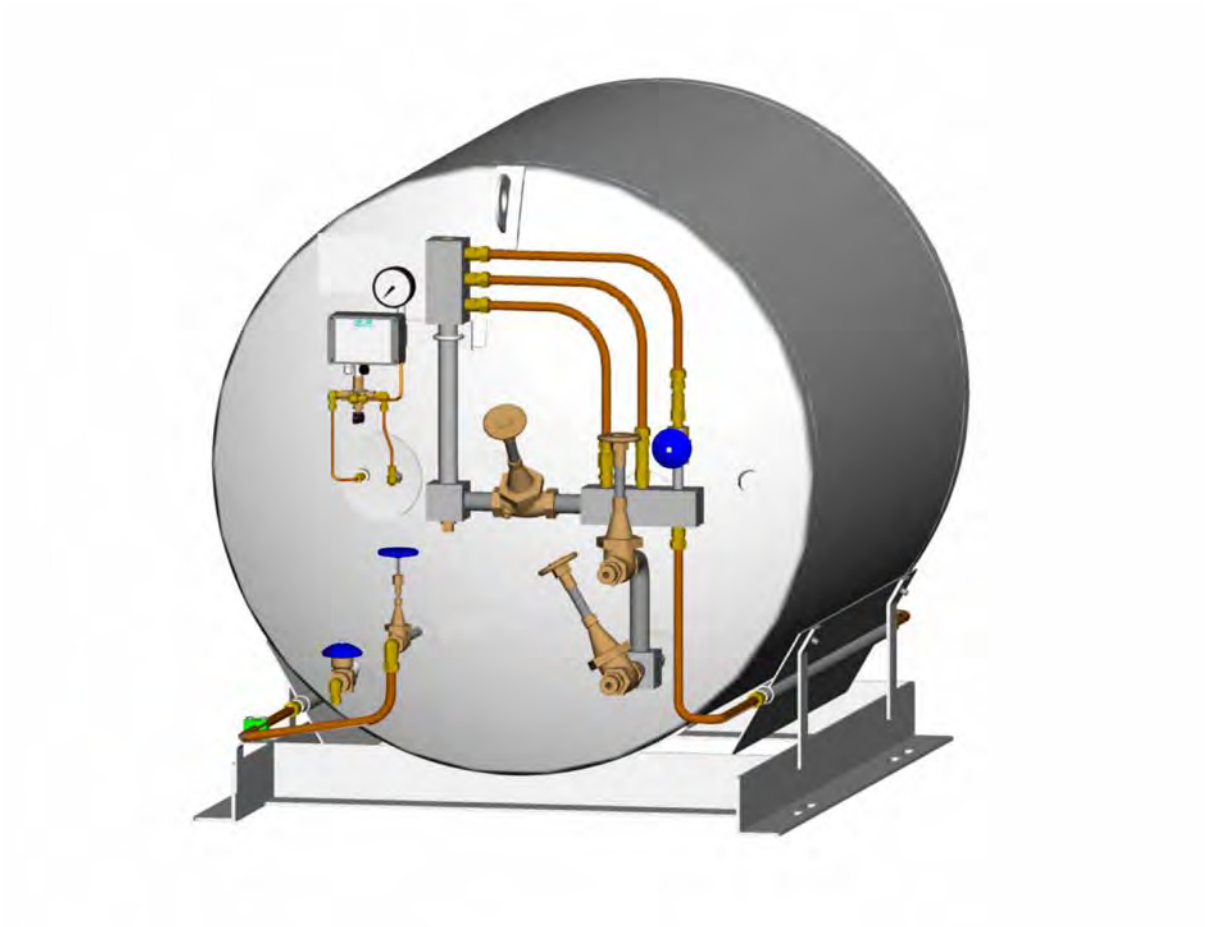
TECHNICAL MANUAL
STANDARD SMALL BULK DELIVERY TANKS



MANUAL # 11827564
REV D

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Revision Log	Description
Rev A (10/08/03)	New picture on cover
Rev B (12/12/03)	Add installation section & update manual.
Rev C (11/30/04)	Add spare parts Section 8
Rev D (06/21/12)	Add liquid level charts to Section 8

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.

To avoid possible hazards, always use the Small Bulk Delivery Tank in an area having adequate ventilation. For further information concerning ventilation, refer to the Compressed Gas Association Inc.'s Safety Bulletin SB-2.

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.

2.2 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). 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 super 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 S1.2, "Pressure Relief Device Standards, Part 2, for Cargo and Portable Tanks for compressed Gases."

The Small Bulk Delivery containers are skid mounted. They are supplied with brackets for trailer or truck bed mounting. Lifting lugs are secured to the top portion of each head on each container to facilitate safe handling.

