BulkLite™ 1400

Product Manual

Designed and Built by:

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Innovation. Experience. Performance.®

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Revision Log

Revision	Date	Description
1	April, 2013	First release

1 Safety

1.1 Safety Statement

All operators should have full and complete understanding of the content of this manual before operating the equipment described. The manual is intended to describe the operation of the equipment and not intended to supersede any site-specific standards.

As with any cryogenic system, it should be observed that any non-insulated piping can get extremely cold and should not be touched by exposed skin. If the system requires maintenance, it should be shut down and allowed to warm-up.

If maintenance is to be done on the system, such as changing valve seats, it is extremely important that the pressure be relieved from the system through the vent valves and that liquid isolation valves are closed.

1.2 Safety Summary

Strict compliance with proper safety and handling practices is necessary when using a cryogenic system. We recommend that all our customers re-emphasize safety and safe handling practices to all their employees and customers.

While every possible safety feature has been designed into the unit and safe operations are anticipated, it is essential that the user of the cryogenic system carefully read to fully understand all WARNINGS and CAUTION notes listed in this safety summary and enumerated below.

Also read the information provided in the Safety Bulletin for Oxygen and Inert Gases following this Safety Summary. Periodic review of the Safety Summary is recommended.

WARNING: In oxygen enriched atmosphere, flammable items burn vigorously and could explode.

WARNING: DO NOT PERMIT SMOKING OR OPEN FLAME IN ANY AREA WHERE OXYGEN IS STORED, HANDLED, OR USED. Failure to comply with this warning may result in serious personal injury.

Excess accumulation of oxygen creates an oxygen-enriched atmosphere (defined by the Compressed Gas Association as an oxygen concentration above 23%). Certain items considered non-combustible in air may burn rapidly in such an environment. Keep all organic materials and other flammable substances away from possible contact with oxygen; particularly oil, grease, kerosene, cloth, wood, paint, tar, coal, dust, and dirt which may contain oil or grease.

WARNING: Nitrogen and argon vapors in air may dilute the concentration of oxygen necessary to support or sustain life.

Exposure to such an oxygen deficient atmosphere can lead to unconsciousness and serious injury, including death.

CAUTION: Before removing any parts or loosening fittings, empty the cryogenic container of liquid contents and release any vapor pressure in a safe manner.

External valves and fittings can become extremely cold and may cause painful burns to personnel unless properly protected. Personnel must wear protective gloves and eye protection whenever removing parts or loosening fittings. Failure to do so may result in personal injury due to the extreme cold and pressure in the tank.

WARNING: Accidental contact of liquid gases with skin or eyes may cause a freezing injury similar to a burn.

Handle liquid so that it will not splash or spill. Protect your eyes and cover skin where the possibility of contact with liquid, cold pipes and equipment, or cold gas exists. Safety goggles or a face shield should be worn if liquid ejection or splashing may occur or cold gas may issue forcefully from equipment. Clean, insulated gloves that can be easily removed and long sleeves are recommended for arm protection. Cuff less trousers should be worn over the shoes to shed spilled liquid.

WARNING: If clothing should be splashed with liquid oxygen it will become highly flammable and easily ignited while concentrated oxygen remains.

Such clothing must be aired out immediately, removing the clothing if possible, and should not be considered safe for at least 30 minutes.

WARNING: Use only replacement parts that are compatible with liquid oxygen and have been cleaned for oxygen use.

Do not use regulators, fittings, hoses, etc., which have been previously used in a compressed air environment. And do not use oxygen equipment for compressed air. Failure to comply with these instructions may result in serious damage to the container.

CAUTION: Before locating oxygen equipment, become familiar with the relevant EU Directives or National Fire Protection Association (NFPA) standards for "Bulk Oxygen Systems at Customer Sites", and with all local safety codes.

The NFPA standard covers general principles recommended for installing bulk oxygen systems on industrial and institutional consumer premises.

CAUTION: To prevent possible tip over, do not leave tank standing upright unless it is secured to its foundation (bolted down).

Transporting and erection of the tank should be performed in accordance with rigging instructions available from CHART. Failure to comply with these instructions may result in serious damage to the container.

1.3 Safety Bulletin

A portion of the following information is extracted from Safety Bulletin SB-2 from the Compressed Gas Association, Inc. (CGA). Additional information on nitrogen and argon and liquid cylinders is available in CGA Pamphlet P-9. Write to the Compressed Gas Association, Inc., 1235 Jefferson Davis Highway, Arlington, VA 22202.

From The CGA Safety Bulletin

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 that 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 in water, exposure to extreme heat or fire, and exposure to most adverse weather conditions (earthquakes, 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 circumstance 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.

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 or 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.

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 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 an unconscious partner unless equipped with a portable air supply.

Best protection is obtainable by equipping all individuals with a portable supply of respiratory air. Lifelines 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:

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

Oxygen Enriched Atmospheres

An oxygen-enriched atmosphere occurs whenever the normal oxygen content of air is allowed to rise above 23%. While oxygen is non-flammable, 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 total 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 alloys) 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.

Nitrogen and Argon

Nitrogen and argon (inert gases) are simple asphyxiants. 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 a worker's skin or eyes, the affected tissues should be promptly flooded or soaked with tepid water (90°F; 32°C).

DO NOT USE HOT WATER. Cryogenic burns, which result in blistering or deeper tissue freezing, should be examined promptly by a physician.

Chart customer stations are designed with the following safety features:

- A vacuum maintenance system specifically designed to provide long life and all possible safety provisions.
- Safety relief devices to protect the pressure vessel and vacuum casing sized and selected in accordance with ASME standards to include a dual relief valve. While Chart equipment is designed and built to the most rigid standards, no piece of mechanical equipment can ever be 100% foolproof.

2 Introduction

Congratulations, you now own a Chart BulkLite™ 1400 bulk storage tank. The new BulkLite 1400 is a compact horizontal bulk storage tank designed for economical turnkey installations. The tank can be installed on common precast concrete foundations, asphalt or directly on class 5 gravel (aggregates 3/4" and smaller), depending on code restrictions. Liquid Oxygen (LOX) requires a pad.

Integrated forklift channels provide for easy mobility without a crane, further reducing the installation costs.

With its low profile and low cost installation, the BulkLite 1400 is ideal for accounts that specify a height restriction or pad restriction due to property constraints. The BulkLite 1400 is also a good solution for temporary installations.

The plumbing is conveniently located on one end of the vessel for easy access in tight locations and the tank can be filled from a standard transport or an Orca delivery system.

2.1 Product Highlights

- Compact, horizontal profile: 69” H x 72” W x 187” L
- On-board high-efficiency gas use vaporizer provides up to 2,000 SCFH (80/20 duty cycle)
- Integrated large forklift channels provide easy mobility and secure mounting for an economical installation
- The forklift channels provide a stable and secure mounting base without the need for a concrete pad, depending on code (NFPA 55 requires "firm concrete or masonry foundation")
- Integrated flat-fin pressure-builder with PCV-1 (combo regulator) includes a single pressure adjusting screw for easy changes to the pressure builder and economizer settings
- Durable, ergonomic plumbing with isolation valves for long service life, easy operation and field maintenance
- Low NER (Normal Evaporation Rate) is ideal for low usage accounts with longer delivery cycles for low distribution costs
- Liquid withdrawal package option available: 1” vacuum-insulated female bayonet, vent-connected back pressure regulator and low-range pressure builder regulator for low liquid loss and accurate tank pressure control. There is also a non-VJ option.
- Height of only 69 inches is easily fenced to comply with stringent local height & zoning requirements

3 System Specifications

Manufacturer	Chart Distribution & Storage Group
Type	Horizontal, Cylindrical, Double-walled
Design Contents	Nitrogen, Oxygen, Argon

Liquid Capacities	
Gross Capacity Gallons	1,380
Net Capacity Gallons	1,320
Gross Capacity Liters	5,193 (Cold)
Nominal Capacity Liters	4,997 (Cold)

Performance / Flow Capability	
Flow Rate * SCFH	2,000 (80 / 20 duty cycle)
Flow Rate m^3/hour	56.6
MAWP psig	250
MAWP barg	17.24
NER %/day O_2/Ar	0.28
NER %/day N_2	0.45

Outside Dimensions	
Height	69 in. (1,753 mm)
Width	72 in. (1,829 mm)
Length	187 in. (4,750 mm)

Weights

Empty	4,900 lbs. (2,223 kg)
Full (Nitrogen)	14,200 lbs. (6,441 kg)
Full (Argon)	21,000 lbs. 9,526 kg
Full (Oxygen)	18,100 lbs. 8,210 kg

Inner Vessel

Maximum Allowable Working Pressure (MAWP)	250 psig (17.24 barg)
Design Temperature	-196° C to +49° C; -320° F to +149° F
Material	SA-240 T304 S/S

Code ASME Section VIII, Div. 1 Code Case 2596

Jacket

Design Pressure	Full Vacuum
Design Temperature	-29° C to +149° C; -20° F to +300° F
Material	A36 Carbon Steel

4 Customer Station Flow Diagram

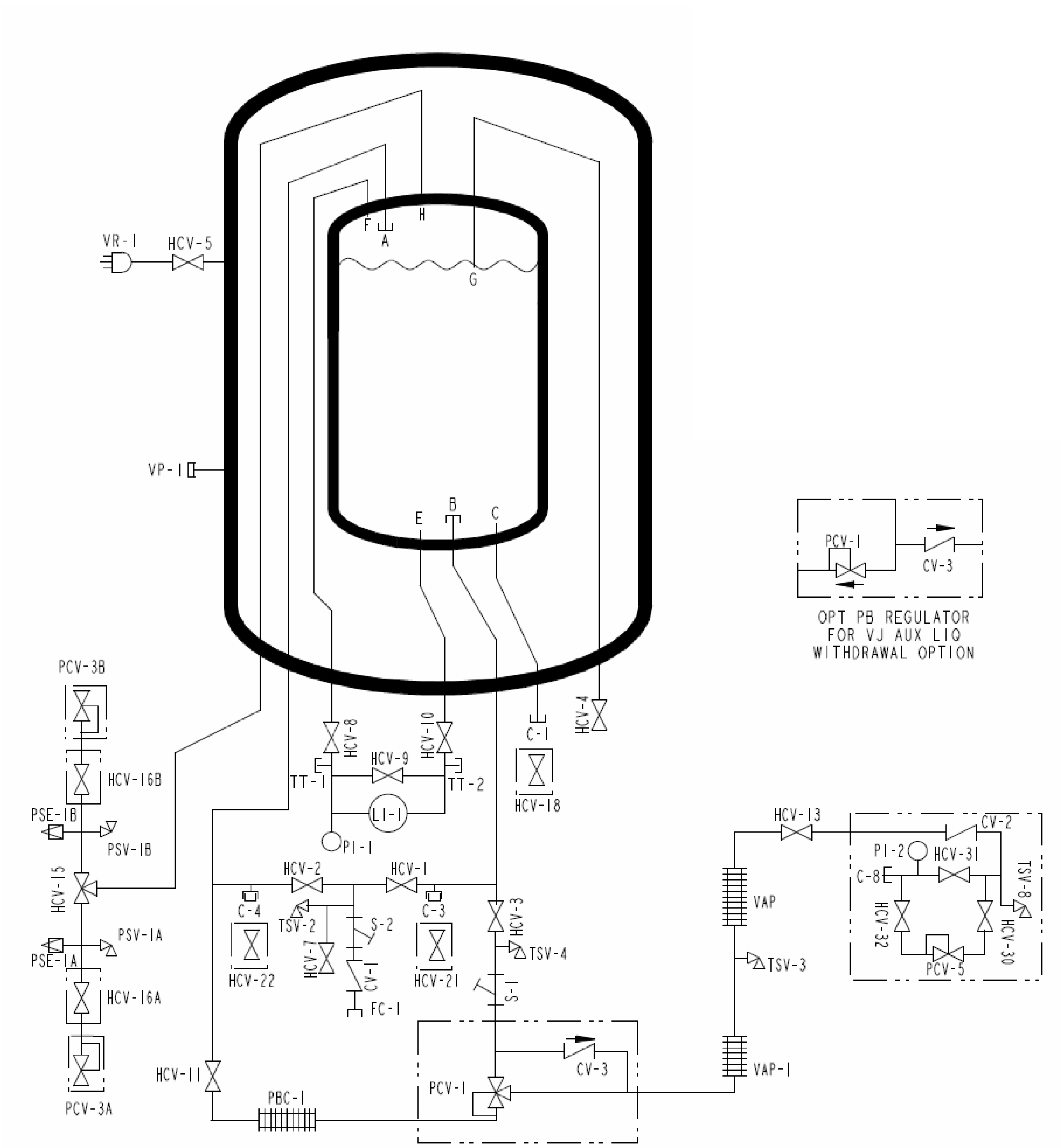
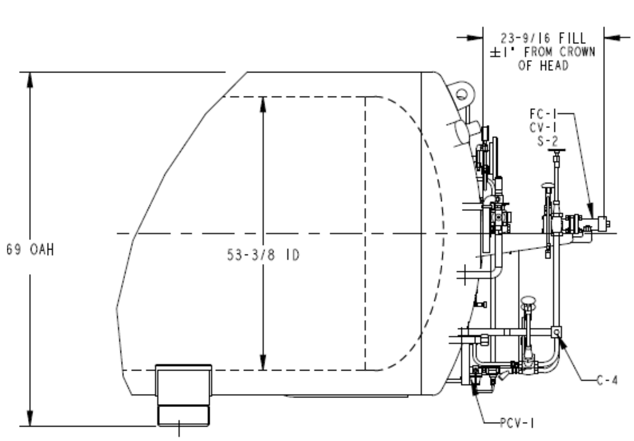


Figure 1. BulkLite 1400 Flow Diagram



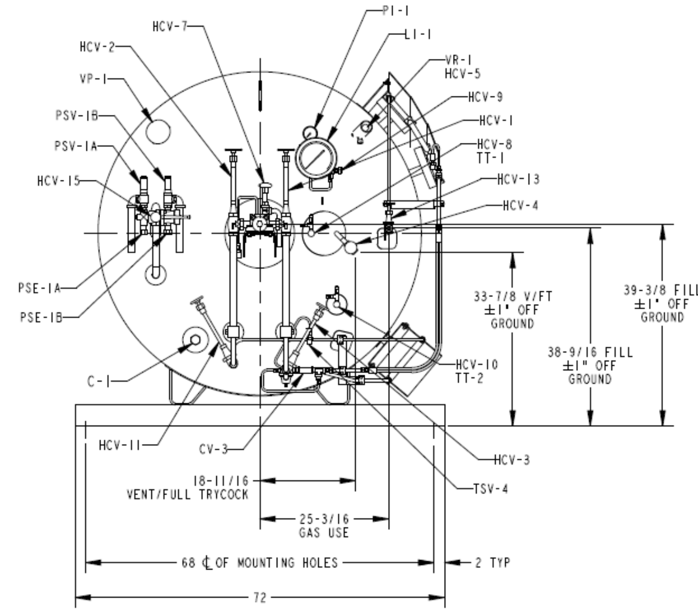


Figure 2. Left: Right Side View. Right: Customer Station Front View

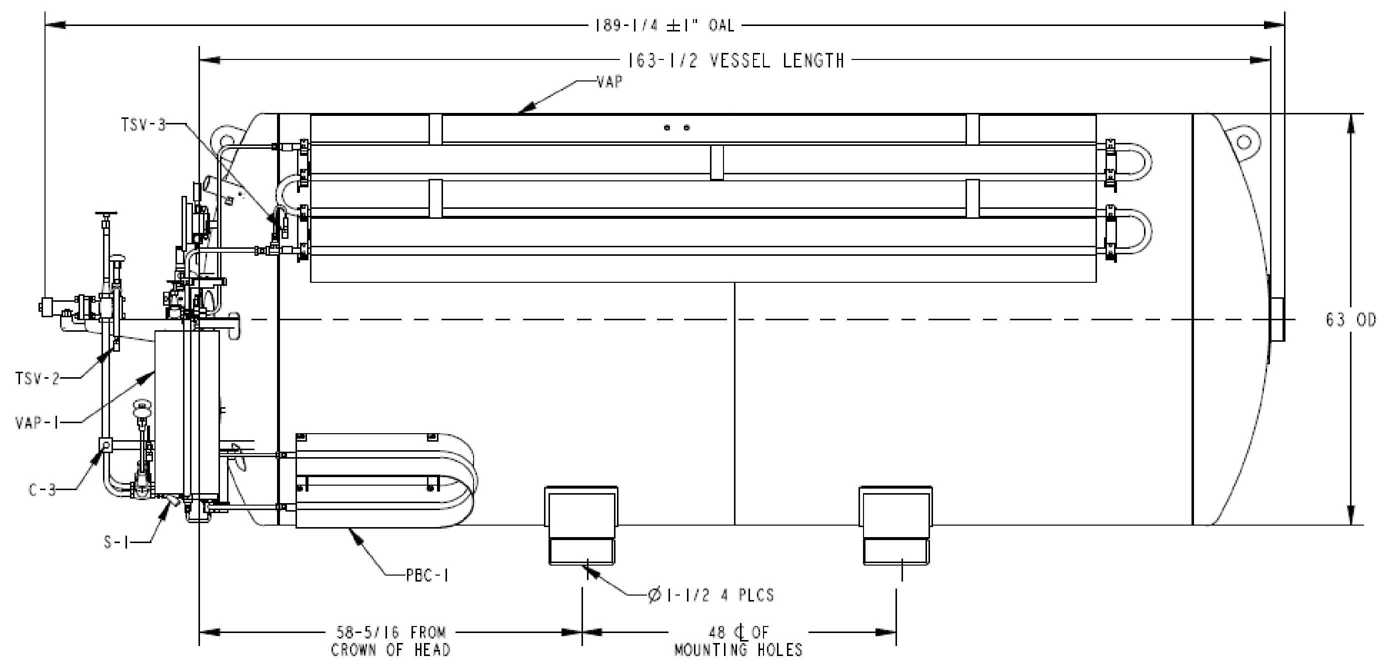
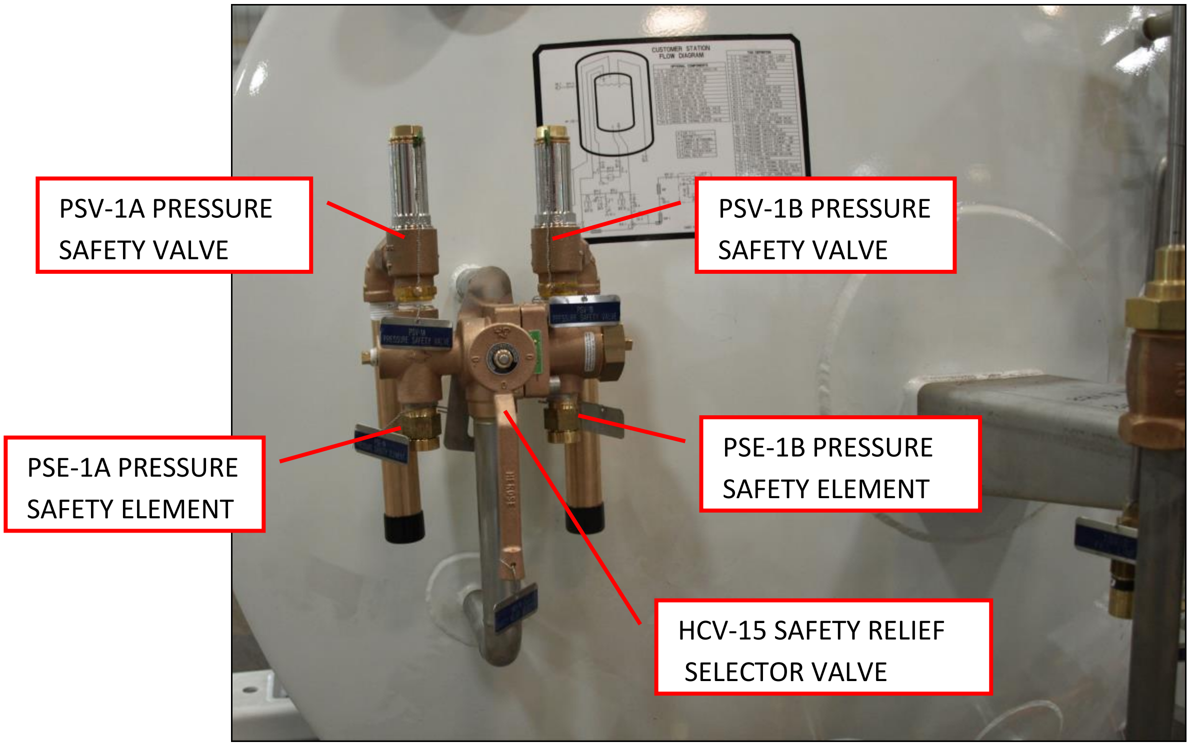
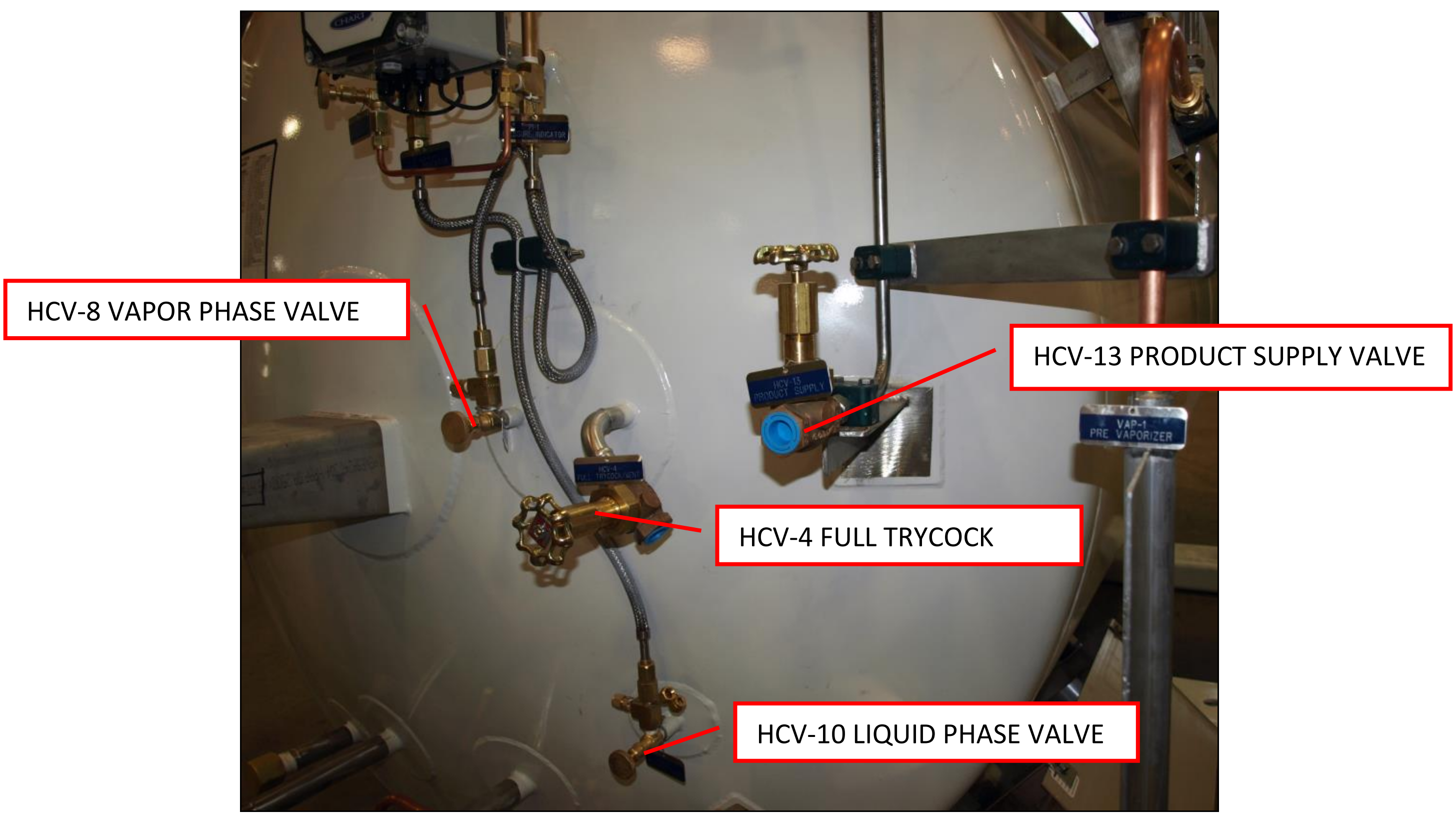
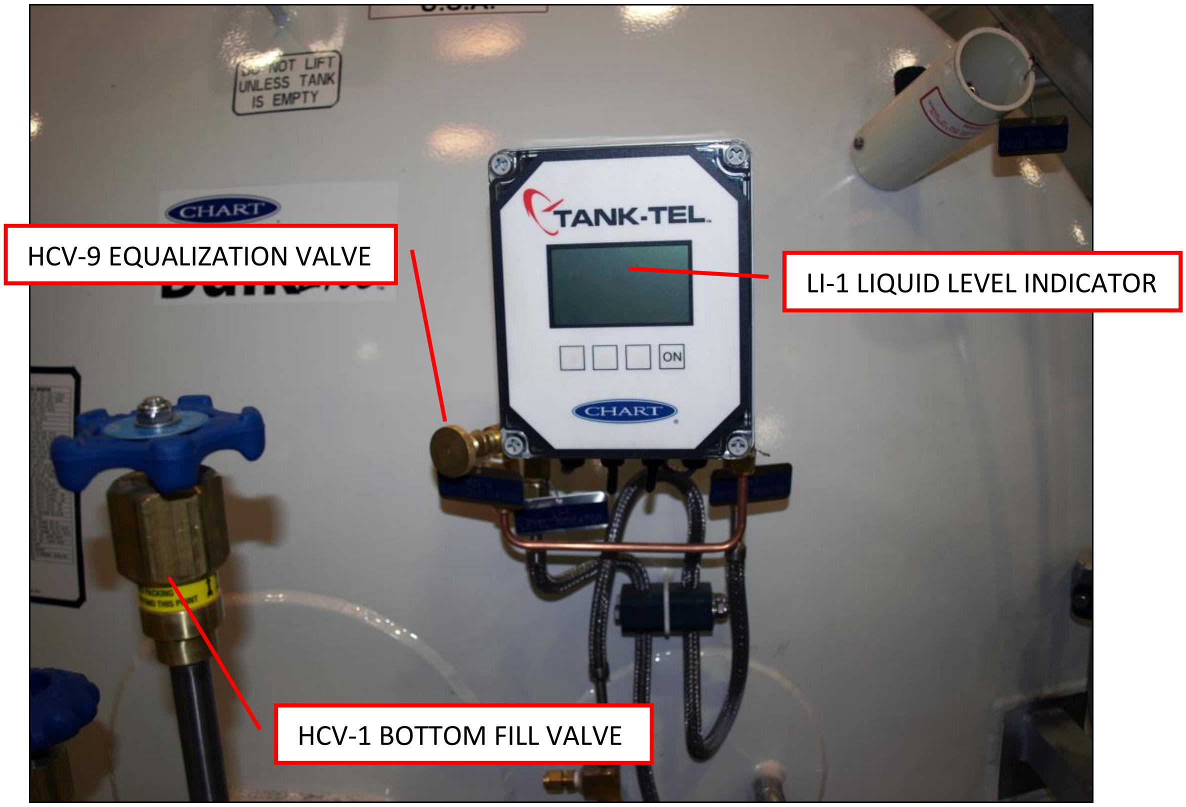


