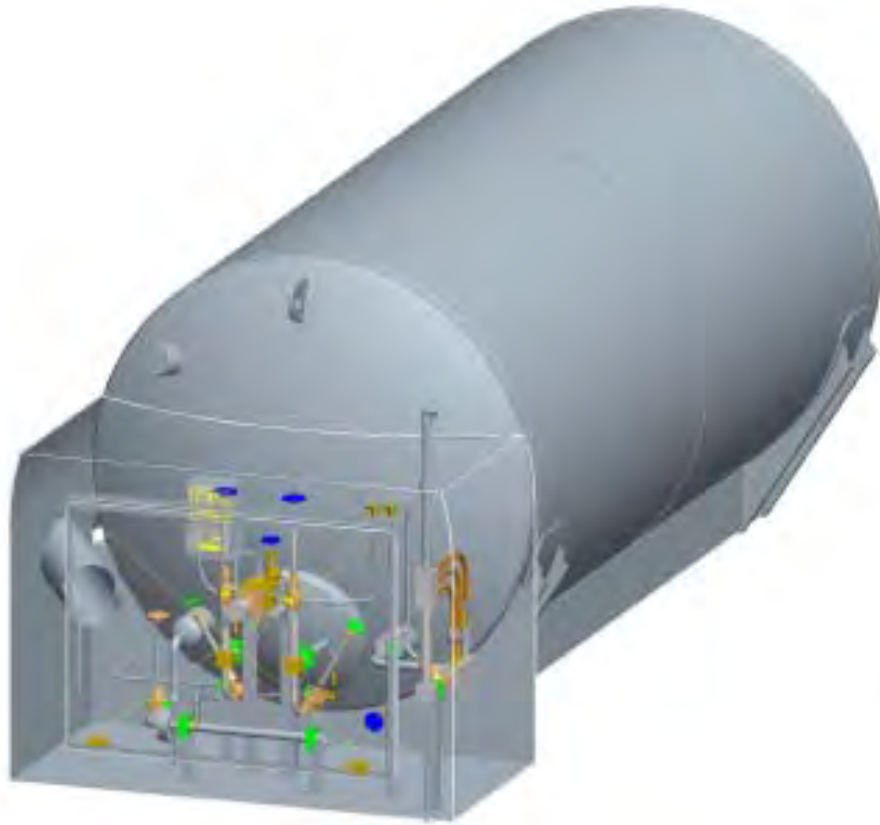




TECHNICAL MANUAL STANDARD HLD ATMOSPHERIC



MANUAL # 11884016
Rev C

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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 (105-115°F or 41-46°C). **DO NOT USE HOT WATER.** Cryogenic burns that result in blistering or deeper tissue freezing should be examined promptly by a physician.

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.

NOTE :

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.

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/cm²) 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 Under And On The Sides Of The Customer Station. The Pressure Gauge And Liquid Level Gauge Are Located At Eye Level On The Container For Ease Of Viewing.

Single Regulator System

Single regulator system has a single pressure building regulator. The pressure building circuit is responsible for maintaining a minimum set pressure in the vessel.

2.4 PRESSURE BUILD-UP SYSTEM

The pressure build-up system may consist of an ambient air vaporizer and pressure building regulator. When tank pressure becomes lower than the set point of the pressure building regulator, the regulator will open. As a result, liquid will be able to flow through the vapor trap in the annulus, through the isolation valve and regulator to be expanded to vapor in the pressure building coil. The vapor accumulates in the inner tank vapor space to increase pressure. This flow continues until inner tank pressure is equal to regulator setting. When the pressures are equal, the regulator closes. This system thus automatically maintains station pressure as required.

**** NOTE: Upon tank installation. The nuts mounting the PB coil (PBC-1) to the respective brackets must be loosened $\frac{1}{2}$ - $\frac{3}{4}$ turns to allow for expansion & contraction.**

2.5 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.

2.6 VESSEL TRANSPORTATION

The Chart vessel described in this manual is designed to be transported over the road. Prior to transporting this vessel over the road with liquid contents, the road relief circuit must be enabled. To prepare the vessel for transportation, follow the procedure in Table 1.

