Product Manual

Perma-Max™ MicroBulk CO_2 Systems

1400 XHP, 2200, 3300, 4400, 6000 HP & 12,000 VHP

Designed and Built by:

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Part Number 20892356 Rev. D

Contents

Revision Log

Revision Level	Date	Description
A	08/04/2016	Original
B	03/28/2018	Update to Perma-Max, Update tank sizes, 12,000 VHP info still in development
C	7/31/2018	Update to Perma-Max 12,000 VHP Info, Schematics on all tanks and installation of C-Stic Gauge on 1400
D	3/13/2024	Content Update

Preface

General

Perma-Max™ MicroBulk CO_2 Systems are specifically designed for CO_2 service. One notable performance improvement is the fast-fill feature — at least three times the fill rate over our standard Perma-Cyl® MicroBulk Storage System Series from a typical beverage delivery truck. The upsizing and redesign of the top fill eductor circuit reduces the overall fill time, and also reduces the amount of vent gas during delivery for a more efficient fill. Other new design features include larger internal pressure builder and vaporizer coils, allowing for faster pressure recovery and increased gas flow rates. Dedicated pressure builder and economizer regulators also contribute to this improved performance.

The Perma-Max tank comes with many of the standard features found on the Perma-Cyl Series for easy installation and fast start up. The Perma-Cyl Series is well known for holding its liquefied gas contents for long periods of time without venting, limiting product loss during periods of little or no gas use.

Product Highlights

The better alternative to full-for-empty cylinders

- Replaces HP cylinders
- Extended hold time over liquid cylinders
- Easy low-cost installation — indoors or outdoors (local codes permitting)
- Safety devices pipe-away required for indoor installation

Fast, efficient fills

- Efficient fill circuit reduces fill times and vent losses
- Fill rates up to 170 lbs/min*

High-performance vaporization

- Up to 51 lbs/hr**
- Available in 125 psig and 300 psig operating pressures
- Dedicated Pressure Builder (1/2”) and economizer regulators
- Perma-Max 1400 XHP - 750 psig operating pressure
- Perma-Max 12,000 VHP - 450 psig operating pressure

Cyl-Tel® Liquid Level Gauge (optional)

- Digital and accurate
- Built-in user selectable scales
- Telemetry ready

Ergonomic instruments and controls

- Located at user height
- Isolation valves for regulators and level gauge

Long life, low maintenance

- Stainless steel bottle and welded piping
- Heavy-duty galvanized pallet base

*Pressure transfer performance from 33% full at 125 psig to 90% full in 12 minutes with delivery vessel at 295 psig starting pressure without Perma-Cyl storage tank venting.

** Based on 12 hours per day of continuous duty at 68°F and 50% RH ambient conditions with internal vaporizer.

Product Manual

This manual contains information regarding the safe operation and maintenance of a Perma-Max MicroBulk CO_2 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 are 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:

ASME	American Society of Mechanical Engineers
BARG	Pressure Gauge (Metric)
CGA	Compressed Gas Association
CO_2	Carbon Dioxide
DP	Differential Pressure
FPT	Female Pipe Thread
HP	High Pressure (350 MAWP)
ID	Inner Diameter
Kg	Kilogram
MAWP	Maximum Allowable Working Pressure
Nm^3	Normal Cubic Meters
NER	Normal Evaporation Rate
NFPA	National Fire Protection Association
NPT	National Pipe Tapered Thread
PB	Pressure Builder
PN	Part Number
PPE	Personal Protective Equipment
PSI	Pounds per Square Inch
PSIG	Pounds per Square Inch (Gauge)
SCFH	Standard Cubic Feet/Hour
UFC	Uniform Fire Code
VHP	Very High Pressure (500 MAWP)
XHP	Extra High Pressure (800 MAWP

Safety

General

While Chart equipment is designed and built to the most rigid standards, no piece of mechanical equipment can ever be made 100% foolproof. Strict compliance with proper safety and handling practices are necessary when using a cryogenic device or other compressed gas equipment. We recommend that all of our customers re-emphasize safety and safe handling practices to all their employees and customers. While every possible safety feature has been designed into the Perma-Max™ MicroBulk CO_2 System and safe operations are anticipated, it is essential that the customer carefully read and fully understand all Warning and Caution notes listed below.

Warning! The Perma-Max 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 liquid cylinder or let it fall over in cryogenic service. In the event a liquid cylinder is inadvertently dropped, tipped over, or abused, slowly raise it to its normal vertical position and immediately open the vent valve to release any excess pressure in a safe manner. As soon as possible, remove the liquid product from the vessel in a safe manner. If 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-Max System can cause loss of vacuum and will VOID any warranty on the unit.

Warning! The Perma-Max 1400 XHP has a MAWP of 800 psig and can be operated at pressures up to 750 psig. Special precautions must be taken to insure that all downstream components and piping have a minimum pressure rating of 800 psig. Special precautions must also be taken when blowing down or servicing the tank.

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

Caution! All valves on an empty Perma-Max 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.

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.

Oxygen Deficient Atmospheres

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

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

When the oxygen content of air is reduced to about 15 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.

Carbon Dioxide

The system described in this manual has the ability to hold and dispense carbon dioxide (CO_2) gas under pressure.

Warning! Asphyxiation hazard. Carbon dioxide gas can cause serious injury or death. Do not breathe CO_2 gas. Avoid entering tank area if a leak is suspected and thoroughly ventilate area.

CO_2 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 CO_2 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 CO_2 can cause:

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

Warning! It is important to note that unlike nitrogen and argon, exposure to high concentrations of CO_2 can be deadly even when normal percentages of oxygen are present in the surrounding atmosphere.

CO_2 is heavier than air and can collect in low areas such as basements, stairwells, and confined spaces. Avoid entry into areas where CO_2 leaks or high concentrations of CO_2 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. CO_2 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 CO_2 and the mini-bulk liquid CO_2 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 - 2200, 3300, 4400, 6000

General

The Perma-Max™ MicroBulk CO_2 System is designed to store and deliver carbon dioxide as a cryogenic liquid. The Perma-Max 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-Max tank models operate on much the same principals of operation.

Initial Inspection

Upon receipt of a Perma-Max 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 the tank passes all the above criteria, it is ready to install and fill. Follow the installation and fill procedures outlined in the Installation and Filling section of this manual.
- New tanks are shipped with plugs in the gas use, liquid use, and vent valves. Remove plugs before commissioning the tank.

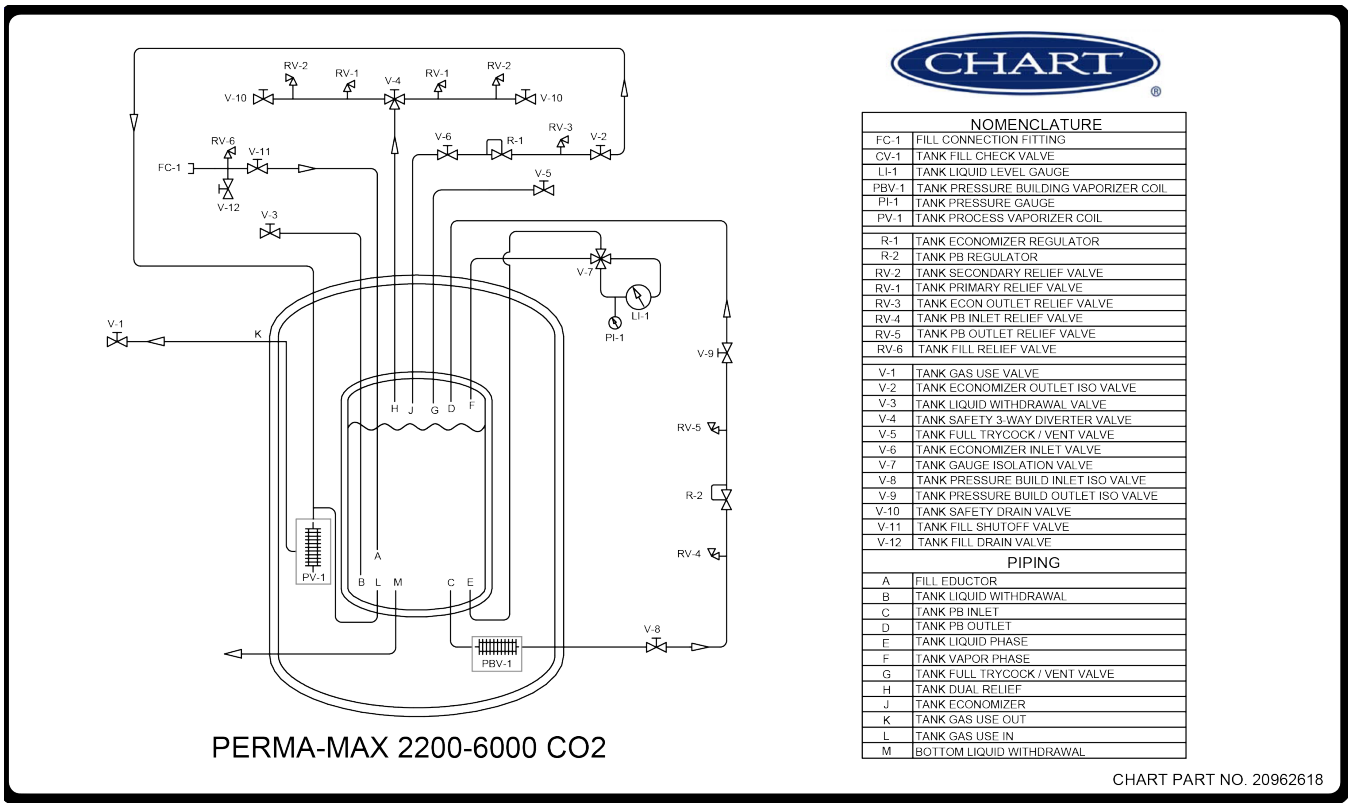


Figure 1 - Schematic for 2200HP-6000HP models

Primary Plumbing Circuits
(see Figure 1)

Fill

The liquid fill circuit is used to top fill the Perma-Max tank using the Chart designed eductor tube (see Figure 3) on the inside to assist in controlling the tank pressure during the fill. The fill line has a fill isolation ball valve and service fitting that provides the sole pressure connection for the delivery vehicle (see Figure 2).

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

A 1-1/2" CGA bulk CO_2 fill fitting can be ordered as an option to replace the standard Snap-Tite fill kit (see Figure 4). A 1" CGA bulk CO_2 vapor balance fill fitting can also be ordered as an option for the standard vent circuit (see Figure 4).

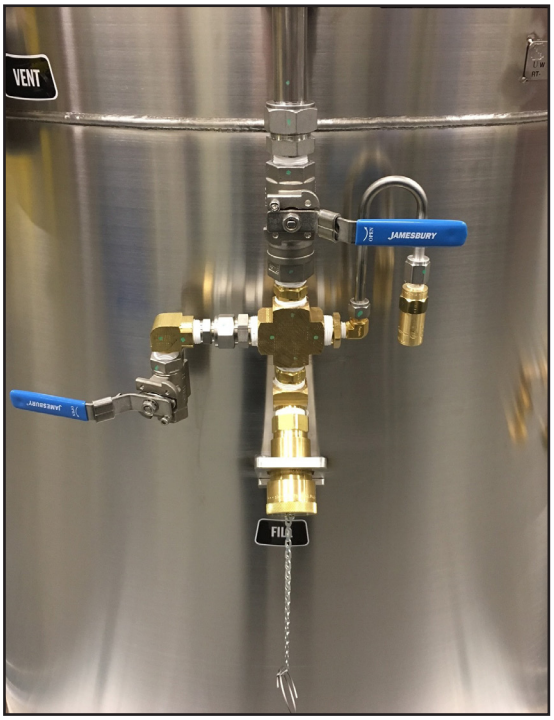


Figure 2 - Fill Line with Snap-Tite connection

Figure 3 - Eductor Tube

Figure 4 - Vapor Balance and Liquid Fill

Pressure Build

The pressure build circuit is used to build pressure back in the vessel after a delivery or to maintain pressure as liquid is withdrawn from the vessel. The vessel pressure is set by adjusting the PB regulator (R2). Standard PB set points are:

125 psig & 300 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-2 and back into the gas phase of the tank as depicted in Figure 1. The pressure build regulator can be isolated by closing valves V-8 and V-9. The PB regulator and isolation valves are shown in Figure 5.

The Perma-Max CO_2 tanks can be equipped with external pressure build vaporizers which allow for much quicker recoveries after the tank has been blown down to fill it or for high flow applications (see Figure 6).

Figure 5 - PB Regulator with Isolation Valves

Figure 6 - External PB Vaporizer

Economizer

The economizer circuit (see Figure 7) allows for the customer to utilize the natural heat leak that occurs in every cryogenic storage vessel. When the pressure is above the set point of the economizer regulator (R-1), the regulator 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, then out through the gas use valve as depicted in Figure 1. 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 vessel.*

The economizer regulator can be isolated by closing valves V-6 and V-2.

Figure 7 - Economizer Regulator with Isolation Valves

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 1, and out through the liquid use valve (V-3). The liquid use valve is a blue handled ball valve (see Figure 8). 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.

Liquid can also be drawn directly off of the bottom of the tank through the auxiliary liquid port (see pipe circuit M in Figure 1). The auxiliary liquid port is a 1/2-inch coupling that normally comes plugged. A valve would need to be added to this circuit while the tank is totally empty and depressurized. This same port is also used for an external PB vaporizer.

Note: *If using the bottom port to flow liquid through an external process vaporizer, the economizer regulator build onto the tank will not work.*

Figure 8 - Liquid Use ball valve

Gas Use

The gas use valve (V-1) leverages the internal vaporization coils contained within the outer shell of the Perma-Max tank. The internal vaporization coils can support specific flow rates as outlined in the Specifications section on page 23. The gas use valve is pictured in Figure 9. The gas use line running into the customer's facility should be sized properly for anticipated pressure and flowrates to include room for future growth. In the event that the internal vaporization coils are not able to handle the flowrates and exit temperatures become a problem, an external vaporizer can be added to further warm the gas. Attach this vaporizer directly in series with the gas use connection and place the line regulator at the exit of the vaporizer. The liquid use valve as outlined in the "Liquid Use" paragraph can also be used for high flow applications that exceed the rating of the vaporization coils.

The Perma-Max tank will deliver gas at various flow rates and temperatures for different applications. The equipment that is being supplied gas from the Perma-Max 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. Regulating manifolds can also be ordered as an option which are included on the tank (see Figure 9A).
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 (see Figure 9).
6. Adjust the gas use regulator for the proper delivery pressure.

Caution! All valves on an empty Perma-Max 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.

Figure 9 - Gas Use ball valve

Figure 9A - Regulating manifold

Safety Circuit
(see Figure 10)

Most Perma-Max tanks are equipped with both a primary spring operated relief valve and a secondary spring operated relief valve. These devices are used to automatically relieve excess pressure in the vessel 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. The diverter valve allows for changing out safety relief devices without the need to empty the tank.

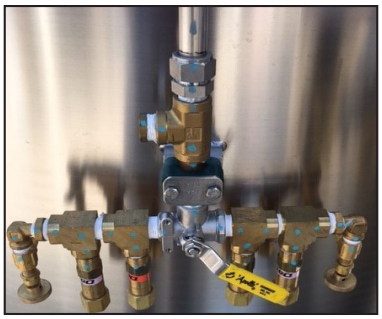


Figure 10 - Safety Relief Valves with Diverter Valve

Vent/Full Trycock
(see Figure 11)

The vent valve is used to relieve excess pressure in the cylinder. On Perma-Max CO_2 systems, the vent valve is a blue handled ball valve (V-5). When installed indoors, the vent line should be piped outdoors using the appropriately sized copper or stainless steel tubing. The vent valve also serves as the full trycock during filling operations. When the Perma-Max tank is filled by pumping or pressure transfer, the full trycock must be used to fill the vessel. When liquid starts to spit out of this valve while being filled, the filling process should be terminated.

Figure 11 - Vent/Full Trycock

Four-Way Valve

The four-way valve (V-7) is the primary isolation valve between the DP gauge and the phase lines from the tank. This four-way valve also provides an easy method to check the zero on the DP gauge. By turning the valve into the equalization position, the DP gauge can be zeroed and isolated from the tank pressure for removal or replacement.

Optional phase line isolation valves can be added to the high and low phase lines coming out of the knuckle at the top of the tank. These valves are normally only used for maintenance and troubleshooting of the liquid level gauge or associated plumbing. The Chart part number for this isolation valve kit is 20837224.

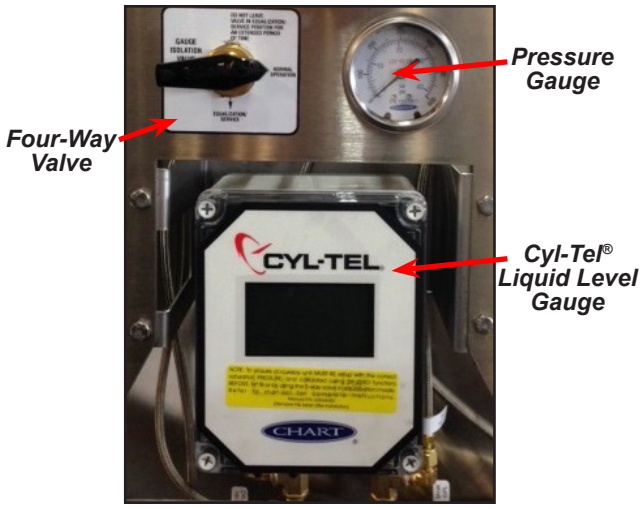


Figure 12 - Four-Way Valve/Optional Cyl-Tel Gauge

Pressure Gauge

A single pressure gauge (P-1) on the Perma-Max tank is also tied into the low phase line and gives the operator a pressure reading in the gas phase of the vessel. This pressure gauge can also be isolated with the four-way valve.

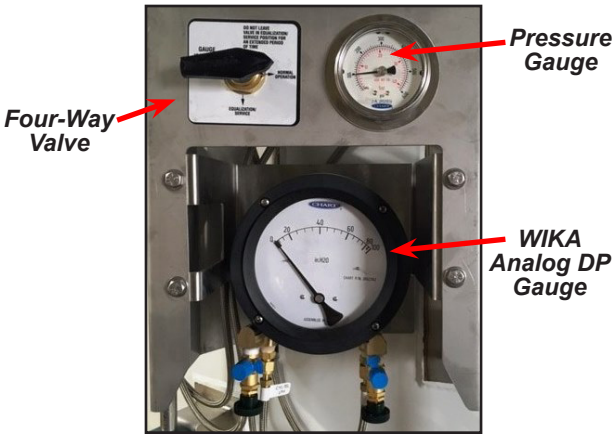


Figure 13 - Pressure gauge / Optional WIKA gauge

Vacuum Evacuation Port

Unlike bulk tanks, Perma-Max storage vessels are normally not provided with an on-board method of taking a vacuum reading. The vacuum evacuation port is sealed using a stainless steel disk with O-rings and a protective cover is placed over it (see Figure 14). Due to the relatively small volume of the annular vacuum space, taking vacuum readings is normally not recommended due to the fact that the vacuum level could be slightly reduced when taking this reading. The troubleshooting portion of this manual gives steps on how to determine if the vacuum might be weak. In the event that the vacuum does need to be checked, a trained vacuum technician would have to bring the appropriate

equipment to get this done. In most cases where a vacuum has been compromised, it is often more economical to swap out the tank.

