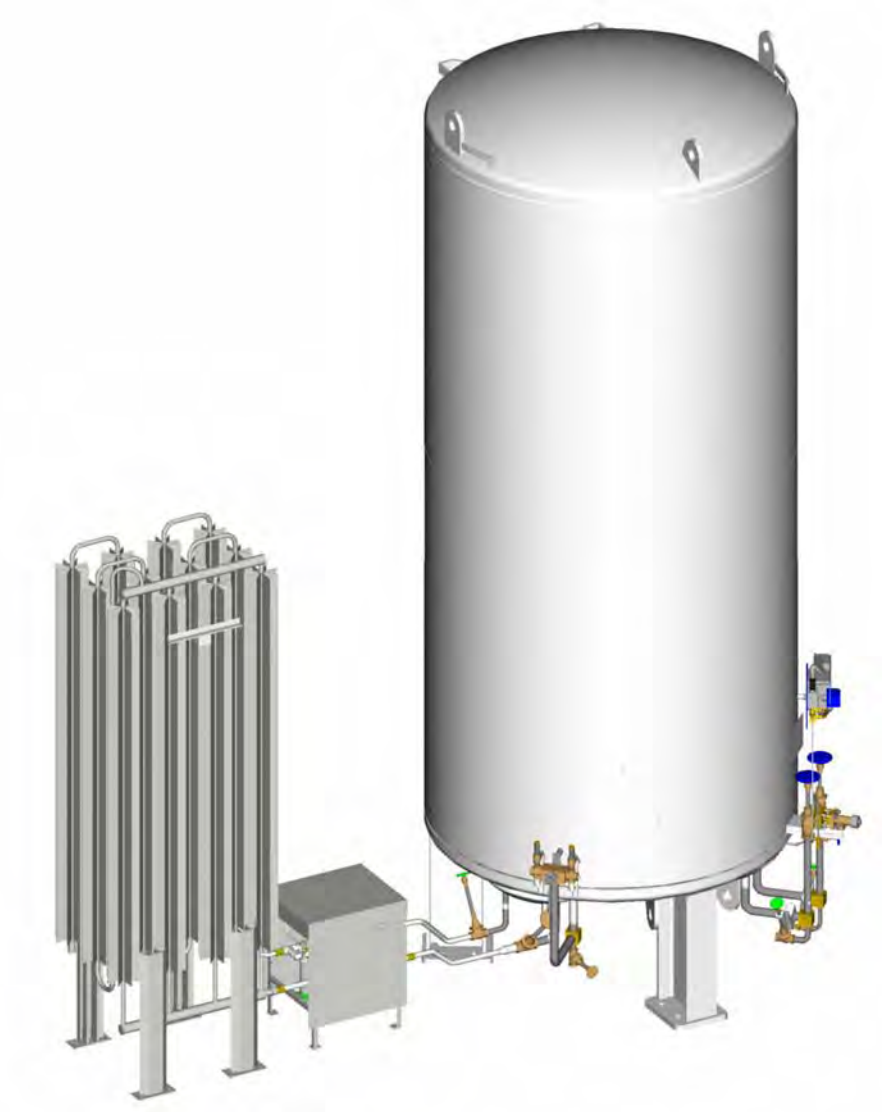
TECHNICAL MANUAL
HP^2 System



CHART

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Chapter 1

1 SAFETY

1.1 GENERAL

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

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

Incidents, which require that such practices be followed, include: highway accidents, impacts that might have caused damage to the outer or inner vessels, supports, plumbing or insulation, immersion of a container in water, exposure to extreme heat or fire, and exposure to most adverse weather conditions (earthquake, tornadoes, etc.) As a rule of thumb, whenever a container is suspected of abnormal operation, or has sustained actual damage, good safety practices must be followed.

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

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

The remainder of this safety bulletin addresses some adverse environments that may be encountered when a cryogenic container has been severely damaged and several safety issues related to cryogenics and gases.

1.2 OXYGEN DEFICIENT ATMOSPHERES

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

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

Human exposure to atmosphere containing 12% or less oxygen leads to rapid unconsciousness. Unconsciousness can occur so rapidly that the user is rendered essentially helpless. Oxygen deficiency can occur by a rapid change of environment or through the gradual depletion of oxygen.

Most individuals working in or around oxygen deficient atmospheres rely on the "buddy system" for protection - obviously, the "buddy" is equally susceptible to asphyxiation if he or she enters the area to assist the unconscious partner unless equipped with a portable air supply. Best protection is obtainable by equipping all individuals with a portable supply of respirable air. 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:

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

1.3 OXYGEN ENRICHED ATMOSPHERES

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

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

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

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

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

1.4 NITROGEN AND ARGON

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

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

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

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

1.5 PRESSURE VESSEL USE

This vessel is can be used to store and dispense gaseous or liquid nitrogen, oxygen and argon under pressures up to 400 psig (27.6 bar) or 500 psig (34.5 bar), depending upon the model. The tank is designed and built in accordance with ASME Sect. VIII Div 1 and should not be used in any manner that exceeds the specifications or guidelines set by Chart Industries, ASME, or local codes.

1.6 EXTREMELY COLD TEMPERATURES

The contents of this tank can be extremely cold, as cold as –320^{o} F or –196^{o} C. Contact with cryogenic liquid or cold gases can cause injury or damage and must be avoided. Proper equipment, accessories, and protective clothing suitable for extremely cold temperatures, including hand and eye or face protection, should be used when operating this tank.

1.7 HIGH PRESSURE

The pressure inside this tank can be as high as 400 psig (27.6 bar) or 500 psig (34.5 bar), depending upon the model. Use care to prevent damage to the tank or to prevent a dangerously rapid release of pressure. Completely empty and depressurize the tank before attempting to service the tank or its components that are not isolated from the tank or pressure. NEVER plug or in any way restrict the pressure-relief safety devices and NEVER replace any safety device with a safety device not approved for this tank.

1.8 OXYGEN CLEANLINESS

Only use equipment and replacement parts, which are compatible with oxygen and have been cleaned for oxygen use. Do not use parts, which have been previously used with compressed air or carbon dioxide.

1.9 QUALIFIED SERVICE

Only professionals, who are fully qualified with cryogenic pressure vessels, gases, and all pertinent safety procedures, should install and/or service this equipment. Filling cryogenic pressure vessels should only be performed by qualified professionals following locally approved procedures and using approved equipment.

1.10 MATERIAL SAFETY DATA SHEETS

All persons using this equipment should be familiar with and have access to a copy of the "Material Safety Data Sheet" (MSDS) for the gas to be stored in this tank. Copies of MSDS sheets are available from the gas supplier.

NOTE:

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

Chapter

2

2 VESSEL INFORMATION

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

2.1 RECEIVING CHECKPOINTS

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

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

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

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

5. Check pressure within vessel using the temporary pressure gauge located on the phase line. If pressure is zero, additional precautions against contamination and impurities must be taken.

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

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

2.2 VACUUM CHECK PROCEDURE

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

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

2. Remove the rubber cap on probe outlet to expose contact. Note, the probe housing need not be opened to do this.

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

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

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

6. Verify that the isolation valve is closed.

7. Replace the rubber probe cap.

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

2.3 PHYSICAL DESCRIPTION

A Chart bulk cryogenic storage and supply system is designed for long-term storage of cryogenic liquefied gases under pressure in the range of 5 psi (0.4 kg/cm^2) to the MAWP (Maximum Allowable Working Pressure). Operation of the system can be fully automatic with the unit's pressure regulatory system set to maintain preset pressure and flow conditions into a customer's gas supply 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 according to U.S. specifications meet the requirements of CGA Pamphlet S1.3, "Pressure Relief Device Standards, Part 1, for Stationary Vessels."

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

Controls Used To Operate The System Are Normally Mounted Under And On The Sides Of The Customer Station. The Pressure And Liquid Level Gauge / Instrumentation Is Located At Eye Level On The Container For Ease Of Viewing.

2.4 THEORY OF OPERATION

2.4.1 PREFACE

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

HP² is a system and consists of three integrated primary components: a high-pressure bulk tank equipped with Tank-Tel and a programmable logic controller (PLC), a plumbing-control module, and a multi-function vaporizer.

Unique to the HP² system is its pressure control technology. Unlike traditional bulk tanks, the pressure is not controlled by mechanical spring-operated regulators. In place of a pressure building regulator and an economizer regulator, the HP² system uses the Tank-Tel, the PLC and dual pneumatically actuated ball valves located in the plumbing module. In simple terms, the Tank-Tel is the eyes and ears of the system; it senses pressure and contents and relays this information to the PLC. The PLC is the brains; its program determines which valves need to be opened or closed and sends the appropriate commands to the valves. The ball valves are the muscles; they open and close according to the operating mode and the pressure and contents status of the tank. The HP² system's improved pressure control technology produces faster responsiveness, greater pressure control precision, easier and faster pressure adjustment, and greater reliability.

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

2.4.2 OPERATING FUNCTIONS

Many of the operating functions of the HP² system are similar those of other conventional cryogenic vessels, such as filling or venting. This portion of the manual will, therefore, only discuss those functions, which are unique to the HP² system.

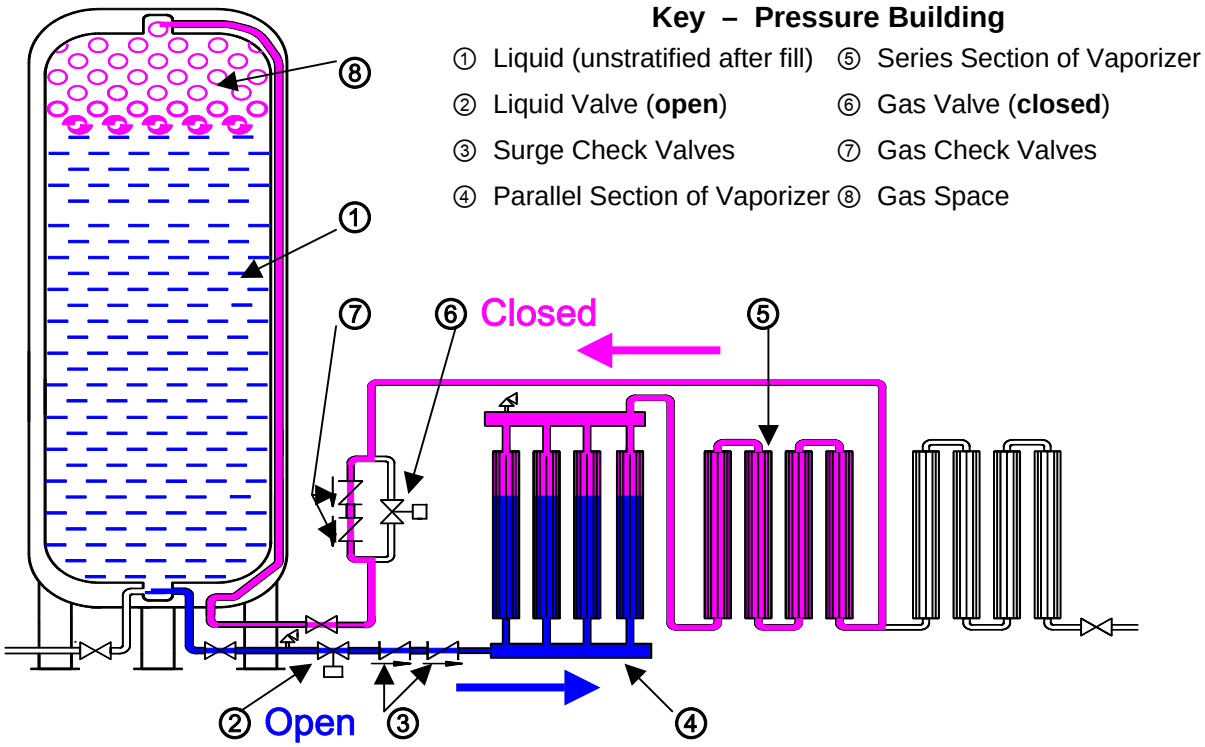
After filling the HP² tank and prior to beginning operation of the HP² system the pressure settings in the Tank-Tel must be adjusted in order for the system to operate properly. The liquid level alarms in the Tank-Tel may or may not be adjusted at the operator's election. (Consult the Tank-Tel manual for details.) Tank-Tel has three user selectable liquid level alarm settings and three pressure settings. Any of these six alarms / settings may be connected to activate either a telemetry alert (if present) or a local or remote alarm. Depending upon gas user and/or supplier preferences, the liquid level alarms may either be set to desired levels or left at their zero (0) default setting. Unlike the liquid level settings, it is essential that the pressure settings be adjusted as they control the operation of the pressure building and economizing functions. The highest pressure setting (high PB set) turns off the pressure building