Plumbing Configurations

Small Bulk Delivery cryogenic containers are constructed with all operating controls and indicators uniquely situated at the front of the container to facilitate liquid dispensing operations. In stand-alone operating environments, these containers enables the user, through the use of the system valves, to easily control container operation. The Small Bulk Delivery is ideal for the medical home delivery market. All of the valves are located in the center of the plumbing head making them easily accessible from the side or rear door of a medical delivery truck. The Small Bulk Delivery is designed with an external pressure building system to build pressure at accelerated rates to fit the medical delivery application.

Pressure Building System

The pressure building system consists of a pressure building coil and a pressure building on/off valve. When tank pressure is lower than desired for a liquid transfer operation, the pressure building valve may be opened. When this occurs, liquid flows from the tank through the pressure building coil where it is converted into gas, and then returned back to the vapor space above the liquid in the inner tank. This flow continues until inner tank pressure has reached the desired setting as indicated on the container pressure gauge. The pressure building valve should be turned off at this point. The rate of pressure rise maybe slowed by "throttling" the PB Valve.

CAUTION: Avoid opening the PB valve all the way until the handle stops, as sticking may occur under extended use leading to uncontrolled pressure rise.

NOTE: When the Small Bulk Delivery container is to be used in a high withdrawal situation, the pressure building system may be activated during the entire withdrawal operation.

Gas Sample Port

A gas sample port can be added to the Small Bulk Delivery model. The drain plug at the bottom of the vertical vent stack can be replaced with an isolation valve for gas sampling. Gas can be sampled from this port when the vent valve (HCV-3) is opened slightly and the gas sampling port isolation valve is opened. Allow 30 seconds of venting to occur before sampling the gas.

2.3 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/she 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.

3

3. INSTALLATION

Before mounting Small Bulk Delivery Unit in cargo area, installer must be familiar with CGA SB-9, "Recommended Practice for the Outfitting and Operation of Vehicles Used in the Transportation and Transfilling of Liquid Oxygen".

3.2 CAUTION

This section describes and illustrates proper Small Bulk Delivery installation considerations.

The Small Bulk Delivery cryogenic containers are specifically designed for mounting on nearly any truck body of proper size and weight capacity. Generally, no special truck equipment is required for mounting these containers. The Small Bulk Delivery container can be mounted on many types of truck and specially designed trailers.

3.2 VEHICLE MOUNTING

Instructions for mounting the Small Bulk Delivery container into a standard truck, step side van, or high cab truck are as follows:

1. Examine the truck to verify that the frame rails are the proper distance apart. Truck frame rail should be 32-3/4" to 35-3/4" apart.

2. Examine the pre-drilled holes in the Small Bulk Delivery Tank frame and make proper measurements for drilling matching holes in the floor.