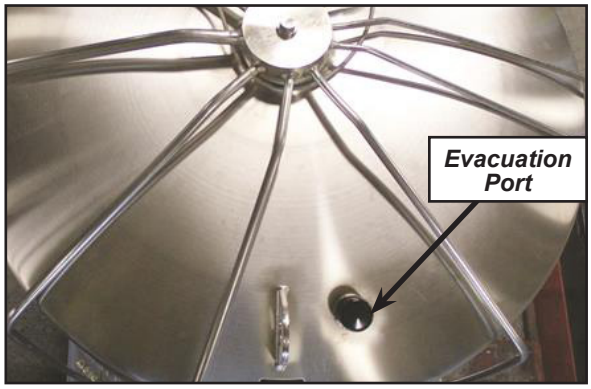


Figure 14 - Vacuum Evacuation Port with Cover

Purging and Fill Considerations

The initial fill is usually performed on a warm tank - one that has not been in use for an extended period of time prior to filling. The warm container must be purged to ensure product purity.

When preparing the tank for filling, or when changing service, the following items should be considered:

1. The vessel should be inspected for possible damage or unsuitability for the intended use. If damage is detected (i.e. serious dents, loose fittings, etc.), remove the unit from service and perform repairs as soon as possible.

2. The vessel should be kept at normal operating pressures above 100 psig to prevent the liquid CO_2 temperature from dropping below the triple point pressure and forming dry ice.

Caution! Liquid CO_2 should never be stored at pressures below 60.5 psig (4.3 kg/cm²) as this will result in the formation of solid CO_2 which can be very difficult to re-liquify.

3. To remove moisture or foreign matter from the tank or tank lines, the vessel must be purged. Use a small amount of the new product for purging when changing service and a small amount of the same product if the purge is to ensure purity or remove contaminants.

Tank Purging Procedure

Caution! The maximum purge pressure should be equal to 50% of the maximum operating pressure of the tank. The maximum purge pressure must be determined before starting the purge operation to prevent drawing atmospheric contaminants back into the tank. A positive pressure of at least 5 psig must always be maintained in the tank.

1. Attach the source of gas purge product to the fill line (FC-1).

Note: *Chart CO_2 storage tanks ship with brass plugs in the following valves: auxiliary liquid valve (V-3), vent valve (V-5) and gas use valve (V-1). These plugs are to be removed at time of installation.*

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 through the tank or hose purge valve if so equipped, or by loosening the fill connection until vapor flows from the connection and then retighten.

3. Close all valves except the pressure building inlet and outlet valves (V-8 and V-9), four-way valve (V-7) should be in the 'normal operation' position.

Note: *When a solenoid valve is used to control the pressure building circuit, it must be energized.*

4. Open tank shutoff valve (V-11) and open the vapor valve on the delivery truck to allow gas to flow into the tank.

Caution! To prevent snow blocking the plumbing lines, do not introduce liquid CO_2 into the vessel or plumbing until the tank is pressurized to at least 100 psig with vapor.

5. Shut off the gas supply source on the delivery vehicle when pressure in the tank reaches the maximum purge pressure as indicated on tank pressure gauge (PI-1).

6. Place the four-way valve (V-7) in the equalization position to prevent damage to the gauge.

7. Loosen the fittings on either side of the liquid level gauge (Ll-1). Move the four-way valve to the normal operation position and purge through the loose fittings. Visually check the gas stream for signs of moisture. Provided no moisture is observed after blowing the lines for approximately two minutes, retighten the fittings on either side of the liquid level gauge. If moisture is observed in the gas stream, the gas should be discharged until it is clear of all moisture.

Note: *A careful check for moisture in the phase lines will ensure trouble-free operation of the liquid level gauge. Due to their small diameter, gauge lines are easily plugged by ice.*

8. Open the purge valves on the safety relief tree (V-10) toggle the safety diverter valve (V-4) to both sides to purge entire circuit. Close purge valves after purging.

9. Ensure the pressure build regulator is open and purge gas is circulating through this circuit.

10. Close the economizer isolation valves (V-2 & V-6). Remove safety relief valve (RV-3). Open economizer isolation valves and purge economizer circuit for several minutes. Replace RV-3 and open V-2 and V-6.

11. Open the liquid use, gas use, and vent valves and purge tank to reduce the pressure to 5 psig.

Warning! Hearing protection must be worn while tank is venting.

12. Repeat purge procedures steps 3, 4, 5 and 11 at least five times until product purity has been obtained.

13. Ensure four-way valve is in the "normal operation" position.

14. Pressure check all valves and fittings while tank is under pressure during purge procedure.

15. After purging the tank, but before filling, verify that the following valves are open or closed as indicated in the table.

Valve	Position
Vent/Full Trycock Valve (V-5)	Closed
Liquid Withdrawal Valve (V-3)	Closed
Gas Use Valve (V-1)	Closed
Pressure Building Inlet Valve (V-9)	Closed
Pressure Building Outlet Valve (V-8)	Closed
Economizer Inlet Isolation Valve (V-2)	Closed
Economizer Outlet Isolation Valve (V-6)	Closed

Initial (Warm Tank) Filling Procedures

1. Purge tank to assure product purity (see tank purging procedure).

2. Verify that the supply unit contains the proper product to be transferred and that the supply unit and tank fill fitting are for CO_2 service.

3. Verify that all valves are closed and the four-way valve is in the "normal operation" position.

4. Connect the supply unit liquid transfer hose to the tank fill connection (FC-1) and ensure that it is properly purged.

5. Connect the vapor recovery transfer hose to the tank vent/full trycock connection (V-5)(for two-hose fill operation only).

6. Open vent valve (V-5) slowly and allow the tank and delivery unit to equalize in pressure (for two-hose fill operation only).

7. If two-hose fill is not being used, ensure that the tank is pressurized to at least 100 psig with vapor off of the delivery unit before introducing liquid into the tank. Open tank fill shutoff valve (V-11).

8. Once tank is at the proper pressure (for single hose fill), open the liquid discharge valve on the delivery unit and start the transfer pump (if equipped). If using pressure transfer, liquid will begin to flow into the Perma-Max tank through the fill connection.

9. Monitor the tank pressure during the fill and ensure that at least a 50 psig differential is maintained between the tank and delivery unit if using a pump or utilizing pressure transfer. For pressure transfer, the higher the differential, the faster the tank will fill. Maintain differential by opening the vent/full trycock valve during the fill (if using a single hose fill).

10. During the first fill of a warm tank, pressure may spike very quickly once liquid starts flowing into the tank. Open the vent/full trycock to keep pressure down until tank stabilizes. If pressure raises too quickly, it may be necessary to temporarily stop the filling operation and blow the tank down before starting to fill again.

11. Monitor liquid level contents gauge (Ll-1) during filling.

12. If using a two-hose fill procedure, when the tank nears full, open the vent/full trycock line drain valve. Stop the

filling operation when liquid begins to discharge from the drain valve.

13. If using a single-hose fill procedure, when the tank nears full, open the vent/full trycock valve and let it blow to atmosphere. Stop the filling operation when the liquid begins to discharge from the vent valve (V-5).

Note: *On the very first fill, it is normally good practice to leave the tank at a liquid level of about 75% since the tank will continue to cool down for the first few days after filling.*

14. Once liquid is discharging out of the vent/full trycock valve, close the valve.

15. Stop the pump on the delivery unit (if equipped) and close the liquid discharge valve. Close tank isolation valve (V-11). Drain all the pressure off of the delivery hoses and disconnect from the tank. Store the hose(s) in the cabinet of the delivery vehicle.

16. Unit is now ready to place into service. Ensure that PB isolation valves (V-8 & V-9), economizer isolation valves (V-2 & V-6), and gas use valves are open after first fill is completed.

Introduction/Operation - Perma Max 1400 XHP

General

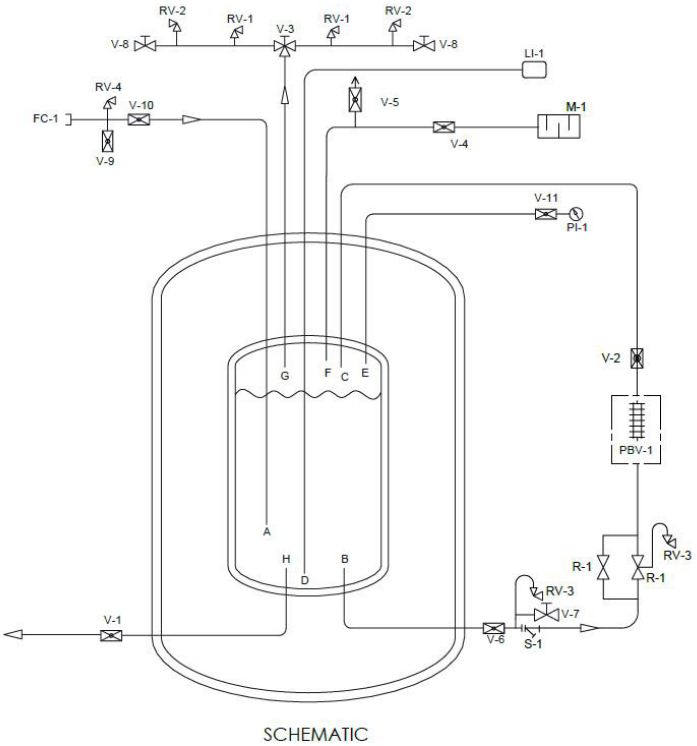
The Perma-Max™ 1400 XHP MicroBulk CO_2 System is designed to store and deliver carbon dioxide as a cryogenic liquid. The Perma-Max tank can build and maintain pressure from the automatically regulated pressure building circuit.

The 1400 XHP is unique in that it has a MAWP of 800 psig and a built-on 6kw electric pressure build vaporizer. This tank is primarily designed for high pressure liquid flow but also can provide small quantities of gaseous product (less than 500 scfh)

Initial Inspection

Upon receipt of a Perma-Max 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 the tank passes all the above criteria, it is ready to install and fill. Follow the installation and fill procedures outlined in the Installation and Filling section of this manual.
- New tanks are shipped with plugs in the gas use, liquid use, and vent valves. Remove plugs before commissioning the tank.
- Check electric vaporizer for any signs of damage to the cabinet or water inside of the panel.
- The electronic digital readout box for the liquid level capacitance probe is shipped separately inside the electric vaporizer control panel. Ensure the box is inside the panel and install on the capacitance probe, per instructions located in Appendix 2.



NOMENCLATURE	
FC-1	FILL CONNECTION FITTING
LI-1	C-STIC TANK LIQUID LEVEL GAUGE
PBV-1	TANK PRESSURE BUILDING ELECTRIC VAPORIZER COIL
PI-1	TANK PRESSURE GAUGE
R-1	TANK PB REGULATORS
RV-1	TANK PRIMARY RELIEF VALVE
RV-2	TANK SECONDARY RELIEF VALVE
RV-3	TANK PB INLET RELIEF VALVE
RV-4	TANK FILL RELIEF VALVE
V-1	TANK LIQUID WITHDRAWAL VALVE
V-2	TANK PRESSURE BUILD OUTLET BALL VALVE
V-3	TANK SAFETY 3-WAY DIVERTER VALVE
V-4	TANK FULL TRYCOCK / VENT VALVE
V-5	TANK GAS USE VALVE
V-6	TANK PRESSURE BUILD INLET BALL VALVE
V-7	TANK PRESSURE BUILD DRAIN VALVE
V-8	TANK SAFETY DRAIN VALVES
V-9	TANK FILL DRAIN BALL VALVE
V-10	TANK FILL SHUT OFF VALVE
V-11	PRESSURE GAUGE ISOLATION VALVE
M-1	MUFFLER
S-1	STRAINER
PIPING	
A	FILL EDUCTOR
B	TANK PB INLET
C	TANK PB OUTLET
D	C-STIC
E	TANK VAPOR PHASE
F	TRYCOCK / VENT VALVE
G	TANK DUAL
H	BOTTOM LIQUID WITHDRAWAL

Figure 15 - Schematic for 1400 XHP model

Primary Plumbing Circuits

Fill

The Fill circuit on the Perma-Max 1400 XHP is the same as the other HP Series of tanks.

See Primary Plumbing Circuits on *page 8*.

Pressure Build

The pressure build circuit is used to build pressure back in the vessel after a delivery or to maintain pressure as liquid is withdrawn from the vessel. The vessel pressure is set by adjusting the PB regulators (R1). Standard PB set point is:

750 psig

Two PB regulators are used in parallel to increase flow to the electric vaporizer for faster response times (See Figure 16).

As the tank pressure drops below the PB set point, the regulators open and allow liquid to flow off the bottom of the tank, through the electric PB vaporizer and back into the gas phase of the tank as depicted in Figure 15. The pressure build regulators can be isolated by closing valves V-2 and V-6. After closing isolation valves, pressure on this circuit should be blown down by opening valve (V-7, see Figure 15).

The electric PB vaporizer is shown in Figure 17. Electrical schematics for this vaporizer are shown in Appendix 1 of this manual. Detailed instructions and troubleshooting are contained in the Thermax Manual for Model H3B-480 (PN 20988229).

Figure 16 - Dual PB regulators

Figure 17 - Electric PB Vaporizer

Economizer

Since the Perma-Max 1400 XHP is designed primarily for liquid use, it does not have an economizer circuit.

Liquid Use

The liquid use circuit comes off the bottom of the vessel and flows liquid CO_2 through the liquid use valve (V-1) This circuit draws liquid. The liquid use valve is a blue handled ball valve (see Figure 18).

Figure 18 - Withdrawal valve

Gas Use (See Fig. 19)

The Perma-Max 1400 XHP is designed primarily for high flow, high pressure (750 psig) applications. Gas use can be pulled through valve (V-5).

Caution! ***Since gas is being pulled directly off the headspace, flowrates for this tank are limited. Pulling excessive flowrates off this vessel can result in icing the tank.***

Caution! ***All valves on an empty Perma-Max 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.

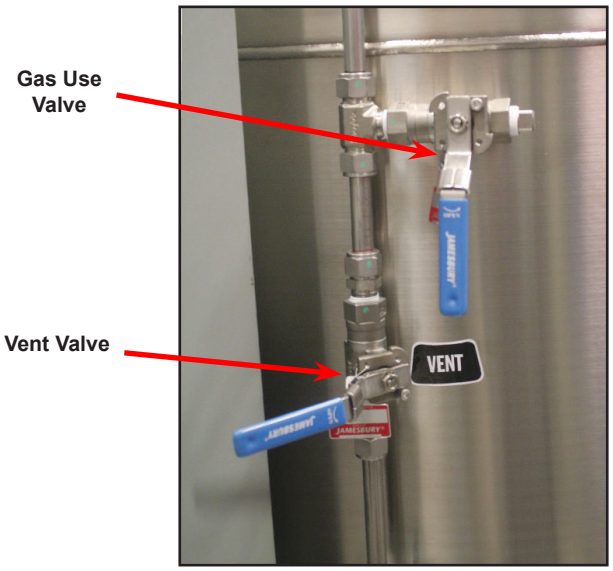


Figure 19 - Gas Use Valve (V-5)

Safety Circuit
(See Figure 20)

The Perma-Max 1400 XHP is equipped with both a primary spring operated relief valve and a secondary spring operated relief valve. These devices are used to automatically relieve excess pressure in the vessel 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. The diverter valve allows for changing out safety relief devices without the need to empty the tank.

The drain valves (V-8) allow pressure to be bled off before attempting to remove the relief valves.

Figure 20 - Diverter valve, Bleed-off valve, Primary Relief valve (top) and Secondary Relief valve (bottom)

Vent/Full Trycock
(See Figure 21 on Pg. 18)

The vent valve is used to relieve excess pressure in the cylinder. On Perma-Max CO_2 systems the vent valve is a blue handled ball valve (V-4). When installed indoors, the vent line should be piped outdoors using the appropriately sized copper or stainless steel tubing. The vent valve also serves as the full trycock during filling operations. When the Perma-Max tank is filled by pumping or pressure transfer, the full trycock must be used to fill the vessel. When liquid starts to spit out of this valve while being filled, the filling process should be terminated.

A muffler is also provided on the vent circuit to assist in keeping down the decibel (DB)levels when blowing down the tank.

Figure 21 - Muffler on vent/full trycock plumbing circuit

C-Stic Liquid Level Gauge

The C-Stic liquid level gauge (Ll-1, see Figure 22) is a very robust level gauge suited for cold-stored liquefied gases such as carbon dioxide. The capacitance of the fully stainless steel sensor increases radiometrically with the liquid coverage and is converted into an easy-to-read, accurate digital readout with 0.1% resolution. Additionally, it has a standard analog 4-20mA loop connection to be used for industrial control or remote readout purposes. The unit is battery powered and there is no need for any additional power or cabling. For detailed installation and calibration instructions, see Appendix 2.

Figure 22 - C-Stic Liquid Level Gauge

Pressure Gauge

A single pressure gauge (P-1) on the Perma-Max tank is tied into the low phase line and gives the operator a pressure reading in the gas phase of the vessel. This pressure gauge (Figure 23) can also be isolated with the pressure gauge isolation valve.

Figure 23 - Pressure Gauge

Vacuum Evacuation Ports

The 1400 XHP Vacuum Evacuation Ports are the same as other Perma-Max HP tanks — See page 11.

Tank Purging Procedure

Caution! The maximum purge pressure should equal 150-200 psig. The maximum purge pressure must be determined before starting the purge operation to prevent drawing atmospheric contaminants back into the tank. A positive pressure of at least 5 psig must always be maintained in the tank.

1. Attach the source of gas purge product to the fill line (FC-1).

Note: *Chart CO_2 storage tanks ship with brass plugs in the following valves: liquid valve (V-1). These plugs are to be removed at time of installation.*

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 through the tank or hose purge valve if so equipped, or by loosening the fill connection until vapor flows from the connection and then retighten.

3. Close all valves except the pressure building inlet and outlet valves (V-6 and V-2) and the pressure gauge isolation valve (V-11).

Note: *When a solenoid valve is used to control the pressure building circuit, it must be energized.*

4. Open tank shutoff valve (V-10) and open the vapor valve on the delivery truck to allow gas to flow into the tank.

Caution! To prevent snow blocking the plumbing lines, do not introduce liquid CO_2 into the vessel or plumbing until the tank is pressurized to at least 100 psig with vapor.