Table 1: Transportation Preparation Procedure

STEP NUMBER	Procedure
1	Ensure all valves are closed except the liquid level gauge vapor phase and liquid phase shutoff valves (HCV-8, HCV-10).
2	Open the vapor vent valve (HCV-12) to relieve head pressure.
3	Monitor tank pressure at gauge (PI-1). When gauge indicates tank pressure is at 20 psi, open the road relief valve (HCV-14) and close the vapor vent valve (HCV-12). To return the vessel to normal service, close the road relief valve (HCV-14).

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 8.

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/cm²) 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 greater 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 2: Vessel Purging Procedure

STEP NUMBER	Purging Procedure
	<p style="text-align: center;">CAUTION</p> <p>The maximum purge pressure should be equal to 50 percent of the maximum operating pressure of the tank or 30 PSI (2.1 kg/cm²), 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/cm²) must always be maintained in the tank.</p> <p>Attach the source of liquid purge to the fill connection (FC-1).</p>
1	<p>Close all valves except the pressure build-up valves (HCV-3, HCV-11) and liquid level gauge vapor phase and liquid phase shutoff valves (HCV-8, HCV-10).</p>
	<p style="text-align: center;">NOTE</p> <p>The pressure building regulator (PCV-1) is <i>normally</i> set to build pressure to 120 PSI. When this pressure is used as the purge pressure, DO NOT adjust the regulator adjusting screw. When a solenoid valve is used to control the pressure building circuit, it must be energized.</p>
2	<p>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).</p>
3	<p>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.</p>
4	<p>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).</p>
5	<p>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.</p>
6	<p>Close drain valve (HCV-7) and bottom fill valve (HCV-1).</p>
7	<p>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).</p>
8	<p>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.</p>

STEP NUMBER	Purging Procedure	
9	<p style="text-align: center;">NOTE</p> <p>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.</p>	
10	<p>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).</p>	
11	<p>Repeat purge procedure 2 through 6 and 10 at least three times to ensure product purity.</p>	
12	<p>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).</p>	
13	<p>After purging the tank, but before filling, verify that the following valves are open or closed as indicated.</p>	
	<p>Valve</p> <p>Bottom fill valve HCV-1</p> <p>Top fill valve HCV-2</p> <p>Vapor vent valve HCV-12</p> <p>Full trycock valve HCV-4</p> <p>Liquid level gauge equalizing valve HCV-9</p> <p>Product supply valve HCV-18</p> <p>Pressure building inlet/outlet valves HCV-3/HCV-11</p> <p>Liquid level gauge liquid phase valve HCV-10</p> <p>Liquid level gauge vapor phase valve HCV-8</p>	<p>Position</p> <p>Closed</p> <p>Closed</p> <p>Closed</p> <p>Closed</p> <p>Closed</p> <p>Closed</p> <p>Closed</p> <p>Open</p> <p>Open</p>

Table 3: 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).
	<p style="text-align: center;">NOTE</p> <p>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).</p>
5	<p>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/cm²) higher than station pressure. Open the discharge valve on the supply unit to begin flow.</p> <p style="text-align: center;">(or)</p> <p>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/cm²) to 100 PSI (7.0 kg/cm²) higher than the tank pressure. Fill slowly.</p>
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 4: Vessel Refilling Procedure

STEP NUMBER	Vessel Refilling Procedure
1	<p style="text-align: center;">NOTE</p> <p>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.</p>
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	Verify that all other valves are in normal operating positions.
6	Connect the supply unit transfer hose to tank fill connection (FC-1).
7	<p style="text-align: center;">NOTE</p> <p>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).</p>
8	Open top fill valve (HCV-2) completely.
	<p>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/cm²) higher than station pressure. Open the discharge valve on the supply unit to begin flow.</p> <p style="text-align: center;">(or)</p> <p>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/cm²) to 100 PSI (7.0 kg/cm²) higher than tank pressure.</p>
9	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.
10	Monitor liquid level contents gauge (LI-1). When the gauge indicates approximately three-quarters full, open full trycock valve (HCV-4).
11	When liquid spurts from full trycock valve (HCV-4), stop fill at the supply source and close full trycock valve (HCV-4).
12	Close tank fill valves (HCV-1, HCV-2).
13	Drain residual liquid in the fill hose via drain valve (HCV-7).
14	Relieve fill hose pressure by loosening the hose at the fill connection, and then disconnect the hose

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.

NOTE

When using a vessel for gaseous service, a free standing vaporizer will have to be installed between the Gas Use connection and a final line pressure regulating system.