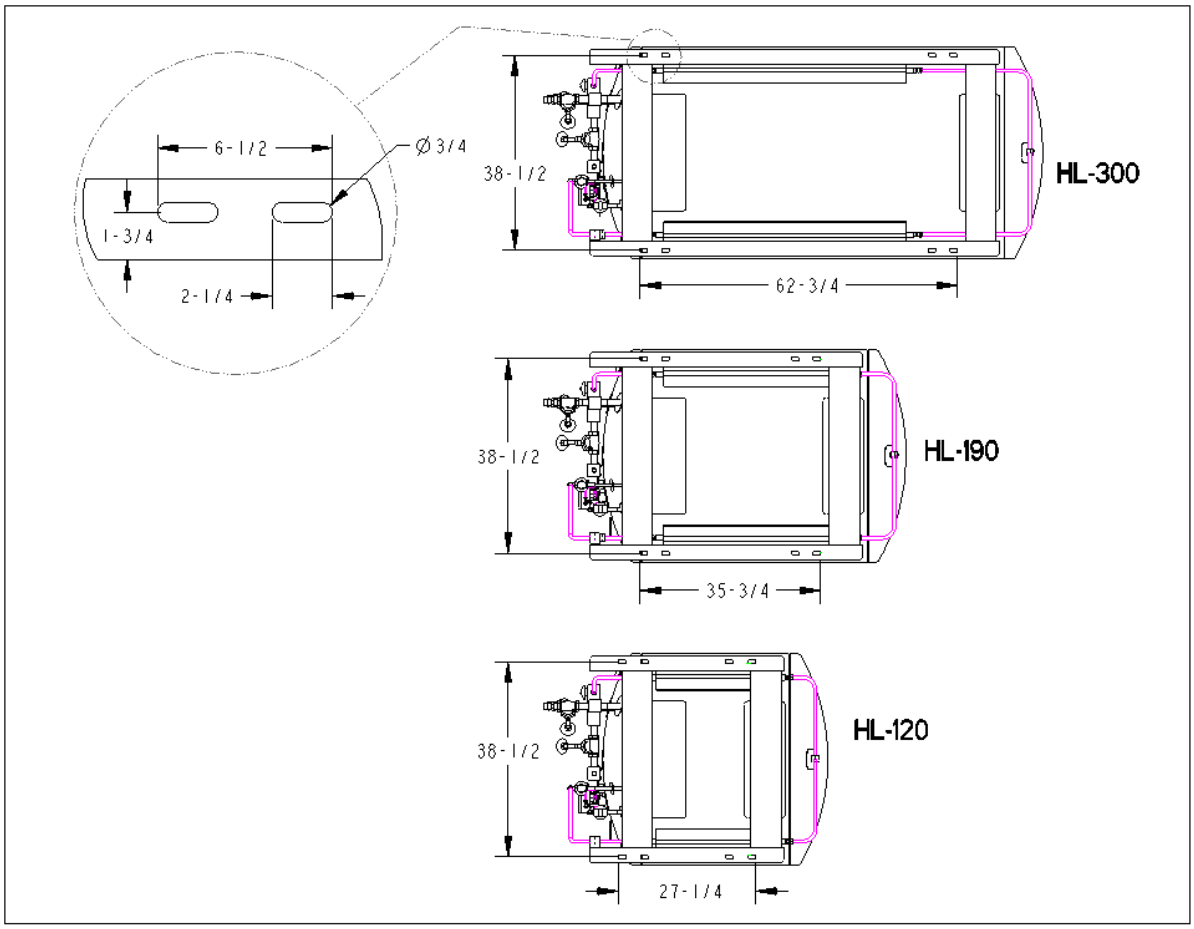


Figure 3.1

3. Drill eight holes through the floor of the vehicle so as to bracket the frame members as shown in Figure 3.1.

   CAUTION: The mounting must be made through floor bed and around the truck frame as shown in Figure 3.2. Failure to do so could result in personal injury and/or damage to the tank in the event of collision or fast stop.

4. Place the tank into the truck with the mounting holes aligned.

5. Assemble a nut, lock washer, and flat washer to one end of each piece of threaded rod (eight required) as shown in Figure 3.2.

6. Insert the rod/nut/washers assembly through the pre-drilled slots in the tank frame and through the holes in the floor.

7. Assemble the pre-drilled mount plates to the under side of the vehicle, where the rod/nut/washer assemblies are bracketing the frame. Install a nut, lock washer, and flat washer. Tighten.

