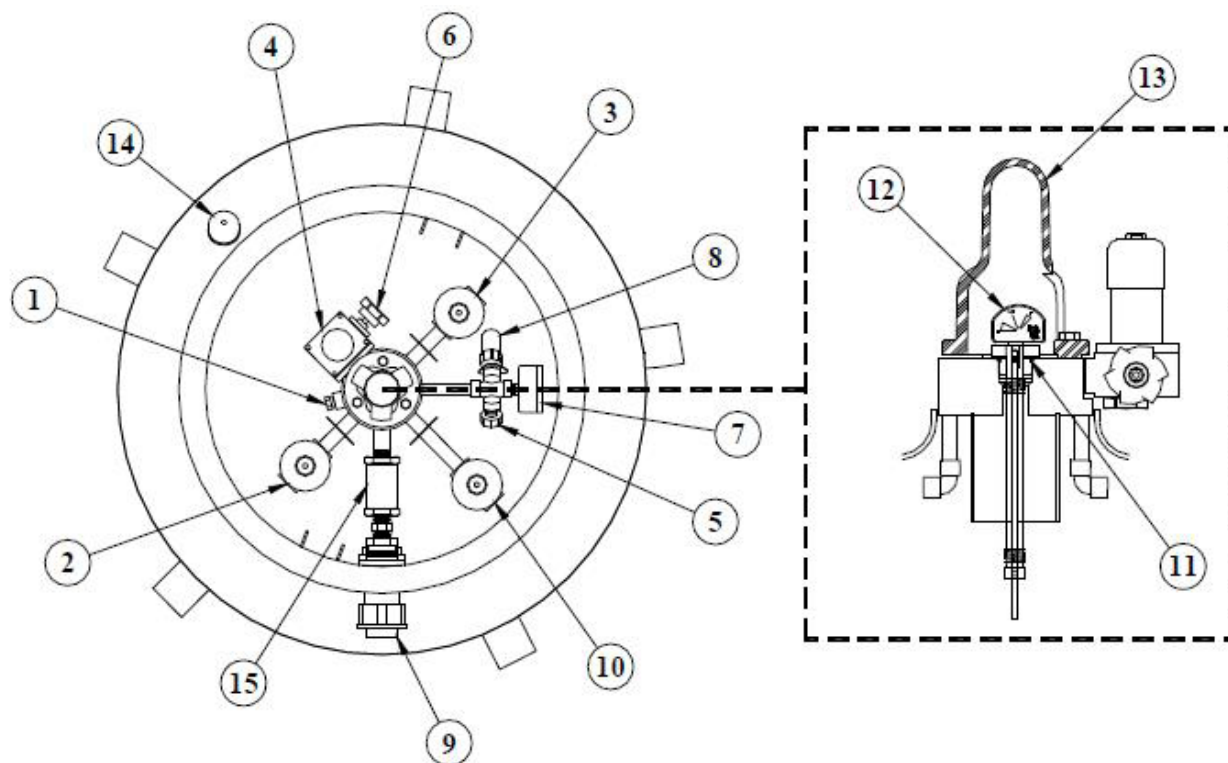
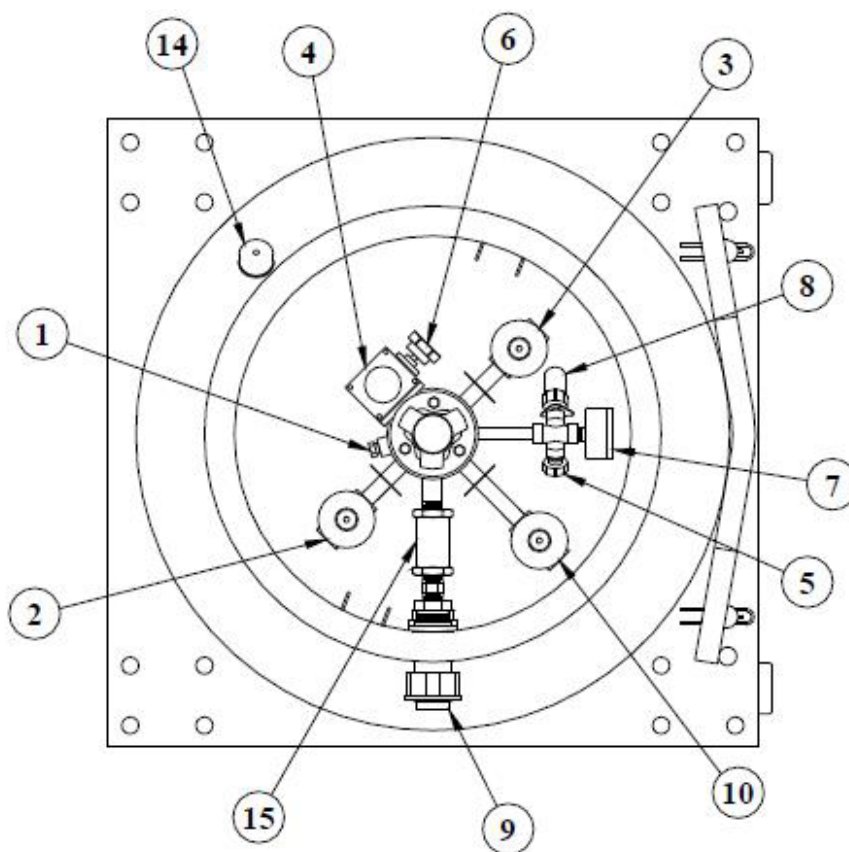


PN	Description	Rev
10939687	Perma-Cyl 230 MP RB DOT LCCM	P
11191674	Perma-Cyl 230 HP RB DOT LCCM	P
11511463	Perma-Cyl 265 MP SB DOT LCCM	P
13344945	Perma-Cyl 265 HP SB DOT LCCM	P
11187211	Perma-Cyl 230 HP SB LCCM SS	P
10896592	Perma-Cyl 230 MP SB LCCM	

Parts List

Item #*	Description	Item #*	Description
1	High Phase Port	8	Primary Relief
2	Liquid Use Valve	9	Service Fitting
3	Vent Valve	10	Gas Use Valve
4	LCCM PB/Econo Regulator	11	Roto Cal Plug/O-Ring
5	Rupture Disc	12	Roto Cal Gauge
6	PB Valve	13	Protective Cap
7	Pressure Gauge	14	Pump Out Port
		15	Check Valve

* Item #'s correspond with all schematics. See following pages for Item #'s 11-14.

Perma-Cyl 230/265 DOT LCCM Round Base Top View**Perma-Cyl 230/265 DOT LCCM Square Base Top View**

Configure to Order

Chart exclusively offers the Configure to Order program that allows you to customize your Perma-Cyl tank specifically for your application.

- **Option 01 - Chart Standard**

Our standard offering.

- **Option 02 - Gauge Isolation Package**

This package includes an equalization/service valve for the differential pressure gauge.

- **Option 03 - Component Service Valve Package**

This package includes isolation valves on all serviceable components including regulators and gauges for easy service and maintenance.

- **Option 04 - Liquid Withdrawal Package**

This package is designed with the liquid use customer in mind. A ball valve is standard on the liquid withdrawal for increased flow-rates while a valved off adjustable low pressure relief maintains low pressure in the tank during use. Isolation valves are included in this package.

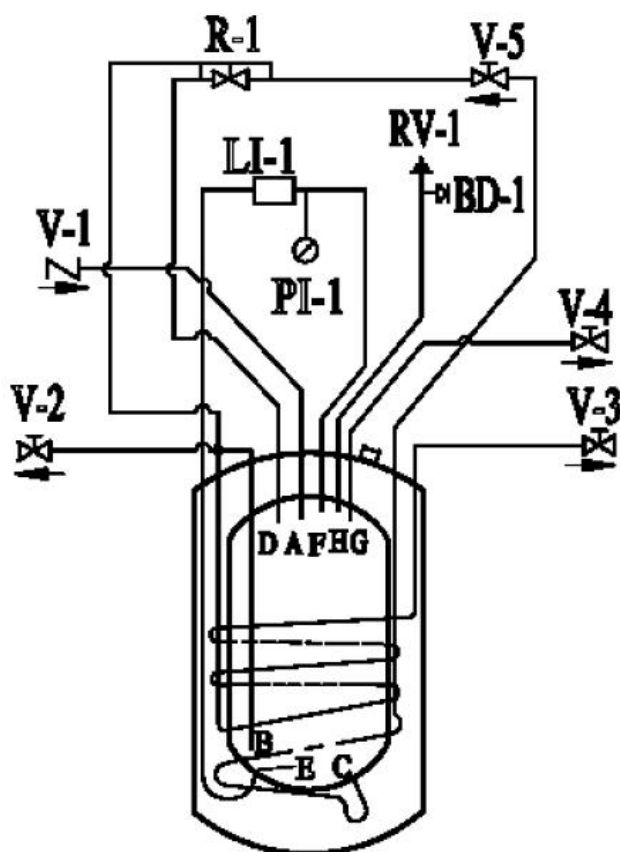
- **Option 05 - CO₂ Package**

This package includes all the features that are standard on Chart Beverage tanks. Isolation valves are included on all regulators and components. A drain valve is located on the PB circuit for easy cleanout of debris. The tank even has the patented Sure-Fill™ CO₂ Tank Filling System and standard CO₂ Fill Fitting for standardization with the existing CO₂ Delivery network.

- **Option 07 - ZX Supercharged PB System**

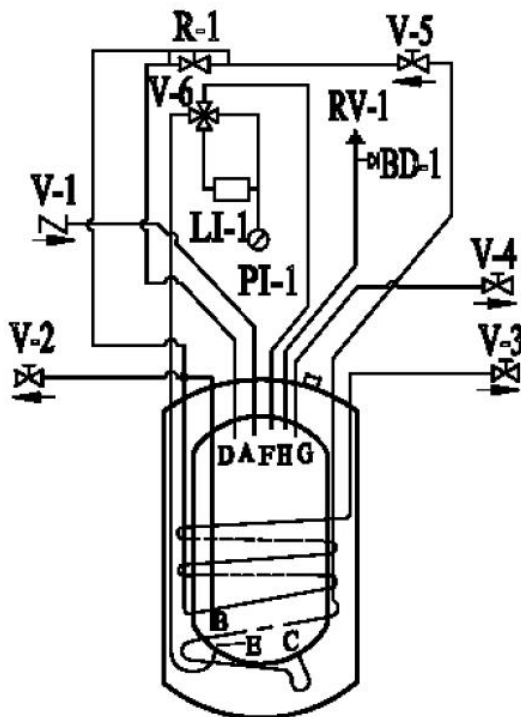
For the utmost in performance in high pressure, high flow accounts the ZX Supercharger delivers. The ZX uses a high flow pressure building system to attain pressure recovery times as low as 12 minutes and can support withdrawal rates up to 7000 scfh. This system is available on 1000 and 1500 VHP tanks.