Figure 3. Customer Station Left Side View

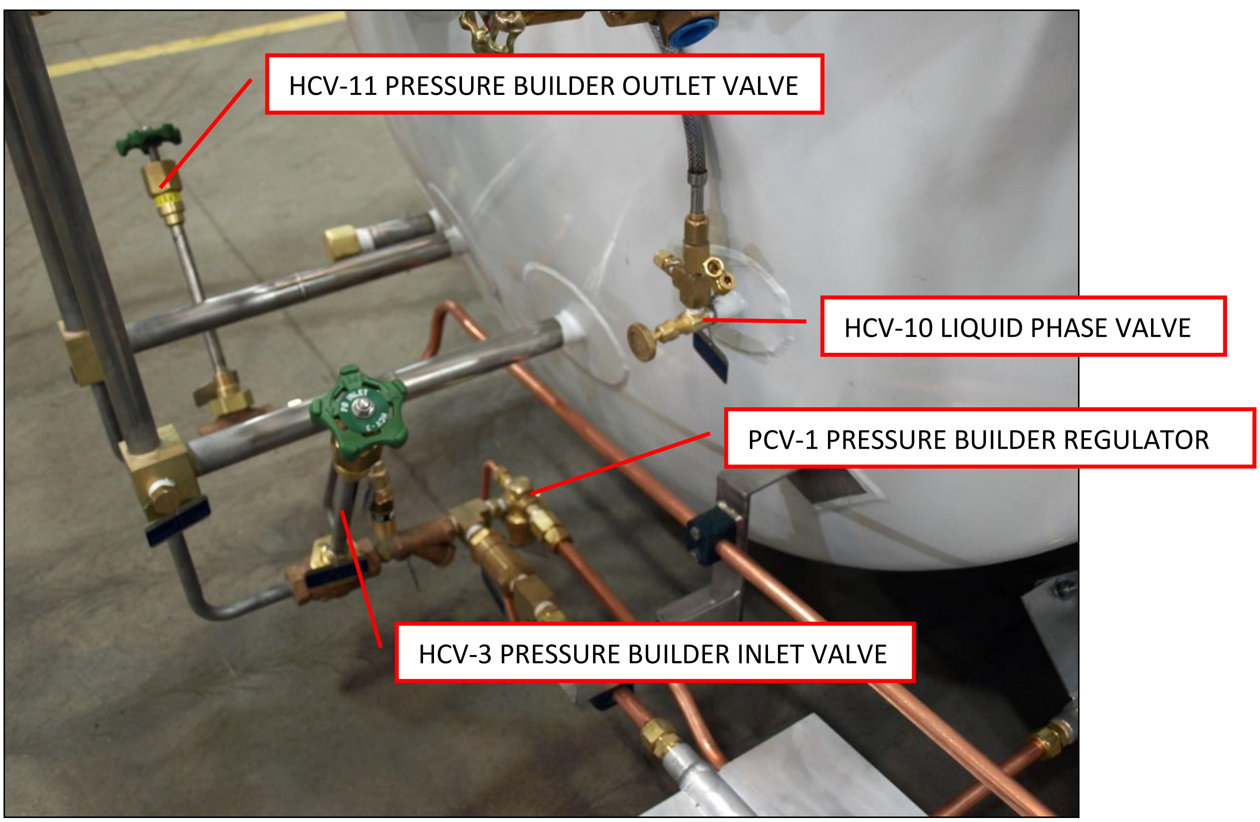


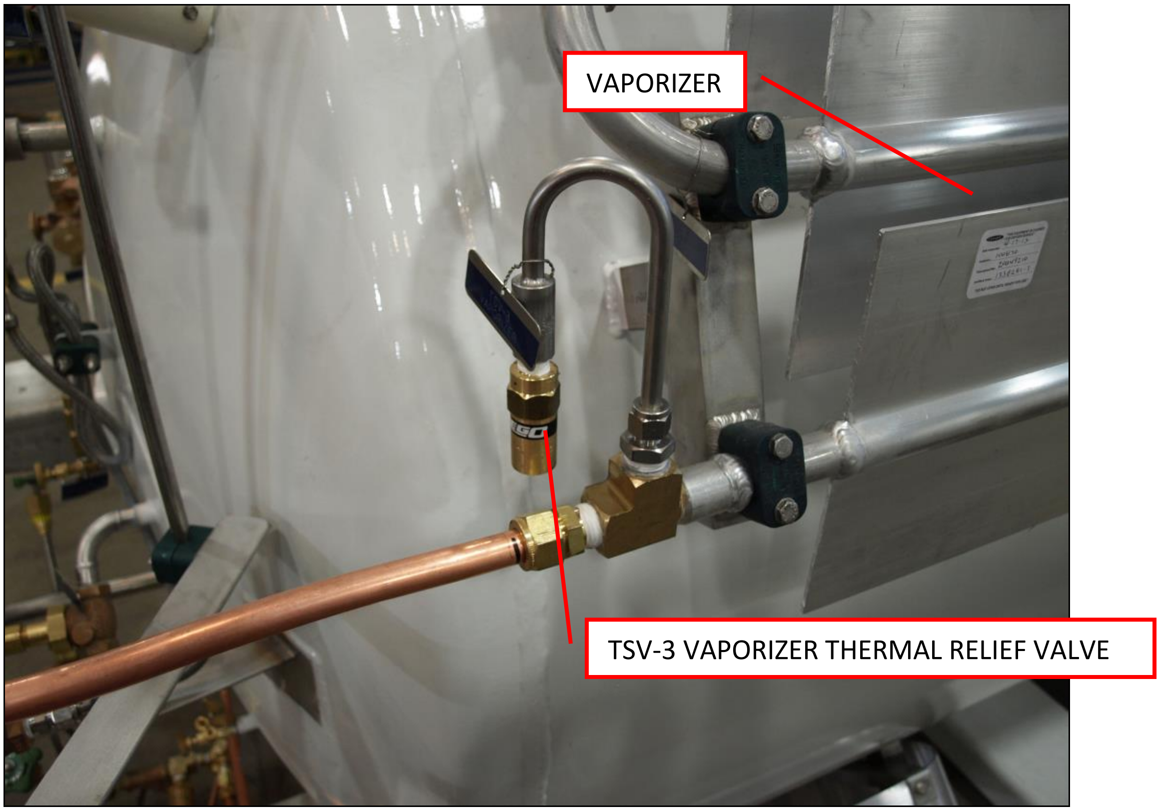
Above: Tank front, left side; Below: Tank front, right side



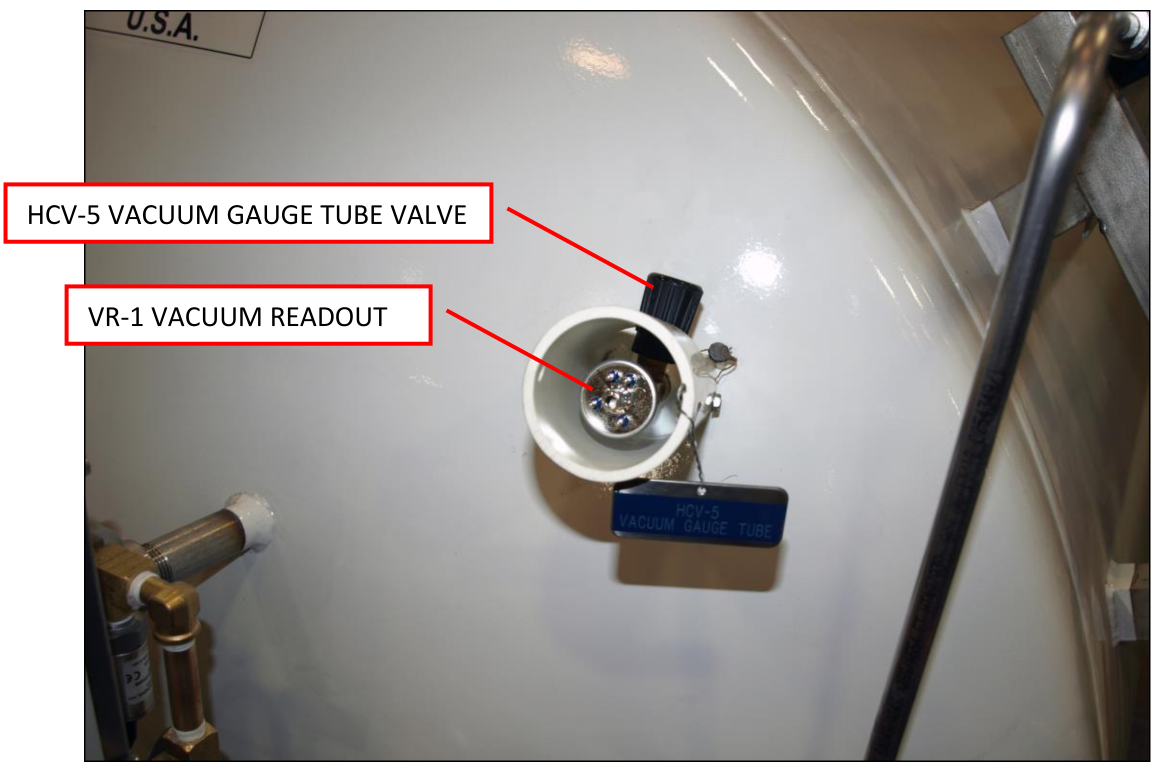


Above: Tank front, upper right; Below: Tank front, bottom right





Above: Vaporizer and Vaporizer Thermal Relief Valve; Below: Vacuum Gauge Tube



INNER VESSEL DESIGN DATA		
MODEL:		BL-1400
MAWP:	PSIG	250
	barg	17.24
DESIGN PRESSURE	PSIG	272.4
	barg	18.78
CODE COMPLIANCE: ASME CODE CASE 2596		
DESIGN TEMPERATURE	°F	-320° TO 120°
	°C	-196° TO 49°
MATERIAL OF CONSTRUCTION: SA240 304 STAINLESS STEEL		
OUTER VESSEL DATA		
CODE COMPLIANCE: FULL VACUUM PER CGA-341		
DESIGN TEMPERATURE	°F	-20° TO 300°
	°C	-29° TO 149°
MATERIAL OF CONSTRUCTION: A36 CARBON STEEL		
INSULATION TYPE: VACUUM AND MULTILAYER INSULATION		
EVACUATION CONNECTION: 3-1/2" PUMPOUT PORT		
VACUUM GAUGE CONNECTION: HASTINGS DV6R		
BUILDING CODE: DESIGNED FOR CURRENT BUILDING CODE SEE CHART POLICY #NP-180		

WEIGHTS AND SHIPPING DATA			
MODEL:			BL-1400
MAWP	PSIG		250
	barg		17.24
WEIGHT EMPTY	POUNDS		4,900
	KILOGRAMS		2,223
WEIGHT FULL	OXYGEN	POUNDS	18,100
		KILOGRAMS	8,210
	NITROGEN	POUNDS	14,200
		KILOGRAMS	6,441
	ARGON	POUNDS	21,000
		KILOGRAMS	9,526
SHIPPING DIMENSIONS	INCHES		190 X 73 X 70
	MM'S		4,826 X 1,854 X 11,778

CAPACITIES			
MODEL:			BL-1400
CAPACITY	GROSS	GALLONS	1,380
	(COLD)	LITERS	5,193
	NET	GALLONS	1,320
	(COLD)	LITERS	4,997
GASES EQUIVALENT AT 1 ATM AND 70°F/ 1 ATM AND 0°C	OXYGEN	SCF	152,000
		NM3	3,995
	NITROGEN	SCF	123,000
		NM3	3,232
	ARGON	SCF	148,500
		NM3	3,903

Figure 4. BulkLite 1400 data and drawing information

5 BulkLite 1400 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."

Lifting lugs are secured 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. Forklift channels are also provided to place the tank—which must be empty—with a standard forklift.

WARNING: Only move the tank when it is empty. NEVER USE A CRANE OR FORKLIFT TO MOVE A FILLED STORAGE TANK.

5.1 Basic Components

For the purposes of this manual, a "Storage Tank" is designed to store and deliver a cryogenic gas or liquid for use at low pressures.

A Storage Tank is made up of a tank, piping, safety devices, and gauges.

5.2 Tank

Most tanks for the common cryogenic liquids, with capacities between 100 gallons and 100,000 gallons, are similar in principle. An "inner vessel" or "liquid container" is supported within an "outer vessel" or "vacuum jacket" with super insulation in the space between the vessels and evacuated. Necessary piping connects from inside of the inner vessel to outside of the vacuum jacket.

Gauges and valves to indicate and control the product in the vessel are mounted outside of the vacuum jacket. Legs or saddles to support the whole assembly are welded to the outside of the vacuum jacket.

5.3 Inner Vessel

Inner vessel is designed, fabricated, tested and stamped in accordance with the ASME Section VIII Division 1 for Unfired Pressure Vessels. Inner vessel materials must have good ductility at cryogenic temperatures. Austenitic stainless steel, SA-240 T304, is the inner vessel material and is designed for a maximum working pressure of 250 psig (17.2 BARG).

The vessel is cleaned for oxygen service.

5.4 Jacket

Outer vessel, intended only for vacuum, is not Code designed or stamped. Since they do not operate at cryogenic temperatures, they are made of carbon steel. Stainless steel stand-offs are used where cold piping penetrates the outer vessel, to protect the mild steel from being excessively chilled.

5.5 Inner Vessel Supports

The main supports for the inner vessel are made from materials that have a low thermal conductivity and excellent structural strength.

5.6 Insulation

This tank uses multi-layer super insulation for improved thermal performance and lower overall tank weight.

5.7 Internal Piping

Figure 1 on page 17 shows schematically the number of lines between inner vessel and jacket.

This piping is austenitic stainless steel, again because of its low conductivity, strength, ductility and availability. Piping connected to the liquid phase (bottom) of an inner vessel is "trapped"— bent in some manner that produces the effect, if not the appearance, of a sink trap near the inner vessel. With a properly trapped line and a closed valve outside, most of the pipe is full of vapor and heat flow to the stored liquid is minimized. (If the line were not trapped, liquid would stand — or try to stand — against the closed valve outside the jacket, and heat flow to the liquid would be drastically increased).

5.8 Jacket Supports

These horizontal storage tanks are supported on four saddles, welded to the bottom of the jacket. Overall tank dimensions and saddle spacing are shown in Figure 2 and 3 on page 18.

5.9 External Piping

The piping shown schematically in Figure 1 on page 17 is comprised of several sub-systems.

For handling of atmospheric gases, materials of external piping include stainless steel pipe and fittings with bronze valves, assembled by silver brazing and welding. See Legend in Figure 1 on page 18 for the listing of major components. All components are cleaned for oxygen service.

5.10 Filling System

This tank is furnished with a “Top Fill” line [A] and "Bottom Fill" line [B] for filling.

The Top Fill line terminates with a spray header inside the top of the inner vessel.

5.11 Pressure Build System

A pressure build system is needed in many situations to keep tank pressure high enough to provide the desired flow of product.

The principle of the pressure build system is simple.

1. Liquid product flows by gravity from the bottom of the inner vessel to a heater outside the vacuum jacket
2. Vaporized product flows back to the top of the inner vessel.
3. As more and more gas fills the space above the liquid the pressure inside the vessel increases.

The major components to make this work are a heater and a means of control.

The heater is an assembly of aluminum fin tubes exposed to the atmosphere. This assembly is called a Vaporizer. As liquid flows through the vaporizer it is heated and becomes a vapor (a gas), thus the term vaporizer.

The control is typically a conventional pressure reducing spring and diaphragm regulating valve. This valve opens when the downstream pressure drops below the set point of the regulator and closes when tank pressure rises to the set point.

The Pressure Builder sub-system consists of an “Inlet Isolation Valve,” “Pressure Build Strainer,” “Pressure Build Regulating Valve,” “Pressure Build Coil,” “Line Safeties,” and a “Vapor Shut-off Valve. The sub-system is connected between the Pressure Build Liquid line and the Pressure Build Vapor Return line.

The “Inlet Isolation” valve and the “Vapor Shut-off” valve are normally left open, but can be closed if repairs on the coil or the regulating valve are needed.

The vessel is supplied with the pressure build coil and controls.

5.12 Safety Devices

The tank safety valve, used to prevent excessive pressure buildup in the inner vessel, is a standard ASME safety relief valve, except that materials are selected, and the valve is cleaned for oxygen service. The valve is soft-seated to minimize leakage below the set point. The tank safety valve is set at the maximum allowable working pressure of the inner vessel, and is sized by CGA rules to relieve the boil-off expected if the tank were to experience a loss of vacuum.

The inner vessel is protected by rupture discs with a room temperature rated rupture pressure that is 50% above the safety valve setting. This rating is necessary to avoid premature creep failure of the disc, and is still slightly below the inner vessel maximum tested pressure. These tanks have a fully replaceable style rupture disc in a union style holder.

This tank has "dual" safeties. A safety valve and a rupture disc safety head are connected to each of the two outlets of a three-way valve, the inlet of which is connected to the tank vent line. The three-way valve is of a design that always has at least one of its outlets connected to the inlet, but can isolate either outlet. This permits removing a safety device for test or repair without blowing the tank down to atmospheric pressure.

Jacket safety heads are intended to relieve any positive pressure, which might result from a leak in an inner vessel, from the jacket. The standard jacket safety is a Chart design stainless steel nozzle with an O-ring. Being held closed only by atmospheric pressure external, this nozzle will relieve at extremely low positive jacket pressure.

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.”

5.13 Gauges

The standard method of measuring contents is by means of a differential pressure instrument (“Contents Gauge”) connected to the top and bottom of the tank which reacts to the pressure difference caused by the weight of the liquid. A content table, showing the quantity of contents as a function of gauge reading, is shown in Appendix A.