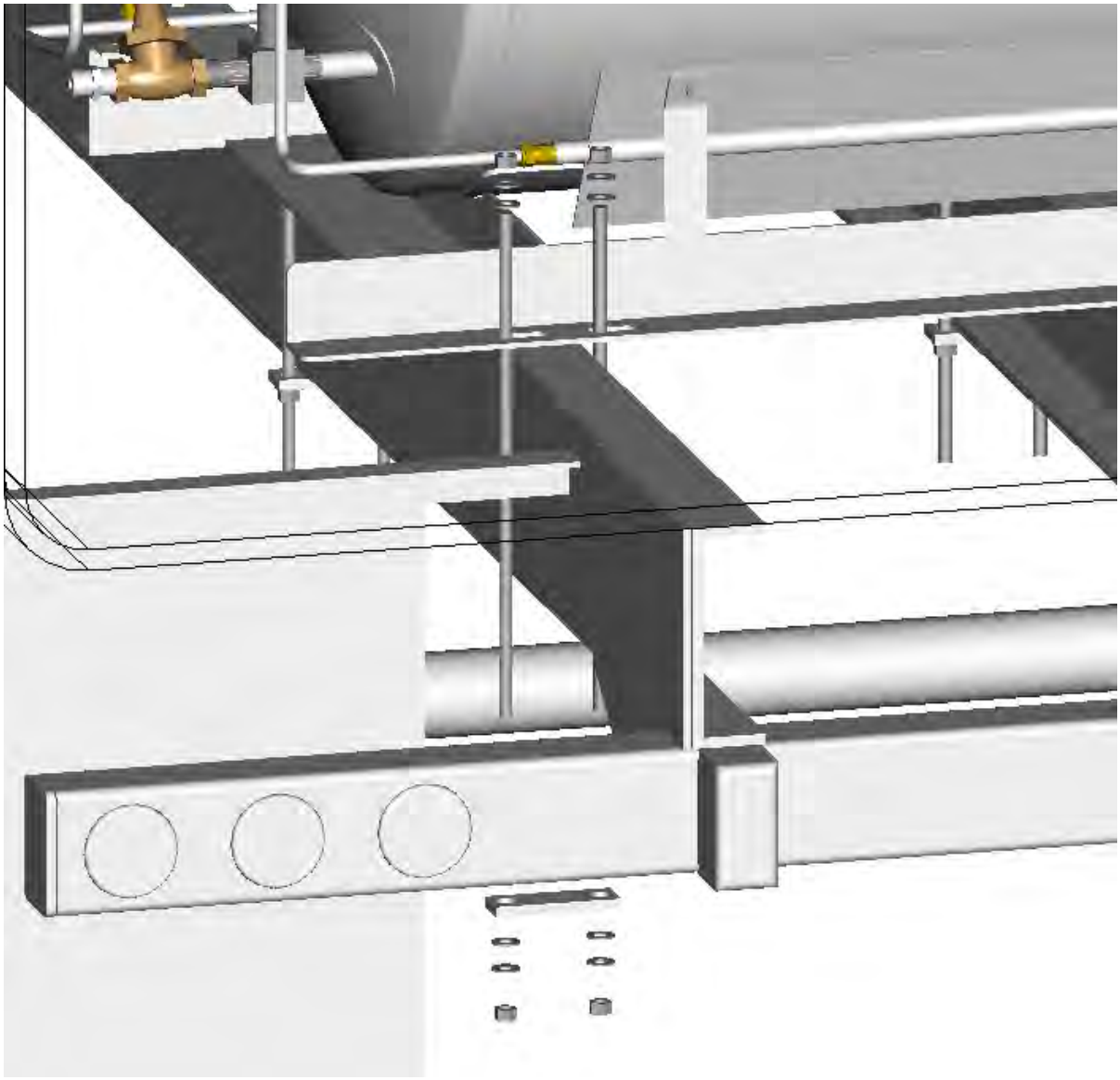


Figure 3.2

3.3 ROOF VENT INSTRUCTIONS

1. Select a location on the roof of the truck to place the vent exhaust assembly. The location should allow the flex hose to reach between the tank and the vent exhaust. See Figure 3.3.

2. Use one of the gaskets as a template to mark the holes on the roof.

3. Remove washers and nuts from the carriage bolts located on the vent exhaust assembly.

4. Drill the center holes using a 1-1/4 hole saw. Using a 3/8" drill the four bolt holes.

5. Place one rubber gasket and top flange of exhaust assembly on top of van. Face the unit such that the output of vent exhaust is toward the back of the truck. Place a small amount of silicone in the square holes. Place the four carriage bolts in the square holes.

6. From inside the van, align the other rubber gasket and bottom flange of the roof assembly with the carriage bolts. Tighten the washers and nuts on the carriage bolts.

7. Return to the top of the van and place a small amount of silicone sealant along the perimeter of the top flange.

8. Attach the flex hose to the brass flare fitting on the roof assembly and the flare fitting on the vent pipe.

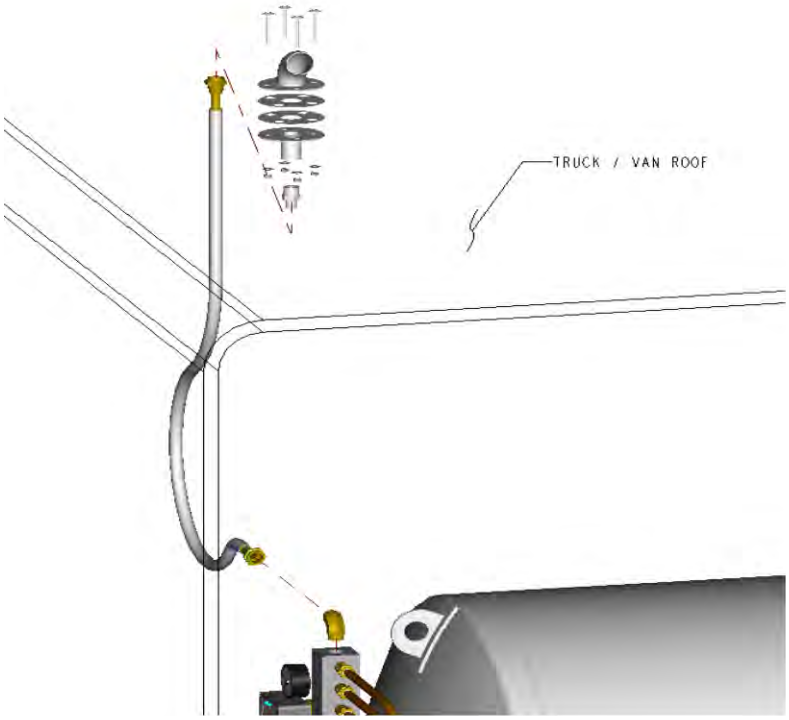


Figure 3.3

Chapter

4

4 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.

Chapter

5

5 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.

