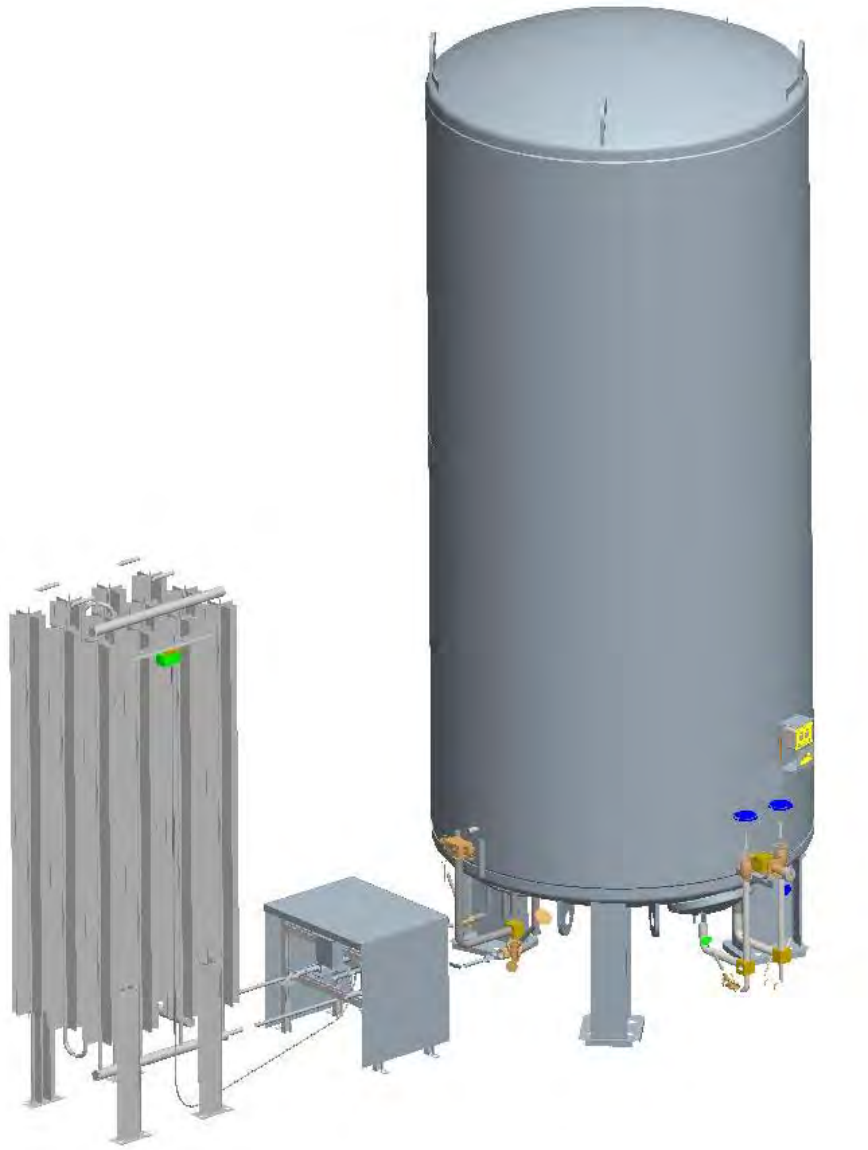
TECHNICAL MANUAL
HP^2 System



MANUAL # 11828962
Rev 3

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Revision Log	Description
Rev 0 (10/03)	Initial Release
Rev 1 (12/03)	Update drawings and move to end of manual
Rev 2 (03/05)	Update Controls
Rev 3 (04/06)	Remove P&IDs, updates for new pressure switch

Chapter 1

1 SAFETY

1.1 GENERAL

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

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

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.) As a rule of thumb, whenever a container is suspected of abnormal operation, or has sustained actual damage, good safety practices must be followed.

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

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.

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.

1.2 OXYGEN DEFICIENT ATMOSPHERES

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

One aspect of this possible hazard is the response of humans when exposed to an atmosphere containing only 8 to 12% oxygen. In this environment, unconsciousness can be immediate with virtually no warning. When the oxygen content of air is reduced to about 15 to 16%, the flame of ordinary combustible materials, including those commonly used as fuel for heat or light, may be extinguished. Somewhat below this concentration, an individual breathing the air is mentally incapable of diagnosing the situation because the onset of symptoms such as sleepiness, fatigue, lassitude, loss of coordination, errors in judgment and confusion can be masked by a state of "euphoria," leaving the victim with a false sense of security and well being.

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

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

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

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

1.3 OXYGEN ENRICHED ATMOSPHERES

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

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

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

1.4 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.

Additional information on nitrogen and argon and liquid cylinders is available in CGA Pamphlet p-9. Write to the Compressed Gas Association, Inc., New York, NY 10110.

N O T E :

Extracted from Safety Bulletin SB-2 from Compressed Gas Association, Inc., New York, dated March 1966 and from the "Nitrogen Material Safety Data Sheet"' published by Air Products and Chemicals, Inc., Allentown, PA 18105, dated 1 June 1978.

Chapter

2

2 VESSEL INFORMATION

Although vessels may vary in piping and plumbing details, some general comments on configuration and operation can be made.

2.1 RECEIVING CHECKPOINTS

1. Check braces, skids, wooden chocks, and other shipping supports. Damage or deformation would indicate the possibility of mishandling during shipment.

2. Examine welded or brazed joints on plumbing for cracks or deformation, especially near valves and fittings.

3. Check points where pipes exit the tank for cracks or breaks.

4. Check relief valves and burst discs for dirt or damage.

5. Check pressure within vessel on PI-1. If pressure is zero, extra precautions against contamination and impurities must be taken.

6. Examine the 5g impactograph. If it has sprung, damage may have occurred during shipment. Notify your company's tank specialist and/or CHART.

7. Check the container vacuum.

    a) If warm vacuum for "NC" models is above 20 microns, consult factory.

2.2 VACUUM CHECK PROCEDURE

CAUTION: UNAUTHORIZED CHANGING OF THE VACUUM PROBE WILL VOID VESSEL WARRANTY.

1. The standard CHART vacuum probe is a Teledyne-Hastings DV-6R probe. Select a compatible instrument to read the output of the vacuum probe.
2. Remove the rubber cap on probe outlet to expose contact. Note .that probe housing need not be opened to do this.

3. Plug the instrument to the probe and calibrate the instrument.

4. Open the vacuum probe isolation valve. Wait for 5 minutes and take vacuum reading. Note that valve handle protrudes through protective housing and can be turned without opening the housing.

5. Close the isolation valve and take a second reading. Monitor the rate of rise in vacuum probe with isolation valve closed. If the vacuum continues to rise at a constant rate, it is possible that the probe assembly is leaking. Consult the factory.

6. Verify that the isolation valve is closed.

7. Replace the rubber probe cap.

Compare the vacuum reading obtained now to reading taken prior to shipping.

2.3 PHYSICAL DESCRIPTION

A Chart vessel is designed for long-term storage of cryogenic liquefied gases under pressure in the range of 5 PSI (0.4 kg/cm^2) to the MAWP (Maximum Allowable Working Pressure). Operation of the station can be fully automatic with the unit's regulator system set to maintain preset pressure and flow conditions into a customer's pipeline. While hardware may vary slightly from model to model, each unit essentially performs the same functions.

The vessel is comprised of an alloy steel inner tank encased in an outer carbon steel vacuum shell. The insulation system between the inner and outer containers consists of composite insulation and high vacuum to ensure long holding time. The insulation system designed for long-term vacuum retention is permanently sealed at the factory to ensure vacuum integrity. The units have a tank pressure relief device, which is set at the factory. As a secondary pressure relief device, the container is further protected from over-pressurization by a rupture disc. The bursting disc will rupture completely to relieve inner tank pressure in the event the tank relief valve fails and pressure exceeds the rupture disc setting. The vacuum space is protected from over-pressurization by use of a tank annulus rupture disc assembly. Pressure relief devices used on Chart vessels designed for the U.S. specifications meet the requirements of CGA Pamphlet S1.3, "Pressure Relief Device Standards, Part 1, for Stationary Vessels."

The stations are leg mounted. Lifting lugs are secured to the bottom head and to the top head of the container. The lifting lugs are provided to facilitate handling. Moving requires the use of a crane and adherence to specific rigging instructions, which may vary from vessel to vessel. Some Chart vessels cannot be lifted with one hook only.

Controls Used To Operate The System Are Mounted On A Separate Pluming Skid Which is Plumbed to The Tank During Installation. The Pressure Gauge And Liquid Level Gauge Are Located At Eye Level On The Container For Ease Of Viewing.

2.4 OPERATING DESCRIPTION

HP² technology is the proprietary property of Chart Inc. and is protected by pending patents.

HP² is a system and consists of three integrated primary components: a high-pressure bulk tank equipped with electrical pressure switch pressure control, a plumbing/control module, and a multi-function vaporizer.

Unique to the HP² system is its pressure control technology. Unlike traditional bulk tanks, mechanical spring-operated regulators do not control the pressure. In place of a pressure building regulator and an economizer regulator, the HP² system uses an electrical pressure switch, solenoid valve, and dual pneumatically actuated ball valves located in the plumbing module. The HP² system's improved pressure control technology produces faster responsiveness, greater pressure control precision, easier and faster pressure adjustment, and greater reliability.

Another significant and unique feature of the HP² system is the multi-function vaporizer. The multi-function vaporizer is an inseparable part of the HP² system because it acts as a combination pressure-building vaporizer and a gas supply vaporizer. Its proprietary design greatly improves the performance of the HP² system over that of a comparable traditional bulk tank. Combined with the pressure switch functionality, the multi-function vaporizer builds pressure many times faster than conventional pressure building systems, produces higher gas flow rates than similarly sized conventional vaporizers, and greatly reduces the entrance of unwanted heat back into the bulk tank.

2.5 PRESSURE BUILD-UP SYSTEM

The pressure build-up system consists of the plumbing module and the multi-function vaporizer. Attached to the plumbing module is an electrical switch box which must be supplied with 120VAC 5a power (wire to local electrical code requirements). The system power switch on the cover energizes the electrical pressure control switch, which determines the PB set pressure. The electrical pressure control switch is mounted to the plumbing module frame, and can be readily accessed to set the desired operating pressure. It is recommended to use the tank pressure gauge to set the operating pressure. The scale located on the electrical pressure control switch is only a rough guide to system setpoint.

