Product Manual

Perma-Cyl® Medical MicroBulk Skid

1000/1500/2000/3000

Designed and Built by:

Chart Inc.

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Part Number 20918023 Rev. B

Contents

Revision Log

Revision Level	Date	Description
A	09/30/2015	Original
B	03/07/2016	Major wording changes throughout manual, Update Form in Appendix 1, Update Drawing in Appendix 2, add Appendix 4, 5 & 6.

Preface

General

The Medical MicroBulk Skid is designed to store and deliver liquid oxygen or nitrogen to medical facilities. The skid is designed to accept Perma-Cyl® MicroBulk Storage System tanks for primary liquid storage in sizes of 1000, 1500, 2000, and 3000 liters. It can also accommodate up to 16 high pressure cylinders for the back-up supply. All manifolds and alarm switches are mounted on the skid, connected to a central termination box, preset, and tested at the manufacturer. Field wiring from the skid to the hospital alarm panel is easy and efficient. An optional local alarm panel is also available and can be specified if required. The only piping required to be run in the field is the final tie-in from the Medical MicroBulk Skid to the medical facility source valve.

The Medical MicroBulk Skid is a perfect solution for a turnkey package to serve critical medical facilities such as surgery centers, nursing homes, small hospitals, clinics, long term care facilities, veterinary facilities, and dental offices.

Product Highlights

- Designed in accordance with NFPA 99, NFPA 55, and CGA M-1
- Available in Perma-Cyl tank sizes from 1000 to 3000 liters
- High flow capable, up to 2000 SCFH
- Utilizes a WIKA analog gauge with adjustable low level alarm set point.
- Maintains residual liquid level in Perma-Cyl tanks for no-loss fill and purity integrity
- Optional external PB and process vaporizer packages available
- Integrates with most alarm panels in medical facilities
- Suitable for outdoor installation
- Dimensions of 84” wide x 95.5” long x 90.25” high (without storage tank)

Product Advantages

- Drop-in solution where everything is cleaned and pre-piped at the factory, eliminating the need for costly and time consuming field medical piping
- Alarms are prewired into one electrical termination point making it very easy to tie in the alarms to the main medical facility alarm panel
- Local alarm panel is optional
- All switches and regulators are pre-set and tested at the factory which greatly simplifies field verification
- Tanks can be easily upgraded and changed out with minimal shutdown time

Product Manual

The purpose of this manual is to provide a procedure for new medical installations and to provide minimum performance criteria identified by industry consensus for Medical MicroBulk System installers. It should be thoroughly read and understood by anyone that installs and operates the equipment.

The safety requirements for installing and operating the Medical MicroBulk Skid as well as the safe handling of liquid nitrogen and oxygen are outlined in the safety section. Read this section prior to installing the equipment.

The remaining sections describe the various components of the medical skid and how to inspect, install and commission the skid per FDA requirements.

References

(use editions currently in effect)

- Applicable State Building Codes
- International Building Code
- National Fire Protection Association 99 / Standard for Healthcare Facilities
- National Fire Protection Association 55 / Standard for the Storage, Use and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks
- Current Editions CGA-M1 Guide for Medical Gas Supply Systems at Consumer Sites

- U.S. Food and Drug Administration / 21 Code of Federal Regulations / Parts 210 and 211
- ASSE/APMO/ANSI Series 6000 Medical Gas Systems Personnel
- Product Manual Perma-Cyl w/FlexFill™ Piping Option PN 20930593
- Manufacturers QC Checklist
- Manufacturers O_2 Certification
- Manufacturers literature on individual components (regulators, switches, excess flow valves)
- Chart specification drawing D-20810866

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.*

Definitions

AHJ	Authority Having Jurisdiction
ASME	American Society of Mechanical Engineers
BAR	Pressure (Metric)
CGA	Compressed Gas Association
DPOR	Design Professional of Record
Kg	Kilogram
MAWP	Maximum Allowable Working Pressure
N_2	Nitrogen
Nm^3	Normal Cubic Meters
NER	Normal Evaporation Rate
NFPA	National Fire Protection Association
O_2	Oxygen
PB	Pressure Builder
PN	Part Number
PRV	Pressure Relief Valve
PSI	Pounds per Square Inch
PSIG	Pounds per Square Inch (Gauge)
RPD	Rupture Disc
RV	Relief Valve
SCF	Standard Cubic Feet
SCFH	Standard Cubic Feet/Hour
SCM	Standard Cubic Meters
UFC	Uniform Fire Code

Third Party Verification: Any individual who tests and verifies the operation of bulk medical gas at health care facilities. Must be qualified per ASSE standard 6035.

Medical Bulk Installation (current edition): An assembly of equipment, such as bulk or microbulk tanks, pressure regulators, vaporizers, manifolds, and interconnecting piping that has a storage capacity of more than 20,000 SCF of gas including unconnected reserves on hand at the site. The bulk system terminates at the point where product, introduced at service pressure, first enters the distribution pipeline at the source valve. The tanks can be stationary or portable, and the product can be stored as gas or liquid.

Note: *By definition, the bulk installation is classified with a capacity more than 20,000 SCF.*

Safety

General

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

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

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

Warning! Before removing cylinder parts or loosening fittings, be sure that all pressure has been released and the section has been properly isolated by closing the appropriate valves. If isolation valves do not exist, it might be necessary to either blow the pressure off the entire tank or to drain it. External valves and fittings can become extremely cold and may cause painful burns to personnel unless properly protected. Personnel must wear protective gloves and eye protection whenever removing parts or loosening fittings. Failure to do so may result in personal injury because of extreme cold and pressure in the cylinder.

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

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

Safety Bulletin

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

Cryogenic containers, stationary or portable, are from time to time subjected to assorted environmental conditions of an unforeseen nature. This safety bulletin is intended to call attention to the fact that whenever a cryogenic container is involved in any incident whereby the container or its

safety devices are damaged, good safety practices must be followed. The same holds true whenever the integrity or function of a container is suspected of abnormal operation.

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

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

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

The remainder of this safety bulletin addresses those adverse environments that may be encountered when a cryogenic container has been severely damaged. These are oxygen deficient atmospheres, oxygen enriched atmospheres, and exposure to inert gases.

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

Oxygen Deficient Atmospheres

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

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

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

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

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

Most individuals working in or around oxygen deficient atmospheres rely on the "buddy system" for protection - obviously the "buddy" is equally susceptible to asphyxiation if he or she enters the area to assist the unconscious partner unless equipped with a portable air supply. Best protection is obtainable by equipping all individuals with a portable supply of respirable air. Life lines are acceptable only if the area is essentially free of obstructions and individuals can assist one another without constraint.

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

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

Oxygen Cleaning

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

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

Oxygen Enriched Atmospheres

An oxygen-enriched atmosphere occurs whenever the normal oxygen content of air is allowed to rise above 23.5%. While oxygen is nonflammable, ignition of combustible materials can occur more readily in an oxygen-rich atmosphere than in air; and combustion proceeds at a faster rate although no more heat is released.

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

Oxygen system components, including but not limited to, containers, valves, valve seats, lubricants, fittings, gaskets and interconnecting equipment including hoses, shall have adequate compatibility with oxygen under the conditions of temperature and pressure to which the components may be exposed in the containment and use of oxygen. Easily ignitable materials shall be avoided unless they are parts of equipment or systems that are approved, listed, or proven suitable by tests or by past experience.

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

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

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

Nitrogen and Argon

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

Nitrogen and argon vapors in air dilute the concentration of oxygen necessary to support or sustain life. Inhalation of high concentrations of these gases can cause anoxia, resulting in dizziness, nausea, vomiting, or unconsciousness and possibly death. Individuals should be prohibited from entering areas where the oxygen content is below 19% unless equipped with a self-contained breathing apparatus. Unconsciousness and death may occur with virtually no warning if the oxygen concentration is below approximately 8%. Contact with cold nitrogen or argon gas or liquid can cause cryogenic (extreme low temperature) burns and freeze body tissue.

Persons suffering from lack of oxygen should be immediately moved to areas with normal atmospheres. SELF-CONTAINED BREATHING APPARATUS MAY BE REQUIRED TO PREVENT ASPHYXIATION OF RESCUE WORKERS. Assisted respiration and supplemental oxygen should be given if the victim is not breathing. If cryogenic liquid or cold boil-off gas contacts worker's skin or eyes, the affected tissue should be flooded or soaked with tepid water (105-115ºF or 41-46ºC). DO NOT USE HOT WATER. Cryogenic burns that result in blistering or deeper tissue freezing should be examined promptly by a physician.

Personal Protective Equipment (PPE)

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

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

Introduction

Product Description

Primary Manifold

Consists of one microbulk cryogenic main header running from the bulk storage tank. This header should have sufficient flow capacity for an average day's supply. Header is connected to a final line regulating manifold consisting of two regulators in parallel that can each be isolated without interrupting the flow of gas into the medical facility. The manifold also has a pressure relief system on a diverter valve installed downstream of the connection of the reserve header and upstream of the final line pressure regulating assembly and is set at 50% above the nominal inlet pressure. Another pressure relief is installed on the downstream side of the pressure regulators on a diverter valve and set at 50% above the outlet pressure. There are pressure indicators on both the high pressure side and the low pressure side of the final line regulators.

Reserve Manifold and Backup Storage Supply

The reserve manifold and backup storage consists of a secondary supply of product from high pressure cylinders with the header connected to the primary manifold assembly in such a manner that either header can supply the system. When the primary header is supplying the system, the secondary or reserve header is prevented from supplying the system based on a pressure differential between the two headers. The reserve manifold requires a sufficient number of gas cylinder connections for an average day's supply, but not fewer than three, connected upstream of the final line pressure regulators. A header shutoff valve must be located downstream of the nearest cylinder connection, but upstream of the point at which the header connects to the central supply system. A check valve is required at each connection to the cylinder lead.

Primary Storage Tank

Normally a 1000-3000 liter top and bottom (FlexFill™ Piping Option) style Perma-Cyl tank. See PN 20930593 Perma-Cyl w/FlexFill Piping Option Manual for details on the proper operation of the storage tank. See Appendix 5 - MicroBulk Skid Tank Sizing Specifications for System Specifications on the various size MicroBulk tanks.

Pre-Installation
(see Appendix 4 Installation Checklist)

Note: *At a minimum the site should be secured in accordance with the requirements of the local jurisdiction. When there is no specific requirements, the site needs to meet the minimum requirements found in NFPA 55, NFPA 99 and CGA M-1.*

- If required, the equipment that will be installed at medical facilities shall be approved by the Authority Having Jurisdiction (AHJ), the owner, and the Design Professional of Record (DPOR). Only approved equipment shall be used.
- If a temporary gas system is required, the owner shall contract with a third party for that service.
- The supervising technician shall establish contact with the medical facility personnel to clarify the point of contact who will become the person informed regarding the installation plan. By doing this, it allows the facility personnel to provide notice to all affected departments and personnel so they are aware of the activity and they can take appropriate actions.
- Depending on the size of tank that is on the medical skid, it may arrive on-site inside a trailer or on a flatbed truck. The skid can be unloaded with either a forklift (minimum of 6000 lb with 6' fork extensions) or a small crane.
- Visually inspect the receiving paperwork from the manufacturer (new tank) to ensure the tank is the correct product and MAWP.
- Visually inspect the concrete pad and the paperwork (e.g. drawings) to verify that it is suitable for installation of the MicroBulk skid.
- When picking up the skid with a crane, pick up the skid using the four lift points on each corner of the frame (see Figure 1). DO NOT PICK UP THE ENTIRE SKID WITH THE LIFTING LUGS FOUND ON THE TOP OF THE PERMA-CYL STORAGE TANK.

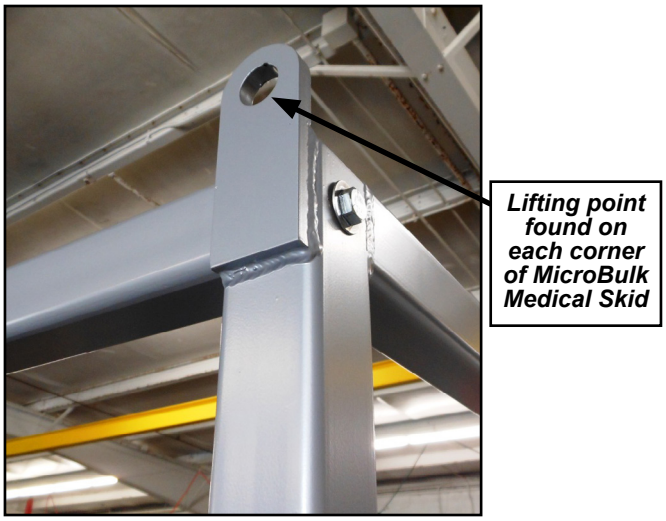


Figure 1 - Lifting points

- Place the skid on the concrete pad in the proper orientation.
- Remove the protective wrapping from the skid and inspect for the following:
  - No visible damage to the outer shell of the liquid storage tank.
  - Check the plumbing on the storage tank for any visible signs of damage.
  - Check to ensure there is still a positive pressure with nitrogen on the tank.
  - Check the piping on both manifolds for any visible signs of damage.
  - If the skid passes all the above criteria, it is ready to set up and first fill.
- Anchor the skid (see Figure 2) to the concrete pad with either chemical adhesive type anchors or wedge anchors. Anchors should be a minimum of ½ inch or as dictated by the local codes or the DPOR.

Figure 2 - Anchoring the skid

- Install any extended fill assembly (if required) and connect to the bulk tank(s). The fill assembly should not be more than 25 feet from the tank and have a clear line of sight to the liquid level and pressure gauges, and clear access for the driver of the molecule provider.
- If the extended fill assembly is more than 25 feet and/or there is no clear line of sight, an additional liquid level gauge and pressure gauge shall be located at the fill point for all bulk and MicroBulk tank installations. If the driver cannot safely access the bulk tank, a remote filling system should be engineered and installed (include valves, PRV(s) and gauges to safely fill the tank). If the tank is located more than 25 feet from the delivery unit, a remote filling system should be considered.

Initial Setup

- The awning covers for the manifolds on each side of the skid are folded down and bolted in place during shipment (see Figure 3). Remove the bottom bolts that are holding the awning in place and swing the awning up into position. Replace the bolts to hold the awning in the proper position (see Figure 4).

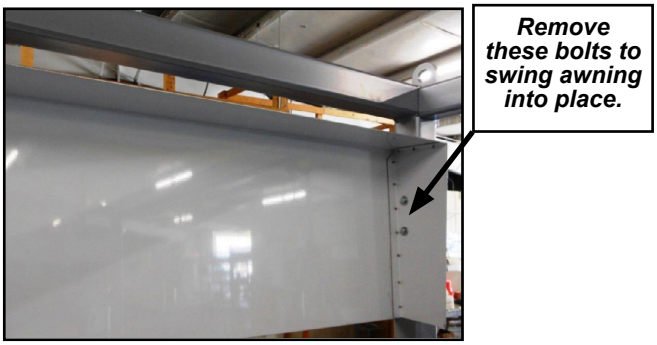


Figure 3 - Removing bolts on awning

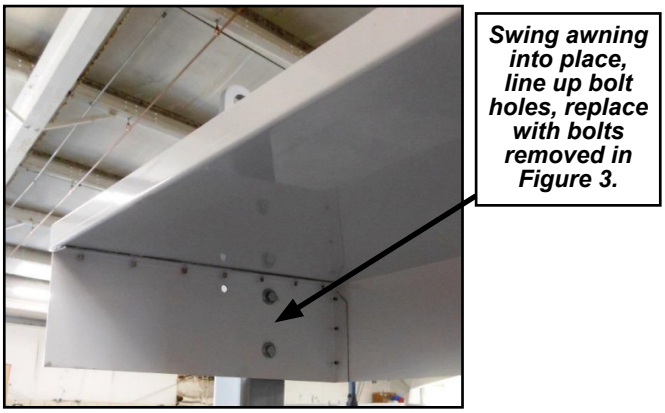


Figure 4 - Replacing bolts on awning

- Metal grating for the high pressure cylinders is shipped with the grating folded up and secured in place with tie wraps (see Figure 5). Cut the tie wraps and lower the metal grating. This grating will be used to keep the high pressure cylinders off the ground.

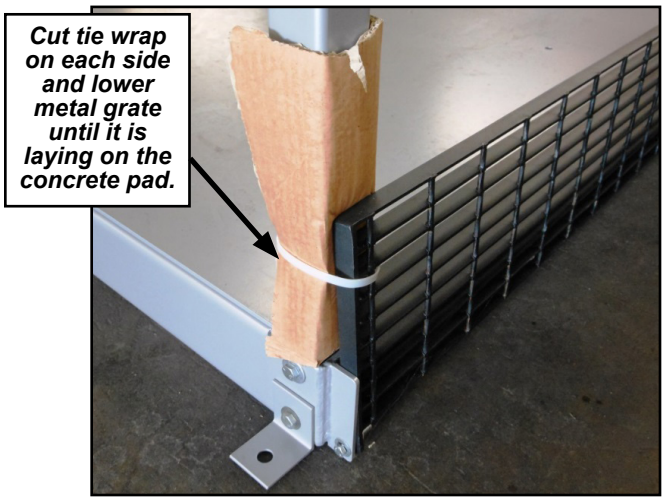


Figure 5 - Installing metal grating

- Install the appropriate number of high pressure cylinders onto the skid and secure them in place with the provided chain restraints (see Figure 6). Do not connect the cylinders to the manifold at this time, but inspect them for the following:
  - Cylinders must meet DOT testing requirements
  - Cylinders must have proper labels and lot number stickers
  - Cylinders must be chained and supported from turning over
  - Cylinders need to be on the metal grating
  - Common DOT test dates, common lot numbers, new and freshly painted cylinders should be installed.

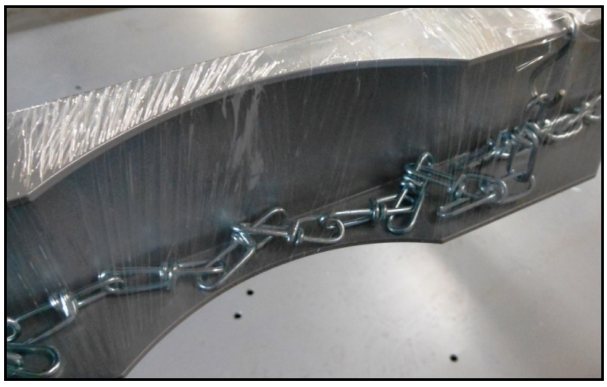


Figure 6 - Chain restraints to secure cylinders

- A qualified electrician hired by the owner should tie in the alarms from the medical facility alarm panel to the medical skid. All medical skids are equipped with a central termination point for all alarms (see Figure 7).

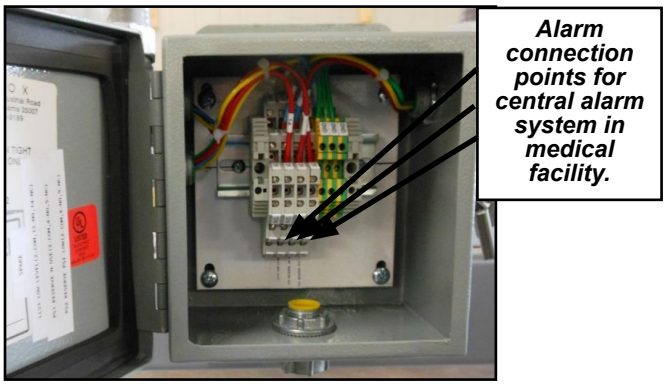


Figure 7 - Alarm connection points

- If the medical skid is equipped with a local signal alarm panel (see Figure 8), termination points CR1, CR2, and CR3 are located inside the panel. (See Appendix 3, Alarm panel electrical schematic) Panel also requires a dedicated 120 VAC, 20 amp circuit that is also connected to the facility back up electrical generator. Control power source for the local alarm relays shall be independent of any of the master alarm panels.