5.1 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 20 PSI (1.41 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 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.

Purging

To purge the Small Bulk Delivery Tank, use the following general procedures.

CAUTION: The maximum purge pressure should be equal to 50 percent of the maximum operating pressure of the tank or 30 psig (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 psig (0.35 kg/cm^2) must always be maintained in the tank.

1. Attach the source of the liquid purge product to the fill and withdraw connection (C-1).

2. Close all valves except pressure building valve (HCV-2) and liquid level gauge valve (HCV-9).

3. Open liquid fill and withdraw valve (HCV-1) enough to allow liquid to flow slowly into the vessel through the fill line. The gradual flow enables the liquid to vaporize in the line and pressure building coil, and to slowly build up pressure in the inner tank.

   CAUTION: While purging through the various lines, observe the tank pressure as indicated on pressure gauge (PI-1). Do not allow tank pressure to go below 5 psig (0.35 kg/cm^2).

4. Shut off the liquid supply source and close liquid fill and withdraw valve (HCV-1) when the pressure in the tank reaches the maximum purge pressure.

5. Disconnect the liquid supply source hose from fill and withdraw connection (C-1).

6. Open liquid fill and withdraw valve (HCV-1) slowly to avoid splashing of the liquid. Drain all liquid from the tank. The appearance of gas (vapor) at the drain indicated that all liquid has been drained.

   WARNING: Do not drain liquid oxygen onto surfaces that contain hydrocarbons, grease, oil, or other organic material (i.e., asphalt).

7. Close liquid fill and withdraw valve (HCV-1).

8. Repeat steps 1 through 7 above at least four times to ensure product purity.

9. After steps 1 through 8 have been performed as specified, check gas in the tank for purity.

10. After purging the tank, but before filling, verify that all of the valves are closed except (HCV-9) gauge lines.

Filling

Small Bulk Delivery may be filled with liquid from a liquid supply unit either by a pumping or a pressure transfer. If internal pressure of the Small Bulk Delivery Tank is at least 20 psi (1.4 kg/cm^2) less than the maximum allowable pressure of the supply unit, liquid may be transferred by a pressure transfer. If the normal working pressure of the Small Bulk Delivery is equal to or greater than the maximum allowable pressure of the supply unit, liquid must be pumped into the tank.

Before filling the Small Bulk Delivery it should be visually 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 conduct the necessary repairs as soon as possible.

To fill the Small Bulk Delivery Tanks use the following general procedure:

1. Verify that the container to be filled is reasonably level to prevent over or under filling.

2. If necessary, purge the container prior to filling (refer to the section on purging)

3. Verify that the contents of the supply unit is the proper product to be transferred to the Small Bulk Delivery Tank.

4. Check for partial blockage or obstruction of the common pressure relief device and the vent valve discharge line by opening the vent valve (HCV-3) and observing vent gas exiting the vent pipe.

5. If necessary, start the pressure building system on the liquid supply source to obtain a working pressure that is sufficient enough to allow the liquid to be transferred from the source to the Small Bulk Delivery Tank.

6. Verify that all container valves except liquid level gauge valve (HCV-9) are closed.

7. Connect the supply unit transfer hose to liquid fill and withdraw connection (C-1).

8. Open vent valve (HCV-3) and full trycock valve (HCV-4).

9. Open liquid fill valve (HCV-1) slowly.

10. Continue to fill the container until the proper amount of liquid has been transferred to the container. This is evidenced when liquid issues from full trycock valve (HCV-4).

    CAUTION: Failure to use full trycock indicator may result in overfill.

11. Stop the flow of liquid from the supply source.

12. Close liquid fill valve (HCV-1) vent valve (HCV-3), and full trycock valve (HCV-4).

13. Relieve fill hose pressure by loosening the hose at liquid fill and withdraw connection (C-1), then disconnect the hose.

14. Check liquid pressure in the container. If pressure continues to rise as the result of a warm unit, open vent valve (HCV-3) until thermal equilibrium in the container has been achieved. Once achieved, close vent valve (HCV-3).

Liquid Withdrawal

Liquid product is drawn at low pressure from the Small Bulk Delivery containers from the fill and withdraw connection, (C-1). Liquid flow from this connection is controlled by throttling open the liquid fill and withdraw valve (HCV-1).

Generally, when withdrawing liquid to fill open or atmospheric dewars, the lower the pressure in the Small Bulk Delivery Tank, the less the transfer and flash loss will be. However, when transferring liquid into a pressure vessel it may be necessary to build and maintain pressure in the Small Bulk Tank.

To withdraw liquid from the Small Bulk Delivery Tank use the following general procedure:

1. Attach fill adapter to fill and withdrawal/connection if necessary.

   WARNING: Use only approved fill adaptor for the liquid product being supplied. Do Not use a nitrogen adaptor on an oxygen system.