5.1 LIQUID DELIVERY

Table 5: Liquid Withdrawal Procedure

STEP NUMBER	Liquid Withdrawal Procedure
1	Connect customer line liquid withdrawal connection.
2	Verify that all valves except gauge liquid phase valve (HCV-10) and the gauge gas phase valve (HCV-8) are closed.
3	Observe pressure building regulator/economizer regulator or pressure building regulator in the dual regulator system (PCV-1) setting as indicated on the station pressure gauge (PI-1). If station pressure is too high, open vent valve (HCV-12) to relieve excessive gas. It is possible that regulator springs will require changing for lower operational pressure.
4	Open liquid withdrawal valve (HCV-23) slowly to begin liquid flow.
5	Once the desired amount of liquid has been delivered, close the liquid withdrawal valve (HCV-23).

5.2 GAS DELIVERY

Table 6: Gas Withdrawal Procedure

STEP NUMBER	Gas Withdrawal Procedure																				
1	Connect customer line to vessel gas use connection (C-5) or to the optional final line connection if used.																				
2	Verify that all valves except gauge liquid phase (HCV-10) and gauge gas phase (HCV-8) are closed.																				
3	Open product supply valve (HCV-18), pressure building inlet valve (HCV-3), PB outlet valve (HCV-11) to start gas flow. At this time, final line pressure gauge will be indicating pressure in the customer line and the system will automatically deliver gas until stopped, or vessel is empty.																				
	Once the required amount of product has been delivered (or to close the tank down for an extended period of time), stop gas flow by closing gas use valve (HCV-18). The operation of an Chart unit is completely automatic, valves need to be opened and closed only during filling and during major maintenance.																				
4	<p>Normal operating valve position for an HLD unit are as follows:</p> <table data-bbox="402 831 998 1075"> <tbody> <tr> <td>Bottom fill valve HCV-1</td> <td>Closed</td> </tr> <tr> <td>Top fill valve HCV-2</td> <td>Closed</td> </tr> <tr> <td>Vapor vent valve HCV-12</td> <td>Closed</td> </tr> <tr> <td>Full trycock valve HCV-4</td> <td>Closed</td> </tr> <tr> <td>Liquid level gauge equalizing valve HCV-9</td> <td>Closed</td> </tr> <tr> <td>Hose drain valve HCV-7</td> <td>Closed</td> </tr> <tr> <td>Product supply valve HCV-18</td> <td>Open</td> </tr> <tr> <td>Pressure building inlet/outlet valves HCV-3/HCV-11</td> <td>Open</td> </tr> <tr> <td>Liquid level gauge liquid phase valve HCV-10</td> <td>Open</td> </tr> <tr> <td>Liquid level gauge vapor phase valve HCV-8</td> <td>Open</td> </tr> </tbody> </table>	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-18	Open	Pressure building inlet/outlet valves HCV-3/HCV-11	Open	Liquid level gauge liquid phase valve HCV-10	Open	Liquid level gauge vapor phase valve HCV-8	Open
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Liquid level gauge equalizing valve HCV-9	Closed																				
Hose drain valve HCV-7	Closed																				
Product supply valve HCV-18	Open																				
Pressure building inlet/outlet valves HCV-3/HCV-11	Open																				
Liquid level gauge liquid phase valve HCV-10	Open																				
Liquid level gauge vapor phase valve HCV-8	Open																				

5.3 REGULATOR ADJUSTMENTS

NOTE :

To field set or adjust regulators quickly the vessel must preferably be a full tank.

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

The adjustments which follows are required to “final set” the regulator following spring replacement, or after completing valve repairs which required disassembly and reassembly.