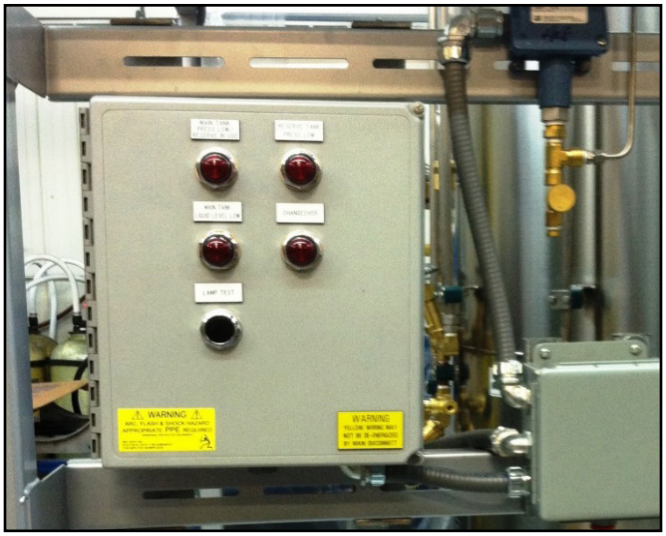


Figure 8 - Optional local signal alarm panel

Installation

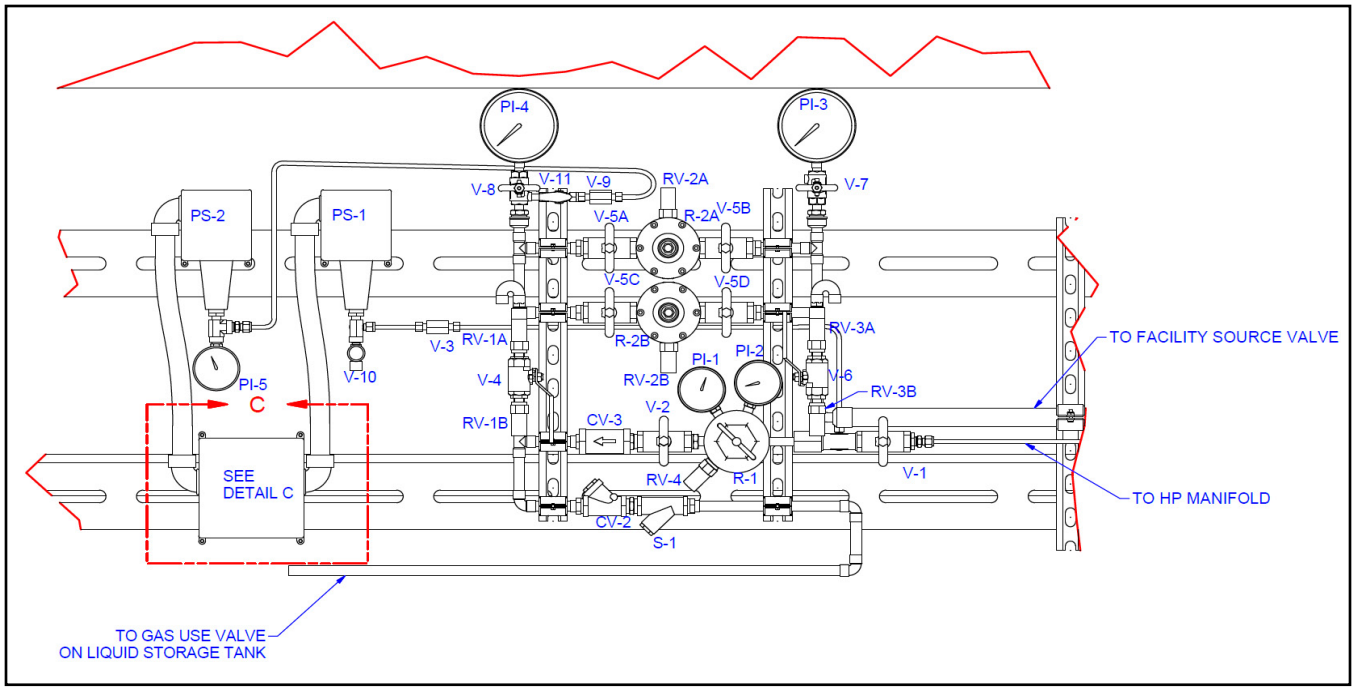


Figure 9 - Final Line Pressure Manifolds

Note: *Installation and commissioning of this Medical MicroBulk Skid should be done by personnel qualified to meet the mandatory requirements of CGA M-1 or ASSE 6015.*

- Make sure all the valves are closed (Gas use valve on tank, see Appendix 6 Perma-Cyl Spec Drawings, all V-5s, V-1 and V-2) (see Figure 9).
- The line on the skid that will be tied into the facility source valve is capped (see Figure 10). Before attempting to remove the cap, blow down any pressure that might be on the line. To do this, close the pressure gauge isolation valve (V-7) on (PI-3) (see Figure 11). Remove the 1/8 inch brass plug (see Figure 11) and open valve (V-7) to relieve all the pressure on the line as verified on (PI-3). Leave the brass plug out for use as purge port if requirement is to silver solder the final tie in piping in place.

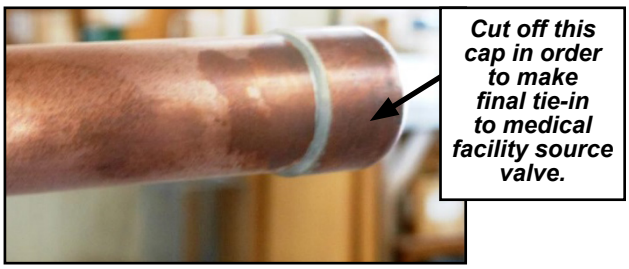


Figure 10 - "Remove 1" source line cap

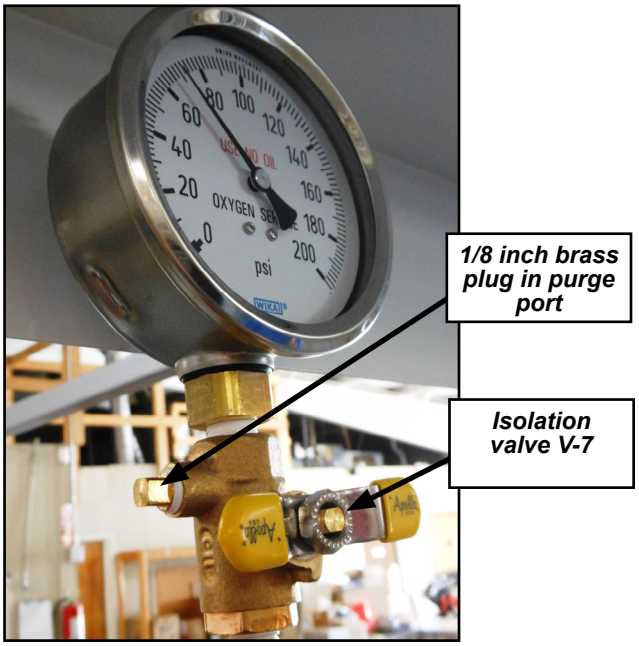


Figure 11 - Location of purge port and valve (V-7)

- Cut the cap off of the 1" copper pipe using a tubing cutter (see Figure 10). Do not ream; deburr using a clean, sharp deburring tool.
- Use a nylon abrasive pad (typically maroon or green) to lightly clean the tube ends to remove all oxidation and surface soils. Wipe off with a clean lint free cloth.

- Recommend using pre-cleaned type L or type K hard drawn copper seamless pipe meeting the requirements of ASTM B-819 to make this tie-in. Copper pipe can either be brazed in place or it can be installed with fittings meeting the requirements on NFPA 99.
- If brazed in place, dry fit the pipe using the appropriate flux dependent on the brazing filler metal. Brazing is permitted on copper to copper joints on the gas side of the system using BCuP brazing filler metal without flux.
- Brazing must be completed under an NF nitrogen purge by personnel qualified in accordance with ASME Section IX certifications, until the joint is cool to the touch. Use 1/8 inch port above valve (V-7) (see Figure 11) for purging and/or the purge port on the upstream side of the source valve if so equipped (see Figure 12).

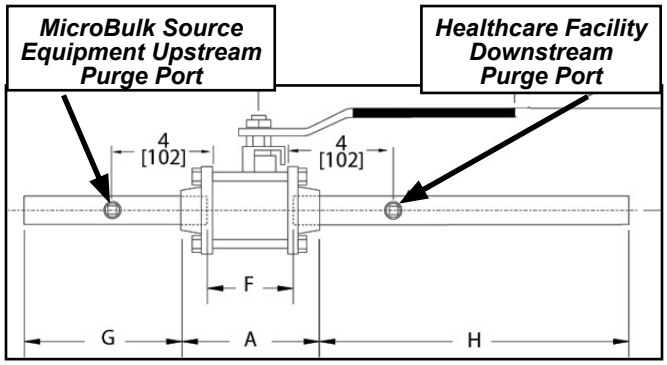


Figure 12 - Purge Ports on Source Valve

- Brazed component should be allowed to cool to a warm condition. Clean joint with a wire brush.
- Visual inspection of the entire piping system shall be completed while the source valve remains in the closed/ locked-out position.

System Pressure Testing

(shall be witnessed by the AHJ or third party verification)

Note: *All third party medical verifiers should be ASSE 6035 certified.*

- The entire MicroBulk Medical Skid has been pressure tested per the provided QC inspection checklist (see Appendix 1) at the factory. Unless dictated otherwise by the third party verifier, the only requirement is to pressure check the final piece of pipe that was installed to tie the skid into the source valve.
- Have available an NF nitrogen source and regulator with accurate pressure gauge near the piping system.
- Complete connections to the MicroBulk source equipment upstream of the purge port with proper pressure rated, oxygen cleaned hose and fittings.
- Remove and plug the active safety (RV-3A or 3B) (see Figure 9) on the main gas outlet three way valve (V-6) and insure that valves (V-5A-D) and (V-7) are closed.

Note: *Lock out source valve prior to introduction of nitrogen for pressure testing.*

Warning! ***Connection is being made to the upstream purge port. Verify that the connection is upstream of the source valve.***

- Pressure up main gas supply line through the upstream purge port of the facility source valve if so equipped (see Figure 12). Pressurize system to a minimum of 1.5 times the normal working pressure (see Appendix 2, table 1, Primary Reg-R2) and hold pressure for 10 minutes while leak checking each joint with an approved leak detection method.
- Open (V-7) and bleed pressure off of line through the 1/8 inch purge port. Replace plug in purge port above (V-7) and the plug in the upstream purge port of the source valve.

Tank and System Piping and Purging Process

After the third party verification process is complete for the system piping, the system purging process is started.

Pre-Fill Inspection

- Re-inspect all tank fittings, connections, and extended fill assemblies (if required) to ensure the components are clean and suitable for medical service, both in terms of pressure and product compatibility.

Note: *Extended fill lines and fill assemblies shall be third party verified with NF nitrogen prior to filling the bulk tank with product.*

- Ensure that the product warning labels and other warning labels have been applied to the tank as required.
- Visually inspect that all valves positions are closed prior to starting the filling process.

Tank Purging (change of grade) and Filling Procedure
(See Appendix 6 for tank valve tag numbers)

Purging the Tank Prior to Filling

1. Attach the source of liquid purge to the fill connection of the Perma-Cyl tank.
2. If the fill hose has not been kept under pressure since the last delivery, it will need to be purged. Purge the fill hose and connector through the hose drain valve (V-3) on the tank piping until a light frost appears on the valve. Close the hose drain valve.
3. If the Perma-Cyl tank is pressurized, open the vent valve (V-9) and blow down to less than 5 psi. To prevent drawing atmospheric contaminants back into the tank during the purging operation, a positive pressure should be maintained in the tank.

First Fill Procedure

1. Partially fill the Perma-Cyl tank with product according to the Tank Fill Table (shown below). Use truck meter to verify the amount put into tank.

   Let liquid build pressure close to safety setting.

   While the vent gas is still warm and tank is under pressure, move the four-way valve (V-11) to the 'Equalization' position. Loosen the fittings on either side of the liquid level gauge to allow the gauge lines to purge with gas. Check the gas stream coming out of the fittings for evidence of moisture. Continue to flow the gas until lines have been purged and there are no visible signs of moisture. Tighten fittings to stop the flow of gas. Move the four-way valve to the 'Normal Operation' position. When liquid is out of the tank and pressure is still high, open the vent valve (V-9). Before blowing remaining pressure out of the vent valves, this would be a good time to leak check all connections that are under pressure.

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

Tank Fill Table			
Tank Size	**Amount of Product**	**Oxygen (gal)**	**Nitrogen (gal)**
1000 L	2000 standard cubic feet	17	21
1500 L	3000 standard cubic feet	26	32
2000 L	4000 standard cubic feet	35	43
3000 L	5000 standard cubic feet	43	54

2. Fill Perma-Cyl tank with product as indicated in the Tank Fill Table. Primarily use the bottom fill (V-5) on a FlexFill™ Piping Option tank. Make sure some product is routed through the top fill lines (V-6) to purge them prior to totally filling the tank.

   Open the PB circuit and set to maximum psi. Insure liquid is flowing through this circuit as indicated by frosting on the pipes. Let liquid in the tank build pressure close to safety setting. Once desired pressure is reached, open liquid valve (V-4). When liquid is out of the tank and pressure is still high, open the vent valve (V-9).

   Once pressure is less than 5 psig, close the liquid (V-4) and vent valves (V-9). Maintain positive pressure on the tank.

3. Fill the Perma-Cyl tank with product (per Tank Fill Table) and let the liquid in the tank build pressure close to the safety setting. Remove safety in economizer unit and ensure the product is flowing through the economizer regulator and purging the economizer lines. Control the pressure by opening the vent valve (V-9). Once pressure is less than 5 psig, close the vent valve (V-9). Maintain a positive pressure on the tank.
4. Fill the Perma-Cyl tank with product (per Tank Fill Table) and let the liquid in the tank build pressure to close to the safety setting. Once the desired psig has been reached, open the vent valve (V-9). Once pressure is less than 5 psig, close the vent valve.

Note: *The purge gas should be cooling the tank. If the tank vent line is HOT, always purge until the vent line is cool or even frosted.*

Note: *While venting down the tank each time, ensure a positive pressure remains on the tank to keep ambient air from flowing back into the tank and contaminating the product.*

Filling the Tank After the Cool Down Process is Complete

1. If equipped with a bottom fill valve (V-5), the bottom fill valve and the tank vent valve (V-9) are the valves to be used to fill the tank.
2. Have the driver start the pump and slowly deliver the liquid into the tank. Observe the tank pressure and control the pressure by venting the tank down or using the top fill valve (V-6) to control the pressure.

3. As the filling proceeds and the tank gets cooler, you should be able to pinch off and, in some cases, close the vent valve (V-9). We recommend that you do not fill the tank to the full trycock (V-9) on the first fill. Fill to 80% in order to allow for liquid expansion as the tank contents absorb heat while the metal continues to cool down over time.

   Insure that PB and economizer regulators are properly set. For medical oxygen installations, tank should be set at 125 psig. For medical nitrogen installations tank should be set at 220 psig.

System Purging

Refer to Figure 9 for valve references in the following procedure.

Note: *The following instructions give details on alarm and regulator set points for the standard oxygen microbulk medical skids. Set points for nitrogen and hyperbaric oxygen skid models can be found on spec drawing D-20810866 in Appendix 2.*

- Connect the pigtails on the high pressure manifold to the high pressure tanks (see Figure 13). Do not over tighten the connection nuts on the pigtails (see Figure 14). This will cause the fitting to distort and leak. Be sure the valve V-1 is closed and then slowly open the valves on each tank listening for any leaks. Check each tank connection using an approved leak detection method.

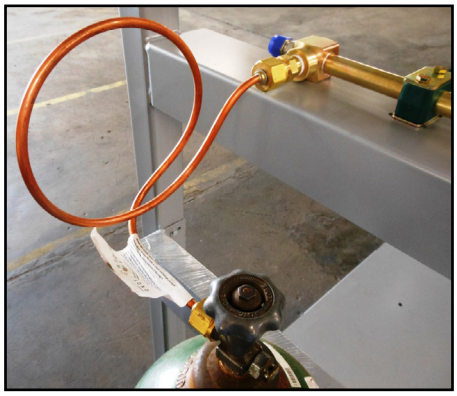


Figure 13 - Pigtail connections

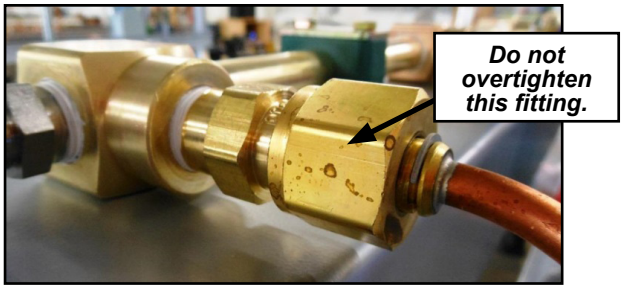


Figure 14 - Connection nuts on pigtails

- Open V-2, all V-5s, V-8 (refer to Figure 9)
- Close V-7 and remove the 1/8 inch plug in the purge port above valve V-7. Reopen V-7.
- Slowly open V-1 to allow pressure to flow through R-1. Insure that the pressure on PI-1 reads 65 psig. (recommended pressures for nitrogen skids and hyperbaric oxygen skids can be found on spec drawing D-20810866 in Appendix 2) If pressure is incorrect, adjust regulator R-1 and then close V-7 and V-2.
- Ensure valves V-10 & V-11 (see Figure 15 & 16) are closed and slowly open valve V-2.
- Remove plug from V-10 valve (see Figure 15) and slowly open the valve in order to purge the short instrument line with oxygen.

Note: *The purge valve below pressure switch PS-1 is directly connected to the high pressure oxygen cylinders. Use extreme caution when opening this valve.*

Once V-10 valve is "burped" with oxygen flow, close the valve and replace the plug.

- Open valve V-11 (see Figure 16) to apply pressure to PS-2 and PI-5. Close valve V-11 and allow pressure to exhaust out of the downstream purge port on the valve. Repeat this process of opening and closing V-11 three to four times in order to purge the instrument line. After purging line, leave valve V-11 open.

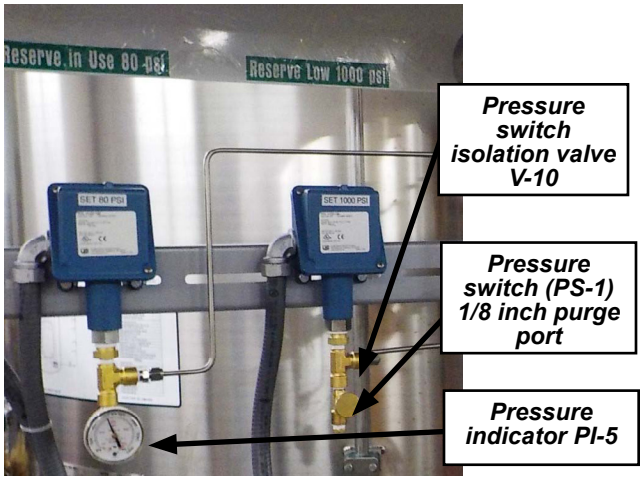


Figure 15 - Pressure switch isolation valves

- Close valve V-1.
- If the source valve has an upstream purge port, open V-7 and bleed all the pressure off the manifold and replace purge port plug above V-7. Open upstream purge port on source valve. If the source valve does not have an upstream purge port, use the purge port above V-7 to complete the remaining purge steps below. SOURCE VALVE SHOULD REMAIN LOCKED OUT.

- Slowly open gas use valve on tank (see Appendix 6 Perma-Cyl Spec Drawings).

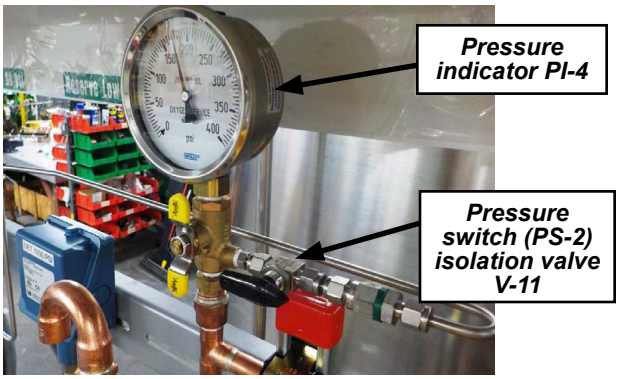


Figure 16 - Pressure valves

- Source gas should now be flowing throughout the entire manifold and out the purge port. Insure that both regulators R-2A & B (see Figure 9) are adjusted to 50-55 psig (or as called out in spec drawing D-20810866 for other model skids in Appendix 2).
- Continue purging the entire system with the source gas. When purging with oxygen as the source gas, recommend using an oxygen analyzer at the purge port to verify when the purge is complete.
- Once purge is complete, cut back purge gas with the gas use valve on the Perma-Cyl tank and replace the plug in the port that was being used for purging.
- Completely open gas use valve on Perma-Cyl tank and leak check all fittings all the way to the source valve using an oxygen approved leak detection method.

Alarms

The third party verifier shall confirm the status of all alarms to the facility and note on their report. All alarms listed below shall be available at time of installation.

- Installer is responsible for verifying the alarm switches at the medical MicroBulk supply system.
  - The medical facility is responsible for maintaining the alarm system, proper power supply (if required), all alarm wires/wiring to their system, monitoring of their system operation, testing and to respond to any alarm conditions at their facility.
- All visual alarm switches shall function at the required set points and be documented.
- The MicroBulk supply system shall initiate an alarm signal at the required master alarm panel(s) under the following conditions:

Local Alarm Name	Condition
Liquid Low Level	When or at a predetermined set point before the main supply reaches an average days supply, indicating main liquid level low. If the use criteria is unknown the alarm level shall be set no less than 25% full trycock.
Tank Pressure Low - Primary (Reserve in Use)	When or at a predetermined set point (see table on spec drawing D-20810866 in Appendix 2) before the main supply reaches an internal pressure too low for the main tank to operate properly, indicated by reserve in use.
Tank Pressure Low - Reserve	When or at a predetermined set point (1000 psig) before the reserve high pressure cylinder bank pressure reaches an internal pressure that indicates it has less than a one day supply of backup product for the medical facility.

Note: *All alarm switches are preset and labeled at the manufacturer as recorded in the table spec drawing D-20810866 in Appendix 2. If the switches need to be adjusted, refer to the following procedures.*

Primary Tank LL Switch

- After the tank has been purged and filled, open the panel where all the alarms are terminated (see Figure 17).

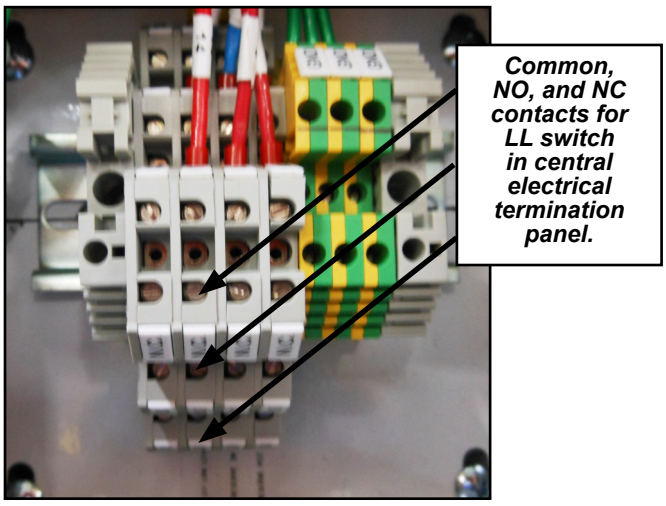


Figure 17 - Central electrical termination panel

- Connect an ohm meter to the common and either the normally open or normally closed connection points on the terminal strip.
- Slowly turn the 4-way valve above the LL gauge to the equalization position and watch the gauge needle begin to fall.
- When the switch changes contact points, it will be apparent on the ohms meter. At this point, take note of the inches reading on the gauge.
- To adjust the alarm set point, use the adjustment tool found on the electrical connection of the switch, push in and turn the alarm switch indicator to the appropriate inches level (see Figure 18).