2. Connect transfer hose to liquid fill and withdrawal connection (C-1) or fill adapter.

3. Observe the liquid level (LI-1) and pressure gauge (PI-1). Check liquid level to make sure there is enough product in the tank. Check pressure gauge to ensure adequate transfer pressure.

Receiver	Necessary Transfer Press
Open Dewar	5-10 psi
Medical Unit	45-50 psi
Liquid Cylinder	45-50 psi
Other	30 psi differential

4. Close road relief valve (HCV-7).

5. Open pressure building valve (HCV-2) to reach appropriate transfer pressure.

   NOTE: If a high withdrawal operation is to be performed, or liquid level in tank is very low, leave pressure building valve (HCV-2) open during the transfer operation.

6. If the customer container to be filled from the Small Bulk Delivery Tank is another pressure vessel, verify that it is properly vented during the transfer operation.

7. Open liquid fill and withdrawal valve (HCV-1) and slowly begin liquid flow.

8. Once the transfer is complete, close liquid fill and withdraw valve (HCV-1).

9. Close the pressure building valve (HCV-2) (if still open) to prevent over pressurization.

10. Relieve fill hose pressure by loosening the hose at liquid fill and withdraw connection (C-1), then disconnect the hose.

Pressure Building

All Small Bulk Delivery Tanks are equipped with a pressure building coil (PBC-1) and a manual pressure building valve (HCV-2).

If it becomes necessary to build pressure in the container, close all system valves except for liquid level gauge valve (HCV-9) and pressure building valve (HCV-2). When the desired pressure is reached as indicated on pressure gauge (PI-1), close pressure building valve (HCV-2).

NOTE: It may be necessary to leave pressure building valve open during high withdrawal operations.

CAUTION: Avoid opening PB valve all the way until the valve handle stops, as sticking may occur under extended use leading to uncontrolled pressure rise.

WARNING: The pressure building valve, (HCV-2), must always be closed when not intentionally building pressure in the container. Failure to do so may result in excess tank pressure and the release of the stored product.

Road Relief

When traveling on public roads, the DOT requires that vessels greater than 119 gallons must be kept below 25 psig (1.76 kg/cm^2). This is accomplished by using a road relief valve (PSV-2). To operate:

1. Blow tank pressure down to below 25 psig using vent valve (HCV-3).
2. Open road relief isolation valve (HCV-7).
3. Upon arrival at next fill location, close road relief isolation valve (HCV-7).
4. Open the pressure building valve (HCV-2) to raise pressure in tank to the desired transfer pressure.
5. Close PB valve (HCV-2) after transfer is complete.
6. Repeat steps 1 thru 5 for every liquid stop.

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.

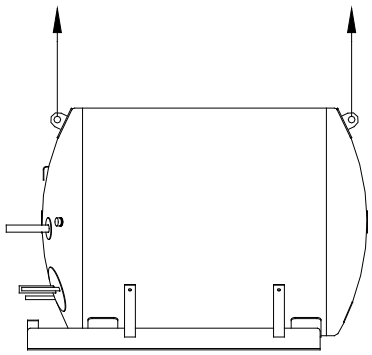
CABLE AND CHAIN TABLE

Tank Size (gal)	Typ. Vessel Weight (lbs)	Maximum Force in Element (lbs)	Recommended Cable	Recommended Chain
120	1,100	1300	(1) ¼" IWRC 6X7 class	(1) 1/4"- Transport
190	1,200	1400	(1) ¼" IWRC 6X7 class	(1) 1/4" -Transport
300	1,600	1850	(1) ¼" IWRC 6X7 class	(1) 1/4" -Transport

This table shows **approximate** Chart tank sizes and weights. Actual Tank weights may vary. 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 60 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.**

FIGURE 1, TWO CRANE INSTALLATION METHOD



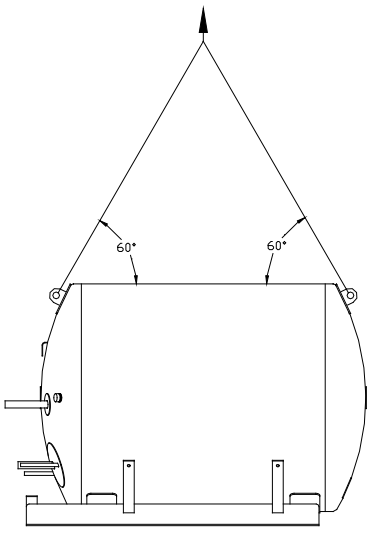


FIGURE 2, SINGLE CRANE INSTALLATION METHOD

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 Small Bulk Delivery clean and free of grease and oil. This is particularly important for units used in oxygen service. It is equally important for tanks 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 air on 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.