Configuration 01 - Perma-Cyl 230/450/700/1000 MP/HP, 450/1000 VHP, 1500 HP



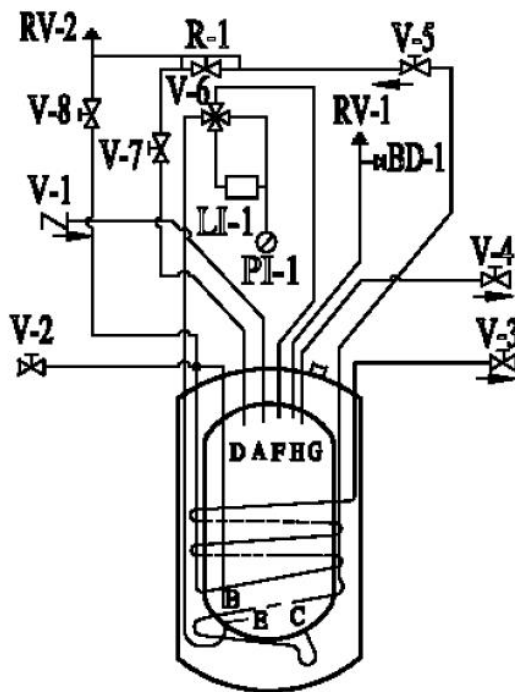
NOMENCLATURE	
V-1	TOP FILL CHECK VALVE
V-2	LIQUID VALVE
V-3	GAS USE VALVE
V-4	VENT/FULL TRYCOCK VALVE
V-5	PRESS. BLDG. VALVE
LI-1	LEVEL INDICATOR
PI-1	PRESSURE INDICATOR
R-1	PRESS. BDLG./ECONO REG.
RV-1	RELIEF VALVE
BD-1	BURST DISC

A	TOP FILL
B	LIQUID W/DRAWAL
C	PRESSURE BUILDING INLET
D	PRESSURE BUILDING OUTLET
E	LIQUID PHASE
F	VAPOR PHASE
G	VENT/FULL TRYCOCK
H	SAFETY CIRCUIT

Configuration 02 - Perma-Cyl 230/450/700/1000 MP/HP, 450/1000VHP, 1500 HP

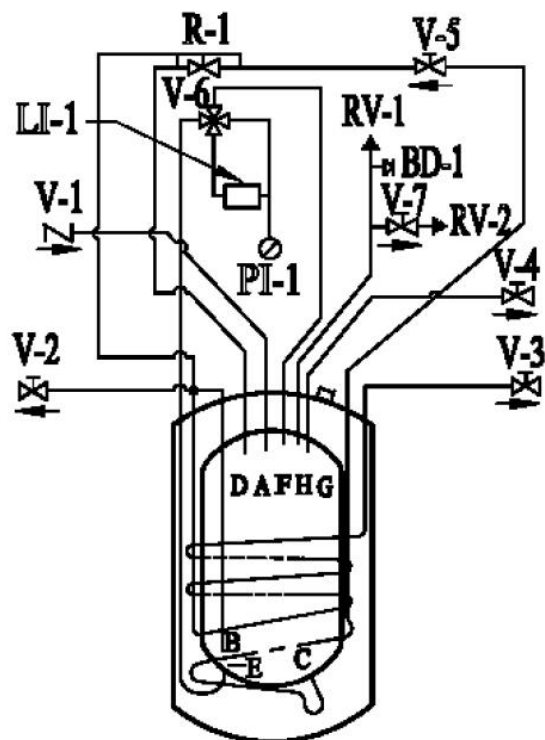
NOMENCLATURE	
V-1	TOP FILL CHECK VALVE
V-2	LIQUID VALVE
V-3	GAS USE VALVE
V-4	VENT/FULL TRYCOCK VALVE
V-5	PRESS. BLDG. VALVE
V-6	4-WAY VALVE
LI-1	LEVEL INDICATOR
PI-1	PRESSURE INDICATOR
R-1	PRESS. BDLG/ ECONO REG.
RV-1	RELIEF VALVE
BD-1	BURST DISC

A	TOP FILL
B	LIQUID W/DRAWAL
C	PRESSURE BUILDING INLET
D	PRESSURE BUILDING OUTLET
E	LIQUID PHASE
F	VAPOR PHASE
G	VENT/FULL TRYCOCK
H	SAFETY CIRCUIT

Configuration 03 - Perma-Cyl 450/700/1000 MP/HP, 450/1000VHP, 1500 HP

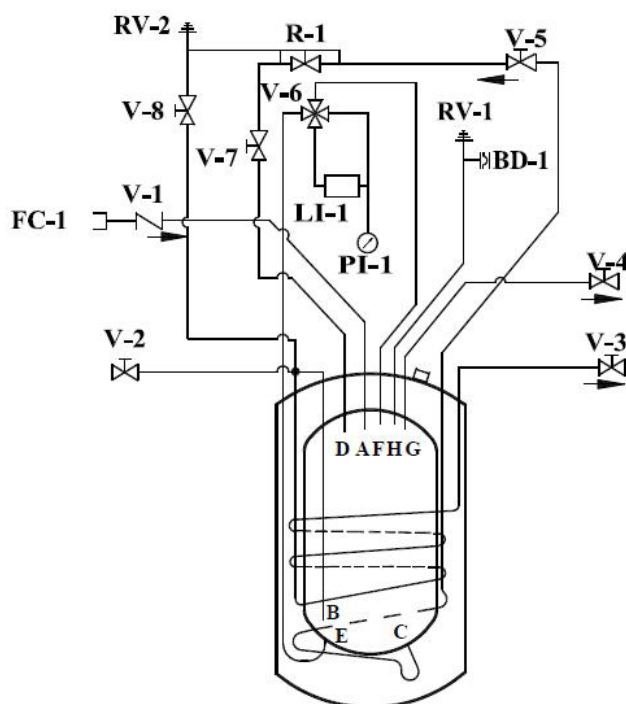
NOMENCLATURE	
V-1	TOP FILL CHECK VALVE
V-2	LIQUID VALVE
V-3	GAS USE VALVE
V-4	VENT/FULL TRYCOCK VALVE
V-5	PRESS. BLDG. VALVE
V-6	4-WAY VALVE
V-7	REG. ISO VALVE
V-8	REG. ISO VALVE
LI-1	LEVEL INDICATOR
PI-1	PRESSURE INDICATOR
R-1	PRESS. BDLG/ ECONO REG.
RV-1	RELIEF VALVE
RV-2	LINE RELIEF
BD-1	BURST DISC

A	TOP FILL
B	LIQUID W/DRAWAL
C	PRESSURE BUILDING INLET
D	PRESSURE BUILDING OUTLET
E	LIQUID PHASE
F	VAPOR PHASE
G	VENT/FULL TRYCOCK
H	SAFETY CIRCUIT

Configuration 04 - Perma-Cyl 450/700/1000 MP/HP, 450/1000 VHP, 1500 HP

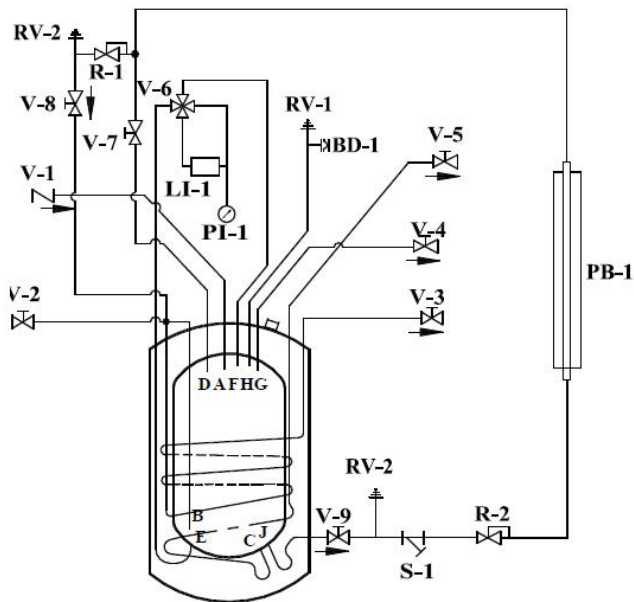
NOMENCLATURE	
V-1	TOP FILL CHECK VALVE
V-2	LIQUID VALVE
V-3	GAS USE VALVE
V-4	VENT/FULL TRYCOCK VALVE
V-5	PRESS. BLDG. VALVE
V-6	4-WAY VALVE
V-7	ISOLATION VALVE
LI-1	LEVEL INDICATOR
PI-1	PRESSURE INDICATOR
R-1	PRESS. BDLG./ ECONO REG.
RV-1	RELIEF VALVE
RV-2	RELIEF VALVE 35 PSI
BD-1	BURST DISC

A	TOP FILL
B	LIQUID W/DRAWAL
C	PRESSURE BUILDING INLET
D	PRESSURE BUILDING OUTLET
E	LIQUID PHASE
F	VAPOR PHASE
G	VENT/FULL TRYCOCK
H	SAFETY CIRCUIT

Configuration 05 - Perma-Cyl 450/700/1000 MP/HP, 450/1000VHP, 1500 HP

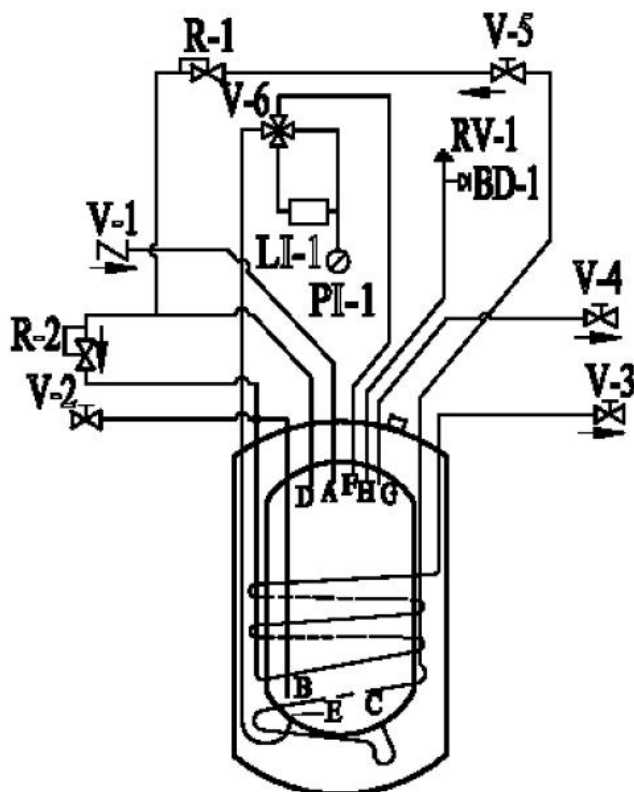
NOMENCLATURE	
V-1	TOP FILL CHECK VALVE
V-2	LIQUID VALVE
V-3	GAS USE VALVE
V-4	VENT/FULL TRYCOCK VALVE
V-5	PRESS. BLDG. VALVE
V-6	4-WAY VALVE
V-7	REG. ISO VALVE
V-8	REG. ISO VALVE
LI-1	LEVEL INDICATOR
PI-1	PRESSURE INDICATOR
R-1	PRESS. BDLG./ ECONO REG.
RV-1	RELIEF VALVE
RV-2	LINE RELIEF
BD-1	BURST DISC
FC-1	FILL CONN. CO2

A	TOP FILL
B	LIQUID W/DRAWAL
C	PRESSURE BUILDING INLET
D	PRESSURE BUILDING OUTLET
E	LIQUID PHASE
F	VAPOR PHASE
G	VENT/FULL TRYCOCK
H	SAFETY CIRCUIT

Configuration 07 - Perma-Cyl 1000 VHP, 1500 VHP

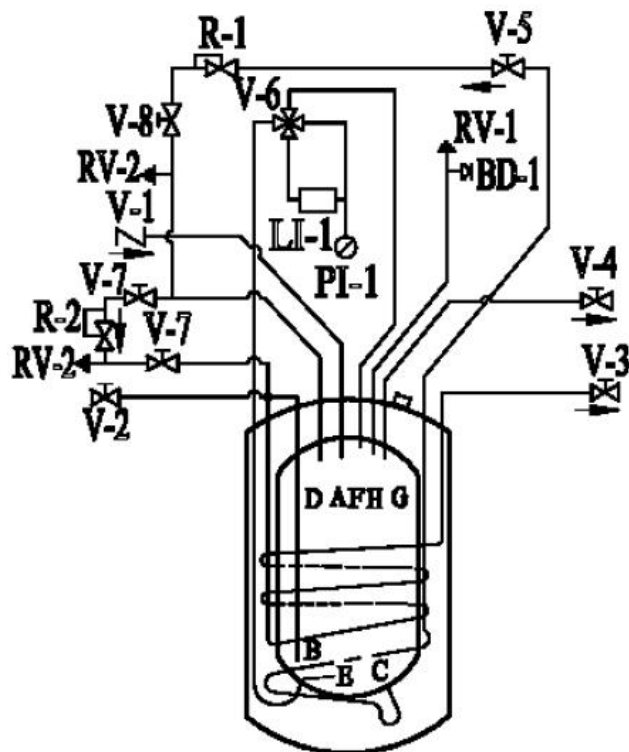
NOMENCLATURE	
V-1	TOP FILL CHECK VALVE
V-2	LIQUID VALVE
V-3	GAS USE VALVE
V-4	VENT/FULL TRYCOCK VALVE
V-5	PRESS. BLDG. VALVE
V-6	4-WAY VALVE
V-7	REG. ISO VALVE
V-8	REG. ISO VALVE
V-9	AUXILIARY LIQUID VALVE
LI-1	LEVEL INDICATOR
PI-1	PRESSURE INDICATOR
PB-1	EXTERNAL PRESS. BUILDER
R-1	ECONOMIZER REG.
R-2	PRESS. BLDG. REG
RV-1	RELIEF VALVE
RV-2	LINE RELIEF
BD-1	BURST DISC
S-1	STRAINER