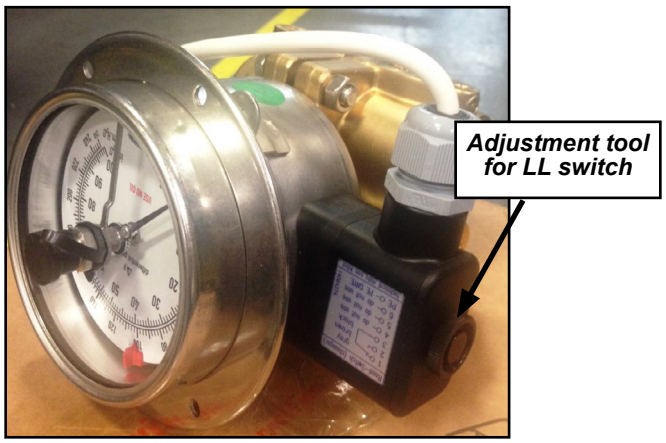


Figure 18 - LL switch adjustment tool

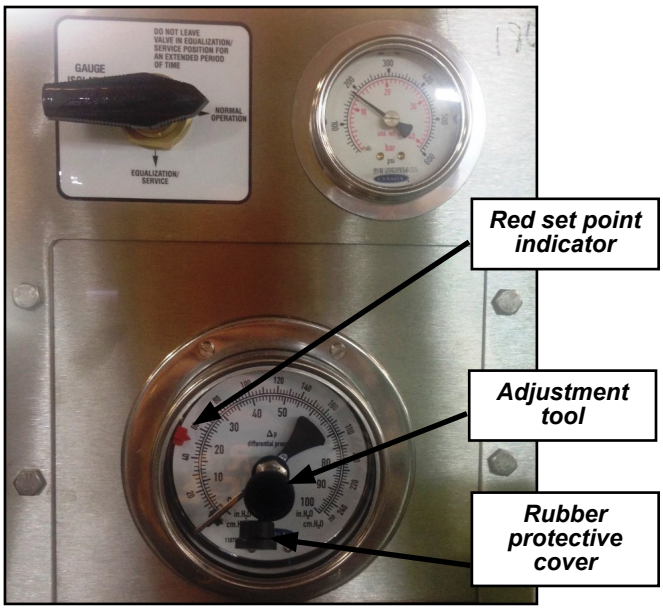


Figure 19 - LL gauge identification

- Put the 4-way valve back into normal operation and repeat the test until the desired reading is established.
- Log the reading on the appropriate paperwork.

Note: *Alarm set point is dictated by the facility usage. A minimum of one day's average supply is required, but additional supply may be required if supply distance or weather conditions dictate.*

Reserve Low - PS-1

- Remove cover from pressure switches.
- Remove plug from the purge valve found at the bottom of the switch (V-10) (see Figure 15).
- Loosen phillips screw adjustment lock (see Figure 20).
- Connect an ohm meter to the common and either the normally open or normally closed connection points on the wiring terminals.
- Ensure that the current pressure on the switch is above the set pressure desired as verified by pressure indicator PI-2.
- Close pressure source for the switch by closing valve V-1 to isolate PS-1.
- Slowly open the purge valve under the pressure switch and watch the pressure indicator gauge start to fall.
- When the switch changes contact points, it will be apparent on the ohms meter. At this point, take note of the pressure reading on the gauge.
- To adjust the set point on the pressure switch, turn the 5/8" hex adjustment clockwise to raise set point, or counter clockwise to lower set point (see Figure 20).
- Apply pressure back to switch by closing the purge valve (V-10) and opening valve V-1 and repeat the test until the desired reading is established.
- If the switch settings have changed, insure that new labels are put on the switches and recorded on the appropriate installation documents.

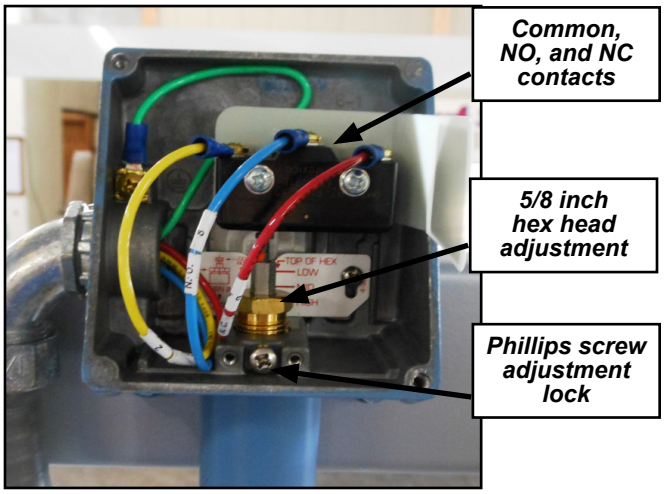


Figure 20 - Setting PS-1 or PS-2

Reserve In Use - PS-2

- Remove cover from pressure switches.
- Open valve V-11 (see Figure 16).
- Loosen phillips screw adjustment lock.
- Connect an ohm meter to the common and either the normally open or normally closed connection points on the wiring terminals.
- Ensure that the current pressure on the switch is above the set pressure desired as verified by pressure indicator PI-4.
- Slowly close valve V-11 which isolates PS-2 and vents the downstream pressure. Watch the pressure indicator PI-5 start to fall as downstream pressure is vented to atmosphere.
- When the switch changes contact points, it will be apparent on the ohms meter. At this point, take note of the pressure reading on the gauge.
- To adjust the set point on the pressure switch, turn the 5/8" hex adjustment clockwise to raise set point, or counter clockwise to lower set point.
- Apply pressure back to each switch by opening the isolation valve (V-11) and repeat the test until the desired reading is established.
- If the switch settings have changed, insure that new labels are put on the switches and recorded on the appropriate installation documents.

Operation

Start-Up

The Source Valve Shall Remain Locked Out At This Point

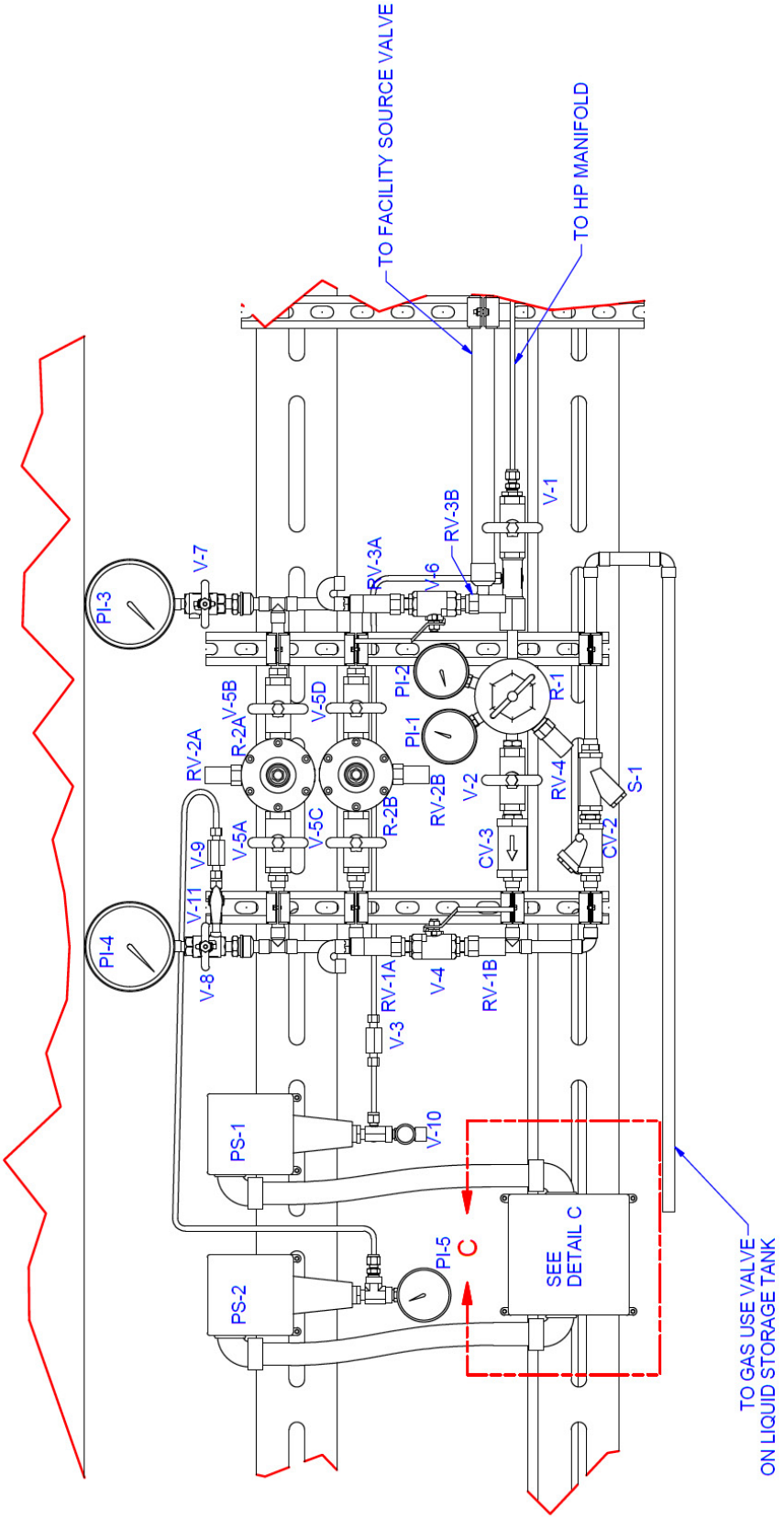
- Visual inspection of all installed equipment - confirm with installation checklist
  - Ensure equipment is anchored per the approved construction documents.
  - System piping is connected and the tie-in location and product flow paths are correct.
  - PRV(s) are installed correctly on risers, pointed down and installed between all points of isolation to prevent trapping liquid or cold gas.
  - Valves are correct type for the source product, correct MAWP, flow arrows are correct.
  - All joints that require silver brazing are complete.
  - All mechanical fittings are correct type, correct MAWP and properly tightened per the manufacturers requirements.
  - Piping system support stands are properly installed, anchored and pipe clamps are the correct size and tightened.
  - Proper labeling on pipe / tubing that meet requirements of NFPA 99.
  - System is completely installed and connected to customer source valve - which remains in the "locked" position.
- Verify or adjust the tank controls to operate in the proper ranges. Set the PB and economizer regulators per the table on spec drawing D-20810866 found in Appendix 2.
- Perform a visual and audible inspection for any leaks, pipe movement, and PRV(s) leaking or other installation concerns while the system is pressurized.
- Verify all gauges are labeled and reading correctly. This includes the bulk tank liquid level gauge, pressure gauge and medical final line pressure gauges.
- Establish flow in the system by creating an opening at the customer source valve purge port for final system purging.
- Re-verify the system regulators are set for customer required gas pressure, verify inlet/outlet pressure gauge readings and adjust the bulk tank regulators as required to balance the system.
- After testing and setting, open both the inlet and outlet isolation valves on both the primary and secondary regulators.
- Review all other manufacturers' manuals and start-up requirements.

System Verification and Commissioning

- Before commissioning and during the start-up procedure:
  - The system needs to be tested in accordance with the requirements of NFPA 99 and the USP/NF Compendia requirements for the product being delivered. Keep a copy of this document.
  - The functionality of the system shall have been verified by the third party verifier.
  - All alarms have been verified by the third party verifier and reviewed with onsite maintenance personnel.
- A final visual inspection of the system shall be completed and reviewed with the owner, inspector(s) and any third party testing agencies.
- Review the third party paperwork and verify the system testing is completed with both the third party verifier and medical facility personnel.
- Confirm that the system is ready to commission with the facility personnel and all signatures are completed on the appropriate documentation.
- When approved, the source valve can be opened by the responsible facility authority or their representative. Make sure the representative SLOWLY opens the source valve.
- Once the source valve has been completely opened, re-verify the regulator settings under normal flow conditions while supplying the medical facility.
- Insure the appropriate owner personnel are trained on operation of the new system, how to handle alarm conditions and any emergency conditions with the system (see Chart Medical MicroBulk training package).

Illustration & Parts Listing

Final Line Pressure Manifolds Illustration



Parts Listing

Oxygen Skid Parts				
Item	**Description**	**Manufacturer**	**PN**	**Qty**
V-1	HIGH PRESS SUPPLY ISO VALVE	REGO 1/2" 9560CA MASTER VALVE	HP9560CA	1
V-2	HIGH PRESS SUPPLY REG ISO VALVE	APOLLO 1/2" BALL VALVE W/UNION END	70-303-07-57	1
V-3	EXCESS FLOW VALVE FOR PS-1	SWAGELOK 1/4"	SS-XSS4-SC11	1
V-4	MAIN GAS INLET SAFETY 3-WAY VALVE	APOLLO 1/2" 3-WAY BALL VALVE	70-603-57	1
V-5A-D	GAS SUPPLY REGULATOR ISO VALVE	APOLLO 1/2" BALL VALVE W/UNION END	70-303-07-57	4
V-6	MAIN GAS OUTLET SAFETY 3-WAY VALVE	APOLLO 1/2" 3-WAY BALL VALVE	70-603-57	1
V-7	0-200 PSI PRESSURE GAUGE ISO VALVE	APOLLO 1/4" BALL VALVE w/1/8" SIDE PORTt	7B-101-01-07	1
V-8	0-400 PSI PRESSURE GAUGE ISO VALVE	APOLLO 1/4" BALL VALVE w/1/8" SIDE PORT	7B-101-01-07	1
V-9	EXCESS FLOW VALVE FOR PS-2	SWAGELOK 1/4"	SS-XSS4-SC11	1
V-10	PRESSURE SWITCH PURGE VALVE	SUPERIOR 1/4" MNPT x 1/4" FNPT 3000 PSI VALVE	V335	1
V-11	PRESSURE SWITCH ISOLATION VALVE	SWAGELOK SS 40G SERIES VENTED VALVE	SS-42G-VS4	1
CV-1	HIGH PRESSURE BTL OUTLET CHECK VALVE	WESTERN B-52 CGA540 1/2"	A593CV	4-16
CV-2	PRIMARY TANK INLET CHECK VALVE	UNITED BRASS 1/2” SWING CHECK VALVE PTFE SEAT	199364	1
CV-3	HIGH PRESSURE INLET CHECK VALVE	APOLLO 1/2” SPRING LOADED CHECK VALVE	811-F-103-01	1
RV-1 A&B	MAIN GAS INLET RELIEF VALVE	REGO 1/2 NPT 350 PSI	PRV 9434TP350	2
RV-2 A&B	THERMAL RELIEF VALVE FOR R-2	REGO 1/4 NPT 350 PSI	PRV 9432TP350	2
RV-3 A&B	MAIN GAS OUTLET RELIEF VALVE ASME	REGO 1/2 NPT 75 PSI	PRV 9434F75	2
RV-4	HIGH PRESSURE REGULATOR RELIEF VALVE	REGO 1/4” NPT 350 PSI	PRV 9432TP350	1
S-1	MAIN GAS LINE INLET STRAINER	TITAN FLOW CONTROL 1/2” Y STRAINER 100 MESH	210781	1
R-1	HIGH PRESSURE SUPPLY REGULATOR	VICTOR HIGH PRESSURE REGULATOR	SR 450D 540	1
R-2 A&B	MAIN GAS SUPPLY REGULATOR	REGO 1/2" 40-110 PSI MEDICAL REGULATOR	BR1784B	2
PI-1	PRESSURE GAUGE 0-200 PSI	VICTOR 1/4 NPT	1424-0039	1
PI-2	PRESSURE GAUGE 0-4000 PSI	VICTOR 1/4 NPT	1424-0057	1
PI-3	PRESSURE GAUGE 0-200 PSI	WIKA 1/4 NPT (4"DIAL)	50994507	1
PI-4	PRESSURE GAUGE 0-400 PSI	WIKA 1/4 NPT (4"DIAL)	4331044	1
PI-5	PRESSURE GAUGE 0-400 PSI	WIKA 1/4” x 2” CENTER BACK MOUNT	50786911	1
PS-1	RESERVE LOW PRESSURE SWITCH ALARM	UNITED ELECTRIC 80-1700 PSI PRESSURE SWITCH	H100-194	1
PS-2	RESERVE IN USE PRESSURE SWITCH ALARM	UNITED ELECTRIC 15-300 PSI PRESSURE SWITCH	H100-192	1
PT	SINGLE LOOPED PIGTAIL	SUPERIOR	PT-4540	4-16

Substitute Parts for Nitrogen Service Skids				
Item	**Description**	**Manufacturer**	**PN**	**Qty**
CV-1	HIGH PRESS BTL OUTLET CHECK VALVE	WESTERN B-52 CGA580 1/2"	A603CV	4-16
RV-3 A&B	MAIN GAS OUTLET RELIEF VALVE	REGO 1/2 NPT 275 PSI	PRV9434FP275	2
R-2 A&B	MAIN GAS SUPPLY REGULATOR	REGO 1/2" 100-200 PSI MEDICAL REGULATOR	BR1784C	2
PI-1	PRESSURE GAUGE 0-400 PSI	VICTOR 1/4 NPT	1424-0046	1
PI-3	PRESSURE GAUGE 0-400 PSI	Wika 1/4 NPT (4"DIAL)	4331044	1
PT	SINGLE LOOPED PIGTAIL - NITROGEN	SUPERIOR	PT-4580	4-16

Substitute Parts for Oxygen Hyperbaric Skids				
Item	**Description**	**Manufacturer**	**PN**	**Qty**
RV-3A	MAIN GAS INLET RELIEF VALVE	REGO 1/2” 150 PSI ASME SAFETY	PRV9434FP150	1
RV-3B	MAIN GAS INLET BACK PRESS REGULATOR	REGO BACK PRESSURE REGULATOR	ECL-140	1
M-1	MUFFLER FOR BACK PRESS REGULATOR	PARKER LEGRIS CONNECTIC MUFFLER	CE70-00-13	1

Appendix 1 - Quality Control Form

Carolina Welding Services Inc.

CHART P/N _____

Final Line Quality Control Form 1.3

Chart

QC Manager Name: _____ Date: _____

Purchase Order Number # _____ Customer Name: _____

Chart Part Number: _____ Make of Regulators: _____

OXYGEN High Pressure Reserve Manifold: _____ Reserve Master Valve: _____

Size and Make of Dual Inlet Safeties: _____ PSI Model of Regulator: _____

Size and Make of Dual Outlet Safeties: _____ PSI Main Dual Inlet Valves: _____

Pressure Range of Regulator: _____ PSI Main Dual Outlet Valves: _____

Inlet Press. Gauge Range: _____ PSI Reserve Regulator: _____

Outlet Press. Gauge Range: _____ PSI Inlet Check Valves: _____

Control Pressure Tested To: _____ PSI Inlet Strainer: _____

High Pressure Manifold Tested To: _____ PSI CGA Pigtails & Manifold Adaptors: _____

Reserve In Use Switch Set To: _____ PSI Order Date: _____

Reserve Low Switch Set To: _____ PSI Dock Date: _____

Has a Continuity Test been completed on the Liquid Level Gauge :	YES		NO	
Has Control and Components Been Cleaned For Oxygen Service:	YES		NO	
Are All Oxygen Certification Papers Attached :	YES		NO	
Is Apperance Of Control Acceptable to QC Manager :	YES		NO	

Has an NF Nitrogen Test Been Completed :	YES		NO		N/A	
Has System been tested for Particulates:	YES		NO		N/A	
Does Tank - Control - Manifold Have a Postive Pressure:	Tank	psi	Control	psi	Manifold	psi

QC Manager Notes: _____

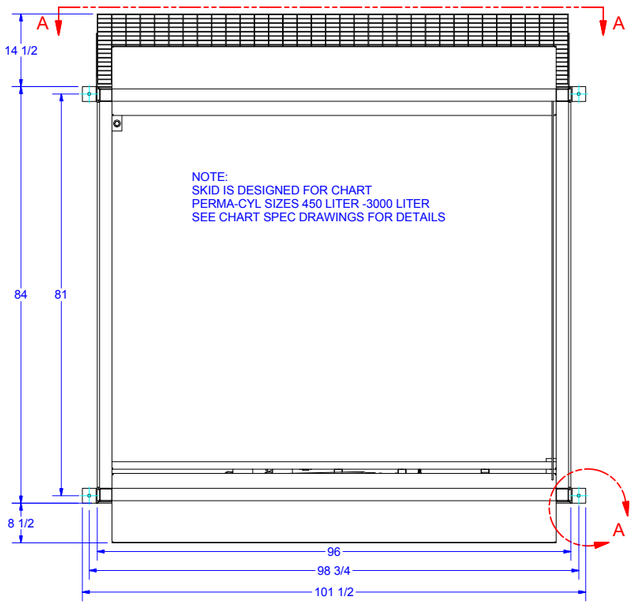
QC Signature: _____ Date of Approval: _____