function (closes the liquid valve and opens the gas valve in the plumbing module). The second pressure setting (low PB set) turns on the pressure building function (opens the liquid valve and closes the gas valve). The third or lowest pressure setting is a user-definable pressure setting that can be used to operate an alarm or other control device. Its purpose is to alert the gas user that gas pressure is reaching a critical low pressure that may affect their application.

2.4.3 PRESSURE BUILDING (PB)

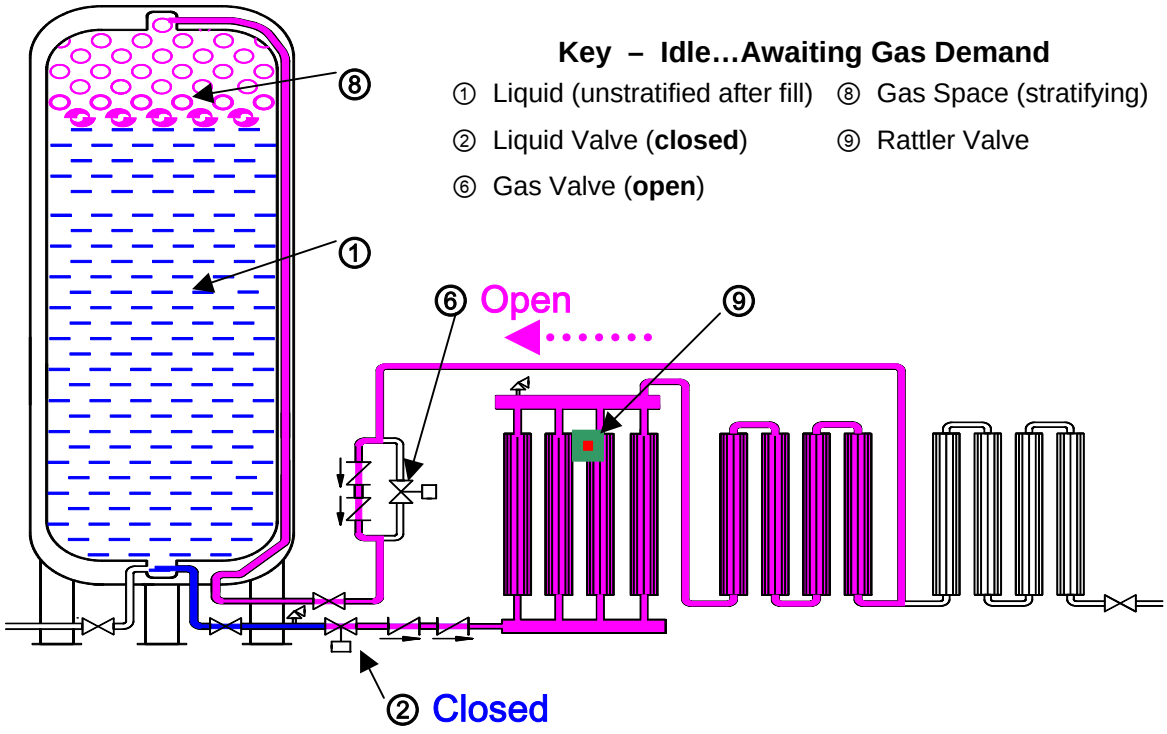
Prior to filling or refilling an HP² bulk tank, the pressure building (PB) system must be turned off and commonly the tank pressure must be vented or blown down to allow the transfer of the liquid cryogen into the tank. Typical tank pressure after filling will be 150 psig to 250 psig. Following filling if the tank pressure is below desired operating pressure the tank pressure must be rebuilt to the desired pressure. In a traditional HP bulk tank the rebuilding process will require one to two hours. In an HP2 system this process usually requires less than 10 minutes.

To rebuild pressure, either following a fill or during normal operation, power to the Tank-Tel and PLC must be turned ON. If the tank pressure is below the desired pressure (the "low PB" set pressure) the PLC commands the liquid valve in the plumbing module to open. When the liquid valve opens liquid first floods the parallel section of the multi-function vaporizer. In the parallel section, the liquid vaporizes and expands in surges (flashing), the surge check valve forces the flow through the first series section of the vaporizer and prevents the return of warm gas or liquid back into the bottom of the tank. In the series section the gas is more fully warmed and expanded. From the vaporizer the fully warmed gas passes through the check valves in the plumbing module and enters the vapor space of the tank. The pressure rises rapidly toward the desired operating pressure.



2.4.4 PB COMPLETE…AWAITING GAS DEMAND

When the tank pressure reaches the upper limit of operating pressure (the "high PB" set pressure), the Tank-Tel senses the pressure and alerts the PLC. The PLC commands the closure of the liquid valve, the opening of the gas valve and activates the "rattler valve" on the parallel section. The rattler valve helps shed any ice or snow build up that may have accumulated on the vaporizer during the PB operation. Any gas or liquid remaining in the vaporizer remains in the vaporizer or is passed through the check valves and into the tank's gas space. No warmed liquid or gas from the vaporizer is allowed to backflow into the bottom of the tank. The system is idle and awaits gas demand.

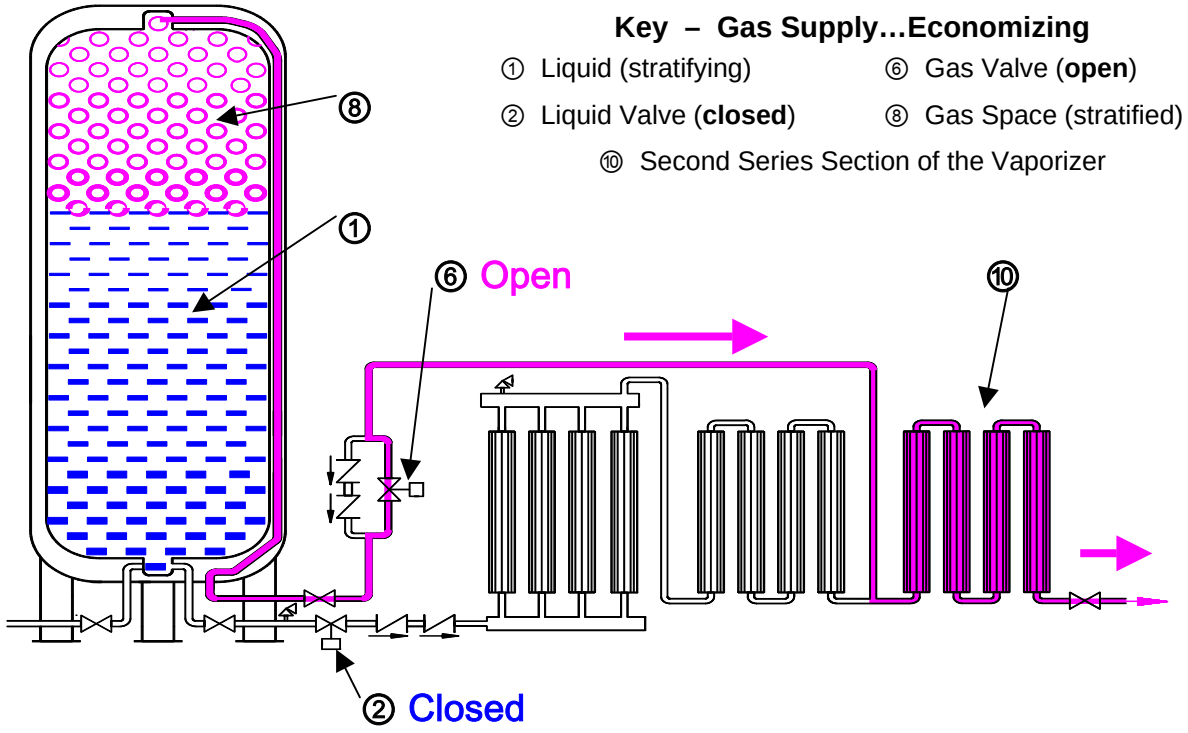


2.4.5 GAS USE…ECONOMIZING

Whenever gas is withdrawn and the tank pressure is above the set pressure at which pressure building normally starts, the HP² system operates in a form of "economizer" mode. In this phase of gas withdrawal the system first withdraws gas only from the gas space of the tank. The liquid valve is closed and the gas valve is open. One of the beneficial features of the HP² technology and the multi-function vaporizer is that it produces stratified gas in the gas space…the hottest and least dense gas is at the top and the coldest densest gas is next to the liquid. When the economizing mode is operating it is the hottest gas that is withdrawn first. In this way the HP² is both economizing by reducing the pressure in the gas space and optimizing the management of heat inside the tank.

As the warm gas is withdrawn from the gas space of the tank it is passed through the last section of the multi-function vaporizer, a second series section. The second series further warms the gas as it passes through and it exists the vaporizer at temperatures much closer to the ambient temperature than would result from comparable conventional vaporizers of the same rated flow capacity.

During the economizing and idle phases of the HP² system's operation the parallel and first series sections of the multi-function vaporizer are not in use and have an opportunity to warm, which improves overall vaporizer performance.