When tank pressure becomes lower than the set point of the electrical pressure control switch, the PB regulating valve will open. As a result, liquid will be able to flow from the tank, through the isolation valve and control valve to the multi-function vaporizer. The resulting gas vapor is then passed to and accumulates in the tank vapor space to increase pressure. This flow continues until inner tank pressure equals the electrical pressure control switch setting, at which time the PB control valve is closed and the economizing control valve is opened. The system then automatically maintains station pressure as required.

2.6 ECONOMIZER SYSTEM

The HP² system is self-economizing by design. The PB return contains an actuated control valve to control tank economizing functions. There is no dedicated economizer circuit on an HP² system tank.

2.7 OPERATOR QUALIFICATIONS

Chart Stations are designed for safe and simple operation. The operator is expected to be knowledgeable of the nature of the gas (es) with which he is working, as well as all applicable safety requirements. This manual contains several chapters dealing with Operating instructions, Handling Instructions, and Maintenance Procedures. To fully understand these procedures, we recommend the operator first become familiar with controls and indicators.

Chapter

3

3 CONTROLS

Chart cryogenic container operating procedures specify that the operator shall be familiar with all controls and indicators as well as safety considerations. The following controls and indicators should be located and identified on the vessel prior to filling or putting the vessel into operation.

For a list of controls and indicators, See Process & Instrument Diagram in Section 9.

Chapter

4

4 FILLING PROCEDURES

This chapter provides the initial fill, gas use, liquid delivery, and refilling procedures for the vessel described in this manual. Before performing any of the procedures contained in this chapter, become familiar with the location and function of the controls and indicators.

4.1 INITIAL FILL

The initial fill is usually performed on a warm vessel, one that has not been in use for an extended period. The warm container must be purged to ensure product purity.

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

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

2. The vessel may be filled by pumping or pressure transfer. If vessel pressure is at least 50 PSI (3.5 kg/cm^2) less than the maximum allowable pressure of the supply unit, liquid may be transferred by pressure transfer. If the normal working pressure of the station is equal to or grater than the maximum allowable pressure of the supply unit, liquid must be pumped into the tank.

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

4. When changing service, the approved CGA (or other keyed) fitting will have to be installed for connection FC-1.

Table 1 Vessel Purging Procedure

STEP NUMBER	Purging Procedure
	CAUTION The maximum purge pressure should be equal to 50 percent of the maximum operating pressure of the tank or 30 PSI (2.1 kg/cm^2), whichever is less. The maximum purge pressure should be determined before starting the purge operation. To prevent drawing atmospheric contaminants back into the tank, a positive pressure of at least 5 PSI (0.4 kg/cm^2) must always be maintained in the tank. Attach the source of liquid purge to the fill connection (FC-1).
1	Close all valves except the pressure build-up valves (HCV-18, HCV-19) and liquid level gauge vapor phase and liquid phase shutoff valves (HCV-8, HCV-10).
	NOTE
2	The electrical pressure control switch is pre-set to 300 psi. **DO NOT** adjust the switch at this point. The PB feed control valve must be open for system purging Open hose drain valve (HCV-7), and allow source to vent through hose. Vent until slight frosting appears on hose. Close hose drain valve (HCV-7).
3	Open the bottom fill valve (HCV-1) enough to allow liquid to flow slowly into the tank through the bottom fill line. The gradual flow enables the liquid to vaporize in the line and pressure buildup coil and slowly build up pressure in the inner tank.
4	Shut off the liquid supply source when the pressure in the tank reaches the maximum purge pressure as indicated on tank pressure gauge (PI-1).
5	Open the fill line drain valve (HCV-7) slowly to avoid splashing of the liquid. Drain all liquid from the tank. The appearance of gas (vapor) at the drain indicates that all liquid has been drained.
6	Close drain valve (HCV-7) and bottom fill valve (HCV-1).
7	Open the liquid level gauge equalization valve (HCV-9) to prevent damage to the gauge before closing the liquid level gauge vapor phase and liquid phase shut-off valves. When all liquid is drained, close the liquid level gauge vapor phase and liquid phase shut-off valves (HCV-8, HCV-10).
8	Loosen the unions on either side of the liquid level gauge (LI-1). Both the upper and lower liquid level gauge valves (HCV-8, HCV-10) should be opened wide and the gas streams visually checked for signs of moisture. Provided no moisture is observed after blowing the lines for approximately two minutes, both valves should be closed. If moisture is observed in the gas stream, the gas should be discharged until it is clear of all moisture.

STEP NUMBER	Purging Procedure
	NOTE
9	A careful check for moisture in the phase lines will ensure trouble free operation of the liquid level gauge. Due to their small diameter, gauge lines are easily plugged by ice.
10	Open the vapor vent valve (HCV-12) and full trycock valve (HCV-4). The top fill valve (HCV-2) will have to be vented by opening hose drain valve (HCV-7).
11	Repeat purge procedure 2 through 6 and 10 at least three times to ensure product purity.
12	Reconnect the liquid level gauge (LI-1), open the liquid level control valves (HCV-8, HCV-10), then close the by-pass valve (HCV-9).
13	After purging the tank, but before filling, verify that the following valves are open or closed as indicated.

Valve	**Position**
Bottom fill valve HCV-1	Closed
Top fill valve HCV-2	Closed
Vapor vent valve HCV-12	Closed
Full trycock valve HCV-4	Closed
Liquid level gauge equalizing valve HCV-9	Closed
Product supply valve HCV-13	Closed
Pressure building inlet/outlet valves HCV-3/HCV-11	Closed
Economizer isolation valve HCV-17	Closed
Liquid level gauge liquid phase valve HCV-10	Open
Liquid level gauge vapor phase valve HCV-8	Open
Aux. Liquid valve (PB feed) HCV-18	Closed
Aux. Vapor valve (PB return) HCV-19	Closed

Table 2 Initial (Warm Tank) Filling Procedure

STEP NUMBER	Initial (Warm Tank) Filling Procedure
1	Purge tank to assure product purity
2	Verify that the contents of the supply unit is the proper product to be transferred.
3	Verify that all valves except liquid phase-high (HCV-10) and gas phase-low (HCV-8) are closed.
4	Connect the supply unit transfer hose to tank fill connection (FC-1).
	NOTE Cool down the transfer hose prior to filling by opening hose drain valve (HCV-7) and venting the supply unit through the hose for approximately three minutes. Close drain valve (HCV-7).
5	Open bottom fill valve (HCV-1) slowly. If a pressure transfer is to be made, allow pressure to build up in the liquid supply unit until it is at least 50 PSI (3.5 kg/cm^2) higher than station pressure. Open the discharge valve on the supply unit to begin flow. (or) If a pump transfer is to be made, make the required connections to the pump. Open the supply unit transport discharge valve slowly. Maintain pump discharge pressure from 50 PSI (3.5 kg/cm^2) to 100 PSI (7.0 kg/cm^2) higher than the tank pressure. Fill slowly.
6	Monitor pressure in tank during filling. If pressure rises above supply pressure, or near relief valve pressure, the tank may have to be vented through the vapor vent valve (HCV-12), should pressure continue to rise, the fill may have to be interrupted to allow pressure to drop.
7	Monitor liquid level contents gauge (LI-1). When the gauge indicates approximately three-quarters full, open full trycock valve (HCV-4)
8	When liquid spurts from full trycock valve (HCV-4), immediately stop fill at the supply source and close full trycock valve (HCV-4).
9	Close bottom fill valve (HCV-1).
10	Drain residual liquid in the fill hose via drain valve (HCV-7).
11	Relieve fill hose pressure by loosening the hose at fill connection, then disconnect the hose. It is recommended that the fill hose be allowed to defrost to prevent moisture from being drawn inside the hose.

Table 3 Vessel Refilling Procedure

STEP NUMBER	Vessel Refilling Procedure
	NOTE
1	Filling a cryogenic vessel through the bottom tends to raise pressure in the vessel as gases in vapor space are compressed. Filling through the top tends to lower pressure as gases in head space are cooled down and re-liquefied.
2	Verify that the contents of the supply unit is the proper product to be transferred.
3	Verify that the bottom and top fill valves are closed (HCV-1, HCV-2).
4	Verify minimum required operating pressure in vessel.
5	Turn off HP^2 PB system by placing system power switch located on plumbing skid to "OFF"
6	Verify that all other valves are in normal operating positions.
7	Connect the supply unit transfer hose to tank fill connection (FC-1).
	NOTE
8	Cool and purge down the transfer hoses prior to filling by opening hose drain valve (HCV-7) and the supply unit discharge valve for approximately three minutes or until hose begins to frost. Close drain valve (HCV-7).
9	Open top fill valve (HCV-2) completely.
	If a PRESSURE TRANSFER is to be made, allow pressure to build up in the liquid supply unit until it is at least 50 PSI (3.5Kg/cm^2) higher than station pressure. Open the discharge valve on the supply unit to begin flow.
	(or)
	If a PUMP TRANSFER is to be made, make the required connections to the pump. Open the supply unit transport discharge valve slowly. Close pump circulating valve slowly, so as not to lose pump prime. Maintain pump discharge pressure from 50 PSI (3.5 kg/cm^2) to 100 PSI (7.0 kg/cm^2) higher than tank pressure.
10	Monitor pressure in vessel as indicated. If pressure begins to drop to near the minimum operating pressure, begin to open bottom fill valve (HCV-1), and throttle top fill valve (HCV-2), until pressure stabilizes.
11	Monitor liquid level contents gauge (LI-1). When the gauge indicates approximately three-quarters full, open full trycock valve (HCV-4).
12	When liquid spurts from full trycock valve (HCV-4), stop fill at the supply source and close full trycock valve (HCV-4).
13	Close tank fill valves (HCV-1, HCV-2).
14	Drain residual liquid in the fill hose via drain valve (HCV-7).
15	Relieve fill hose pressure by loosening the hose at the fill connection, and then disconnect the hose
16	Turn on HP^2 PB system by placing system power switch located on plumbing skid to "ON"

Chapter

5

5 WITHDRAWAL PROCEDURES

This chapter provides general guidelines for product decanting in either gaseous or liquid form for the vessel described in this manual. Before performing any of the procedures contained in this chapter, become familiar with the location and function of the controls and indicators.