Appendix 2 - Drawing D-20810866

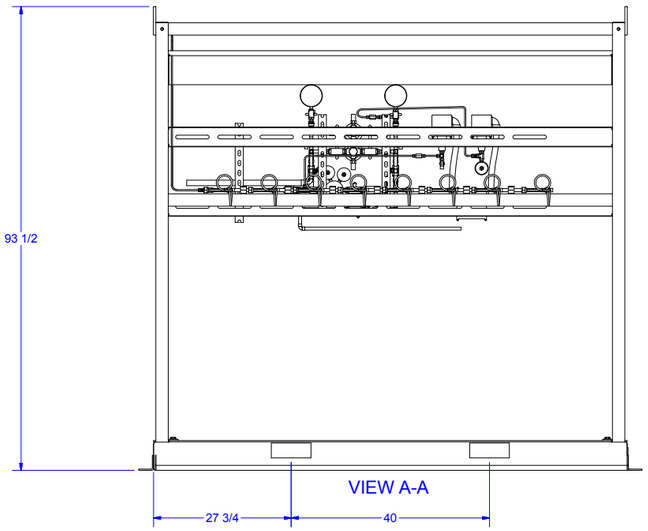
TABLE 1 - MEDICAL SKID PART NUMBERS AND SET POINTS						
PART NUMBER	DESCRIPTION	RESERVE IN USE PS2	RESERVE LOW PS1	PRIMARY REG-R2	RESERVE REG -R1	TANK PSI
20810864	MEDICAL MB 4 BOTTLE O2 SKID	80 PSIG (PI-4)	1000 PSIG (PI-2)	50 - 55 PSIG (PI-3)	65 PSIG (PI-1)	125
20810865	MEDICAL MB 6 BOTTLE O2 SKID	80 PSIG (PI-4)	1000 PSIG (PI-2)	50 - 55 PSIG (PI-3)	65 PSIG (PI-1)	125
20810866	MEDICAL MB 8 BOTTLE O2 SKID	80 PSIG (PI-4)	1000 PSIG (PI-2)	50 - 55 PSIG (PI-3)	65 PSIG (PI-1)	125
20891908	MEDICAL MB 12 BOTTLE O2 SKID	80 PSIG (PI-4)	1000 PSIG (PI-2)	50 - 55 PSIG (PI-3)	65 PSIG (PI-1)	125
20891909	MEDICAL MB 16 BOTTLE O2 SKID	80 PSIG (PI-4)	1000 PSIG (PI-2)	50 - 55 PSIG (PI-3)	65 PSIG (PI-1)	125
20810867	MEDICAL MB 4 BOTTLE N2 SKID	180 PSIG (PI-4)	1000 PSIG (PI-2)	170 - 175 PSIG (PI-3)	185 PSIG (PI-1)	220
20810868	MEDICAL MB 6 BOTTLE N2 SKID	180 PSIG (PI-4)	1000 PSIG (PI-2)	170 - 175 PSIG (PI-3)	185 PSIG (PI-1)	220
20810869	MEDICAL MB 8 BOTTLE N2 SKID	180 PSIG (PI-4)	1000 PSIG (PI-2)	170 - 175 PSIG (PI-3)	185 PSIG (PI-1)	220
20894778	MEDICAL MB 12 BOTTLE N2 SKID	180 PSIG (PI-4)	1000 PSIG (PI-2)	170 - 175 PSIG (PI-3)	185 PSIG (PI-1)	220
20894774	MEDICAL MB 16 BOTTLE N2 SKID	180 PSIG (PI-4)	1000 PSIG (PI-2)	170 - 175 PSIG (PI-3)	185 PSIG (PI-1)	220
20840682	SKID MMB 8HPBU HYPERBARIC O2	80 PSIG (PI-4)	1000 PSIG (PI-2)	65 PSIG (PI-3)	75 PSIG (PI-1)	125
20987482	SKID MMB 4HPBU HYPERBARIC 02	80PSIG (PI-4)	1000 PSIG (PI-2)	65 PSIG (PI-3)	75 PSIG (PI-1)	125

Table 2 - PRIMARY STORAGE TANKS		
PART NO.	DESCRIPTION	SPEC DWG.
20814390	PERMA-CYL 1000HP FF	20852345
20814391	PERMA-CYL 1500HP FF	20852342
20814392	PERMA-CYL 2000HP FF	20852343
20814394	PERMA-CYL 3000HP FF	20852344
20755351	PERMA-CYL 1000VHP FF	20852345
20755352	PERMA-CYL 1500VHP FF	20852342
20793147	PERMA-CYL 2000VHP FF	20852341
20793148	PERMA-CYL 3000VHP FF	20852350

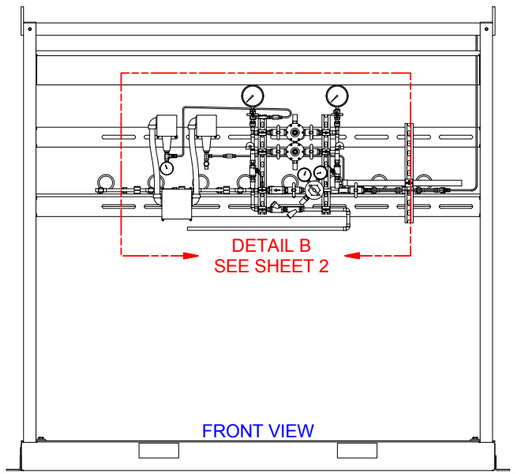
DRAWING NO D-20810866



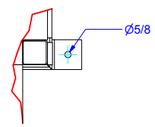
TOP VIEW



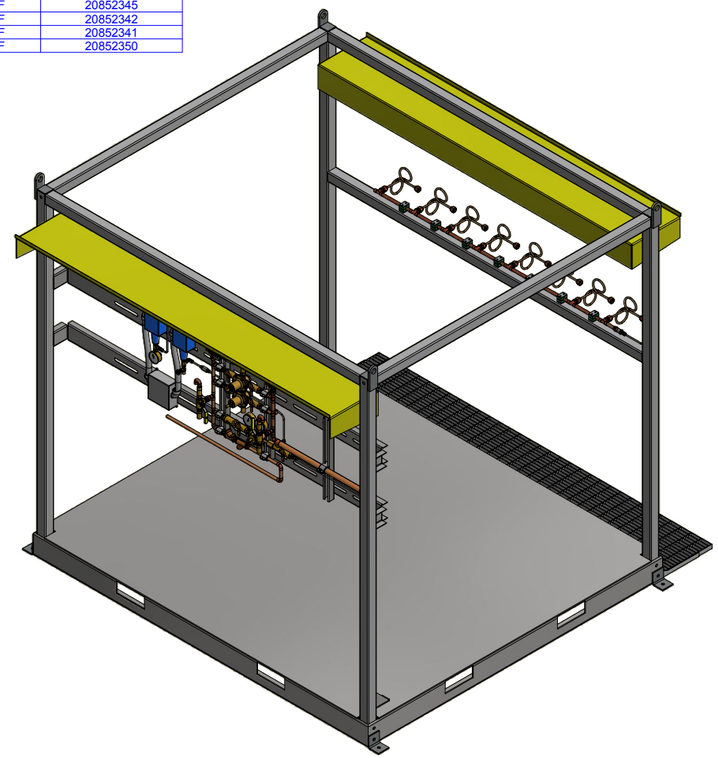
VIEW A-A



FRONT VIEW



DETAIL A



NOTES:
1. WEIGHT OF SKID; 1,100 LBS
2. ALL PIPING, VALVES, FITTINGS TO BE CLEANED FOR OXYGEN SERVICE
3. ALL BRAZING TO BE COMPLETED ONLY WITH 56% SILVER SOLDER
4. ALL BRAZING TO BE COMPLETED ONLY BAG-7 CERTIFIED EMPLOYEES
5. PIPING MEETS REQUIREMENT OF NFPA55 AND NFPA99
6. NOT DESIGNED TO PICK UP OR MOVE WITH PRODUCT IN TANK
7. OPTIONAL LOCAL ALARM PANEL AVAILABLE (P/N 11896754)
8. ALL DIMENSIONS ARE ±1/2"
9. CARBON STEEL FRAME W/ POWDERCOATED
10. NON-SLIP STRIPS ON FLOOR

REV	APPV	ECR	REVISION DESCRIPTION	BY	DATE
B	CGT	209381	DWG MARKUPS	JNB	3/7/16
A	CGT	209298	TABLE AND SCHEMATIC UPDATED	JNB	10/21/15

DESIGNATES A NOTE REFERENCE.

MAT'L
SEE B.O.M.

FINISH P/N
SEE TABLE

APPV'D	DATE
DRAWN BY JNB	2/2/2015
CHECKED BY	
PROJ. ENGR.	

USED ON
APPLICATION ORIGINAL ECR/ER

CHART, INC.
BALL GROUND, GA 30107

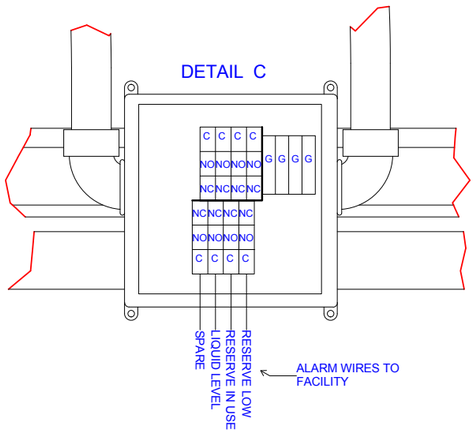
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES.
TOLERANCES:
FRACTIONS ± 1/8"
ANGLES ± 1 °
2 PLACE DECIMAL ± N/A
3 PLACE DECIMAL ± N/A

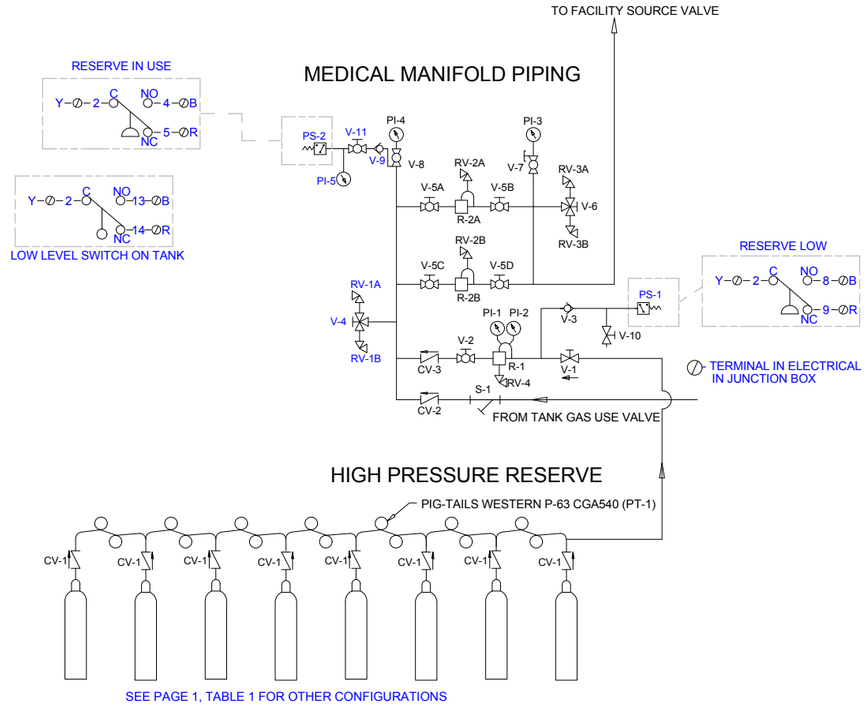
TITLE: SPECIFICATION DWG MEDICAL MICROBULK

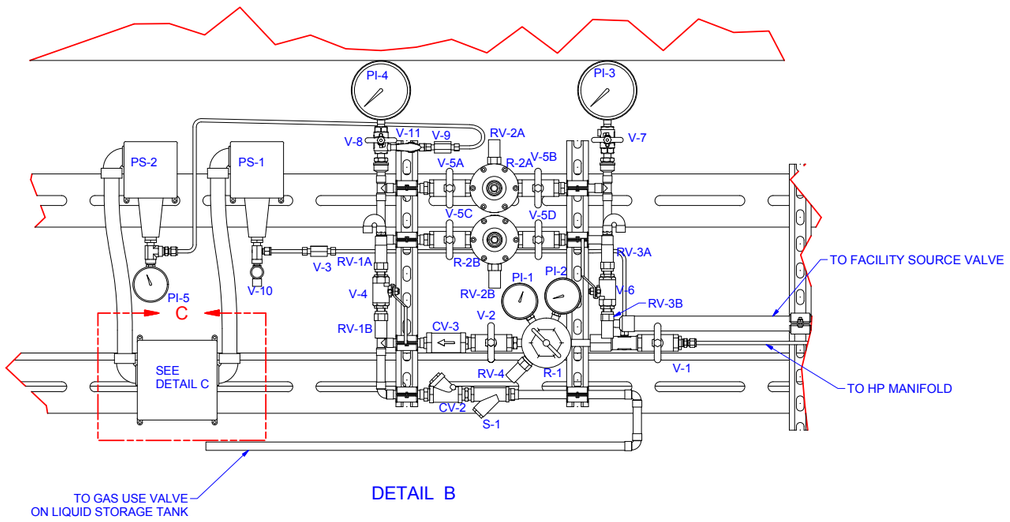
DRAWING NO. D-20810866 REV: B

SCALE: DO NOT SCALE DRAWING SHEET: 1 of 2

DRAWING NO D-20810866







DETAIL B

NOMENCLATURE

ITEM	DESCRIPTION	MANUFACTURER
V-1	HIGH PRESS SUPPLY ISO VALVE	REGO 1/2" 9560CA MASTER VALVE
V-2	HIGH PRESS SUPPLY REG ISO VALVE	APOLLO 1/2" BALL VALVE W/UNION END
V-3	EXCESS FLOW VALVE FOR PS-1	SS-XSS4-1 EXCESS FLOW VALVE - SWAGELOK
V-4	MAIN GAS INLET SAFETY 3-WAY VALVE	APOLLO 1/2" 3-WAY DIVERTER VALVE
V-5 A-D	GAS SUPPLY REGULATOR ISO VALVE	APOLLO 1/2" BALL VALVE W/UNION END
V-6	MAIN GAS OUTLET SAFETY 3-WAY VALVE	APOLLO 1/2" 3-WAY DIVERTER VALVE
V-7	0-200 PSI PRESSURE GAUGE ISO VALVE	APOLLO 1/4" BALL VALVE W/ 1/8 PURGE PORT
V-8	0-400 PSI PRESSURE GAUGE ISO VALVE	APOLLO 1/4" BALL VALVE W/ 1/8 PURGE PORT
V-9	EXCESS FLOW VALVE FOR PS-2	SS-XSS4-1 EXCESS FLOW VALVE - SWAGELOK
V-10	BRASS BLEED VALVE	SUPERIOR 3000PSI 1/4"x1/4" BRASS VALVE
V-11	PS-2 ISOLATION VALVE W/PORT EXHAUST	SWAGELOK SS-42GVS4
CV-1	VALVE OUTLET ADAPTER W/ CHECK VALVE	WESTERN B-52 CGA 540 1/2"
CV-2	TANK INLET CHECK VALVE	UNITED BRASS 1/2" SWING CHECK VALVE
CV-3	HIGH PRESS INLET CHECK VALVE	APOLLO 1/2" 400WOG SPRING LOADED
RV-1 A&B	MAIN GAS INLET RELIEF VALVE	REGO 1/2 NPT 350 PSIG
RV-2 A&B	THERMAL RELIEF VALVE FOR R-2	REGO 1/4 NPT 350 PSIG
RV-3 A&B	MAIN GAS OUTLET RELIEF VALVE ASME	REGO 1/2 NPT 75 PSIG ASME
RV-4	HP REGULATOR RELIEF VALVE	REGO NPT 1/4" 350PSIG
S-1	MAIN GAS LINE INLET STRAINER	TITAN 1/2" W/100 MESH SS
R-1	HIGH PRESSURE SUPPLY REGULATOR	VICTOR HIGH PRESSURE REGULATOR SR450D
R-2 A&B	MAIN GAS SUPPLY REGULATOR	REGO 1/2" 40-110 PSI MEDICAL REGULATOR
PI-1	PRESSURE GAUGE 0-200 PSI	VICTOR 1/4 NPT
PI-2	PRESSURE GAUGE 0-4000 PSI	VICTOR 1/4 NPT
PI-3	PRESSURE GAUGE 0-200 PSI	1/4 NPT (4"DIAL) - WIKA
PI-4	PRESSURE GAUGE 0-400 PSI	1/4 NPT (4"DIAL) - WIKA
PI-5	PRESSURE GAUGE 0-400 PSI	1/4 NPT (2"DIAL) - WIKA
PS-1	RESERVE LOW PRESS SWITCH ALARM	UNITED ELECTRIC 80-1700 PSI PRESS SWITCH
PS-2	RESERVE IN USE PRESS SWITCH ALARM	UNITED ELECTRIC 15-300 PSI PRESS SWITCH
PT-1	OXYGEN PIGTAILS	PT4540 OXYGEN PIGTAILS - SUPERIOR

NOMENCLATURE (PARTS TO SUBSTITUTE FOR NITROGEN SKID)

ITEM	DESCRIPTION	MANUFACTURER
CV-1	VALVE OUTLET ADAPTER W/ CHECK VALVE	WESTERN B-52 CGA 540 1/2"
RV-3 A&B	MAIN GAS OUTLET RELIEF VALVE ASME	REGO 1/2 NPT 275 PSIG ASME
R-2 A&B	MAIN GAS SUPPLY REGULATOR	REGO 1/2" 100-200 PSIG MEDICAL
PI-1	PRESSURE GAUGE 0-400 PSIG	VICTOR 1/4 NPT
PI-3	PRESSURE GAUGE 0-400 PSIG	VICTOR 1/4 NPT (4"DIAL) - WIKA
PT-1	NITROGEN PIGTAILS	PT4580 NITROGEN PIGTAILS - SUPERIOR

PARTS TO SUBSTITUE FOR HYPERBARIC O2

ITEM	DESCRIPTION	MANUFACTURER
RV-3B	BACK PRESSURE REGULATOR	REGO ECL-140 SET 75 PSIG
RV-3A	MAIN GAS OUTLET RELIEF VALVE ASME	REGO 1/2" NPT 90PSIG
M	MUFFLER IN BP REGULATOR	PARKER LEGRIS COMECTIC P/N 0670-00-13

APPV'D	DATE				
DRAWN BY JNB	2/2/2015				
CHECKED BY		USED ON			
PROJ. ENGR.		APPLICATION	ORIGINAL ECR/ER		

REV	APPV	ECR	REVISION DESCRIPTION	BY	DATE

DESIGNATES A NOTE REFERENCE.

MAT'L

FINISH P/N SEE TABLE

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES.
TOLERANCES:
FRACTIONS ±
ANGLES ± °
2 PLACE DECIMAL ±
3 PLACE DECIMAL ±

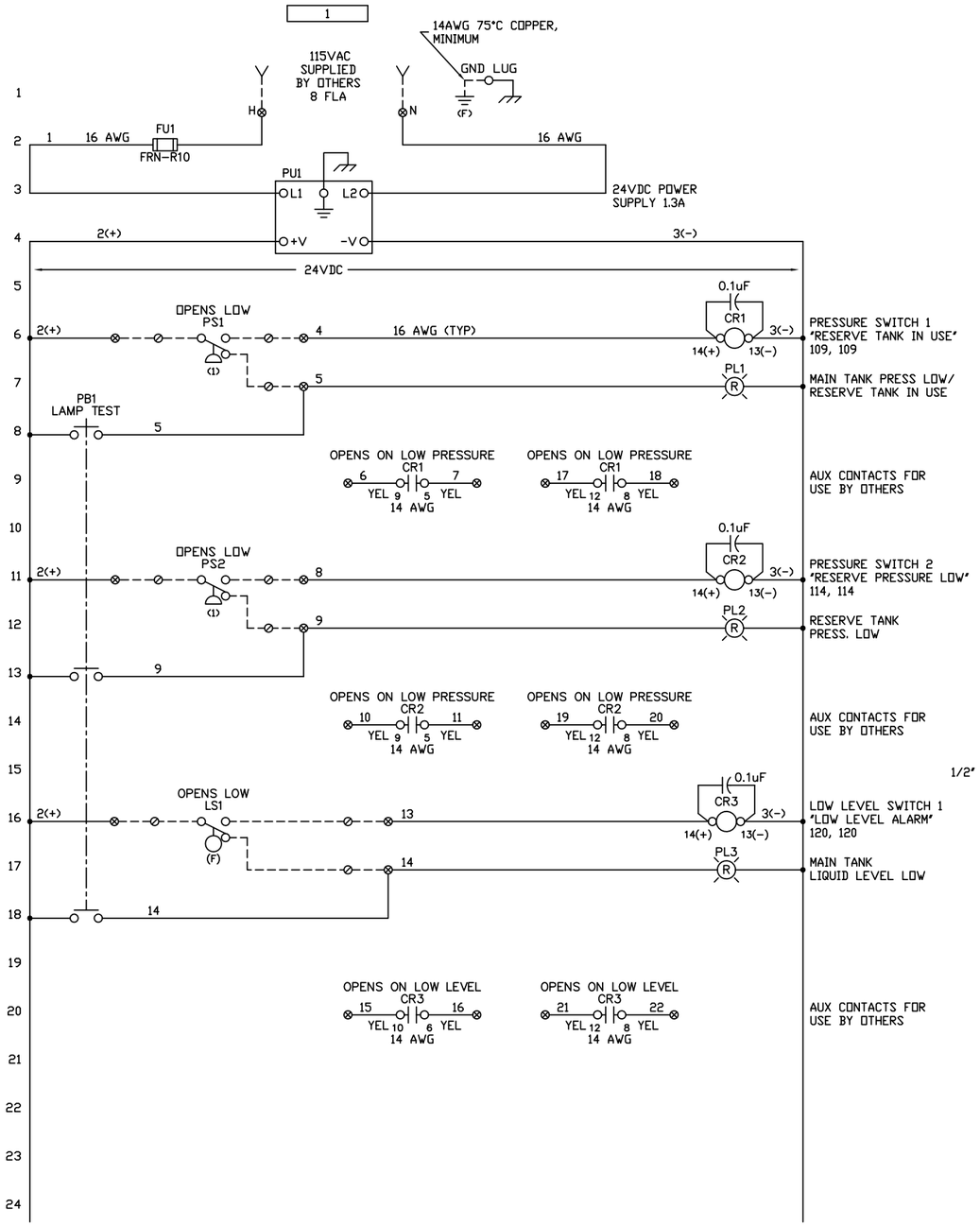
CHART, INC.
BALL GROUND, GA 30107

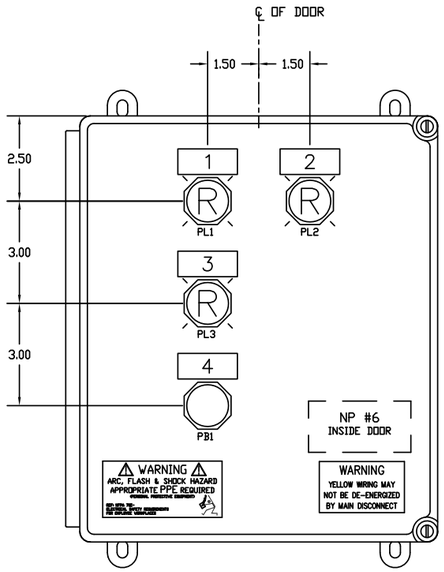
TITLE: SPECIFICATION DWG MEDICAL MICROBULK

DRAWING NO. D-20810866 REV: B

SCALE: DO NOT SCALE DRAWING SHEET: 2 of 2

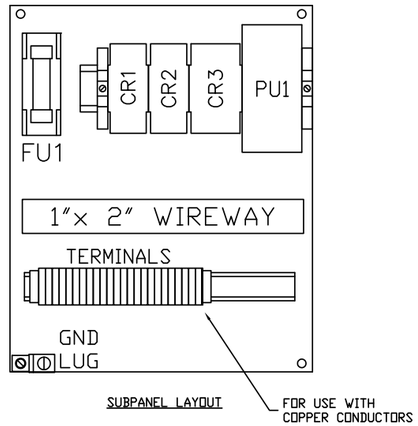
Appendix 3 - Alarm Panel Schematic





ENCLOSURE:
12.0"H X 10.0"W X 6.0"D
HOFFMAN #A-12106CHSCFG
NEMA 4X CONSTRUCTION
W/ONE 10.75"H X 8.875"W SUBPANEL
HOFFMAN #A-12P10

FINISH:
EXTERIOR = FIBERGLASS



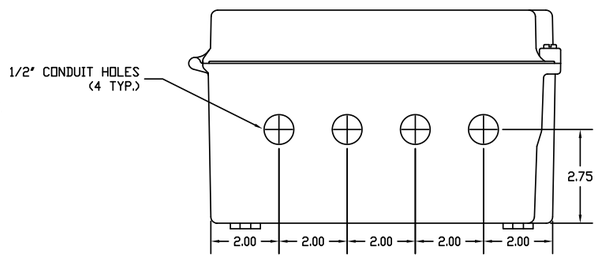
SUBPANEL LAYOUT

FOR USE WITH COPPER CONDUCTORS

NAMEPLATE SPECIFICATIONS :
MATERIAL : GRAVOPLY II, WHT W/BLK LETTERS
LETTER SIZE : .156
CUTTER : .020
DEPTH : 5

NAMEPLATE SCHEDULE		
NP#	SIZE	DESCRIPTION
1	A	MAIN TANK PRESS LOW/ RESERVE IN USE
2	A	RESERVE TANK PRESS LOW
3	A	MAIN TANK LIQUID LEVEL LOW
4	A	LAMP TEST

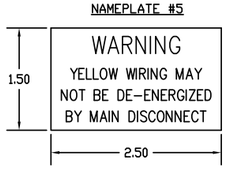
A = 1.75" x .75"



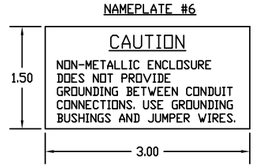
BOTTOM VIEW

NOTE: PANEL ASSEMBLY IS NEMA 4X.
ALL CONDUIT HUBS MUST HAVE EQUAL RATING OR BETTER.