These instruments are not directly affected by the total tank pressure; however product density does change with total pressure. Because of the density change, contents tables in gallons vary considerably with pressure; and because the average density is not directly related to the tank pressure, it is very difficult to select the correct table to use.

However, the number of pounds or of equivalent standard cubic feet, of product represented by any given gauge reading changes very little with product density and pressure.

These instruments are connected with three valves — a liquid side shut-off (HCV-10), a gas side shut-off (HCV-8), and an equalization valve (HCV-9). The equalization valve creates a by-pass around the liquid level indicator (LI-01). It connects the liquid side to the gas side and is used for checking the instrument. By closing both shut-off valves and opening the equalization valve, the pressure is made the same on both sides of the instrument and a properly operating instrument will read "0" inches of water, regardless of the tank pressure.

If the two shut-off valves and the equalization valve are left open, at the same time, the instrument lines become a small “pressure build-up circuit” and cause a slow rise in tank pressure. Always follow proper procedures when working on the liquid level gauge to avoid damage to the gauge.

Tank pressure gauge (PI-1), to indicate pressure inside the inner vessel, is a standard Bourdon tube pressure gauge that has been cleaned for oxygen service.

5.14 Vacuum

The standard vacuum gauging equipment is a thermocouple vacuum gauge tube. This tube is a Hastings Model DV-6R and will require a Hastings vacuum gauge to measure vacuum level.

For the level of vacuum used in converter installation, the common unit of pressure is (or was) "microns of mercury absolute," usually abbreviated to "microns." (It is pointless to measure such pressures down from atmospheric – the atmosphere changes thousands of microns from day to day). Units "Torr" and Millitorr" have come into use for vacuum measurements. A "Torr" is a pressure of one millimeter of mercury absolute. A Millitorr is 1/1000 Torr.

5.15 Full Trycock

The "Full Trycock" is an internal line that ends inside the inner vessel at the highest level to which the vessel is intended to be filled, and has a valve (HCV-4) outside the outer vessel. If this valve is opened during the later stages of filling, it will emit vapor (very cold vapor) until the liquid level reaches the open end of the line, when it will start to emit liquid. The change from vapor emission to liquid emission is both visible and audible. At this point the fill should be terminated.

6 Initial Inspection

Receiving inspection is one of the most important operations in the life of the tank, and should be done thoroughly and conscientiously so as to find any possible indications of damage, and prevent expensive surprises during first use of the vessel on site.

Cryogenic storage and distribution tanks are carefully designed and engineered to hold a cryogenic liquid with minimum losses from conduction, convection and radiation. These tanks are not designed to be operated from any position except the designed horizontal or vertical position.

A vertical vessel, for example, is susceptible to damage during shipment when it is on its side, braced only by auxiliary internal supports. Stationary vessels are not designed for transport over rough roads, railroad tracks, etc.

Upon receiving the BulkLite 1400, inspect for the following:

- Any shipping damage to the BulkLite tank including dents, cuts, and broken or bent plumbing components. Report damage to the shipping company immediately.
- Examine welded or brazed joints on plumbing for cracks or deformation, especially near valves and fittings.
- Check points where pipes exit the tank for cracks or breaks.
- Check relief valves and burst discs for dirt or damage.
- Examine the 5g impactograph. This is typically found on the inside of one of the tank's legs. If it has sprung, damage may have occurred during shipment. Notify your company's tank specialist and/or Chart.
- Check for gas pressure in the inner vessel. Vessels are shipped with 10 to 20 psig nitrogen pressure. If the pressure is in this region on arrival, the piping must be free from leaks. If pressure is zero, extra precautions against contamination and impurities must be taken.
- Check the insulation space pressure with a suitable thermocouple vacuum gauge. Make note of the ambient temperature when the vacuum is read. Temperature changes affect the vacuum reading in a warm empty vessel.
    - **If warm vacuum is above 20 microns, consult factory.**
- Your BulkLite is shipped with NF purity nitrogen gas. Purging is necessary prior to filling

6.1 Vacuum Check Procedure

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

CAUTION: Unauthorized changing of the vacuum probe will void vessel warranty.

1. Remove the rubber cap on probe outlet to expose contact. Note that probe housing need not be opened to do this.
2. Plug the instrument to the probe and calibrate the instrument.
3. 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.
4. Close the isolation valve and take a second reading. Monitor the rate of rise in vacuum probe with isolation valve closed. If the vacuum continues to rise at a constant rate, it is possible that the probe assembly is leaking. Consult the factory.
5. Verify that the isolation valve is closed.
6. Replace the rubber probe cap.
7. Compare the vacuum reading obtained now to reading taken prior to shipping.

6.2 Storage

If tank will be stored for a considerable period:

- Protect it from vandals and "valve twiddlers";
- Maintain a positive pressure of nitrogen in the inner vessel;
- Keep openings sealed against rain, dirt and insects; and
- Monitor jacket vacuum.

7 Installation Procedure

The BulkLite 1400 has two lifting lugs on the tank top. These lifting lugs allow for placement of the skid by an overhead crane. If a crane is not available, the skid has fork truck access at the sides**.**

Chart storage tanks are not designed to be lifted or moved unless empty. Never place or move a filled storage tank.

The BulkLite 1400 may be placed on a pre-cast concrete foundation, asphalt pad or on a class 5 gavel bed, if codes permit. NFPA requires a "firm concrete or masonry foundation."

CAUTION: If the tank will contain liquid oxygen, it must be placed on a pad. Be sure to check and follow local or special regulations concerning tank siting.

7.1 Placement of BulkLite 1400

The tank has a tare weight of 4,900 lbs and a 36” load center. An appropriately sized fork truck should be used to unload/move the tank. Most fork trucks are marked with a maximum load and load center. If the load center of your truck is different than 36” then the maximum load for your truck at this distance must be calculated to ensure safe operation. The following equation will help you calculate the maximum load for you truck at a 36” load center.

Your trucks load center in inches / 36 inches x Your trucks max load in lbs = New safe load in lbs

The tank should be placed in a location with easy access to all sides of the unit. The tank should receive a maximum amount of sunlight and airflow. There should be convenient access to the controls and gauges and all connections from the tank. If the tank is surrounded by fencing, allow least at least three feet – and ideally more – around the tank for access.

One must be able to check the BulkLite gauges and controls.

Consideration should also be given to the external vaporizer orientation. The vaporizer should receive a maximum amount of sunlight and wind exposure for optimal operation.

Important considerations:

- The BulkLite 1400 assembly weighs approximately 4,900 lbs. empty (2,223 kg).
- It is important that the sun and wind contact both the external vaporizer and pressure build coils to insure optimal operation of the unit and prevent the unusual buildup of ice.
- Do not locate the BulkLite 1400 near equipment that produces excessive moisture, such as cooling towers, drains, etc.

Permanent placement without a pad is acceptable providing the local substrate can handle the weight and the local jurisdiction clears the installation. The BulkLite 1400 weights 21,000 lbs when it is full of Argon liquid. With 10 ft^2 of supporting surface under the tank the distributed weight is 2,100 psf. Please note the following chart for approximate load bearing capacity.

Soil Bearing Capacity Table

Type of Soil	Load Bearing (Pounds Per Square Foot)
Rock w/ Gravel	6,000 psf +
Gravel	5000 psf
Sandy Gravel	5000 psf
Sand	3000 psf
Silt Sand	3000 psf
Silt Gravel	3000 psf
Gravel w/ Clay	3000 psf
Clay	2000 psf
Sandy Clay	2000 psf
Silt Clay	2000 psf

7.2 Connections

This tank will require connections to the “Liquid Draw” lines and top fill and bottom fill connection.

Make sure all the materials, cleaning and joining procedures are suitable for Oxygen service.

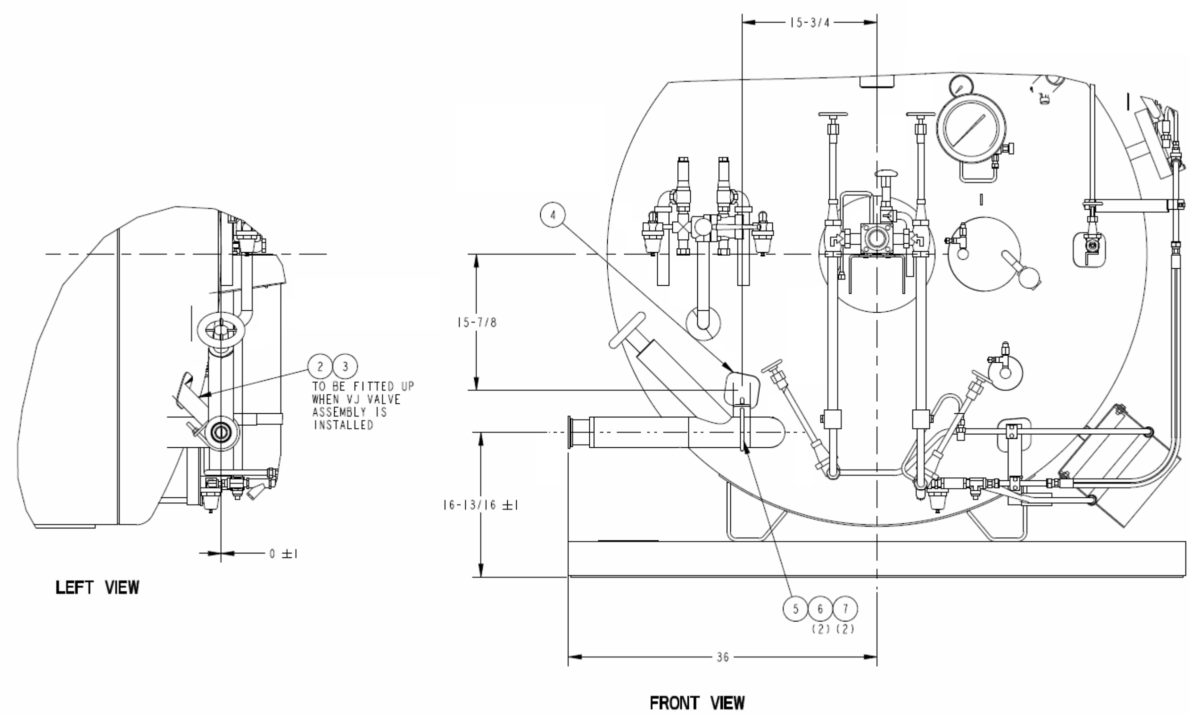
Be sure to install a safety valve in any section of piping where liquid or very cold vapor could be trapped between shut-off or regulating valves, and in the customer's line.

Test all joints.

NOTE: The isolation valve on the bulk tank liquid line should not be opened until all plumbing connections are complete.

7.3 Optional Vacuum Jacketed Auxiliary Liquid Connection

Shown below is the optional auxiliary liquid connection. Using this connection requires a 1-inch male bayonet Pro, part number 20624612, which includes a clamp and O-ring. There is also a non-VJ valve option.



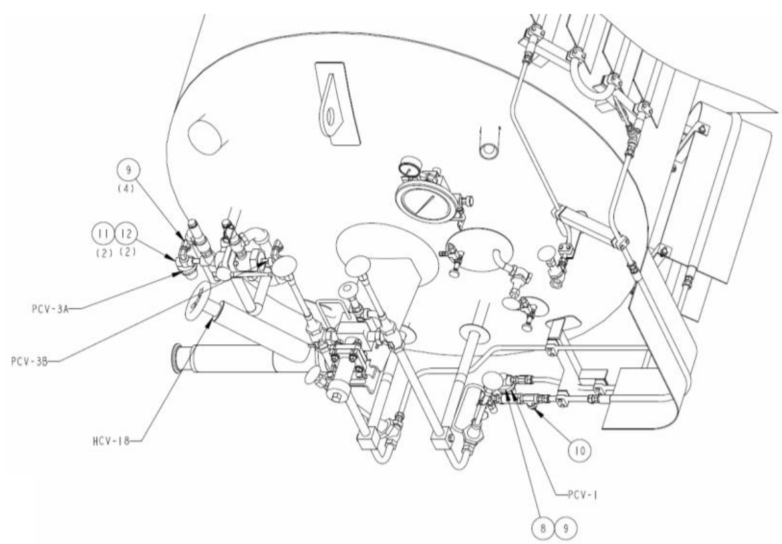


Figure 5. Optional vacuum jacketed auxiliary liquid connection

8 Commissioning

With all lines connected, commission the system. The commissioning steps are:

1. Purge
2. Leak check
3. Safety check

8.1 Purging the Tank

The vessel should arrive with a positive pressure of nitrogen. It is necessary to purge the vessel with clean, dry nitrogen to achieve the required purity.

It is important to purge the tank with warm, dry gas (gas of service) before running the system with liquid. Water vapor can cause ice crystals to form, which may cause controls to freeze open or close.

Purging will depend on the supplies and equipment available. The major point is that no liquid should be allowed in the vessel until the gaseous contents are of the desired purity. Once contaminated liquid is in the vessel, it is a slow and costly operation to get it out completely.

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.

NOTE: The pressure building/economizer regulator or pressure building regulator in the dual regulator system is *normally* set to build pressure to 120 PSI. When this pressure is used as the purge pressure, DO NOT adjust the regulator adjusting screw.

1. Attach the source of liquid purge to the fill connection.

2. Close all valves except the pressure build-up valves and liquid level gauge vapor phase and liquid phase shutoff valves.
3. Open hose drain valve, and allow source to vent through hose.
4. Vent until slight frosting appears on hose.
5. Open hose drain valve and allow source to vent through hose. Vent until slight frost appears on the hose, then close hose drain valve.
6. Open the bottom fill valve 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.
7. Shut off the liquid supply source when the pressure in the tank reaches the maximum purge pressure as indicated on tank pressure gauge.
8. Open the fill line drain valve 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.
9. Close drain valve and bottom fill valve.
10. Open the liquid level gauge equalization valve 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.
11. Loosen the unions on either side of the liquid level gauge. Both the upper and lower liquid level gauge valves 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.

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

12. Open the vapor vent valve and full trycock valve. The top fill valve will have to be vented by opening hose drain valve.
13. Repeat purge procedure 2 through 6 and 10 at least three times to ensure product purity.
14. Reconnect the liquid level gauge, open the liquid level control valves and then close the equalization valve.
15. After purging the tank, but before filling, verify that the following valves are open or closed as indicated.

Bottom fill valve ....Closed

Top fill valve ....Closed

Vapor vent valve ....Closed

Full trycock valve.....................................Closed

Liquid level gauge equalizing valve ....Closed

Product supply valve................................Closed

Pressure building inlet/outlet valves ....Closed

Economizer isolation valve ....Closed

Liquid level gauge liquid phase valve ....Open

Liquid level gauge vapor phase valve ....Open

8.2 Vessel Purge

It is good practice to blow out all lines – particularly gauge lines – during the cool-down phase of the initial fill.

When all connections to the BulkLite™ 1400 are made, pressurize the complete system using low-pressure gas. With all the lines connected, follow these steps:

1. Crack open the Bulk Tank Isolation Valve to allow a low flow of liquid to flow to the system.
2. Regulate the valve to assure that liquid vaporizes in the feed line.
3. Allow the pressures to equalize.

8.3 Leak Check

Leak check all fittings by spraying them with a liquid soap solution. Bubbles indicate loose fittings. Although the system is pressure tested at the factory, it is not uncommon for threaded fittings to vibrate loose during shipment.

8.4 Inspect Safety Circuits

Check all fittings, lines and relief valves to assure that they did not incur damage during shipment. If damage has occurred, repair the system with proper procedures and components.

9 Operation

9.1 Initial Fill

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

Filling of the tank may be from the plant or initially from a transport.

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

- 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.
- 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.
- 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.

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

The important consideration is: **FILL A WARM TANK SLOWLY.** Once the tank is filled and the regulating valves set, the vessel is ready to go into service.

Be sure manual valves are as listed below, and open any additional shut-off valve to the customer's piping.

Vacuum valve	Closed tight and sealed
Thermocouple tube shut off	Closed
Full Trycock	Closed
Contents Gauge By-Pass	Closed
Vent valve	Closed

Contents Gauge Liquid and Vapor	Open, at least partially
Liquid Withdrawal valve (s)	Open
Top Fill	Open
Vapor shut-off valve	Open
Pressure Build manual valve	Open

1. Purge tank to assure product purity
2. Verify that the contents of the supply unit are the proper product to be transferred.
3. Verify that all valves except liquid phase-high (HCV-10) and gas phase-low (HCV-8) are closed.
4. Connect the supply unit transfer hose to tank fill connection (FC-1).

NOTE: Cool down the transfer hose prior to filling by opening hose drain valve (HCV-7) and venting the supply unit through the hose for approximately three minutes. Close drain valve (HCV-7).

5. Open bottom fill valve (HCV01) slowly.
6. **For PRESSURE TRANSFER**: allow pressure to build up in the liquid supply unit until it is at least 50 PSI (3.5 kg/cm^2) higher than station pressure. Open the discharge valve on the supply unit to begin flow.

    (or)

    For PUMP TRANSFER: make the required connections to the pump. Open the supply unit transport discharge valve slowly. Maintain pump discharge pressure from 50 PSI (3.5 kg/cm^2) to 100 PSI (7.0 kg/cm^2) higher than the tank pressure. Fill slowly.

7. 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-4), should pressure continue to rise, the fill may have to be interrupted to allow pressure to drop.
8. Monitor liquid level contents gauge (LI-1). When the gauge indicates approximately three-quarters full, open full trycock valve (HCV-4).
9. When liquid spurts from full trycock valve (HCV-4), immediately stop fill at the supply source and close full trycock valve (HCV-4).
10. Close bottom fill valve (HCV-1).
11. Drain residual liquid in the fill hose via drain valve.
12. 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.

9.2 Refilling Tank

NOTE: 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.

1. Verify that the contents of the supply unit are the proper product to be transferred.
2. Verify that the bottom and top fill valves are closed.
3. Verify minimum required operating pressure in vessel.
4. Verify that all other valves are in normal operating positions.
5. Connect the supply unit transfer hose to tank fill connection.

NOTE: 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.

6. Open top fill valve completely.
7. **For PRESSURE TRANSFER**:
   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.

8. **For PUMP TRANSFER**:
   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.
9. Monitor pressure in vessel as indicated. If pressure begins to drop to near the minimum operating pressure, begin to open bottom fill valve, and throttle top fill valve, until pressure stabilizes.
10. Monitor liquid level contents gauge. When the gauge indicates approximately three-quarters full, open full trycock valve.
11. When liquid spurts from full trycock valve, stop fill at the supply source and close full trycock valve.
12. Close tank fill valve.
13. Drain residual liquid in the fill hose via drain valve.
14. Relieve fill hose pressure by loosening the hose at the fill connection, and then disconnect the hose.

9.3 Gas Withdrawal Procedure

1. Connect customer line to vessel gas use connection or to the optional final line connection if used.
2. Verify that all valves except gauge liquid phase and gauge gas phase are closed.
3. Open product supply valve, pressure building inlet valve, PB outlet valve, and economizer shut-off valve 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.
4. The liquid regulator will not open until the set pressure is reached, thus preferentially drawing vapor off the head space.
5. 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.

Normal operating valve positions for a BulkLite unit are:

Bottom fill valve .... Closed

Top fill valve .... Closed

Vapor vent valve .... Closed

Full trycock valve....................................Closed

Liquid level gauge equalizing valve.........Closed

Hose drain valve.....................................Closed

Product supply valve...............................Open

Pressure building inlet/outlet valves......Open

Economizer isolation valve ....Open

Liquid level gauge liquid phase valve......Open

Liquid level gauge vapor phase valve .....Open

9.4 Liquid Withdrawal Procedure

NOTE: To use the BulkLite 1400 for liquid, use the "Liquid withdrawal package," which consists of a 1" vacuum-insulated female bayonet; vent connected back pressure regulator and low-range PCV-1 spring for low liquid loss and accurate tank pressure control. For part numbers, see Appendix B.

A non-vacuum jacketed isolation valve can also be ordered for an un-insulated liquid withdrawal.

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

10 Maintenance

10.1 Re-evacuating the Vessel

The insulation space should be re-evacuated any time the pressure gets too high. What pressure is "too high" cannot be exactly defined. It will depend on the application. Heat leak into the vessel increases gradually with pressure. An installation using large quantities of product at fairly steady rates can stand more heat leak than one using small quantities of gas or one having long periods of no gas consumption at all.

Evacuation of super insulation requires special knowledge and Chart field service should be contacted. For re-evacuating, the pump should be equipped to prevent backflow of pump fluid into the converter in case of power failure. A solenoid valve or electropneumatic vacuum valve in the pumping line will do this and will also stop loss of tank vacuum. A trap in the pumping line, large enough to hold the pump's entire fluid charge, will prevent fluid backflow but will not prevent loss of tank vacuum.

For re-evacuating a cold tank, a compound pump of 8 to 10 cfm capacity is suggested. For a warm tank, where pressures are likely to be higher and gas volumes are likely to be larger, a single-stage pump of 20 to 30 cfm capacity is more suitable.

In either case a suitable flexible hose is needed. This can be either flexible metal or reinforced rubber.

To re-evacuate a cold tank:

1. Connect the pump and hose to the tank evacuation valve,
2. Start the pump and evacuate the line; then
3. Slowly open the tank evacuating valve.

It is desirable to have a thermocouple tube at the pump, and to check that the pump and line blank-off is as low as they should be, before opening tank valve.

The thermocouple gauge can be used while pumping to get an idea of progress. Sometimes there is an appreciable gradient within a tank insulation space while pumping: when the pumping is stopped, pressures equalize and pressure at the tube may increase. Therefore, when evacuation appears complete, close the evacuating valve, wait 10 minutes, and reread the gauge. If there is no change, evacuation is complete.

10.2 Replacing the Thermocouple Tube

1. Close the gauge shut-off valve. In unscrewing the old tube, be very careful not to disturb the joint on the other side of the valve.
2. Put thread-sealant on a new tube (starting one thread from the open end) and screw it into the valve. Again, be careful of the joint behind the valve.

NOTE: Teflon tape is a good sealant for most pipe thread joints, but it is useless on vacuum joints

3. Check for leakage.

10.3 Replacing the Liquid Level Gauge

If the liquid level gauge (LI-1) is ever damaged and needs to be replaced, these procedures need to be followed to ensure a proper transition that does not to damage the new gauge.