CAUTION: Before conducting maintenance or replacing parts on Small Bulk Delivery Tanks, release container pressure in a safe manner. Replacement of certain parts may also require that the container contents be completely emptied.

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. In vessels being operated in areas having extreme hot or cold climates, inspection intervals should be shortened.

Periodic Inspection Intervals

Item	Interval
Valves and fittings for leaks and other malfunctions	Quarterly
Indicating gauges for malfunction	Annually
Relief valves to verify proper settings	2 years
Tank burst disc (PSE-1)	2 years *

*Requires replacement ; refer to the information on tank burst disc replacement in this section.

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 have vacuum integrity that 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-3).
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.
8	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 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. Ensure that connection lines are properly mated.
3. Verify that the gauge is properly zeroed.
4. 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 tank burst disc should be replaced at least every two (2) years.

1. Open vent valve (V-3) to vent pressure from the inner tank vapor space.
2. Remove tank burst disc (PSE-1) from the container.
3. Install the new burst disc, making sure that mating surfaces are clean and properly seated. Use a Teflon tape or oxygen compatible thread sealant to prevent leaking.

7.7 TANK SAFETY RELIEF VALVE (PSV-1)

The safety relief valve will open and release gas to protect the tank from over-pressurization. The relief valve cannot be repaired; it needs to be replaced when it shows signs of leaking or malfunctioning.

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 10 Troubleshooting

PROBLEM	POSSIBLE CAUSE	DIAGNOSIS	SOLUTION
Excessive Tank Pressure Vessel	1. Inadequate vacuum	1. Take vacuum reading	1. Consult factory
	2. Leakage through pressure building valve (HCV-2)	2. Clean or replace valve seat	2. Replace valve
	3. Tank was filled with higher pressure (warm) liquid	3. Tank is venting	3. Vent pressure (HCV-3) to restabilize at a lower pressure
	4. Excessive shutdown time or low withdrawal rate	4. NER is greater that use rate	4. Vent tank properly to desired operating pressure
	5. Tank pressure gauge (P1-1) in error	5. Confirm tank pressure with calibrated test gauge	5. Replace defective gauge
Failure to maintain tank pressure	1. Excessive withdrawal rate	1. Pressure declining	1. Open pressure building valve (HCV-2)
	2. Relief valve (PSV-1) leaking or frozen up	2. Valve stuck open	2. Replace defective valve
	3. Tank burst disc (PSE-1) ruptured	3. Gas flowing through rupture disc	3. Replace burst disc
	4. Piping leak	4. Soap test piping	4. Repair leaks
	5. Low liquid level	5. Inadequate product to build pressure	5. Refill tank
Erratic or erroneous contents gauge readings	1. Leaking gauge lines	1. Soap test	1. Repair leaks
	2. Gauge damaged or faulty	2. Confirm level or pressure with test gauge	2. Replace gauge
Leaking safety relief valve	1. Dirt or ice under disc	1. Valve continues to vent	Reseat or replace valve as required
	2. Valve improperly seated		
	3. Damaged seat or disc	3. Valve fails to reset	3. Replace valve
Ruptured tank bursting disc (PSE-1)	1. Excessive tank pressure	1. Lower pressure	1. Replace disc
	2. Atmospheric corrosion and/or fatigue		2. Replace disc
	3. Interior corrosion		3. Replace disc after blowing out line
	4. Defective disc		4. Replace disc

Chapter 8

8 RECOMMENDED SPARE PARTS

8.1 11942685 RECOMMENDED SPARES 01 100PSI

Component	Description	Quantity
11819425	KIT REPAIR VLV BNT 1-2-1" REGO	1
11819441	KIT REPAIR VLV SEAT 1" REGO	1
11819521	KIT REPAIR VLV STEM 1/2-1/2" REGO	1
11819548	KIT REPAIR VLV STEM 1/4-1/2" REGO	1
11827433	RPD ASSY INLINE 1/2MPT 147PSI	1
11899226	RV BRS 1/2MPT 100 PSI REGO	1
11823352	RV BRS 3/8MPT 22 PSI REGO	1

8.2 LIQUID LEVEL CHARTS

HL-120 - Oxygen @ 10.0 psi			
Level (inH2O)	Volume (gal)	Weight (lb)	Gas Vol (SCF)
0	0	0	0
0.3	0	8	92
1	0	11	128
2	1	19	225
3	2	30	365
4	4	45	542
5	6	62	751
6	8	82	990
7	10	104	1,255
8	13	128	1,545
9	16	154	1,857
10	19	181	2,190
11	22	210	2,540
12	25	241	2,907
13	29	272	3,289
14	32	305	3,685
15	36	339	4,091
16	40	373	4,508
17	43	408	4,933
18	47	444	5,364
19	51	480	5,800
20	55	517	6,240
21	59	553	6,682
22	63	590	7,125
23	67	627	7,566
24	71	663	8,004
25	75	699	8,438
26	79	734	8,867
27	82	769	9,288
28	86	803	9,700
29	90	836	10,101
30	93	869	10,491
31	97	900	10,866
32	100	930	11,225
33	103	958	11,568
34	106	985	11,890
34.9	108	1,007	12,164