Table 7: Pressure Building Regulator Adjustment

STEP NUMBER	Pressure Building Regulator Adjustment
1	This procedure is best performed with a completely full tank, so that all changes in adjustment of the pressure building regulator will be reflected rapidly. Observe reading on pressure gauge (PI-1). If pressure is lower than desired set point of pressure building regulator/economizer regulator (PCV-1), proceed to Step 2; if higher, proceed to step 3.
2	If tank pressure is below the desired setting, loosen the pressure screw lock nut on the regulator. With PB Inlet and PB Outlet valves (HCV-3, HCV-11) open, gradually open regulator by turning the pressure screw (clockwise) to build tank pressure to the desired setting. Note that the pressure screw should be adjusted in small increments, allowing sufficient time for tank pressure to stabilize each time the screw is turned. The tank can be considered stabilized when no frost is found on the pressure building circuit. This reduces the possibility of over-shooting the desired pressure, which would in turn, require partial tank blow-down via the vent valve (HCV-12). Tighten lock nut on regulator, and return vessel to normal service.
3	If the tank is above the desired setting, open vent valve (HCV-12) to vent excess gas. Should pressure continue to rise above the desired level, proceed to step 4.
4	Again vent excess gas by opening vent valve (HCV-12). Reduce pressure until tank pressure gauge (PI-1) indicates a reading of 10 PSI (0.7 kg/cm ²) below the desired setting. Loosen set screw on PB regulator/economizer valve (PCV-1), and proceed to Step 2, gradually decrease tank pressure by adjusting the pressure screw (counter clockwise).

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

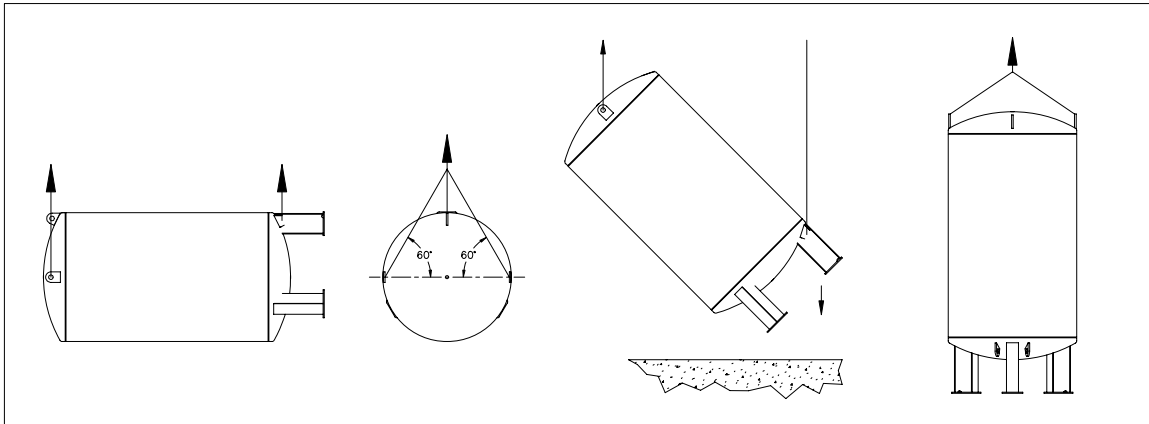
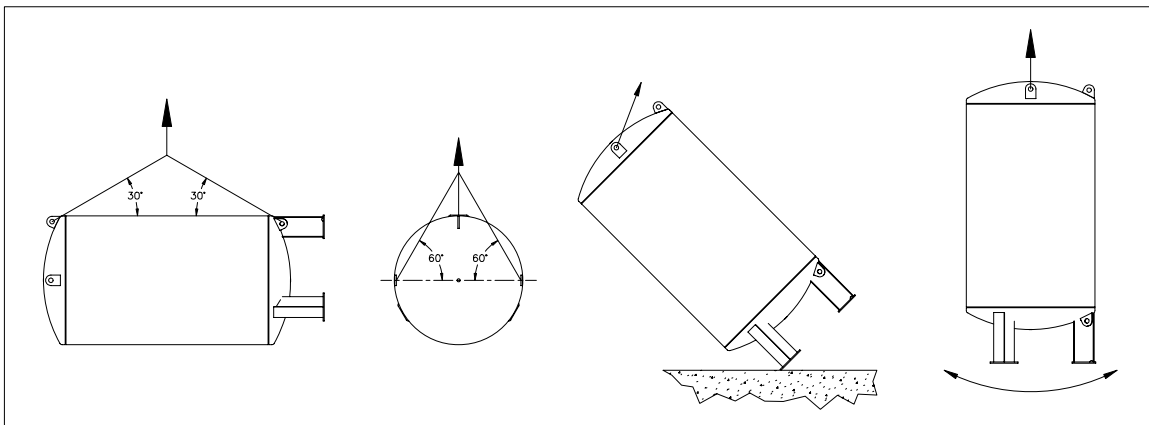