NAMEPLATE #5



NAMEPLATE #6



YELLOW W/ BLACK LETTERS

LOCATION CODE:
(1) MEDICAL GAS CABINET
(F) FIELD DEVICE
⊘-TERMINAL IN MEDICAL GAS CABINET
⊗-TERMINAL IN ALARM BOX
---- INDICATES FIELD WIRING ALL FIELD WIRING TO BE MINIMUM 14 AWG, 75 DEG C UNLESS OTHERWISE NOTED.

REV	DATE	BY	DESCRIPTION	REV	DATE	BY	DESCRIPTION
G	11-21-14	ESJ	REPLACE TANK TEL WITH LIMIT SWITCH	D	8-30-04	TTN	ADDED CAPACITORS ACROSS RELAY COILS
F	11-3-08	ESM	ADDED DRY CONTACTS (44838-1)	C	6-7-04	BGB	REMOVED FU2, MOVED PU1 TO RIGHT SIDE
E	10-17-05	BGB	LAMP TEST BUTTON PB1 ADDED	B	05-26-04	SRU	UPGRADED POWER SUPPLY TO 1.3 A
				A	4-29-04	BGB	ORIGINAL ISSUE (26633)

SCALE N/A | APPR | DR BGB | DATE 4-29-04 | CK DJW | DATE 4-29-04 | SHOP ISSUE | DATE

Control Assemblies Co.
OEM & Factory Automation Specialists — *Minneapolis, Minnesota*

DESCRIPTION:
MEDICAL GAS CABINET (3) ALARM BOX
UL LABELED
PANEL LAYOUT AND
ELECTRICAL DIAGRAM

FOR:
CHART INDUSTRIES, INC.
407 SEVENTH ST NW
NEW PRAGUE, MN 56071-1000, USA

DRAWING NO. 11896754

SHEET 1 OF 1

Appendix 4 - Installation Checklist

Distribution & Storage
Chart Industries, Inc.

Interstate 575 & Airport Drive Exit
Canton, GA 30114 USA
Tel: 770.479.6531 *Fax:* 770.479.4603
www.chartindustries.com

MEDICAL INSTALLATION CHECKLIST

Company Name _____

Project Name _____

Project Address _____

Item Description	Date	Initials
PRE-INSTALLATION CHECKLIST		
Visually inspect the receiving paperwork from the manufacturer (new tank) to insure the skid and the tank are the correct product and MAWP. Inspect Medical Skid for damage. Inspect tank, manifolds, and gauges for cracks or deformation to verify if any damage occurred during shipping and handling.		
Tank Serial # _____		
Skid Model Number _____		
Damage - Yes_____No_____ (* If damage is noted, please follow procedure below)		
Positive Pressure on Manifolds - Yes _____ No_____		
Positive Pressure on Vessel - Yes _____ No_____ (* If no pressure is present, please follow procedure below)		
Inspect Relief Valves and Burst Disks for damage - Yes_____ No_____ (* If damage is noted, please follow procedure below)		
Inspect all plumbing on skid for any damage Damage - Yes_____No_____ (* If damage is noted, please follow procedure below)		
Inspect Local Alarm Panel (optional on skid package) for damage.		
Damage - Yes_____No_____ (* If damage is noted, please follow procedure below)		
Confirm all system components, piping and equipment have arrived O2 clean. O2 clean certificate should be with medical skid paperwork.		
O2 Cleaned - Yes_____No_____ (* If No, please follow procedure below)		

PRE-FILL INSPECTION CHECKLIST		
Re-inspect all tank fittings, connections, and extended fill assemblies (if required) to ensure the components are clean and suitable for medical service, both in terms of pressure and product compatibility.		
Verify that product warning labels and other required labels have been applied to the tank.		
Follow purging and filling procedure as outlined in the manufacturer installation manual.		
FINAL INSTALLATION CHECKLIST		
Verify that all equipment has been properly anchored to the concrete pad per approved construction drawings.		
Verify that awning covers over the plumbing manifolds and high pressure cylinders have been swung into place and secured with bolts.		
Verify that all of field installed piping has been purged during brazing using the NF nitrogen shipping gas from the main vessel or NF cylinders		
All field installed piping is square and level		
Adequate piping supports on all field piping		
Verify, using the site installation drawing and manufacture installation manual(s), that all piping and equipment are properly installed from the main and reserve supply's to the source valve		
Initial Pressure test of system piping from the skid to the source valve per the current adopted NFPA 99 and the manufacture installation manual has been completed.		
PRV(s) are installed correctly on risers, pointed down and installed between all points of isolation to prevent trapping liquid or cold gas.		
Valves are correct type for the source product, correct MAWP, flow arrows are correct.		
Tank PRV pressure _____ Tank Rupture Disc Pressure _____		
All joints that require silver brazing are complete		
All mechanical fittings are correct type, correct MAWP and properly tightened per the manufacturers requirements.		
All labeling on pipe/tubing meets the requirements of NFPA 99.		
Verify all gauges and pressure switches are labeled and reading correctly.		
Verify that high pressure cylinders meet DOT testing requirements		
Verify that high pressure cylinders have proper labels and lot number stickers		
Verify that high pressure cylinders are properly secured.		
Verify that high pressure cylinders are on the metal grating provided with the skid		
Recommend that high pressure cylinders have common test dates, common lot numbers, and are new or freshly painted.		
Main supply pressure building regulator setpoint _____		
Main supply economizer regulator setpoint_____		
Main Pressure low / Reserve in use pressure switch setting PS-2 _____		
Reserve pressure low pressure switch setting PS-1 _____		

Main Tank Liquid level low level alarm setting, a minimum of one days average supply is required LL _____ Inches		
Control manifold regulator primary R-2 A&B setting _____		
Control manifold regulator reserve R-1 setting _____		
Verify Local Alarm Panel Main Tank Liquid Level Low		
Verify Local Alarm Panel Reserve in Use		
Verify Local Alarm Panel Reserve Tank Pressure Low		
Perform a visual and audible inspection for any leaks, pipe movement, and PRV(s) leaking or other installation concerns while system is pressurized.		
Review the third party paperwork and verify the system testing is completed with both the third party verifier and medical facility personnel. Attach a copy of the Third Party Verification Report(s)		
Ensure the appropriate owner personnel are trained on the operation of the new system, how to handle alarm conditions, and any emergency conditions with the system. See manufacturers training package.		

* If any damage is noted during the inspection of the listed equipment prior to offloading, during the installation or if equipment is received that is not 02 cleaned or suitable for installation, immediately document and notify Chart Inc,Technical Services and the Microbulk Product Manager.

Source Valve to remain locked out until All Parties have signed below

The undersigned agree that the above-described Medical Bulk Site System has been substantially completed. The owner/operator has agreed to take possession of the system and intends on putting the equipment to useful work. The agreed to warranty commences on this date.

_____ _____

Equipment Installer Representative Date

_____ _____

Owner Representative Date

_____ _____

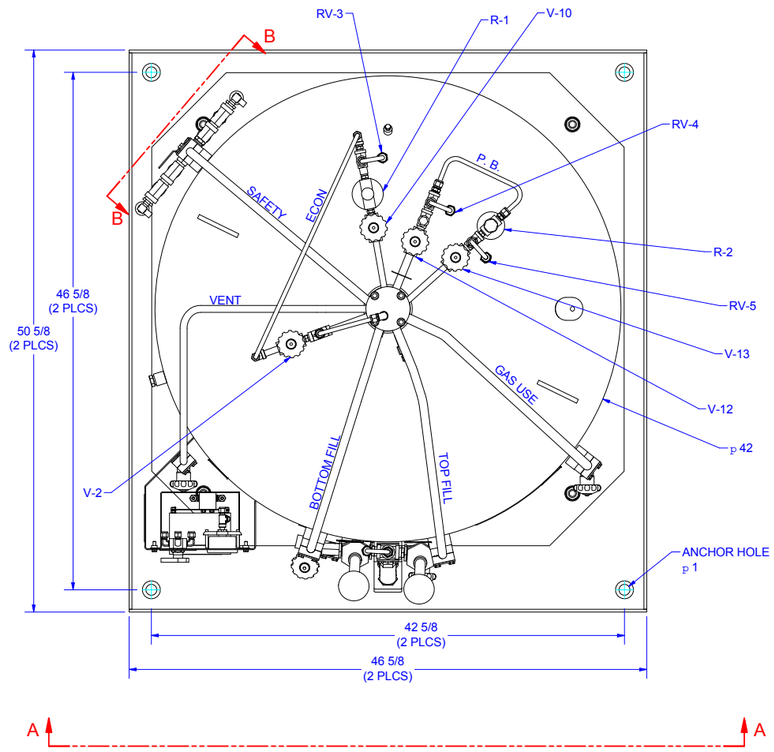
Third Party Verifier Representative Date

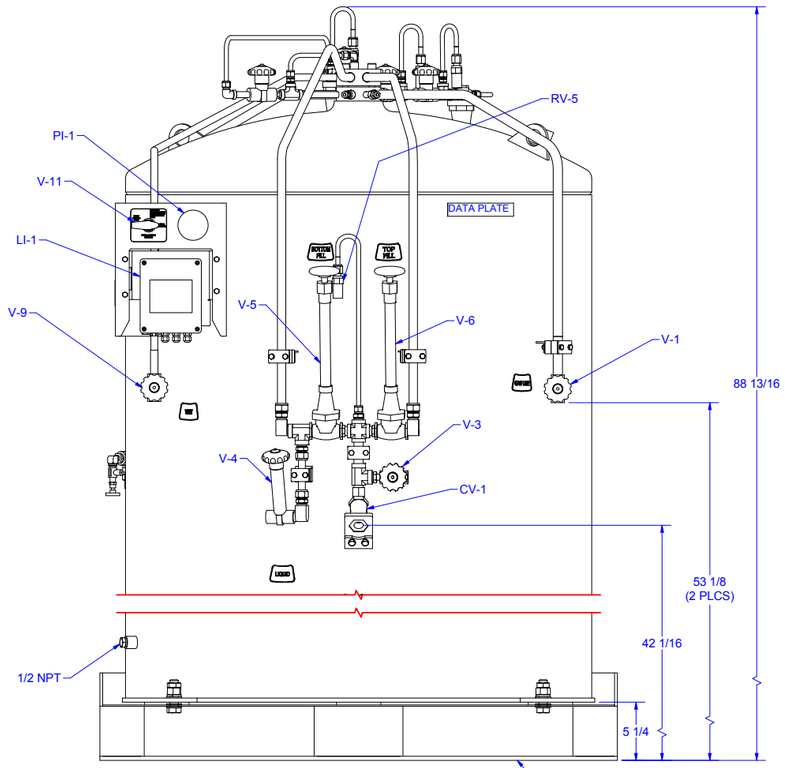
Appendix 5 - MicroBulk Skid Tank Sizing Specifications

		Oxygen Volumes		Nitrogen Volumes		
		1 Delivery	3 Deliveries	1 Delivery	3 Deliveries	
MB Tank Description	Max Flowrate (SCFH)	Mth Volume (SCF)	Mth Volume (SCF)	Mth Volume (SCF)	Mth Volume (SCF)	1 Day Supply HP Backup Cyl.
1000 Liter	960	19,000	38,500	19,500	39,000	4 Cylinders
1500 Liter	1350	35,500	70,800	28,650	57,300	4-6 Cylinders
2000 Liter	1350	47,500	94,600	38,300	76,600	6-8 Cylinders
3000 Liter	2000	66,000	132,000	53,300	106,600	8-10 Cylinders

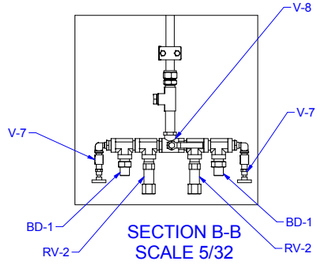
Appendix 6 - Perma-Cyl Spec Drawings

DRAWING NO D-20852345

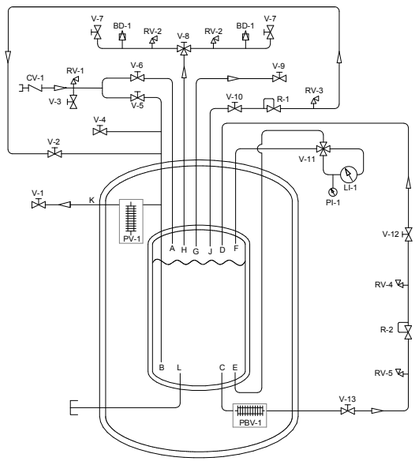




FRONT VIEW



SECTION B-B
SCALE 5/32



SCHEMATIC

NOMENCLATURE	
BD-1	TANK SECONDARY RELIEF DEVICE BURST DISC
CV-1	TANK FILL CHECK VALVE
LI-1	TANK LIQUID LEVEL GAUGE
PBV-1	TANK PRESSURE BUILDING VAPORIZER COIL
PI-1	TANK PRESSURE GAUGE
PV-1	TANK PROCESS VAPORIZER COIL
R-1	TANK ECONOMIZER REGULATOR
R-2	TANK PB REGULATOR
RV-1	TANK FILL ASSEMBLY RELIEF VALVE
RV-2	TANK PRIMARY RELIEF VALVE
RV-3	TANK ECON INLET RELIEF VALVE
RV-4	TANK PB OUTLET RELIEF VALVE
RV-5	TANK PB INLET RELIEF VALVE
V-1	TANK GAS USE VALVE
V-2	TANK ECONOMIZER INLET ISO VALVE
V-3	TANK FILL HOSE DRAIN VALVE
V-4	TANK LIQUID WITHDRAWAL VALVE
V-5	TANK BOTTOM FILL VALVE
V-6	TANK TOP FILL VALVE
V-7	TANK SAFETY LINE PURGE VALVE
V-8	TANK SAFETY 3-WAY DIVERTER VALVE
V-9	TANK FULL TRYCOCK / VENT VALVE
V-10	TANK ECONOMIZER VALVE
V-11	TANK GAUGE ISOLATION VALVE
V-12	TANK PRESSURE BUILD OUTLET ISO VALVE
V-13	TANK PRESSURE BUILD INLET ISO VALVE
PIPING	
A	TANK TOP FILL
B	TANK BOTTOM FILL & LIQUID USE
C	TANK PB INLET
D	TANK PB OUTLET
E	TANK LIQUID PHASE
F	TANK VAPOR PHASE
G	TANK FULL TRYCOCK / VENT VALVE
H	TANK DUAL RELIEF
J	TANK ECONOMIZER
K	TANK GAS USE
L	AUXILIARY BOTTOM WITHDRAWAL

DESIGN SPECIFICATION	
ITEM	1000 HP/VHP FLEX FILL
CODE	ASME SEC. VIII. DIV 1
RELIEF SETTING MAWP	250 PSI / 17.2 BAR
	350 PSI / 24.1 BAR
	500 PSI / 34.5 BAR
GROSS VOLUME	1,056 LITERS / 279.0 GALLONS
NET VOLUME	950 LITERS / 251.0 GALLONS
TARE WEIGHT WITH LAB BASE	1,500 lbs / 680 kg HP
	1,750 lbs / 794 kg VHP
NORMAL EVAPORATION RATE	1 % PER DAY NITROGEN .62 % PER DAY OXYGEN .62 % PER DAY ARGON
MATERIAL	TYPE 304 STAINLESS STEEL
	PALLET BASE GALVANIZED
GASEOUS EQUIVALENT: SCF AT 1 ATM & 70° F / Nm³ AT 1 ATM & 0°C	
NITROGEN	24,350 SCF / 689 Nm³
OXYGEN	30,070 SCF / 850 Nm³
ARGON	29,400 SCF / 832 Nm³
GAS DELIVERY RATE	
NITROGEN	960 SCF/H / 25.2 Nm³/h
OXYGEN	960 SCF/H / 25.2 Nm³/h
ARGON	960 SCF/H / 25.2 Nm³/h

PARTS LIST

ITEM	QTY	PART NO.	DESCRIPTION	MANUFACTURER P/N	MANUFACTURER
*BD-1	2	11671281	RPD ASSY INLINE 1/2MPT 375PSI	-	BS&B
		11526569	RPD ASSY INLINE 1/2MPT 525PSI	011-0258	BS&B
		11526622	RPD ASSY INLINE 1/2MPT 700PSI	011-0258	BS&B
CV-1	1	11051090	VALVE CHECK BRS 1/2FPTX1/2FPT	CV-503B-T-5	GENERANT
*LI-1	1	20910598	CYL-TEL GEN 5, 0-200"H2O	-	CHART
		20923160	DIFF PG 4.5" 0-60" H2O VITON (O2, N2)	52721122	WIKA
		20923161	DIFF PG 4.5" 0-80" H2O VITON (AR)	52721120	WIKA
PI-1	1	20827654	PG 2-1/2" 0-600PSI/BAR 1/8MPT	52553914	WIKA
*R-1	1	11501177	REGULATOR .250FPT @ 140PSI	12790-0140	CASH-ACME
		20885664	REGULATOR .250FPT @ 325PSI	12790-0325	CASH-ACME
		10619675	REGULATOR .250NPT @ 475PSI	12790-0475	CASH-ACME
*R-2	1	2110032	REGULATOR .250FPT @ 125PSI	21999-0125	CASH-ACME
		2110742	REGULATOR .250FPT @ 300PSI	21999-0300	CASH-ACME
		10619667	REGULATOR .250NPT @ 450PSI	21999-0450	CASH-ACME
RV-1	1	1812702	RV BRS 1/4MPT 550PSI	PRV9432T550	REGO
*RV-2	2	11488574	RV BRS 1/2MPT 250PSI	PRV19434TP250	REGO
		20599868	RV BRS 1/2MPT 350PSI	PRV19434TP250	REGO
		20894583	RV BRS 1/2MPT 500PSI	PRV19434TP250	REGO
RV-3	1	1812702	RV BRS 1/4MPT 550PSI	PRV9432T550	REGO
RV-4	1	1812702	RV BRS 1/4MPT 550PSI	PRV9432T550	REGO
RV-5	1	1812702	RV BRS 1/4MPT 550PSI	PRV9432T550	REGO
V-1	1	10502848	VALVE SHUTOFF BRZ 1/2FPT SHORT	T9454	REGO
V-2	1	11905999	VALVE SHUTOFF 1/4FPT	T9452	REGO
V-3	1	11905999	VALVE SHUTOFF 1/4FPT	T9452	REGO
V-4	1	11625639	VALVE GLOBE BRS 1/2FPT EX.STEM	BK9454	REGO
V-5	1	10616790	VALVE GLOBE BRS 1/2NPT SCRD	BK9404T	REGO
V-6	1	10616790	VALVE GLOBE BRS 1/2NPT SCRD	BK9404T	REGO
V-7	2	10907239	VALVE NEEDLE BRS 1/4MPT(ANGLE)	CMM250A	REGO
V-8	1	11773885	VALVE BALL DIV SS 1/2NPT	76-603-57	APOLLO
V-9	1	11905956	VALVE BRS SH 3/8FPTX3/8 SCH 10	T9464DA	REGO
V-10	1	11905999	VALVE SHUTOFF 1/4FPT	T9452	REGO
V-11	1	20683719	VALVE 4-WAY BRS 1/8FPT	B-43YTF2-WL8	SWAGELOK
V-12	1	11905999	VALVE SHUTOFF 1/4FPT	T9452	REGO
V-13	1	11905999	VALVE SHUTOFF 1/4FPT	T9452	REGO

NOTE:
* - PART NUMBERS ARE DEPENDENT ON THE PLUMBING OPTION KIT CHOSEN FOR THE VESSEL.