HL-190 - Oxygen @ 10.0 psi			
Level (inH2O)	Volume (gal)	Weight (lb)	Gas Vol (SCF)
0	0	0	0
0.3	0	12	148
1	1	18	221
2	2	33	403
3	5	54	655
4	7	80	964
5	11	110	1,322
6	14	143	1,725
7	18	179	2,166
8	22	219	2,643
9	27	261	3,151
10	32	305	3,689
11	37	352	4,252
12	42	401	4,838
13	47	451	5,445
14	53	503	6,070
15	59	556	6,711
16	65	610	7,366
17	71	665	8,032
18	77	721	8,707
19	83	777	9,389
20	89	834	10,076
21	95	891	10,766
22	101	949	11,456
23	107	1,006	12,145
24	114	1,062	12,831
25	120	1,119	13,510
26	126	1,174	14,182
27	132	1,229	14,844
28	137	1,283	15,494
29	143	1,336	16,130
30	149	1,387	16,749
31	154	1,437	17,349
32	159	1,485	17,927
33	164	1,530	18,481
34	169	1,574	19,008
35	173	1,615	19,505
35.3	175	1,628	19,655

HL-300 - Oxygen @ 10.0 psi			
Level (inH2O)	Volume (gal)	Weight (lb)	Gas Vol (SCF)
0	0	0	0
0.4	0	21	253
1	1	27	328
2	3	44	533
3	5	68	821
4	8	98	1,179
5	12	132	1,598
6	16	172	2,071
7	21	215	2,594
8	26	262	3,162
9	32	312	3,772
10	37	366	4,421
11	43	423	5,106
12	50	482	5,824
13	57	544	6,572
14	64	608	7,348
15	71	675	8,150
16	78	743	8,975
17	86	813	9,822
18	93	885	10,687
19	101	958	11,570
20	109	1,032	12,468
21	118	1,108	13,379
22	126	1,184	14,300
23	134	1,261	15,231
24	143	1,339	16,169
25	151	1,417	17,113
26	160	1,496	18,059
27	168	1,574	19,008
28	176	1,652	19,955
29	185	1,731	20,900
30	193	1,809	21,841
31	202	1,886	22,776
32	210	1,963	23,703
33	218	2,039	24,619
34	226	2,114	25,524
35	234	2,187	26,414
36	242	2,260	27,288
37	250	2,331	28,145
38	257	2,400	28,981
39	265	2,467	29,794
40	272	2,533	30,583
41	279	2,596	31,346
42	285	2,656	32,079
43	291	2,715	32,780
44	297	2,770	33,447
44.2	298	2,780	33,574

HL-300 Special - Oxygen @ 10.0 psi (12946240)			
Level (inH2O)	Volume (gal)	Weight (lb)	GasVol (SCF)
0	0	0	0
0.3	0	19	234
1	1	28	333
2	3	49	587
3	6	78	936
4	10	113	1,363
5	15	154	1,856
6	19	199	2,408
7	25	250	3,014
8	31	304	3,666
9	37	361	4,362
10	44	422	5,098
11	50	486	5,869
12	58	553	6,672
13	65	621	7,505
14	73	693	8,364
15	81	766	9,247
16	89	841	10,151
17	97	917	11,073
18	105	995	12,011
19	114	1,073	12,962
20	123	1,153	13,923
21	131	1,233	14,893
22	140	1,314	15,869
23	149	1,395	16,848
24	158	1,476	17,829
25	166	1,558	18,808
26	175	1,638	19,784
27	184	1,719	20,754
28	192	1,798	21,716
29	201	1,877	22,667
30	209	1,955	23,605
31	218	2,031	24,527
32	226	2,106	25,430
33	234	2,179	26,313
34	241	2,250	27,173
35	249	2,319	28,006
36	256	2,386	28,809
37	263	2,450	29,580
38	269	2,510	30,316
39	276	2,568	31,012
40	282	2,622	31,665
40.1	282	2,625	31,702

Chapter

9

9 DRAWINGS

9.1 OUTLINE & DIMENSION DRAWING

HL-120/190/300	**C-11826511**

9.2 P&ID DRAWING

HL-120	**C-11836031**
HL-190	**C-11826529**
HL-300	**C-11848277**