1. Close liquid side isolation valve (HCV-10)
2. Close gas side isolation valve (HCV-8)
3. Open equalization valve (HCV-9)
4. If the gauge does not read “0” in H2O, or if there is anything else wrong with the gauge it can now be removed from the tank
5. Install new liquid level gauge (LI-1)
6. Ensure the equalization valve (HCV-9) is OPEN
7. Confirm that the new gauge reads “0” in H2O
8. Open gas side isolation valve (HCV-8)
9. Open liquid side isolation valve (HCV-10)
10. Close equalization valve (HCV-9)

10.4 Replacing Jacket Safety O-Rings

On tanks for atmospheric gases, it is entirely practical to replace O-rings while the tank is in service.

11. Break the vacuum with dry nitrogen,
12. Lift off the safety head cover, and
13. Remove the old O-ring. Be careful not to scratch the groove surfaces.
14. Carefully clean the O-ring groove, the sealing surface and the new O-ring.
15. Coat the new O-ring with a very thin layer of vacuum grease,
16. Place it in the O-ring groove, and
17. Install the cover.
18. Hold the cover down until there is enough vacuum to hold it.

10.5 Replacing the Rupture Disc

The rupture disc is a throw-away style and must be replaced entirely if ruptured.

1. Switch selector valve (HCV-15) to other side.
2. Depressurize the isolated side of the relief valve system by opening HCV-16A or HCV-16B. If the tank is not equipped with HCV-16A or HCV-16B then slowly loosen PSE-1A or PSE-1B allowing pressure to escape.
3. Remove burst disc (PSE-1A or PSE-1B).
4. Install new burst disc (PSE-1A or PSE-1B), making sure that mating surfaces are clean and properly seated. Use an oxygen compatible liquid thread sealant to prevent leaking.

10.6 Replacing the Inner Vessel Safety Valve

5. Isolate the bad safety valve with the switch valve and wait for the safety valve to defrost.
6. Open the safety test valve, if equipped (optional), to vent off excess pressure.
7. Unscrew the short outlet tube from the safety valve and
8. Unscrew the safety valve from the inlet fitting, using two wrenches to minimize the strain on inlet piping.
9. Put suitable thread sealant on the inlet threads of the new safety valve and

10. Install safety valve, again using two wrenches.
11. Install outlet tube in safety valve, aiming it down and under the tank.
12. Open the switch valve to new safety valve and test inner joint.

10.7 Replacing the Line Safety Valves

1. Isolate the safety valve by closing appropriate manual valves. (Be sure this won't unnecessarily upset your customer's operations.)
2. Bleed the line section by use of the corresponding bleed valve.
3. Remove the safety, using one wrench on the safety valve and another on the fitting.
4. Install new safety valve, using suitable thread sealant and again using two wrenches to avoid twisting piping.
5. Reopen manual valves closed above, and
6. Check for leaks.

11 Warranty

Chart Inc. warrants to the purchaser of any Chart manufactured equipment that for ninety (90) days after invoice said Chart manufactured equipment shall be free from any defects in workmanship and materials, and that for five (5) years after the date of shipment to the original purchaser said Chart manufactured equipment will maintain all vacuum and performance standards for said equipment as published by Chart on the date of invoice.

Purchaser agrees that as a pre-condition to any Chart liability hereunder, purchaser shall fully inspect all goods immediately upon delivery to purchaser and shall give Chart written notice of any claim or purported defect within ten (10) days after discovery of such defect. As a further pre-condition to any Chart liability hereunder, purchaser shall return said purportedly defective equipment, freight prepaid, to the plant of the manufacturer. Chart shall inspect all returned equipment, and, if said equipment is found defective, shall, at its option as purchaser’s sole and exclusive remedy, repair or replace such equipment or any defective component or part thereof which proves to be defective, or refund the net purchase price paid by the original purchaser. Alterations or repairs by others or operation of such equipment in a manner inconsistent with Chart accepted practices and all operating instructions, unless pre-authorized in writing by Chart, shall void this warranty. Chart shall not be liable for defects caused by the effects of normal wear and tear, erosion, corrosion, fire or explosion.

Chart’s sole and exclusive liability under this Warranty is to the original purchaser and shall not exceed the lesser of the cost of repair, cost of replacement, or refund of the net purchase price paid by the original purchaser. Chart is not liable for any other losses, damages, or costs of delays, including incidental or consequential damages. CHART SPECIFICALLY MAKES NO WARRANTIES OR GUARANTEES, EXPRESS OR IMPLIED, INCLUDING THE WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR USE, OTHER THAN OR WHICH EXTEND THOSE WARRANTIES EXPRESSED HEREIN

12 Troubleshooting

Problem	Cause / Diagnosis	Correction
TOO MUCH PRESSURE IN THE TANK	Low/No product usage	To ensure no venting of product or excess pressure in the tank, ensure that product usage is at least the same if not more than the NER of the tank. For BulkLite the NER is 0.45% for N2. So you should use at least 0.45% of the 1,400 gallon tank – or 6.3 gallons – daily.
NOT ENOUGH PRESSURE IN THE TANK	Pressure Builder inlet valve closed	Ensure that both the pressure builder inlet valve (HCV-3) and the pressure builder return valve (HCV-11) are open.
	Overdrawing the tank	Draw less product from the tank in order to allow the pressure builder to keep up.
TANK WILL NOT BUILD ENOUGH PRESSURE	Pressure Builder inlet valve partially closed	Ensure that both the pressure builder inlet valve (HCV-3) and the pressure builder return valve (HCV-11) are open.
	Pressure Builder regulator set too low	Check the screw setting on the pressure building regulator (PCV-1). Screw it in to increase the pressure builder setting.
NO PRESSURE BUT TANK CONTAINS PRODUCT	Manual vent valve open	Ensure that the manual vent valve (HCV-4) is closed. Pressure building from this point will be very slow. To help pull liquid into the pressure building coil (PBC-1), open the gas use valve (HCV-13) or draw product from the tank. This should pull liquid into the pressure building coil and build some subcool in the tank, allowing the pressure to build more quickly.

Problem	Cause / Diagnosis	Correction
	Safety valve is leaking	Ensure all safeties are closed (PSV-1A, PSV-1B). If a safety valve has opened to relieve pressure in the tank, it may freeze open. Switch safeties using safety selector valve (HCV-15), or thaw out the frozen safety.
PRESSURE SURGES DURING NORMAL OPERATION	Check valve in gas withdrawal line	This is normal. At startup or during periods of heavy draw, the vaporizer will pull in a large quantity of liquid. This liquid then flashes to gas rapidly and back pressure closes the check valve (CV-3). More product is not drawn into the vaporizer until the pressure then drops below the tank pressure.
PRESSURE IN THE TANK BUT NOT SUPPLYING ENOUGH GAS	Gas supply valve partially closed	Ensure all valves in the gas supply line are fully open (HCV-3, HCV-13).
	Undersized tank	The BulkLite is rated for 2000 SCFH with the attached vaporizer and pressure builder. The attached pressure builder is capable of sustaining flows up to 8,000 SCFH if additional vaporizers are provided. If pressure builder is operating correctly and there is still not enough flow, then the tank is undersized for the application.
GAS TOO COLD AT USAGE POINT	Overdrawing the vaporizer	Draw less product from the tank in order to allow the vaporizer to keep up, or • Add trim heaters, or • Add additional vaporization. The BulkLite is rated for 2,000 SCFH with the attached vaporizer.

Problem	Cause / Diagnosis	Correction
SAFETY VALVES OPEN	liquid in vaporizer during normal operation	During times of long or heavy draw, the system will pull a large amount of liquid into the vaporizer. When the demand is shut off and the pressure in the vaporizer is not bled back into the tank fast enough, the safety (TSV-3, TSV-4) may open to relieve pressure in the vaporizer.
	pressure in the tank is higher than 250 psig	To ensure no venting of product or excess pressure in the tank, ensure that product usage is at least the same if not more than the NER of the tank. For BulkLite the NER is 0.45% for N2. So you should use at least 0.45% of the 1,400 gallon tank – or 6.3 gallons – daily.
SAFETY VALVES STUCK OPEN	Frozen open	Switch safeties using safety selector valve (HCV-15) or warm safeties to get them to close.
LIQUID LEVEL GAUGE READS TOO LOW	Too much liquid in the liquid phase line	There may be a leak in the high phase DP line to atmosphere and/or leakage across the isolation equalization valve. This valve could also leak to atmosphere. These leaks allow liquid to push up toward the gauge (still in the vacuum space), thus reducing the level reading. Also, check the zero point of the Liquid Level Gauge. The gauge could also be defective. If so: replace gauge.
LIQUID LEVEL GAUGE READS TOO HIGH	Leaks? Defective gauge?	If the Liquid Level Gauge reads too high, it could be leaks to atmosphere on the low phase DP line (but would need to be big). Check the zero point. Check for defective gauge.
LIQUID LEVEL GAUGE READING IS BOUNCING	Not enough subcool on the liquid	If the tank is at or near 0 psig, there is very little to no subcool on the liquid. This affects the liquid in the liquid phase line. Adding some subcool to the tank will stabilize the reading.

Problem	Cause / Diagnosis	Correction
PRESSURE GAUGE IS NOT READING CORRECTLY	Isolation valve closed	Ensure gas phase isolation valve (HCV-8) is open so tank pressure gauge can detect tank pressure.
	Bad/Broken pressure gauge	Replace pressure gauge (PI-1).
FROST ON THE OUTSIDE OF THE TANK AWAY FROM ANY PIPING	Bad vacuum	Check the vacuum level of the tank using vacuum connection (VR-1); ensure valve (HCV-5) is open to check vacuum level. If the vacuum level is above 100 microns call Chart for service.
FROST AROUND A VALVE WHICH IS SHUT OFF	Valve packing is Leaking	Leak check the valve packing and tighten if necessary. If packing still leaks, follow valve repair instructions.

Still Need Help?

For additional help, please call Chart technical assistance at 1-800-400-4683.

13 Cryogenic Terms & Fundamentals

Cryogenics: A branch of engineering that relates to the production and effects of very low temperature, usually -238° F and colder.

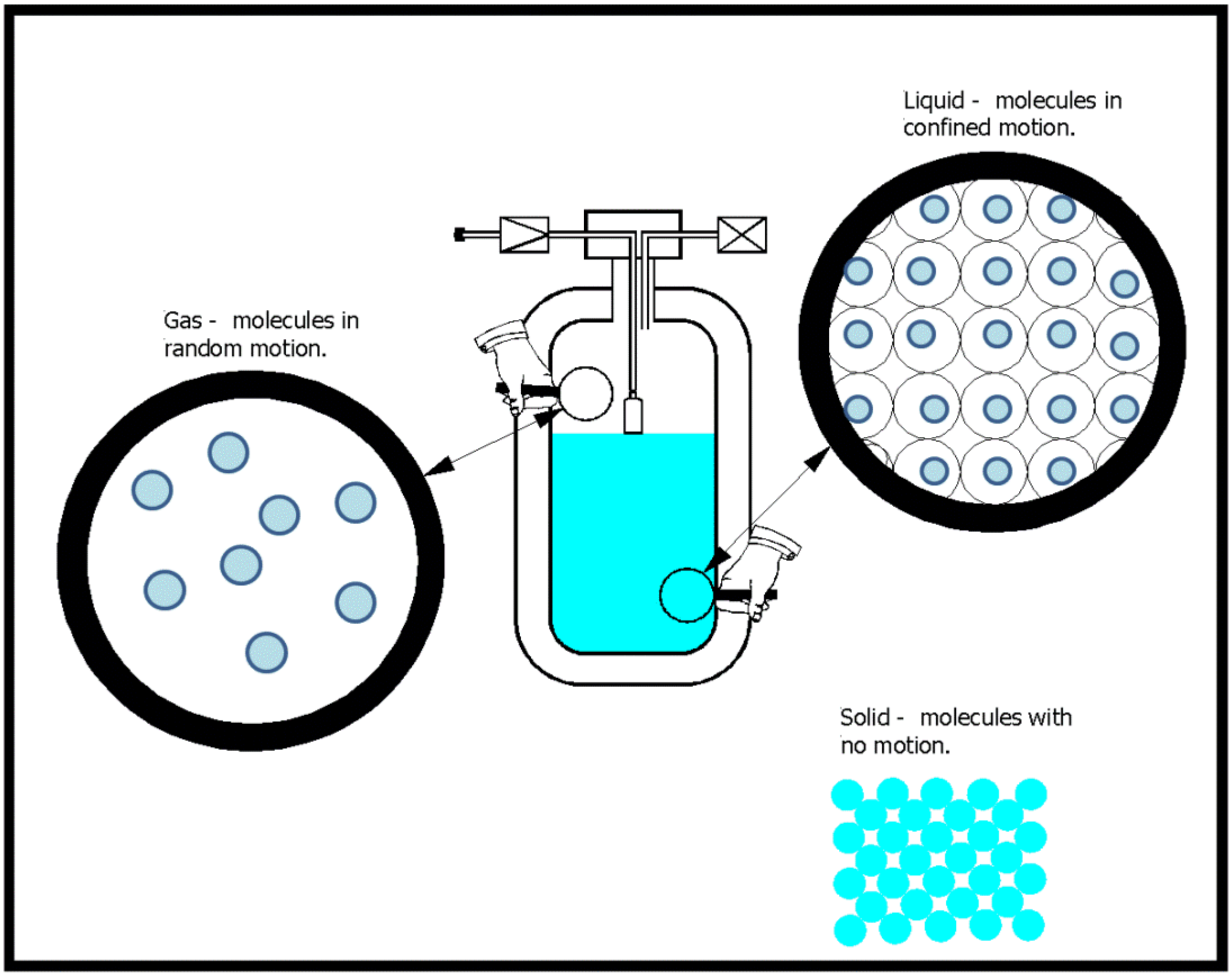
Gas	Boiling Temperature (at 0 psig) (°F)
Argon	-302
Nitrogen	-320
Oxygen	-297

A. Classical states of matter

Types of matter:

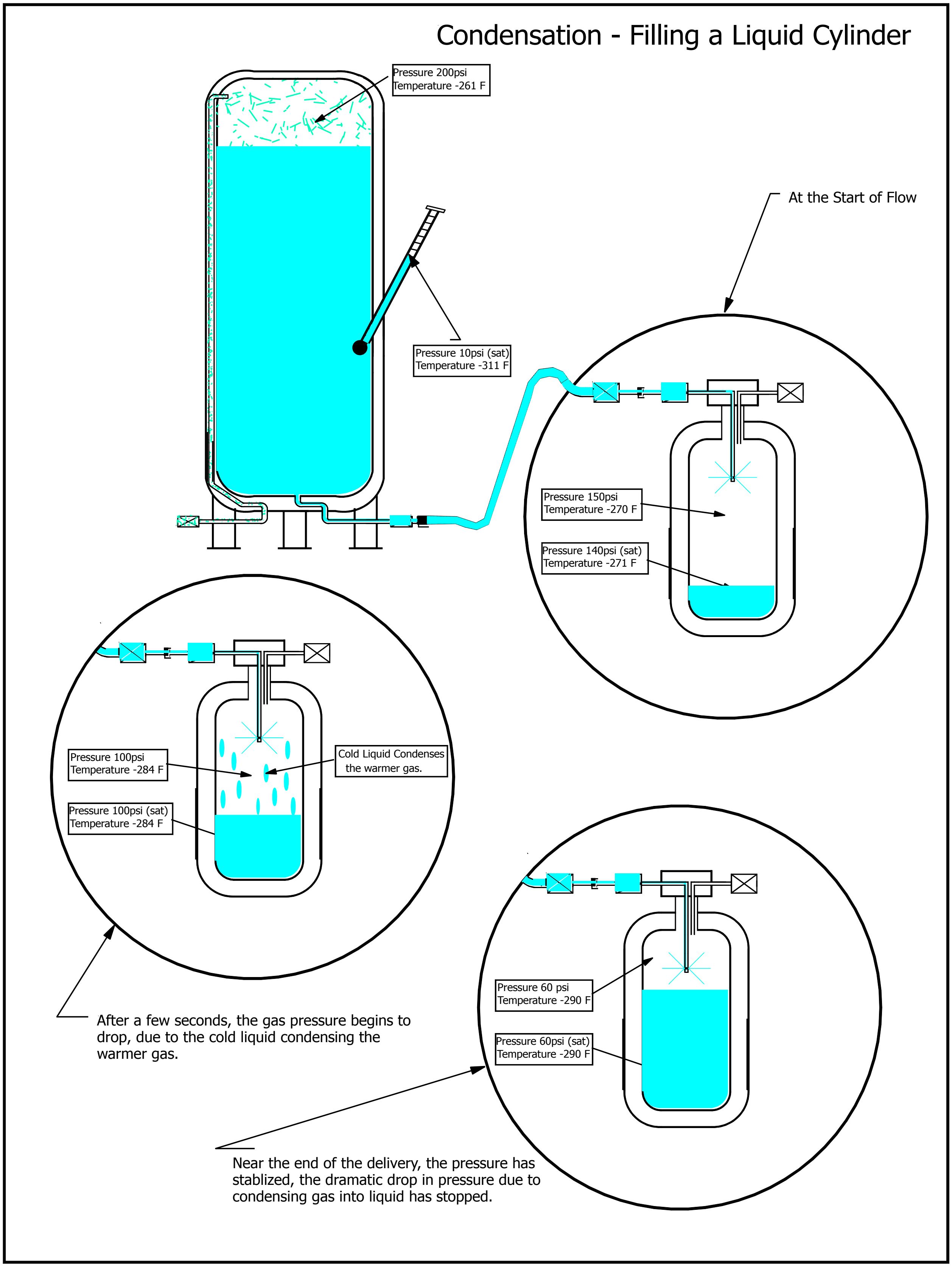
- GAS — Molecules in random motion
- LIQUID — Molecules in confined motion
- SOLID — Molecules with no motion

State of Matter - Solid, Liquid and Gas



B. Condensation

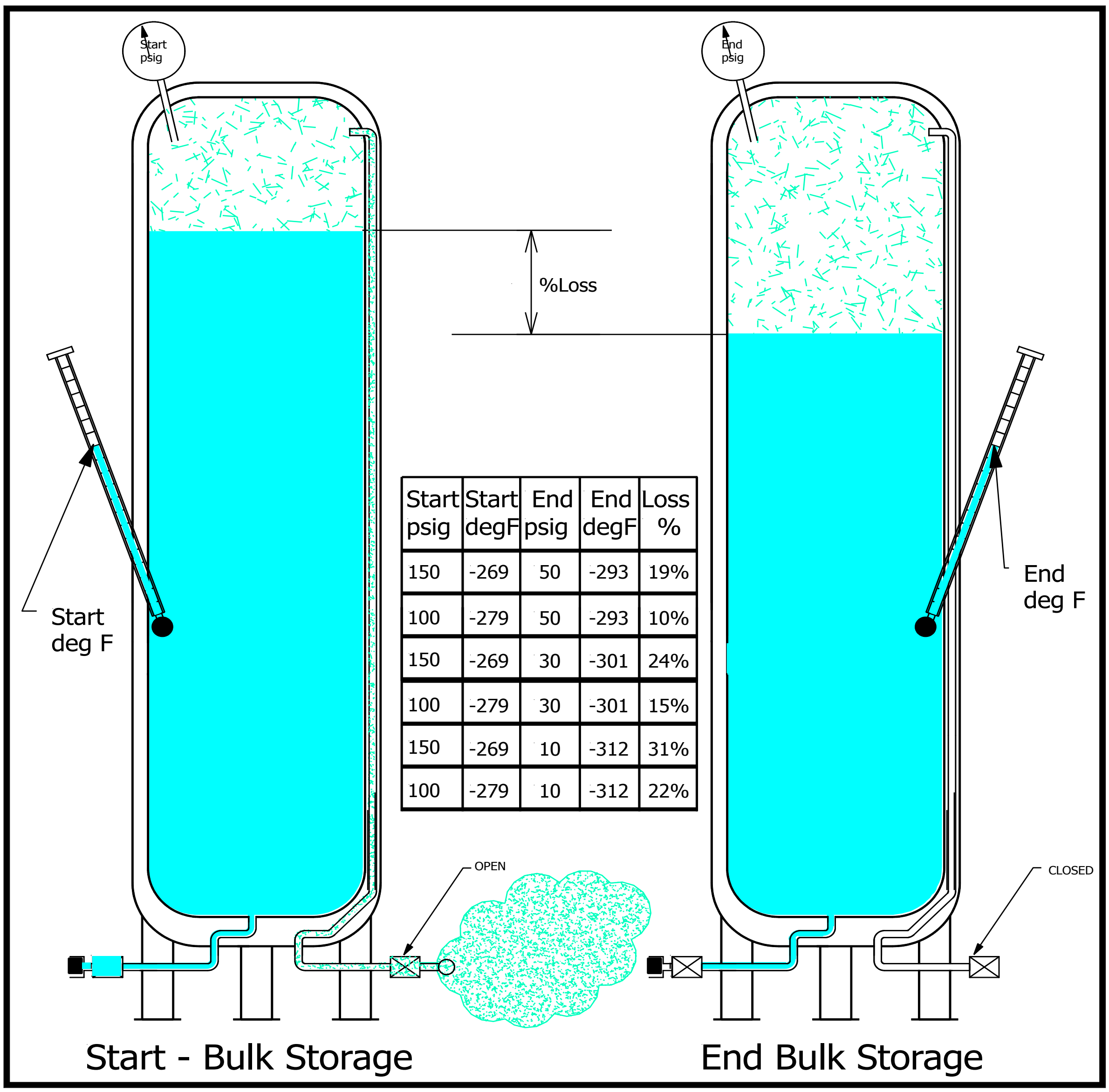
- **Definition** — The conversion of vapors into liquid phase by cooling the vapor.
- **Top Filling** is possible due to condensation
  - The fresh cold liquid passing through the vapor space condenses the vapor back to Liquid form
  - This process causes the collapse of vapor pressure in the trailer


Condensation - Filling a Liquid Cylinder
Pressure 200psi
Temperature -261 F
At the Start of Flow
Pressure 10psi (sat)
Temperature -311 F
Pressure 150psi
Temperature -270 F
Pressure 140psi (sat)
Temperature -271 F
Pressure 100psi
Temperature -284 F
Cold Liquid Condenses
the warmer gas.
Pressure 100psi (sat)
Temperature -284 F
After a few seconds, the gas pressure begins to drop, due to the cold liquid condensing the warmer gas.
Pressure 60 psi
Temperature -290 F
Pressure 60psi (sat)
Temperature -290 F
Near the end of the delivery, the pressure has stablized, the dramatic drop in pressure due to condensing gas into liquid has stopped.