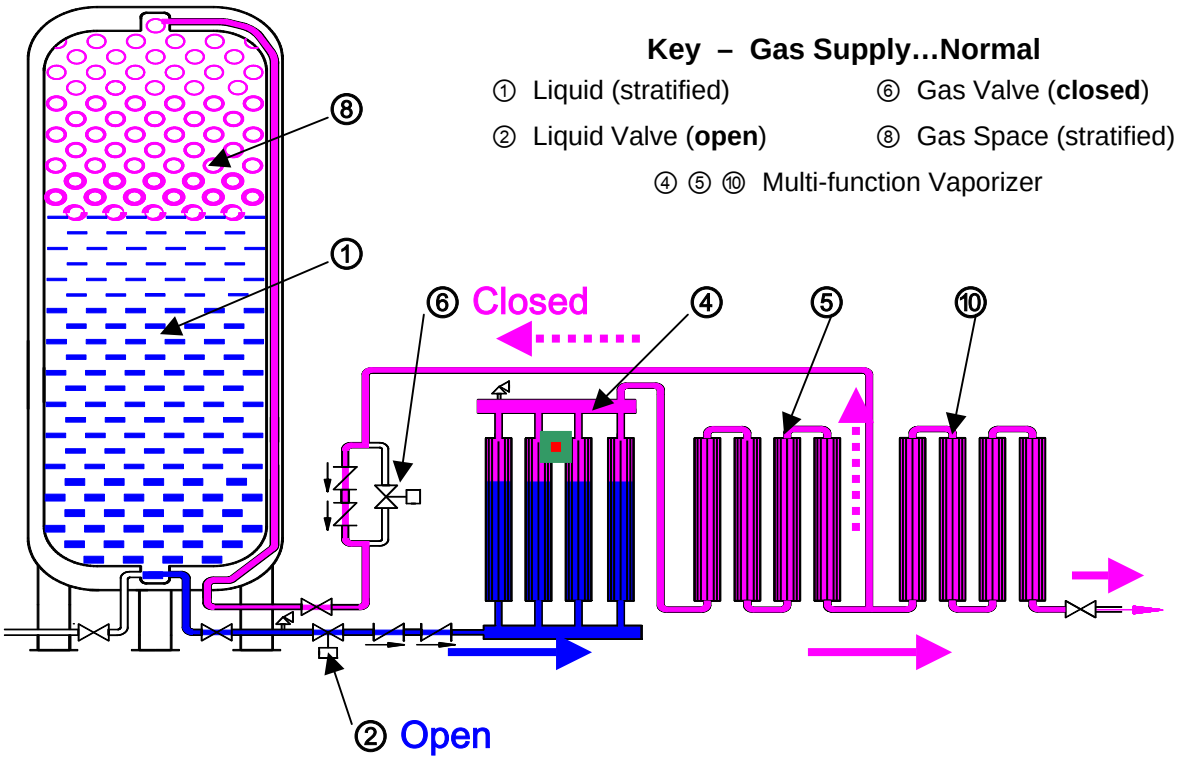


2.4.6 GAS USE…NORMAL

As gas withdrawal continues in the economizing mode, described above, the pressure in the tank drops until it reaches the set-pressure at which the pressure building system is activated. At this time the PLC commands the closure of the gas valve and the opening of the liquid valve. The gas supply is now more like a conventional gas supply with liquid being withdrawn from the tank, vaporized in the parallel section of the vaporizer and then warmed in the series sections of the multi-function vaporizer. The major difference between HP² and traditional high-pressure bulk tanks is that in HP² the gas produced by the vaporizer is supplying both the gas user's demand and maintaining the internal tank pressure. The multi-function vaporizer is sized to vaporize enough liquid to fulfill both these gas requirements, even at high pressures and high flows, as well as to adequately warm the gas.

When the pressure in the tank rises to the PB shut-off pressure, the liquid valve is closed and the gas valve is re-opened and the system returns to the economizing mode described above. In effect the HP² during sustained gas supply alternates between the economizing mode and the normal gas supply mode, depending upon the pressure in the tank. The frequency of the alternation is fundamentally a function of the gas flow rate and the differential in the pressure settings between the PB "on" setting and the PB "off" setting as set by the operator in the Tank-Tel. Operators can adjust the pressure settings to assure optimum performance based on their current application needs.

In the process of cycling between the economizing mode and the normal gas supply mode, the HP2 provides and opportunity for the parallel vaporize section to idle and warm up and for the rattler valve to activate and help the parallel vaporizer section shed ice and snow.

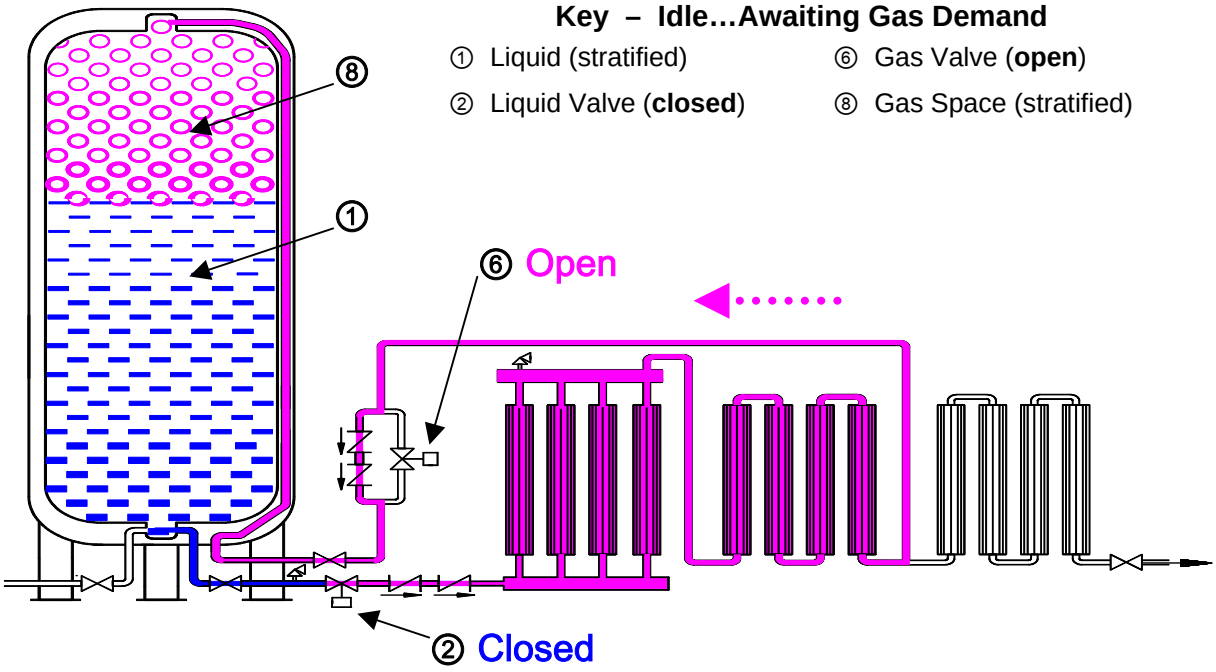


2.4.7 END OF GAS USE

When gas use is terminated, if there is no operator intervention, the HP² system will continue in whatever self-pressure-regulating mode of operation that it was in at the time gas withdrawal ceased. That is, if the tank was building pressure, it will continue to build pressure until it reaches the PB "off" set-pressure. If it was in the economizing mode, it will remain in this mode. The exception is that over time the much colder liquid in the tank will affected the warm gas above it. And unlike most traditional HP tanks the pressure in the gas space will start to decline as the gas condenses. The process helps insure that gas is not unnecessarily vented and wasted during brief periods of little or no gas use. However, if the tank pressure should decline to the level of the PB "on" pressure and the system is turned on, the PB cycle will automatically start and raise the pressure to the PB "off" pressure.

To conserve gas in the tank over longer periods of time (holidays, weekends, etc.), the operator can turn off the HP² system. In the off condition, the liquid valve will close and the gas valve will open (note, these are the normal power off positions). And, as described above, the warm gas will begin to cool and condense and cause the tank pressure to drop. However, in this situation the pressure building will not activate when the pressure reaches the low pressure set-pressure at which the PB would normally be initiated. This behavior allows the tank to sit idle for extended periods of time with little or no gas loss due to venting. And because of the HP² system's unique ability to rebuild pressure in a fraction of the

time required by a tradition high-pressure tank, high-pressure high-flow gas supply can be achieved quickly and easily after turning the system back on.



2.5 PRESSURE REGULATING SYSTEM

The pressure building (PB) system consists of an ambient air vaporizer and pneumatic actuated ball valves operated by a PLC, which interfaces with the Tank-Tel. When the tank pressure goes below the middle set pressure of Tank-Tel (Alarm-1), the liquid / PB ball valve will open. As a result, liquid will be able to flow through the vapor trap in the annulus of the bulk tank, through the tank's isolation valve, the HP^2 plumbing module and into the multi-function vaporizer to be vaporized and expanded. The expanded vapor accumulates in the inner tank gas space where it increases the tank pressure. The flow of liquid and expanded gas continues through the PB system until the inner tank pressure is equal to the high set-pressure on the Tank-Tel (Alarm-2). When the pressures are equal, the liquid ball valve is closed by the PLC and the gas ball valve is opened.

Opening the gas ball valve after achieving the desired high pressure allows gas to be withdrawn from the top to the tank's gas space when gas supply occurs. Drawing gas from the gas space helps to reduce inner tank pressure and remove heat. This phase or mode of operation is often referred to as the economizing mode, because it helps prevent unwanted gas losses due to venting and thus economizes the gas supply.

This cycle between pressure building and economizing continues throughout the operation of the HP^2 system and automatically maintains tank pressure as required. It is important to note that the two set-pressures for starting and ending the pressure building process should be set above the desired pressure at which gas should be feed into the gas supply piping. The lower of the two pressures, which activates the

PB mode (Alarm 1) should be adjusted to approximately 10 psig to 20 psig above the desired operating pressure and the higher pressure (Alarm 2) should be a minimum of 10 psig above the first pressure.

2.6 OPERATOR QUALIFICATIONS

Chart cryogenic bulk tanks and systems, including the HP^2 system, are designed for safe and simple operation. The operator is expected to be knowledgeable of the nature of the gas(es) with which he is working, as well as all applicable operating and safety regulations and requirements and the contents of this manual. This manual contains several chapters dealing with safety, operating instructions, handling instructions, and maintenance procedures. To fully understand these procedures, we recommend the operator first become familiar with controls and instruments. Persons not meeting these basic qualifications should not operate these products.

3

3 CONTROL IDENTIFICATION & FUNCTION

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

For a list of controls and indicators and a flow diagram, see Process & Instrument Diagram in Chapter 8.

Table 1 Tank And Tank-Tel & PLC Subassembly Component Identification And Function

HP^2 TANK WITH TANK-TEL & PLC SUBASSEMBLY		
ITEM	**DESCRIPTION**	**FUNCTION**
C-3	Connection, secondary auxiliary liquid	Alternative bottom fill or liquid withdrawal
C-4	Connection, secondary auxiliary gas	Alternative top fill or gas withdrawal / vent
C-5	Connection, gas use	Traditional connection for external vaporizer for gas use (not used in HP^2)
C-6	Connection, economizer	Traditional connection for economizer function during gas use (not used in HP^2)
C-7	Connection, pressure building gas return	Traditional connection for pressure building vapor return (not used in HP^2)
C-8	Connection, pressure building liquid feed / auxiliary liquid	Traditional connection for pressure building liquid feed (not used in HP^2) and auxiliary liquid withdrawal
CV-1	Check Valve, fill	Prevents back flow of liquid or gas
FC-1	Connection for bottom and/or top filling	Fitting for attachment of transfer hose for bottom and/or top filling
HCV-1	Valve, bottom fill	Manually controls bottom filling
HCV-2	Valve, top fill	Manually controls top filling
HCV-3	Valve, PB feed / auxiliary liquid	Manually controls liquid flow (Traditional valve to control PB feed – not used in HP^2)
HCV-4	Valve, trycock	Manually controls venting from trycock for filling or venting
HCV-5	Valve, vacuum gauge tube	Manually controls vacuum gauge access to vacuum space
HCV-7	Valve, fill line drain	Manually controls purging and draining of fill line and hose
HCV-8	Valve, vapor phase / low-pressure line for Tank-Tel	Manually isolates low-pressure vapor line to Tank-Tel for service

Table 1 continues on next page.