5. Shut off the gas supply source on the delivery vehicle when pressure in the tank reaches the maximum purge pressure as indicated on tank pressure gauge (PI-1).

6. Close the tank shutoff valve (V-10).

7. Open the purge valves on the safety relief tree (V-8) toggle the safety diverter valve (V-3) to both sides to purge entire circuit. Close purge valves after purging.

8. Ensure the pressure build regulators are open and purge gas is circulating through this circuit.

9. Pressure check all valves and fittings while tank is under pressure during purge procedure.

10. Open vent valve (V-4) and purge tank to reduce the pressure to 5 psig. Gas use valve (V-5) and liquid withdrawal valve (V-1) should also be open while blowing down the tank.

Warning! Hearing protection must be worn while tank is venting.

11. Repeat purge procedures steps 3, 4, 5, 6 and 10 at least five times until product purity has been obtained.

Note: After the last purging sequence, leave the tank pressurized with vapor at a minimum of 100 psig.

12. After purging the tank, but before filling, verify that all valves are closed with the exception of the pressure gauge isolation valve (V-11).

Note: Ensure that the capacitance meter (Ll-1) is zeroed before filling the tank. See instructions in Appendix 2.

Initial (Warm Tank) Filling Procedures

1. Purge tank to assure product purity (see tank purging procedure).

2. Verify that the supply unit contains the proper product to be transferred and that the supply unit and tank fill fitting are for CO_2 service.

3. Verify that all valves are closed with the exception of the pressure gauge isolation valve (V-11).

4. Connect the supply unit liquid transfer hose to the tank fill connection (FC-1) and ensure that it is properly purged by opening the hose purge valve (V-9).

5. The 1400 XHP tank is not currently set up to allow for a two-hose fill.

6. Open tank fill shutoff valve (V-10) and ensure that the tank is pressurized to at least 100 psig with vapor off of the delivery unit before introducing liquid into the tank.

7. Once tank is at the proper pressure (for single hose fill), open the liquid discharge valve on the delivery unit and start the transfer pump (if equipped). If using pressure transfer, liquid will begin to flow into the Perma-Max tank through the fill connection.

8. Monitor the tank pressure during the fill and ensure that at least a 50 psig differential is maintained between the tank and delivery unit if using a pump or utilizing pressure transfer. For pressure transfer, the higher the differential, the faster the tank will fill. Maintain differential by opening the vent/full trycock valve during the fill.

9. During the first fill of a warm tank, pressure may spike very quickly once liquid starts flowing into the tank. Open the vent/full trycock to keep pressure down until tank stabilizes. If pressure raises too quickly, it may be necessary to temporarily stop the filling operation and blow the tank down before starting to fill again.

10. Monitor liquid level contents gauge (Ll-1) during filling.

11. When the tank nears full, open the vent/full trycock valve on the vessel. Stop the filling process when liquid begins to discharge from the vent valve (V-4).

12. Once liquid is discharging out of the vent/full trycock valve, close the valve.

13. Stop the pump on the delivery unit (if equipped) and close the liquid discharge valve. Drain all the pressure off of the delivery hoses and disconnect from the tank. Store the hose(s) in the cabinet of the delivery vehicle. Close tank isolation valve (V-10).

14. Unit is now ready to place into service. Ensure that PB isolation valves (V-2 & V-6) are open after first fill is completed.

15. Ensure that the electric PB vaporizer is on and liquid is flowing through it in order to bring the tank up to operating pressure. (See electric PB operating instructions in Appendix 1 of this manual).

Note: Calibrate the capacitance probe (Ll-1) while the tank is full of product. See instructions in Appendix 2.

Operation - Perma-Max 12,000 VHP

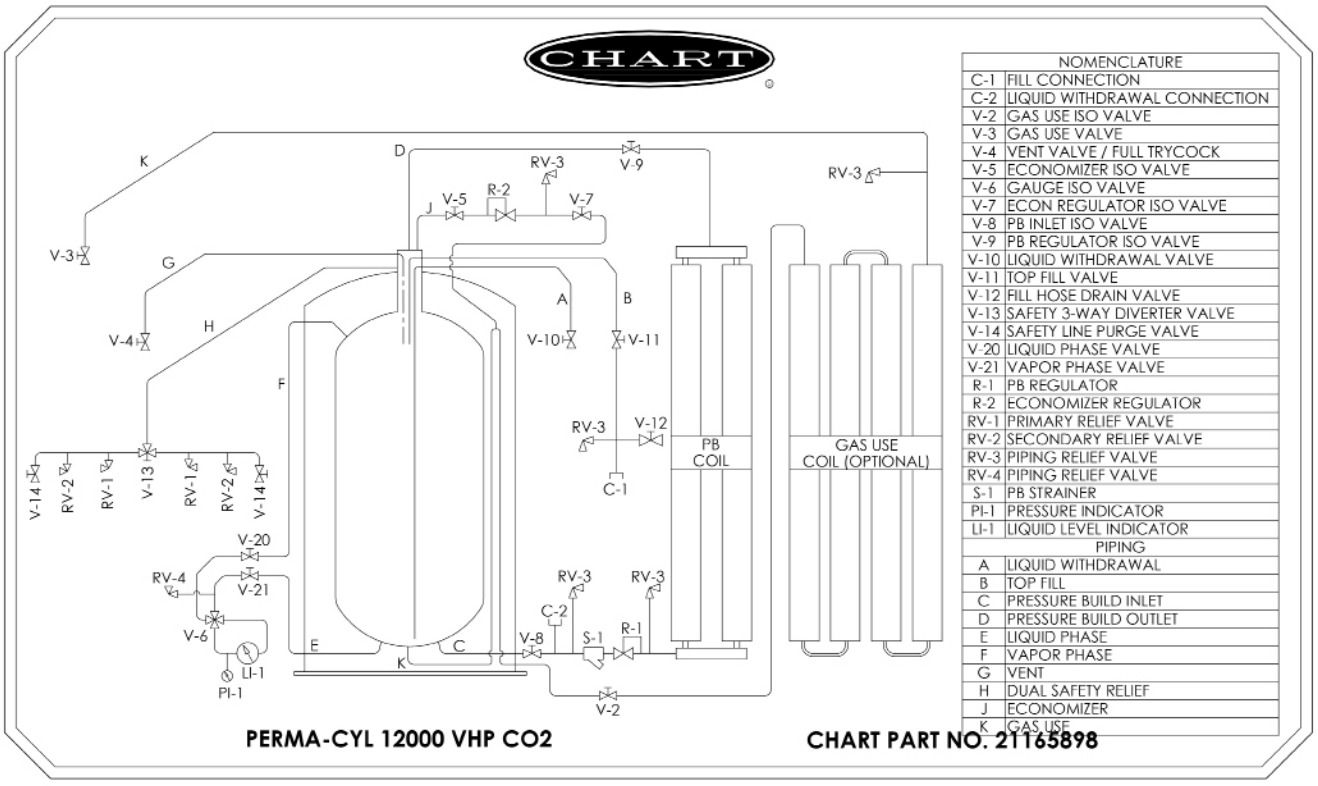
General

The Perma-Max™ 12,000 VHP MicroBulk CO_2 System is designed to store and deliver carbon dioxide as a cryogenic liquid. The Perma-Max tank can build and maintain pressure from the automatically regulated pressure building circuit. A continuous liquid or gas flow can be provided from these tanks.

Initial Inspection

Upon receipt of a Perma-Max 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 the tank passes all the above criteria, it is ready to install and fill. Follow the installation and fill procedures outlined in the Installation and Filling section of this manual.
- New tanks are shipped with plugs in the gas use, liquid use, and vent valves. Remove plugs before commissioning the tank.



NOMENCLATURE	
C-1	FILL CONNECTION
C-2	LIQUID WITHDRAWAL CONNECTION
V-2	GAS USE ISO VALVE
V-3	GAS USE VALVE
V-4	VENT VALVE / FULL TRYCOCK
V-5	ECONOMIZER ISO VALVE
V-6	GAUGE ISO VALVE
V-7	ECON REGULATOR ISO VALVE
V-8	PB INLET ISO VALVE
V-9	PB REGULATOR ISO VALVE
V-10	LIQUID WITHDRAWAL VALVE
V-11	TOP FILL VALVE
V-12	FILL HOSE DRAIN VALVE
V-13	SAFETY 3-WAY DIVERTER VALVE
V-14	SAFETY LINE PURGE VALVE
V-20	LIQUID PHASE VALVE
V-21	VAPOR PHASE VALVE
R-1	PB REGULATOR
R-2	ECONOMIZER REGULATOR
RV-1	PRIMARY RELIEF VALVE
RV-2	SECONDARY RELIEF VALVE
RV-3	PIPING RELIEF VALVE
RV-4	PIPING RELIEF VALVE
S-1	PB STRAINER
PI-1	PRESSURE INDICATOR
LI-1	LIQUID LEVEL INDICATOR
PIPING	
A	LIQUID WITHDRAWAL
B	TOP FILL
C	PRESSURE BUILD INLET
D	PRESSURE BUILD OUTLET
E	LIQUID PHASE
F	VAPOR PHASE
G	VENT
H	DUAL SAFETY RELIEF
J	ECONOMIZER
K	GAS USE

Figure 25 - Perma-Max 12,000 Schematic

Vacuum Check Procedure

The standard Chart vacuum probe is a Teledyne-Hastings DV-6R probe. Select a compatible instrument to read the output of the vacuum probe.

Caution! Unauthorized changing of the vacuum probe will void vessel warranty.

1. Remove rubber cap on probe outlet to expose contact. Note that the probe housing need not be opened to do this.
2. Plug the instrument into the probe and calibrate the instrument.
3. Open the vacuum probe isolation valve. Wait for five minutes and take vacuum reading. Note that valve handle protrudes through protective housing and can be turned without opening the housing.
4. Close the isolation valve and take a second reading. Monitor the rate of rise in vacuum probe with isolation valve closed. If the vacuum continues to rise at a constant rate, it is possible that the probe assembly is leaking. Consult the factory.
5. Verify that the isolation valve is closed.
6. Replace the rubber probe cap.
7. Compare the vacuum reading obtained now to the reading taken prior to shipping.

Primary Plumbing Circuits

Fill

The Perma-Max 12,000 VHP has the same standard fill and optional fill connections as other Perma-Max sizes. See page 8 and reference the photo below.

Figure 26 - Fill Valve (Shown with 1 1/2 CGA Bulk Fill Connection)

Pressure Build

The pressure build circuit is used to build pressure back in the vessel after a delivery or to maintain pressure as liquid is withdrawn from the vessel. The vessel pressure is set by adjusting the PB regulator (R-1). 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 R-1, through the external PB vaporizer and back into the gas phase of the tank as depicted in Figure 25. The pressure build regulator and vaporizer can be isolated by closing valves V-8 and V-9. The PB regulator and inlet isolation valve are shown in Figure 27.

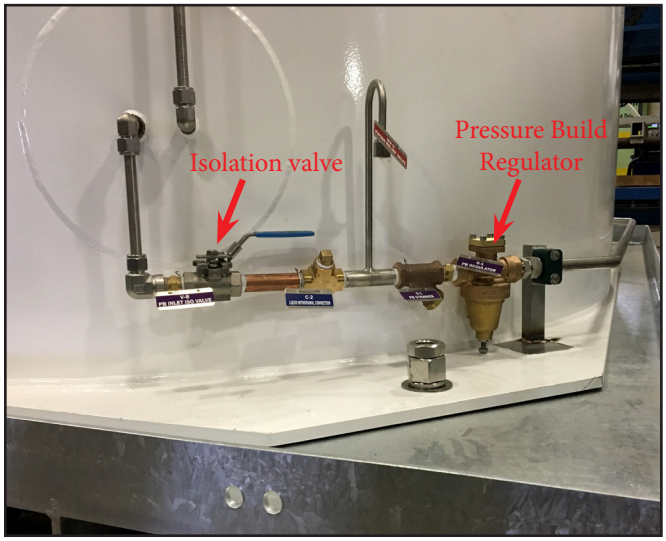


Figure 27 - Pressure Build (PB) Regulator and Isolation valves

PB Vaporizer

Perma-Max 12,000 VHP CO_2 tanks come standard with an external pressure build vaporizer (Figure 28). This vaporizer allows for much quicker recoveries after the tank has been blown down to fill it or for high-flow applications.

Figure 28 - Pressure Build (PB) Vaporizer

Economizer

The economizer circuit (See Figure 29) allows for the customer to utilize the natural heat leak that occurs in every cryogenic storage vessel. When the pressure is above the set point of the economizer regulator (R-2), the regulator opens. This allows gas to be withdrawn directly off the head space of the tank, travel through the internal lines and come out the gas valve as depicted in the schematic in Figure 25. 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 gas use circuit.*

The economizer regulator can be isolated by closing valves V-5 and V-7.

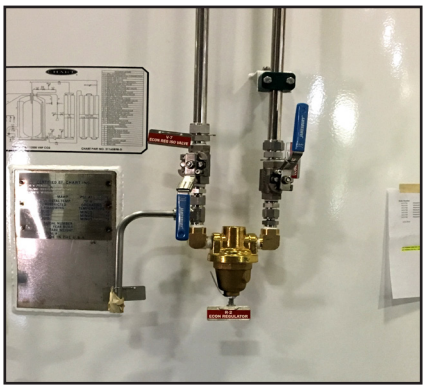


Figure 29 - Economizer circuit

Liquid Use

The liquid use circuit can be used for either a liquid application or a high-flow gas use application. This circuit draws liquid directly up the dip tube, as depicted in schematic Figure 25, and out through the liquid use valve (V-10). The liquid use valve is a blue handled ball valve (Figure 30).

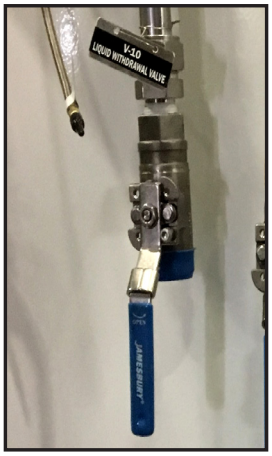


Figure 30 - Liquid use valve (V-10)

The Perma-Max 12,000 VHP is also equipped with an auxiliary liquid port (Figure 31) that can be used for high-flow liquid applications or to pipe liquid through a standalone external process vaporizer. The difference between this and the liquid use valve (V-10) is that this port is a bottom withdrawal while the liquid use valve (V-10) pulls liquid through a dip tube. This bottom liquid port is plugged and does not come standard with a valve. It can only be modified when the tank is completely empty.

Note: *The economizer does not work when using either the liquid use valve or the auxiliary liquid port. It only works when using the gas use circuit.*

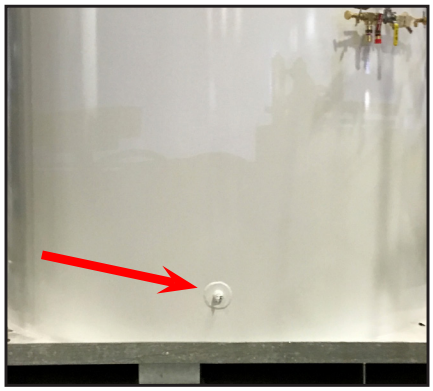


Figure 31 - Auxiliary Liquid Port

Gas Use

The gas use line delivers liquid to the gas use valve (V-2, Figure 32) and then through the optional hang on external gas use vaporizer. The vaporizer can support specific flow rates as outlined in the Specifications section on page 37. The external gas use vaporizer can be isolated by closing valves V-2 and V-3. The gas use line running into the customer's facility should be size properly for anticipated pressure and flowrates to include room for future growth.

If the optional hang on external gas use vaporizer is not selected, a stand-alone ambient vaporizer can be used for additional vaporization. Attach this vaporizer directly in series with the gas use connection and place the line regulator at the exit of the vaporizer.

The Perma-Max tank will deliver gas at various flow rates and temperatures for different applications. The downstream equipment controls the flow rate from the Perma-Max tank. Higher flow rates may provide very cold gas that could damage the equipment to which they are attached.

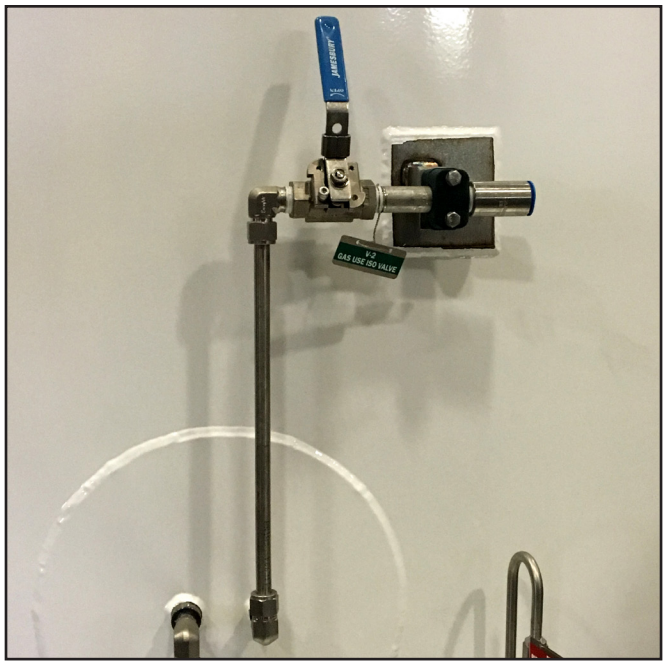


Figure 32 - Gas Use Valve (V-2)

To supply gaseous product, follow this step-by-step procedure.

1. Connect the proper regulator/regulating manifold to the Perma-Max's gas use outlet (or after a standalone vaporizer). Regulating manifolds can also be ordered as an option, which are included on the tank.
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.
5. Open the gas use valve (V-2 and valve downstream from gas use vaporizer (V-3)).
6. Adjust the gas use regulator for the proper delivery pressure.

Caution! All valves on an empty Perma-Max 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.

Safety Circuit

The Perma-Max 12,000 VHP has the same standard safety circuit as other Perma-Max tanks. See page 10 and reference photo below (Figure 33).

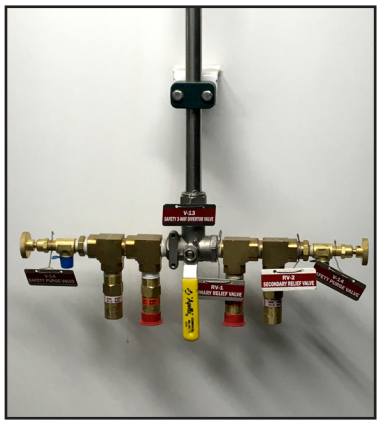


Figure 33 - Safety Circuit

Vent/Full Trycock

The vent valve is used to relieve excess pressure in the cylinder. On Perma-Max CO_2 systems, the vent valve is a blue handled ball valve (Figure 34, V-4). When installed indoors, the vent line should be piped outdoors using the appropriately sized copper or stainless steel tubing. The vent valve also serves as the full trycock during filling operations. When the Perma-Max tank is filled by pumping or pressure transfer, the full trycock must be used to verify fill level of the vessel. When liquid starts to spit out of this valve while being filled, the filling process should be terminated.