REV	APPV	ECR	REVISION DESCRIPTION	BY	DATE

(#) DESIGNATES A NOTE REFERENCE.

MAT'L
SEE B.O.M.

FINISH P/N
20852345

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES.
TOLERANCES:
FRACTIONS ± 1/2
ANGLES ± 1 °
2 PLACE DECIMAL ± N/A
3 PLACE DECIMAL ± N/A

	APPV'D	DATE
DRAWN BY	JNB	7/31/2015
CHECKED BY		
PROJ. ENGR.	CGT	10/6/2015

USED ON 208999
APPLICATION ORIGINAL ECR/ER

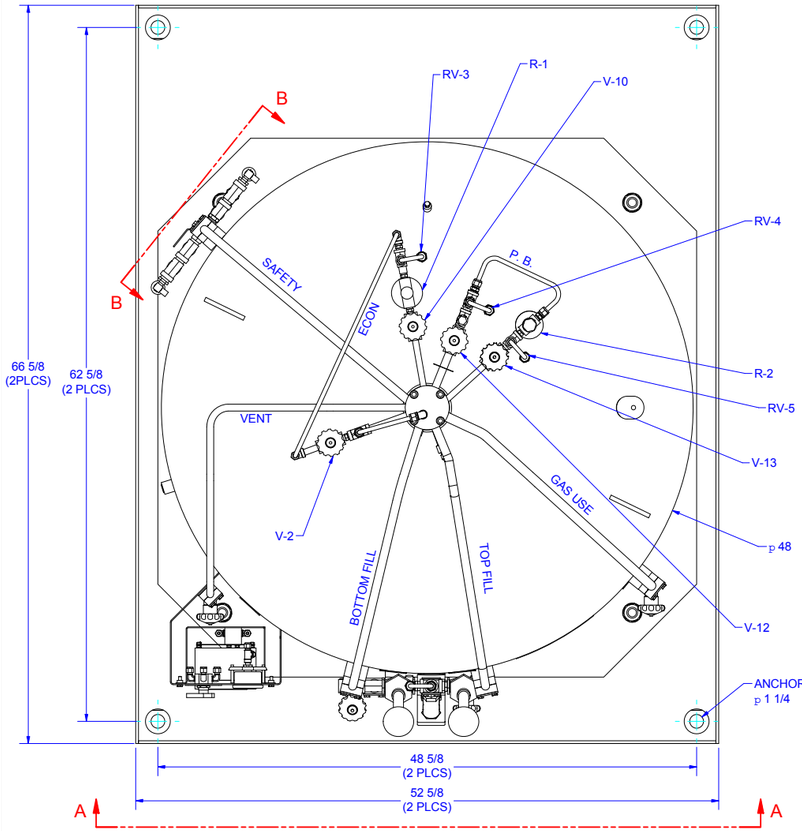
CHART INC.
BALL GROUND, GA 30107

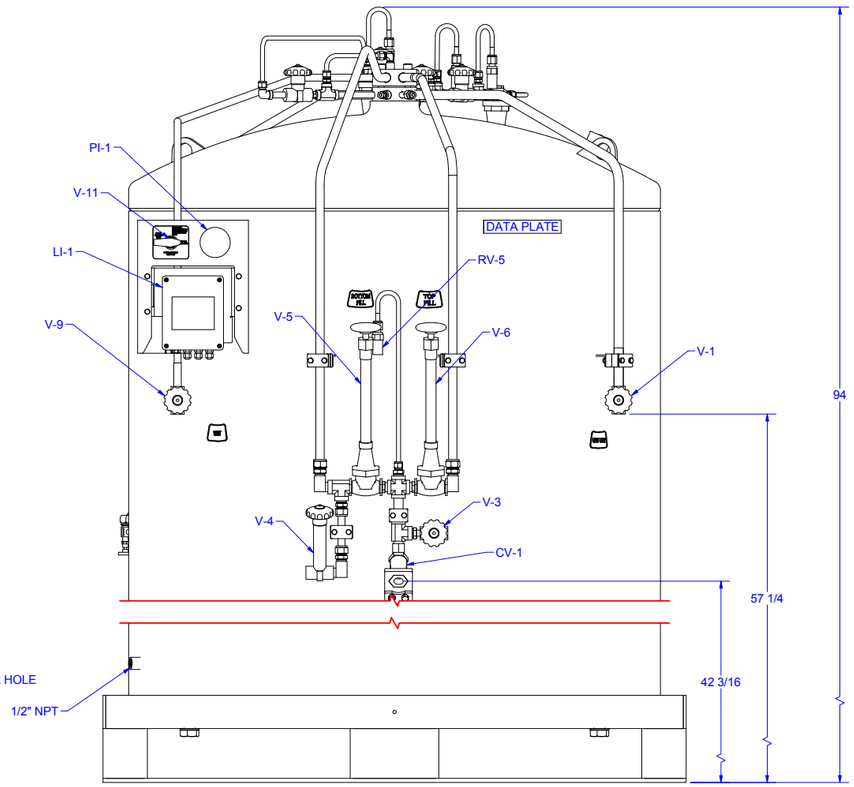
TITLE: SPEC DWG PERMA-CYL 1000HP/VHP PSTR FLEX FILL

DRAWING NO. D-20852345 REV:

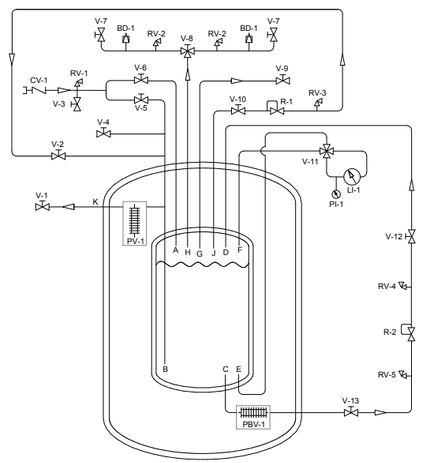
SCALE: N/A DO NOT SCALE DRAWING SHEET: 1 of 1

DRAWING NO D-20852342



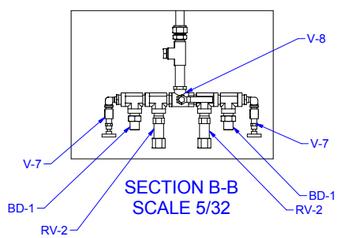


FRONT VIEW



NOMENCLATURE	
BD-1	TANK SECONDARY RELIEF DEVICE BURST DISC
CV-1	TANK FILL CHECK VALVE
LI-1	TANK LIQUID LEVEL GAUGE
PBV-1	TANK PRESSURE BUILDING VAPORIZER COIL
PI-1	TANK PRESSURE GAUGE 0-400 PSI
PV-1	TANK PROCESS VAPORIZER COIL
R-1	TANK ECONOMIZER REGULATOR
R-2	TANK PB REGULATOR
RV-1	TANK FILL ASSEMBLY RELIEF VALVE
RV-2	TANK PRIMARY RELIEF VALVE
RV-3	TANK ECON INLET RELIEF VALVE
RV-4	TANK PB OUTLET RELIEF VALVE
RV-5	TANK PB INLET RELIEF VALVE
V-1	TANK GAS USE VALVE
V-2	TANK ECONOMIZER INLET ISO VALVE
V-3	TANK FILL HOSE DRAIN VALVE
V-4	TANK LIQUID WITHDRAWAL VALVE
V-5	TANK BOTTOM FILL VALVE
V-6	TANK TOP FILL VALVE
V-7	TANK SAFETY LINE PURGE VALVE
V-8	TANK SAFETY 3-WAY DIVERTER VALVE
V-9	TANK FULL TRYCOCK / VENT VALVE
V-10	TANK ECONOMIZER VALVE
V-11	TANK GAUGE ISOLATION VALVE
V-12	TANK PRESSURE BUILD OUTLET ISO VALVE
V-13	TANK PRESSURE BUILD INLET ISO VALVE
PIPING	
A	TANK TOP FILL
B	TANK BOTTOM FILL & LIQUID USE
C	TANK PB INLET
D	TANK PB OUTLET
E	TANK LIQUID PHASE
F	TANK VAPOR PHASE
G	TANK FULL TRYCOCK / VENT VALVE
H	TANK DUAL RELIEF
J	TANK ECONOMIZER
K	TANK GAS USE

SCHEMATIC



SECTION B-B
SCALE 5/32

DESIGN SPECIFICATION	
ITEM	1500 HP/VHP FLEX FILL
CODE	ASME SEC. VIII. DIV 1
RELIEF SETTING MAWP	250 PSI / 17.2 BAR
	350 PSI / 24.1 BAR
	500 PSI / 34.5 BAR
GROSS VOLUME	1,550 LITERS / 409.5 GALLONS
NET VOLUME	1,455 LITERS / 384.4 GALLONS
TARE WEIGHT WITH LAB BASE	2,200 lbs / 998 kg HP
	2,500 lbs / 1,134 kg VHP
NORMAL EVAPORATION RATE	1 % PER DAY NITROGEN .62 % PER DAY OXYGEN .62 % PER DAY ARGON
MATERIAL	TYPE 304 STAINLESS STEEL
	PALLET BASE GALVANIZED
GASEOUS EQUIVALENT: SCF AT 1 ATM & 70° F / Nm³ AT 1 ATM & 0°C	
NITROGEN	35,790 SCF / 1,013 Nm³
OXYGEN	44,220 SCF / 1,250 Nm³
ARGON	43,220 SCF / 1,223 Nm³
GAS DELIVERY RATE	
NITROGEN	1,350 SCF/H / 35.4 Nm³/h
OXYGEN	1,350 SCF/H / 35.4 Nm³/h
ARGON	1,350 SCF/H / 35.4 Nm³/h

PARTS LIST

ITEM	QTY	PART NO.	DESCRIPTION	MANUFACTURER P/N	MANUFACTURER
*BD-1	2	11671281	RPD ASSY INLINE 1/2MPT 375PSI	-	BS&B
		11526569	RPD ASSY INLINE 1/2MPT 525PSI	011-0258	BS&B
		11526622	RPD ASSY INLINE 1/2MPT 700PSI	011-0258	BS&B
CV-1	1	11051090	VALVE CHECK BRS 1/2FPTX1/2FPT	CV-503B-T-5	GENERANT
*LI-1	1	20910598	CYL-TEL GEN 5 0-200"H2O	-	CHART
		20923162	DIFF PG 4.5" 0-100" H2O VITON (O2, N2)	52721099	WIKA
		20909588	DIFF PG 4.5" 0-150" H2O VITON (AR)	52721125	WIKA
PI-1	1	20827654	PG 2-1/2" 0-600PSI/BAR 1/8MPT	52553914	WIKA
*R-1	1	11501177	REGULATOR .250FPT @ 140PSI	12790-0140	CASH-ACME
		20885664	REGULATOR .250FPT @ 325PSI	12790-0325	CASH-ACME
		10619675	REGULATOR .250NPT @ 475PSI	12790-0475	CASH-ACME
*R-2	1	2110032	REGULATOR .250FPT @ 125PSI	21999-0125	CASH-ACME
		2110742	REGULATOR .250FPT @ 300PSI	21999-0300	CASH-ACME
		10619667	REGULATOR .250NPT @ 450PSI	21999-0450	CASH-ACME
RV-1	1	1812702	RV BRS 1/4MPT 550PSI	PRV9432T550	REGO
*RV-2	2	11488574	RV BRS 1/2MPT 250PSI	PRV19434TP250	REGO
		20599868	RV BRS 1/2MPT 350PSI	PRV19434TP250	REGO
		20894583	RV BRS 1/2MPT 500PSI	PRV19434TP250	REGO
RV-3	1	1812702	RV BRS 1/4MPT 550PSI	PRV9432T550	REGO
RV-4	1	1812702	RV BRS 1/4MPT 550PSI	PRV9432T550	REGO
RV-5	1	1812702	RV BRS 1/4MPT 550PSI	PRV9432T550	REGO
V-1	1	10502848	VALVE SHUTOFF BRZ 1/2FPT SHORT	T9454	REGO
V-2	1	11905999	VALVE SHUTOFF 1/4FPT	T9452	REGO
V-3	1	11905999	VALVE SHUTOFF 1/4FPT	T9452	REGO
V-4	1	11625639	VALVE GLOBE BRS 1/2FPT EX.STEM	BK9454	REGO
V-5	1	10616790	VALVE GLOBE BRS 1/2NPT SCRD	BK9404T	REGO
V-6	1	10616790	VALVE GLOBE BRS 1/2NPT SCRD	BK9404T	REGO
V-7	2	10907239	VALVE NEEDLE BRS 1/4MPT(ANGLE)	CMM250A	REGO
V-8	1	11773885	VALVE BALL DIV SS 1/2NPT	76-603-57	APOLLO
V-9	1	11905956	VALVE BRS SH 3/8FPTX3/8 SCH 10	T9464DA	REGO
V-10	1	11905999	VALVE SHUTOFF 1/4FPT	T9452	REGO
V-11	1	20683719	VALVE 4-WAY BRS 1/8FPT	B-43YTF2-WL8	SWAGELOK
V-12	1	11905999	VALVE SHUTOFF 1/4FPT	T9452	REGO
V-13	1	11905999	VALVE SHUTOFF 1/4FPT	T9452	REGO

NOTE:
* - PART NUMBERS ARE DEPENDENT ON THE PLUMBING OPTION KIT CHOSEN FOR THE VESSEL.

REV	APPV	ECR	REVISION DESCRIPTION	BY	DATE

DESIGNATES A NOTE REFERENCE.

MAT'L
SEE B.O.M.

FINISH P/N
20852342

	APPV'D	DATE
DRAWN BY	JNB	7/31/2015
CHECKED BY		
PROJ. ENGR.	CGT	10/6/2015

USED ON 208999
APPLICATION ORIGINAL ECR/ER

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES.
TOLERANCES:
FRACTIONS ± 1/2
ANGLES ± 1 °
2 PLACE DECIMAL ± N/A
3 PLACE DECIMAL ± N/A

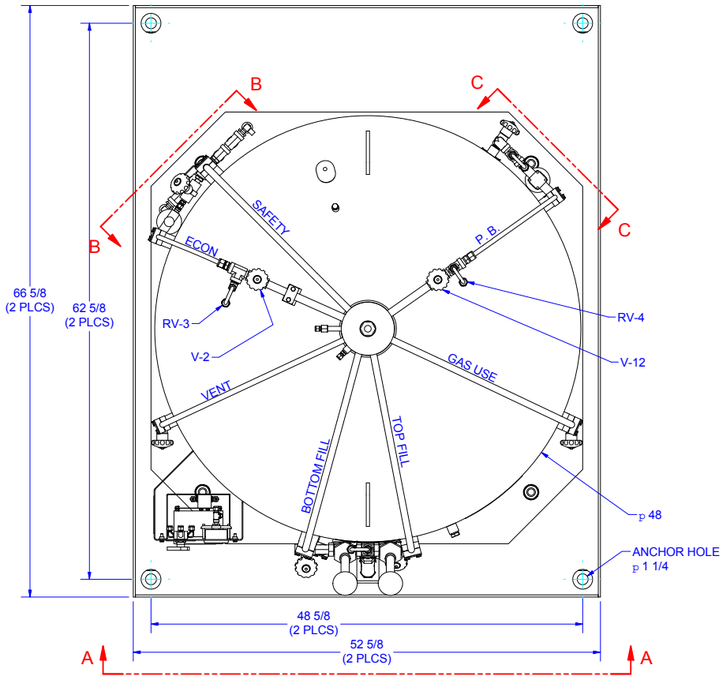
CHART INC.
BALL GROUND, GA 30107

TITLE: SPEC DWG PERMA-CYL 1500HP/VHP PSTR FLEX FILL

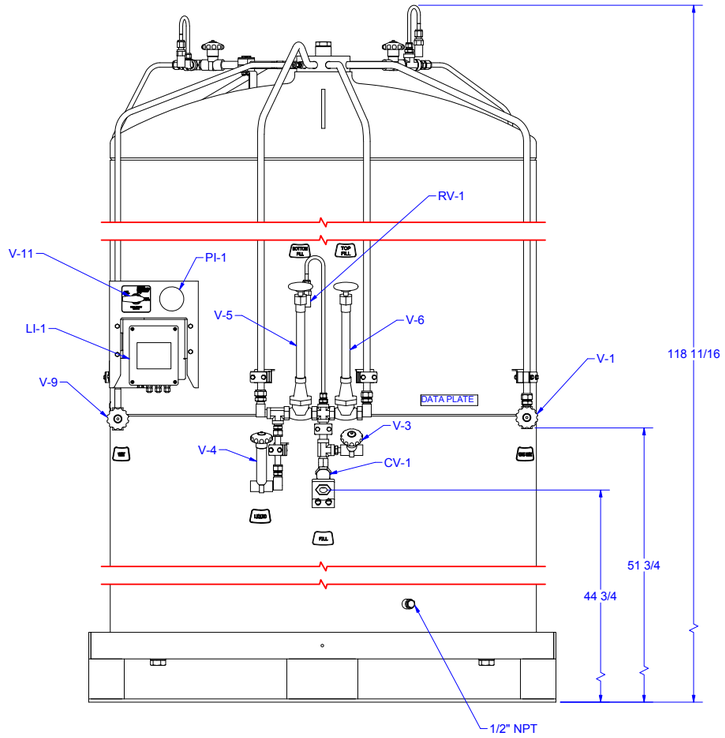
DRAWING NO. D-20852342 REV:

SCALE: N/A DO NOT SCALE DRAWING SHEET: 1 of 1

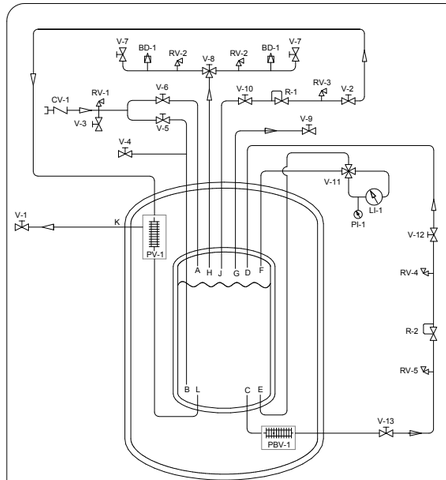
DRAWING NO D-20852343



TOP VIEW

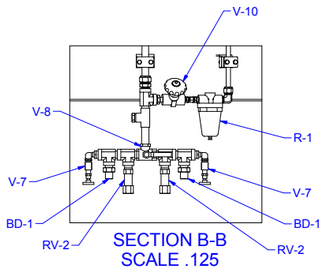


FRONT VIEW

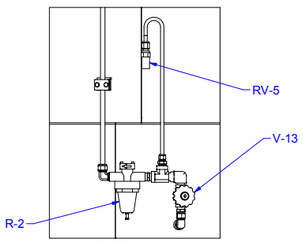


SCHEMATIC

NOMENCLATURE	
BD-1	TANK SECONDARY RELIEF DEVICE BURST DISC
CV-1	TANK FILL CHECK VALVE
LI-1	TANK LIQUID LEVEL GAUGE
PBV-1	TANK PRESSURE BUILDING VAPORIZER COIL
PI-1	TANK PRESSURE GAUGE 0-400 PSI
PV-1	TANK PROCESS VAPORIZER COIL
R-1	TANK ECONOMIZER REGULATOR
R-2	TANK PB REGULATOR
RV-1	TANK FILL ASSEMBLY RELIEF VALVE
RV-2	TANK PRIMARY RELIEF VALVE
RV-3	TANK ECON INLET RELIEF VALVE
RV-4	TANK PB OUTLET RELIEF VALVE
RV-5	TANK PB INLET RELIEF VALVE
V-1	TANK GAS USE VALVE
V-2	TANK ECONOMIZER INLET ISO VALVE
V-3	TANK FILL HOSE DRAIN VALVE
V-4	TANK LIQUID WITHDRAWAL VALVE
V-5	TANK BOTTOM FILL VALVE
V-6	TANK TOP FILL VALVE
V-7	TANK SAFETY LINE PURGE VALVE
V-8	TANK SAFETY 3-WAY DIVERTER VALVE
V-9	TANK FULL TRYCOCK / VENT VALVE
V-10	TANK ECONOMIZER VALVE
V-11	TANK GAUGE ISOLATION VALVE
V-12	TANK PRESSURE BUILD OUTLET ISO VALVE
V-13	TANK PRESSURE BUILD INLET ISO VALVE
PIPING	
A	TANK TOP FILL
B	TANK BOTTOM FILL & LIQUID USE
C	TANK PB INLET
D	TANK PB OUTLET
E	TANK LIQUID PHASE
F	TANK VAPOR PHASE
G	TANK FULL TRYCOCK / VENT VALVE
H	TANK DUAL RELIEF
J	TANK ECONOMIZER
K	TANK GAS USE OUT
L	TANK GAS USE IN



SECTION B-B
SCALE .125



SECTION C-C
SCALE .125

DESIGN SPECIFICATION	
ITEM	2000 HP FLEX FILL
CODE	ASME SEC. VIII. DIV 1
RELIEF SETTING MAWP	250 PSI / 17.2 BAR
	350 PSI / 24.1 BAR
	500 PSI / 34.5 BAR
GROSS VOLUME	2,042 LITERS / 539 GALLONS
NET VOLUME	1,945 LITERS / 513.9 GALLONS
TARE WEIGHT WITH LAB BASE	2,600 lbs / 1,179 kg
NORMAL EVAPORATION RATE	1 % PER DAY NITROGEN .62 % PER DAY OXYGEN .62 % PER DAY ARGON
MATERIAL	TYPE 304 STAINLESS STEEL
	PALLET BASE GALVANIZED
GASEOUS EQUIVALENT: SCF AT 1 ATM & 70° F / Nm³ AT 1 ATM & 0ºC	
NITROGEN	47,847 SCF / 1,257 Nm³
OXYGEN	59,089 SCF / 1,553 Nm³
ARGON	57,786 SCF / 1,519 Nm³
GAS DELIVERY RATE **	
NITROGEN	1,350 SCF/H / 35.4 Nm³/h
OXYGEN	1,350 SCF/H / 35.4 Nm³/h
ARGON	1,350 SCF/H / 35.4 Nm³/h