A	TOP FILL
B	LIQUID W/DRAWAL
C	PRESSURE BUILDING INLET
D	PRESSURE BUILDING OUTLET
E	LIQUID PHASE
F	VAPOR PHASE
G	VENT/FULL TRYCOCK
H	SAFETY CIRCUIT
J	AUXILIARY LIQUID W/DRWL

Configuration 02 - Perma-Cyl 1500 VHP

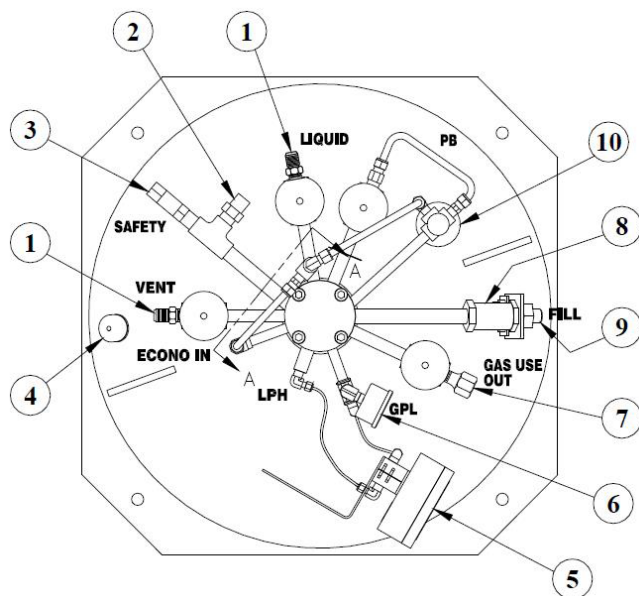
NOMENCLATURE	
V-1	TOP FILL CHECK VALVE
V-2	LIQUID VALVE
V-3	GAS USE VALVE
V-4	VENT/FULL TRYCOCK VALVE
V-5	PRESS. BLDG. VALVE
V-6	4-WAY VALVE
LI-1	LEVEL INDICATOR
PI-1	PRESSURE INDICATOR
R-1	PRESS. BLDG. REGULATOR
R-2	ECONOMIZER REGULATOR
RV-1	MAIN RELIEF VALVE
BD-1	BURST DISC

A	TOP FILL
B	LIQUID W/DRAWAL
C	PRESSURE BUILDING INLET
D	PRESSURE BUILDING OUTLET
E	LIQUID PHASE
F	VAPOR PHASE
G	VENT/FULL TRYCOCK
H	SAFETY CIRCUIT

Configuration 03 - Perma-Cyl 1500 VHP

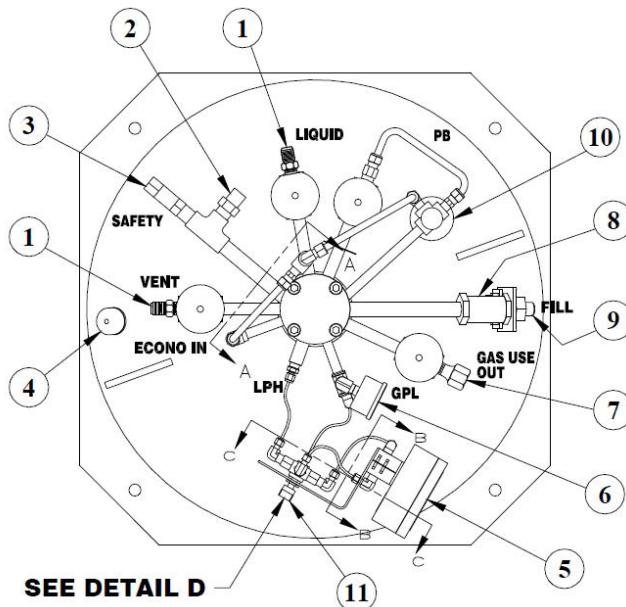
NOMENCLATURE	
V-1	TOP FILL CHECK VALVE
V-2	LIQUID VALVE
V-3	GAS USE VALVE
V-4	VENT/FULL TRYCOCK VALVE
V-5	PRESS. BLDG. VALVE
V-6	4-WAY VALVE
V-7	REG. ISO VALVE
V-8	REG. ISO VALVE
LI-1	LEVEL INDICATOR
PI-1	PRESSURE INDICATOR
R-1	PRESS. BLDG. REGULATOR
R-2	ECONOMIZER REGULATOR
RV-1	MAIN RELIEF VALVE
RV-2	LINE RELIEF VALVE
BD-1	BURST DISC

A	TOP FILL
B	LIQUID W/DRAWAL
C	PRESSURE BUILDING INLET
D	PRESSURE BUILDING OUTLET
E	LIQUID PHASE
F	VAPOR PHASE
G	VENT/FULL TRYCOCK
H	SAFETY CIRCUIT

Perma-Cyl 230-01 Chart Standard

PN 11560847
PN 11560855

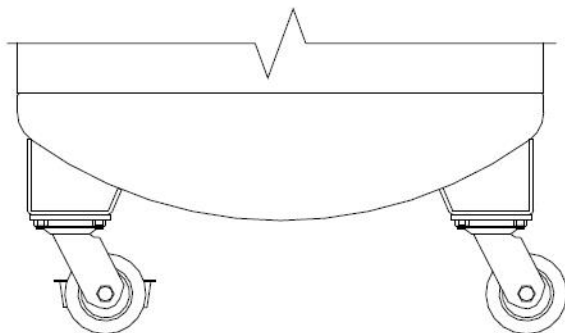
The Chart Standard tank configuration provides our customers with the essentials needed for a standard cryogenic tank.

Perma-Cyl 230-02 Cyl-Tel® Liquid Level Gauge Service Valve

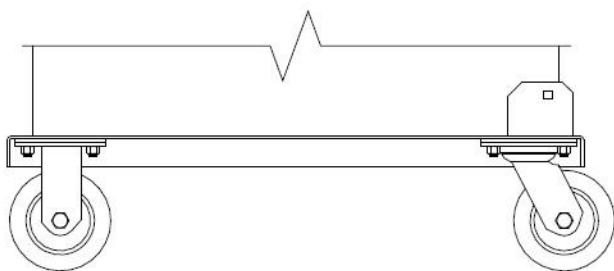
PN 11525806
PN 11542420

The Cyl-Tel Gauge Service Valve tank configuration provides our customer with a 4-way valve gauge isolation.

*Top View of 230 liter model w/base plate. The 230 model has optional square base w/casters or round base w/casters. See detail.



230 ROUND BASE

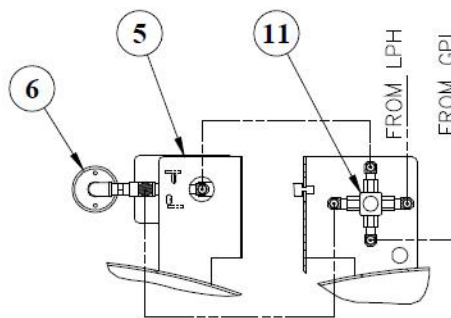


230 SQUARE BASE



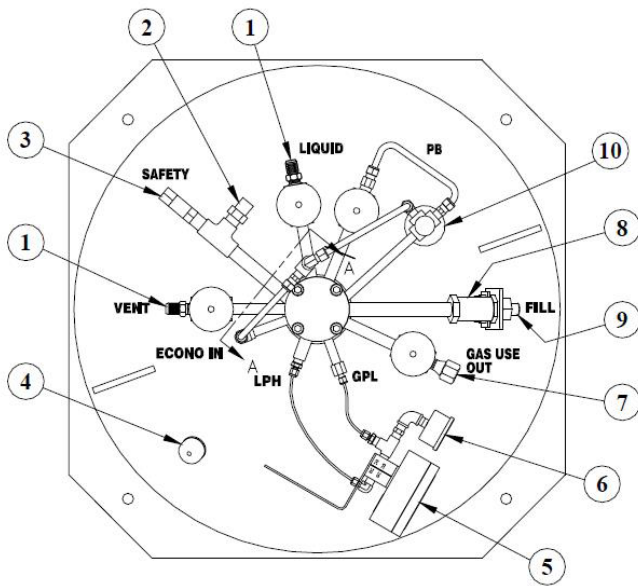
SECTION A-A

DETAIL D



SECTION B-B SECTION C-C

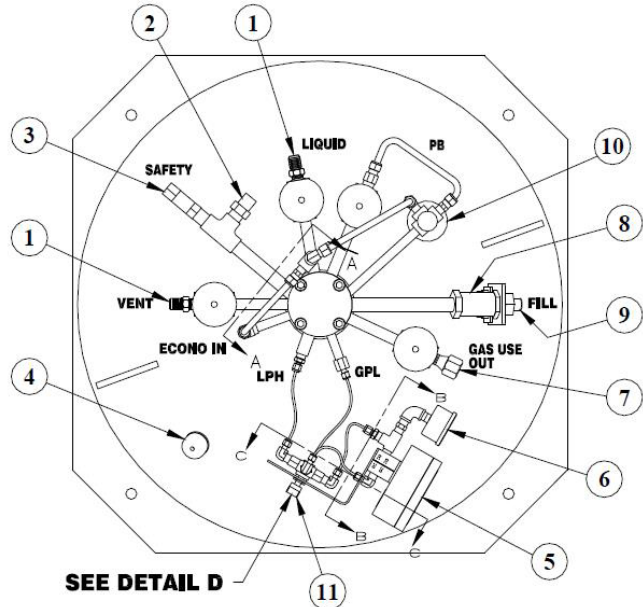
Perma-Cyl 450/700-01 Chart Standard



PN 11560847-450 PN 11725066-700
 PN 11560855-450 PN 11725031-700
 PN 11560863-450

The Chart Standard tank configuration provides our customers with the essentials needed for a standard cryogenic tank.

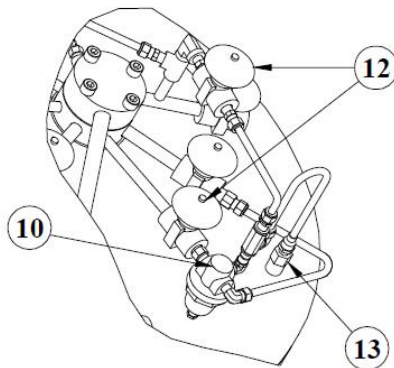
Perma-Cyl 450/700-02 Cyl-Tel® Liquid Level Gauge Service Valve



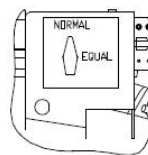
PN 11525806-450 PN 11725058-700
 PN 11542420-450 PN 11684292-700
 PN 11542649-450

The Cyl-Tel Gauge Service Valve tank configuration provides our customer with a 4-way valve gauge isolation.