5.1 LIQUID DELIVERY

Table 4 Liquid Withdrawal Procedure

STEP NUMBER	Liquid Withdrawal Procedure
1	Ensure Aux Liquid valve HCV-18 is closed before connecting to C-1 (NOTE: This will terminate product withdrawal).
2	Connect customer line liquid withdrawal connection (C-1).
3	Verify that all valves except gauge liquid phase valve (HCV-10) and the gauge gas phase valve (HCV-8) are closed.
4	Observe tank pressure as indicated on the station pressure gauge (PI-1). If station pressure is too high, readjust electrical pressure control switch as required for desired operating pressure. Open vent valve (HCV-12) as necessary to relieve excessive gas. It is possible that the electrical pressure control switch will require changing for lower operational pressure.
5	Open liquid withdrawal valve (HCV-18) slowly to begin liquid flow.
6	Once the desired amount of liquid has been delivered, close the liquid withdrawal valve (HCV-18).

5.2 GAS DELIVERY

Table 5 Gas Withdrawal Procedure

STEP NUMBER	Gas Withdrawal Procedure
1	Connect customer line to vaporizer main supply connection (C-10).
2	Verify that all valves except gauge liquid phase (HCV-10) and gauge gas phase (HCV-8) are closed.
3	Open Aux Vapor valve (HCV-19) and Aux Liquid valve (HCV-18) to start gas flow. The system will automatically deliver gas until stopped or vessel is empty.
4	Turn on HP^2 PB system by placing system power switch located on plumbing skid to "ON." Adjust electrical pressure control switch as required to control system operating pressure.
5	The pressure build control valve will open when the set pressure is reached. Once the required amount of product has been delivered (or to close the tank down for an extended period of time), turn off HP^2 PB system by placing system power switch located on plumbing skid to "OFF." The operation of a Chart unit is completely automatic, valves need to be opened and closed only during filling and during major maintenance.
6	Normal operating valve position for an HP^2 unit are as follows: Bottom fill valve HCV-1 — Closed Top fill valve HCV-2 — Closed Vapor vent valve HCV-12 — Closed Full trycock valve HCV-4 — Closed Liquid level gauge equalizing valve HCV-9 — Closed Hose drain valve HCV-7 — Closed Product supply valve HCV-13 — Closed Pressure building inlet/outlet valves HCV-3/HCV-11 — Closed Economizer isolation valve HCV-17 — Closed Liquid level gauge liquid phase valve HCV-10 — Open Liquid level gauge vapor phase valve HCV-8 — Open Aux Liquid valve HCV-18 — Open Aux Vapor valve HCV-19 — Open

5.3 ELECTRICAL PRESSURE CONTROL SWITCH ADJUSTMENTS

Under normal circumstances, the system does not require adjustment. However, it may be necessary to change the electrical pressure control switch settings to obtain either higher or lower pressure setting within the range of the pressure switch, at the time of starting up a vessel. It is good practice to verify set points during an initial fill.

STEP NUMBER	Electrical Pressure Control Switch Adjustments
1	Observe tank pressure as indicated on the station pressure gauge (PI-1).
2	Note setting on scale on pressure switch. Scale is for use as a reference only: use actual tank pressure at tank pressure indicator PI-1 for pressure settings
3	Turn the adjustment knob on the electrical pressure control switch in ¼-turn increments as required to adjust PB cut-out (high setpoint) pressure. It may be necessary to vent the tank (open HCV-12) between adjustments to actuate the PB system.

Chapter

6

6 VESSEL HANDLING INSTRUCTIONS

Figures 1 and 2 depict two methods of handling vessels during installation. The handling method pictured in Figure 2 uses two cranes to place the tank. The two-crane method is the safer, and thus, more preferred method of installing the vessel. The alternate method of installation uses a single crane. This method is pictured in Figure 2.

FIGURE 1, TWO-CRANE INSTALLATION METHOD

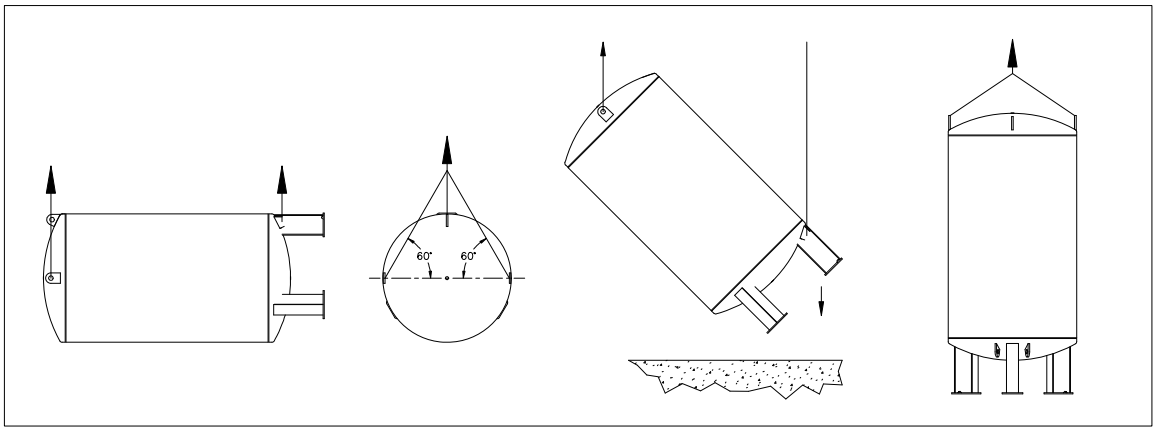
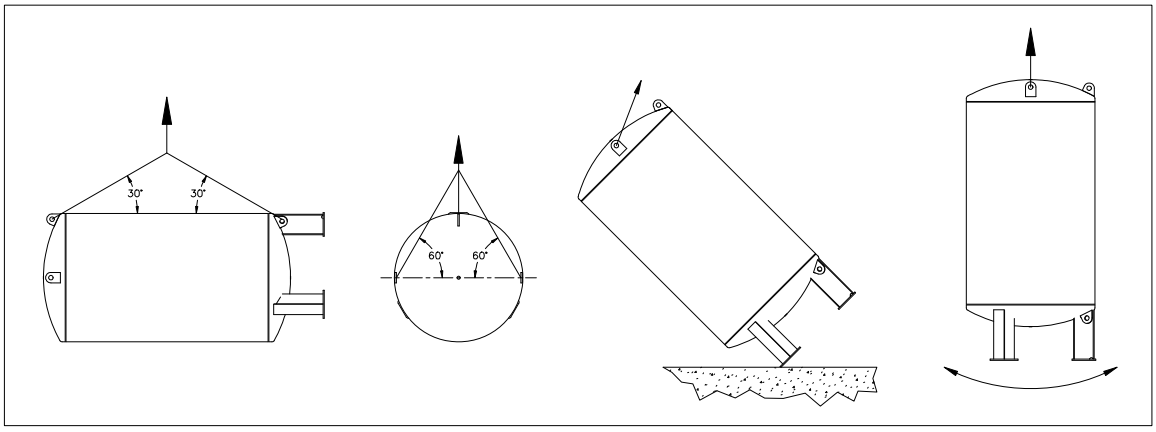


FIGURE 2, SINGLE-CRANE INSTALLATION METHOD



6.1 VESSEL TIE DOWN GUIDELINES

Chart Inc. Vessel Tie Down Guidelines

PURPOSE: TO BE GIVEN or SHOWN TO DRIVERS PRIOR TO LOADING IF POSSIBLE.

- Unless otherwise specified by customer, the tank should be orientated with the plumbed head pointing backward. The plumbing is less likely to be damaged during shipping in this orientation.
- Place supports or saddles on the head-shell seam, never in the middle of the head.
- Using appropriately sized element, tie the vessel to the bed of the trailer at the lifting lugs on the top of the vessel and at any lug clearly marked "Tie Down Only".
- If no lugs exist on the bottom portion of a vertical tank, tie the vessel to the bed of the trailer at the mounting holes on the leg pad. Attach elements to the vessel as close to the head as possible. If possible, avoid attaching chains to the outer part of the leg.
- A minimum of eight elements should be used to secure any vessel. The elements should be situated such that the tank cannot slide or roll in *any* direction.
- **Straps can cause damage to the tank finish. Avoid using straps to secure the vessel.**
- Under no circumstances should a chain, strap, or other tie down equipment that may damage the tank finish, come in direct contact with the outer shell of the vessel. Use rubber pad, corrugated cardboard or a similar material to protect the tank in areas where contact may occur. The trucker is responsible for providing these materials when required.
- If additional blocking is required due to placing the vessel partially over the drop section of the trailer, the trucker is responsible for providing that blocking.

Figure 1 below shows a side view of an acceptable element configuration for a conventional CHART vertical vessel.

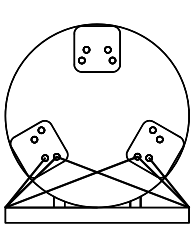


Figure 2 - Vertical Rear View

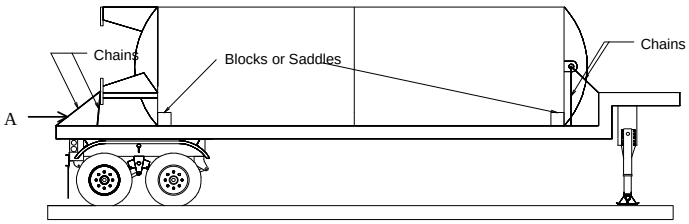


Figure 1 - Vertical Side View

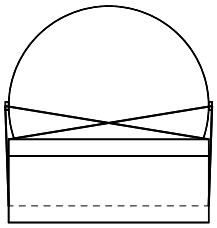


Figure 3 - Vertical Frontal View

Figures 4 and 5 below show side and end views of a horizontal tank with tie down lugs on the saddle supports. The element configuration shown is acceptable for this type of vessel. If a tank is not equipped with tie down lugs on the saddle supports, use the holes in the saddle supports as tie down points. Use a chain configuration similar to the figure below.