PARTS LIST

ITEM	QTY	PART NO.	DESCRIPTION	MANUFACTURER P/N	MANUFACTURER
*BD-1	2	11671281	RPD ASSY INLINE 1/2MPT 375PSI	011-0258	BS&B
		11526569	RPD ASSY INLINE 1/2MPT 525PSI	011-0258	BS&B
CV-1	1	11051090	VALVE CHECK BRS 1/2FPTX1/2FPT	CV-503B-T-5	GENERANT
*LI-1	1	20910598	CYL-TEL GEN 5 0-200"H2O	-	CHART
		20923162	DIFF PG 4.5" 0-100" H2O VITON (O2, N2)	52721099	WIKA
		20909588	DIFF PG 4.5" 0-150" H2O VITON (AR)	52721125	WIKA
PI-1	1	20827654	PG 2-1/2" 0-600PSI/BAR 1/8MPT	52553914	WIKA
*R-1	1	11501177	REGULATOR .250FPT @ 140PSI	12790-0140	CASH-ACME
		20885664	REGULATOR .250FPT @ 325PSI	12790-0140	CASH-ACME
*R-2	1	11779806	REGULATOR .500NPT @ 125PSI	21999-0125	CASH-ACME
		11690211	REGULATOR .500NPT @ 300PSI	21999-0300	CASH-ACME
RV-1	1	1812702	RV BRS 1/4MPT 550PSI	PRV9432T550	REGO
*RV-2	2	11488574	RV BRS 1/2MPT 250PSI	PRV19434TP250	REGO
		20599868	RV BRS 1/2MPT 350PSI	PRV19434TP250	REGO
RV-3	1	1812702	RV BRS 1/4MPT 550PSI	PRV9432T550	REGO
RV-4	1	1812702	RV BRS 1/4MPT 550PSI	PRV9432T550	REGO
RV-5	1	1812702	RV BRS 1/4MPT 550PSI	PRV9432T550	REGO
V-1	1	10502848	VALVE SHUTOFF BRZ 1/2FPT SHORT	T9454	REGO
V-2	1	11905999	VALVE SHUTOFF 1/4FPT	T9452	REGO
V-3	1	11905999	VALVE SHUTOFF 1/4FPT	T9452	REGO
V-4	1	11625639	VALVE GLOBE BRS 1/2FPT EX.STEM	BK9454	REGO
V-5	1	10616790	VALVE GLOBE BRS 1/2NPT SCRD	BK9404T	REGO
V-6	1	10616790	VALVE GLOBE BRS 1/2NPT SCRD	BK9404T	REGO
V-7	2	10907239	VALVE NEEDLE BRS 1/4MPT(ANGLE)	CMM250A	REGO
V-8	1	11773885	VALVE BALL DIV SS 1/2NPT	76-603-57	APOLLO
V-9	1	11905956	VALVE BRS SH 3/8FPTX3/8 SCH 10	T9464DA	REGO
V-10	1	11905999	VALVE SHUTOFF 1/4FPT	T9452	REGO
V-11	1	20683719	VALVE 4-WAY BRS 1/8FPT	B-43YTF2-WL8	SWAGELOK
V-12	1	11905999	VALVE SHUTOFF 1/4FPT	T9452	REGO
V-13	1	11905999	VALVE SHUTOFF 1/4FPT	T9452	REGO

NOTE:
* - PART NUMBERS ARE DEPENDENT ON THE PLUMBING OPTION KIT CHOSEN FOR THE VESSEL.
** - OPTIONAL 3,500 SCF/H (92 Mn³h) FLOW KIT AVAILABLE

REV	APPV	ECR	REVISION DESCRIPTION	BY	DATE

DESIGNATES A NOTE REFERENCE.

MAT'L
SEE B.O.M.

FINISH P/N
20852343

	APPV'D	DATE
DRAWN BY	JNB	7/31/2015
CHECKED BY		
PROJ. ENGR.	CGT	10/6/2015

USED ON 208999
APPLICATION ORIGINAL ECR/ER

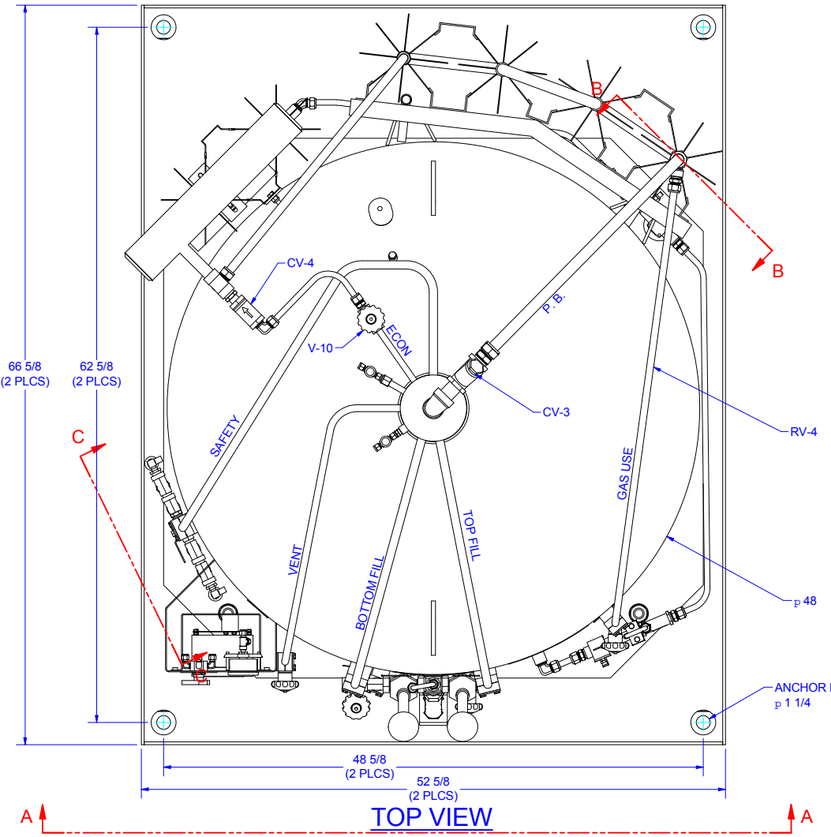
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES.
TOLERANCES:
FRACTIONS ± 1/2
ANGLES ± 1 °
2 PLACE DECIMAL ± N/A
3 PLACE DECIMAL ± N/A

CHART, INC.
BALL GROUND, GA 30107

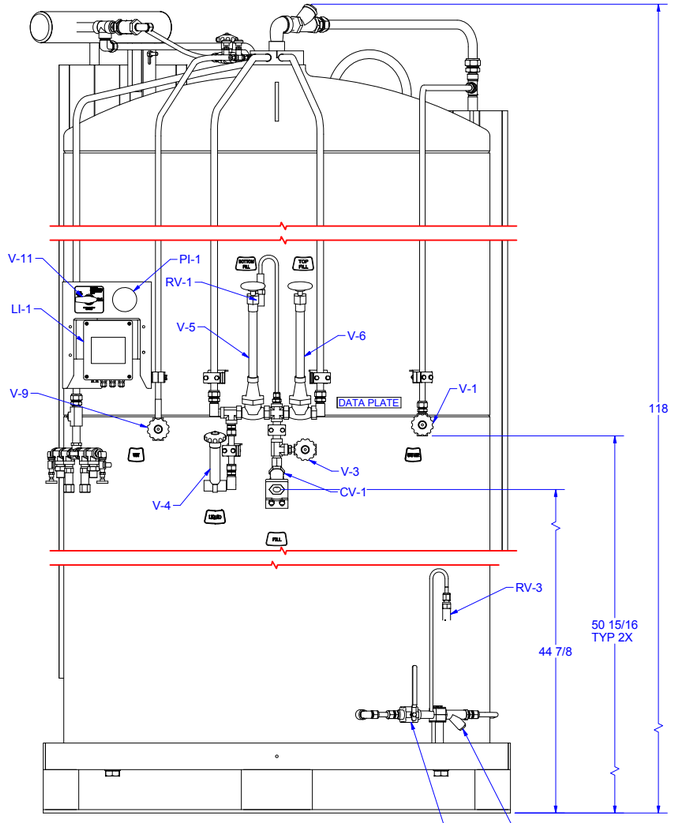
TITLE: SPEC DWG PERMA-CYL 2000HP PSTR FLEX FILL

DRAWING NO. D-20852343 REV:

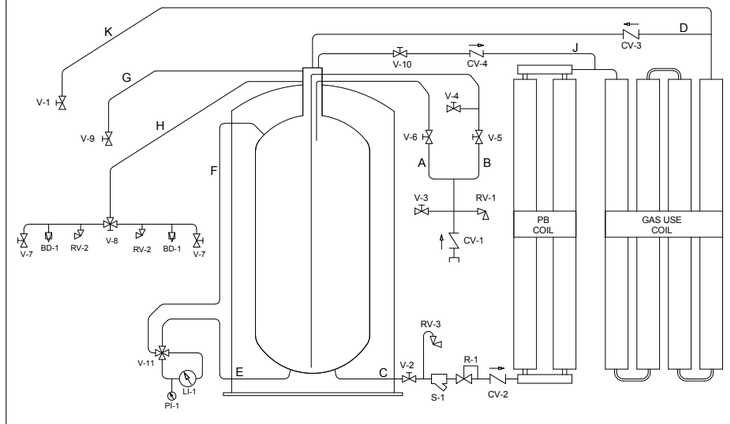
SCALE: N/A DO NOT SCALE DRAWING SHEET: 1 of 1



TOP VIEW

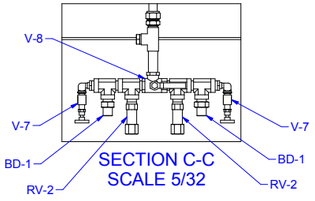


FRONT VIEW

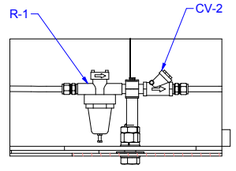


SCHEMATIC

NOMENCLATURE	
BD-1	TANK SECONDARY RELIEF DEVICE BURST DISC
CV-1	TANK FILL CHECK VALVE
CV-2	TANK P.B. INLET CHECK VALVE
CV-3	TANK P.B. OUTLET CHECK VALVE
CV-4	TANK ECONOMIZER CHECK VALVE
LI-1	TANK LIQUID LEVEL GAUGE
PI-1	TANK PRESSURE GAUGE
R-1	TANK P.B. REGULATOR
RV-1	TANK FILL ASSEMBLY RELIEF VALVE
RV-2	TANK PRIMARY RELIEF VALVE
RV-3	TANK P.B. INLET RELIEF VALVE
S-1	TANK P.B. STRAINER
V-1	TANK GAS USE VALVE
V-2	TANK P.B. INLET ISO VALVE
V-3	TANK FILL HOSE DRAIN VALVE
V-4	TANK LIQUID WITHDRAWAL VALVE
V-5	TANK BOTTOM FILL VALVE
V-6	TANK TOP FILL VALVE
V-7	TANK SAFETY LINE PURGE VALVE
V-8	TANK SAFETY 3-WAY DIVERTER VALVE
V-9	TANK FULL TRYCOCK/VENT VALVE
V-10	TANK ECONOMIZER ISO VALVE
V-11	TANK GAUGE ISOLATION VALVE
PIPING	
A	TANK TOP FILL
B	TANK BOTTOM FILL & LIQUID USE
C	TANK P.B. INLET
D	TANK P.B. OUTLET
E	TANK LIQUID PHASE
F	TANK VAPOR PHASE
G	TANK VENT
H	TANK DUAL RELIEF
J	TANK ECONOMIZER
K	TANK GAS USE



SECTION C-C
SCALE 5/32



SECTION B-B
SCALE 5/32

DRAWING NO D-20852341

DESIGN SPECIFICATION	
ITEM	2000 VHP FLEX FILL
CODE	ASME SEC. VIII. DIV 1
RELIEF SETTING MAWP	250 PSI / 17.2 BAR
	350 PSI / 24.1 BAR
	500 PSI / 34.5 BAR
GROSS VOLUME	2,042 LITERS / 539.5 GALLONS
NET VOLUME	1,945 LITERS / 513.9 GALLONS
TARE WEIGHT WITH LAB BASE	2,950 lbs / 1,338 kg
NORMAL EVAPORATION RATE	1 % PER DAY NITROGEN .62 % PER DAY OXYGEN .62 % PER DAY ARGON
MATERIAL	TYPE 304 STAINLESS STEEL
	PALLET BASE GALVANIZED
GASEOUS EQUIVALENT: SCF AT 1 ATM & 70° F / Nm³ AT 1 ATM & 0°C	
NITROGEN	47,847 SCF / 1,257 Nm³
OXYGEN	59,089 SCF / 1,553 Nm³
ARGON	57,786 SCF / 1,519 Nm³
GAS DELIVERY RATE **	
NITROGEN	2,000 SCF/H / 52.4 Nm³/h
OXYGEN	2,000 SCF/H / 52.4 Nm³/h
ARGON	2,000 SCF/H / 52.4 Nm³/h

PARTS LIST

ITEM	QTY	PART NO.	DESCRIPTION	MANUFACTURER P/N	MANUFACTURER
*BD-1	2	11671281	RPD ASSY INLINE 1/2MPT 375PSI	011-0258	BS&B
		11526569	RPD ASSY INLINE 1/2MPT 525PSI	005-0026	BS&B
		11526622	RPD ASSY INLINE 1/2MPT 700PSI	005-0023	BS&B
CV-1	1	11051090	VALVE CHECK BRS 1/2FPTX1/2FPT	CV-503B-T-5	GENERANT
CV-2	1	13462175	KIT CHECK VALVE NIBCO 1/2"FPT	T-473-Y 1/2"	NIBCO
CV-3	1	11656072	VALVE CHECK BRS 1FPT	T-473-Y 1" CLASS 300	NIBCO
CV-4	1	13620233	VALVE CHECK BRS 1/2FPTX1/2FPT	CV-513B-T-1-X	GENERANT
*LI-1	1	20910598	CYL-TEL GEN 4 0-200"H2O	#9500-8200BL	CYL-TEL
		20923162	DIFF PG 4.5" 0-100" H2O VITON (O2, N2)	52721099	WIKA
		20909588	DIFF PG 4.5" 0-150" H2O VITON (AR)	52721125	WIKA
PI-1	1	20827654	PG 2-1/2" 0-600PSI/BAR 1/8MPT	52553914	WIKA
*R-1	1	11779806	REGULATOR .500NPT @ 125PSI	21999-0125	CASH-ACME
		11690211	REGULATOR .500NPT @ 300PSI	21999-0300	CASH-ACME
		11635511	REGULATOR .500NPT @ 450PSI	21971-0450	CASH-ACME
RV-1	1	1812702	RV BRS 1/4MPT 550PSI	PRV9432T550	REGO
*RV-2	2	11488574	RV BRS 1/2MPT 250PSI	PRV19434TP250	REGO
		20599868	RV BRS 1/2MPT 350PSI	PRV19434TP350	REGO
		20894583	RV BRS 1/2MPT 500PSI	PRV19434TP500	REGO
RV-3	1	1812702	RV BRS 1/4MPT 550PSI	PRV9432T550	REGO
S-1	1	11529090	STRAINER .500NPT BRZ BODY	200WSH 600	UNITED BRASS
V-1	1	10502848	VALVE SHUTOFF BRZ 1/2FPT SHORT	T9454	REGO
V-2	1	1712202	VALVE BALL BRS 1/2FPT	CN4416PMSE	WORCESTER
V-3	1	11905999	VALVE SHUTOFF 1/4FPT	T9452	REGO
V-4	1	11625639	VALVE GLOBE BRS 1/2FPT EX.STEM	BK9454	REGO
V-5	1	10616790	VALVE GLOBE BRS 1/2NPT SCRD	BK9404T	REGO
V-6	1	10616790	VALVE GLOBE BRS 1/2NPT SCRD	BK9404T	REGO
V-7	2	10907239	VALVE NEEDLE BRS 1/4MPT(ANGLE)	CMM250A	REGO
V-8	1	11773885	VALVE BALL DIV SS 1/2NPT	76-603-57	APOLLO
V-9	1	11905956	VALVE BRS SH 3/8FPTX3/8 SCH 10	T9464DA	REGO
V-10	1	11905999	VALVE SHUTOFF 1/4FPT	T9452	REGO
V-11	1	20683719	VALVE 4-WAY BRS 1/8FPT	B-43YTF2-WL8	SWAGELOK

NOTE:
* - PART NUMBERS ARE DEPENDENT ON THE PLUMBING OPTION KIT CHOSEN FOR THE VESSEL.
** - OPTIONAL 3,500 SCF/H (92 Mn³h) FLOW KIT AVAILABLE

REV	APPV	ECR	REVISION DESCRIPTION	BY	DATE

DESIGNATES A NOTE REFERENCE.

MAT'L
SEE B.O.M.

FINISH P/N
20852341

	APPV'D	DATE
DRAWN BY	JNB	7/31/2015
CHECKED BY		
PROJ. ENGR.	CGT	10/6/2015

USED ON 208999
APPLICATION ORIGINAL ECR/ER

CHART INC., BALL GROUND, GA 30107

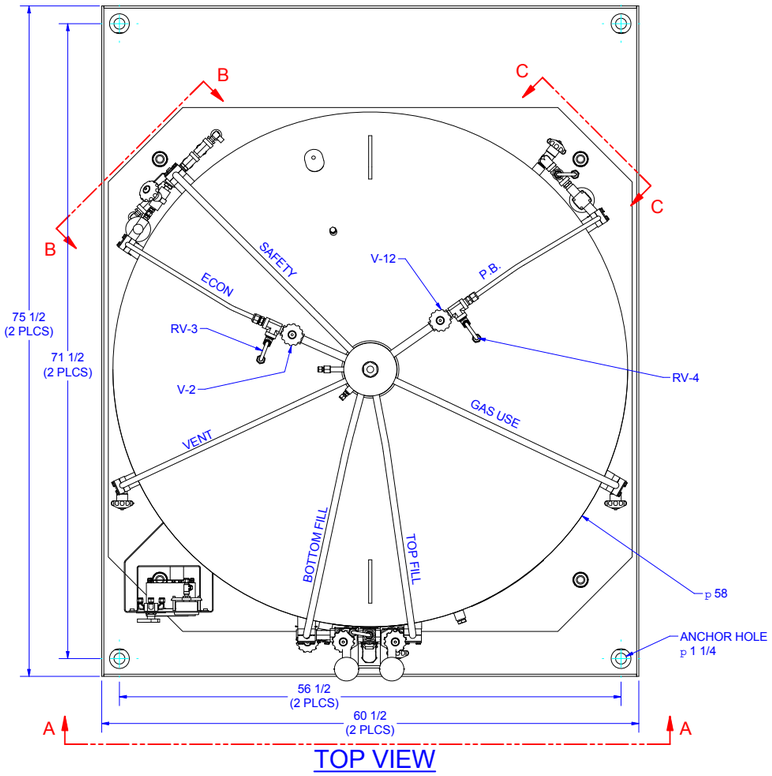
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES.
TOLERANCES:
FRACTIONS ± 1/2
ANGLES ± 1 °
2 PLACE DECIMAL ± N/A
3 PLACE DECIMAL ± N/A

TITLE: SPEC DWG PERMA-CYL 2000VHP PSTR FLEX FILL

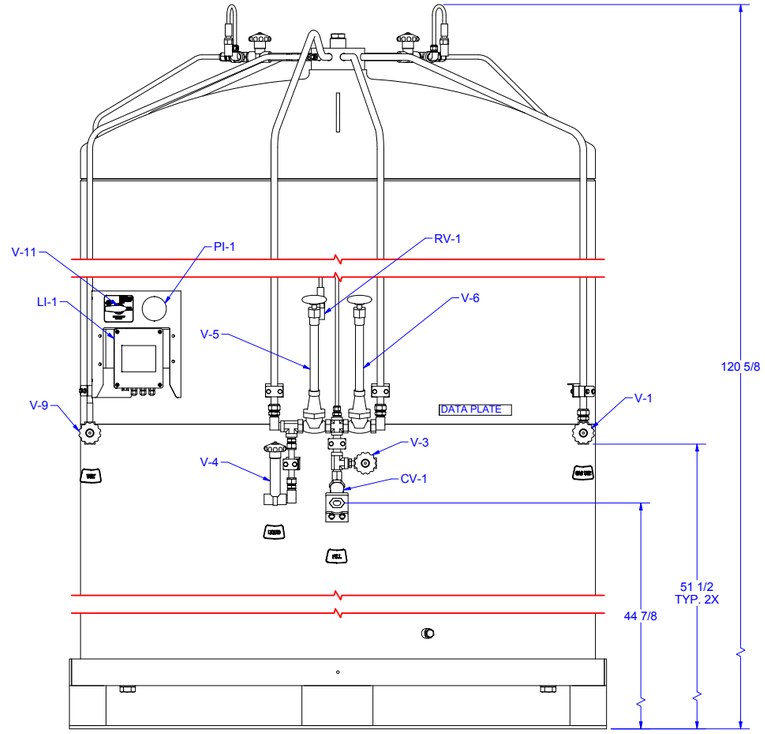
DRAWING NO. D-20852341 REV:

SCALE: N/A DO NOT SCALE DRAWING SHEET: 1 of 1

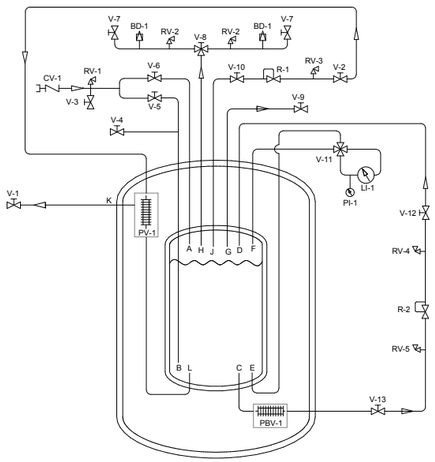
DRAWING NO D-20852344



TOP VIEW

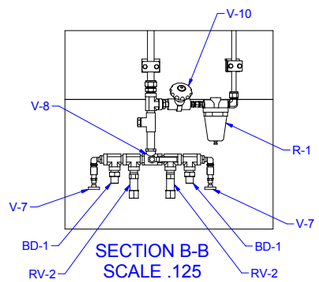


FRONT VIEW

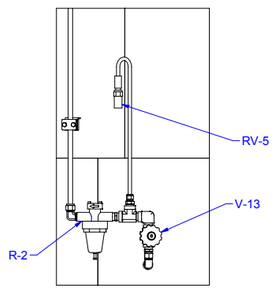


SCHEMATIC

NOMENCLATURE	
BD-1	TANK SECONDARY RELIEF DEVICE BURST DISC
CV-1	TANK FILL CHECK VALVE
LI-1	TANK LIQUID LEVEL GAUGE
PBV-1	TANK PRESSURE BUILDING VAPORIZER COIL
PI-1	TANK PRESSURE GAUGE 0-400 PSI
PV-1	TANK PROCESS VAPORIZER COIL
R-1	TANK ECONOMIZER REGULATOR
R-2	TANK PB REGULATOR
RV-1	TANK FILL ASSEMBLY RELIEF VALVE
RV-2	TANK PRIMARY RELIEF VALVE
RV-3	TANK ECON INLET RELIEF VALVE
RV-4	TANK PB OUTLET RELIEF VALVE
RV-5	TANK PB INLET RELIEF VALVE
V-1	TANK GAS USE VALVE
V-2	TANK ECONOMIZER INLET ISO VALVE
V-3	TANK FILL HOSE DRAIN VALVE
V-4	TANK LIQUID WITHDRAWAL VALVE
V-5	TANK BOTTOM FILL VALVE
V-6	TANK TOP FILL VALVE
V-7	TANK SAFETY LINE PURGE VALVE
V-8	TANK SAFETY 3-WAY DIVERTER VALVE
V-9	TANK FULL TRYCOCK / VENT VALVE
V-10	TANK ECONOMIZER VALVE
V-11	TANK GAUGE ISOLATION VALVE
V-12	TANK PRESSURE BUILD OUTLET ISO VALVE
V-13	TANK PRESSURE BUILD INLET ISO VALVE
PIPING	
A	TANK TOP FILL
B	TANK BOTTOM FILL & LIQUID USE
C	TANK PB INLET
D	TANK PB OUTLET
E	TANK LIQUID PHASE
F	TANK VAPOR PHASE
G	TANK FULL TRYCOCK / VENT VALVE
H	TANK DUAL RELIEF
J	TANK ECONOMIZER
K	TANK GAS USE OUT
L	TANK GAS USE IN



SECTION B-B
SCALE .125



SECTION C-C
SCALE .125

DESIGN SPECIFICATION	
ITEM	3000 HP FLEX FILL
CODE	ASME SEC. VIII. DIV 1
RELIEF SETTING MAWP	250 PSI / 17.2 BAR
	350 PSI / 24.1 BAR
	500 PSI / 34.4 BAR
GROSS VOLUME	2,911 LITERS / 769 GALLONS
NET VOLUME	2,707 LITERS / 715 GALLONS
TARE WEIGHT WITH LAB BASE	3,800 lbs / 1,724 kg
NORMAL EVAPORATION RATE	1 % PER DAY NITROGEN .62 % PER DAY OXYGEN .62 % PER DAY ARGON
MATERIAL	TYPE 304 STAINLESS STEEL
	PALLET BASE GALVANIZED
GASEOUS EQUIVALENT: SCF AT 1 ATM & 70° F / Nm³ AT 1 ATM & 0ºC	
NITROGEN	66,592 SCF / 1,750 Nm³
OXYGEN	82,239 SCF / 2,161 Nm³
ARGON	80,425 SCF / 2,115 Nm³
GAS DELIVERY RATE **	
NITROGEN	1,350 SCF/H / 35.4 Nm³/h
OXYGEN	1,350 SCF/H / 35.4 Nm³/h
ARGON	1,350 SCF/H / 35.4 Nm³/h

PARTS LIST

ITEM	QTY	PART NO.	DESCRIPTION	MANUFACTURER P/N	MANUFACTURER
*BD-1	2	11671281	RPD ASSY INLINE 1/2MPT 375PSI	011-0258	BS&B
		11526569	RPD ASSY INLINE 1/2MPT 525PSI	011-0258	BS&B
CV-1	1	11051090	VALVE CHECK BRS 1/2FPTX1/2FPT	CV-503B-T-5	GENERANT
*LI-1	1	20910598	CYL-TEL GEN 5 0-200"H2O	-	Chart
		20923162	DIFF PG 4.5" 0-100" H2O VITON (O2, N2)	52721099	WIKA
		20909588	DIFF PG 4.5" 0-150" H2O VITON (AR)	52721125	WIKA
PI-1	1	20827654	PG 2-1/2" 0-600PSI/BAR 1/8MPT	52553914	WIKA
*R-1	1	11501177	REGULATOR .250FPT @ 140PSI	12790-0140	CASH-ACME
		20885664	REGULATOR .250FPT @ 325PSI	12790-0140	CASH-ACME
*R-2	1	11779806	REGULATOR .500NPT @ 125PSI	21999-0125	CASH-ACME
		11690211	REGULATOR .500NPT @ 300PSI	21999-0300	CASH-ACME
RV-1	1	1812702	RV BRS 1/4MPT 550PSI	PRV9432T550	REGO
*RV-2	2	11488574	RV BRS 1/2MPT 250PSI	PRV19434TP250	REGO
		20599868	RV BRS 1/2MPT 350PSI	PRV19434TP250	REGO
RV-3	1	1812702	RV BRS 1/4MPT 550PSI	PRV9432T550	REGO
RV-4	1	1812702	RV BRS 1/4MPT 550PSI	PRV9432T550	REGO
RV-5	1	1812702	RV BRS 1/4MPT 550PSI	PRV9432T550	REGO
V-1	1	10502848	VALVE SHUTOFF BRZ 1/2FPT SHORT	T9454	REGO
V-2	1	11905999	VALVE SHUTOFF 1/4FPT	T9452	REGO
V-3	1	11905999	VALVE SHUTOFF 1/4FPT	T9452	REGO
V-4	1	11625639	VALVE GLOBE BRS 1/2FPT EX.STEM	BK9454	REGO
V-5	1	10616790	VALVE GLOBE BRS 1/2NPT SCRD	BK9404T	REGO
V-6	1	10616790	VALVE GLOBE BRS 1/2NPT SCRD	BK9404T	REGO
V-7	2	10907239	VALVE NEEDLE BRS 1/4MPT(ANGLE)	CMM250A	REGO
V-8	1	11773885	VALVE BALL DIV SS 1/2NPT	76-603-57	APOLLO
V-9	1	11905956	VALVE BRS SH 3/8FPTX3/8 SCH 10	T9464DA	REGO
V-10	1	11905999	VALVE SHUTOFF 1/4FPT	T9452	REGO
V-11	1	20683719	VALVE 4-WAY BRS 1/8FPT	B-43YTF2-WL8	SWAGELOK
V-12	1	10502848	VALVE SHUTOFF BRZ 1/2FPT SHORT	T9454	REGO
V-13	1	10502848	VALVE SHUTOFF BRZ 1/2FPT SHORT	T9454	REGO

NOTE:
* - PART NUMBERS ARE DEPENDENT ON THE PLUMBING OPTION KIT CHOSEN FOR THE VESSEL.
** - OPTIONAL 3,500 SCF/H (92 Mn³h) FLOW KIT AVAILABLE

REV	APPV	ECR	REVISION DESCRIPTION	BY	DATE

DESIGNATES A NOTE REFERENCE.

MAT'L
SEE B.O.M.

FINISH P/N
20852344

	APPV'D	DATE
DRAWN BY	JNB	7/31/2015
CHECKED BY		
PROJ ENGR	CGT	10/6/2015

USED ON 208999
APPLICATION ORIGINAL ECR/ER

CHART, INC.
BALL GROUND, GA 30107

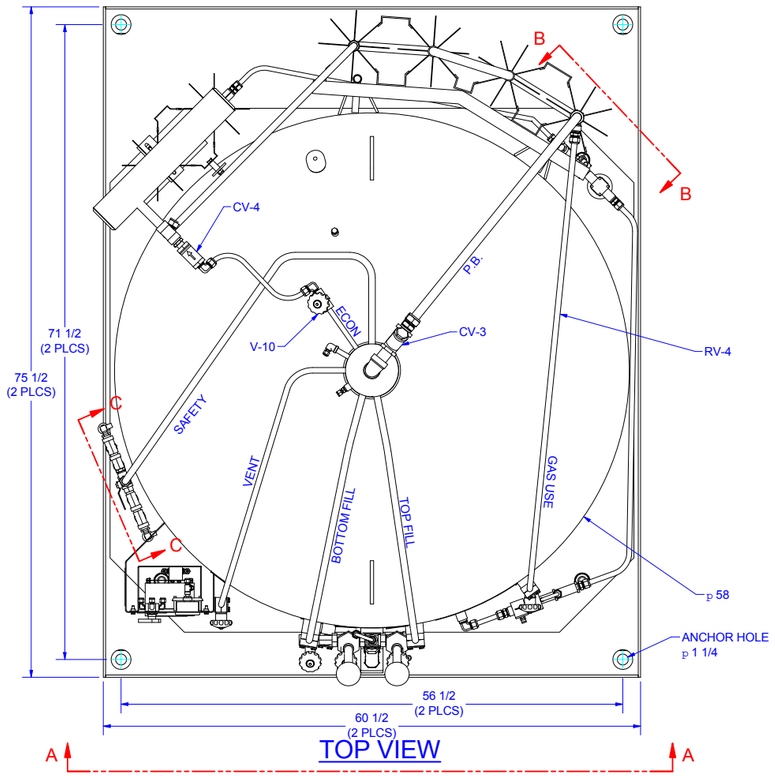
TITLE: SPEC DWG PERMA-CYL 3000HP PSTR FLEX FILL

DRAWING NO. D-20852344 REV:

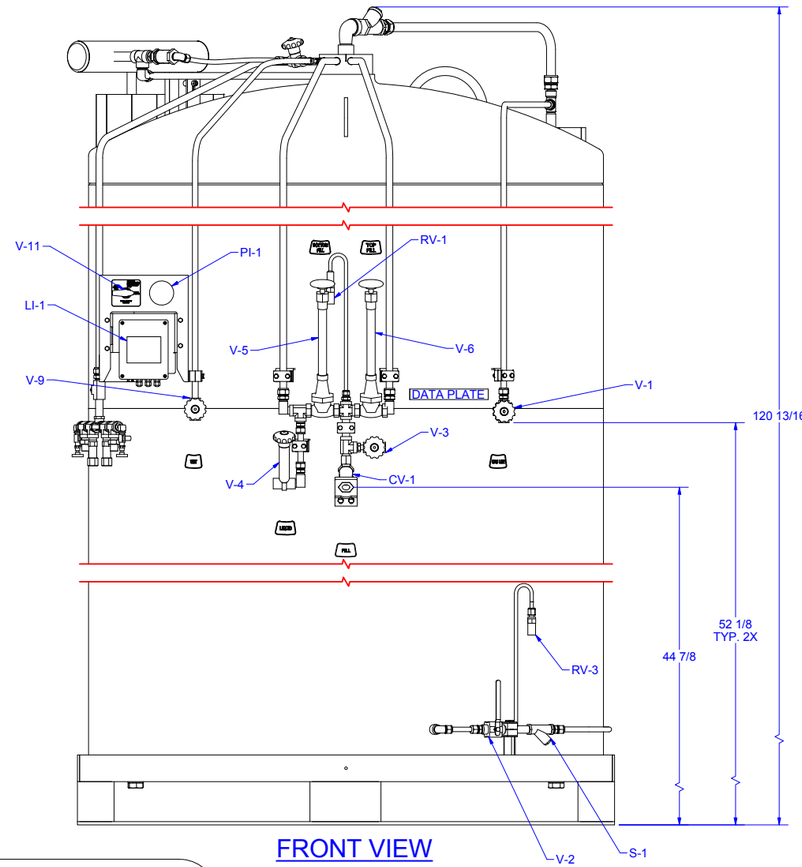
SCALE: N/A DO NOT SCALE DRAWING SHEET: 1 of 1

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES.
TOLERANCES:
FRACTIONS ± 1/2
ANGLES ± 1 °
2 PLACE DECIMAL ± N/A
3 PLACE DECIMAL ± N/A

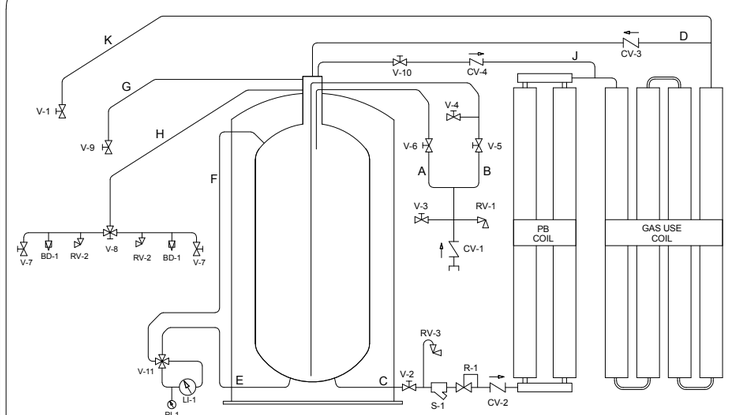
DRAWING NO D-20852350



TOP VIEW

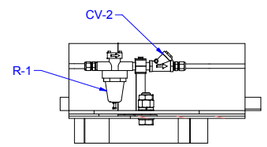


FRONT VIEW

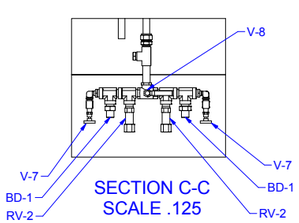


SCHEMATIC

NOMENCLATURE	
BD-1	TANK SECONDARY RELIEF DEVICE BURST DISC
CV-1	TANK FILL CHECK VALVE
CV-2	TANK P.B. INLET CHECK VALVE
CV-3	TANK P.B. OUTLET CHECK VALVE
CV-4	TANK ECONOMIZER CHECK VALVE
LI-1	TANK LIQUID LEVEL GAUGE
PI-1	TANK PRESSURE GAUGE
R-1	TANK P.B. REGULATOR
RV-1	TANK FILL ASSEMBLY RELIEF VALVE
RV-2	TANK PRIMARY RELIEF VALVE
RV-3	TANK P.B. INLET RELIEF VALVE
S-1	TANK P.B. STRAINER
V-1	TANK GAS USE VALVE
V-2	TANK P.B. INLET ISO VALVE
V-3	TANK FILL HOSE DRAIN VALVE
V-4	TANK LIQUID WITHDRAWAL VALVE
V-5	TANK BOTTOM FILL VALVE
V-6	TANK TOP FILL VALVE
V-7	TANK SAFETY LINE PURGE VALVE
V-8	TANK SAFETY 3-WAY DIVERTER VALVE
V-9	TANK FULL TRYCOCK/VENT VALVE
V-10	TANK ECONOMIZER ISO VALVE
V-11	TANK GAUGE ISOLATION VALVE
	PIPING
A	TANK TOP FILL
B	TANK BOTTOM FILL & LIQUID USE
C	TANK P.B. INLET
D	TANK P.B. OUTLET
E	TANK LIQUID PHASE
F	TANK VAPOR PHASE
G	TANK VENT
H	TANK DUAL RELIEF
J	TANK ECONOMIZER
K	TANK GAS USE



SECTION B-B
SCALE .125



SECTION C-C
SCALE .125

DESIGN SPECIFICATION	
ITEM	3000 VHP FF
CODE	ASME SEC. VIII. DIV 1
RELIEF SETTING MAWP	250 PSI / 17.2 BAR
	350 PSI / 24.1 BAR
	500 PSI / 34.5 BAR
GROSS VOLUME	2,911 LITERS / 769 GALLONS
NET VOLUME	2,707 LITERS / 715 GALLONS
TARE WEIGHT WITH LAB BASE	4,750 lbs / 2,155 kg
NORMAL EVAPORATION RATE	1 % PER DAY NITROGEN .62 % PER DAY OXYGEN .62 % PER DAY ARGON
MATERIAL	TYPE 304 STAINLESS STEEL
	PALLET BASE GALVANIZED
GASEOUS EQUIVALENT: SCF AT 1 ATM & 70° F / Nm³ AT 1 ATM & 0°C	
NITROGEN	66,592 SCF / 1,750 Nm³
OXYGEN	82,239 SCF / 2,161 Nm³
ARGON	80,425 SCF / 2,115 Nm³
GAS DELIVERY RATE **	
NITROGEN	2,000 SCF/H / 52.4 Nm³/h
OXYGEN	2,000 SCF/H / 52.4 Nm³/h
ARGON	2,000 SCF/H / 52.4 Nm³/h

PARTS LIST

ITEM	QTY	PART NO.	DESCRIPTION	MANUFACTURER P/N	MANUFACTURER
*BD-1	2	11671281	RPD ASSY INLINE 1/2MPT 375PSI	-	BS&B
		11526569	RPD ASSY INLINE 1/2MPT 525PSI	005-0026	BS&B
		11526622	RPD ASSY INLINE 1/2MPT 700PSI	005-0023	BS&B
CV-1	1	11051090	VALVE CHECK BRS 1/2FPTX1/2FPT	CV-503B-T-5	GENERANT
CV-2	1	13462175	KIT CHECK VALVE NIBCO 1/2"FPT	T-473-Y 1/2"	NIBCO
CV-3	1	11656072	VALVE CHECK BRS 1FPT	T-473-Y 1" CLASS 300	NIBCO
CV-4	1	13620233	VALVE CHECK BRS 1/2FPTX1/2FPT	CV-513B-T-1-X	GENERANT
*LI-1	1	20786602	CYL-TEL GEN 5 BACK 0-200"H2O	-	CHART
		20923162	DIFF PG 4.5" 0-100" H2O VITON (O2, N2)	52721099	WIKA
		20909588	DIFF PG 4.5" 0-150" H2O VITON (AR)	52721125	WIKA
PI-1	1	20827654	PG 2-1/2" 0-600PSI/BAR 1/8MPT	52553914	WIKA
*R-1	1	11779806	REGULATOR .500NPT @ 125PSI	21999-0125	CASH-ACME
		11690211	REGULATOR .500NPT @ 300PSI	21999-0300	CASH-ACME
		11635511	REGULATOR .500NPT @ 450PSI	21971-0450	CASH-ACME
RV-1	1	1812702	RV BRS 1/4MPT 550PSI	PRV9432T550	REGO
*RV-2	2	11488574	RV BRS 1/2MPT 250PSI	PRV19434TP250	REGO
		20599868	RV BRS 1/2MPT 350PSI	PRV19434TP350	REGO
		20894583	RV BRS 1/2MPT 500PSI	PRV19434TP500	REGO
RV-3	1	1812702	RV BRS 1/4MPT 550PSI	PRV9432T550	REGO
S-1	1	11529090	STRAINER .500NPT BRZ BODY	200WSH 600	UNITED BRASS
V-1	1	10502848	VALVE SHUTOFF BRZ 1/2FPT SHORT	T9454	REGO
V-2	1	11905999	VALVE SHUTOFF 1/4FPT	T9452	REGO
V-3	1	11905999	VALVE SHUTOFF 1/4FPT	T9452	REGO
V-4	1	11625639	VALVE GLOBE BRS 1/2FPT EX.STEM	BK9454	REGO
V-5	1	10616790	VALVE GLOBE BRS 1/2NPT SCRD	BK9404T	REGO
V-6	1	10616790	VALVE GLOBE BRS 1/2NPT SCRD	BK9404T	REGO
V-7	2	10907239	VALVE NEEDLE BRS 1/4MPT(ANGLE)	CMM250A	REGO
V-8	1	11773885	VALVE BALL DIV SS 1/2NPT	76-603-57	APOLLO
V-9	1	11905956	VALVE BRS SH 3/8FPTX3/8 SCH 10	T9464DA	REGO
V-10	1	11905999	VALVE SHUTOFF 1/4FPT	T9452	REGO
V-11	1	20683719	VALVE 4-WAY BRS 1/8FPT	B-43YTF2-WL8	SWAGELOK

NOTE:
* - PART NUMBERS ARE DEPENDENT ON THE PLUMBING OPTION KIT CHOSEN FOR THE VESSEL.
** - OPTIONAL 3,500 SCF/H (92 Mn³h) FLOW KIT AVAILABLE

REV	APPV	ECR	REVISION DESCRIPTION	BY	DATE

(#) DESIGNATES A NOTE REFERENCE.

MAT'L
SEE B.O.M.

FINISH P/N
20852350

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES.
TOLERANCES:
FRACTIONS ± 1/2
ANGLES ± 1 °
2 PLACE DECIMAL ± N/A
3 PLACE DECIMAL ± N/A

	APPV'D	DATE
DRAWN BY	JNB	3/27/2015
CHECKED BY		
PROJ ENGR	CGT	10/6/2015

USED ON 208999
APPLICATION ORIGINAL ECR/ER

CHART
CHART, INC.
BALL GROUND, GA 30107

TITLE: SPEC DWG PERMA-CYL 3000VHP PSTR FF

DRAWING NO. D-20852350 REV:

SCALE: N/A DO NOT SCALE DRAWING SHEET: 1 of 1