Figure 34 - Vent Valve/Full Trycock (V-4)

Vent/Full Trycock cont.

An optional 1" CGA CO2 Vapor balance connection can also be ordered for this plumbing circuit. See Figure 35.

Figure 35 - Vapor Balance Kit

Four-Way Valve

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

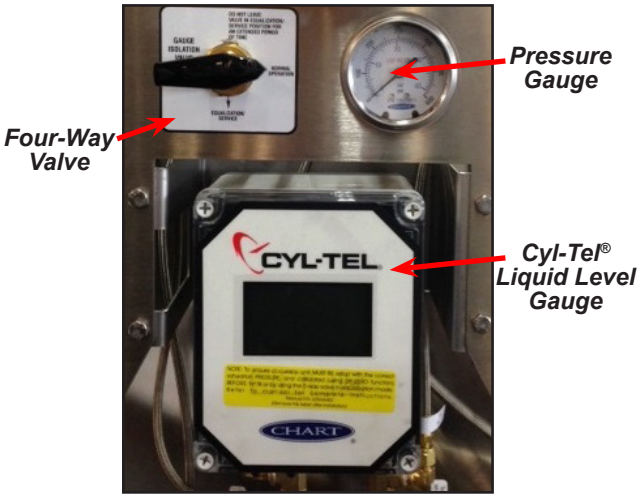


Figure 36 - Four-Way Valve/Optional Cyl-Tel Gauge

The phase lines also come standard with phase line isolation valves on the top of the tank. The phase lines can be isolated by closing V-20 and V-21. See Figure 37.

Note: The four-way valve should be placed into the equalization position before closing isolation valves V-20 & V-21.

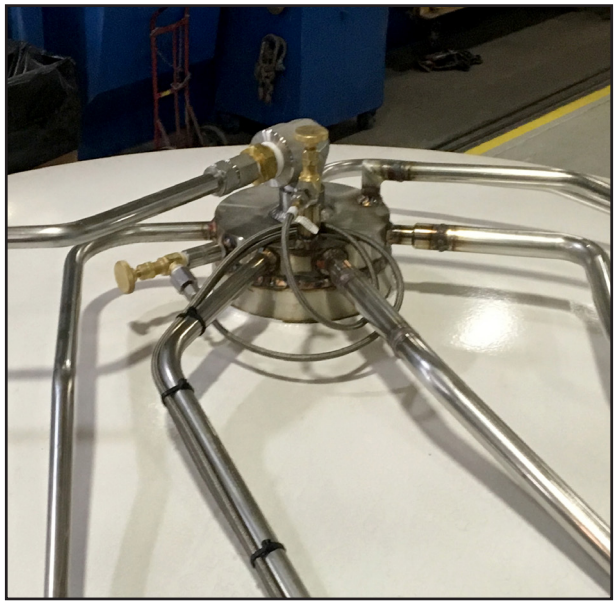


Figure 37 - Phase Line Isolation Valves

Pressure Gauge

A single pressure gauge (PI-1) on the Perma-Max tank is also tied into the low phase line and gives the operator a pressure reading in the gas phase of the vessel. This pressure gauge can also be isolated with the four-way valve.

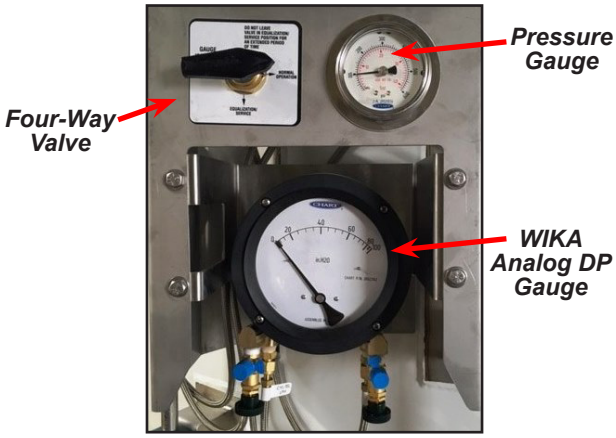


Figure 38 - Pressure Gauge / Optional Wika Gauge

Vacuum Integrity

The Perma-Max 12,000 VHP model is equipped with Hastings 1415671S #DV-6R vacuum thermocouple gauge tubes (PN 4210049). Vacuum integrity may be tested with a vacuum meter. Deterioration or loss of vacuum will be apparent by cold spots, frost, condensation on the jacket or evidenced by abnormally rapid pressure buildup. Unless one of these conditions is evident, the vacuum level should not be suspected.

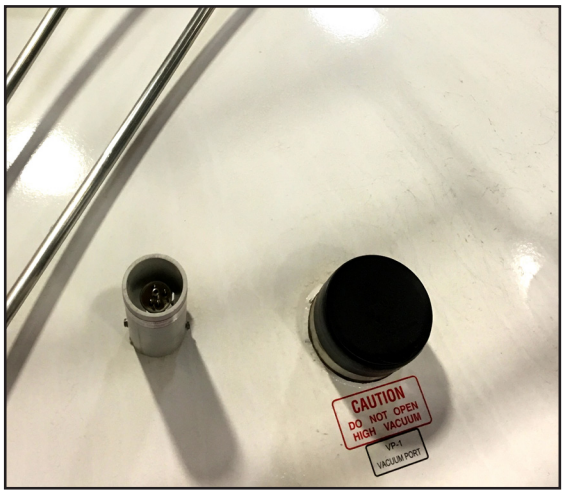


Figure 39 - DV-6R and Pump Out Port

Tank Purging Procedure

Caution! The maximum purge pressure should be equal to 50% of the maximum operating pressure of the tank. The maximum purge pressure must be determined before starting the purge operation to prevent drawing atmospheric contaminants back into the tank. A positive pressure of at least 5 psig must always be maintained in the tank.

1. Attach the source of gas purge product to the fill line (C-1).

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 through the hose purge valve (V-12).

3. Close all valves except the pressure building inlet and outlet valves (V-8 and V-9). The four-way valve (V-6) should be in the 'normal operation' position.

Note: *When a solenoid valve is used to control the pressure building circuit, it must be energized.*

4. Open the vapor valve on the delivery truck to allow gas to flow into the tank.

Caution! To prevent snow blocking the plumbing lines, do not introduce liquid CO_2 into the vessel or plumbing until the tank is pressurized to at least 100 psig with vapor.

5. Shut off the gas supply source on the delivery vehicle when pressure in the tank reaches the maximum purge pressure as indicated on tank pressure gauge (PI-1).

6. Place the four-way valve (V-6) in the equalization position to prevent damage to the gauge.

7. Loosen the fittings on either side of the liquid level gauge (LI-1). Move the four-way valve to the normal operation position and purge through the loose fittings. Visually check the gas stream for signs of moisture. Provided no moisture is observed after blowing the lines for approximately two minutes, retighten the fittings on either side of the liquid level gauge. If moisture is observed in the gas stream, the gas should be discharged until it is clear of all moisture.

Note: *A careful check for moisture in the phase lines will ensure trouble-free operation of the liquid level gauge. Due to their small diameter, gauge lines are easily plugged by ice.*

8. Open the purge valves on the safety relief tree (V-14) and toggle the safety diverter valve (V-13) to both sides to purge entire circuit. Close purge valves after purging.

9. Ensure the pressure build regulator is open and purge gas is circulating through this circuit.

10. Close the economizer isolation valves (V-5 and V-7). Remove safety relief valve (RV-3). Open economizer isolation valves and purge economizer circuit for several minutes. Replace RV-3 and open V-5 and V-7.

11. Open the liquid use, gas use and vent valves and purge tank to reduce the pressure to 5 psig — There should be no liquid in the tank at this point. Insure that purge gas is also directed through to process vaporizer.

Warning! Hearing protection must be worn while tank is venting.

12. Repeat purge procedure steps 3, 4, 5 and 11 at least five times until product purity has been obtained.

13. Ensure four-way valve is in the 'normal operation' position.

14. Pressure check all valves and fittings while tank is under pressure during purge procedure.

15. After purging the tank, but before filling, verify that the following valves are open or closed as indicated in the table below.

Vent/Full Trycock Valve (V-4)	Closed
Liquid Withdrawal Valve (V-10)	Closed
Gas Use Valve (V-2 & V-3 (Optional))	Closed
Pressure Building Inlet Valve (V-9)	Closed
Pressure Building Outlet Valve (V-8)	Closed
Economizer Inlet Isolation Valve (V-5)	Closed
Economizer Outlet Isolation Valve (V-7)	Closed

Initial (Warm Tank) Filling Procedures

1. Purge tank to assure product purity (see tank purging procedure).
2. Verify that the supply unit contains the proper product to be transferred and that the supply unit and tank fill fitting are for CO_2 service.
3. Verify that all valves are closed and the four-way valve is in the 'normal operation' position.
4. Connect the supply unit liquid transfer hose to the tank fill connection (C-1) and ensure that it is properly purged.
5. Connect the vapor recovery transfer hose to the tank vent/full trycock connection (V-4) — for two-hose fill operation only.
6. Open vent valve (V-4) slowly and allow the tank and delivery unit to equalize in pressure — for two-hose fill operation only.

Note: *Do not let pressure drop below 100 psig . Tank pressure might need to be increased before opening vent valve and equalizing pressure with the trailer.*

7. If two-hose fill is not being used, ensure that the tank is pressurized to at least 100 psig with vapor off of the delivery unit before introducing liquid into the tank.
8. Once tank is at the proper pressure — for single hose fill — open the liquid discharge valve on the delivery unit and start the transfer pump (if equipped). If using pressure transfer, liquid will begin to flow into the Perma-Max tank through the fill connection.
9. Monitor the tank pressure during the fill and ensure that at least a 50 psig differential is maintained between the tank and delivery unit if using a pump or utilizing pressure transfer. For pressure transfer, the higher the differential, the faster the tank will fill. Maintain differential by opening the vent/full trycock valve during the fill — if using a single hose fill.
10. During the first fill of a warm tank, pressure may spike very quickly once liquid starts flowing into the tank. Open the vent/full trycock to keep pressure down until tank stabilizes. If pressure raises too quickly, it may be necessary to temporarily stop the filling operation and blow the tank down before starting to fill again.
11. Monitor liquid level contents gauge (Ll-1) during filling.
12. If using a two-hose fill procedure, when the tank nears full, open the vent/full trycock line drain valve. Stop the filling operation when liquid begins to discharge from the drain valve.
13. If using a single-hose fill procedure, when the tank nears full, open the vent/full trycock valve and let it blow to atmosphere. Stop the filling operation when the liquid begins to discharge from the vent valve (V-4).

Note: *On the very first fill, it is normally good practice to leave the tank at a liquid level of about 75% since the tank will continue to cool down for the first few days after filling.*

14. Once liquid is discharging out of the vent/full trycock valve (V-4), close the valve.
15. Stop the pump on the delivery unit — if equipped — and close the liquid discharge valve. Drain all the pressure off of the delivery hoses and disconnect from the tank. Store the hose(s) in the cabinet of the delivery vehicle.
16. Unit is now ready to place into service. Ensure that PB isolation valves (V-8 & V-9), economizer isolation valves (V-5 & V-7) and gas use valves (V-2 & V-3) are open after first fill is completed.

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-Max 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-Max System will be used for. Decide whether the installation will be inside or outside. Proximity to the CO_2 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.

Outdoor Installations

Required:

- Open
- Well ventilated
- At or above ground level

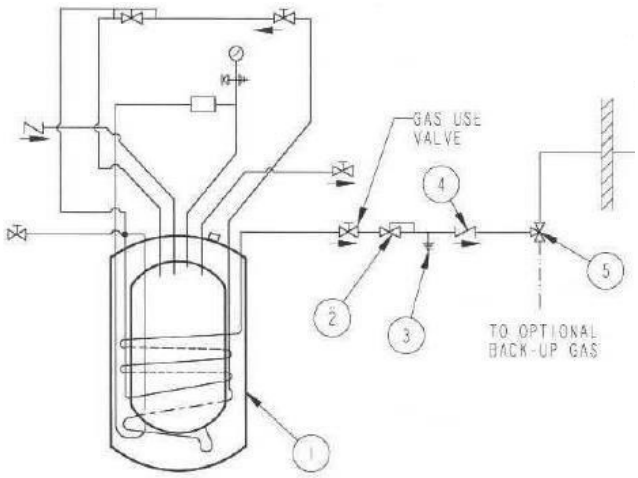


Figure 26 - Externally Sited/Gas Use Installation

Figure 25 - Perma-Max 3300HP with external pressure build vaporizer

Externally Sited / Gas Use Indoors

Outdoor installations can offer better accessibility for the CO_2 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-Max 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-Max system and work to eliminate tampering with any plumbing component.

Outdoor Installation Schematic

At a minimum, installation should include liquid CO_2 piping with a minimum MAWR of 800 psig — gaseous CO_2 piping if required. A typical piping schematic is depicted in Figure 26.

Item #	Description
1	Perma-Max Storage Tank
2	Final Line Regulator
3	Final Line Safety Relief
4	Final Line Check Valve
5	Back-up Supply Isolation Valve

Indoor Installations

Required:

- Room size - Air volume must allow oxygen level to stay between 18% to 25%
- Increased ventilation
- Valves vented outside (including mobile tanks)
- CO_2 monitors required for all CO_2 installations

Preferred:

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

Figure 27 - Indoor Installation of a Perma-Max 3300HP tank

Perma-Max 1400 XHP

The Perma-Max 1400 XHP does not currently offer all the accessories required for an indoor application. Current pip away kits and fill boxes are not rated for 800 psig.

Internally Sited / Filled Indoors / Pipe Out Safeties

Some indoor installations allow for direct filling of the cylinder 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 properly sized copper or stainless steel tube 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-Max 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.

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.

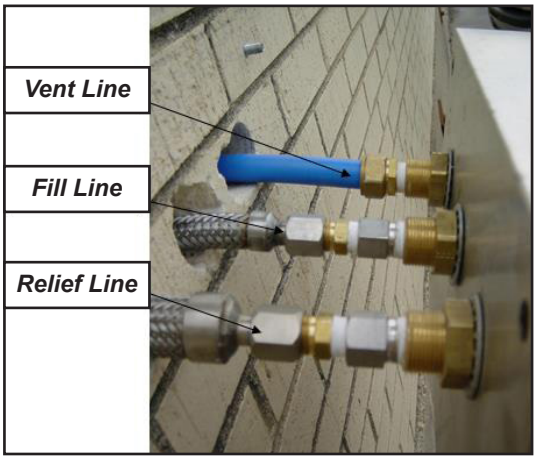


Figure 28 - 1/2" Connections on back of wall box

Line Connection to Fill Box Panel

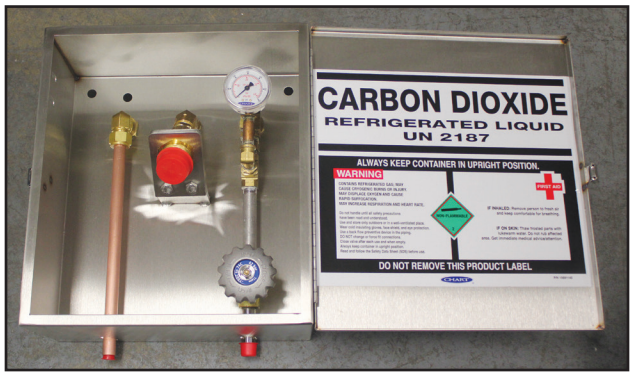


Figure 29 - Fill Box

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 or stainless steel pipe or tube. The line should be connected from the fill connection in the wall box to the liquid fill check valve on the Perma-Max System. When piping this line there are a few guidelines that should be followed.
  - 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 a minimum of 1/2" nominal copper or the stainless steel pipe or tubing. This vent line should connect the vent valve in the wall box to the vent valve on the Perma-Max System.
- Relief Line - The relief line should be run using copper or stainless steel pipe or tubing. Sizing is dependant on the length of the line and number of bends/restrictions.

Caution! ***Improperly sized relief discharge piping can put high back pressures against the primary and secondary relief valve, thus reducing their capacity potentially creating an unsafe condition.***

Bolting to Floor

The Perma-Max tank is equipped with either a flange on the bottom or a pallet base 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 anchor bolts.
6. Tighten bolts.

Caution! ***All safeties located on the tank need to be piped outdoors to a safe location.***

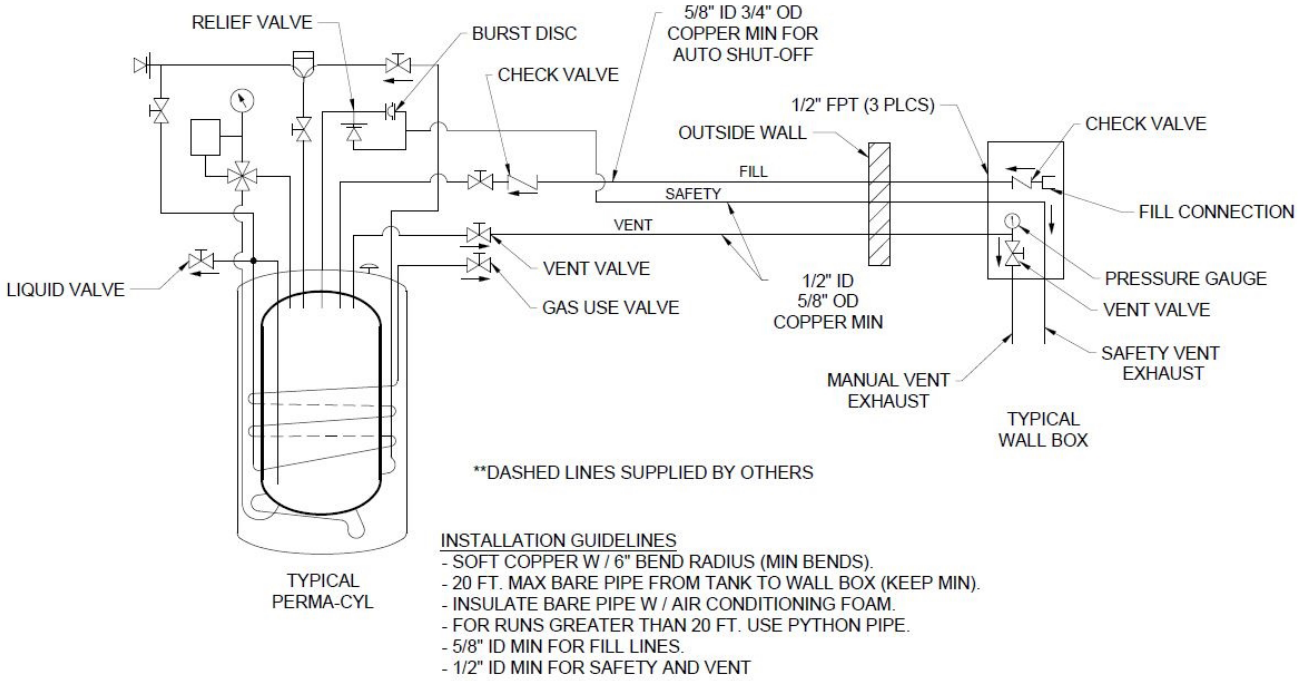


Figure 30 - Schematic

Troubleshooting

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

Trouble	Probable Cause	Remedy
No gas to gas-use equipment. OR Insufficient pressure to gas-use equipment *__Note:__ Perma-Max 1400 XHP is not designed for high-gas flowrates (500 SCFH max)	Perma-Max 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. *__Note:__ Perma-Max 1400 XHP & 12,000 VHP do not have internal vaporizer coils	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 switch-over system to allow tank to rest and warm up when not in use. 4. Add separate ambient or electric vaporizer sized for the flowrate and pull off the liquid withdrawal line.
	Leak in gas supply lines, gas-use equipment, or tank plumbing. (Frost is present on tank even after an extended period with no gas or liquid use.)	1. Evacuate and ventilate room. 2. If possible, locate and correct leak, 3. User to check tank for frost / leaks each morning before starting gas use. 4. Call appropriate equipment service technician.