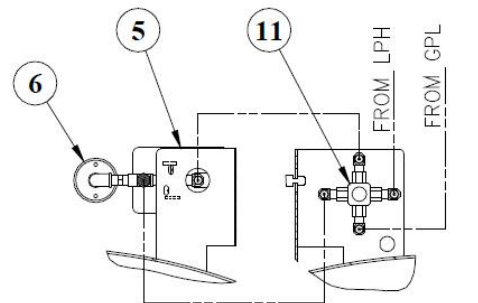
*O.D. of 450 is 30" (shown above), O.D. of 700 is 42".



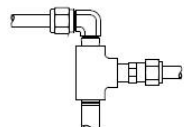
DETAIL E



DETAIL D



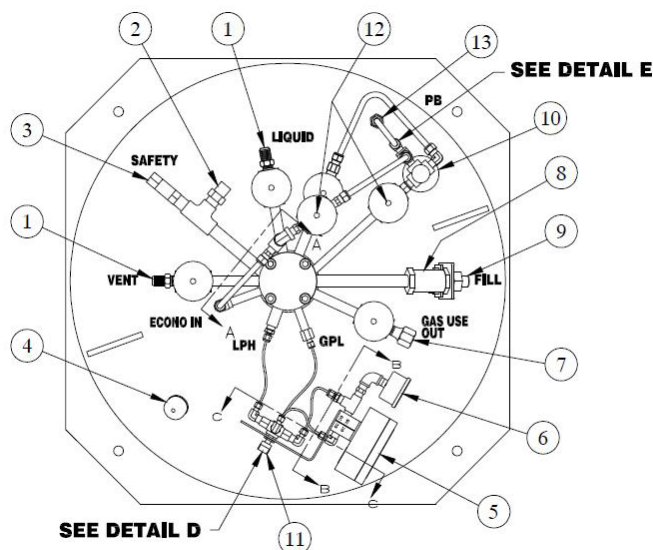
SECTION B-B SECTION C-C



SECTION A-A

TO ECONO IN

Perma-Cyl 450/700-03 Service Valves & High Pressure



PN 11526024-450

PN 11724936-700

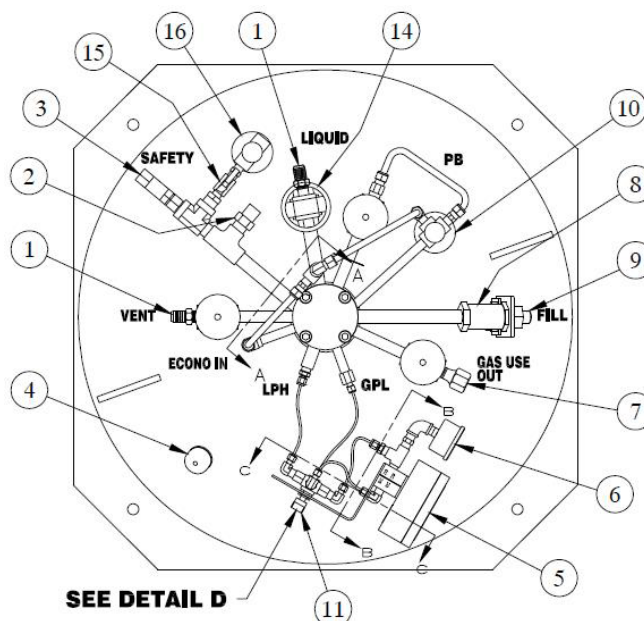
PN 11542411-450

PN 11725040-700

PN 11542631-450

The Service Valves and High Pressure tank configuration provides our customer with a 4-way gauge isolation, and regulator isolation valves.

Perma-Cyl 450/700-04 Low Pressure Liquid

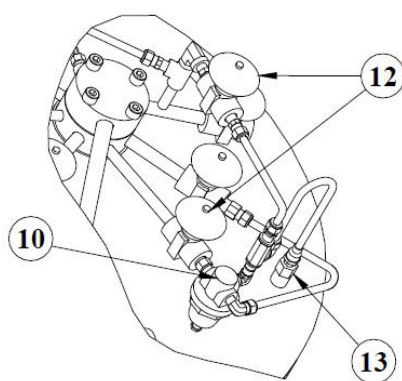


PN 11394480-450

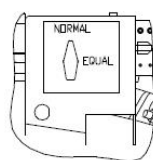
PN 11725023-700

The Low Pressure Liquid tank configuration provides our customers with a 4-way valve gauge isolation, liquid withdrawal ball valve, and a valved relief regulator (15-50 psi range).

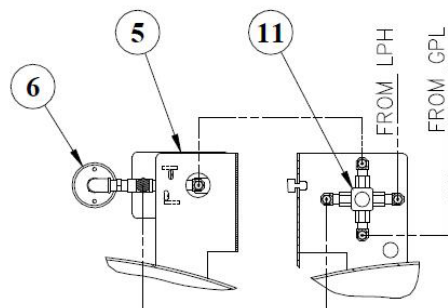
*O.D. of 450 is 30" (shown above), O.D. of 700 is 42".



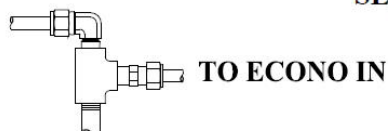
DETAIL E



DETAIL D

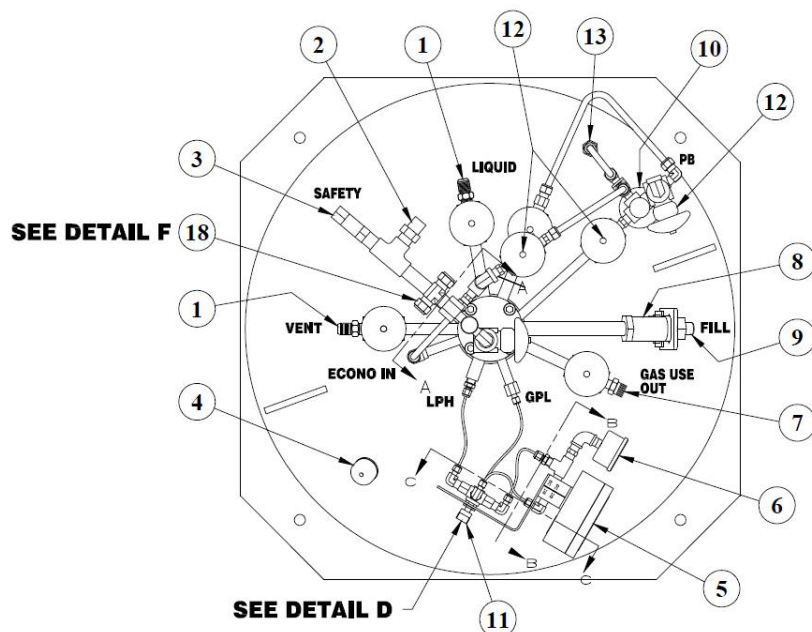


SECTION B-B SECTION C-C



SECTION A-A

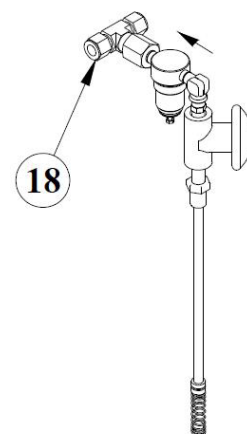
Perma-Cyl 450/700-05 CO₂ Service



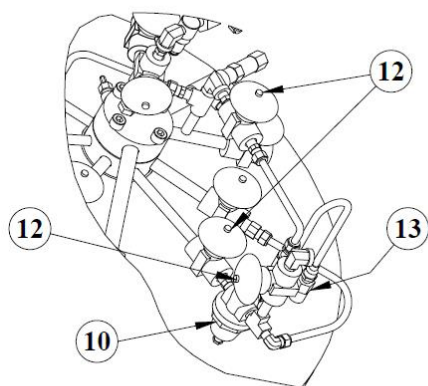
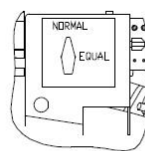
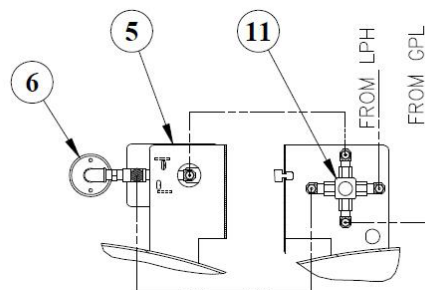
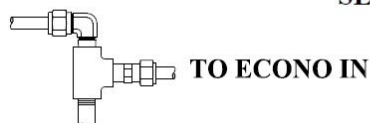
PN 11541523-450

PN 11700264-700

The CO₂ Service tank configuration provides our customers with a 4-way valve gauge isolation, regulator isolation valves, and a CO₂ Package, including the patented Sure-Fill™ CO₂ Tank Filling System.

**DETAIL F**

*O.D. of 450 is 30" (shown above), O.D. of 700 is 42".

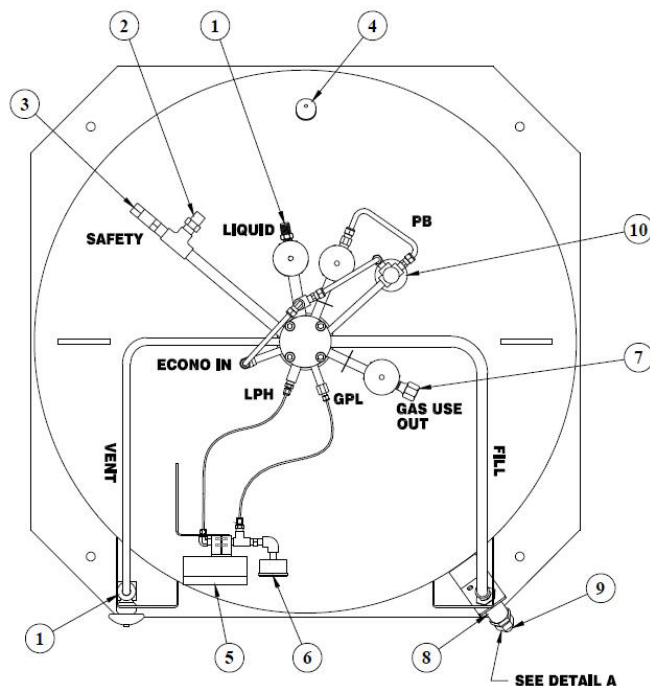
**DETAIL E****DETAIL D****SECTION B-B SECTION C-C****SECTION A-A**

Perma-Cyl 230/450/700 Standard Parts List:

Item	Part No.	Description
1a	1110072	Connection 1/2" ODT x 3/8" (45° Flare-Inert)
1b	1110112	Connection 5/8" ODT x 3/8" (45° Flare-OXY)
2a	11671281	Rupture Disk (375PSI)
2b	11526569	Rupture Disk (525PSI)
2c	11526622	Rupture Disk (700PSI)
3a	11488574	Relief Valve (250PSI)
3b	11488591	Relief Valve (350PSI)
3c	11385111	Relief Valve (500PSI)
4	3911217	Black Plastic Cap
5	13141662	Cyl-Tel® Gauge
7a	4010022	Outlet 3/8" MPT (INERT)
7b	4010012	Outlet 3/8" MPT (OXY)
7c	4010562	Outlet 3/8" MPT (CO ₂)
8	11051090	Check Valve 1/2" FPT x 1/2" FPT
9.2a	1110122	Connection 1/2" ODT x 1/2" (45° Flare-Inert)
9.2b	1110912	Connection 5/8" ODT x 1/2" (45° Flare-OXY)
10a	11081336	Combination Regulator 1/4" NPT (125 PSI)
10b	11081328	Combination Regulator 1/4" NPT (300 PSI)
10c	11375625	Combination Regulator 1/4" NPT (450 PSI)