C. Depressurization flash loss

- Vaporization caused by reducing the gas phase pressure to something less than
    - the saturated vapor pressure of the liquid
- During the venting of the tank below the saturation pressure of the liquid :
    - The liquid temperature will drop
    - The weight of the liquid decreases
    - The saturation pressure will drop

Depressurization (Flash) Losses - Product loss through Vent Valve



Start psig	Start degF	End psig	End degF	Loss %
150	-269	50	-293	19%
100	-279	50	-293	10%
150	-269	30	-301	24%
100	-279	30	-301	15%
150	-269	10	-312	31%
100	-279	10	-312	22%

D. Economizing

- At high vessel pressures use gas is supplied from vapor side of storage.
- Reduction in pressure reduces storage temperatures

E. Entrainment

- Liquid droplets carried along with a flowing gas stream
- Can occur during violent depressurization of a tank and during the top filling of a tank with the vent valve open
- Large product losses will occur during this event

F. Equilibrium

- **Definition** — A state where the liquid and gas phases co-exist at the same temperature and vapor pressure
- If there is a temperature difference between the gas and the liquid (with the tank closed), the gas and liquid will change their temperatures until they are equal.

G. Flowing gas pressure drop

H. Pressure lost due to the flow of gas

I. The faster a gas flow through a piping circuit, the higher the pressure drop

Table of Pressure Drops

Pipe Length 200 ft * Pressure Drop given in psi.

Pipe Diameter 1 in

# of Bends 40

Working Pressure (PSI)

Flow Rate (SCFH)	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600	625
500	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1000	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
1500	0.5	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2000	0.8	0.8	0.7	0.6	0.6	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.3
2500	1.3	1.1	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.6	0.5	0.5	0.5	0.5	0.4	0.4
3000	1.8	1.6	1.5	1.3	1.2	1.1	1.1	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.7	0.7	0.6	0.6
3500	2.4	2.1	1.9	1.8	1.6	1.5	1.4	1.3	1.2	1.2	1.1	1.0	1.0	1.0	0.9	0.9	0.8	0.8
4000	3.1	2.7	2.5	2.3	2.1	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.3	1.2	1.2	1.1	1.1	1.0
4500	3.8	3.4	3.1	2.8	2.6	2.4	2.2	2.1	2.0	1.9	1.8	1.7	1.6	1.5	1.4	1.4	1.3	1.3
5000	4.6	4.1	3.8	3.4	3.2	2.9	2.7	2.6	2.4	2.3	2.1	2.0	1.9	1.8	1.8	1.7	1.6	1.6
5500	5.5	4.9	4.5	4.1	3.8	3.5	3.3	3.0	2.9	2.7	2.6	2.4	2.3	2.2	2.1	2.0	1.9	1.9
6000	6.5	5.8	5.3	4.8	4.4	4.1	3.8	3.6	3.4	3.2	3.0	2.8	2.7	2.6	2.5	2.4	2.3	2.2
6500	7.5	6.7	6.1	5.6	5.1	4.8	4.4	4.1	3.9	3.7	3.5	3.3	3.1	3.0	2.9	2.7	2.6	2.5
7000	8.6	7.7	7.0	6.4	5.9	5.5	5.1	4.8	4.5	4.2	4.0	3.8	3.6	3.4	3.3	3.1	3.0	2.9
7500	9.8	8.8	8.0	7.3	6.7	6.2	5.8	5.4	5.1	4.8	4.5	4.3	4.1	3.9	3.7	3.6	3.4	3.3
8000	11.1	9.9	9.0	8.2	7.5	7.0	6.5	6.1	5.7	5.4	5.1	4.9	4.6	4.4	4.2	4.0	3.9	3.7
8500	12.4	11.1	10.0	9.2	8.4	7.8	7.3	6.8	6.4	6.0	5.7	5.4	5.2	4.9	4.7	4.5	4.3	4.2
9000	13.8	12.3	11.2	10.2	9.4	8.7	8.1	7.6	7.1	6.7	6.4	6.0	5.7	5.5	5.2	5.0	4.8	4.6
9500	15.2	13.6	12.3	11.3	10.4	9.6	9.0	8.4	7.9	7.4	7.0	6.7	6.3	6.1	5.8	5.5	5.3	5.1
10000	16.7	15.0	13.6	12.4	11.4	10.6	9.9	9.2	8.7	8.2	7.7	7.3	7.0	6.7	6.4	6.1	5.8	5.6
10500	18.3	16.4	14.9	13.6	12.5	11.6	10.8	10.1	9.5	8.9	8.5	8.0	7.6	7.3	7.0	6.7	6.4	6.1
11000	20.0	17.9	16.2	14.8	13.6	12.6	11.8	11.0	10.3	9.8	9.2	8.8	8.3	7.9	7.6	7.3	7.0	6.7
11500	21.7	19.4	17.6	16.1	14.8	13.7	12.8	11.9	11.2	10.6	10.0	9.5	9.0	8.6	8.2	7.9	7.6	7.3
12000	23.5	21.0	19.0	17.4	16.0	14.8	13.8	12.9	12.1	11.5	10.8	10.3	9.8	9.3	8.9	8.5	8.2	7.9
12500	25.3	22.7	20.5	18.8	17.3	16.0	14.9	13.9	13.1	12.4	11.7	11.1	10.6	10.1	9.6	9.2	8.8	8.5
13000	27.2	24.4	22.1	20.2	18.6	17.2	16.0	15.0	14.1	13.3	12.6	11.9	11.4	10.8	10.3	9.9	9.5	9.1
13500	29.2	26.1	23.7	21.6	19.9	18.4	17.2	16.1	15.1	14.3	13.5	12.8	12.2	11.6	11.1	10.6	10.2	9.8
14000	31.2	28.0	25.3	23.1	21.3	19.7	18.4	17.2	16.2	15.2	14.4	13.7	13.0	12.4	11.9	11.4	10.9	10.5
14500	33.3	29.9	27.0	24.7	22.7	21.1	19.6	18.4	17.3	16.3	15.4	14.6	13.9	13.3	12.7	12.1	11.6	11.2
15000	35.5	31.8	28.8	26.3	24.2	22.4	20.9	19.6	18.4	17.3	16.4	15.6	14.8	14.1	13.5	12.9	12.4	11.9

Calculations made using Eqn 3-20 from "Flow of Fluids Through Valves, Fittings and Pipe" by Crane

****** Important Assumptions ******

Highest allowable pressure drop 10 psi.

Acceptable Pressure Drop

Unacceptable Pressure Drop

J. **Note**: The table above only valid for a predetermined condition. Contact Chart Inc. for the pressure drops table calculator that will generate a new table for your specific application.

K. Flowing liquid pressure drop

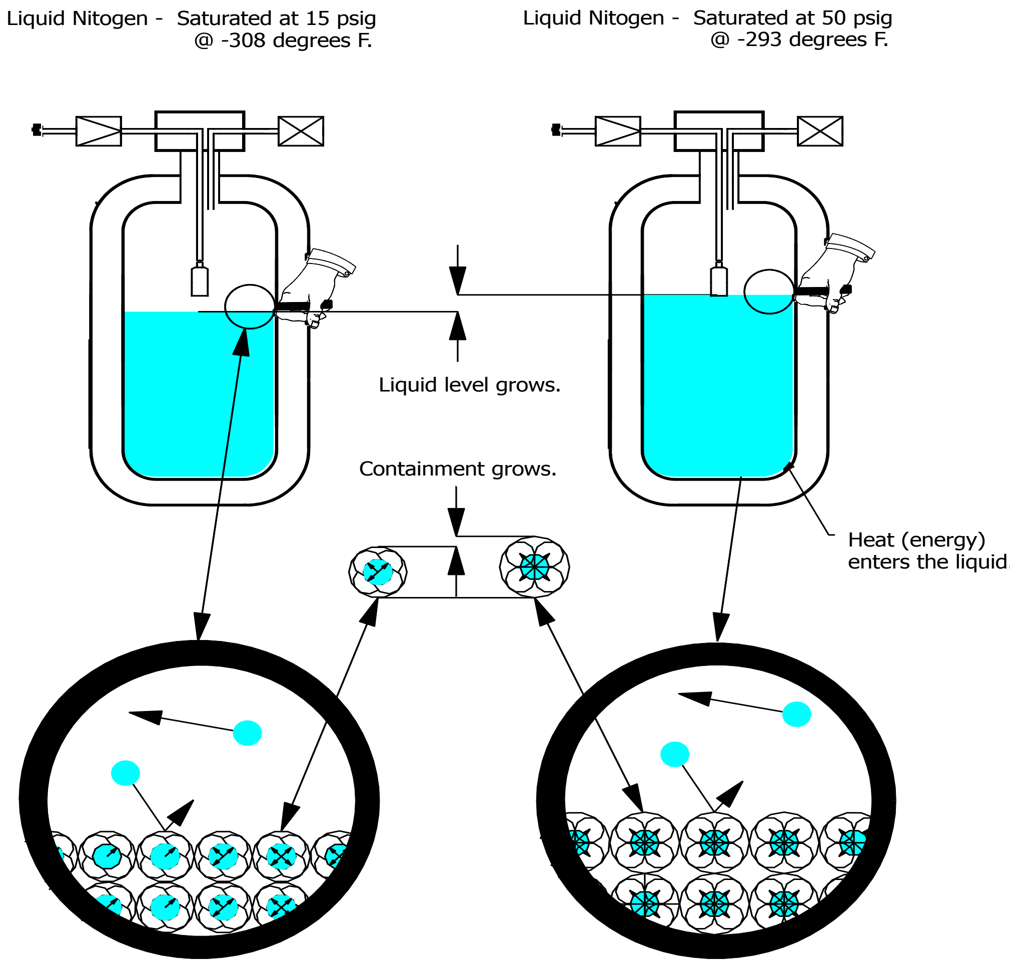
- Pressure lost due to the flow of liquid
- The faster a liquid flows through a piping circuit, the higher the pressure drop

L. Liquid growth

- Heat enters the tank (not perfect insulation)
    a. The liquid warms -
    b. Vapor pressure slowly begins to build -
    c. Decrease in liquid density -
    d. Increase in liquid volume (liquid growth)
- Liquid growth is a safety concern
- Liquid full or hydraulically full:
    a. The liquid grow until it fills the entire storage vessel
    b. The pressure rises rapidly
    c. The safety valve will relieve and the tank will vent liquid

Liquid Growth - Warmer liquid has more energy and takes up more volume. This higher level of energy results in the liquid molecule taking up more space.

Example - Tank is filled with 15 psig saturated liquid. Allowed to sit. Heat (energy) enters the tank, resulting in a higher level of molecular energy.



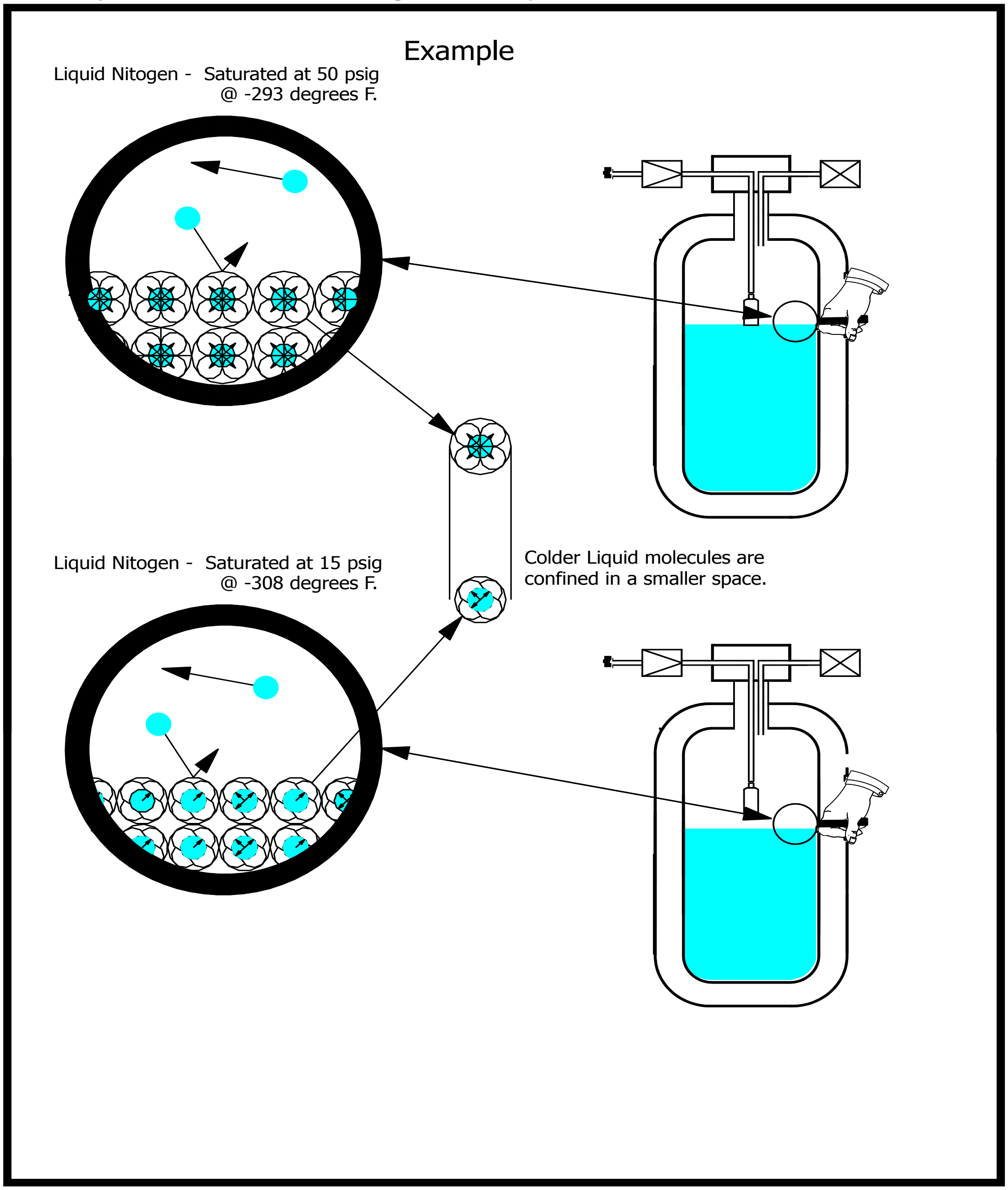
M. Liquid head pressure

- **Definition** — The internal energy of a fluid due to the pressure exerted on its container

N. Liquid saturation

- **Definition** — A state where the liquid and gas phase co-exist at the same temperature and vapor pressure (in equilibrium)
- Liquid density, temperature, and equilibrium pressure changes with the saturation level of the liquid
- At a higher or warmer temperature, liquid molecules takes up more space

Saturation - Liquid can exist at a range of temperatures. Each temperature state has a pressure at which the gas and liquid motion are constant.



O. Net positive suction head

- **Definition** — A pressure, associated with the intake of a pump, expressed in feet of pumped liquid, resulting from the algebraic evaluation of both the accretive and depletive aspects of that suction system. NPSH is a measure of how much spare pull you have before bubbles form.

- Usually denoted by the expression : NPSH

P. Pump cavitations

- **Definition** — Partial or full loss of pump primarily due to insufficient sub-cooling or net positive suction head
- Audible changes in the pump often are an indication of partial loss of prime
- The pump will stop pumping during full loss of prime capitations will cause damage to the pump

Q. Saturation pressure

- **Definition** — The pressure (usually in psi) that is used to describe the current condition of a liquid and gas within a closed container

R. Stratification

- A vertical temperature gradient (temperature change) from top to bottom
    - with colder product at the bottom and warmer product at the top
- Warm liquid is **<u>less</u>** dense — Stays at the **top** of the tank
- Cold liquid is **<u>more</u>** dense — Stays at the **bottom** of the tank

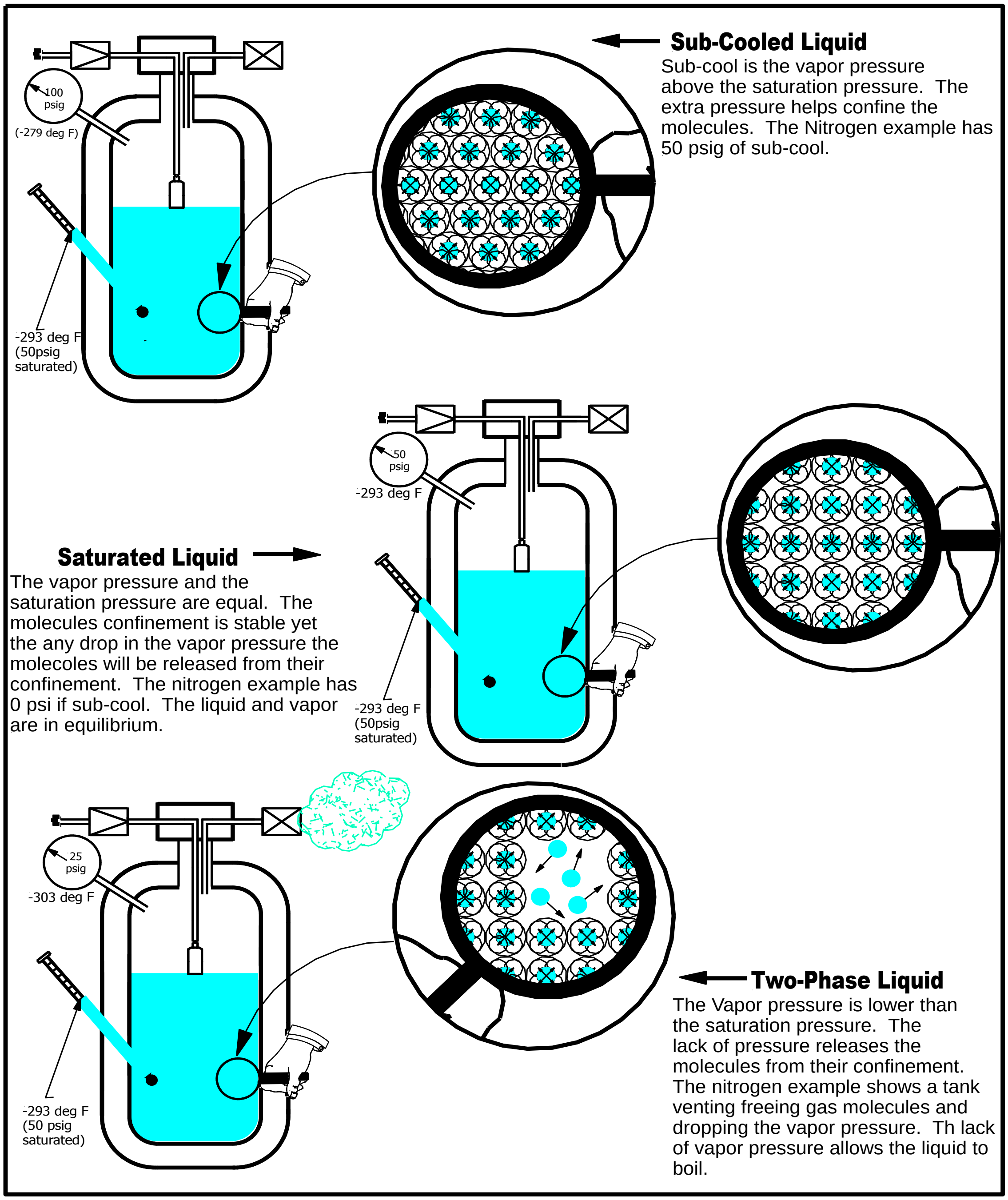
S. Sub-cool

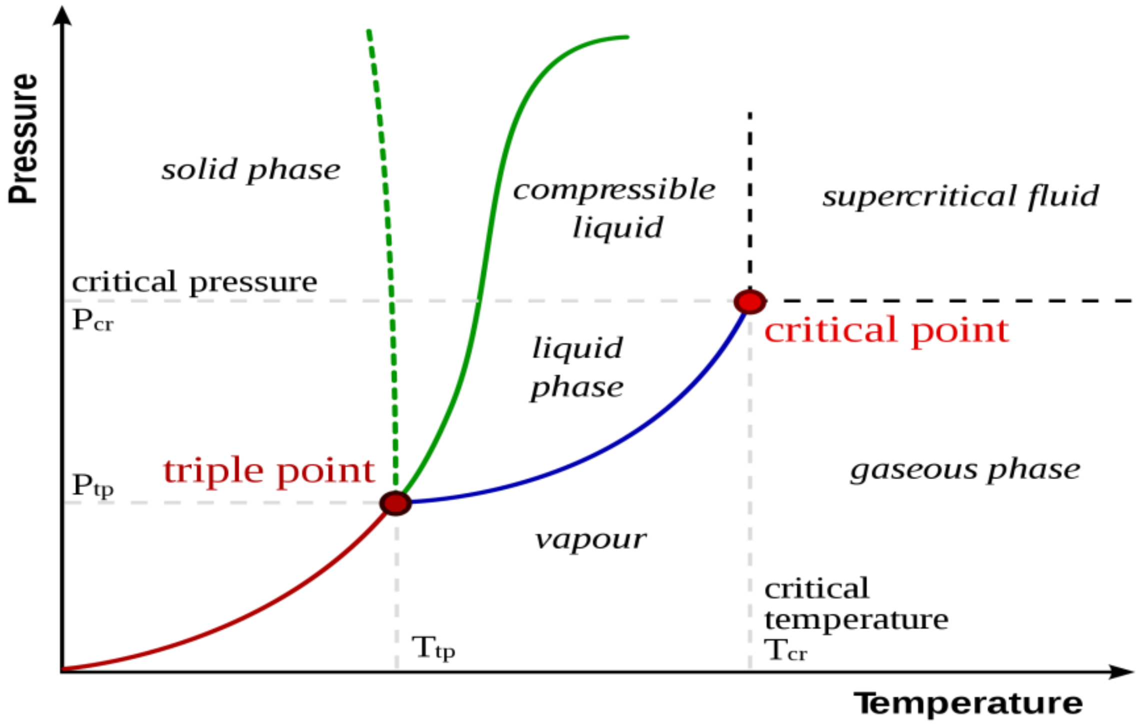
- Raising gas space pressure above the normal vapor pressure of a saturated liquid
    - creating Net Positive Suction Head (NPSH)
- When transferring liquid from a vessel, sub-cool is important to maintain the liquid in the liquid state as it travels from the tank through the piping circuit
- Liquid leaving the pump must be replaced in the sump at the same rate
- Liquid flowing creates pressure drop as it travels through the feed line
- if the pressure drops below the saturation pressure of the liquid, the liquid will begin to boil

T. Two phase liquid

- **Definition** — The mix of liquid and gas due to the pressure dropping below the saturation pressure of the liquid

Two-Phase Liquid





U. Vapor pressure

- **Definition** — The pressure of a liquid in equilibrium with its own vapor
- The vapor pressure is a function of temperature
- Measured by reading the tank pressure gauge

V. Vaporization

- **Definition** — The converting of liquid into vapor by warming the liquid
- **This process is usually used for the purpose of sub-cooling or for gas use**

W. Vapor pressure

- **Definition** -- The pressure of a liquid in equilibrium with its own vapor
- The vapor pressure is a function of temperature
- Measured by reading the tank pressure gauge

X. Vaporization

- **Definition** -- The converting of liquid into vapor by warming the liquid
- **This process is usually used for the purpose of sub-cooling or for gas use**

14 Glossary & Abbreviations

Abnormal Pressure — Pressure outside the normal or expected range.