FIGURE 2: SINGLE-CRANE INSTALLATION METHOD



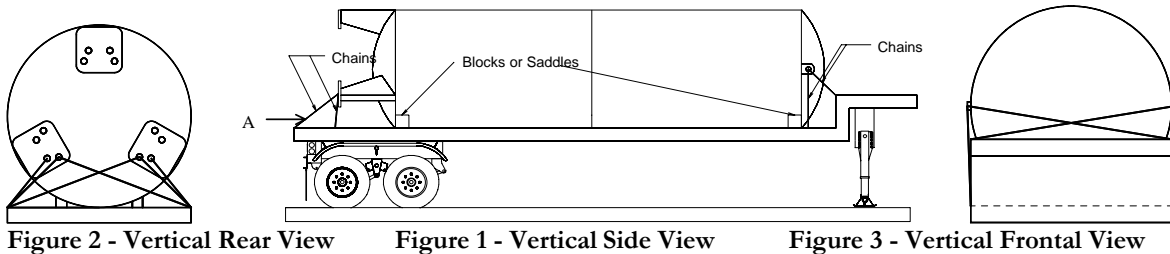
6.1 VESSEL TIE DOWN GUIDELINES

Chart Industries, Inc. Vessel Tie Down Guidelines 3/5/99

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.



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.

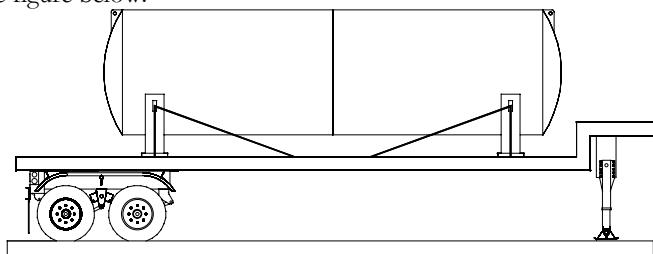


Figure 4 - Horizontal Side View

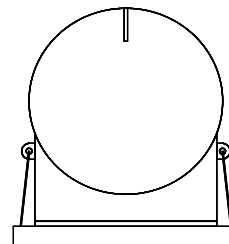


Figure 5 - Horizontal End View

CABLE AND CHAIN TABLE

Tank Size (gal)	Typ. Vessel Weight (lbs)	Maximum Force in Element (lbs)	Recommended Cable	Recommended Chain
1500	10000	17800	(1) 1/2" IWRC 6X19	(2) 1/2" Transport Grade 7
3000	17000	30600	(1) 3/4" IWRC 6X19	(3) 1/2" Transport Grade 7
6000	30000	53900	(1) 3/4" IWRC 6X19	(2) 7/8" Alloy Grade 8
9000	45000	66200	(2) 3/4" IWRC 6X19	(2) 7/8" Alloy Grade 8
11000	54000	79400	(2) 3/4" IWRC 6X19	(3) 7/8" Alloy Grade 8
13000	63000	92700	(2) 3/4" IWRC 6X19	(3) 7/8" Alloy Grade 8
15000	72000	106000	(2) 3/4" 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.**

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 exists, contact the factory for advice on vessel vacuum testing.

7.2 TROUBLESHOOTING

The Table 11 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 1/4" 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 8: Valve Repair

STEP NUMBER	PROCEDURE
	<p style="text-align: center;">NOTE</p> <p>Unless valve component parts are available in inventory, a defective valve should be replaced with a new assembly.</p>
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	<p>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.</p> <p>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."</p>

7.5 REGULATOR REPAIR

When a defective pressure building regulator/ economizer regulator or final line regulator is identified, remove and repair the units as detailed in this manual.

NOTE :

Replacement regulators should be obtained from Chart to ensure compatibility.