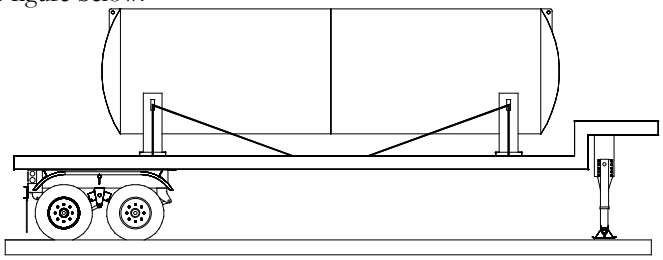


Figure 4 - Horizontal Side View

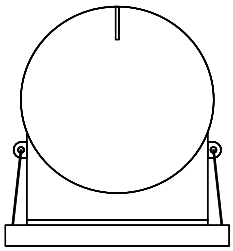


Figure 5 - Horizontal End View

CABLE AND CHAIN TABLE

Tank Size (gal)	Typ. Vessel Weight (lbs)	Maximum Force in Element (lbs)	Recommended Cable	Recommended Chain
1500	10000	17800	(1) ½" IWRC 6X19	(2) ½" Transport Grade 7
3000	17000	30600	(1) ¾" IWRC 6X19	(3) ½" Transport Grade 7
6000	30000	53900	(1) ¾" IWRC 6X19	(2) 7/8" Alloy Grade 8
9000	45000	66200	(2) ¾" IWRC 6X19	(2) 7/8" Alloy Grade 8
11000	54000	79400	(2) ¾" IWRC 6X19	(3) 7/8" Alloy Grade 8
13000	63000	92700	(2) ¾" IWRC 6X19	(3) 7/8" Alloy Grade 8
15000	72000	106000	(2) ¾" IWRC 6X19	(3) 7/8" Alloy Grade 8

This table shows **approximate** Chart tank sizes and weights. Tank sizes and volumes are based off of a standard 400 psi tank. Actual Tank weights may vary. Consult the data plate for the actual tank weight. The maximum force in any element is found from the weakest element on the vertical tank tie down configuration (Element "A"). If element "A" exceeds a 45 degree angle from horizontal the force in the element will exceed the value indicated in the table.
**** IT IS THE DRIVERS RESPONSIBILITY TO SECURE LOAD IN ACCORDANCE WITH DOT REGULATIONS.**

6.2 INSTALLATION

Ensure local code and safety authorities are consulted for specific area regulations prior to system installation. The concrete tank pad should be designed in accordance with O&D drawings located in Chapter 9 of this manual.

Remember to allow sufficient clearance around the tank, piping, and vaporizer for service and proper air circulation. Orientation of the piping module and vaporizer is not critical and may be rotated to fit your pad dimensions.

Installation Overview:

- Stand tank and secure to the concrete pad.
- Position the piping module next to tank connection points (or as required). Plumb piping module to tank using supplied connection hoses. See drawing D-11814915 in Chapter 9 for guidance.
- Attach the rattler valve (not on 3.5k systems) to the multi-function vaporizer using included hardware. Install compression fitting and nylon tube to rattler valve.
- Stand and position multi-function vaporizer next to piping module connection points (or as required). Plumb vaporizer to piping module using supplied connection hoses.
- Anchor vaporizer and piping module to concrete pad

- Connect nylon tube from rattler to open connection on solenoid valve SOL-1 on piping module. Trim nylon tube to length as required for installation.

- Connect electrical switch box to 120VAC 5a power source. NOTE: supplied electrical connection may not be in compliance with electrical codes. Consult local electrical code to determine correct connection of electrical power.

Chapter 7

7 GENERAL

This chapter contains vessel maintenance information, including troubleshooting and repair procedures. Before performing any of the procedures in this chapter, be sure you are familiar with the location and function of controls and indicators discussed in other chapters.

7.1 MAINTENANCE

7.1.1 COMPATIBILITY AND CLEANING

It is essential to always keep the vessel clean and free of grease and oil. This is particularly important for units used in nitrogen and argon service since the temperature of liquid nitrogen or argon is below the liquefaction temperature of air; thus making it possible to condense liquid oxygen from air on the piping and vaporizer surfaces.

When replacing components, use only parts that are considered compatible with liquid oxygen and have been properly cleaned for oxygen service. (Refer to CGA Bulletin G4.1 "Equipment Cleaned for Oxygen Service".) Do not use regulators, fittings, or hoses that were previously used in a compressed air environment. Only oxygen compatible sealants or virgin Teflon tape should be used on threaded fittings. All new joints should be leak tested with oxygen compatible leak test solution. When de-greasing parts use a suitable solvent for cleaning metallic parts.

7.1.2 PERIODIC INSPECTION

In order to maintain a cryogenic vessel in good operating condition, certain system components should be inspected on a periodic basis. Those components requiring periodic inspection are listed in this manual. In vessels being operated in areas having extreme hot or cold climates, inspection intervals should be shortened.

7.1.3 SOLDERING

Before performing any soldering work, always exhaust oxygen from oxygen lines and purge with nitrogen gas. Verify that lines are inert.

7.1.4 VACUUM INTEGRITY

These vessels are equipped with vacuum thermocouple gauge tubes and vacuum integrity may be tested with a vacuum meter. Deterioration or loss of vacuum will be apparent by cold spots, frost, or condensation on the jacket, or evidenced by abnormally rapid pressure buildup. Unless one of these conditions is evident, the vacuum level should not be suspected. In the event one of the above conditions exist, contact the factory for advice on vessel vacuum testing.

7.2 TROUBLESHOOTING

The Table 10 provides some troubleshooting procedures. The table is arranged in a Trouble/ Probable Cause/Remedy format. Note that probable causes for specific problems are listed in descending order of significance. That is, check out the first cause listed before proceeding to the next. Repair procedures required, as listed in the remedy column, may be found in the Repair portion of this chapter. Perform procedures in order listed and exactly as stated (Refer to drawings as required to locate system components identified in the troubleshooting guide.)

7.3 REPAIR

CAUTION:

Plumbing should always be allowed to return to ambient temperature before repair work is performed. Vent or drain the vessel as necessary before replacing any component(s) exposed to pressure or to cryogenic liquid.

When repair of damaged components is required (in those instances when a spare part is not readily available), follow the instructions below.

When disassembly of an assembly is required, removed parts should be coded to facilitate reassembly. Reassembly of components should always be performed in the reverse manner in which they are disassembled. Parts removed during disassembly should be protected from damage, thoroughly cleaned, and stored in protective polyethylene bags if not immediately reinstalled. Clean all metal parts with a good industrial cleaning solvent. All rubber components should be washed in a soap and warm water solution. Air dry all cleaned parts using an oil-free, clean, low-pressure air source. Before reassembly, make sure that all parts are thoroughly cleaned and have been degreased. Cleaning will prevent valves and regulators from freezing while in service and prevent contamination of the liquid product.

When removing components from a vessel remember to always plug pipe openings as soon as they are exposed. Plastic pipe plugs of a clean plastic film may be used for this purpose.

7.4 VALVE REPAIR

When a defective valve is suspected, remove and repair the assembly as described in this manual. If a valve is leaking through the packing, tighten the packing nut first to see if the leakage will stop before removing the valve. Packing is best tightened when the valve is warm. If a safety relief valve fails, the defective assembly should be discarded and a new valve installed.

NOTE:

Globe valves used on containers vary in tube size from ¼" to 2". While internal valve components may vary from valve to valve, the functional operation and repair procedures for these valves are the same.

Table 7 Valve Repair

STEP NUMBER	PROCEDURE
	NOTE Unless valve component parts are available in inventory, a defective valve should be replace with a new assembly.
1	Release pressure in the vessel by opening vent valve (HCV-12).
2	Remove the valve seat assembly.
3	Disassemble the valve and inspect all piece parts
4	Clean all metallic parts with a good industrial cleaner, and all rubber & teflon parts in a warm water and soap solution.
5	Air dry all components using a clean low pressure air source.
6	Replace all worn, deformed or damaged parts.
7	Repack the valve. Either preformed or twisted Teflon filament packing can be used. When using twisted Teflon filament packing, untwist Teflon and use only a single strand. Pack Teflon tightly; otherwise, moisture can get into the valve and freeze when the valve is cold. Reassemble the valve. Make sure that mating surfaces are clean and properly seated. If the repaired valve is not to be reinstalled immediately, seal it in a polyethylene bag for storage. Apply a label to the bag such as "CLEAN VALVE. DO NOT OPEN BAG UNLESS UNIT IS TO BE INSTALLED."

7.5 GAUGE REPAIRS

Since a special instrument is normally required for making gauge repairs it is advised that a defective gauge be replaced with a new unit and the defective one returned to your local Chart distributor or to the factory for repairs. However, before replacing gauges there are a number of checks that can be performed.

CAUTION:

Before removing (or calibrating) the tank pressure gauge or liquid level gauge, make sure gauge isolation valves are closed and that the equalizing valve is open.

The major cause of gauge malfunction is a leakage in the gauge line. Therefore, as a first check, make certain that gauge lines are leak tight. Other gauge tests include:

1. Check gauge lines of obstructions.
2. Check leaky equalizer valve.
3. Ensure that connection lines are properly mated.
4. Verify that the gauge is properly zeroed.
5. Ensure that the pointer doesn't stick.

If the above checks fail to correct the problem, remove and replace the gauge. When returning the gauge to Chart for repair, indicate the nature of the difficulty experienced with the gauge in your letter of transmittal.

7.6 INNER TANK BURST DISC REPAIR

The tank burst disc is a safety relief device that will rupture completely to relieve inner tank pressure in the event tank relief valve fails or is unable to accommodate sufficient flow. Due to changes in pressure in the vessel, the disc will flex, gradually harden, embrittle, and consequently rupture at a lower pressure.

The following table serves to describe replacement of the inner vessel burst disc for vessels equipped with a dual relief system. In the event that a component needs to be replaced in the dual relief system,

simply switch the selector handle to the other side of the safety system to allow routine maintenance and repair.

Table 9 Tank Burst Disc Replacement - Dual Safety System

STEP NUMBER	PROCEDURE
1	Switch selector valve (HCV-15) to other side, and depressurize the isolated side of the relief valve system, rather than venting vessel.
2	Remove burst disc (PSE-1) by opening HCV-16 if equipped. Or loosen PSE-1 allowing pressure to escape..
3	Install new burst disc (PSE-1), making sure that mating surfaces are clean and properly seated. Use an oxygen compatible liquid thread sealant to prevent leaking.

7.7 TESTING AFTER REPAIR

After making repairs requiring disassembly or part replacement, leak test all valves and piping joints that were taken apart and reconnected. Do not return the vessel to service until all leaks have been corrected or retested.