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

*Perma-Max 12,000 VHP does not have internal PB coils. Frost will appear on external PB vaporizer.
**N/A for Perma-Max 1400 VHP, 12,000 XHP

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

*N/A for Perma-Max 1400 XHP

Trouble	Probable Cause	Remedy
Hissing sounds or evidence of gas leaking near tank, gas lines, or gas-use equipment. (continued)	Large leaks, leaks from elsewhere in the system, sustained leaks, or frequent leaks (not normal)	1. Evacuate all personnel from affected areas. Ventilate room / area. 2. If possible, locate the leak and repair it or call gas service or gas-use equipment service technician.
High gas usage.	Unrecognized increase in actual gas use.	1. None for Perma-Max tank or gas supplier 2. Gas user to determine reason for increase in gas use.
	Leak in gas supply line or network or in gas-use equipment or tank plumbing, e.g. relief valve.	1. Evacuate and ventilate room, if necessary. 2. If possible, locate and repair leak or call gas-use equipment service agent. 3. User to check tank for frost / leaks before operations.
	Tank pressure routinely too high and venting.	1. See troubleshooting section on routinely high tank pressure.
	Error in gas delivery or supplier invoice.	1. Check gas usage history / pattern against supplier invoices. 2. Call gas supplier, if necessary.
Perma-Max tank cannot be filled.	Perma-Max tank is full.	1. None
	Fill line is blocked or inoperative.	1. Check for obstructions in the fill line. Clear if necessary. 2. Call gas service technician.
	Not enough differential in pressures between Perma-Max tank and delivery vehicle	1. Vent down Perma-Max tank until pressure is at least 50 psig lower than delivery vehicle. ***Do not vent the tank pressure below 100 PSI if it contains liquid carbon dioxide.***
Vacuum pump-out port and / or vacuum plug are open or damaged.	Pump-out plug or port have been damaged or tampered with.	1. If possible, transfer any remaining contents to another tank. 2. Call gas service technician to replace and repair tank.
	Inner vacuum space leak has dislodged safety pump-out plug.	1. If possible, transfer any remaining contents to another tank. 2. Call gas service technician to replace and repair tank.

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

Specifications

General Specifications	1400 CO_2 XHP	2200 CO_2 HP	3300 CO_2 HP	4400 CO_2 HP	6000 CO_2 HP	12,000 CO_2 HP
Relief Valve Setting / MAWP (psig/barg)	800 / 55	350 / 24.1	350 / 24.1	350 / 24.1	350 / 24.1	350 / 24.1(1)
Overall Height (in/mm)	66.7 / 1694	82 / 2083	92 / 2337	116 / 2946	122 / 3099	119 / 3020
Width with Pallet Base (in/mm)	46.6 / 1184	46.6 / 1184	53 / 1346	53 / 1346	60.5 / 1537	86 / 2180
Length with Pallet Base (in/mm)	62.6 / 1590	50.6 / 1285	67 / 1702	67 / 1702	75.5 / 1918	102 / 2590
Tank Diameter (in/mm)	42 / 1067	42 / 1067	48 / 1219	48 / 1219	58 / 1473	80 / 2030
Tare Weight(2) (lbs/kg)	2015 / 914	1500 / 680	2200 / 998	2600 / 1179	3300 / 1497	9100 / 4128
Capacities						
Gross Volume (gal/liters)	171 / 646	279 / 1056	409 / 1550	539.5 / 2042	769 / 2911	1435 / 5434
Net Volume (gal/liters)	160 / 606	251 / 950	384 / 1455	513.9 / 1945	715 / 2707	1350 / 5110
Gaseous Volume(3) (scf/Nm^3)	11,826 / 335	19,960 / 564	29,340 / 830	38,048 / 1000	52,954 / 1390	99,954 / 2627
Weight Volume(3) (lbs/kg)	1352 / 615	2283 / 1035	3256 / 1477	4352 / 1974	6058 / 2747	11,427 / 5183
Performance						
Normal Evaporation Rate (% per day)(4)	.3%					
Gas Supply Rate @ 150 psig (scfh/Nm^3H)	N/A	320 / 9.0	450 / 12.7	500 / 14.2	500 / 14.2	1167 / 33
(lbs/hr) / (kg/hr)	2 / 1	36 / 16.3	51 / 23	51 / 23	51 / 23	130 / 59
Construction						
Design & Manufacturing Code	ASME Section VIII Div. 1					
Outer Vessel	Type 304 SS					Paint(5)
Pallet Base	Galvanized Carbon Steel					

Footnotes: Specifications subject to change without prior notice.

(1) Can be upgraded to 500 psig / 34.5 barg.

(2) Weights include lab base (Does not come standard on the Model 2200).

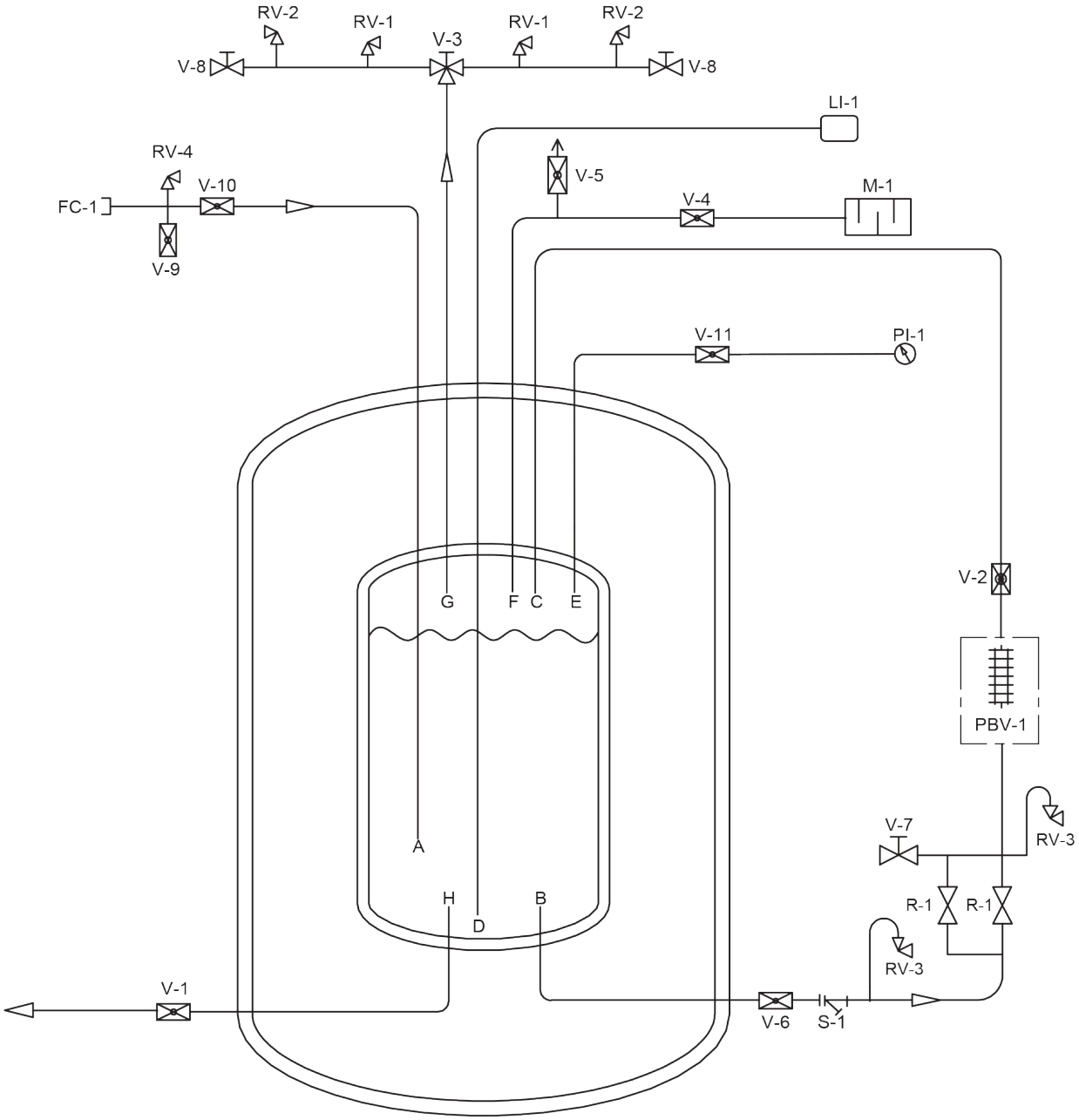
(3) Gas measured at 1 atm and 70°F. Liquid measured at 1.7°F and 300 psig/20.7 barg saturated pressure..

(4) Values are based on gross volume.

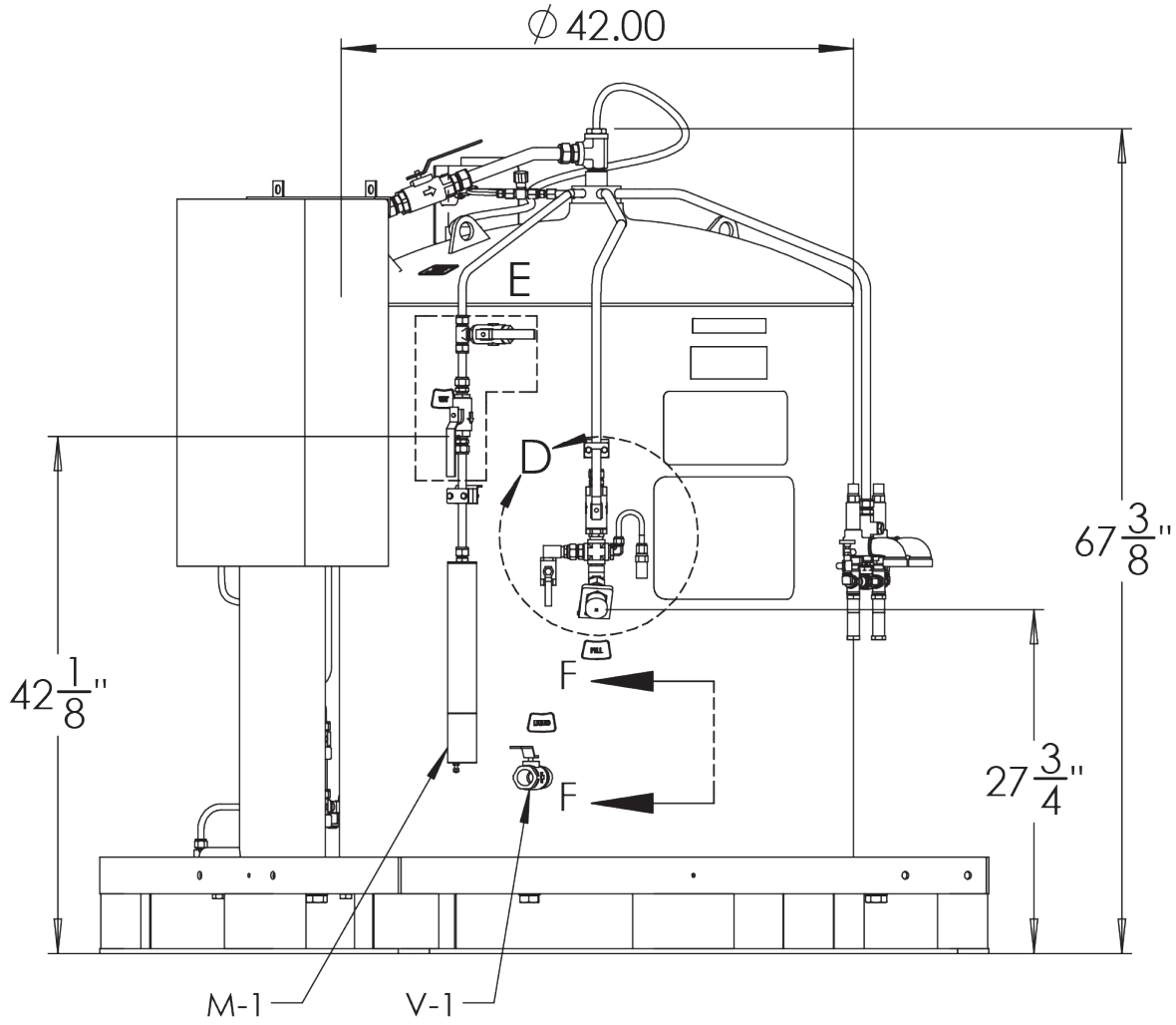
(5) Model 12,000 is built with a stainless steel outer top and bottom plate.

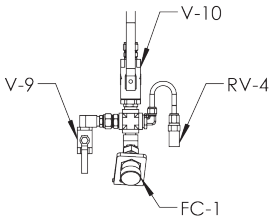
Illustrations & Parts Listing

1400 XHP CO_2 Schematic

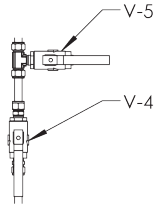


1400 XHP CO_2 Front View

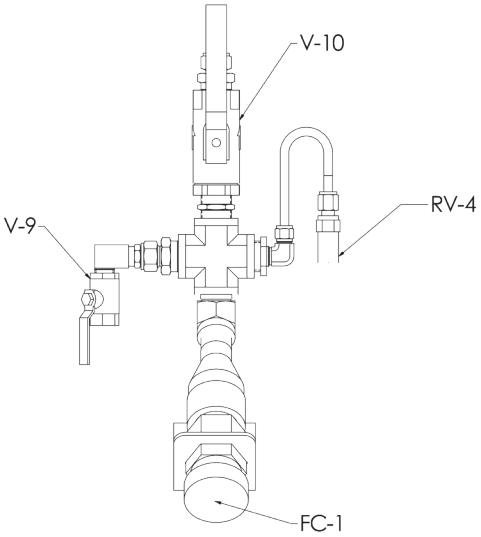




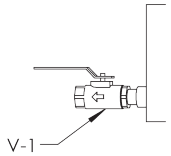
DETAIL D
3/4"QDC (QUICK DISCONNECT) FILL KIT