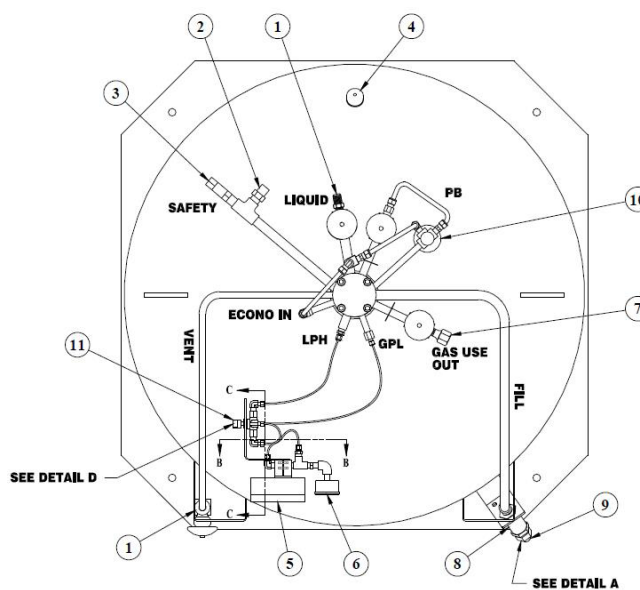
Perma-Cyl 230/450/700 Options:

Item	Part No.	Description
10d	10645339	Combination Regulator 1/4" NPT (15-50PSI)
11	20683719	4-Way Valve
12	11905999	1/4" Isolation Valve
13	1812702	Line Relief Valve (550PSI)
14	11539491	1/2" Ball Valve
16	11696795	Adjustable Relief Regulator (35PSI)
7	11905999	1/4" Drain Valve
18	10601045	Sure-Fill S/A 3/4" CO ₂

Perma-Cyl 1000-01 Chart Standard

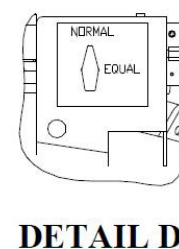
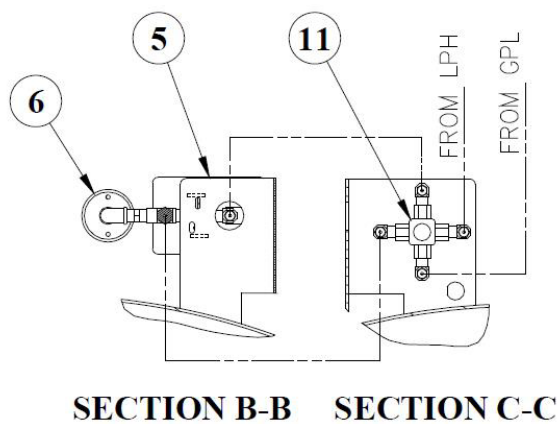
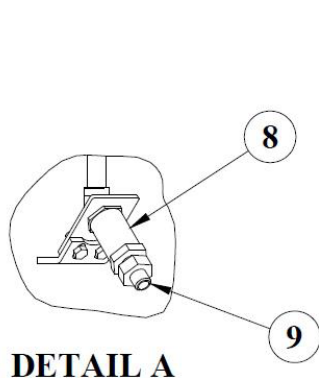
PN 11560898
 PN 11482017
 PN 11482050

The Chart Standard tank configuration provides our customers with the essentials for a standard cryogenic tank.

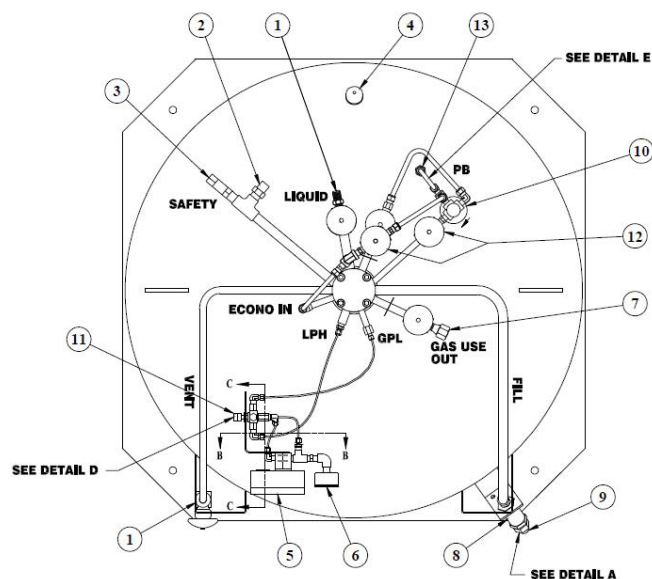
Perma-Cyl 1000-02 Cyl-Tel® Liquid Level Gauge Service Valve

PN 11394404
 PN 11482025
 PN 11482041

The Cyl-Tel Gauge Service Valve tank configuration provides our customers with a 4-way valve gauge isolation.



Perma-Cyl 1000-03 Service Valves & High Pressure



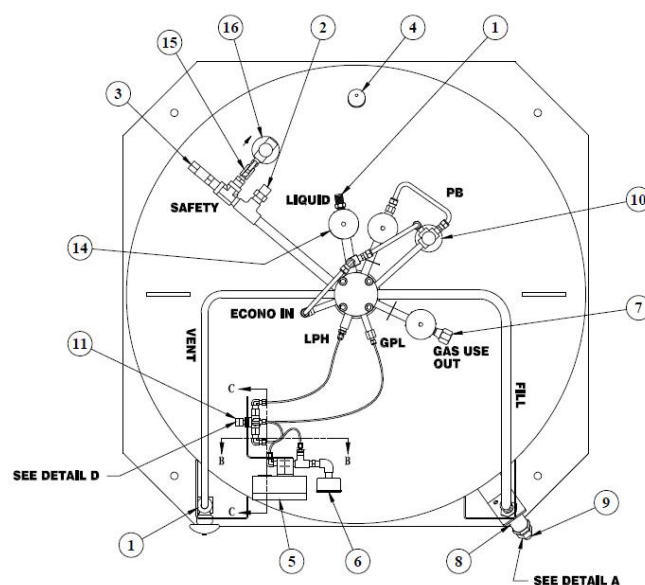
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PN 11482033

PN 11482009

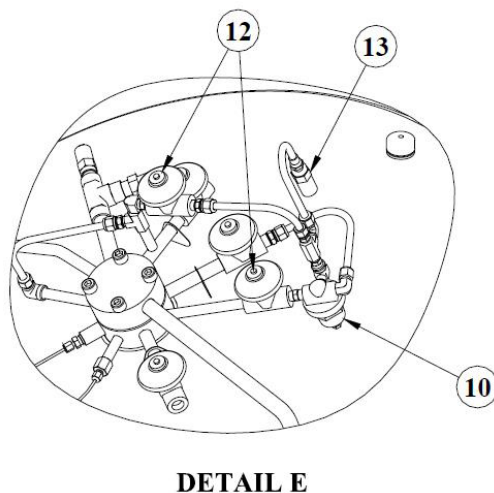
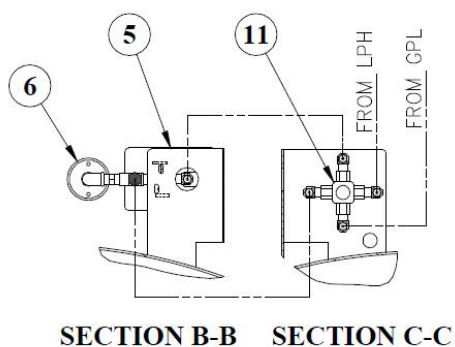
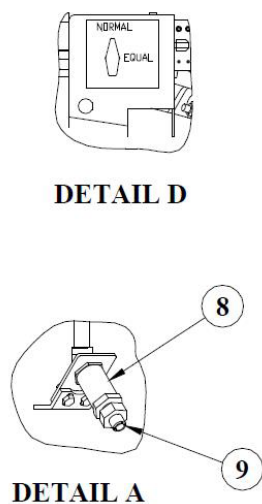
The Service Valves and High Pressure tank configuration provides our customers with a 4-way valve gauge isolation, and regulator isolation valves

Perma-Cyl 1000-04 Low Pressure Liquid

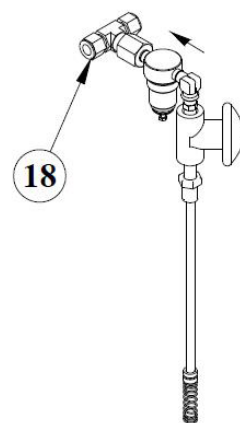
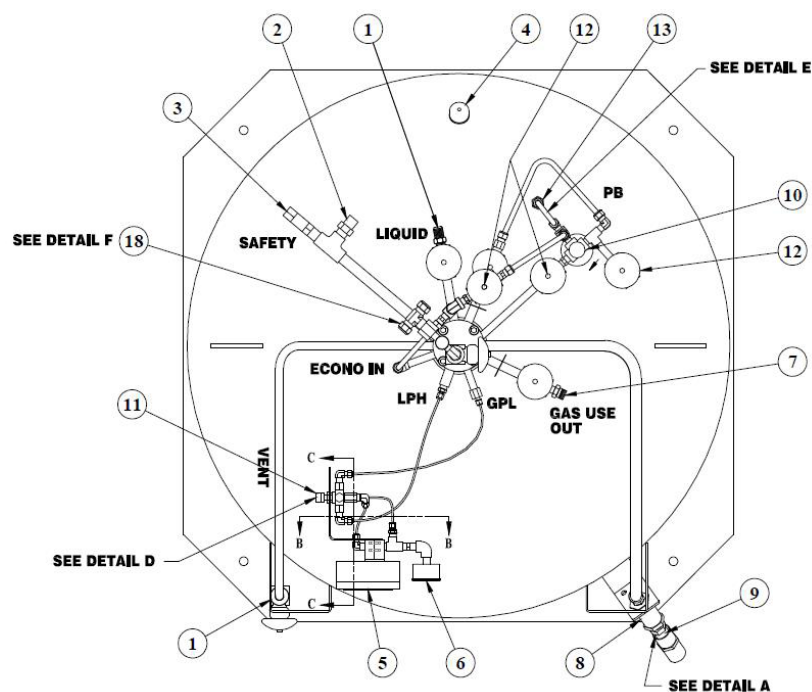


PN 11394501

The Low Pressure Liquid tank configuration provides our customers with a 4-way valve gauge isolation, a liquid withdrawal ball valve, and a valved relief regulator (15-50 psi range).



Perma-Cyl 1000-05 CO₂ Service

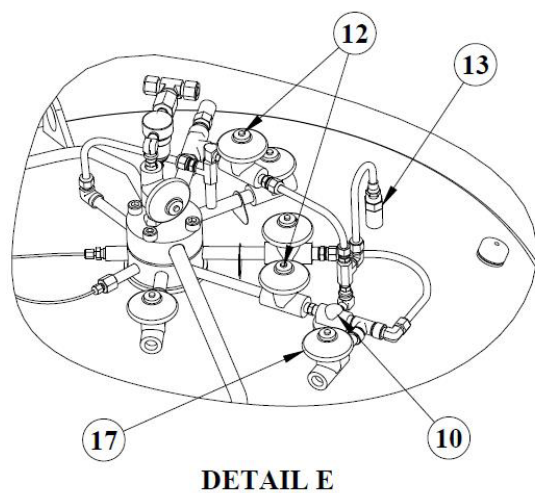


DETAIL F

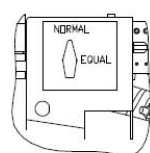
PN 11394519

PN 11552548

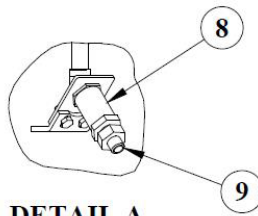
The CO₂ Service tank configuration provides our customers with a 4-way valve gauge isolation, regulator isolation valves, and a CO₂ Package, including the patented Sure-fill System.