Table 10 Troubleshooting

PROBLEM	POSSIBLE CAUSE	DIAGNOSIS	SOLUTION
Excessive Tank Pressure Vessel	1. Inadequate vacuum	1. Take vacuum reading	Consult factory
*Vessel vents through relief valve frequently	2. Leaking pressure building control valve AOL-1	1. Line to AOL-1 frosted from tank to multi-function vaporizer	1. Repair or replace
*Pressure remains above economizer set point	3. System not economizing	1. No frost evident on PB return line through AOL-2	1. Check air supply to AOR-2 2. Check operation of AOL-2, repair or replace as necessary
	4. Tank gauge (PI-1) in error	1. Compare with gauge of known accuracy	1. Replace
	5. Low withdrawal rate	1. Frosting on PB return piping. No frosting on PB supply piping	1. Consult factory
	6. Excessive shutdown time	1. User pattern	1. Replace vessel with more efficient model
Failure to maintain set delivery pressure	1. Pressure builder not operational	1. PB Valve Closed	1. Check air supply to SOL-1 2. Check operation of SOL-1, repair or replace as necessary
*House pressure is low	2. Electrical control pressure switch set too low or faulty	1. No frosting on PB feed lines 2. Set pressure at or below final line pressure	1. Check for power to electrical controls 2. Readjust pressure switch 3. If pressure switch is faulty, replace
	3. Cannot maintain pressure	1. PB feed line always frosted 2. Withdrawal too high	1. Install higher capacity system-consult factory
	4. Tank burst disc (PSE-1) ruptured	1. Flow can be felt at outlet of PSE-1	1. Replace
	5. Piping leak	1. Leak is audible	1. Replace
Erratic contents gauge reading	1. Needle is stuck	1. Tap gauge	1. Inspect pointer and bend if need be
	2. Needle binds	1. Tap gauge repeatedly	1. Replace gauge
	3. Needle does not adjust to "0"	1. Does not "0" when HCV-9 (equalizing valve) opened	1. Adjust
	4. Leaky gauge lines	1. Reading does not correspond to use	1. Tighten lines and fittings
	5. Incorrect span	1. Reading does not correspond to use	1. Reading does not correspond to use
	6. Valves not opened	1. Needle stays at "0"	1. Equalization valve closed (HCV-9) 2. Isolation valves (HCV-8 and HCV-10) open
	7. Reverse lines	1. Needle stays at "0"	1. Check stampings in gauge and vessel bottom "HP" corresponds to liquid phase
	8. Plugged line	1. Needle pegs, or moves very slowly	1.Consult factory

PROBLEM	POSSIBLE CAUSE	DIAGNOSIS	SOLUTION
Leaking relief valve	1. Ice under/in seat	1. Valve reseats when warming up	1. Warm and dry valve to prevent moisture accumulation
	2. Damaged seat	1. Valve does not re-seat	1. Replace valve
Ruptured tank burst disc	1. Excessive pressure	1. Relief valve damaged	1. Replace disc and valve
	2. Fatigue or corrosion	1. Environment	1. Replace disc
Inability to hold vacuum	1. Improper vacuum gauge change (voids warranty)	1. Measure vacuum rise in gauge assembly	1. Consult factory
	2. Internal/external leak	1. Vacuum rises in tank over short time	1. Consult factory
	3. Corroded safety disk (PSE-3)	1. Visual on helium leak test	1. Replace and re-pump
	4. Outgassing	1. Slow vacuum rise over long time	1. Re-pump

7.8 NEW YORK CITY FIRE DEPARTMENT APPROVALS

The City of New York Fire Department requires that vessels placed into service meet certain conditions for approval.

The Certificates of Approval, stating the conditions are available upon request from the factory as manual addendums.

Chapter 8

8 RECOMMENDED SPARES

8.1 11001551 RECOMMENDED SPARES 01 1”

Component	Description	Quantity
11509339	RPD ASSY 3/4"MPT*FREE 375PSI	1
11494835	RV BRZ 3/4MPT*1FPT 250 PSIG	1
1810802	RV BRS 1/4MPT 400PSI	1
11656638	KIT REPAIR REG PBE-1 W/CHECK	1
11819564	KIT REPAIR VLV FILL CHECK REGO	1
11819572	KIT REPAIR VLV FILL CHECK REGO	1
11819450	KIT REPAIR VLV BNT 1-1/2"ANGLE	1
11819468	KIT REPAIR VLV SEAT 1-1/2"ANGLE	1
11819425	KIT REPAIR VLV BNT 1/2-1" REGO	2
11819433	KIT REPAIR VLV SEAT 1/2-3/4"	1
11819441	KIT REPAIR VLV SEAT 1" REGO	1
11819521	KIT REPAIR VLV STEM 1/2-1/2”	1

8.2 11001560 RECOMMENDED SPARES 01 1-1/2”

Component	Description	Quantity
11494835	RV BRZ 3/4MPT*1FPT 250 PSIG	1
11509304	RPD ASSY 1"MPT*FREE 375PSI	1
1810802	RV BRS 1/4MPT 400PSI	1
11656700	KIT REPAIR REG PBE-2 W/CHECK	1
11819564	KIT REPAIR VLV FILL CHECK REGO	1
11819572	KIT REPAIR VLV FILL CHECK REGO	1
11819450	KIT REPAIR VLV BNT 1-1/2"ANGLE	1
11819468	KIT REPAIR VLV SEAT 1-1/2"ANGLE	1
11819425	KIT REPAIR VLV BNT 1/2-1" REGO	2
11819433	KIT REPAIR VLV SEAT 1/2-3/4"	1
11819441	KIT REPAIR VLV SEAT 1" REGO	1
11819521	KIT REPAIR VLV STEM 1/2-1/2"	1

8.3 RECOMMENDED SPARES HP^2 CONTROLS

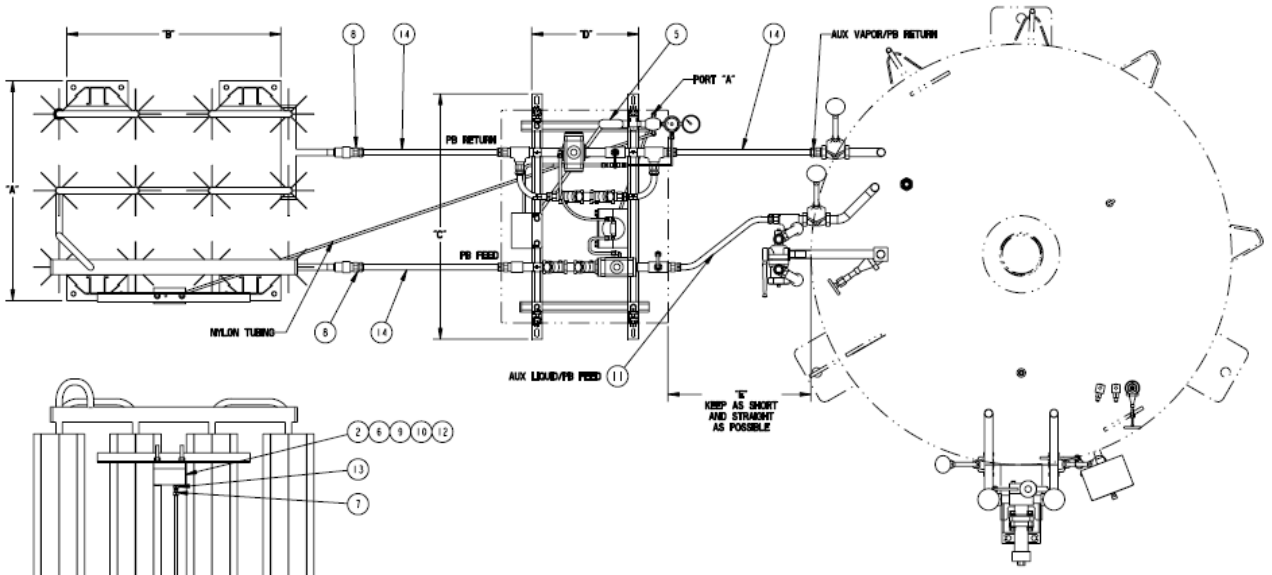
Component	Description	Quantity
12993804	PRESS SWITCH 1/2"FPT 50-500PSI DWYER	1
10732096	VALVE SOLENOID 1/4 120VAC ASCO 3-WAY	1
12932711	KIT REPAIR BALL VALVE SS 1" EMC	2

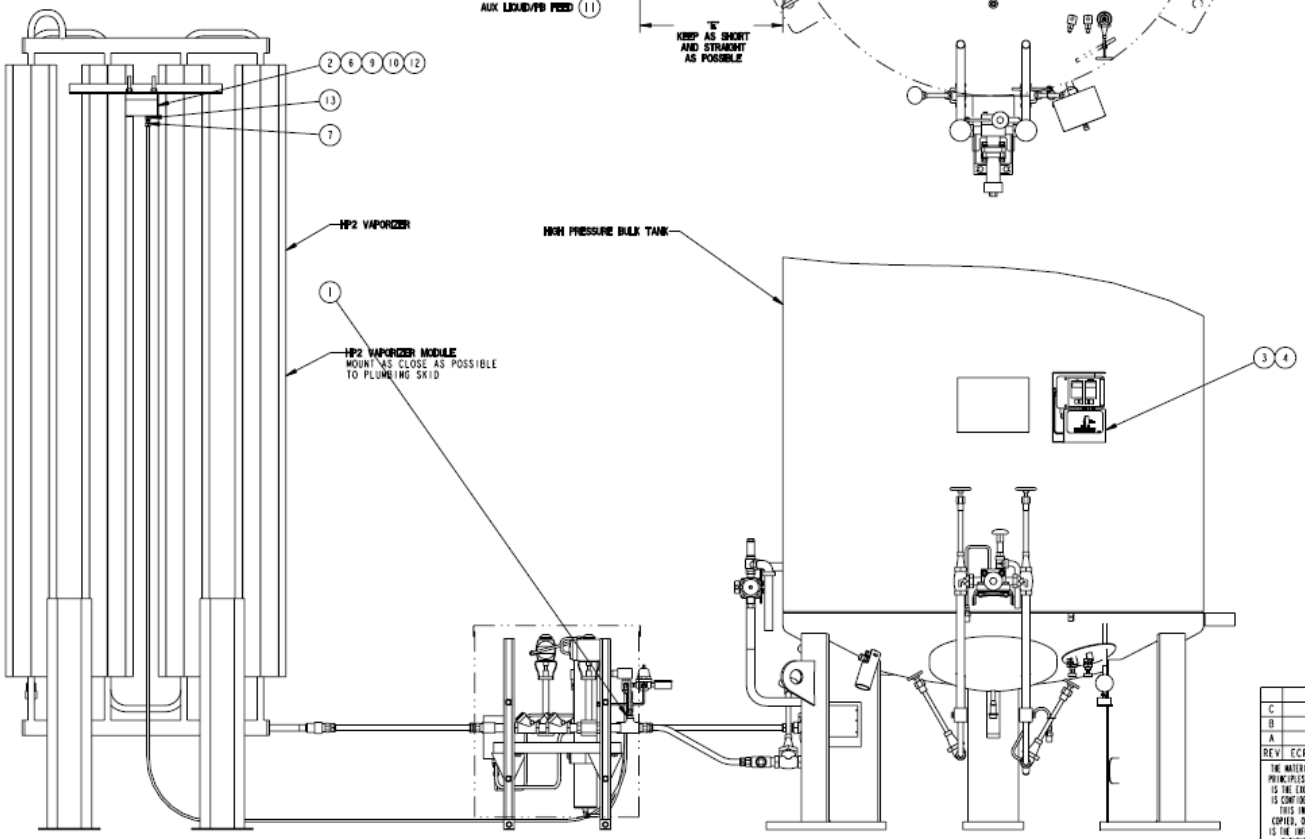
Chapter 9

9 DRAWINGS

Installation Kit
D-11814915

Outline & Dimension	
VS-525-1500	C-11534201
VS-3000-6000	C-11517988
VS-9000-15000	C-11502954