Absolute Zero — The lowest temperature attainable. All molecular activity is considered to cease. Its value is -459.7° F (-273.15° C).

Annular space — The space surrounding one cylindrical object placed inside another, such as the space surrounding a container placed in an enclosing container.

Ball-And-Seat Valve — A device used to restrict fluid flow to one direction. It consists of a polished sphere, or ball, usually of metal, and an annular piece, the seat, ground and polished to form a seal with the surface of the ball.

Gravitational force or the force of a spring holds the ball against the seat. Flow in the direction of the force is prevented, while flow in the opposite direction overcomes the force and unseats the ball.

Bleed — To drain off liquid or gas, generally slowly, through a valve called a bleeder. To bleed down, or bleed off, means to release pressure slowly from a well or from pressurized equipment.

Bottled Gas — LPG, usually Butane or Propane stored in the liquid state at moderate pressure in steel containers for use in small residential and commercial applications.

British thermal unit (Btu) — An energy unit equivalent to the amount of energy needed to raise the temperature of 1 pound of water 1°F from 58.5°F to 59.5°F under standard pressure of 30 in. of mercury. Commonly used for measuring gas and other energy sales quantities.

Bushing — 1. A pipe fitting on which the external thread is larger than the internal thread to allow two pipes of different sizes to be connected. 2. a removable lining or sleeve inserted or screwed into an opening to limit its size, resist wear or corrosion, or serve as a guide.

Butane — A member of the alkane group of Hydrocarbons with four carbon atoms in its molecule (C_4H_{10}, often abbreviated to C4 in non-technical usage). Butane is a colorless, flammable gas at normal temperature and pressure but is easily liquefied by pressure for storage and transportation.

There are two isomeric forms, normal and iso-butane. At atmospheric pressure iso-butane liquefies at -1,200° C and normal butane at -100° C.

Centrifugal Pump — A pump with an impeller or rotor, an impeller shaft, and a casing, which discharges fluid by centrifugal force. An electric submersible pump is a centrifugal pump.

Coefficient of Viscosity — A measure of the tendency of a fluid to resist shear. The unity for viscosity is the poise which is defined as the resistance (in dynes per square centimeter of its surface) to one layer of fluid to the motion of a parallel layer one centimeter away and with a relative velocity of one cm per second.

Coiled tubing — A long, small diameter pipe flexible enough to be stored on and deployed from a large, truck-mounted roll. Coiled tubing is used to replace jointed pipe in certain types of drilling, completion, and workover operations.

CGA — Compressed Gas Association.

CNG — Compressed Natural Gas.

Compressed Natural Gas (CNG) — CNG is natural gas compressed into gas cylinders, chiefly used as an alternative for liquid fuels in road vehicles. CNG remains a gas irrespective of the amount of pressure. Not to be confused with Liquefied Petroleum Gas.

Compressor — A device that raises the pressure of a compressible fluid such as air or gas. Compressors create a pressure differential to move or compress a vapor or a gas.

Compressor Station — Station used to increase the pressure of natural gas when it is being transported.

Condensate — A natural gas liquid with low vapor pressure, produced from a reservoir with high pressure and temperature. Condensate will separate naturally in a pipeline or separation plant through the normal process of condensation. Can refer to any mixture of relatively light Hydrocarbons which remain liquid at normal temperature and pressure. There will be some propane and butane dissolved in it.

Unlike Crude Oil, it contains little or none of the heavy hydrocarbons which constitute heavy fuel oil.

There are three main sources of condensate: a) The liquid hydrocarbons which are produced from a gas/condensate reservoir. These may be only slightly distinguishable from a light stabilized crude oil. b) The liquid hydrocarbons which are recovered at the surface from non-associated gas. c) The liquid hydrocarbons which are separated out when raw gas is treated. This condensate typically consists of C5 to C8.

Corrosion — Any of a variety of complex chemical or electrochemical processes, such as rust, by which metal is destroyed through reaction with its environment.

Corrosion Inhibitor — A chemical substance that minimizes or prevents corrosion in metal equipment.

Coupling — 1. in piping, a metal collar with internal threads used to join two sections of threaded pipe. 2. in power transmission, a connection extending between a driving shaft and a driven shaft.

Critical Pressure — The minimum pressure which must be applied to a gas before it can be liquefied.

Critical Temperature — The temperature above which a gas will not liquefy, irrespective of the pressure applied.

Cryogenics — The process of producing, maintaining and utilizing very low temperatures (below -46° C / - 50° F).

Cubic Foot (CF) — The most common measurement of gas volume. One Cubic Foot is equal to the amount of gas required to fill one cubic foot under standard temperature and pressure. 1 Cubic Foot is approximately 1,025 British Thermal Units (BTUs). 100 Cubic Feet = 1 CCF.

Density — Mass per unit volume.

Dew Point — The temperatures below which either hydrocarbons (hydrocarbon dew point) or water (water dew point) will start to condense out of a given gas stream. Condensation reduces the accuracy of metering and creates the nuisance of liquid slugs in pipelines, which will need to be cleared out periodically by passing a Pig though the pipeline.

In addition, water may react with carbon dioxide or hydrogen sulphide in the gas stream to form acids, and with methane itself, under appropriate conditions, to form Hydrates. Therefore, at the Treatment stage, water is normally removed from the gas stream to reduce the Dew Point to somewhere around -10° C at standard pipeline pressures.

Dielectric Constant — The specific inductive capacitance of a material. It is equal to the ratio of the capacitances of two condensers of identical size, one using the particular dielectric, the other using air or a vacuum as the dielectric.

Ethane — Ethane (C_2H_6, often abbreviated to C2 in non-technical usage) is one of the main constituent elements of natural gas along with methane. Boils at -84.4° C. At normal temperatures it is a dry, colorless and odorless gas. A feedstock for ethylene production.

Ethylene — Also known as Ethene. A colorless gas (C_2H_4) produced by cracking Hydrocarbons such as Ethane or naphtha and used as a feedstock for petrochemicals, such as fibres and many plastics. Boils at -103.7° C.

Flow — A current or stream of fluid or gas.

Flow Meter — A type of meter used to measure gas flows.

Flow Rate — the speed, or velocity, of fluid or gas flow through a pipe or vessel.

Fuel Gas — Gaseous fuels, in particular low pressure natural gas used to fuel production or treatment facilities.

Gas Detector — An instrument used to detect the presence of various gases, often as a safety precaution to guard against leakage of flammable or toxic gases.

Gas Liquefaction — The conversion of natural gas into LNG**.**

GN2 — Gaseous nitrogen.

Gravity — A standard adopted by the American Petroleum Institute for measuring the density of a liquid. Gravity is expressed in degrees with lower numbers indicating heavier liquids and higher numbers indicating lighter liquids.

Hexane — A colorless gas (C_9H_{14}) naturally occurring in gas fields and normally left as part of the condensate stream after separation. Hexane boils at -69° C.

Hydrocarbon — An organic compound containing only the elements hydrogen and carbon. Hydrocarbons exist as solids, liquids and gases.

Joule-Thomson Effect — The change in temperature resulting from expansion of a gas or vapor through an orifice or other restriction. In general, a lowering of temperature or cooling effect is the usual result of such an expansion.

LAR — Liquid Argon.

Latent Heat of Fusion — The heat required to convert a unit mass of substance from the solid state to the liquid state at a given pressure (and temperature).

Latent Heat of Sublimation — The heat required to convert a unit mass of substance from the solid state to the gaseous state.

Latent Heat of Vaporization — The heat required to convert a unit mass of substance from the liquid state to the gaseous state at a given pressure (and temperature).

LCO_2 — Liquid Carbon Dioxide.

LH_2 — Liquid Hydrogen.

LHe — Liquid Helium.

Liquefaction — The conversion of natural gas into LNG.

Liquefied Gases — Usually applied to the liquid form of substances which under normal conditions of temperature and pressure are found as gases.

Liquefied Natural Gas — See LNG.

LN_2 — Liquid nitrogen

L**iquefied Petroleum Gas** — Liquefied Petroleum Gas (LPG) is Propane, Butane, or propane-butane mixtures which have been liquefied through pressure, mild refrigeration, or a combination of both. Usually a derivative of refinery operations but often stripped out of natural gas streams, if rich enough. Conventionally sold in steel containers as Bottle Gas. Not to be confused with LNG.

LNG (Liquefied Natural Gas) — LNG is Natural Gas which has been cooled to a temperature, around the boiling point of methane (-162° C), at which it liquefies, thus reducing its volume by a factor of about 600. The exact boiling of any gas mixture and the reduction in volume depends on its composition.

The process of Liquefaction is carried out in a liquefaction plant. Mostly these are very large scale plants built for projects transporting gas by sea, but in many countries small LNG plants have been built to liquefy gas during the seasons of low demand to provide Peak Shaving when required.

LNG Plants consist of one or more LNG Trains, each of which is an independent gas liquefaction unit. It is more cost effective to add a train to an existing LNG plant, than to build a new LNG plant, because infrastructure built for early trains, such as ship terminals and other utilities, may be capable of being used or expanded for new LNG trains.

The term Train is sometimes extended loosely to embrace the relevant shipping, storage and other facilities required to bring the resultant LNG to market. Liquefied gas is transported and stored as a boiling liquid under slight positive pressure until required for use, when it is warmed and allowed to re-gasify.

In the case of Peak Shaving, the gas will normally be regasified at the plant itself or possibly transported for short distances by road, but large scale transportation is by sea, in specially designed insulated LNG vessels and delivered to LNG terminals, which have the requisite facilities for storage and regasification – the process by which LNG is warmed, usually through a heat exchanger, in order to become once more gaseous before emission into the Gas Grid.

LO_2 — Liquid Oxygen

Methane — A colorless, odorless flammable gas, lighter than air under normal conditions (CH4, often abbreviated to C1 in non-technical usage). Methane is the first member in the alkane (paraffin) series and is the chief constituent of Natural Gas. At atmospheric pressure, it liquefies at -162° C.

Molecular Weight — The sum of the atomic weights of all the atoms in a molecule. The atomic weight is the relative weight of the atom, on the basis of a carbon isotope C^{12}.

Natural Gas — Natural gas (NG) is a mixture of generally gaseous hydrocarbons occurring naturally in underground structures. Natural gas consists mainly of Methane and variable proportions of Ethane, Propane and Butane. There will usually be some condensate and/or oil associated with the gas. More specifically, the term is also used to mean treated natural gas which is supplied to industrial, commercial and domestic users and meeting a specified quality.

Natural Gas Liquids (NGLs) — Heavier hydrocarbons found in natural gas production streams and extracted for disposal separately. Within defined limits ethane, propane and butane may be left in the gas to enrich the Calorific Value.

Whether to extract them or not is largely a commercial decision. Heavier fractions which are liquids at normal temperatures and pressures will be removed. The terms Natural Gas Liquids and Condensates are in practice used virtually interchangeably. Rather confusingly, there is no agreement on whether the term NGLs includes or excludes LPGs and both usages are current.

Natural Gas Vehicle (NGV) — A motorized vehicle powered by natural gas. See Compressed Natural Gas.

Natural Gasoline — Butanes and heavier fractions extracted from rich natural gas which, after stabilization (removal of the lighter fractions) may be blended into motor gasoline.

NER Normal Evaporation Rate — The amount of heat influx into the tank determines the factor commonly called boil off, which refers to the percentage of the tank's contents that will evaporate in a given period under specified ambient temperature conditions. The term normal evaporate rate (NER) is used.

Normal Boiling Point — The temperature at which a liquid boils when under a total pressure of one atmosphere.

Normal Sublimation Temperature — The temperature at which a solid sublimes under a total pressure of one atmosphere.

Odorants — Strong smelling chemicals injected into natural gas, which otherwise is odorless, in order to make its presence more easily detectable.

Petrochemical — An intermediate chemical derived from petroleum, hydrocarbon liquids, or natural gas, such as ethylene, propylene, benzene, toluene, and xylene.

Petroleum — The general name for Hydrocarbons, including Crude Oil, Natural Gas and NGLs. The name is derived from the Greek word petros (rock) and the Latin word oleum (oil).

Propane — A member of the alkane (paraffin) group of hydrocarbons with three carbon atoms in its molecule (C_3H_8, often abbreviated to C3 in non-technical usage). A frequent component of natural gas, also sold as a form of Bottled Gas. Propane liquefies at -42° C.

Processing plants — Plants used to purify natural gas, separating natural gas (predominately methane) from other hydrocarbons.

Raw Natural Gas — Natural gas still containing impurities and unwanted substances, such as water, nitrogen, carbon dioxide, hydrogen sulphide gas and helium.

Regasification — The reconversion of LNG into gas suitable for pipeline transportation. See LNG.

Regulator — A mechanical device for controlling the pressure of gas within acceptable limits; Typically installed when gas enters a low pressure distribution system for final use by small customers.

Specific Gravity — The ratio of the density of gas to that of air, or the ratio of the density of a liquid to that of water, in both cases at the same temperature and pressure.

Specific Heat — The ratio of the heat capacity of a body to the heat capacity of water at some reference point.

Specific Heat Ratio — Ratio of specific heat at a constant pressure to the specific heat at constant volume at a particular temperature.

Specific Volume — The volume occupied by one unit weight of a substance.

Sublimation — the transition of a substance directly from the solid phase to the gas phase without passing through an intermediate liquid phase. The reverse process of sublimation is deposition. The formation of frost is an example of meteorological deposition.

Superconductivity — The phenomenon by which some substances suddenly lose all electrical resistance when their temperatures are reduced. These transitions occur at temperatures lower than that of liquid hydrogen.

Synthetic Gasoline — Motor gasoline produced from coal (by the Fischer Tropsch process) or from natural gas (by the Fischer Tropsch process or via methanol).

Synthetic Natural Gas (SNG) — (Also referred to as substitute natural gas) A manufactured product, chemically similar in most respects to natural gas, resulting from the conversion or reforming of hydrocarbons that may easily be substituted for or interchanged with pipeline-quality natural gas.

Therm — One hundred thousand (100,000) BTU.

Thermal Conductivity — The property of a material that describes the rate at which heat will be conducted through a unit area of material for a given driving force. It is dependent on the material and upon its temperature.

Torr — The torr (symbol: Torr) is a traditional unit of pressure, now defined as exactly 1/760 of a standard atmosphere, which in turn is defined as exactly 101325 Pascal's. Thus one torr is about 133.322368421053 Pascal's (the exact value being an infinitely repeating decimal fraction. Historically, one torr was intended to be the same as one "millimeter of mercury".

Treatment — Any gas purification process, but most generally applied to the treatment of gas immediately after production, to bring it to acceptable standard for the market in question and/or to extract valuable components for separate sale. This may involve the removal of LPGs and will certainly involve stripping out Condensates, Carbon Dioxide and Hydrogen Sulphide and other sulphur compounds (see also Acid Gas) mercury and excessive water which may be in the raw gas.

Other impurities are occasionally encountered. Whether other inert gases such as nitrogen, helium and other gases are extracted will be a matter for economic evaluation.

Triple Point — The particular condition under which a substance can be present in any or all phases (gaseous, liquid, or solid).

Vacuum Insulated Pipe (VIP) — A double-walled pipe with a factory-evacuated vacuum between the inner and outer walls of the pipe. The double wall design provides less than 1/10th the heat leak of mechanically insulated pipe (MIP).

The annular space between the inner and outer pipes is factory evacuated to a vacuum level of 1 x 10-3 torr and conditioned to last the lifetime of the pipe (typically assessed at 30 years).

Working Gas — In a gas store, the total volume of gas present less Cushion Gas, In other words the gas available for normal working. Hence working gas capacity - the total capacity of a storage facility minus cushion gas.

Volume Abbreviations:

Gas

SCFM	Standard cubic feet per minute
SCFH	Standard cubic feet per hour
MCF	One thousand cubic feet of natural gas
MMCF	One million cubic feet of natural gas

BCF	One billion cubic feet of natural gas
TCF	One trillion cubic feet of natural gas
MMCF/D	Millions of cubic feet of gas per day

Energy equivalents

BOE	Barrel of oil (one barrel of oil equals 6,000 cubic feet of natural gas)
MBOE	One thousand barrels of oil equivalent
MMBOE	One million barrels of oil equivalent
MMCFE	One million cubic feet of natural gas equivalent
BCFE	One billion cubic feet of natural gas equivalent
TCFE	One trillion cubic feet of natural gas equivalent

15 Appendix A – Contents Table

BulkLite 1400: Nitrogen saturated @ 25.0 psi. The table shows quantity of contents as a function of gauge reading.

Level (H2O)	Volume (gal)	Weight (lb)	Gas Volume (SCF)
0	0	0	0
0.6	0	132	1,817
1	3	152	2,100
2	16	230	3,172
3	33	340	4,691
4	55	474	6,548
5	79	629	8,683
6	107	801	11,057
7	136	988	13,639
8	168	1,188	16,403
9	202	1,400	19,329
10	238	1,623	22,399
11	274	1,854	25,595
12	313	2,094	28,904
13	352	2,341	32,310
14	392	2,594	35,801
15	433	2,852	39,363
16	475	3,114	42,986

Level (H2O)	Volume (gal)	Weight (lb)	Gas Volume (SCF)
17	518	3,380	46,657
18	560	3,649	50,366
19	603	3,920	54,100
20	647	4,191	57,850
21	690	4,463	61,604
22	733	4,735	65,352
23	776	5,005	69,082
24	819	5,273	72,784
25	861	5,539	76,446
26	903	5,800	80,058
27	944	6,057	83,607
28	984	6,309	87,082
29	1,023	6,555	90,470
30	1,061	6,793	93,757
31	1,098	7,023	96,929
32	1,133	7,243	99,971
33	1,166	7,453	102,867
34	1,198	7,650	105,596
35	1,227	7,835	108,138
36	1,254	8,003	110,467
36.9	1,275	8,135	112,279

16 Appendix B – Standard Components

Recommended spare parts in bold

Ref #	Valve #	Tag Definition	Chart PN	Item Master Description	Manufacturer Info
1	C-1	CONNECTION, AUX. LIQUID	11672566	CAP PIPE BRS HEX 1"NPT	600 CWP REGO #CAP001000 B31.3
2	C-3	CONNECTION, SEC. AUX. LIQUID	11827441	TOP & BOTTOM FILL CIRCUIT	PLUG, 1/2"MPT
3	C-4	CONNECTION, SEC. AUX. VAPOR	11827441	TOP & BOTTOM FILL CIRCUIT	PLUG, 1/2"MPT
4	CV-1	FILL LINE CHECK VALVE	11827441	TOP & BOTTOM FILL CIRCUIT	INTERNAL REGO #TCV8512R
5	CV-3	ECONOMIZER CHECK VALVE	20630368	VALVE CHECK BRS 1/2FPTX1/2FPT	GENERANT CV-503B-T-8 O2 CLN
6	**FC-1**	**FILL CONNECTION**	**10821005**	**CGA LIN (ACCESSORY NUMBER)**	
			10821013	**CGA LOX (ACCESSORY NUMBER)**	
			10821021	**CGA LAR (ACCESSORY NUMBER)**	
7	HCV-1	BOTTOM FILL VALVE	11827441	TOP & BOTTOM FILL CIRCUIT	REGO #BKA9408
8	HCV-2	TOP FILL VALVE	11827441	TOP & BOTTOM FILL CIRCUIT	REGO #BKA9408
9	HCV-3	PB INLET VALVE	11827441	TOP & BOTTOM FILL CIRCUIT	REGO #BK9404
10	**HCV-4**	**FULL TRYCOCK/VENT VALVE**	**1713922**	**VALVE GLOBE BRZ 1/2NPT**	**REGO #B206LL-4T6**
11	HCV-5	VACUUM GAUGE TUBE VALVE	10482381	VALVE BELLOWS SEALED BRZ	HOKE 4111L2B
12	HCV-7	FILL LINE DRAIN VALVE	11827441	TOP & BOTTOM FILL CIRCUIT	REGO #BK9450
13	HCV-8	LI-1 VAPOR PHASE VALVE	10907239	VALVE NEEDLE BRS 1/4MPT(ANGLE)	REGO #CMM250A B31.3
14	HCV-9	LI-1 EQUALIZATION VALVE	10907239	VALVE NEEDLE BRS 1/4MPT(ANGLE)	REGO #CMM250A B31.3
15	HCV-10	LI-1 LIQUID PHASE VALVE	10907239	VALVE NEEDLE BRS 1/4MPT(ANGLE)	REGO #CMM250A B31.3
16	HCV-11	PB OUTLET VALVE	11827441	TOP & BOTTOM FILL CIRCUIT	REGO #BK9404