Table 9: General Regulator Repair

STEP NUMBER	PROCEDURE
	<p>NOTE Unless regulator component parts are available in inventory, a defective regulator should be replaced with a new assembly.</p>
1	Release pressure in the vessel by opening vent valve (HCV-12).
2	Depressurize the regulator.
3	It is possible that the body of the regulator is permanently installed in the vessel; in this case the seats, domes, pistons, springs, gaskets, etc. can be removed and replaced.
4	Disassemble the regulator, making sure to identify all piece parts removed.
5	Inspect all parts for wear, deformation, nicks, or damage. Replace all gaskets and O-rings.
6	Clean all metal parts with an industrial cleaning solvent. Air dry with a clean, low-pressure air source.
7	Reassemble the regulator in the reverse order of disassembly.
8	Bench test the rebuilt unit to make sure that it actuates properly at the set pressure. The pressure builder/economizer and final line regulators close to regulate downstream pressure.
9	If the regulator is to be reinstalled on a vessel, do so as soon as possible following repair. If it is to be returned to inventory, seal the unit in a polyethylene bag for storage. Apply a label to the bag such as "CLEAN REGULATOR, DO NOT OPEN BAG UNLESS UNIT IS TO BE INSTALLED. "
10	Pressurize the regulator by opening the applicable pressure building and isolation valves. Allow pressure to build up in the system and verify the reliability of the rebuilt unit.

7.6 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 a gauge 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.

7.7 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 10: 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. Otherwise, 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.

7.8 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 11: Troubleshooting

PROBLEM	POSSIBLE CAUSE	DIAGNOSIS	SOLUTION
Excessive Tank Pressure Vessel *Vessel vents through relief valve frequently *Pressure remains above economizer set point	1. Inadequate vacuum	1. Take vacuum reading	Consult factory
	2. Leaking pressure building/economizer regulator (PCV-1)	1. Line to PCV-1 frosted from tank to HCV-3, and beyond	1. Check adjustment 2. Repair or replace
	3. Tank gauge (PI-1) in error	1. Compare with gauge of known accuracy	1. Replace
	4. Low withdrawal rate	1. Frosting on economizer piping. No frosting on HCV-18 or Vap	1. Consult factory
	5. Excessive shutdown time	1. User pattern	1. Replace vessel with more efficient model
Failure to maintain set delivery pressure *House pressure is low	1. Pressure builder not operational	1. PB Valve Closed	1. PB Valve Open
	2. Regulator set too low	1. No frosting on pipe to HCV-3, PCV-1 or PBC-1 2. Set pressure at or below final line pressure	1. Readjust
	3. Cannot maintain pressure	1. HCV-3, PCV-1 always frosted 2. Withdrawal too high	1. Install higher capacity PB 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

7.9 REGULATOR MAINTENANCE INSTRUCTIONS

Type B Regulator:

The Type PBE-2 regulator is designed for cryogenic. It is a direct acting, single seated, spring loaded diaphragm-type regulator.

OPERATING INSTRUCTIONS

Adjusting the Delivery Pressure

The regulator's delivery pressure setting is adjusted by turning the adjusting screw at the top of the spring chamber after loosening the adjusting screw lock nut. To increase the delivery pressure, turn the adjusting screw clockwise (into the spring chamber). To decrease the delivery pressure, turn the adjusting screw counter-clockwise (out of the spring chamber). Tighten the adjusting screw lock nut after the adjusting has been made.

REPAIR KITS

REGULATOR PART NUMBER	REGULATOR		KIT PART NUMBER
	SIZE	MODEL	
11490623	1/4"	PBE-1	11656638
11490631	1/2"	PBE-2	11656700
2110032	1/4"	A-32	9715652
2110072	1/2"	TYPE B	10620123
11640353	1/2"	G-60-HP	11656734
11049205	1/4"	FRM	9715572
2111462	1/2"	FRM-2 HP	10620115
11691812	1"	Type B	11635888

SPRINGS

REGULATOR	MODEL SIZE	SPRING PART NUMBER	RANGE (PSI)
PBE-1	1/4"	10525193	75-175
		10972348	150-350
PBE-2	1/2"	5710131	20-75
		10522363	25-125
		11525371	100-200
		10707392	150-250
A-32	1/4"	5710191	15-65
		5710111	40-100
		10525193	75-175
		5710201	100-250
TYPE B	1/2"	5710131	20-75
		10522363	25-125
		11525371	100-200
		10707392	150-250
G-60	1/2"	5710431	0-7
		5710371	5-70
		5710411	100-400
FRM	1/4"	5710031	2-25
		5710191	15-65
		5710111	40-100
		10525193	75-175
		5710201	100-250
FRM-2	1/2"	5710301	200-400
Type B	1"		

8 DRAWINGS

Final	Outline & Dimension	P&ID
HLD-900 #11881034	C-11874766	C-11884008
HLD-900 #11862431	C-11835919	C-11862693
HLD-1500 #11862474	C-11835919	C-11862693
HLD-3600 #13095580	C-13222892	CS-13344