DRAWING NO. D-11814915

ITEM	QTY	PART NUMBER	P/N DESCRIPTION
1	20	11731781	TUBE NYL .375"OD .065W BLACK
2	2	11816961	BOLT HEX SS .500-13NC*6LG
3	1	11683038	FLEX HOSE SET LIQ LEVEL GAUGE
4	1	PER ORDER	ASSY TANK-TEL
5	4	11798468	WIRE NUT YELLOW (1)16 (2)18
6	1	11859700	VIBRATOR SILVER SONIC TURBINE
7	1	162073	CONN BRS 3/8ODT*1/4MPT
8	2	11506357	CONN BRS 7/8ODT*1MPT
9	2	2911161	WASHER LOCK SS 1/2 18-8
10	2	2920761	NUT HEX SS 1/2-13NC
11	1	11895840	TUBE CU .750"NOM HP2 SKID
12	1	11873561	MICARTA 1.000 THK NEMA G-10
13	1	10847395	BSHG HEX BRS 3/8MPT*1/4FPT
14	3	11895831	TUBE CU .750"NOM HP2 SKID

INSTALLATION INSTRUCTION / STEPS.

1. TANK PLUMBING. MOUNT THE TANK-TEL AND PLC ASSEMBLY TO THE NIPPLE TOE ON THE BULK TANK.
2. HOOK UP THE FLEX HOSES PER THE TANK-TEL INSTALLATION INSTRUCTIONS.
3. LINE UP AND CONNECT THE AUX LIQUID CONNECTION ON THE BULK TANK WITH THE PB FEED CONNECTION ON THE PIPING USING PART NUMBER 11895840.
4. CONNECT THE AUX VAPOR CONNECTION ON THE BULK TANK WITH THE PB RETURN CONNECTION ON THE PIPING SKID USING PART NUMBER 11895831.
5. PRIOR TO STANDING UP THE VAPORIZER, MOUNT THE TURBINE VALVE (P/N 11859700) TO THE VAPORIZER USING THE MICARTA AND THE SUPPLIED HARDWARE. THEN THREAD THE SUPPLIED CONNECTOR & HEX BUSHING (P/N 162073 & 10847395) INTO THE TURBINE VALVE AND CONNECT THE NYLON TUBING TO THE CONNECTOR.
6. STAND UP AND LOCATE THE VAPORIZER SUCH THAT THE PB FEED SIDE OF THE PIPING SKID LINES UP WITH THE INLET ON THE VAPORIZER.
7. CONNECT THE TWO PORTS USING PART NUMBER 11895831.
8. CONNECT THE PB RETURN SIDE OF THE PIPING SKID TO THE VAPORIZER USING PART NUMBER 11895831.
9. ANCHOR THE PIPING SKID AND THE VAPORIZER AS REQUIRED.
10. HOOK UP THE NYLON TUBING, NOW ATTACTED TO THE TURBINE VALVE, TO THE AIR CONNECTION ON THE 3-WAY VALVE. THE 3-WAY VALVE IS MOUNTED ON THE PIPING SKID (PORT "A"). CUT TUBING TO LENGTH AS NEEDED.
11. WIRE THE ELECTRICAL CORD SUPPLIED WITH THE TANK-TEL & PLC ASSEMBLY TO THE TANK-TEL ASSEMBLY IF NEEDED. THEN TO THE 3-WAY VALVE USING SUPPLIED WIRE NUTS. CUT CORD AS NEEDED.
12. CUT WIRE TO LENGTH AS NEEDED AND ATTACH SUPPLIED POWER SUPPLY. PLUG IN THE TANK-TEL AND 12VDC POWER SUPPLIES.
13. WIRE THE PLC TO A 110V 5A CIRCUIT.

KEY DIMENSIONS IN INCHES					
MODEL	A	B	C	D	E
7.5K	34-3/8	33-1/2	43-5/8	16-3/4	22-1/2
12.5K	46-3/8	33-1/2	43-5/8	16-3/4	22-1/2

REV	ECR NO	REVISION DESCRIPTION	BY	DATE	APPROVED	DATE
C	-	UPDATE PARTS LIST	JJC	4-21-04	YB	4-17-03
B	-	UPDATE PARTS LIST	JJC	1-9-04	MDS	5-12-03
A	-	AS BUILT CHANGES	JJC	12-8-03	KJR	4-17-03

NEXT ASS'T | USED ON | NEXT ASS'T | FINAL ASS'T
APPLICATION | QUANTITY REQ'D

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MAT'L: SEE B.O.M.

PART NUMBER 11814915

DRWN FAS 4-21-03
ENGR JAB 4-17-03

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES.
TOLERANCES:
FRACTIONS ± 1/8
ANGLES ± 1°
2 PLACE DECIMALS ± .01
3 PLACE DECIMALS ± .005

Distribution & Storage Group
New Program Operations

TITLE: MDL INSTALLATION KIT FOR SITE

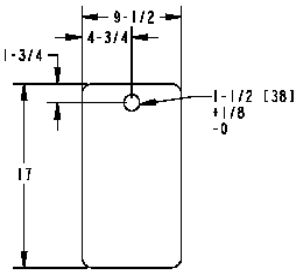
DRAWING NO. D-11814915 REV C

SCALE 7/64":1" DO NOT SCALE DRAWING SHEET 1 OF 1

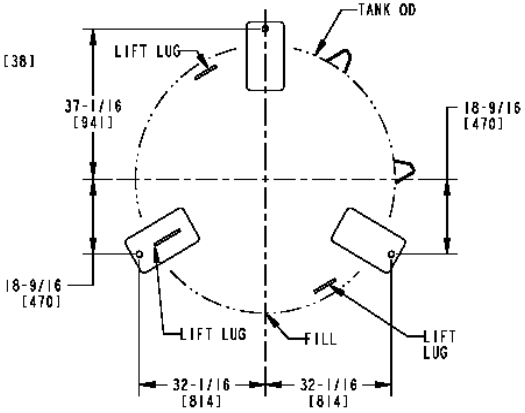
DRAWING NO. C-11534201

INNER VESSEL DESIGN DATA				
Model:		VS-525 / 900 / 1500		
MAWP:	PSIG	250	400	500
	barg	17.24	27.58	34.47
DESIGN PRESSURE	PSIG	264.7	414.7	514.7
	barg	18.25	28.59	35.49
CODE COMPLIANCE:		ASME SECTION VIII DIVISION 1		
DESIGN TEMPERATURE	°F	-320° TO 100°		
	°C	-196° TO 38°		
MATERIAL OF CONSTRUCTION:		SA353/553 9% NICKEL STEEL		
OUTER VESSEL DATA				
CODE COMPLIANCE:		FULL VACUUM PER CGA-341		
DESIGN TEMPERATURE	°F	-20° TO 300°		
	°C	-29° TO 149°		
MATERIAL OF CONSTRUCTION:		A36 CARBON STEEL		
INSULATION TYPE:		VACUUM AND MULTILAYER INSULATION		
EVACUATION CONNECTION:		3-1/2" PUMPOUT PORT		
VACUUM GAUGE CONNECTION:		HASTINGS DV6R		

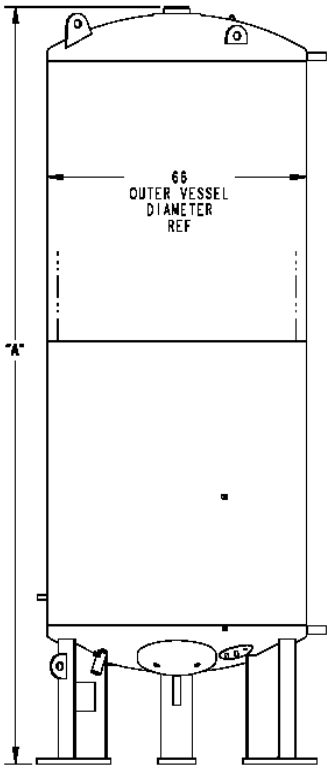
BUILDING CODE:
DESIGNED FOR CURRENT BUILDING CODE SEE MVE
UBC POLICY #NP-180



FOOT PAD
1-1/4 [32] THK
TYP 3 PLCS



BOLT HOLE LAYOUT
TOP VIEW
SCALE: N/A



WEIGHTS AND SHIPPING DATA											
MODEL:			VS-525			VS-900			VS-1500		
MAWP	PSIG		250	400	500	250	400	500	250	400	500
	barg		17.24	27.58	34.47	17.24	27.58	34.47	17.24	27.58	34.47
WEIGHT EMPTY	POUNDS		3,800	4,600	5,100	5,100	6,000	6,700	7,000	8,400	9,500
	KILOGRAMS		1,720	2,090	2,310	2,310	2,720	3,040	3,180	3,810	4,310
WEIGHT FULL	OXYGEN	POUNDS	8,500	9,300	9,800	13,100	14,000	14,800	21,400	22,800	23,900
		KILOGRAMS	3,860	4,220	4,450	5,940	6,350	6,710	9,710	10,340	10,840
	NITROGEN	POUNDS	7,100	7,900	8,500	10,800	11,700	12,400	17,200	18,600	19,700
		KILOGRAMS	3,220	3,580	3,860	4,900	5,310	5,630	7,800	8,440	8,940
	ARGON	POUNDS	9,500	10,300	10,900	14,900	15,900	16,500	24,600	26,000	27,100
		KILOGRAMS	4,310	4,670	4,940	6,760	7,220	7,480	11,160	11,790	12,290
SHIPPING DIMENSIONS	INCHES		102 X 85 X 75			134 X 85 X 75			188 X 85 X 75		
	MM'S		2,591 X 2,159 X 1,905			3,404 X 2,159 X 1,905			4,775 X 2,159 X 1,905		