Table 1 continued.

ITEM	DESCRIPTION	FUNCTION
HCV-10	Valve, liquid phase / high-pressure line for Tank-Tel	Manually isolates high-pressure liquid line to Tank-Tel for service
HCV-11	Valve, PB vapor return / auxiliary vapor	Manually controls access to vapor space (Traditional valve to control PB vapor return – not used in HP^2)
HCV-12	Valve, vapor vent	Manually controls venting of gas
HCV-15	3-Way Valve, safety relief selector	Manually controls selection of one or both safety relief assemblies
HCV-16A	Valve, safety line purge	Manually controls purging of safety line and flow of gas to pneumatic actuator system when connected
HCV-16B	Valve, safety line purge	Manually controls purging of safety line and flow of gas to pneumatic actuator system when connected
HCV-18	Valve, auxiliary liquid	Manually controls liquid supply for pressure building and gas supply
HCV-19	Valve, vapor return	Manually controls vapor return during pressure building and gas supply during economizing
PCV-1	Pressure Regulator, pneumatic system	Controls pressure to pneumatic system for actuating pneumatic valves and rattler valve
PSE-1A	Pressure Safety Element (Burst Disc)	Protects inner pressure vessel against over-pressurization
PSE-1B	Pressure Safety Element (Burst Disc)	Protects inner pressure vessel against over-pressurization
PSV-1A	Pressure Safety Valve (Safety Relief Valve)	Protects inner pressure vessel against over-pressurization
PSV-1B	Pressure Safety Valve (Safety Relief Valve)	Protects inner pressure vessel against over-pressurization
S-1	Strainer, liquid	Prevents entry of particulates into auxiliary liquid withdrawal
SOL-1	Electric Solenoid, pneumatic system	Controls flow of gas to rattler valve and gas accumulator
TSV-2	Thermal Relief Valve, fill line	Protects against over-pressurization in fill line
TSV-4	Thermal Relief Valve, auxiliary liquid line	Protects against over-pressurization in auxiliary liquid line
VP-1	Vacuum Port with safety device	Access to vacuum space and protects against over-pressurization of annual space
VR-1	Vacuum Readout (Thermo-Couple)	Connection for reading vacuum status

Table 1 continues on next page.

Table 1 continued

ITEM	DESCRIPTION	FUNCTION
TANK-TEL & PLC SUBASSEMBLY		
HCV-9	5-Way Valve, Tank-Tel	Manually isolates and allows equalization of phase line pressure to Tank-Tel for service
LI-1	Liquid Level Indicator (integrated part of Tank-Tel)	Indicates current tank liquid level and allows adjustment of contents settings / alarms / units of measure • Setting "1A" – liquid level at which first alarm is activate • Setting "2A" – liquid level at which second alarm is activate (Remote alarms and/or telemetry system are optional or customer supplied accessories.)
PI-1	Pressure Indicator (integrated part of Tank-Tel)	Indicates current tank pressure and allows adjustment of pressure settings / alerts / units of measure • Setting "1A" – pressure at which pneumatic liquid valve opens and PB function starts (pneumatic vapor valve closes) • Setting "2A" – pressure at which pneumatic vapor valve opens and economizing function starts (pneumatic liquid valve closes) • Setting "3A" – optional setting which can be used to trigger an alarm or other device to warn of unwanted low or high pressure (Remote alarms and/or telemetry system are optional or customer supplied accessories.)
PLC-1	Programmable Logic Controller (PLC)	Analyzes inputs from Tank-Tel and provides activation commands to pneumatic valves and rattler valve
SW-1	Power Switch	Turns HP2 system "ON" and "OFF"
SI-1	Status Light	Indicates operating status of the HP^2 system ♦ Light off – system normal / no alarms ♦ Light flashing – re-order level alarm 1A activated ♦ Light on continuously – low level alarm 2A and/or critical pressure alarm 3A activated
EI-1	Economize Light	Indicates if economize function is active (pneumatic gas valve open and pneumatic liquid valve closed)
PBI-1	PB Light	Indicates if PB / pressure building function is active (pneumatic liquid valve open and pneumatic gas valve closed)

Table 2 Piping And Control Module Component Identification And Function

PIPING AND CONTROL MODULE		
ITEM	**DESCRIPTION**	**FUNCTION**
AAC-1	Pneumatic Pressure Accumulator Cylinder	Proves pressure to operate pneumatic valves and rattler valve
AOL-1	Pneumatic Valve, liquid	Automatically controls liquid feed to multi-function vaporizer for PB and/or gas supply
AOL-2	Pneumatic Valve, gas / vapor	Automatically controls vapor flow from or to multi-function vaporizer during PB or economizing
CV-4	Check Valve, liquid	Prevents unwanted backflow of liquid into the tank
CV-5	Check Valve, liquid	Prevents unwanted backflow of liquid into the tank
CV-6	Check Valve, gas / vapor	Prevents unwanted backflow of vapor out of the tank
CV-7	Check Valve, gas / vapor	Prevents unwanted backflow of vapor out of the tank
TSV-5	Thermal Safety Valve, liquid feed	Protects against over-pressurization in liquid feed line
TSV-6	Thermal Safety Valve, vapor return	Protects against over-pressurization in vapor return line

Table 3 Multi-Function Vaporizer Component Identification And Function

MULTI-FUNCTION VAPORIZR		
ITEM	**DESCRIPTION**	**FUNCTION**
AOR-1	Pneumatic Rattler Valve	Rattles parallel vaporizer section after each PB mode to shed snow and ice
C-10	Connection, gas use	Connection for gas supply in both normal and economizer modes
HCV-20	Valve, gas use (customer supplied)	Controls supply of gas to customer's gas supply piping network and gas-use equipment
TSV-7	Thermal Safety Valve, multi-function vaporizer	Protects against over-pressurization in multi-function vaporizer
VAP-1	Multi-Function Vaporizer	Vaporizes liquid and warms gas for pressure building and gas supply

Chapter

4

4 FILLING PROCEDURES

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

4.1 INITIAL FILL

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

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

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

2. The tank may be filled by pumping or pressure transfer. Pressure transfer can normally be used if the delivery vessel can sustain a pressure that is at least 50 psi (3.5 kg/cm^2) higher than the working pressure of the receiving tank. If the normal sustainable working pressure of the delivery vessel is equal to or less than the maximum allowable pressure of the receiving tank, then liquid must be pump transferred into the tank.

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

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

Tables 4 and 5 for purging and initial warm-tank fill procedures follow on the next pages.

4.2 REFILLING

The procedure for refilling an already cold tank follows in Table 3.

Table 6 for refilling follows in several pages.

Table 4 Vessel Purging Procedure

STEP NUMBER	Purging Procedure
	CAUTION The maximum purge pressure should be equal to not more than 50% 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. Insure the Tank-Tel has power to operate and is turned "ON".
1	Attach the source of liquid purge to the fill connection (FC-1).
2	Adjust the pressure settings on Tank-Tel as follows: pressure 2A at the maximum purge pressure and pressure 1A at least 10 psi below the maximum purge pressure.
3	Close all valves, except the Tank-Tel gauge vapor phase and liquid phase shutoff valves (HCV-8 & HCV-10), the 5-way valve (HCV-9 set to "normal") to the Tank-Tel, the auxiliary liquid valve (HCV-18) and vapor return valve (HCV-19).
4	Open hose drain valve (HCV-7), and allow cryogenic liquid from the supply tank to vent through hose. Vent until slight frosting appears on hose. Close hose drain valve (HCV-7).
5	Open vapor vent valve (HCV-12) to allow the pressure in the tank to drop below the pressure of the supply tank and below the pressure set on the Tank-Tel for Alarm 1A. Close the valve after the pressure has been reduced.
6	Open the bottom fill valve (HCV-1) enough to allow liquid to flow slowly into the tank through the bottom fill line. The gradual flow enables the liquid to vaporize in the line and the pressure building system and to 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-Tel pressure gauge (PI-1).
8	Open the fill line drain valve (HCV-7) slowly to avoid splashing of the liquid. Drain all liquid from the tank. The appearance of gas (vapor) at the drain indicates that all liquid has been drained.
9	Close drain valve (HCV-7) and bottom fill valve (HCV-1).
10	Set the pathway in the 5-way valve (HCV-9) to "equalization" to prevent damage to the Tank-Tel gauge. When all liquid is drained, close the liquid level gauge vapor phase and liquid phase shut-off valves (HCV-8 and HCV-10) to the 5-way valve (HCV-9).
	Continued on next page.

STEP NUMBER	Purging Procedure (continued)
11	Loosen the unions connecting the gauge lines to the 5-way valve (HCV-9). Both the liquid level gauge phase lines from the valves (HCV-8 & HCV-10) should be fully open 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.
12	Carefully check for moisture in the phase lines to the Tank-Tel gauge. Due to their small diameter, gauge lines are easily plugged by ice.
13	Open the vapor vent valve (HCV-12) and full trycock valve (HCV-4) to purge. The top fill valve (HCV-2) will have to be vented by opening hose drain valve (HCV-7). Close valves after purging.
14	Turn off power (SW-1) to the Tank-Tel to open the vapor return valve (AOL-2). Then open gas use valve (HCV-20) to purge last section of vaporizer. When purge is complete turn power on to Tank-Tel.
15	Repeat purge procedures 3 through 9 and 14 at least three times to ensure purity.
16	Reconnect 5-way valve (HCV-9 set to “equalization”) and Tank-Tel, open the Tank-Tel phase valves (HCV-8 & HCV-10), and set 5-way valve (HCV-9) to “normal”.
17	Readjust the Tank-Tel pressures to the desired operating pressures for the intended gas supply application.
18	After purging the tank, but before filling, verify that the following valves are open or closed as indicated. **Valve** — **Position** Bottom fill valve (HCV-1) — Closed Top fill valve (HCV-2) — Closed Vapor vent valve (HCV-12) — Closed Full trycock valve (HCV-4) — Closed 5-way valve (HCV-9) — Normal Tank-Tel gauge liquid phase valve (HCV-10) — Open Tank-Tel gauge vapor phase valve (HCV-8) — Open Auxiliary liquid valve (HCV-18) — Open Vapor return valve (HCV-19) — Open

Table 5 Initial Filling Procedure (Warm Tank)

STEP NUMBER	Initial Filling Procedure (Warm Tank)
1	Purge tank to assure product purity.
2	Verify that the contents of the supply tank are the proper product to be transferred.
3	Verify that all valves are closed, except liquid level / Tank-Tel gauge valves (HCV-8, HCV-10 and HPCV-9 to “normal”).