Ref #	Valve #	Tag Definition	Chart PN	Item Master Description	Manufacturer Info
17	**HCV-13**	**PRODUCT SUPPLY VALVE**	**1713922**	**VALVE GLOBE BRZ 1/2NPT**	**REGO #B206LL-4T6**
18	HCV-15	SAFETY RELIEF SELECTOR VALVE	20630617	MDL DUAL RELIEF S/A	REGO 1" DIVERTOR
19	**LI-1**	**LEVEL INDICATOR, INNER VESSEL**	**11689261**	**DIFF PG ASSY 0-100"H2O DSS**	**175/250 PSI REGO VALVE**
20	PBC-1	PRESSURE BUILD COIL	11657518	MDL PB COIL 5FT VERT FIN	VS-66"
21	**PCV-1**	**PRESSURE CONTROL VALVE**	**10931061**	**REGULATOR COMBO .250FPT@120PSI**	**CASH #23110-0120 TYPE PBE-1 SPRING #12108**
22	**PI-1**	**PRESSURE INDICATOR GAUGE**	**2010272**	**PG 2-1/2"DIAL 0-400PSI/KPA**	**1/4"LM WIKA#52194434**
23	**PSE-1A**	**PRESSURE SAFETY ELEMENT, INR**	**11494835**	**RV BRZ 3/4MPTX1FPT 250 PSIG**	**HEROSE #06388-1006-6040**
24	**PSE-1B**		**11494835**	**RV BRZ 3/4MPTX1FPT 250 PSIG**	**HEROSE #06388-1006-6040**
25	**PSV-1A**	**PRESSURE SAFETY VALVE, INR**	**11509339**	**RPD ASSY 3/4"MPTXFREE 375PSI**	**BRS W/NICKEL DISC B31.3 ASME**
26	**PSV-1B**		**11509339**	**RPD ASSY 3/4"MPTXFREE 375PSI**	**BRS W/NICKEL DISC B31.3 ASME**
27	**S-1**	**STRAINER, PRESSURE BUILDING**	**11827441**	**TOP & BOTTOM FILL CIRCUIT**	**1/2" NOM. W/ 100 MESH MONEL SCREEN UNITED BRASS #200WSCH/600#WOG**
28	**S-2**	**FILL STRAINER**	**11827441**	**TOP & BOTTOM FILL CIRCUIT**	**FILL STRAINER, WITH 400 MESH MONEL SCREEN**
29	**TSV-2**	**FILL LINE THERMAL RELIEF**	**1810802**	**RV BRS 1/4MPT 400PSI**	**REGO #PRV9432T400 (TEFLON SEAT)**
30	**TSV-3**	**VAPORIZER THERMAL RELIEF VALVE**	**1810802**	**RV BRS 1/4MPT 400PSI**	**REGO #PRV9432T400 (TEFLON SEAT)**
31	**TSV-4**	**PB CIRCUIT THERMAL RELIEF VALVE**	**1810802**	**RV BRS 1/4MPT 400PSI**	**REGO #PRV9432T400 (TEFLON SEAT)**

Ref #	Valve #	Tag Definition	Chart PN	Item Master Description	Manufacturer Info
32	TT-1	TELEMETRY TAP, VAPOR PHASE	10501263	CONN BRS 1/4ODTX1/4MPT	PARKER A-LOK # 4MSC4N-B B31.3
33	TT-2	TELEMETRY TAP, LIQUID PHASE	10501263	CONN BRS 1/4ODTX1/4MPT	PARKER A-LOK # 4MSC4N-B B31.3
34	VP-1	VACUUM PORT	10826172		Chart SUPPLIED
35	VR-1	VACUUM READOUT	4210049	VACUUM GAUGE TUBE	HASTINGS DV-6R
36	VAP	PRODUCT WITHDRAWAL VAPORIZER	20649210	MDL VAPORIZER ASSY	Chart SUPPLIED
37	VAP-1	PRE VAP	20646574	VAPORIZER COIL ASSY 90D	Chart SUPPLIED

Optional Components

Ref #	Valve #	Description	Chart PN	Item Master Description	Manufacturer info
38	C-8	CONNECTION, CUSTOMER HOUSELINE			
39	CV-2	HOUSELINE CHECK VALVE			
40	HCV-16A	RELIEF LINE PURGE VALVE	10907239		REGO
41	HCV-16B	RELIEF LINE PURGE VALVE	10907239		REGO
42	HCV-18	AUX. LIQUID VALVE			REGO
43	HCV-20	ECONOMIZER VENT VALVE			REGO
44	HCV-21	SEC. AUX. LIQUID VALVE			REGO
45	HCV-22	SEC. AUX. VAPOR VALVE			REGO
46	HCV-30	INLET HOUSELINE VALVE			
47	HCV-31	BYPASS HOUSELINE VALVE			
48	HCV-32	OUTLET HOUSELINE VALVE			
49	**PCV-3**	**ECONO VENT PRESS CONTROL VALVE**			**CASH ACME**
50	**PCV-5**	**HOUSELINE PRESS CONTROL VALVE**			
51	**PI-2**	**HOUSELINE PRESSURE GAUGE**			
52	**TSV-8**	**HOUSELINE THERMAL RELIEF VALVE**			**REGO**

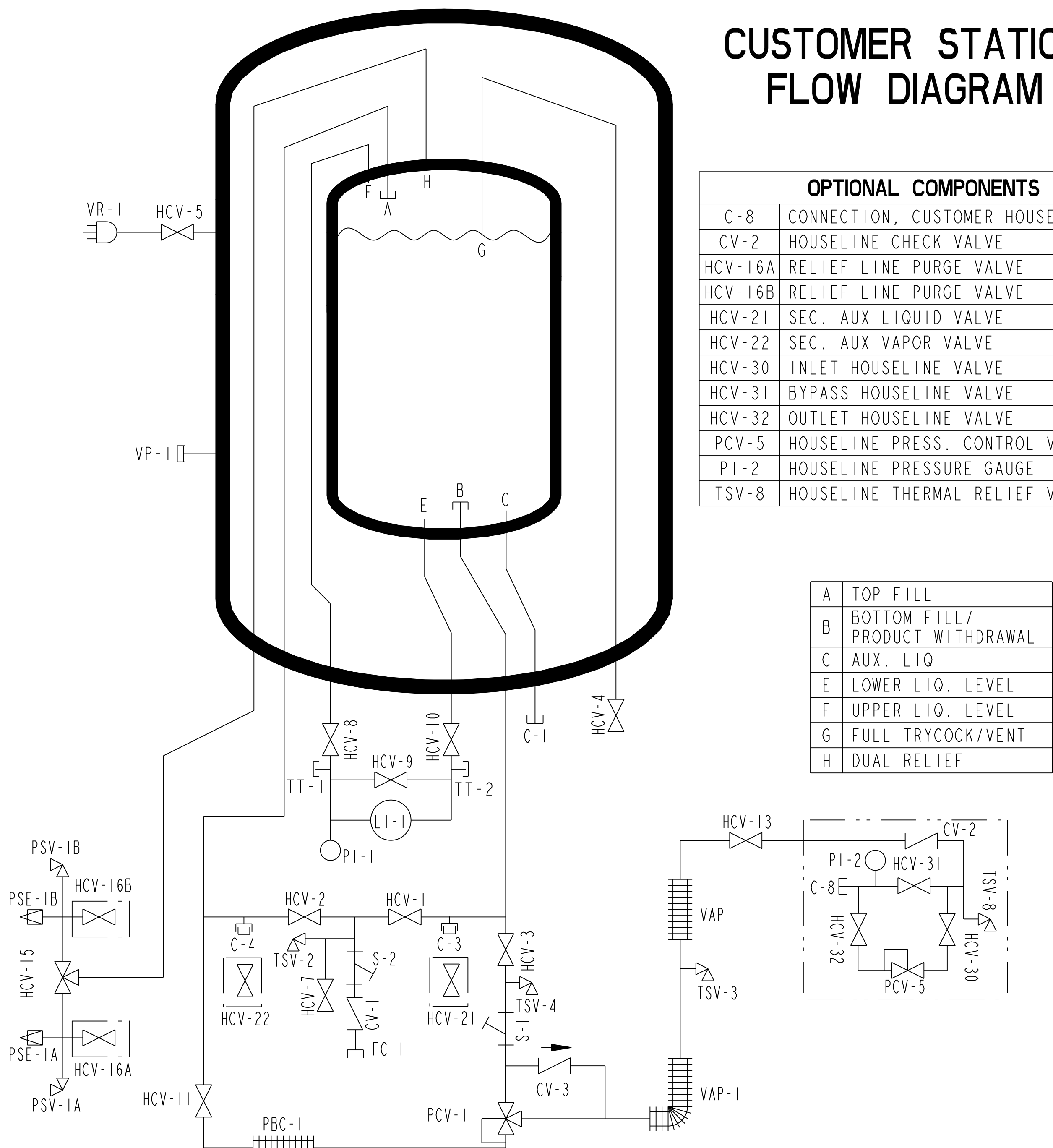
10-1/2

5/16 x 45° CHAMFER TYP

8

BORDER TO BE BLACK

CUSTOMER STATION FLOW DIAGRAM



OPTIONAL COMPONENTS	
C-8	CONNECTION, CUSTOMER HOUSELINE
CV-2	HOUSELINE CHECK VALVE
HCV-16A	RELIEF LINE PURGE VALVE
HCV-16B	RELIEF LINE PURGE VALVE
HCV-21	SEC. AUX LIQUID VALVE
HCV-22	SEC. AUX VAPOR VALVE
HCV-30	INLET HOUSELINE VALVE
HCV-31	BYPASS HOUSELINE VALVE
HCV-32	OUTLET HOUSELINE VALVE
PCV-5	HOUSELINE PRESS. CONTROL VALVE
PI-2	HOUSELINE PRESSURE GAUGE
TSV-8	HOUSELINE THERMAL RELIEF VALVE

A	TOP FILL
B	BOTTOM FILL/ PRODUCT WITHDRAWAL
C	AUX. LIQ
E	LOWER LIQ. LEVEL
F	UPPER LIQ. LEVEL
G	FULL TRYCOCK/VENT
H	DUAL RELIEF

TAG DEFINITION	
C-1	CONNECTION, AUX. LIQUID
C-3	CONNECTION, SEC. AUX. LIQUID
C-4	CONNECTION, SEC. AUX. VAPOR
CV-1	FILL LINE CHECK VALVE
CV-3	ECONOMIZER CHECK VALVE
FC-1	FILL CONNECTION
HCV-1	BOTTOM FILL VALVE
HCV-2	TOP FILL VALVE
HCV-3	PB INLET VALVE
HCV-4	FULL TRYCOCK/VENT VALVE
HCV-5	VACUUM GAUGE TUBE VALVE
HCV-7	FILL LINE DRAIN VALVE
HCV-8	LI-1 VAPOR PHASE VALVE
HCV-9	LI-1 EQUALIZATION VALVE
HCV-10	LI-1 LIQUID PHASE VALVE
HCV-11	PB OUTLET VALVE
HCV-13	PRODUCT SUPPLY VALVE
HCV-15	SAFETY RELIEF SELECTOR VALVE
LI-1	LEVEL INDICATOR, INNER VESSEL
PBC-1	PRESSURE BUILD COIL
PCV-1	PRESSURE CONTROL VALVE
PI-1	PRESSURE INDICATOR GAUGE
PSE-1A	PRESSURE SAFETY ELEMENT, INR
PSE-1B	PRESSURE SAFETY ELEMENT, INR
PSV-1A	PRESSURE SAFETY VALVE, INR
PSV-1B	PRESSURE SAFETY VALVE, INR
S-1	STRAINER, PRESSURE BUILDING
S-2	FILL STRAINER
TSV-2	FILL LINE THERMAL RELIEF
TSV-3	VAPORIZER THERMAL RELIEF VALVE
TSV-4	PB CIRCUIT THERMAL RELIEF VALVE
TT-1	TELEMETRY TAP, VAPOR PHASE
TT-2	TELEMETRY TAP, LIQUID PHASE
VP-1	VACUUM PORT
VR-1	VACUUM READOUT
VAP	PRODUCT WITHDRAWAL VAPORIZER
VAP-1	PRE VAP

CHART P/N 20630498 REV C CHART IND., NEW PRAGUE, MN 56071

NOTES:

1.) LABEL SHOWN ACTUAL SIZE
2.) CHARACTERS NOT TO BE TYPED
3.) ALL CHARACTERS TO BE APPROXIMATE STYLE AND SIZE.
4.) ALL CHARACTERS TO BE BLACK ON 2 MIL WHITE MYLAR, LAMINATED WITH 2 MIL CLEAR MYLAR.

THIRD ANGLE PROJECTION

Material Required
SEE B.O.M. UNLESS OTHERWISE STATED

VISIT US AT CHARTINDUSTRIES.COM
OEM PARTS AT CHARTPARTS.COM

	APPROVED	DATE
DRAWN BY	TJS	9/18/12
CHK'D BY	JSG	9/26/12
PROJ. ENGR.	TBS	9/27/12
QUAL. CONT.	CPL	9/24/12
MFG. ENGR.	RC	9/24/12
MFG. SERV.	KJR	9/24/12

REV	ECR NO	DESCRIPTION	BY	DATE
C	15388	REMOVE AUXLIQ VALVE OPT	TJS	6/13/13
B	15229	ADDED AUX LIQ LINE	TJS	2/9/13
A	15149	ADDED VAP-1	TJS	12/6/12

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES.
TOLERANCES:
FRACTIONS ± 1/16
ANGLES ± .01°
2 PLACE DECIMALS ± .01
3 PLACE DECIMALS ± .005

CHART®
Distribution & Storage, New Prague Operations
Innovation. Experience. Performance.®

TITLE SCHEMATIC BL-1400

DRAWING NUMBER C-20630498 Rev C

SCALE FULL

PART NUMBER 20630498

SHEET 1 OF 1

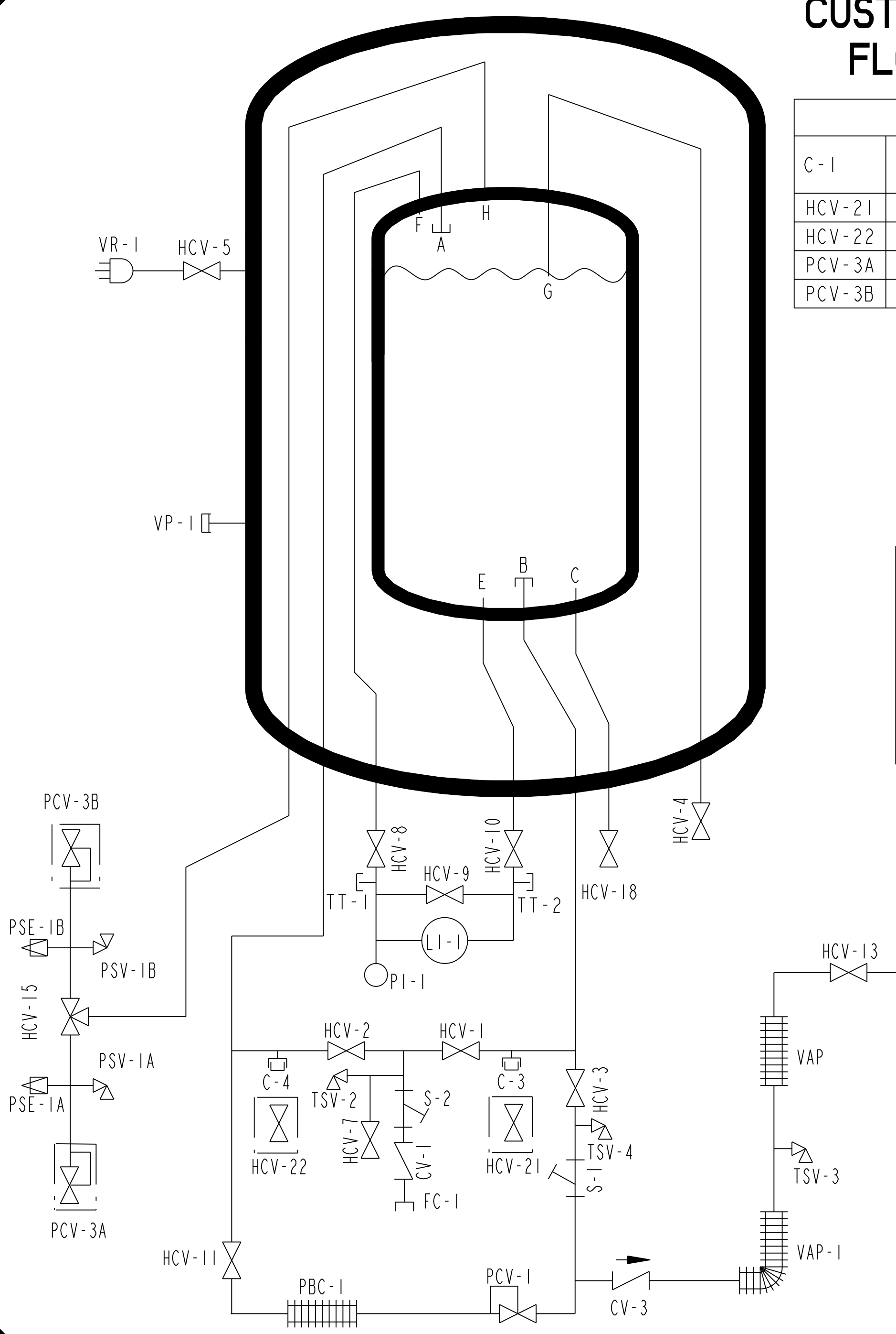
10-1/2

5/16 x 45° CHAMFER TYP

8

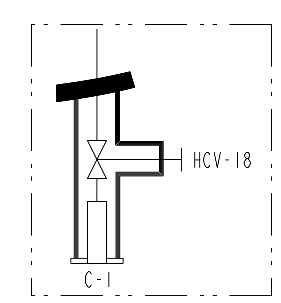
BORDER TO BE BLACK

CUSTOMER STATION FLOW DIAGRAM



OPTIONAL COMPONENTS	
C-1	CONNECTION AUX LIQUID FEMALE BAYONET
HCV-21	SEC. AUX LIQUID VALVE
HCV-22	SEC. AUX VAPOR VALVE
PCV-3A	ECONO VENT PRESS CONTROL VALVE
PCV-3B	ECONO VENT PRESS CONTROL VALVE

A	TOP FILL
B	BOTTOM FILL/ PRODUCT WITHDRAWAL
C	AUX. LIQ
E	LOWER LIQ. LEVEL
F	UPPER LIQ. LEVEL
G	FULL TRYCOCK/VENT
H	DUAL RELIEF



OPTIONAL VACUUM JACKETED AUX LIQ WITHDRAWAL

TAG DEFINITION	
C-3	CONNECTION, SEC. AUX. LIQUID
C-4	CONNECTION, SEC. AUX. VAPOR
CV-1	FILL LINE CHECK VALVE
CV-3	ECONOMIZER CHECK VALVE
FC-1	FILL CONNECTION
HCV-1	BOTTOM FILL VALVE
HCV-2	TOP FILL VALVE
HCV-3	PB INLET VALVE
HCV-4	FULL TRYCOCK/VENT VALVE
HCV-5	VACUUM GAUGE TUBE VALVE
HCV-7	FILL LINE DRAIN VALVE
HCV-8	LI-1 VAPOR PHASE VALVE
HCV-9	LI-1 EQUALIZATION VALVE
HCV-10	LI-1 LIQUID PHASE VALVE
HCV-11	PB OUTLET VALVE
HCV-13	PRODUCT SUPPLY VALVE
HCV-15	SAFETY RELIEF SELECTOR VALVE
HCV-18	AUX. LIQUID VALVE
LI-1	LEVEL INDICATOR, INNER VESSEL
PBC-1	PRESSURE BUILD COIL
PCV-1	PRESSURE CONTROL VALVE
PI-1	PRESSURE INDICATOR GAUGE
PSE-1A	PRESSURE SAFETY ELEMENT, INR
PSE-1B	PRESSURE SAFETY ELEMENT, INR
PSV-1A	PRESSURE SAFETY VALVE, INR
PSV-1B	PRESSURE SAFETY VALVE, INR
S-1	STRAINER, PRESSURE BUILDING
S-2	FILL STRAINER
TSV-2	FILL LINE THERMAL RELIEF
TSV-3	VAPORIZER THERMAL RELIEF VALVE
TSV-4	PB CIRCUIT THERMAL RELIEF VALVE
TT-1	TELEMETRY TAP, VAPOR PHASE
TT-2	TELEMETRY TAP, LIQUID PHASE
VP-1	VACUUM PORT
VR-1	VACUUM READOUT
VAP	PRODUCT WITHDRAWAL VAPORIZER
VAP-1	PRE VAP

CHART P/N20679113 REV - CHART IND., NEW PRAGUE, MN 56071

NOTES:

1.) LABEL SHOWN ACTUAL SIZE
2.) CHARACTERS NOT TO BE TYPED
3.) ALL CHARACTERS TO BE APPROXIMATE STYLE AND SIZE.
4.) ALL CHARACTERS TO BE BLACK ON 2 MIL WHITE MYLAR, LAMINATED WITH 2 MIL CLEAR MYLAR.