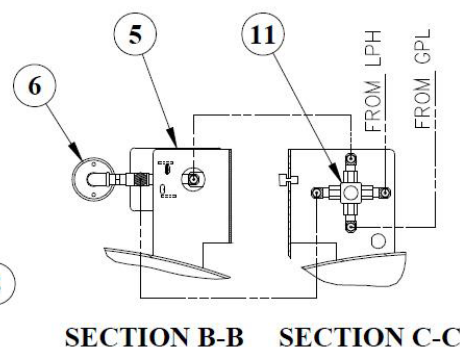
DETAIL E



DETAIL D

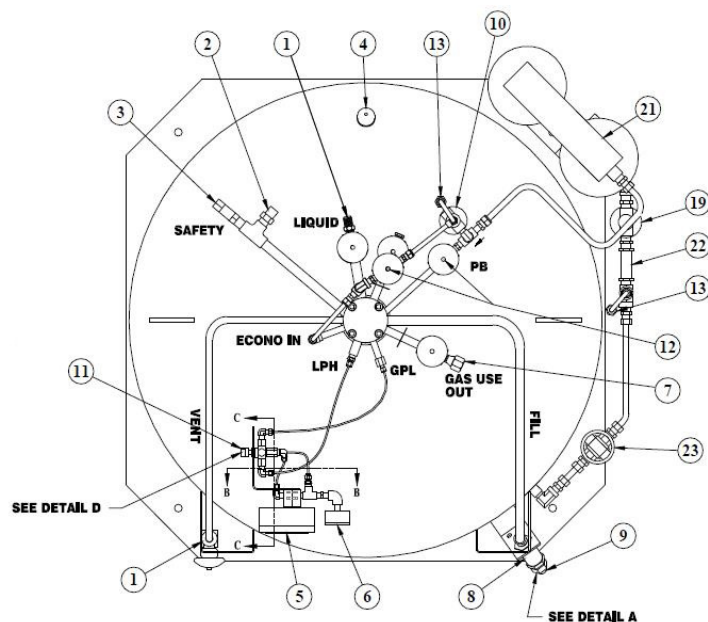


DETAIL A



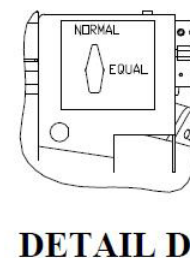
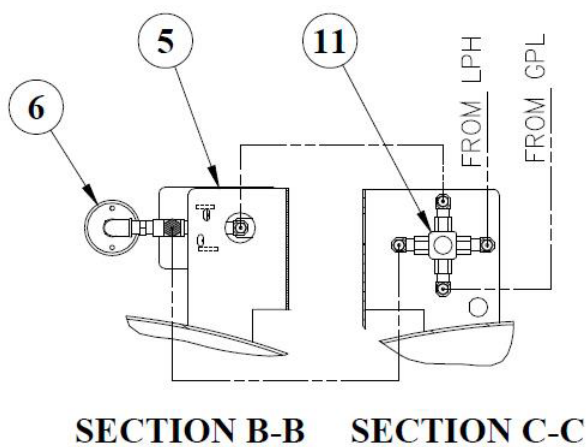
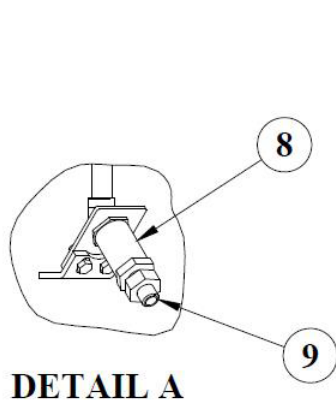
SECTION B-B SECTION C-C

Perma-Cyl 1000-07 ZX Super-Charged PB



PN 11725091

The ZX Supercharged PB (option 07) should be specified when the utmost in tank performance is required. This system will dramatically reduce pressure recovery time to around 15 minutes or less in most cases. When used with an external vaporizer, withdrawal rates of up to 7000 SCFH can be obtained.



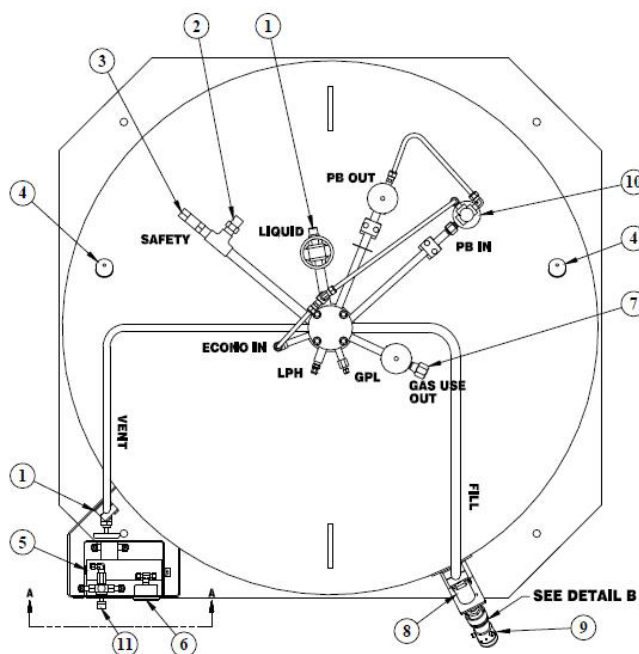
Perma-Cyl 1000 Standard Parts List:

Item	Part No.	Description
1a	1110072	Connection 1/2" ODT x 3/8" (45° Flare-Inert)
1b	1110112	Connection 5/8" ODT x 3/8" (45° Flare-OXY)
2a	11671281	Rupture Disk (375PSI)
2b	11526569	Rupture Disk (525PSI)
2c	11526622	Rupture Disk (700PSI)
3a	11488574	Relief Valve (250PSI)
3b	11488591	Relief Valve (350PSI)
3c	11385111	Relief Valve (500PSI)
4	3911217	Black Plastic Cap
5	13141662	Cyl-Tel® Gauge
7a	4010022	Outlet 3/8" MPT (INERT)
7b	4010012	Outlet 3/8" MPT (OXY)
7c	4010562	Outlet 3/8" MPT (CO ₂)
8	11051090	Check Valve 1/2" FPT x 1/2" FPT
9.2a	1110122	Connection 1/2" ODT x 1/2" (45° Flare-Inert)
9.2b	1110912	Connection 5/8" ODT x 1/2" (45° Flare-OXY)
10a	11081336	Combination Regulator 1/4" NPT (125 PSI)
10b	11081328	Combination Regulator 1/4" NPT (300 PSI)
10c	11375625	Combination Regulator 1/4" NPT (450 PSI)

Perma-Cyl 1000 Options:

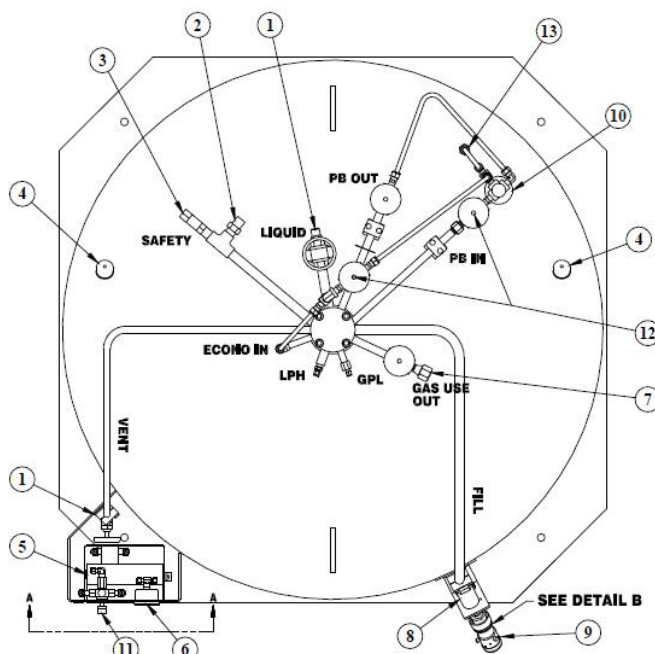
Item	Part No.	Description
10d	10645339	Combination Regulator 1/4" NPT (15-50PSI)
11	20683719	4-Way Valve
12	11905999	1/4" Isolation Valve
13	1812702	Line Relief Valve (550PSI)
14	11539491	1/2" Ball Valve
16	11696795	Adjustable Relief Regulator (35PSI)
7	11905999	1/4" Drain Valve

Perma-Cyl 1500 HP-02 Cyl-Tel® Liquid Level Gauge Service Valve

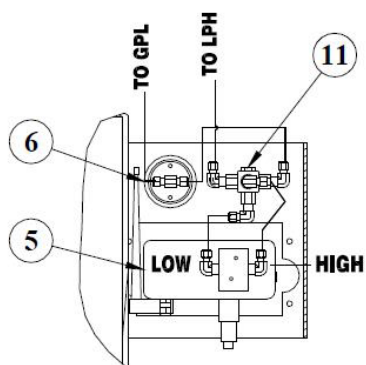


The Cyl-Tel Gauge Service Valve tank configuration provides our customers with a 4-way valve gauge isolation.

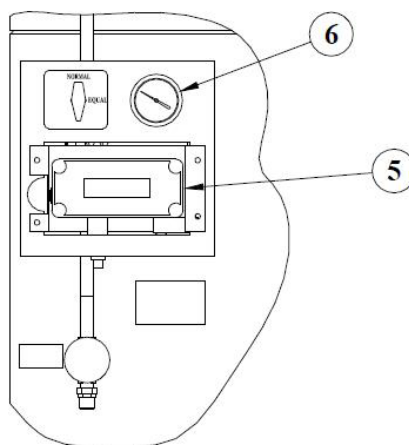
Perma-Cyl 1500 HP-03 Service Valves & High Pressure



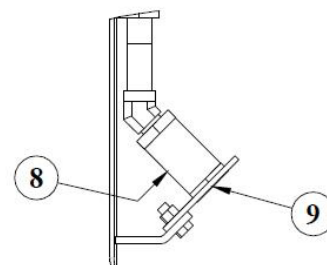
The Service Valves & High Pressure tank configuration provides our customers with a 4-way gauge isolation, and regulator isolation valves.



VIEW A-A

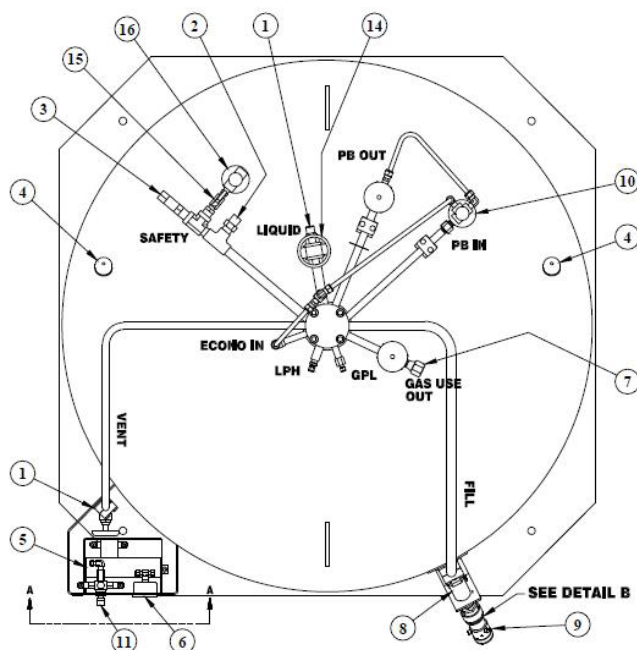


**PLUMBING VIEW
OF VIEW A-A**



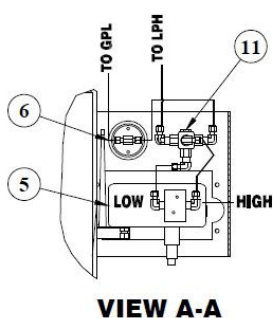
DETAIL B

Perma-Cyl 1500 HP-04 Low Pressure Liquid

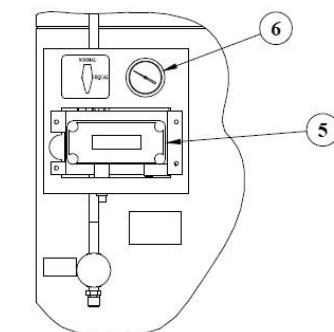


PN 1151570

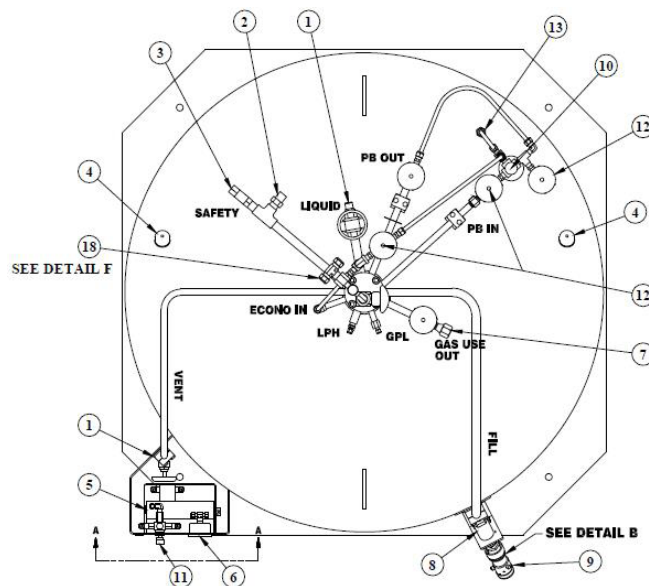
The Low Pressure Liquid tank configuration provides our customers with a 4-way valve gauge isolation, a liquid withdrawal ball valve, a valved relief regulator (15-50 psi range).