TANK HEIGHT	
MODEL	DIM "A" REF
VS-525	102[2591]
VS-900	134[3404]
VS-1500	188[4776]

CAPACITIES					
MODEL:			VS-525	VS-900	VS-1500
CAPACITY	GROSS	GALLONS	540	929	1,585
	(COLD)	LITERS	2,044	3,517	6,000
	NET	GALLONS	491	845	1,509
	(COLD)	LITERS	1,860	3,197	5,714
GASES EQUIVALENT AT 1 ATM AND 70°F/ 1 ATM AND 0°C	OXYGEN	SCF	57,000	97,000	174,000
		NM3	1,500	2,600	4,600
	NITROGEN	SCF	46,000	79,000	141,000
		NM3	1,200	2,100	3,700
	ARGON	SCF	55,000	95,000	170,000
		NM3	1,500	2,500	4,500

IN[mm]

REV	ECR NO	REVISION DESCRIPTION	BY	DATE
B	12022	CHG BLT HL DIM SCHEME	RDW	12/9/02
A	11942	UPDATE 1500 WEIGHTS	JJC	6-21-02

	APPROVED	DATE
DRAWN BY	JJS	3/23/01
CHK'D BY	MMK	3-23-01
ENG. APPR.	KJR	-
PROJ. ENGR.	MDS	3/23/01
MFG. ENGR.	FAS	-
QUAL. CONT.	GHE	-

NEXT ASS'Y	USED ON	NEXT ASS'Y	FINAL ASS'T
	APPLICATION	QUANTITY REQ'D	

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MAT'L: SEE B.O.M.

PART NUMBER 11534201

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES.
TOLERANCES: FRACTIONS ± 1/4
ANGLES ± 1°
2 PLACE DECIMALS ± NA
3 PLACE DECIMALS ± NA

CHART Storage Systems Division New Progus Operations

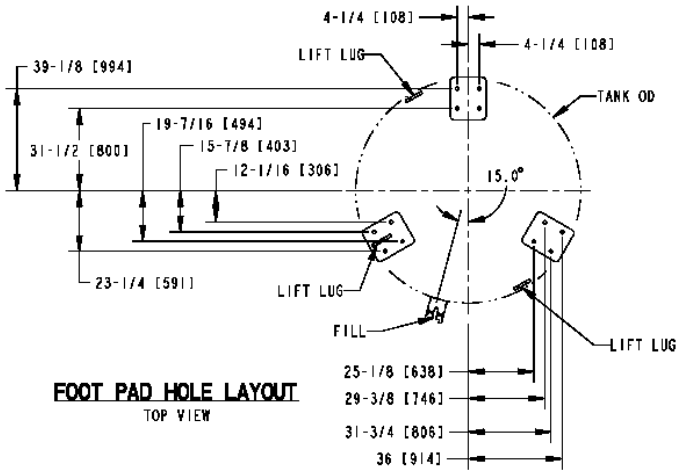
TITLE O&D VS-525/900/1500
9% NI 250/400/500 ASME

DRAWING NO. C-11534201 REV B

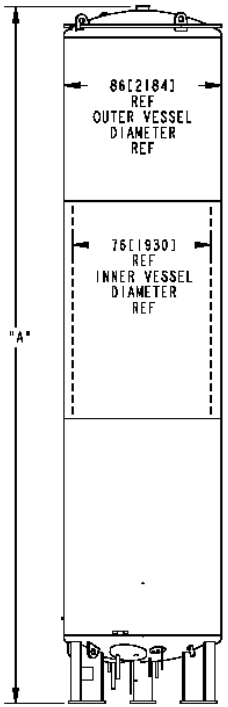
SCALE N/A | DO NOT SCALE DRAWING | SHEET 1 OF 1

DRAWING NO. C-11517988

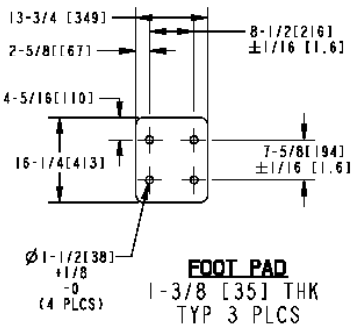
INNER VESSEL DESIGN DATA					
Model:		VS-3000 THRU 6000			
MAWP:	PSIG	175	250	400	500
	barg	12.07	17.24	27.58	34.47
DESIGN PRESSURE	PSIG	189.7	264.7	414.7	514.7
	barg	13.08	18.25	28.59	35.49
CODE COMPLIANCE:		ASME SECTION VIII DIVISION 1			
DESIGN TEMPERATURE	°F	-320° TO 100°			
	°C	-195.56° TO 37.78°			
MATERIAL OF CONSTRUCTION:		SA553 9% NICKEL STEEL			
OUTER VESSEL DATA					
CODE COMPLIANCE:		FULL VACUUM PER CGA-341			
DESIGN TEMPERATURE	°F	-20° TO 300°			
	°C	-28.89 TO 148.9			
MATERIAL OF CONSTRUCTION:		A36 CARBON STEEL			
INSULATION TYPE:		VACUUM AND MULTILAYER INSULATION			
EVACUATION CONNECTION:		3-1/2" PUMPOUT PORT			
VACUUM GAUGE CONNECTION:		HASTING DV6R			
BUILDING CODE: DESIGNED FOR CURRENT BUILDING CODE SEE MVE UBC POLICY #NP-180					



FOOT PAD HOLE LAYOUT
TOP VIEW



WEIGHTS AND SHIPPING DATA										
MODEL:			VS-3000				VS-6000			
MAWP	PSIG		175	250	400	500	175	250	400	500
	barg		12.07	17.24	27.58	34.47	12.07	17.24	27.58	34.47
WEIGHT EMPTY	POUNDS		12,600	13,500	16,400	18,300	22,200	24,500	29,700	33,000
	KILOGRAMS		5,720	6,130	7,440	8,301	10,070	11,120	13,480	14,969
WEIGHT FULL	OXYGEN	POUNDS	41,600	42,500	45,400	47,200	77,900	80,200	85,400	88,700
		KILOGRAMS	18,870	19,280	20,600	21,410	35,340	36,380	38,740	40,234
	NITROGEN	POUNDS	33,100	34,000	36,900	38,800	61,600	63,900	69,100	72,400
		KILOGRAMS	15,020	15,430	16,740	17,599	27,950	28,990	31,350	32,840
	ARGON	POUNDS	48,000	48,900	51,700	53,600	90,200	92,500	97,700	101,000
		KILOGRAMS	21,780	22,190	23,500	24,313	40,920	41,960	44,320	45,813
SHIPPING DIMENSIONS	INCHES (L * W * H)		228 x 86 x 86				382 x 86 x 86			
	MM'S (L * W * H)		5,791 x 2,184 x 2,184				9,703 x 2,184 x 2,184			



FOOT PAD
1-3/8 [35] THK
TYP 3 PLCS
SCALE 1/16

TANK HEIGHT	
MODEL	DIM "A" REF
VS-3000	228[5,791.2]
VS-6000	382[9,702.8]

CAPACITIES				
MODEL:			VS-3000	VS-6000
CAPACITY	GROSS	GALLONS	3,158	6,075
	(COLD)	LITERS	11,954	22,996
	NET	GALLONS	3,037	5,841
	(COLD)	LITERS	11,496	22,111
GASES EQUIVALENT AT 1 ATM AND 70°F/ 1 ATM AND 0°C	OXYGEN	SCF	349,000	672,000
		NM3	9,100	17,600
	NITROGEN	SCF	282,000	543,000
		NM3	7,400	14,200
	ARGON	SCF	341,000	657,000
		NM3	8,900	17,200

REV	ECR NO	REVISION DESCRIPTION	BY	DATE
B	12022	CHNG BOLT DIM LAYOUT	RDW	12-6-02
A	-	RELEASED FOR PRODUCTION	MMK	3-13-01

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MAT'L: SEE B.O.M.

PART NUMBER 11517988

	APPROVED	DATE
DRAWN BY: MO		01-29-01
ENG: MMK		2-8-01
MFG. ENGR.: KJR		2-06-01
PROJ. ENGR.: MDS		2-08-01
MFG. MGR.: FAS		2-07-01
QUAL. CONT.: GHE		2-6-01

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES.
TOLERANCES: FRACTIONS ± 1/4
ANGLES ± 1°
2 PLACE DECIMALS ± NA
3 PLACE DECIMALS ± NA

NEXT ASS'Y	USED ON	NEXT ASS'Y	FINAL ASS'Y
	APPLICATION		QUANTITY REQ'D

Chart Inc. Storage Systems Division New Program Operations

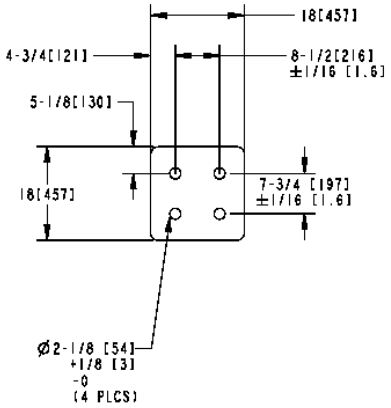
TITLE: O&D VS-3000 THRU 6000
9% NI 175/250/400/500 ASME

DRAWING NO. C-11517988 REV B

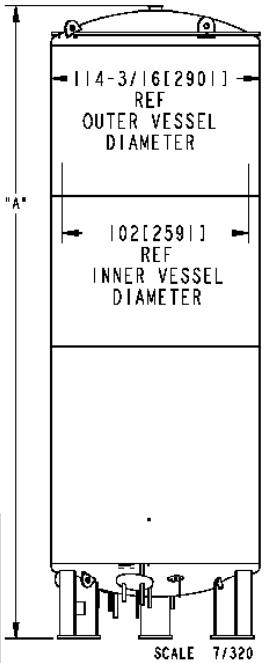
SCALE N/A | DO NOT SCALE DRAWING | SHEET 1 OF 1