THIRD ANGLE PROJECTION

Material Required
SEE B.O.M. UNLESS OTHERWISE STATED

VISIT US AT CHARTINDUSTRIES.COM
OEM PARTS AT CHARTPARTS.COM

	APPROVED	DATE
DRAWN BY	TJS	6/11/13
CHK'D BY	DA	6/16/13
PROJ. ENGR.	TBS	6/14/13
QUAL. CONT.	CPL	6/13/13
MFG. ENGR.	RC	6/14/13
MFG. SERV.	RB	6/13/13

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES.
TOLERANCES:
FRACTIONS ± 1/16
ANGLES ± .01°
2 PLACE DECIMALS ± .01
3 PLACE DECIMALS ± .005

REV	ECR NO	DESCRIPTION	BY	DATE

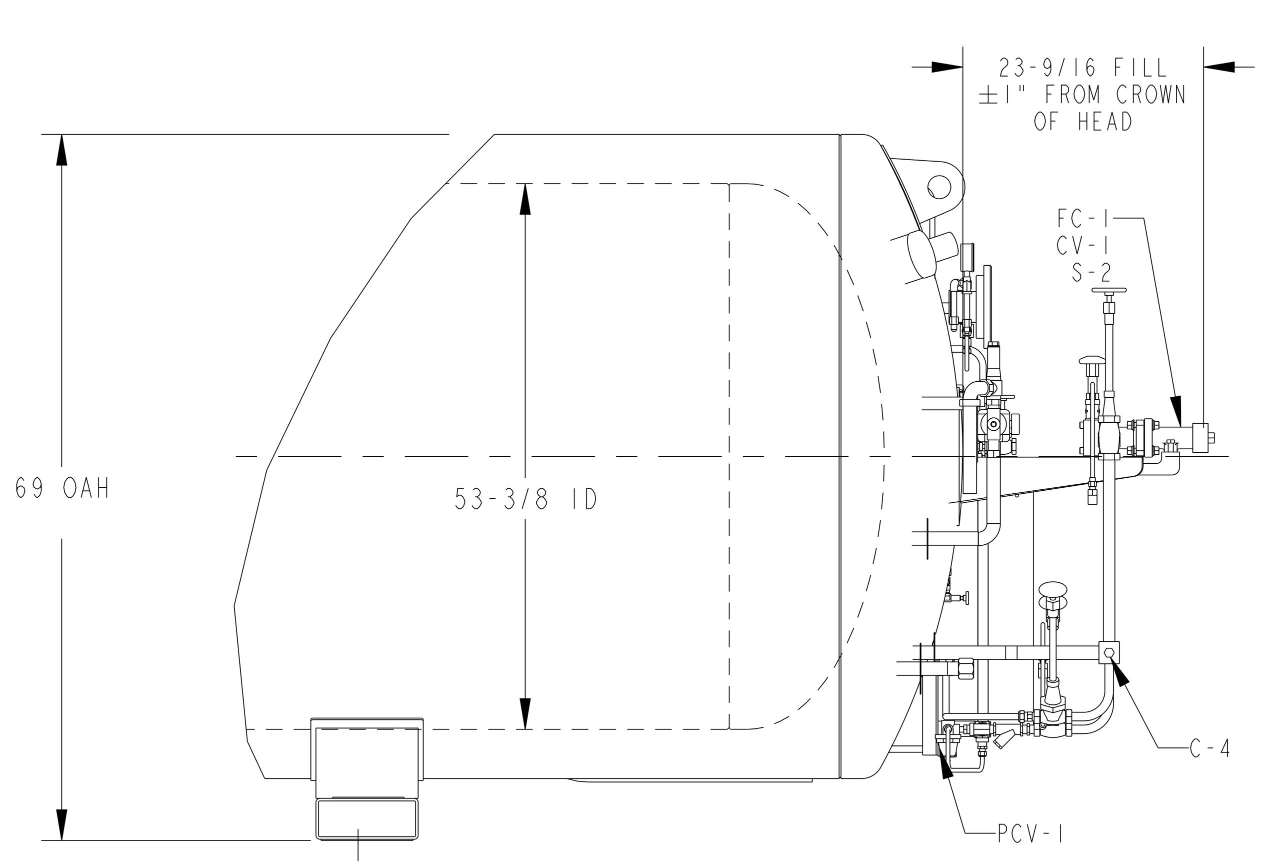
CHART — Distribution & Storage, New Prague Operations
Innovation. Experience. Performance.®

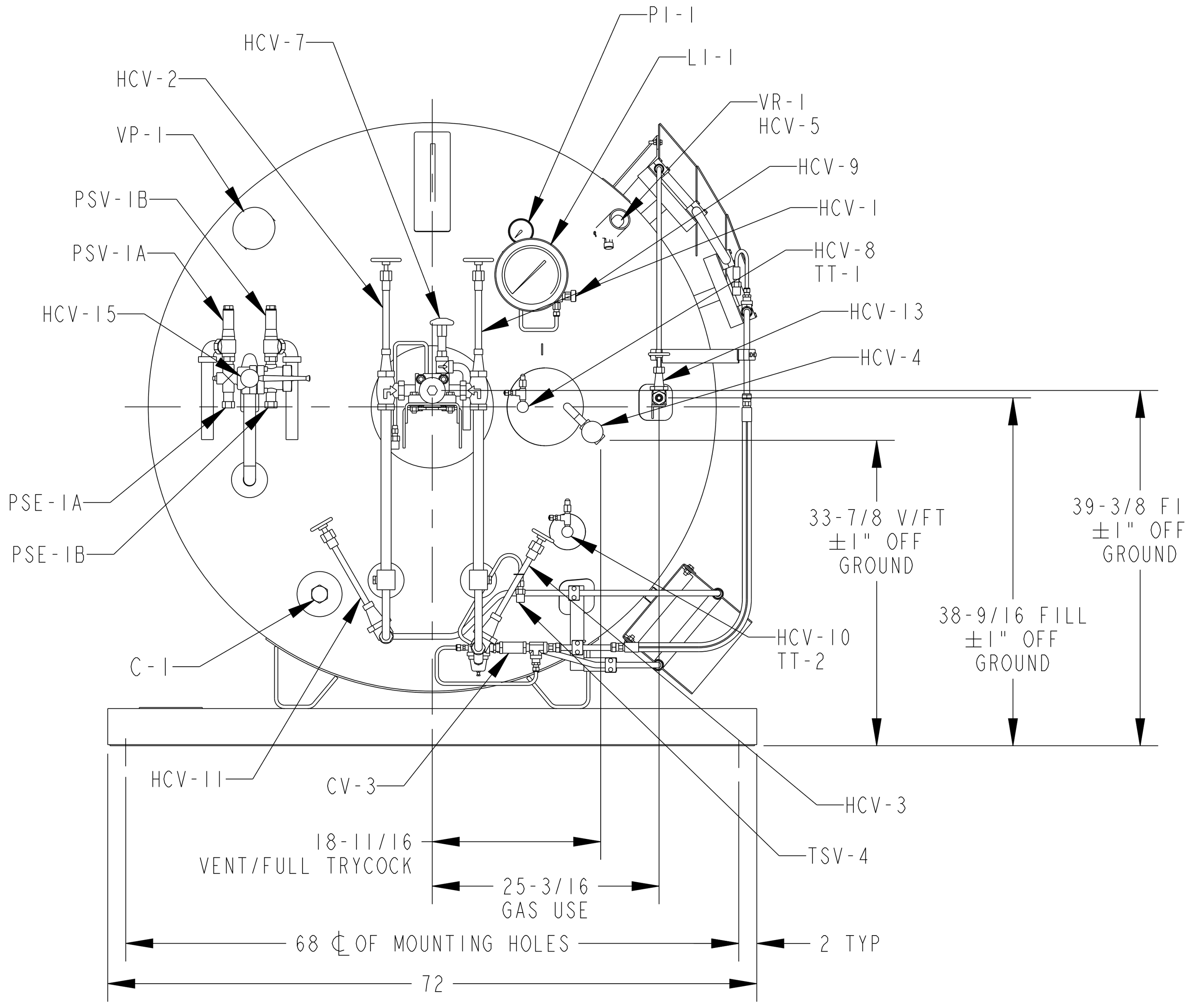
TITLE: SCHEMATIC BL-1400 AUX LIQUID WITHDRAWAL

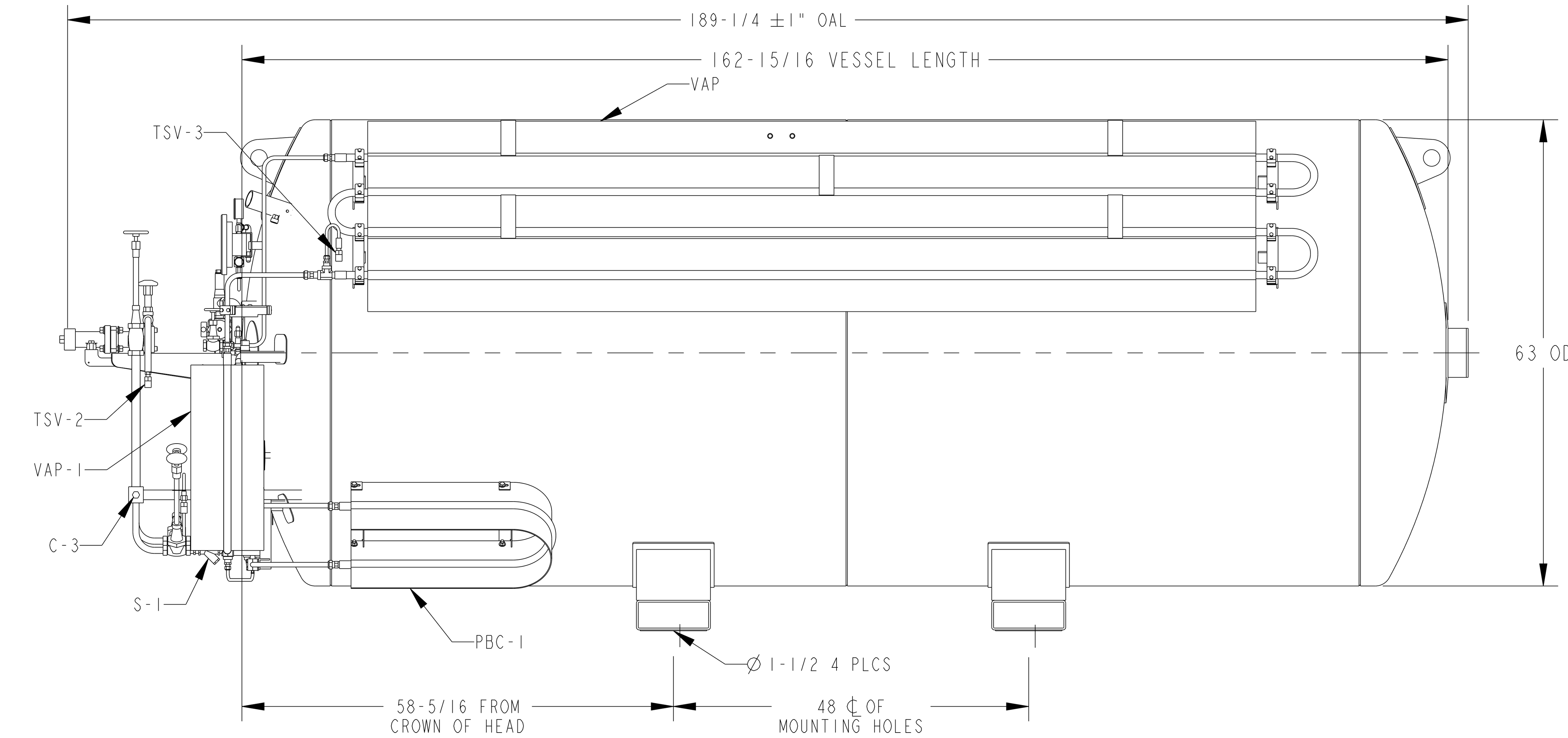
DRAWING NUMBER: C-20679113 | Rev -

SCALE: FULL | PART NUMBER: 20679113 | SHEET: 1 OF 1

DRAWING NUMBER D-20660271





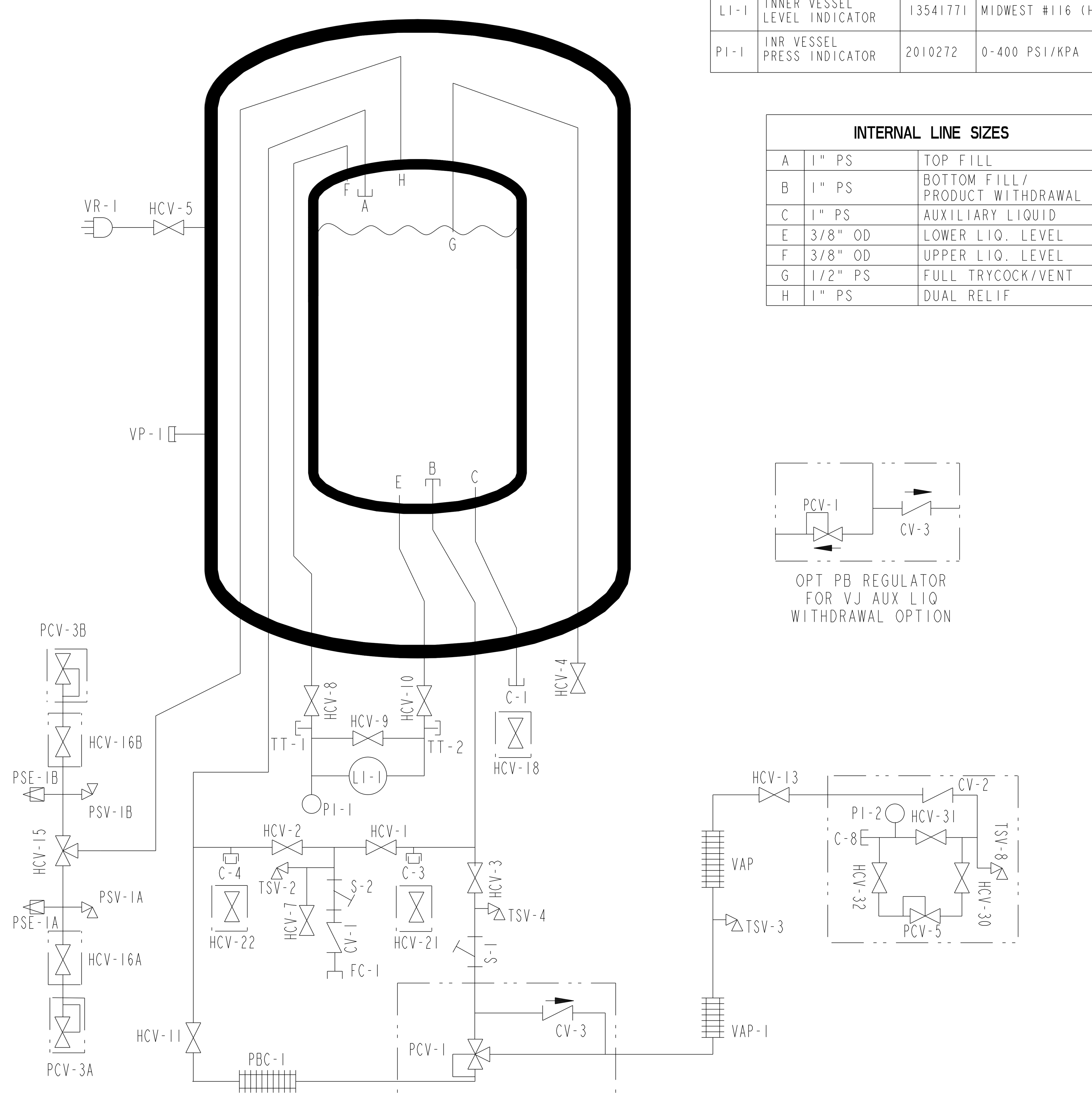


INNER VESSEL LEVEL INDICATOR OPTIONS

TAG	DEFINITION	CHART NO	VENDOR INFORMATION
HCV-9	LI-1 EQUALIZATION VALVE	10907239	REGO SUPPLIED W/MIDWEST
LI-1	INNER VESSEL LEVEL INDICATOR	13541771	MIDWEST #116 (HS-6TON)
PI-1	INR VESSEL PRESS INDICATOR	2010272	0-400 PSI/KPA

INTERNAL LINE SIZES

A	1" PS	TOP FILL
B	1" PS	BOTTOM FILL/ PRODUCT WITHDRAWAL
C	1" PS	AUXILIARY LIQUID
E	3/8" OD	LOWER LIQ. LEVEL
F	3/8" OD	UPPER LIQ. LEVEL
G	1/2" PS	FULL TRYCOCK/VENT
H	1" PS	DUAL RELIF



OPT PB REGULATOR FOR VJ AUX LIQ WITHDRAWAL OPTION

PIPING LEGEND

TAG	DEFINITION	CHART NO	VENDOR INFORMATION	SIZE
C-1	CONNECTION, AUX LIQUID			1" MPT
C-3	CONNECTION, SECONDARY AUX LIQUID			1" FPT
C-4	CONNECTION, SECONDARY AUX VAPOR			1" FPT
CV-1	FILL LINE CHECK VALVE	11827441	REGO #TCV8512 R	1-1/2" NPS
CV-3	ECONOMIZER CHECK VALVE	20630368	GENERANT #CV-503B-T-8	1/2" FPT
FC-1	FILL CONNECTION	10821005 10821013 10821021	CGA LIN (ACCESSORY NUMBER) CGA LOX (ACCESSORY NUMBER) CGA LAR (ACCESSORY NUMBER)	1-1/2 CGA
HCV-1	BOTTOM FILL VALVE	11827441	REGO #BKA9408	1" NPS
HCV-2	TOP FILL VALVE	11827441	REGO #BKA9408	1" NPS
HCV-3	PB INLET VALVE	11827441	REGO #BK9404	1/2" NPS
HCV-4	FULL TRYCOCK VALVE/VENT	1713922	REGO #B206LL-4T6	1/2" FPT
HCV-5	VACUUM GAUGE TUBE VALVE	10482381	HOKE 4111L2B	1/8" FPT
HCV-7	FILL LINE DRAIN VALVE	11827441	REGO #BK9450	3/8" FPT
HCV-8	LI-1 VAPOR PHASE VALVE	10907239	REGO #CMM250A	1/4" MPT
HCV-10	LI-1 LIQUID PHASE VALVE	10907239	REGO #CMM250A	1/4" MPT
HCV-11	PB OUTLET VALVE	11827441	REGO #BK9404	1/2" NPS
HCV-13	PRODUCT SUPPLY VALVE	1713922	REGO #B206LL-4T6	1/2" FPT
HCV-15	SAFETY RELIEF SELECTOR VALVE	10975557	HEROSE #DN20 PN45	1" NPS
PBC-1	PRESSURE BUILD COIL	11657534	CHART SUPPLIED	1/2" FPT
PCV-1	PRESS CONTROL VALVE	10931061	CASH ACME VALVE #23110-0120 SPRING #12108	1/4" FPT
PSE-1A PSE-1B	PRESSURE SAFETY ELEMENT, INNER	11509339	BS&B (375 PSI)	3/4" MPT * FREE
PSV-1A PSV-1B	PRESSURE SAFETY VALVE, INNER	11494835	HEROSE #06388-1006-6046	3/4" MPT * 1" FPT
S-1	STRAINER, PRESSURE BUILDING	11827441	UNITED BRASS 600# WOG	1/2" FPT
S-2	STRAINER, FILL	11827441	REGO FILL STRAINER	
TT-1	TELEMETRY TAP VAPOR PHASE	10501263	PARKER A-LOK #4MSC4N-B	1/4" OD
TT-2	TELEMETRY TAP LIQUID PHASE	10501263	PARKER A-LOK #4MSC4N-B	1/4" OD
TSV-2	FILL LINE THERMAL RELIEF	1810802	REGO #PRV9432T400	1/4" MPT
TSV-3	VAPORIZER THERMAL RELIEF VALVE	1810802	REGO #PRV9432T400	1/4" MPT
TSV-4	PB CIRCUIT THERMAL RELIEF VALVE	1810802	REGO #PRV9432T400	1/4" MPT
VAP	PRODUCT WITHDRAWAL VAPORIZER	20649210	CHART SUPPLIED	1" OD
VAP-1	PRODUCT WITHDRAWAL VAPORIZER 90D	20646574	CHART SUPPLIED	1" OD
VP-1	VACUUM PORT	10826172	CHART SUPPLIED	3-1/2" NPS
VR-1	VACUUM READOUT	4210049	HASTINGS #DV-6R	
OPTIONAL ON TANK				
C-8	CONNECTION, CUSTOMER HOUSELINE			PER ORDER
CV-2	HOUSELINE CHECK VALVE			PER ORDER
HCV-16A	RELIEF LINE PURGE VALVE	10907239	REGO	PER ORDER
HCV-16B	RELIEF LINE PURGE VALVE	10907239	REGO	PER ORDER
HCV-18	AUX LIQUID VALVE		REGO OR CVI	PER ORDER
HCV-21	SEC AUX LIQUID VALVE		REGO	PER ORDER
HCV-22	SEC AUX VAPOR VALVE		REGO	PER ORDER
HCV-30	INLET HOUSELINE VALVE			PER ORDER
HCV-31	BYPASS HOUSELINE VALVE			PER ORDER
HCV-32	OUTLET HOUSELINE VALVE			PER ORDER
PCV-1	PRESS CONTROL VALVE	20693498	CASH ACME #19077-A32 @30PSI SPRING # 4765	1/4" FPT
PCV-3A	ECONO VENT PRESS. CONTROL VALVE	20693498	CASH ACME #7335-FRM @45 PSI SPRING #4765	1/4" FPT
PCV-3A	ECONO VENT PRESS. CONTROL VALVE	20693498	CASH ACME #7335-FRM @45 PSI SPRING #4765	1/4" FPT
PCV-5	HOUSELINE PRESS. CONTROL VALVE			PER ORDER
PI-2	HOUSELINE PRESSURE GAUGE			PER ORDER
TSV-8	HOUSELINE THERMAL RELIEF VALVE		REGO	1/4" MPT

INNER VESSEL DESIGN DATA

MODEL:		BL-1400
MAWP:	PSIG	250
	barg	17.24
DESIGN PRESSURE	PSIG	272.4
	barg	18.78
CODE COMPLIANCE: ASME CODE CASE 2596		
DESIGN TEMPERATURE	°F	-320° TO 120°
	°C	-196° TO 49°
MATERIAL OF CONSTRUCTION: SA240 304 STAINLESS STEEL		
OUTER VESSEL DATA		
CODE COMPLIANCE: FULL VACUUM PER CGA-341		
DESIGN TEMPERATURE	°F	-20° TO 300°
	°C	-29° TO 149°
MATERIAL OF CONSTRUCTION: A36 CARBON STEEL		
INSULATION TYPE: VACUUM AND MULTILAYER INSULATION		
EVACUATION CONNECTION: 3-1/2" PUMPOUT PORT		
VACUUM GAUGE CONNECTION: HASTINGS DV6R		
BUILDING CODE: DESIGNED FOR CURRENT BUILDING CODE SEE CHART POLICY #NP-180		

WEIGHTS AND SHIPPING DATA

MODEL:			BL-1400
MAWP	PSIG		250
	barg		17.24
WEIGHT EMPTY	POUNDS		4,900
	KILOGRAMS		2,223
WEIGHT FULL	OXYGEN	POUNDS	18,100
		KILOGRAMS	8,210
	NITROGEN	POUNDS	14,200
		KILOGRAMS	6,441
	ARGON	POUNDS	21,000
		KILOGRAMS	9,526
SHIPPING DIMENSIONS	INCHES		190 X 73 X 70
	MM'S		4,826 X 1,854 X 11,778

CAPACITIES

MODEL:			BL-1400
CAPACITY	GROSS	GALLONS	1,380
	(COLD)	LITERS	5,193
	NET	GALLONS	1,320
	(COLD)	LITERS	4,997
GASES EQUIVALENT AT 1 ATM AND 70°F/ 1 ATM AND 0°C	OXYGEN	SCF	152,000
		NM3	3,995
	NITROGEN	SCF	123,000
		NM3	3,232
	ARGON	SCF	148,500
		NM3	3,903

THIRD ANGLE PROJECTION

Material Required
SEE B.O.M. UNLESS OTHERWISE STATED

VISIT US AT CHARTINDUSTRIES.COM
OEM PARTS AT CHARTPARTS.COM

APPROVED		DATE
DRAWN BY	TJS	1/9/13
CHK'D BY	JSG	1/10/13
PROJ. ENGR.	TAB	1/10/13
QUAL CONT.	CPL	1/10/13
MFG. ENGR.	RC	1/10/13
MFG. SERV.	JKR	1/10/13

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

REV	ECR NO	DESCRIPTION	BY	DATE
B	15388	ADDED VJ AUX LIQ INFO	TJS	6/14/13
A	15229	ADDED AUX LIQ LINE	TJS	2/12/13

CHART — Distribution & Storage, New Prague Operations. Innovation. Experience. Performance.®

TITLE: P&ID BL-1400SS-250CS

DRAWING NUMBER: D-20660271 | Rev B

SCALE: 1/16"=1" | PART NUMBER: 20660271 | SHEET: 1 OF 1

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