VIEW A-A



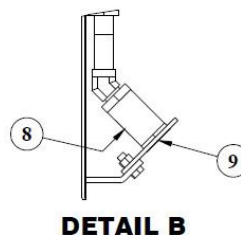
**PLUMBING VIEW
OF VIEW A-A**



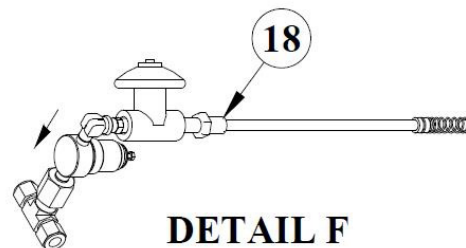
PN 11551561

PN 11552513

The CO₂ Service tank configuration provides our customers with a 4-way valve gauge isolation, regulator isolation valves, and a CO₂ Package, including the patented Sure-fill System.



DETAIL B



DETAIL F

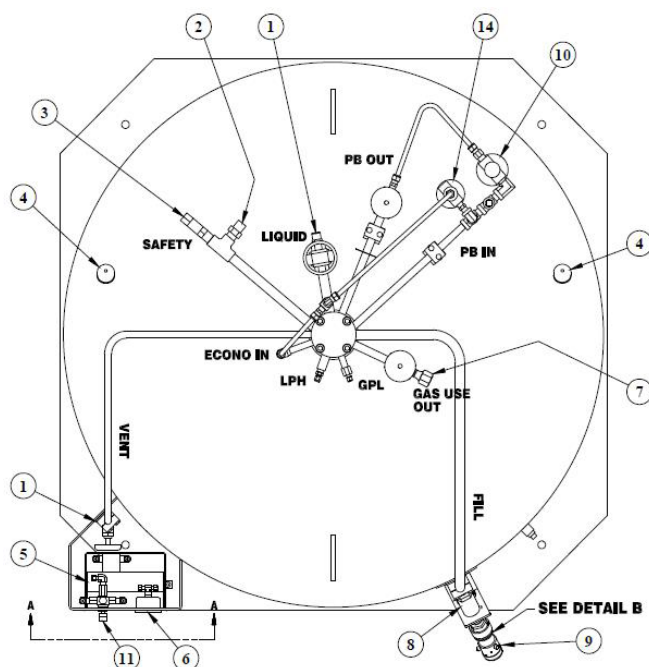
Perma-Cyl 1500 HP Standard Parts List:

Item	Part No.	Description
1a	1110072	Connection 1/2" ODT x 3/8" (45° Flare-Inert)
1b	1110112	Connection 5/8" ODT x 3/8" (45° Flare-OXY)
2	11526569	Rupture Disk (525PSI)
3	11488591	Relief Valve (350PSI)
4	3911217	Black Plastic Cap
5	13141662	Cyl-Tel® Gauge
7a	4010022	Outlet 3/8" MPT (INERT)
7b	4010012	Outlet 3/8" MPT (OXY)
7c	4010562	Outlet 3/8" MPT (CO ₂)
8	11051090	Check Valve 1/2" FPT x 1/2" FPT
9.2a	1110122	Connection 1/2" ODT x 1/2" (45° Flare-Inert)
9.2b	1110912	Connection 5/8" ODT x 1/2" (45° Flare-OXY)
10a	11081336	Combination Regulator 1/4" NPT (125 PSI)

Perma-Cyl 1500 HP Options:

Item	Part No.	Description
10b	10645339	Combination Regulator 1/4" NPT (15-50PSI)
11	20683719	4-Way Valve
12	11905999	1/4" Isolation Valve
13	1812702	Line Relief Valve (550PSI)
14	11539491	1/2" Ball Valve
16	11696795	Adjustable Relief Regulator (35PSI)
7	11905999	1/4" Drain Valve

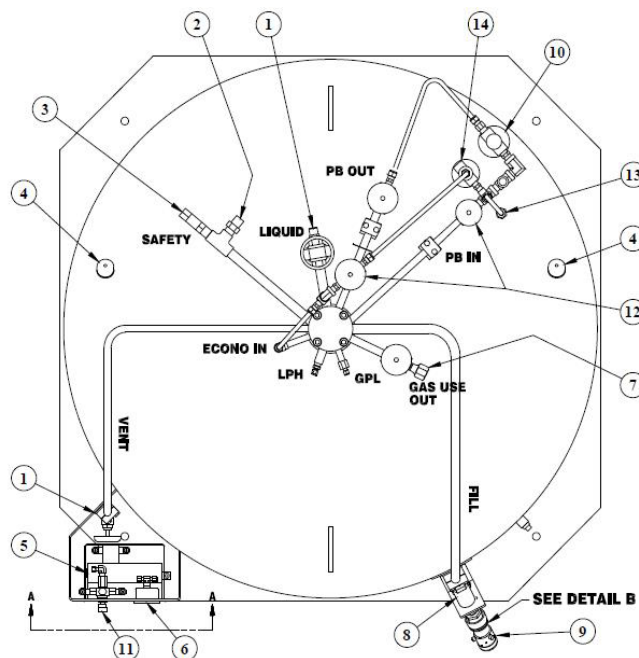
Perma-Cyl 1500 VHP-02 Cyl-Tel® Liquid Level Gauge Service Valve



PN 11560935

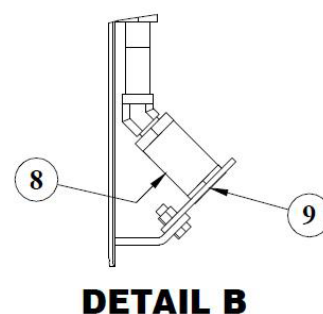
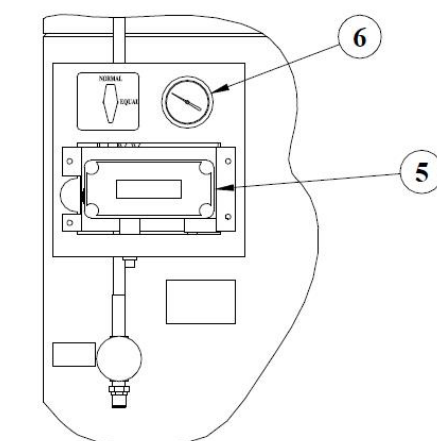
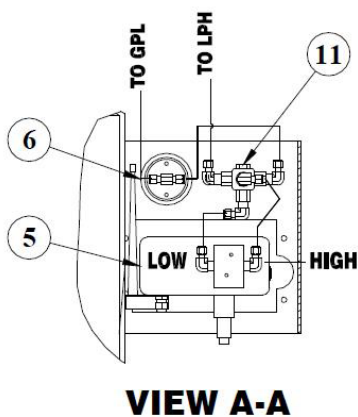
The Cyl-Tel Gauge Service Valve tank configuration provides our customer with a 4-way valve gauge isolation.

Perma-Cyl 1500 VHP-03 Service Valves & High Pressure

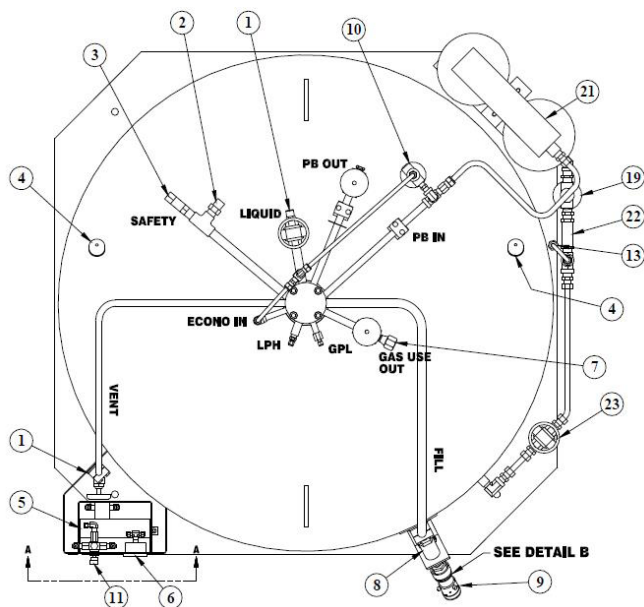


PN 11554244

The Service Valves and High Pressure tank configuration provides our customers with a 4-way valve gauge isolation, and regulator isolation valves.



Perma-Cyl 1500 VHP-07 ZX Super-Charged PB



PN 11722586

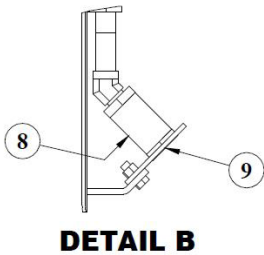
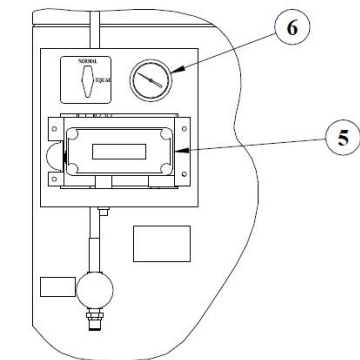
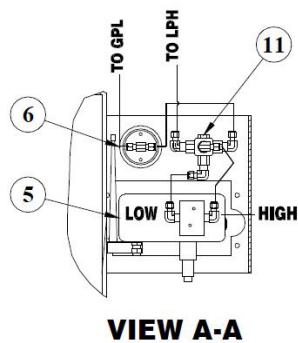
The ZX Supercharged PB (option 07) should be specified when the utmost in tank performance is required. This system will dramatically reduce pressure recovery time to around 15 minutes or less in most cases. When used with an external vaporizer, withdrawal rates of up to 7000 SCFH can be obtained.