Continued on the next page.

Table 5 Initial Filling Procedure (Warm Tank) - **Continued**

STEP NUMBER	Initial Filling Procedure (Warm Tank) - Continued
4	Connect the supply tank transfer hose to receiving tank fill connection (FC-1). Cool down the transfer hose prior to filling by opening hose drain valve (HCV-7) and venting a portion of the supply tank contents through the hose for approximately three minutes. Close drain valve (HCV-7).
5	Open bottom fill valve (HCV-1) slowly. If a PRESSURE TRANSFER is to be made, allow pressure to build up in the liquid supply unit until it is at least 50 psi (3.5 kg/cm^2) higher than receiving tank pressure. Open the discharge valve on the supply tank to begin flow. -or- If a PUMP TRANSFER is to be made, make the required connections to the pump. Open the supply unit transport discharge valve slowly. Maintain pump discharge pressure from 50 psi (3.5 kg/cm^2) to 100 psi (7.0 kg/cm^2) higher than the tank pressure and use caution to assure the pressure in the receiving tank does not exceed it maximum allowable working pressure. Fill slowly.
6	Monitor pressure in tank during filling. If receiving tank pressure rises near the pressure of the supply source or the receiving tank relief valve pressure, the tank may have to be vented through the vapor vent valve (HCV-12), should pressure continue to rise, the fill may have to be interrupted to allow pressure to drop. -or- If air and moisture have been previously purged from the tank, it may be possible to partially re-condense the gas in the vapor space by either switching to top fill by open the top fill valve (HCV-2) and closing the bottom fill valve (HCV-1) for a period of time or by a throttled mix of top and bottom filling by a controlled opening of both the bottom and top fill valves (HCV-1 and HCV-2) until tank is approximately ¾ full.
7	Monitor Tank-Tel liquid level contents gauge (LI-1). When the gauge indicates approximately ¾ full, continue filling by bottom filling (open HCV-1) and open full trycock valve (HCV-4).
8	When liquid spurts from full trycock valve (HCV-4), immediately stop fill at the supply source and close full trycock valve (HCV-4).
9	Close bottom fill valve (HCV-1) and/or top fill valve (HCV-2).
10	Drain residual liquid in the fill hose via drain valve (HCV-7).
11	Relieve fill hose pressure by loosening the hose at fill connection, and then disconnect the hose. It is recommended that the fill hose be allowed to defrost to prevent moisture from being drawn inside the hose.

Table 6 Vessel Refilling Procedure (Cold Tank)

STEP NUMBER	Vessel Refilling Procedure (Cold Tank)
	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 the 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 (HCV-1 and HCV-2).
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 (FC-1).
6	Cool and purge the transfer hoses prior to filling by opening hose drain valve (HCV-7) and the supply unit discharge valve for approximately three minutes or until hose begins to frost. Close drain valve (HCV-7).
7	Open top fill valve (HCV-2) completely.
8	If a PRESSURE TRANSFER is to be made, allow pressure to build up in the liquid supply unit until it is at least 50 psi (3.5Kg/cm^2) higher than station pressure. Open the discharge valve on the supply unit to begin flow. -or- If a PUMP TRANSFER is to be made, make the required connections to the pump. Open the supply unit transport discharge valve slowly. Close pump circulating valve slowly, so as not to lose pump prime. Maintain pump discharge pressure from 50 psi (3.5 kg/cm^2) to 100 psi (7.0 kg/cm^2) higher than tank pressure.
9	Monitor pressure in vessel as indicated. If pressure begins to drop near the minimum operating pressure, begin to open bottom fill valve (HCV-1), and throttle top fill valve (HCV-2) until pressure stabilizes.
10	Monitor liquid level gauge (LI-1) on the Tank-Tel. When the gauge indicates approximately ¾ full, open full trycock valve (HCV-4).
11	When liquid spurts from full trycock valve (HCV-4), stop fill at the supply source and close full trycock valve (HCV-4).
12	Close tank fill valves (HCV-1 and HCV-2).
13	Drain residual liquid in the fill hose via drain valve (HCV-7).
14	Relieve fill hose pressure by loosening the hose at the fill connection, and then disconnect the hose

Chapter

5

5 WITHDRAWAL PROCEDURES

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

NOTE

When using the HP^2 system for gaseous service, the gas supply connection to the gas pipe line and the final line pressure regulating system should be made at the Gas Use connection on the outlet of the multi-function vaporizer and not on the gas use line of the tank.

5.1 GAS SUPPLY

Table 7 Gas Withdrawal Procedure

STEP NUMBER	Gas Withdrawal Procedure
1	Insure customer gas supply line and final line pressure regulating assembly are connected to gas use connection (C-10) on outlet of multi-function vaporizer.
2	Verify that all valves are closed, except Tank-Tel liquid phase (HCV-10) and gauge gas phase (HCV-8) valves and the "normal" pathway in 5-way valve (HCV-9), auxiliary liquid valve (HCV-18) and vapor return valve (HCV-19).
3	Turn on power to PLC and adjust pressure alarm settings as described in Tank-Tel manual. Alarm 1A sets pressure at which pressure building commences. Alarm 2A sets pressure at which pressure building ends and economizing begins. Alarm 3A sets pressure at which a remote alarm or control device can be activated. During normal operation tank pressure will vary from the pressure settings of Alarm 1A and Alarm 2A. At the same time, final line pressure gauge will be indicating pressure in the customer gas supply line and the HP^2 system will automatically deliver gas until stopped or the vessel is empty.

(Continued on next page.)

STEP NUMBER	Gas Withdrawal Procedure (continued)
4	Open gas use valve (HCV-20) on customer gas supply line and begin gas use.
5	To end gas supply quickly at the HP^2 System close the gas use valve (HCV-20) at the end of the multi-function vaporizer or close the liquid auxiliary valve (HCV-18) and vapor return valve (HCV-19). To close down the system for an extended period of time turn off power to the PLC. (Turning off the power to the PLC will help extend the holding time by stopping any further automatic pressure building.) The operation of HP^2 unit is completely automatic. Valves normally only need to be manually opened or closed during installation, filling, service or emergencies.
6	Normal operating valve positions for HP^2 system when power to the PLC is off are as follows:

Valve	**Position**
Bottom fill valve (HCV-1)	Closed
Top fill valve (HCV-2)	Closed
Auxiliary liquid valve (HCV-18)	Open
Vapor return valve (HCV-19)	Open
Vapor vent valve (HCV-12)	Closed
Full trycock valve (HCV-4)	Closed
Tank-Tel gauge equalizing valve (HCV-9)	Normal
Hose drain valve (HCV-7)	Closed
Gas use valve, customer (HCV-20)	Open
Tank-Tel gauge liquid phase valve (HCV-10)	Open
Tank-Tel gauge vapor phase valve (HCV-8)	Open
PB feed / auxiliary liquid valve (HCV-3)	Closed

Liquid supply procedures continue on next page.

5.2 LIQUID SUPPLY

While liquid use is not a normal use for an HP^2 system, the following procedure may be used to supply liquid or to remove the liquid contents from the tank. Pressure settings on the Tank-Tel may need to be adjusted for liquid supply to maintain desired flow rate and/or saturation level.

Table 8 Liquid Withdrawal Procedure

STEP NUMBER	Liquid Withdrawal Procedure
1	Connect customer line to liquid withdrawal connection (C-8).
2	Verify that all valves are closed, except Tank-Tel liquid phase (HCV-10) and gauge gas phase (HCV-8) valves, "normal" setting in 5-way valve (HVC-9), auxiliary liquid valve (HCV-18) and vapor return valve (HCV-19).
3	Observe pressure setting, as indicated on the pressure indicator (PI-1) of the Tank-Tel. If tank pressure is too high, open vent-valve (HCV-12) to relieve excessive gas and, if necessary, readjust the pressure settings for the pressure building function in the Tank-Tel as needed. (See Tank-Tel manual.)
4	Open liquid withdrawal valve (HCV-3) slowly to begin liquid flow.
5	Once the desired amount of liquid has been withdrawn, close the liquid withdrawal valve (HCV-3).

6

6 VESSEL HANDLING INSTRUCTIONS

6.1 CRANE HANDLING METHODS

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

FIGURE 1 TWO-CRANE INSTALLATION METHOD

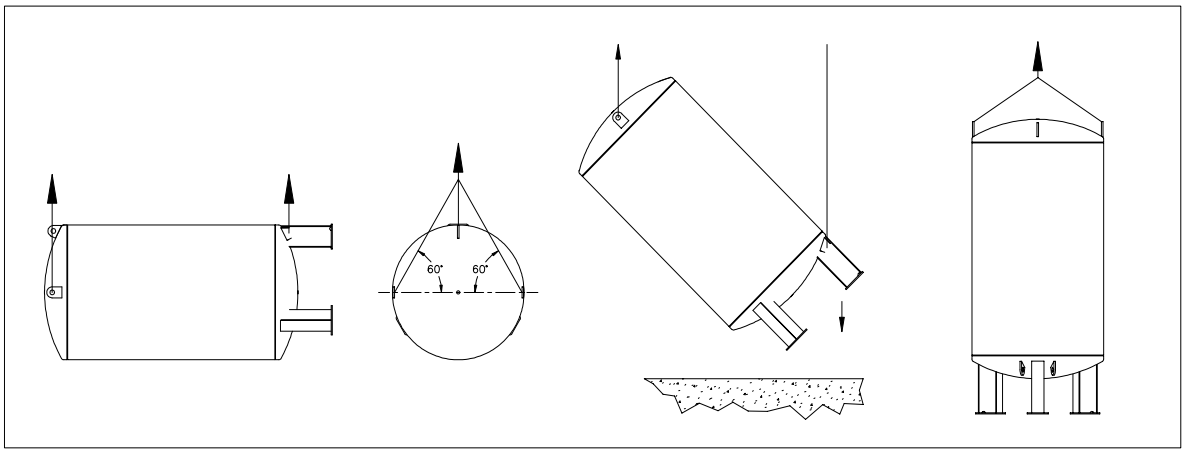


FIGURE 2 SINGLE-CRANE INSTALLATION METHOD

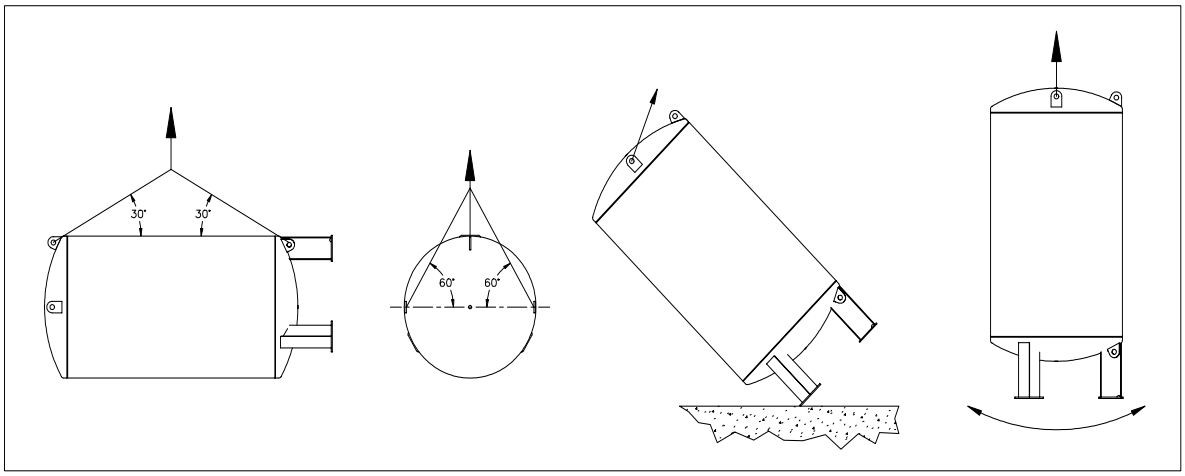


Chart Industries, Inc. Vessel Tie Down Guidelines of 3/5/99

PURPOSE: THESE GUIDELINES SHOULD BE GIVEN OR SHOWN TO DRIVERS PRIOR TO LOADING OF THE TANK, IF AT ALL POSSIBLE.