DRAWING NO. C-11502954

INNER VESSEL DESIGN DATA				
Model:		VS-9000 THRU 15000		
MAWP:	PSIG	175	250	400
	barg	12.07	17.24	27.58
DESIGN PRESSURE	PSIG	189.7	264.7	414.7
	barg	13.08	18.25	28.59
CODE COMPLIANCE:		ASME SECTION VIII DIVISION 1		
DESIGN TEMPERATURE	°F	-320° TO 100°		
	°C	-195.56° TO 37.78°		
MATERIAL OF CONSTRUCTION:		SA553 9% NICKEL STEEL		
OUTER VESSEL DATA				
CODE COMPLIANCE:		FULL VACUUM PER CGA-341		
DESIGN TEMPERATURE	°F	-20° TO 300°		
	°C	-28.89 TO 148.9		
MATERIAL OF CONSTRUCTION:		A36 CARBON STEEL		
INSULATION TYPE:		VACUUM AND MULTILAYER INSULATION		
EVACUATION CONNECTION:		3-1/2" PUMPOUT PORT		
VACUUM GAUGE CONNECTION:		HASTING DVR6		
BUILDING CODE: DESIGNED FOR CURRENT BUILDING CODE SEE MVE UBC POLICY #NP-180				



FOOT PAD
1-3/8[35] THK 9000/11000/13000
1-3/4[44] THK 15000
TYP (3) PLCS



WEIGHTS AND SHIPPING DATA															
MODEL:			VS-9000			VS-11000			VS-13000			VS-15000			
MAWP	PSIG		175	250	400	175	250	400	175	250	400	175	250	400	
	barg		12.07	17.24	27.58	12.07	17.24	27.58	12.07	17.24	27.58	12.07	17.24	27.58	
WEIGHT EMPTY	POUNDS		33,000	36,800	44,800	39,500	44,100	53,700	46,700	52,100	62,700	53,700	59,900	72,200	
	KILOGRAMS		14,970	16,700	20,330	17,920	20,010	24,360	21,190	23,640	28,450	24,360	27,180	32,660	
WEIGHT FULL	OXYGEN	POUNDS	119,600	123,400	131,400	145,700	150,300	159,900	171,700	177,100	187,700	197,500	203,700	215,800	
		KILOGRAMS	54,250	55,980	59,610	66,090	68,180	72,530	77,890	80,340	85,140	89,590	92,400	97,890	
	NITROGEN	POUNDS	94,300	98,100	106,100	114,700	119,300	128,900	135,200	140,600	151,200	155,600	161,800	173,900	
		KILOGRAMS	42,780	44,500	48,130	52,030	54,120	58,470	61,330	63,780	68,590	70,580	73,400	78,880	
	ARGON	POUNDS	138,700	142,500	150,500	169,200	173,800	183,400	199,300	204,700	215,300	229,300	235,500	247,600	
		KILOGRAMS	62,690	64,640	68,270	76,750	78,840	83,190	90,410	92,860	97,660	104,010	106,830	112,310	
SHIPPING DIMENSIONS	INCHES (L * W * H)		347 x 114.2 x 114.2			406 x 114.2 x 114.2			465 x 114.2 x 114.2			525 x 114.2 x 114.2			
	MM'S (L * W * H)		8,814 x 2'901 x 2,901			10,312 x 2,901 x 2,901			11,811 x 2,901 x 2,901			13,335 x 2,901 x 2,901			

TANK HEIGHT	
MODEL	DIM "A" REF
VS-9000	347[8,814]
VS-11000	406[10,312]
VS-13000	465[11,811]
VS-15000	525[13,335]

CAPACITIES						
MODEL:			VS-9000	VS-11000	VS-13000	VS-15000
CAPACITY	GROSS	GALLONS	9,447	11,480	13,513	15,545
	(COLD)	LITERS	35,761	43,457	51,152	58,844
	NET	GALLONS	9,084	11,145	13,119	15,093
	(COLD)	LITERS	34,387	42,188	49,661	57,133
GASES EQUIVALENT AT 1 ATM AND 70°F/ 1 ATM AND 0°C	OXYGEN	SCF	1,045,000	1,282,000	1,509,000	1,737,000
		NM3	27,400	33,700	39,600	45,600
	NITROGEN	SCF	845,000	1,037,000	1,221,000	1,405,000
		NM3	22,200	27,200	32,100	36,900
	ARGON	SCF	1,021,000	1,253,000	1,475,000	1,697,000
		NM3	26,800	32,900	38,700	44,600

REV	ECR NO	REVISION DESCRIPTION	BY	DATE
C	12022	CHG BLT HL DIM SCHEME	RDW	12/9/02
B	-	UPDATE DRWG TOL	MMK	2-8--01
A	11583	CHG LEG PAD	MMK	1-01-01

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MAT'L: SEE B.O.M.

PART NUMBER 11502954

	APPROVED	DATE
DRAWN BY	JEN	12-7-00
CHK'D BY	DCH	12-11-00
ENG. MGR.	KJR	12-12-00
PROJ. ENGR.	GAP	12-11-00
MFG. ENGR.	FAS	12-14-00
QUAL. CONT.	LBL	12-12-00

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES: FRACTIONS ± 1/4, ANGLES ±, 2 PLACE DECIMALS ± NA, 3 PLACE DECIMALS ± NA

NEXT ASS'Y	USED ON	NEXT ASS'Y	FINAL ASS'Y
APPLICATION		QUANTITY REQ'D	

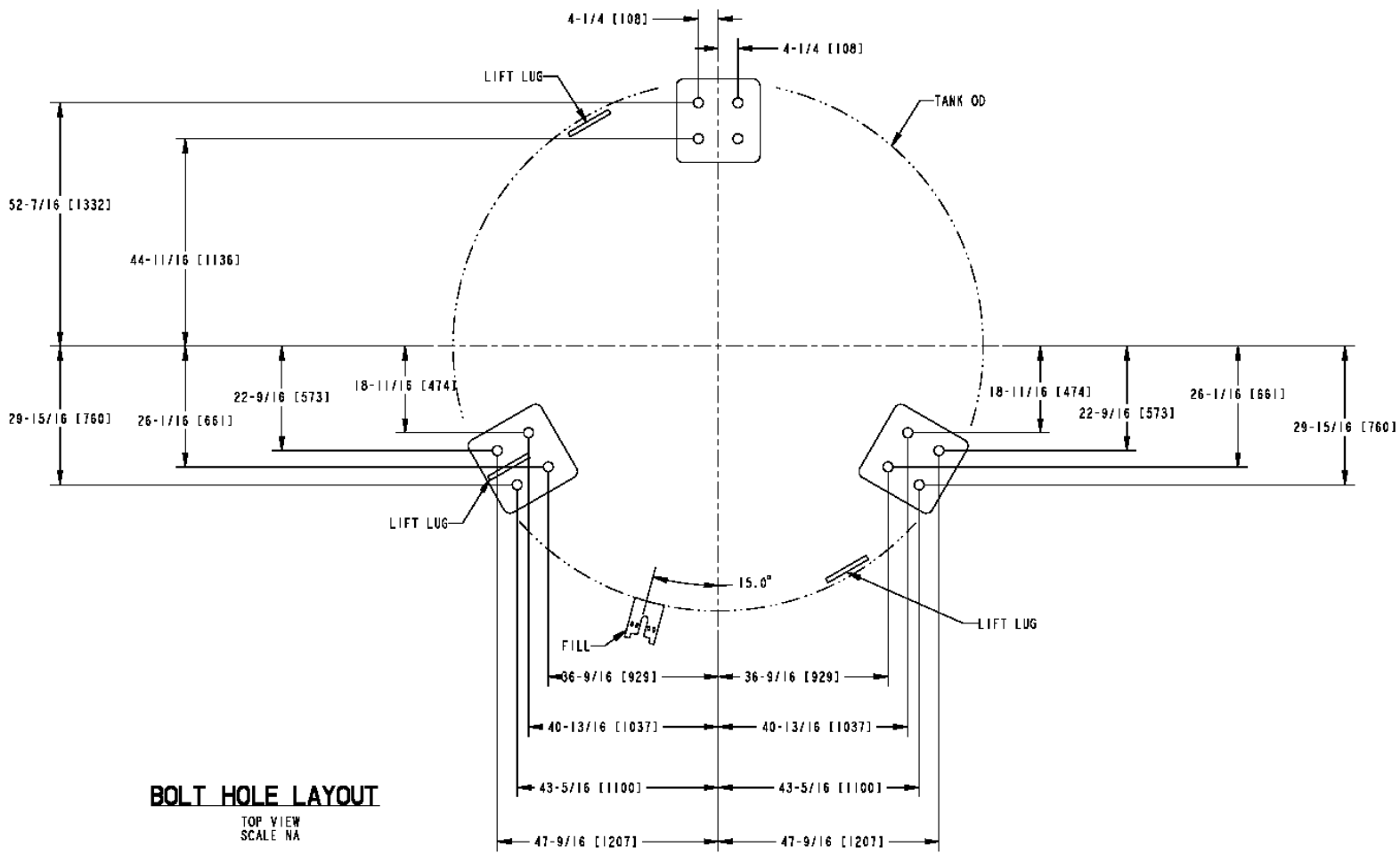
Chart Industries — Storage Systems Division New Prague Operations

TITLE: O&D VS-9000 THRU 15000 9% NI 175/250/400 ASME

DRAWING NO. C-11502954 REV C

SCALE N/A DO NOT SCALE DRAWING SHEET 1 OF 2

DRAWING NO. C-11502954



BOLT HOLE LAYOUT

TOP VIEW
SCALE NA

REV	ECR NO	REVISION DESCRIPTION	BY	DATE
C	12022	CHG BLT HL DIM SCHEME	RDW	12/9/02
B	-	UPDATE DRWG TOL	MMK	2-8--01
A	11583	CHG LEG PAD	MMK	1-01-01

	APPROVED	DATE
DRAWN BY	JEN	12-7-00
CHK'D BY	DCH	12-11-00
ENG'G APPR.	KJR	12-12-00
MFG. APPR.	GAP	12-11-00
QUAL. APPR.	FAS	12-14-00
PURCH. CONT.	LBL	12-12-00

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MAT'L: SEE B.O.M.

PART NUMBER 11502954

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES.
TOLERANCES:
FRACTIONS ± 1/4
ANGLES ± 1°
2 PLACE DECIMALS ± NA
3 PLACE DECIMALS ± NA

NEXT ASS'Y | USED ON | NEXT ASS'Y | FINAL ASS'Y
APPLICATION | QUANTITY REQ'D

CHART Storage Systems Division New Prague Operations

TITLE: 9% NI 175/250/400 ASME

DRAWING NO. C-11502954 REV C

SCALE N/A | DO NOT SCALE DRAWING | SHEET 2 OF 2