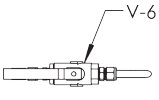
DETAIL E
SCALE 1 : 12



DETAIL D
1-½" BULK FITTING FILL KIT

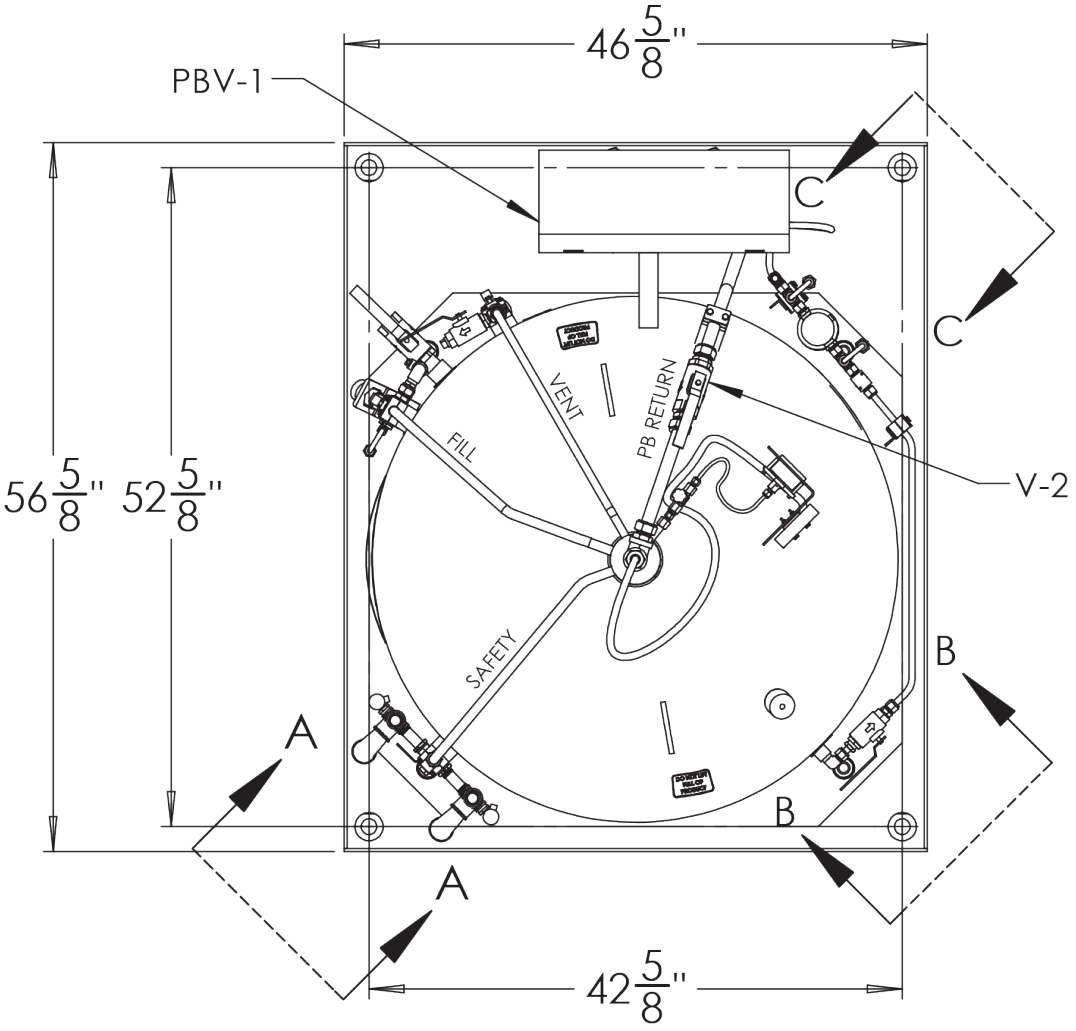


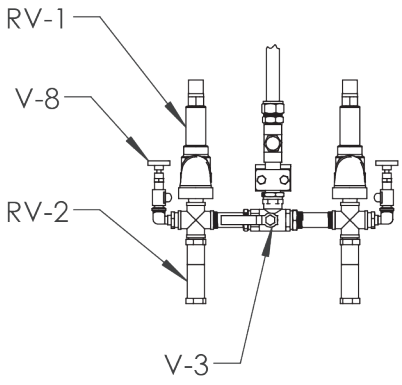
SECTION F-F
SCALE 1 : 12



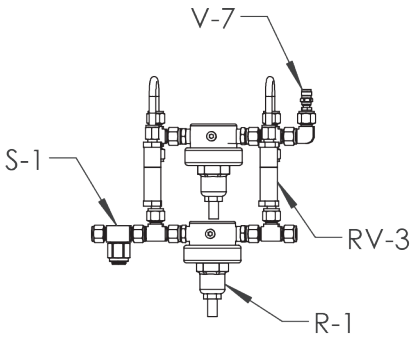
SECTION B-B
SCALE 1 : 12

1400 XHP CO_2 Top View





SECTION A-A
SCALE 1 : 12



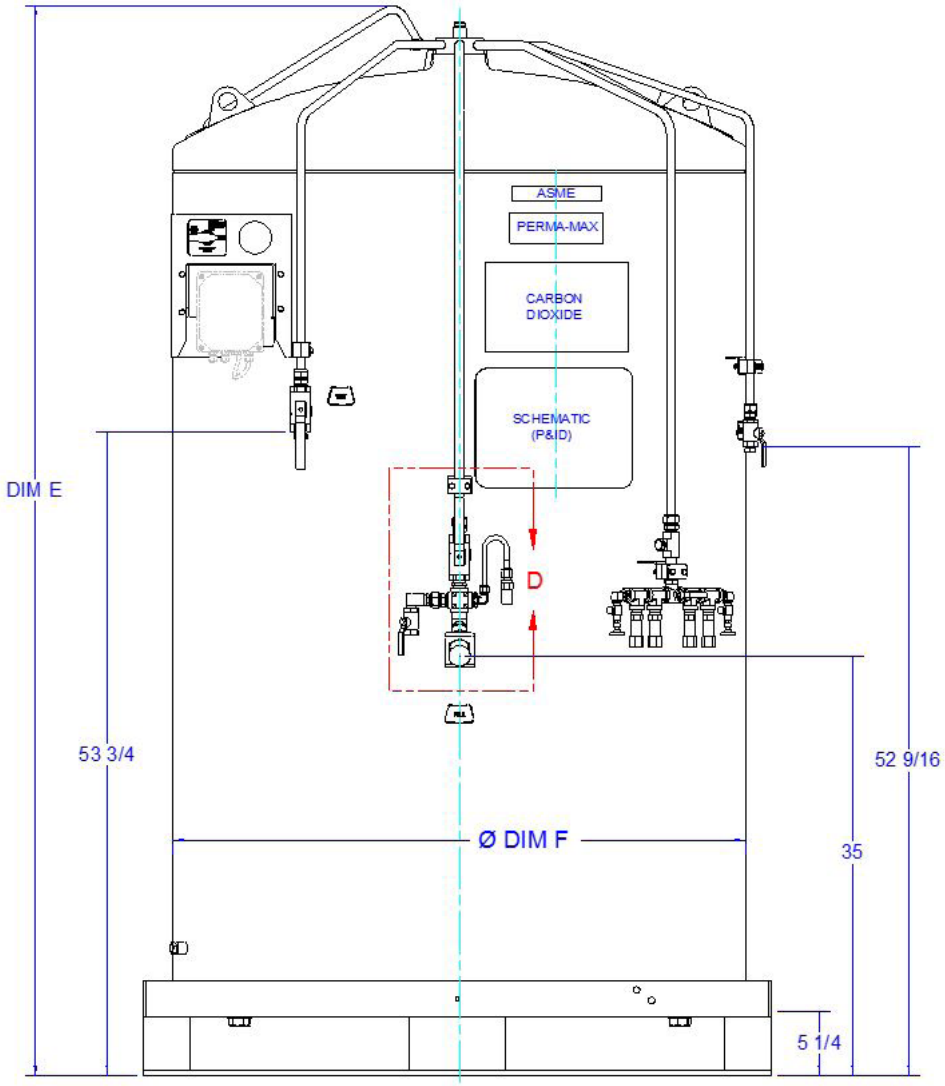
SECTION C-C
SCALE 1 : 12

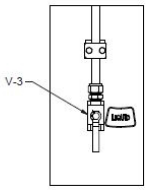
1400 XHP CO_2 Parts Listing

Item	Qty	PN	Description	Mfg PN	Manufacturer
FC-1*	1	10582833	CONN BRS QK MALE FILL FTG	6660-13	SNAP-TITE
	1	10715026	FIXED END ASSY BRS CGA CO2-150	N/A	MEP
LI-1	1	20910598	CYL-TEL GEN 5 0-200"H20	N/A	CHART
	1	20897094	C-STIC CAPACITANCE GAUGE BOX	008.007.008	ROTAREX
PI-1	1	21297699	PG D"Dial 0-1200 PSI/BAR	52848457	WKA
R-1*	2	21149690	750 PSI REGULATOR 1/2NPT	3530-750	HARRIS
RV-1	2	21297863	RV BRS 1/2MPT 800 PSI CO2 ONLY	913BDCB31-KE0900	KUNKLE
RV-2	2	21773983	RV BRS 1/2MPT 875PSI CO2 ONLY	HPRV-500B-T-875	GENERANT
RV-3	2	21153172	RV BRS 1/4MPT 900PSI CO2 ONLY	HPRV-250B-T-900	GENERANT
RV-4	1	1812702	RV BRS 1/4MPT 550 PSI	PRV9432T550	REGO
V-1	1	12930205	VALVE BALL SS 1FPT CO2 ONLY	A-EW0013600XTD	JAMESBURY
V-2	1	12930205	VALVE BALL SS 1FPT CO2 ONLY	A-EW0013600XTD	JAMESBURY
V-3	1	20905991	VALVE BALL DIV SS 3/4NPT	76-604-57 B31.3	APOLLO
V-4	1	12930184	VALVE BALL SS 1/2FPT CO2 ONLY	A-EW0013600XTD	JAMESBURY
V-5	1	12930184	VALVE BALL SS 1/2FPT CO2 ONLY	A-EW0013600XTD	JAMESBURY
V-6	1	12930184	VALVE BALL SS 1/2FPT CO2 ONLY	A-EW0013600XTD	JAMESBURY
V-7	1	N/A	VALVE PURGE SS 1/2ODT SHORT	SS-4PT8	SWAGELOK
V-8	1	10907239	VALVE NEEDLE BRS 1/4 MPT (ANGLE)	CMM250A	REGO
V-9	1	20888626	VALVE BALL SS 1/2NPT	00129FB3600XTB	JAMESBURY
V-10	1	12930192	VALVE BALL SS 3/4FPT CO2 ONLY	0222-0034A3600XTD-TD	JAMESBURY
M-1	1	13744164	MUFFLER VENT	N/A	Chart
S-1	1	21280171	STRAINER .500ODT SS BODY	SS-8TF-440	SWAGELOK
PBV-1	1	FG02798	VAPAMB AL ENGINEERED/270PSI	FG02798	THERMAX

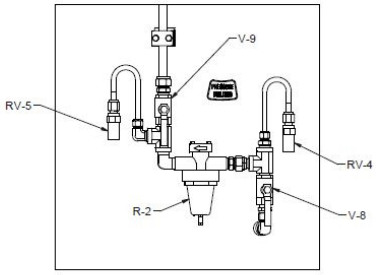
**Denotes customer option*

2200/3300 HP CO_2 Front View

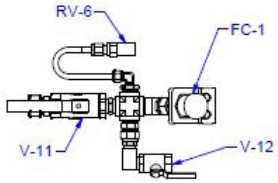




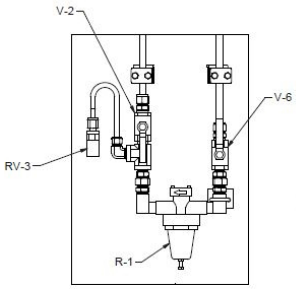
SECTION A-A
SCALE 3 / 16



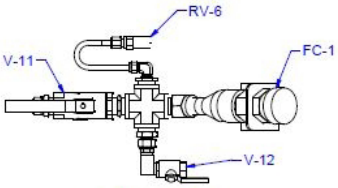
SECTION C-C
SCALE 3 / 16



VIEW D-D
3/4" QDC (QUICK DISCONNECT) FILL KIT

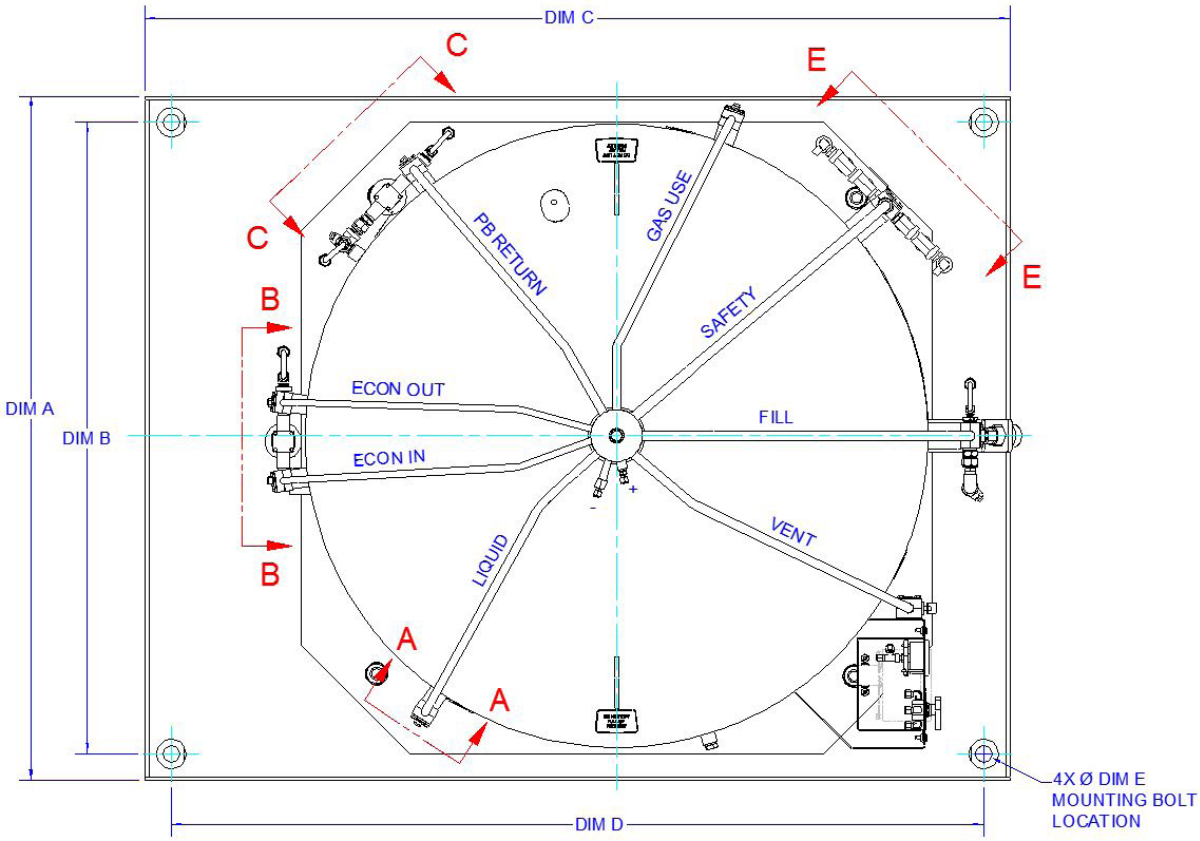


SECTION B-B
SCALE 3 / 16



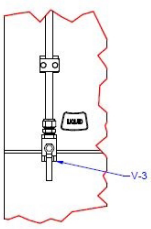
VIEW D-D
1-1/2" BULK FITTING FILL KIT

2200/3300 HP CO_2 Top View

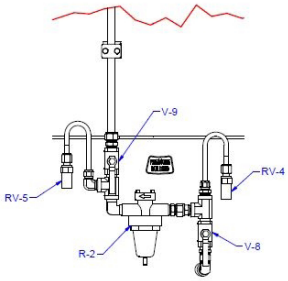


Model Dimensions						
Model	**Dim A**	**Dim B**	**Dim C**	**Dim D**	**Dim E**	**Dim F**
Perma-Max 2200 CO_2	40 5/8	36 5/8	50 5/8	46 5/8	78 5/16*	42
Perma-Max 3300 CO_2	52 5/8	48 5/8	66 5/8	62 5/8	89 7/16	48