Perma-Cyl 1500 VHP Standard Parts List:

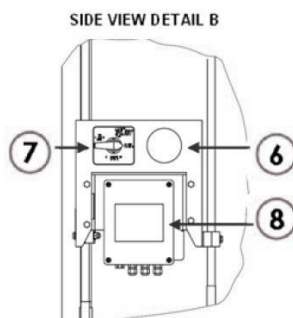
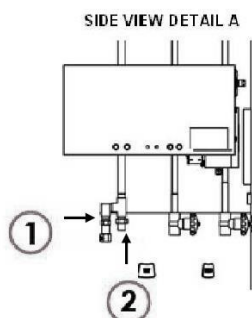
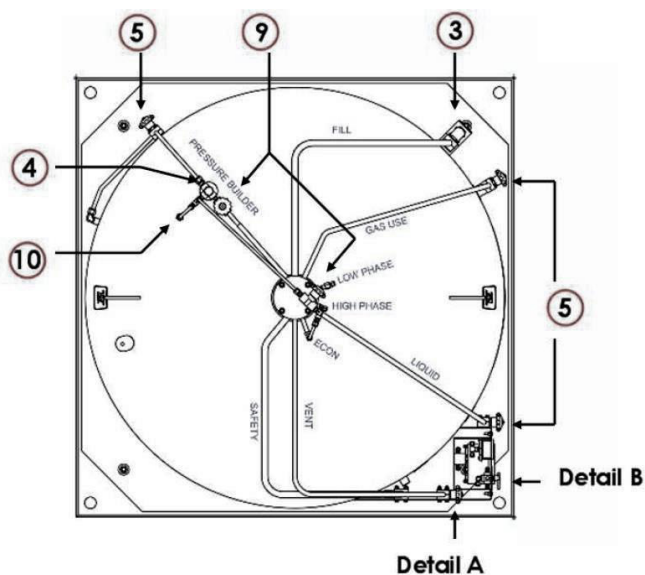
Item	Part No.	Description
1a	1110072	Connection 1/2" ODT x 3/8" (45° Flare-Inert)
1b	1110112	Connection 5/8" ODT x 3/8" (45° Flare-OXY)
2c	11526622	Rupture Disk (700PSI)
3c	11385111	Relief Valve (500PSI)
5	13141662	Cyl-Tel® Gauge
7a	4010022	Outlet 3/8" MPT (INERT)
7b	4010012	Outlet 3/8" MPT (OXY)
7c	4010562	Outlet 3/8" MPT (CO ₂)
8	11051090	Check Valve 1/2" FPT x 1/2" FPT
9.2a	1110122	Connection 1/2" ODT x 1/2" (45° Flare-Inert)
9.2b	1110912	Connection 5/8" ODT x 1/2" (45° Flare-OXY)
10	11061036	Pressure Building Regulator 3/8" NPT (450PSI)
11	20683719	4-Way Valve
14	10619675	Econ. Regulator 1/4" NPT (475PSI)

Perma-Cyl 1500 VHP Options:

Item	Part No.	Description
12	11905999	1/4" Isolation Valve
13	1812702	Line Relief Valve (550PSI)



Perma-Cyl 2000/3000 HP Plumbing Components



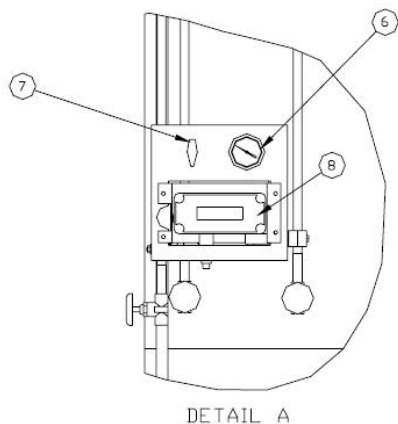
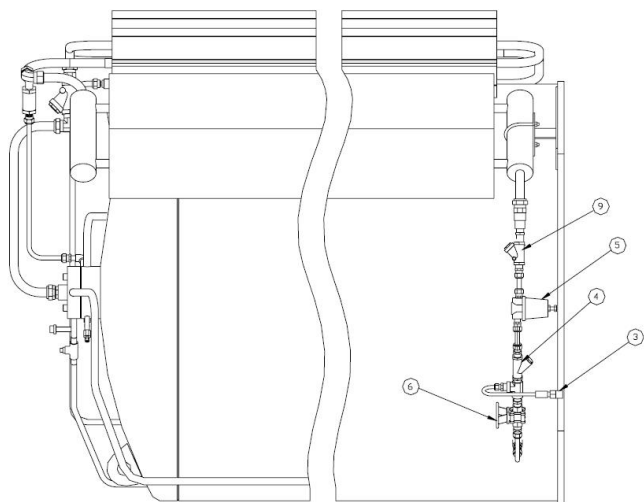
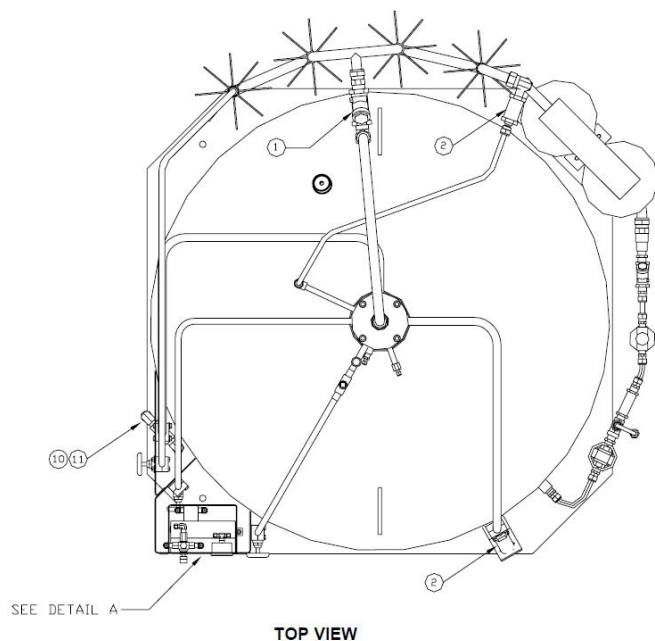
Perma-Cyl 2000/3000 HP Parts List:

Item	Part No.	Description
1	11488591	Line Relief Valve (350PSI)
2	11526569	Rupture Disk (525PSI)
3	11051090	Check Valve 1/2" FPT x 1/2" FPT
4	11081328	MCR Regulator (300PSI)
5	10502848	Shut-Off Valve 1/2 FPT
6	13909811	Pressure Gauge (0-600PSI)
7	20683719	4-Way Valve
8	13141662	Cyl-Tel® Gauge
9	11905999	Shut-Off Valve 1/4 FPT
10	1812702	Relief Valve (550PSI)

Perma-Cyl 2000/3000 HP Standard Product Connections:

Part No.	Description
4010022	Outlet 3/8" MPT (INERT)
4010012	Outlet 3/8" MPT (OXY)
1110122	Connection 1/2" ODT x 1/2" (45° Flare-Inert)
1110912	Connection 5/8" ODT x 1/2" (45° Flare-OXY)

Perma-Cyl 2000 VHP Plumbing Components



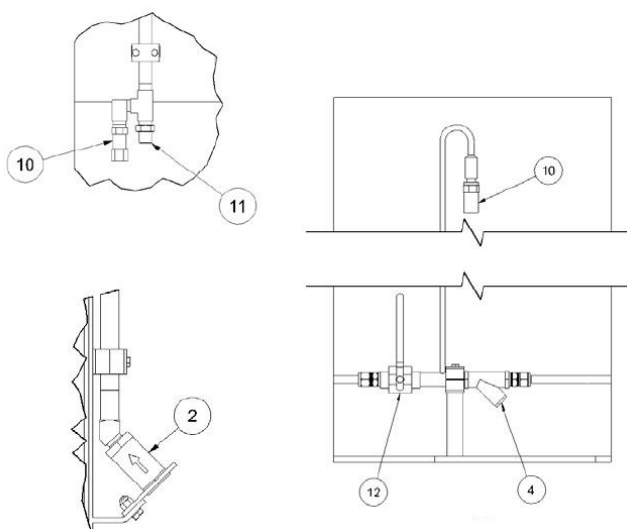
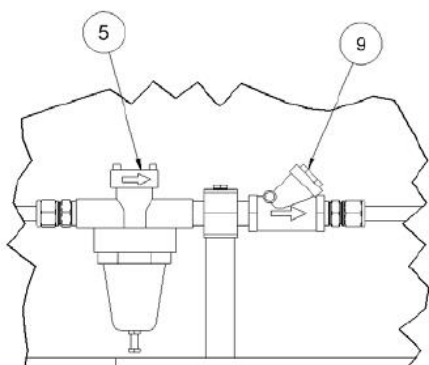
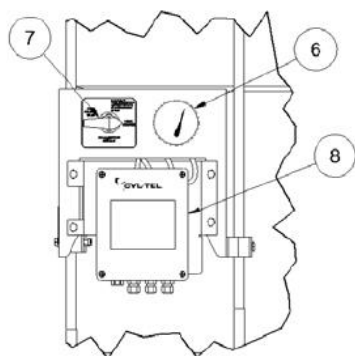
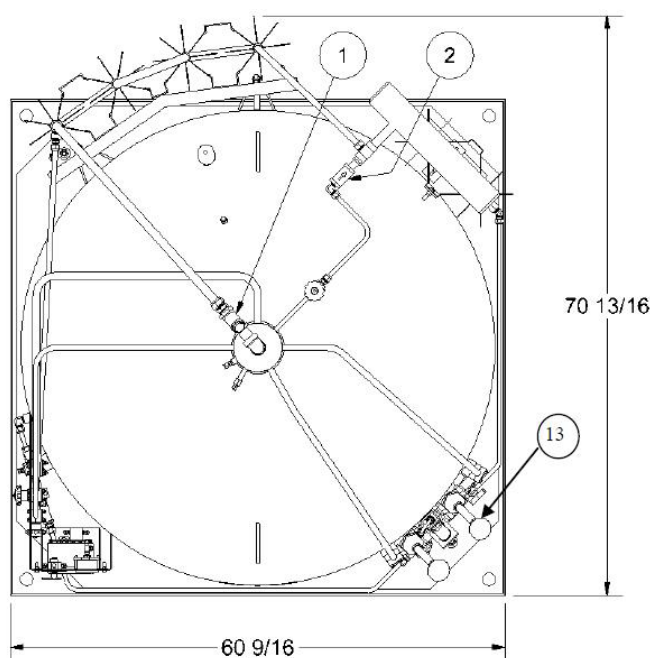
Perma-Cyl 2000 VHP Parts List:

Item	Part No.	Description
1	11656072	Check Valve 1" 600WOG
2	11051090	Check Valve 1/2" FPT x 1/2" FPT
3	1812702	Line Relief Valve (550 psi)
4	11529090	Line Strainer 1/2"
5	11635511	PB Regulator 1/2" 450 psi
6	2010064	Pressure Gauge (0-600 psi)
7	20683719	4-Way Valve
8	11018142	Cyl-Tel Gauge
9	11208931	Check Valve 1/2" WOG
10	11385111	Relief Valve (500 psi)
11	11526622	Rupture Disc (700 psi)

Perma-Cyl 2000 VHP Standard Product Connections:

Part No.	Description
4010022	Outlet 3/8" MPT (INERT)
4010012	Outlet 3/8" MPT (OXY)
1110122	Connection 1/2" ODT x 1/2" (45° Flare-Inert)
1110912	Connection 5/8" ODT x 1/2" (45° Flare-OXY)

Perma-Cyl 3000 VHP Plumbing Components



Perma-Cyl 3000 VHP Parts List:

Item	Part No.	Description
1	11656072	Check Valve 1" 6000WOG
2	11051090	Check Valve 1/2" FPT x 1/2" FPT
3	1812702	Line Relief Valve (550 psi)
4	11529090	Line Strainer 1/2"
5	11635511	PB Regulator 1/2" 450 psi
6	13909811	Pressure Gauge (0-600 psi)
7	20683719	4-Way Valve
8	15087831	Cyl-Tel Gauge
9	13462175	Check Valve 1/2" WOG
10	11385111	Relief Valve (500 psi)
11	11526622	Rupture Disc (700 psi)
12	1712202	Rupture Disc (700 psi)
13	10616790	Valve Globe Brass 1/2" NPT

Perma-Cyl 3000 VHP Standard Product Connections:

Part No.	Description
4010022	Outlet 3/8" MPT (INERT)
4010012	Outlet 3/8" MPT (OXY)
1110122	Connection 1/2" ODT x 1/2" (45° Flare-Inert)
1110912	Connection 5/8" ODT x 1/2" (45° Flare-OXY)

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™ tanks - 5 years from date of invoice.
- All Chart repaired tanks - 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.