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

Figure 1 below shows a side view of an acceptable element configuration for a conventional Chart vertical vessel. Figure 2 and 3 below show rear view and front view of an acceptable element configuration for a conventional Chart vertical vessel.

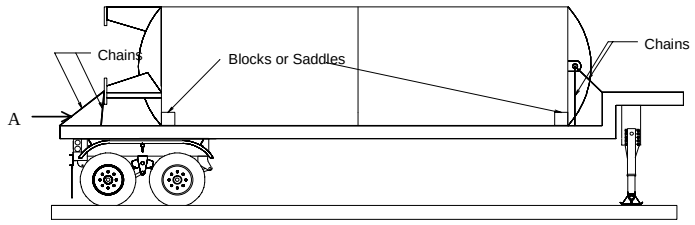


Figure 1 - Vertical Side View

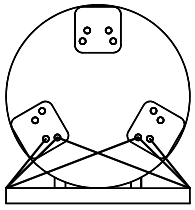


Figure 2 - Vertical Rear View

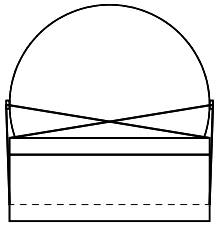


Figure 3 - Vertical Frontal View

Table 9 CABLE AND CHAIN TABLE * & **

Tank Size (gal)	Type Vessel Weight (lbs)	Maximum Force in Element (lbs)	Recommended Cable	Recommended Chain
900	7000	12600	(1) ½" IWRC 6X19	(2) ½" Transport Grade 7
1500	10000	17800	(1) ½" IWRC 6X19	(2) ½" Transport Grade 7
3000	17000	30600	(1) ¾" IWRC 6X19	(3) ½" Transport Grade 7
6000	30000	53900	(1) ¾" IWRC 6X19	(2) 7/8" Alloy Grade 8
9000	45000	66200	(2) ¾" IWRC 6X19	(2) 7/8" Alloy Grade 8
11000	54000	79400	(2) ¾" IWRC 6X19	(3) 7/8" Alloy Grade 8
13000	63000	92700	(2) ¾" IWRC 6X19	(3) 7/8" Alloy Grade 8
15000	72000	106000	(2) ¾" IWRC 6X19	(3) 7/8" Alloy Grade 8

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

**** IT IS THE DRIVERS RESPONSIBILITY TO SECURE LOAD IN ACCORDANCE WITH DOT REGULATIONS.**

6.3 INSTALLATION

Use the following overview as a guide. Sections 6.3.2 to 6.3.4 have additional details to assist in the planning and execution of the installation.

6.3.1 INSTALLATION OVERVIEW

- Consult local code and safety authorities as well as company policies regarding cryogenic pressure vessel installation and operating regulations and policies and local electrical wiring regulations
- Read the manual completely and pay close attention to all issues related to safety

- Layout concrete pad: (reference section 6.3.2 and Chapter 8)
    - Locate and mark approximate location of tank footpads
    - Mark orientation of the tank (fill assembly/front of tank)
    - Locate approximate location of piping and control module
    - Locate approximate location of multi-function vaporizer assembly
    - Assure there is proper clearance above and to the sides
- Place Equipment / Installation and Secure: (reference section 6.3.2 and Chapter 8)
    - Stand tank and secure
    - Position piping module, attach to the tank, and secure to pad

      (Remember to allow for contraction and expansion between the bulk tank, the piping module and the multi-function vaporizer.)
    - Stand up vaporizer, attach to the piping module, and secure to pad

      (Remember to allow for contraction and expansion between the bulk tank, the piping module and the multi-function vaporizer.)
    - Attach Tank-Tel and PLC subassembly to tank

      (Note, the PLC, and even the Tank-Tel, can be remotely mounted inside the user's facility to enhance operation and monitoring. Interior mounting of PLC is recommended for harsh or extreme environments.)
    - Connect flexible stainless steel phase lines to 5-way valve (HCV-9) below Tank-Tel and to tank phase line valves (HCV-8 & HCV-10)
    - Attach pneumatic control subassembly with electric 3-way valve (SOL-1) to tank at safety line purge valve (HCV-16A)

      (IMPORTANT: The gas source for operation of the pneumatic system should be either clean dry nitrogen gas or air [dew point –40o F / C]. If the HP^2 system is to be operated in oxygen service, then the gas for the pneumatic system cannot be drawn from the oxygen service bulk tank.)
    - Attach pneumatic hose from pneumatic control subassembly solenoid valve (SOL-1) to rattler valve (AOR-1)
    - Plug in electric solenoid (SOL-1) to bottom of PLC (at electrical connection PS-1), in accordance with wiring diagram in Chapter 8

- Setup Controls: (reference section 6.3.3, Chapter 8, and Tank-Tel Manual)

    - Plug in PLC (and Tank-Tel) using supplied 12 foot power cable into suitable 110 volt minimum 2 Amp power source fitted with ground fault interrupter, in accordance with local codes and the wiring diagram in Chapter 8

    - Program Tank-Tel, if factory settings are not appropriate. See paragraph 6.3.3, Chapter 8 and Tank-Tel Manual

- Commissioning: (reference section 6.3.4 and Chapter 8)

    - Purge tank in accordance with enclosed procedures or other gas supplier required procedures

    - Leak check tank and all piping and controls

    - Turn 5-way valve (HCV-9) to "equalization", open safety purge valves (HCV-8 & HCV-10), leak check lines and connections, and return 5-way valve to "normal" when complete

    - Fill tank in accordance with enclosed procedures or other gas supplier required procedures

    - Connect to the customer's house gas supply line

    - Turn on the PLC

6.3.2 PAD LAYOUT

Included in the appendix are drawings that will assist with the layout and installation. The O&D drawings include footpad layouts and overall dimensions. Drawing D-11814915 has detail including the multi-function vaporizer assembly and piping and control module dimensions and installation instructions.

Remember to allow sufficient clearance around the tank, piping and vaporizer for service and proper air flow. The piping module should be kept as close to the tank as possible. The orientation of the piping module and vaporizer is not critical and can be rotated to fit your pad dimensions.

The tank and the vaporizer should be secured (bolted) to comply with local codes. When securing the three primary assemblies (tank, piping module, and vaporizer), do not forget to allow for movement caused by expansion and contraction.

See drawing on next page.

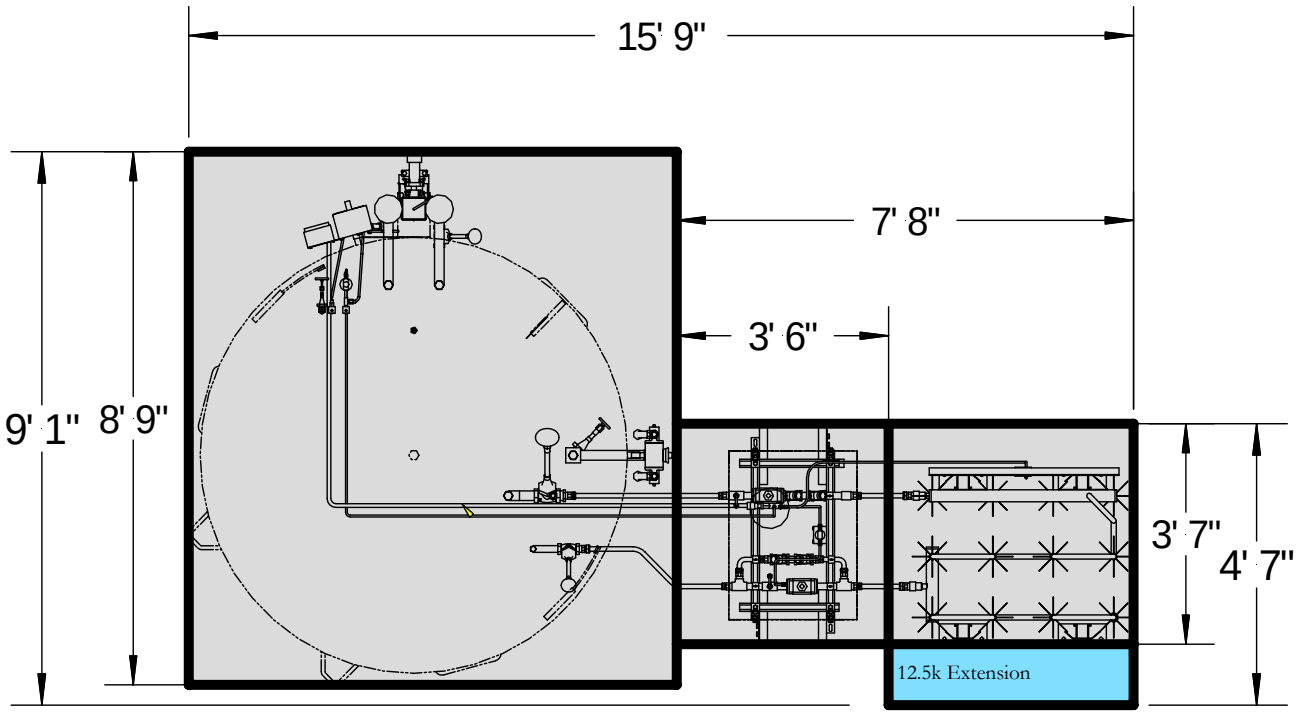


Figure 1 – Typical Layout – 3000-gallon tank with piping and control module and 7.5k HP^2 multi-function vaporizer (note 12.5k HP^2 vaporizer requires additional space)

6.3.3 SETUP CONTROLS

The Tank-Tel liquid level gauge is supplied with the liquid level parameters pre-programmed. The alarms (3 settings for liquid level and 3 settings for pressure) require setup based on the specifics of the customer's installation and needs. See the Tank-Tel Manual for full details on operating unit and adjusting the settings. The following is the recommended setup:

Table 10 for initial pressure and liquid level alarm settings follows on the next page.