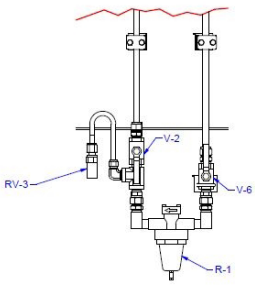
**No pallet base*



DETAIL A
SCALE 3/16



DETAIL C
SCALE 3/16



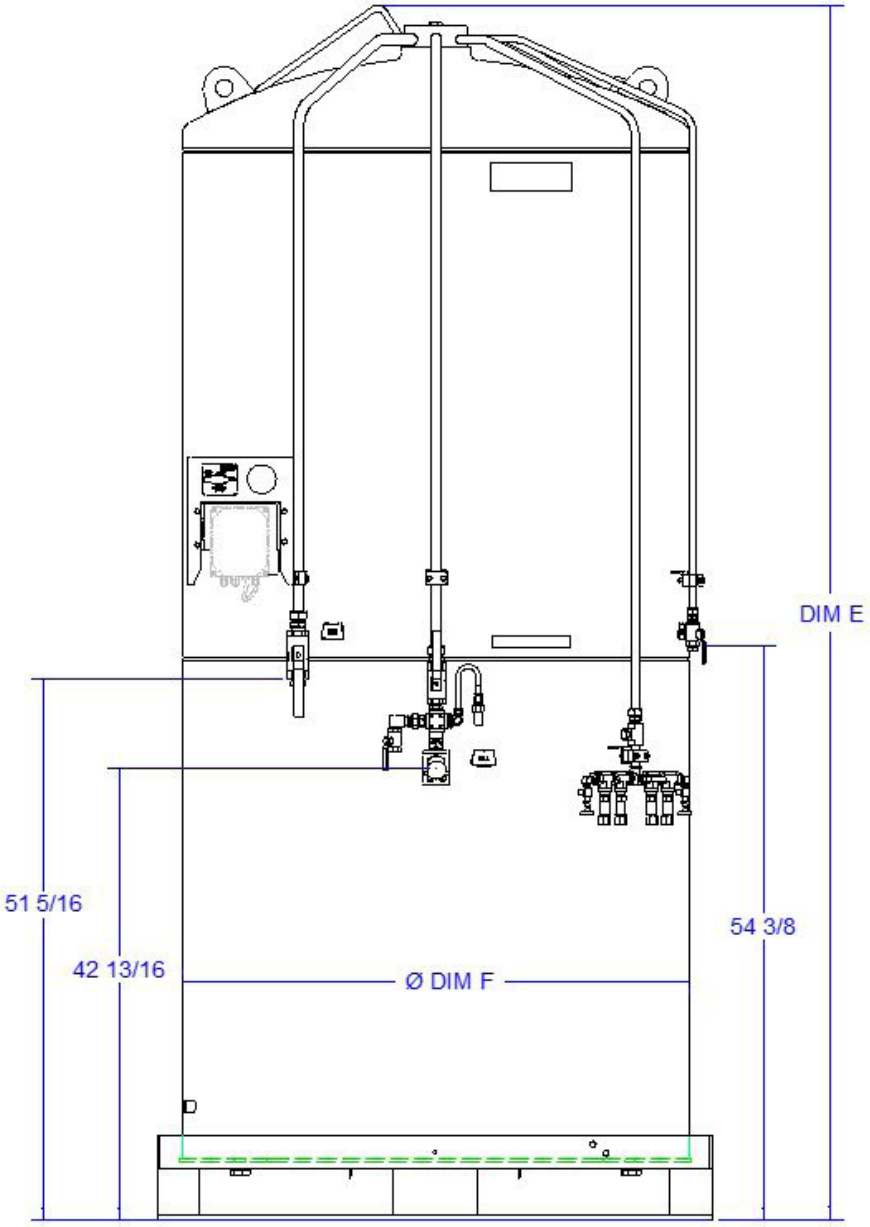
DETAIL B
SCALE 3/16

2200/3300 HP CO_2 Parts Listing

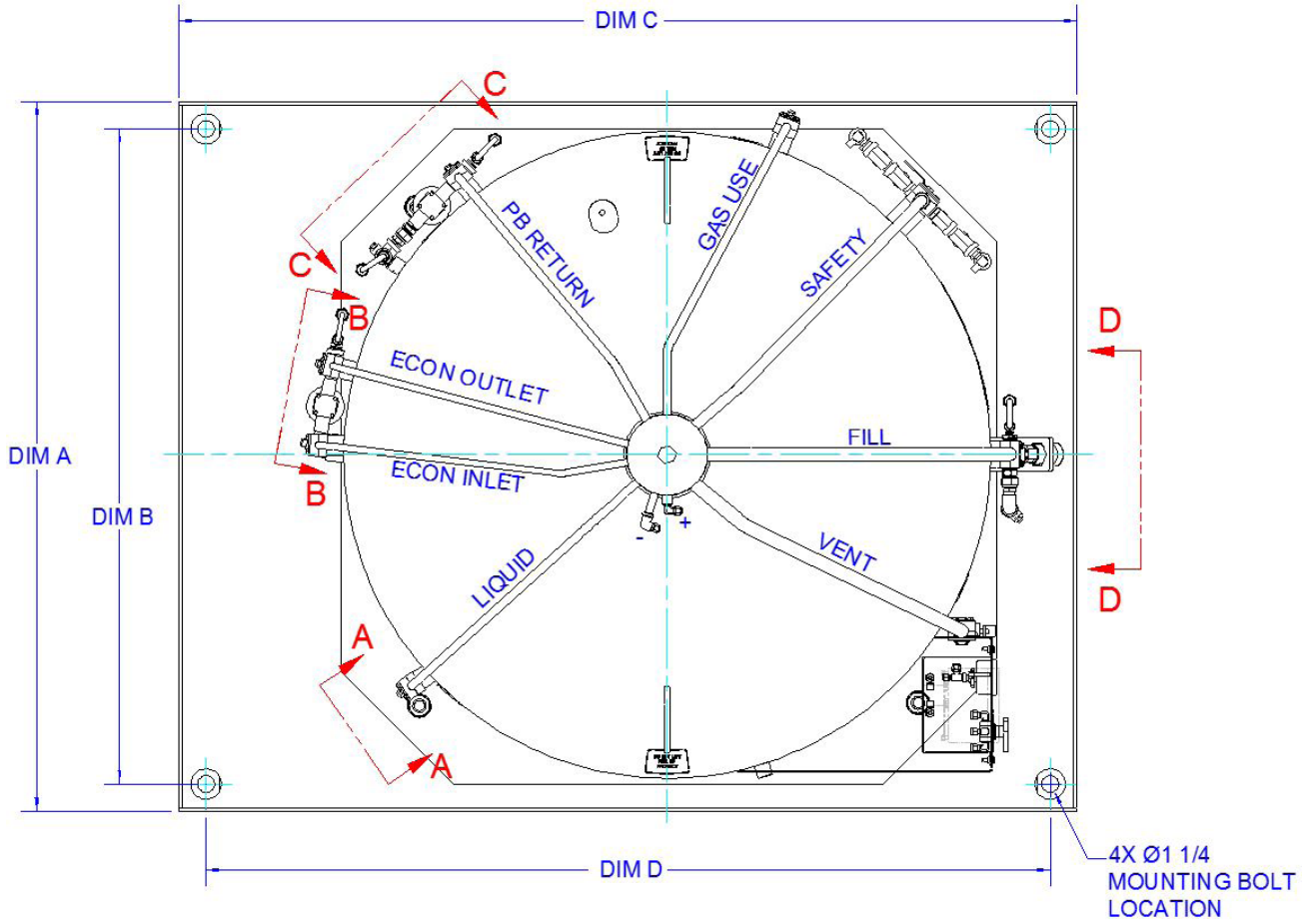
Item	Qty	PN	Description	Mfg PN	Manufacturer
FC-1*	1	10582833	CONN BRS QK MALE FILL FTG	SNAP-TITE	6660-13
	1	10715026	FIXED END ASSY BRS CGA CO2-150	N/A	MEP
LI-1*	1	20910598	CYL-TEL GEN 5	N/A	Chart
	1	20909590	DIFF PG 4-1/2" DIAL 0-100"H2O 1/4NPT	52718757	Wika
PI-1	1	20827654	PG 2" DIAL 0-600PSI/BAR 1/8MPT PANEL MNT	52553914	Wika
R-1*	1	11388741	REGULATOR .500NPT @ 150 PSI	FRM-2 51-50	Pentair
	1	20818549	REGULATOR .500NPT @ 325 PSI	E-1	Pentair
R-2*	1	11779806	REGULATOR .500NPT @ 125 PSI	E-1	Pentair
	1	11690211	REGULATOR .500NPT @ 300 PSI	E-1	Pentair
RV-1	2	20599868	RV BRS 350 PSI 1/2 MPT (ASME)	C19434TP350	Rego
RV-2	2	21773984	RV BRS 1/2MPT 375PSI W/0 WEEP	PRV9434TP375	Rego
RV-3	1	1812702	RV BRS 550 PSI 1/4 MPT	PRV94432TP550	Rego
RV-4	1	1812702	RV BRS 550 PSI 1/4 MPT	PRV94432TP550	Rego
RV-5	1	1812702	RV BRS 550 PSI 1/4 MPT	PRV94432TP550	Rego
V-1	1	20888626	VALVE BALL SS 1/2 NPT (GAS USE)	00129FB3600XTB 31.3	Jamesbury
V-2	1	20888626	VALVE BALL SS 1/2 NPT (ECON OUTLET)	00129FB3600XTB 31.3	Jamesbury
V-3	1	20888626	VALVE BALL SS 1/2 NPT (LIQUID)	00129FB3600XTB 31.3	Jamesbury
V-4	1	11773885	VALVE BALL DIV SS 1/2 NPT (SAFETY)	76-603-57 B31.3	Apollo
V-5	1	12930205	VALVE BALL SS 1FPT (VENT/FULL TRYCOCK)	A-EW0013600XTD NON	Jamesbury
V-6	1	20888626	VALVE BALL SS 1/2 NPT (ECON INLET)	00129FB3600XTB 31.3	Jamesbury
V-7	1	20683719	VALVE 4 WAY 1/4 FPT (PRESSURE/LEVEL)	B-43ZTF2-WL8	Swagelok
V-8	1	20888626	VALVE BALL SS 1/2 NPT (PB INLET)	00129FB3600XTB 31.3	Jamesbury
V-9	1	20888626	VALVE BALL SS 1/2 NPT (PB OUTLET)	00129FB3600XTB 31.3	Jamesbury
V-10	2	10907239	NEEDLE VALVE BRS 1/4 NPT (SAFETY DRAIN)	CMM250A B31.3	Rego
V-11*	1	12930192	VALVE BALL SS 3/4 FPT (QDC FILL)	022-0034A3600XTD	Jamesbury
	1	12930205	VALVE BALL SS 1 FPT (BULK FILL)	A-EW0013600XTD	Jamesbury
V-12	1	20888626	VALVE BALL SS 1/2 FPT (FILL DRAIN)	00129FB3600XTB	Jamesbury

**Denotes customer option*

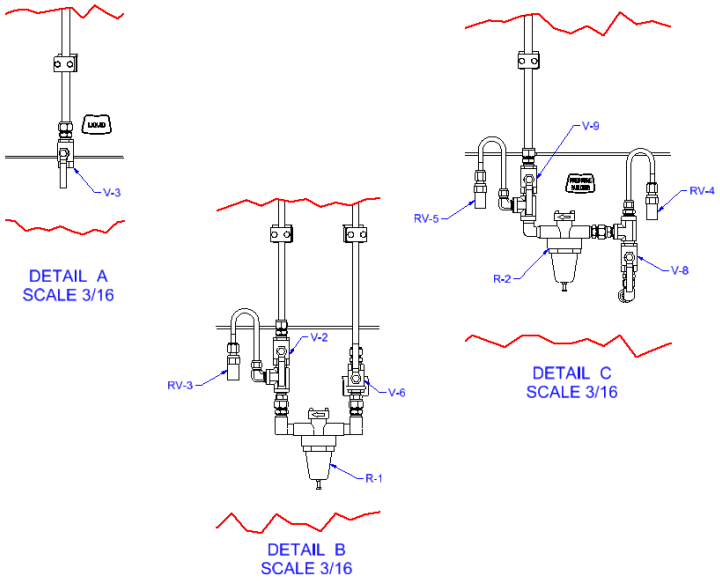
4400/6000 HP CO_2 Front View



4400/6000 HP CO_2 Top View



Model Dimensions						
Model	**Dim A**	**Dim B**	**Dim C**	**Dim D**	**Dim E**	**Dim F**
Perma-Max 4400 CO_2	52 5/8	48 5/8	66 5/8	62 5/8	115 1/4	48
Perma-Max 6000 CO_2	60 1/2	56 1/2	75 1/2	71 1/2	121 1/4	58

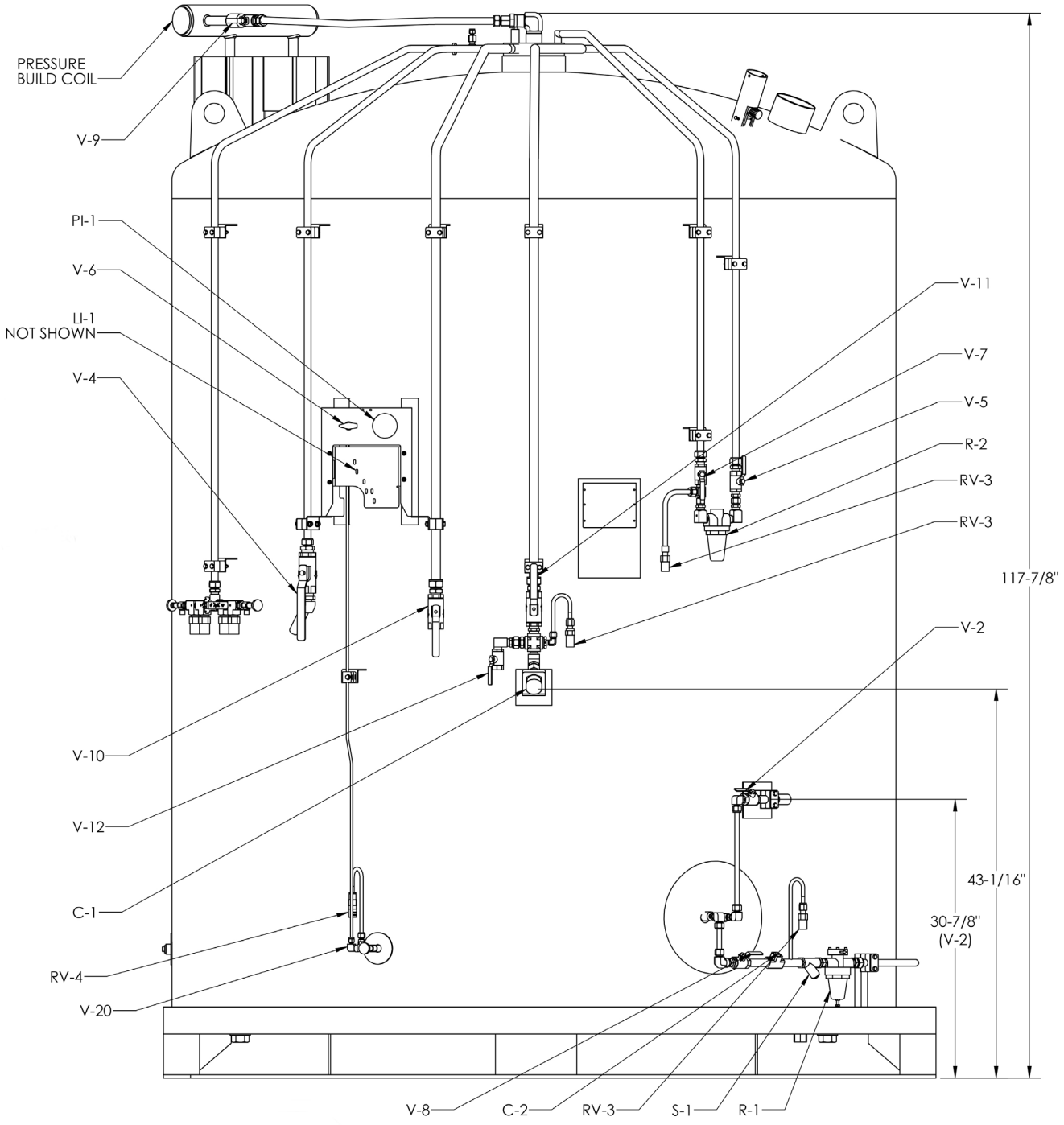


4400/6000 HP CO_2 Parts Listing

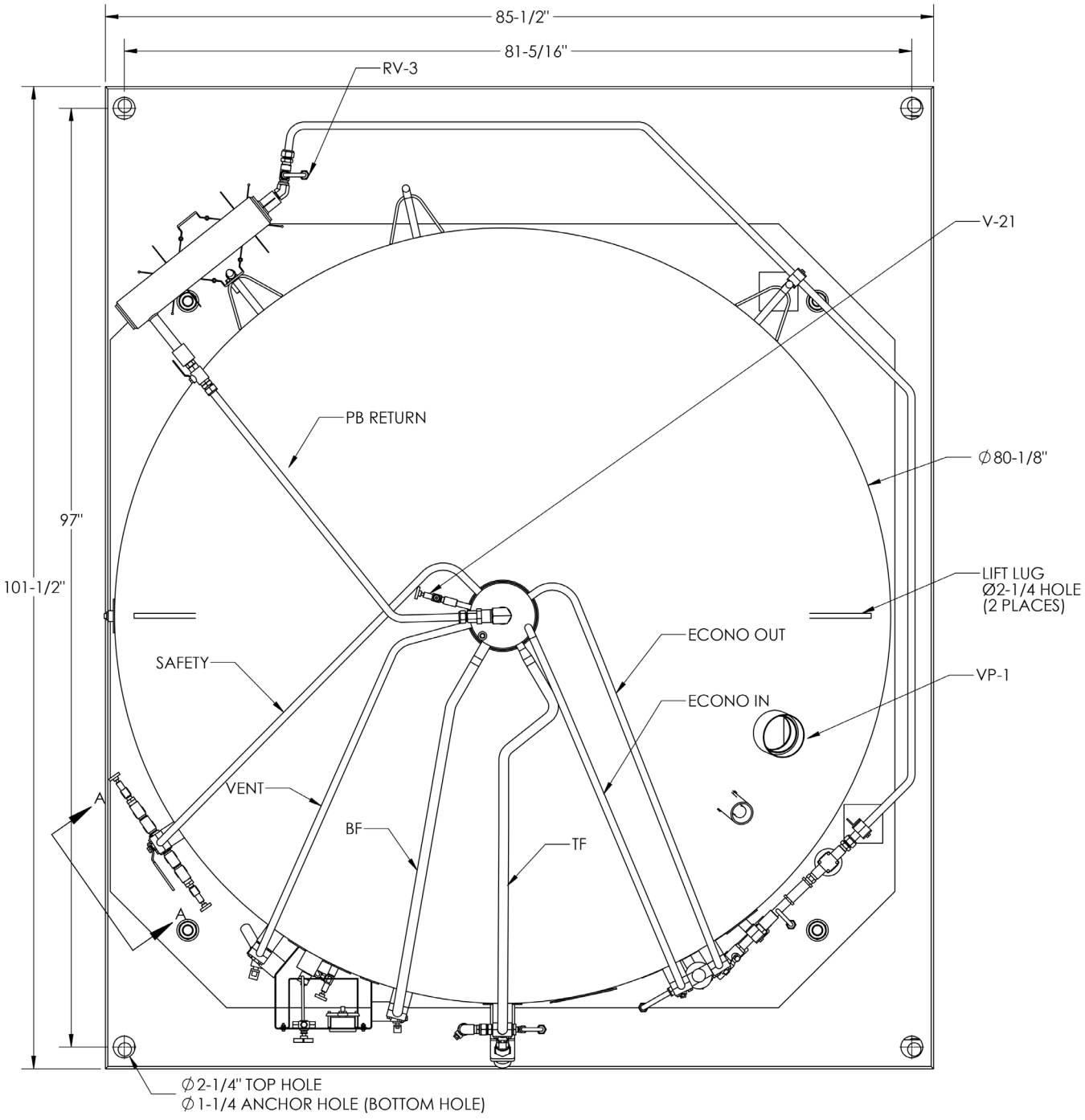
Item	Qty	PN	Description	Mfg PN	Manufacturer
FC-1*	1	10582833	CONN BRS QK MALE FILL FTG	SNAP-TITE	6660-13
	1	10715026	FIXED END ASSY BRS CGA CO2-150	N/A	MEP
LI-1*	1	20910598	CYL-TEL GEN 5	N/A	Chart
	1	20909590	DIFF PG 4-1/2" DIAL 0-100"H2O 1/4NPT	52718757	Wika
PI-1	1	20827654	PG 2" DIAL 0-600PSI/BAR 1/8MPT PANEL MNT	52553914	Wika
R-1*	1	11388741	REGULATOR .500NPT @ 150 PSI	FRM-2 51-50	Pentair
	1	20818549	REGULATOR .500NPT @ 325 PSI	E-1	Pentair
R-2*	1	11779806	REGULATOR .500NPT @ 125 PSI	E-1	Pentair
	1	11690211	REGULATOR .500NPT @ 300 PSI	E-1	Pentair
RV-2	2	21773984	RV BRS 1/2MPT 375PSI W/O Weep	PRV9434TP375	Rego
RV-3	1	1812702	RV BRS 550 PSI 1/4 MPT	PRV94432TP550	Rego
RV-4	1	1812702	RV BRS 550 PSI 1/4 MPT	PRV94432TP550	Rego
RV-5	1	1812702	RV BRS 550 PSI 1/4 MPT	PRV94432TP550	Rego
V-1	1	20888626	VALVE BALL SS 1/2 NPT (GAS USE)	00129FB3600XTB 31.3	Jamesbury
V-2	1	20888626	VALVE BALL SS 1/2 NPT (ECON OUTLET)	00129FB3600XTB 31.3	Jamesbury
V-3	1	20888626	VALVE BALL SS 1/2 NPT (LIQUID)	00129FB3600XTB 31.3	Jamesbury
V-4	1	11773885	VALVE BALL DIV SS 1/2 NPT (SAFETY)	76-603-57 B31.3	Apollo
V-5	1	12930205	VALVE BALL SS 1FPT (VENT/FULL TRYCOCK)	A-EW0013600XTD NON	Jamesbury
V-6	1	20888626	VALVE BALL SS 1/2 NPT (ECON INLET)	00129FB3600XTB 31.3	Jamesbury
V-7	1	20683719	VALVE 4 WAY 1/4 FPT (PRESSURE/LEVEL)	B-43ZTF2-WL8	Swagelok
V-8	1	20888626	VALVE BALL SS 1/2 NPT (PB INLET)	00129FB3600XTB 31.3	Jamesbury
V-9	1	20888626	VALVE BALL SS 1/2 NPT (PB OUTLET)	00129FB3600XTB 31.3	Jamesbury
V-10	2	10907239	NEEDLE VALVE BRS 1/4 NPT (SAFETY DRAIN)	CMM250A B31.3	Rego
V-11*	1	12930192	VALVE BALL SS 3/4 FPT (QDC FILL)	022-0034A3600XTD	Jamesbury
	1	12930205	VALVE BALL SS 1 FPT (BULK FILL)	A-EW0013600XTD	Jamesbury
V-12	1	20888626	VALVE BALL SS 1/2 FPT (FILL DRAIN)	00129FB3600XTB	Jamesbury