Table 10 Recommended Initial Pressure and Liquid Level Alarm Settings on Tank-Tel

Setting No.	Description	Factory Settings 400 psi MAWP	Factory Settings 500 psi MAWP	Actual Setting
Level Alarm 1A	Re-Order Point *	50%	50%	
Level Alarm 2A	Low Level. * Operation below this point may cause performance problems *	20%	20%	
Level Alarm 3A	Extremely Low Level * Not normally used but available *	0%	0%	
Pressure 1A	Low PB Set Pressure (PB turns on)	350 psi	420 psi	
Pressure 2A	High PB Set Pressure (PB ends & economizing begins)	375 psi	450 psi	
Pressure 3A	Critical Pressure (User defined)	325 psi	380 psi	

Footnote: * Remote alarms and/or telemetry are optional.

It is recommended that the initial pressure and liquid level settings be recorded. Space has been provided in the Table above for recording the Tank-Tel settings.

When the re-order point (liquid level 1A) set point is reached the "Status" light (SI-1) on the PLC box (PLC-1) will flash. At the low level set point (liquid level 2A) and critical pressure (pressure 3A) the "Status" light (SI-1) will remain illuminated (always on). An optional remote status light or audible alarm can be located at a remote site selected by the customer and powered by the remote plug located at the bottom of the PLC box. (connection PS-2)

The low PB set pressure (pressure 1A) is the pressure at which pressure building (PB) commences by opening the pneumatic liquid valve (AOL-1) and closing the pneumatic gas valve (AOL-2). When pressure building begins or is operating the "PB" light (PBI-1) is on. The high PB set pressure is the pressure at which pressure building ends and the economizing mode begins. In this mode, the liquid valve (AOL-1) closes; the gas valve (AOL-2) opens; and the "Economize". light turns on.

For a quick reference guide to adjusting the Tank-Tel pressure settings and liquid level alarms, see Chapter 8. For further details, consult the Tank-Tel Manual.

6.3.4 COMMISSIONING

It is important to inspect the customer's house gas lines and controls prior to commencing operations.

Particular attention should be paid to safety. Insure that customer lines have the appropriate pressure ratings, are adequately equipped with properly sized and coded thermal relief valves and that existing safety devices are sized to handle what may now be higher pressures and/or higher flow rates.

Additional attention should be paid to gas supply line layout, line diameter and overall pressure drop. Gas at high flow rates has a significantly higher pressure drop that the same lines at lower flow rates. Highly restrictive lines or pressure regulating devices can prevent the successful operation of the customer's equipment. It is also important to insure that the customer system does not have too many pressure control devices, highly restrictive devices or regulating devices with insufficient pressure differential between the inlet pressure and the outlet pressure.

Should it be necessary or desirable, instruments for measuring gas supply temperature, pressure and flow are available. For convenience, check www.chartparts.com.

Chapter

7

7 GENERAL

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

7.1 MAINTENANCE

7.1.1 COMPATIBILITY AND CLEANING

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

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

7.1.2 PERIODIC INSPECTION

In order to maintain a cryogenic vessel in good operating condition, certain system components should be inspected on a periodic basis. Those components requiring periodic inspection are listed in this manual; however periodic inspections should be conducted on all components of the HP^2 system. For systems being operated in extremely hot or cold climates and/or in harsh or caustic environments, the inspection intervals should be shortened.

Table 10 for recommended period inspections follows on next page.

Table 10 Recommended Inspection Interval

Component / Item	Recommended Interval
Valves and fittings – leaks and proper operation	Quarterly
Strainer (optional) – clogged / unclogged condition	Semi-Annually
Regulators – proper function	Annually
Tank-Tel and PLC – proper operation	Annually
Relief valves – proper operation, settings and code	2-years
Inner tank burst disc -- replacement	2-years

7.1.3 SOLDERING, HEATING, OR WELDING

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

7.1.4 VACUUM INTEGRITY

These vessels are equipped with vacuum thermocouple gauge tubes and vacuum integrity may be tested with a vacuum meter. Deterioration or loss of vacuum will be apparent by cold spots, frost, or condensation on the jacket, or by abnormally rapid pressure build rise or the inability of the economizer function to reduce pressure. Unless one or more of these conditions is evident and other possible causes have been first investigated, the vacuum level should not be suspected. In the event one of the above conditions exists and all other possible causes have been eliminated, contact the factory for advice on vessel vacuum testing.

7.2 TROUBLESHOOTING

Table 11 provides some troubleshooting procedures. The table is arranged in a Trouble - Probable Cause - Remedy format. Note that probable causes for specific problems are listed in descending order of probability. Therefore, check out the first cause listed before proceeding to the next. Repair procedures required, as listed in the remedy column, may be found in the Repair portion of this chapter. Perform procedures in order listed and exactly as stated (Refer to drawings as required to locate system components identified in the troubleshooting guide.)

Table 11 for troubleshooting follows on the next page.

Table 11 Troubleshooting

PROBLEM	POSSIBLE CAUSE	DIAGNOSIS	SOLUTION
Routinely High Tank Pressure * Vessel vents through relief valve frequently * Pressure remains above pressure building shut-off set pressure (Tank-Tel pressure setting 2A)	Excess down-time without gas use	Determine user operating pattern and gas usage	1 Self-correcting with return to normal operation 2 Replace tank with smaller lower-NER tank if normal operation will not use enough gas
	Inadequate average gas use to lower tank pressure in economizing mode	Pressure building function seldom / never activates and parallel vaporizer remains warm	1 Consult factory 2 Replace tank with smaller lower-NER tank
	Pressure settings on Tank-Tel mis-adjusted - pressure(s) set too high	Check pressure alarm settings on Tank-Tel for pressure settings 1A and 2A	1 Adjust pressure alarms settings 2 Insure pressure 1A is at least 10 psig lower than pressure 2A
	Vapor return valve (HCV-19) is closed	Valve (HCV-19) is turned in / closed	1 Open vapor return valve
	Pneumatic system failure (leak, blockage, faulty solenoid, moisture in the valve actuator, low pressure in tank, etc.) that prevents the gas valve from opening	Gas return valve (AOL-2) will not open pneumatically Audible or visible leaks Noisy solenoid	1 Insect and fix faulty pneumatic lines or dry wet lines or actuators 2 Test operation of gas control solenoid and repair or replace, if needed 3 Insure tank pressure is over 70 psi (pressure needed to operate valve actuators). If necessary, actuator can be turned manually.
	No power to Tank-Tel, PLC, or pneumatic gas control solenoid to open gas valve	LEDs and lights on Tank-Tel and PLC do not operate and solenoid has no current	1 Reconnect power 2 Replace faulty power supply unit, if needed
	No signal from Tank-Tel to PLC or PLC to pneumatic solenoid to open gas valve	Tank-Tel and PLC are powered Loose or broken wires No current when tested	1 Reconnect or replace wiring 2 Replace Tank-Tel or PLC, if required.
	Erroneous reading on Tank-Tel pressure indicator (PI-1)	Compare against another pressure gauge of known accuracy	1 Insure that pressure readings are in the desired unit of measurement (psi, bars or kPa) and alarms are “low alarms” 2 Replace Tank-Tel, if needed.
	Inadequate vacuum	Take vacuum reading	1 Consult factory

PROBLEM	POSSIBLE CAUSE	DIAGNOSIS	SOLUTION
Failure to maintain desired delivery pressure to gas use equipment *Customer's gas line pressure is low	Empty tank or insufficient gas in bulk tank	Check tank contents	1 Refill tank 2 Consider use of telemetry or remote alarms for contents and/or pressure
	Leak in the gas supply system	Tank pressure is adequate, but pressure in line is low or decays after auxiliary liquid valve (HCV-18) and vapor return valve (HCV-19) are closed and gas use application is turned off. Vaporizer continuously frosted.	1 Locate leak 2 Repair or replace problem components
	Customer's gas supply line or related components create too much pressure drop for the required flow rate and pressure	With no flow or at lower flows the line pressure is adequate	1 Raising HP^2 tank pressure to overcome the downstream pressure drop 2 If step 1 cannot overcome problem, eliminate the restrictive line(s) or components
	Total or peak flow exceeds HP^2 system specifications	Compare specifications to gas use	1 Consider options to reduce peak or total flows to within specification or to increase gas supply system capacity 2 Consult Chart for options
	Pressure settings on Tank-Tel mis-adjusted…set too low	Check pressure alarm settings on Tank-Tel for pressure 1A and 2A. Rattler valve goes activates below desired working pressure.	1 Adjust pressure alarms settings 2 Insure pressure 1A is at least 10 psig lower than pressure 2A
	Pneumatic system failure (leak, blockage, faulty solenoid, moisture in the valve actuator, low pressure in tank, etc.) that prevents the liquid and/or gas valve from opening	Pneumatic liquid valve (AOL-1) and/or vapor return valve (AOL-2) will not open pneumatically. Audible or visible leaks Noisy solenoid	1 Insect and fix faulty pneumatic lines or dry wet lines or actuators 2 Test operation of gas control solenoid and repair or replace, if needed 3 Insure tank pressure is over 70 psi (pressure needed to operate valve actuators). If necessary, actuator can be turned manually.
(Continued on the next page.)	No power to Tank-Tel, PLC, or pneumatic gas control solenoid to open gas valve	LEDs and lights on Tank-Tel and PLC do not operate and solenoid has no current	1 Reconnect power 2 Replace faulty power supply unit, if needed

PROBLEM	POSSIBLE CAUSE	DIAGNOSIS	SOLUTION
(Continued) Failure to maintain desired delivery pressure to gas use equipment *Customer's gas line pressure is low	No signal from Tank-Tel to PLC or PLC to pneumatic solenoid to open gas valve	Tank-Tel and PLC are powered Loose or broken wires No current when tested	1 Reconnect or replace wiring 2 Replace Tank-Tel or PLC, if required.
	Erroneous reading on Tank-Tel pressure indicator (PI-1)	Compare against another pressure gauge of known accuracy	1 Insure that pressure readings are in the desired unit of measurement (psi, bars or kPa) and alarms are "low alarms" 2 Replace Tank-Tel, if needed.
	Relief valve (PSV-1) venting or burst disc (PSE-1) ruptured or leaking	Check for gas leak	1 Tighten or replace troublesome component
Erratic, erroneous, or no contents or pressure readings on Tank-Tel	Tank-Tel set for wrong unit(s) of measure	Check Tank-Tel to verify which units of measure have been selected	1 Consult Tank-Tel manual 2 Adjust units of measure as desired
	No or erratic power to Tank-Tel	LEDs and lights on Tank-Tel and PLC do not operate or flicker	1 Reconnect or repair power source 2 Replace faulty power supply unit, if needed
	Fuse in PLC box burned out	LED and PLC lights do not operate	1 Find and fix power problem that caused fuse to burn 2 Replace fuse in PLC box
	Alarms / settings incorrectly set as "high alarms"	In alarm adjustment menu, one or more alarms contain a colon (**:**)	1 Consult Tank-Tel Manual regarding "high" and "low" alarms & adjustment 2 Change alarm(s) back to "low alarms"
	Phase line(s) to gauge leaking	Evidence of leak when leak tested. Audible leak.	1 Tighten lines and fittings 2 Replace any faulty components
	Phase line valve(s) not open	One or more readings may be either at zero or 100%	1 5-way valve (HCV-9) set to "normal" 2 Gauge phase isolation valves (HCV-8 and HCV-10) are open
	Phase lines reverse	One or more readings may be either at zero or 100%	1 Follow instructions regarding Tank-Tel installation 2 Correct line connections
(Continued on the next page.)	Plugged phase line(s)	One or more readings remains constant or changes very slowly	1 Inspect lines between tank and Tank-Tel and clean / dry as necessary 2 For lines in/on tank, consult factory