**Denotes customer option*

12,000 VHP CO_2 Front View



12,000 VHP CO_2 Top View



12,000 VHP CO_2 Parts Listing

Item	Qty	PN	Description	Mfg PN	Manufacturer
*FC-1	1	10582833	FILL CONNECTION SNAP-TITE	6660-13	SNAP-TITE
		10715026	FILL CONNECTION CO2 1-1/2 CGA	CO2-25102-15	MEP
V-2	1	20888626	VALVE BALL SS 1/2NPT (GAS USE ISO)	00129FB3600XTB	JAMESBURY
*V-3	1	10502848	VALVE SHUTOFF BRZ 1/2FPTSHORT (GAS USE)	T9454	REGO
V-4	1	12930205	VALVE VALL SS 1FPT (VENT VALVE)	A-EW0013600XTD	JAMESBURY
V-5	1	20888626	VALVE BALL SS 1/2NPT (ECON ISO VALVE)	00129FB3600XTB	JAMESBURY
V-6	1	20683719	VALVE 4-WAY BRS 1/8FTP (LL GAUGE ISO)	B-43YTF2-WL8	SWAGELOK
V-7	1	20888626	VALVE BALL SS 1/2NPT (ECON ISO VALVE)	00129FB3600XTB	JAMESBURY
V-8	1	20888626	VALVE BALL SS 1/2NPT (PB INLET ISO VALVE)	00129FB3600XTB	JAMESBURY
V-9	1	20888626	VALVE BALL SS 1/2NPT (PB ISO VALVE)	00129FB3600XTB	JAMESBURY
V-10	1	12930192	VALVE BALL SS 3/4FPT (LIQUID WITHDRAWAL)	0222-0034A3600XTD	JAMESBURY
*V-11	1	12930192	VALVE BALL SS 3/4FPT (FILL VALVE)	0222-0034A3600XTD	JAMESBURY
		12930205	VALVE BALL SS 1FPT (FILL VALVE)	A-EW0013600XTD	JAMESBURY
V-12	1	20888626	VALVE BALL SS 1/2NPT (HOSE DRAIN VALVE)	00129FB3600XTB	JAMESBURY
V-13	1	11773885	VALVE BALL DIV SS 1/2NPT (DIVERTER VALVE)	76-603-57	APOLLO
V-14	2	10907239	VALVE NEEDLE BRS 1/4MPT(ANGLE)	CMM250A	REGO
*R-1	1	11779806	REGULATOR .500NPT @ 125PSI (PB)	A401CCSZSZTH01-E0125	CASH-ACME
		11690211	REGULATOR .500NPT @ 300PSI (PB)	A401CCSZSZTH01-E0300	CASH-ACME
		11635511	REGULATOR .500NPT @ 450PSI (PB)	A401CCSZSZTH01-E0450	CASH-ACME
*R-2	1	11388741	REGULATOR .250NPT @ 150PSI (ECON)	FRM2 10673-0150	CASH-ACME
		20818549	REGULATOR .250NPT @ 325PSI (ECON)	FRM2 15895-0325	CASH-ACME
		20952735	REGULATOR .500NPT @470PSI (ECON)	FRM2 20457-0465	CASH-ACME
*RV-1	2	20599868	RV BRS 1/2MPT 350PSI (PRIMARY RELIEF)	PRV19434TP350	REGO
		20894583	RV BRS 1/2MPT 500PSI W/O DRAIN (PRIMARY RELIEF)	PRV19434TP500	REGO
RV-3	*4/5	1812702	RV BRS 1/4MPT 550PSI	PRV9432T550	REGO
S-1	1	11529090	STRAINER .500NPT BRZ BODY	200WSCH 600	UNITED BRASS
PI-1	1	20827654	PG 2-1/2” 0-600PSI/BAR 1/8MPT	52553914	WIKA
*LI-1	1	20910598	CYL-TEL GEN 5 BACK 0-200”H2O	#9500-8201	CYL-TEL
		20909590	DIFF PG 4.5” 0-100” H20 VITON (CO2)	52718757	WIKA
RV-2	2	21841965	RV BRS 1/2MPT 375PSI W/O Weep (SECONDARY RELIEF)	PRV19434TP375	REGO
		21841966	RV BRS 1/2MPT 550PSI W/O WEEP (SECONDARY RELIEF)	PRV19434TP550	REGO
VP-1	1		VACUUM PUMPOUT PORT		
KIT	1	21263445	KIT PERMA CO2 VR 12,000		
	1	21099768	KIT PERMA CO2 FILL ≥ 4400 BULK		

**Denotes customer option*

Appendix 1

Thermax Electric PB Vaporizer

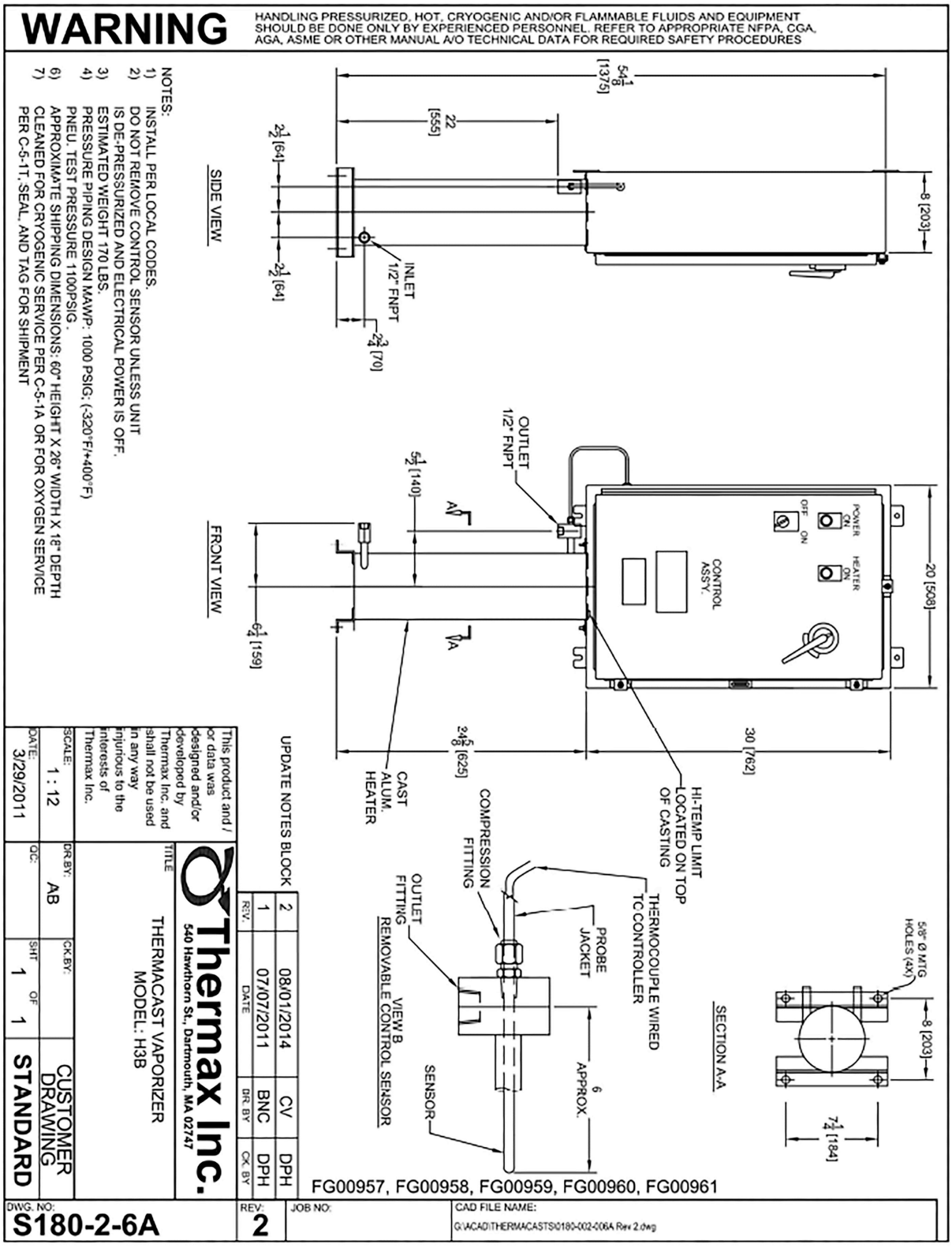


Figure 1 - Schematic 1

Thermax vaporizer cont.

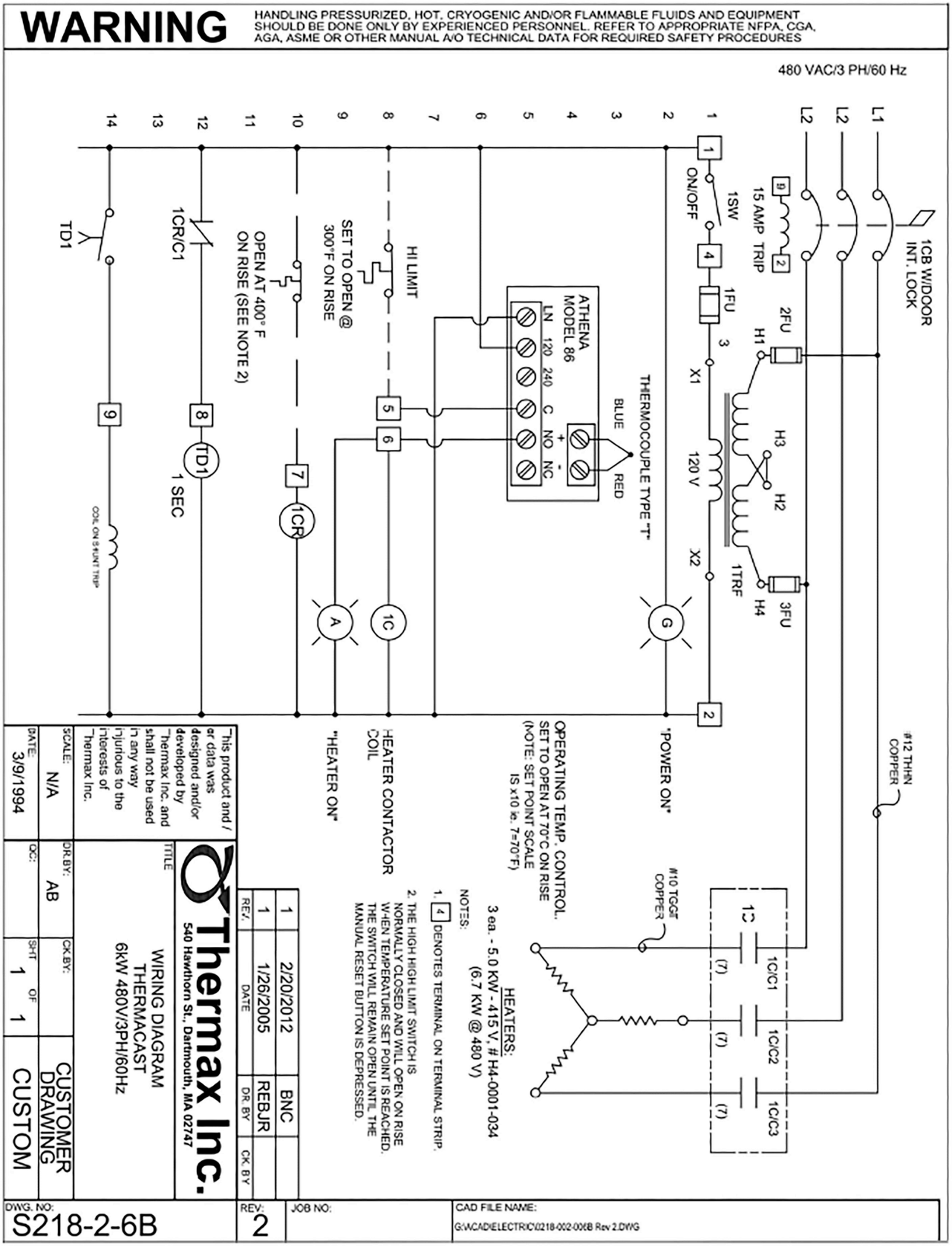


Figure 2 - Schematic 2

Appendix 2

C-Stic Liquid Level Gauge Installation

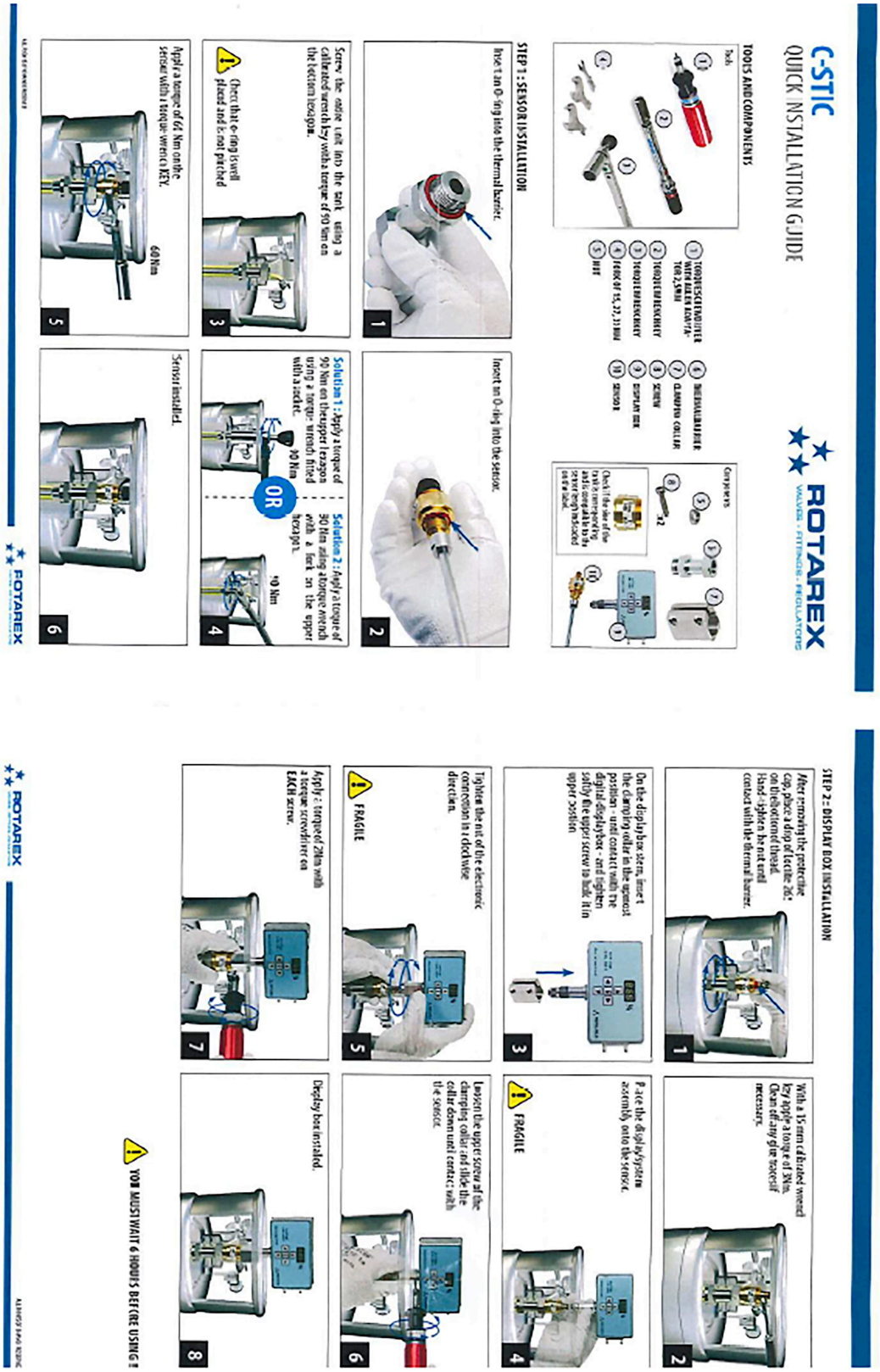


Figure 3 - C-Stic Installation Guide

C-Stic Level Gauge cont.

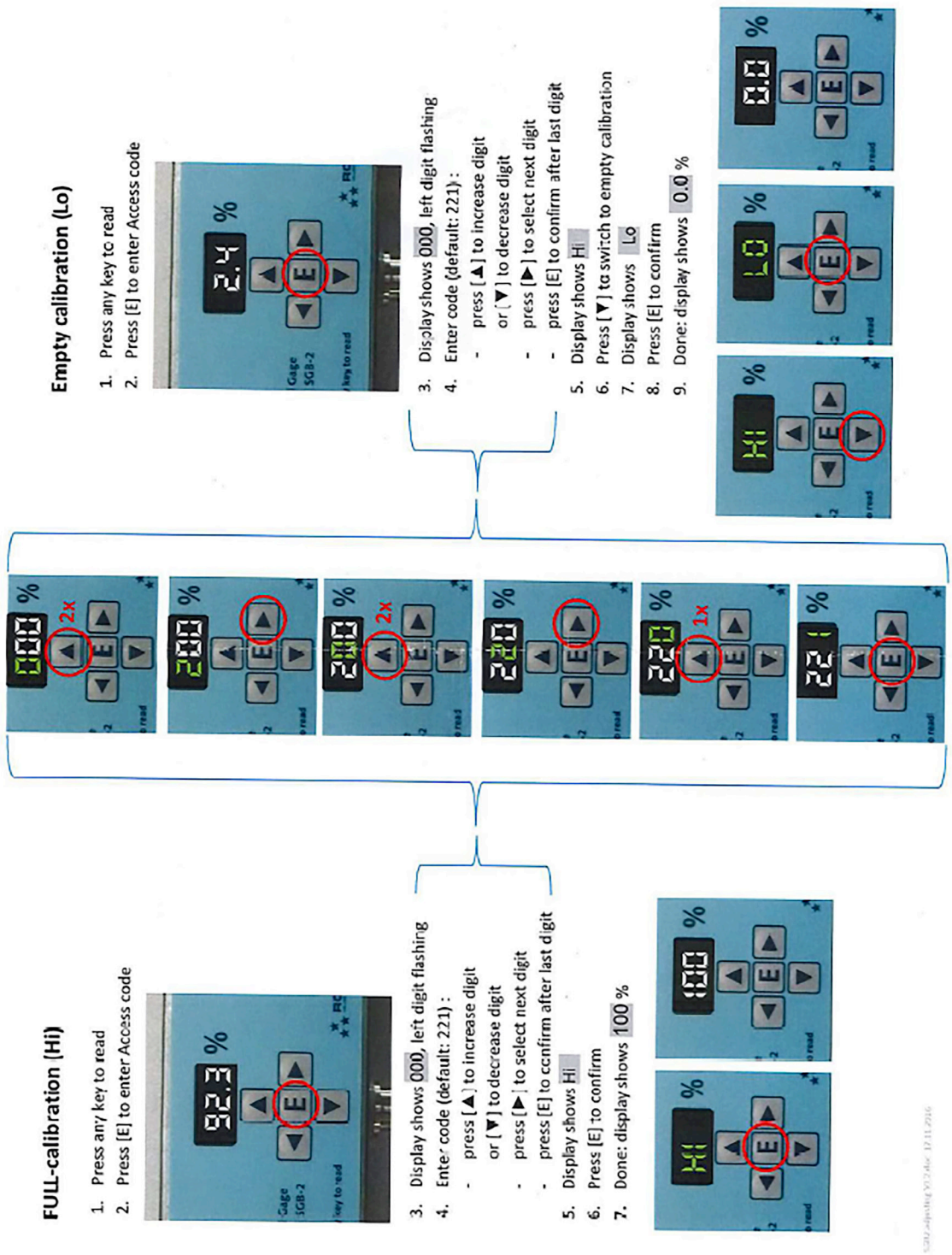


Figure 2 - C-Stic Calibration Guide