PROBLEM	POSSIBLE CAUSE	DIAGNOSIS	SOLUTION
(Continued) Erratic, erroneous, or no contents or pressure readings on Tank-Tel	Tank-Tel or sensor(s) damaged or faulty	Evidence of damage, internal moisture, or excess pressure	1 Replace faulty Tank-Tel or sensor
Leaking relief valve	Ice under / in seat	Valve closes after warming	1 Warm and dry valve to prevent moisture accumulation 2 If appropriate and possible, check moisture level in tank
	Contaminants under / in seat	Possible evidence of dirt or contamination	1 Blow and clean out contaminants, if possible, and re-test relief valve performance before reinstalling 2 If relief valve cannot be cleaned or has suffered permanent damage, replace the relief valve 3 Investigate source of contamination and eliminate source
	Damaged or worn out seat or spring	Valve does not close or close at proper pressure	1 Replace relief valve
Ruptured tank burst disc	Excess tank pressure	Relief valve damaged	1 Determine cause of excess pressure and correct 2 Replace burst disc and relief valve
	Fatigue or corrosion	Age and/or environment	1 Replace burst disc
Inability to hold vacuum * Fast pressure rise * Inability to reduce pressure via economizing	Improper vacuum gauge tampering or change (voids warranty)	Measure vacuum rise in gauge assembly	1 Consult factory
	Internal / external leak	Vacuum pressure rises in tank over short time	1 Consult factory
	Corroded, damaged or aged outer vessel safety device	Visual on helium leak test	1 Replace and re-pump vacuum
	Effects of progressive outgassing and permeation	Slow vacuum rise over a long period of time	1 Re-pump

7.3 REPAIR

CAUTION:

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

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

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

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

NOTE: Many of the spare parts used in Chart products are available from Chart Parts or Chart customer service at: Internet address: www.chartparts.com or email: chartparts@chart-ind.com or fax: 1-952-882-5191 or telephone: 1-800-400-4683 from the US or Canada or 1-952-882-5000 worldwide.

7.4 VALVE REPAIR

When a defective isolation or shut-off valve is suspected, remove and repair the assembly as described in this manual. If a valve is leaking through the packing, tighten the packing nut first to see if the leakage will stop before removing the valve. Packing is best tightened when the valve is warm. If a safety relief valve fails, the defective assembly should be discarded and a new correctly specified relief valve installed. Never attempt to repair a safety relief valve!

NOTE:

Globe valves used on containers vary in tube size from ¼" to 2". While internal valve components may vary from valve to valve, the functional operation and repair procedures for these valves are basically the same. If in doubt as to the correct procedure, consult the valve's manufacturer.

Table 12 for valve repair follows on the next page.

Table 12 Valve Repair

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

7.5 INNER TANK BURST DISC REPLACEMENT

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

The following table serves to describe replacement of the inner vessel burst disc for vessels equipped with a dual relief system. In the event that a component needs to be replaced in the dual relief system, simply switch the selector handle to the other side of the safety system to allow routine maintenance and repair.

Table 13 for inner burst disc replacement follows on the next page.

Table 13 Tank Burst Disc Replacement - Dual Safety System

STEP NUMBER	PROCEDURE
1	Switch selector valve (HCV-15) to other side, and depressurize the isolated side of the relief valve system. (When a vessel is equipped with a dual safety system with diverter valve it is not necessary to vent the pressure in the vessel.)
2	Remove burst disc (PSE-1) by opening HCV-16, if equipped. Or loosen PSE-1 and allow pressure to escape before fully removing the burst disc.
3	Install new burst disc (PSE-1), making sure that the replacement disc is properly specified for the vessel and that the mating surfaces are clean and properly seated. Use an oxygen compatible liquid thread sealant to prevent leaking.

7.6 TESTING AFTER REPAIR

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

Chapter

8

8 DRAWINGS AND DOCUMENTATION

Table 14 Outline and Dimension Drawings, P&I Drawings and Supporting Documentation

Outline & Dimension Drawings	
Quick Reference Guide – Adjusting Tank-Tel Settings / Alarms	**Attachment**
O&D VS-525 / 900 / 1500 9% Ni 250/400/500	**C-11534201**
O&D VS-3000-6000 9% Ni 175/250/400/500	**C-11517988**
O&D VS-9000-15000 9% Ni 175/250/400	**C-11502954**
Foundation L/O (Lay Out) Zone 0/4 175-500 psi (Pages 1-5)	**C-11682254**
Mdl Installation Kit for Site	**D-11814915**
Process & Instrumentation Drawing – Unit Specific	**C-11828954** (page 2 of 2)
HP^2 Control Summary with Wiring Schematic	**Attachment**
HP^2 System Photographs	**Attachment**
Tank-Tel Installation and Operating Instruction Manual	**11682772 Supplied Separately**

Quick Reference Guide

Adjusting The Tank-Tel Pressure Settings And Liquid Level Alarms

For further information or detailed instructions, refer to the Tank-Tel Manual.

Tank-Tel Control Buttons (Left to Right)

- "**ON**" — In battery operation only, turns Tank-Tel power ON (In battery mode, Tank-Tel will automatically turn off after 15 seconds if no buttons are pushed. ON function is not operational when wired for 12 VDC power supply.)
- "**SELECT**" — Moves the cursor from one position to the next position or alarm / setting. The current position, digit or field is identified as flashing number or item.
- "⇧" (up arrow) — Scrolls up through numbers 0 to 9 and back again and through any available options in each selected cursor position.
- "**MODE**" — Moves from "LEVEL" and "PRESSURE" screens for adjustment. (Also allows the user to select if an alarm [or setting] is to be a "high" or a "low" alarm [or setting]. Under normal circumstances it should not be necessary to change any alarm or setting from its factory setting, which is a "low alarm". See Tank-Tel Manual for further information, if necessary.)
- **Multi-Button** — Some programming steps require the pushing or holding down of two or more buttons simultaneously. The multi-button operations are described where appropriate.

Adjustment Procedures for Liquid Level Alarms and Pressure Settings

Note HP2 system should arrive with the tank parameters pre-programmed into the Tank-Tel. In addition, the Tank-Tel has been programmed for the gas service indicated in the customer order. If for any reason, the tank parameters or gas service have not been programmed, changed, or lost, then consult the Tank-Tel Manual for programming the tank parameters and gas service specifications. The Tank-Tel will also arrive pre-set to the pressures and liquid levels indicated in the paragraph 6.3.3 of Chapter 6. The pressure settings and the liquid level alarms may be adjusted by using the procedures described below.

Step 1 Turning on the power

Either turn "Power Switch" (SW-1) to ON at the PLC box if remote power is available or alternatively if no remote power is available or to avoid activating the complete HP2 system, press the "On" button on the face of the Tank-Tel.

Tank-Tel is equipped with dual 9-volt batteries for backup operation of the Tank-Tel only.

Step 2 With Tank-Tel powered, determine if you wish to first or only adjust LEVEL or PRESSURE. If you are only adjusting LEVEL or are going to adjust LEVEL first, proceed to Step 3. If PRESSURE, then press **SELECT** button so that a colon (**:**) appears in the PRESSURE screen in front of the tank pressure.

The default screen for alarm / setting adjustment is the liquid level field unless it has been changed as described in step 2.

Step 3 Press and hold the **SELECT** and ⇧ buttons simultaneously for approximately 5 seconds to access the "liquid level alarms / pressure settings" configuration menu, described in the Tank-Tel Manual.

Holding down the two buttons for too long (approximately 10 seconds) will access the "tank parameters and gas service" configuration menu.

The alarm menus can be recognized by the first two characters on the screen. The first two characters will be "1A", followed by three numbers. The three numbers, which follow, are the current settings for the level or the pressure. "1A" in the LEVEL screen indicates liquid level alarm 1A. "1A" in the PRESSURE screen indicates pressure setting 1A.

Step 4 To change the first number/digit, which is flashing, press the ⇧ button as often as necessary until the desired number is reached.

The Tank-Tel screen starts with the number in the 100's position as the first flashing digit.

Only the flashing number can be adjusted using the ⇧ button.

Do NOT leave any horizontal lines (--) in place of a number position on the screen. In place of horizontal line enter a zero (0) if no other number is appropriate. For example, for liquid level if the desired setting for the low level alarm is 25%, then enter 0 7 5 (not – 7 5). If any horizontal lines remain in either the values for the liquid level or pressure settings the Tank-Tel will move to the next screen.

Step 5 To move to the next position / number, press the **SELECT** button.

Pressing the **SELECT** button will move the flashing number from the 100's position to the 10's position, and finally to the 0's. If the an error is made in adjusting a previous digit, then it will be necessary to exit the adjustment menu and start again at step 2.

> **NOTE:** Do not press the **MODE** button after entering the alarm / pressure setting menu as this may cause the adjustments to change from their factory set condition as "low level" alarms to "high level" alarms. Changing to "high level" alarms will adversely affect the operation of the HP^2 system.

LEVEL alarms can be adjusted from 0% to 100% in increments of 5%.

PRESSURE settings can be adjusted from 0 psi to 500 psi in increments of 5 psi. (Use care not to set any pressure setting higher than 10 psi below the actual opening pressure of the safety relief valve used on the tank.)

Step 6 To move to the next alarm / setting, press the **SELECT** button.

Step 7 After all alarms or settings are adjusted as desired, press the **SELECT** button as often as necessary to exit the adjustment menu.

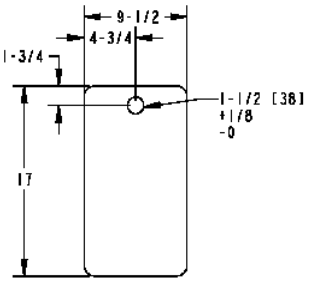
Step 8 To change the pressure settings after having adjusted level settings or vise versa, repeat steps 2 through 7.

DRAWING NO. C-11534201

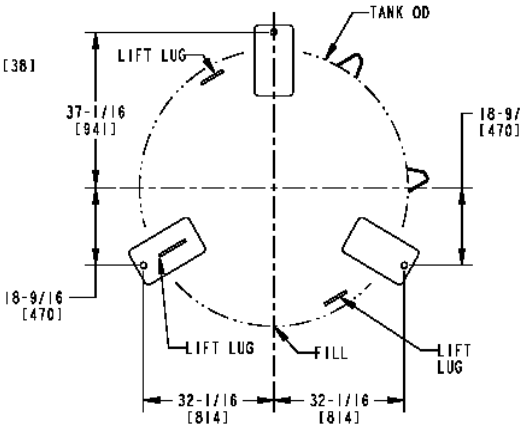
INNER VESSEL DESIGN DATA				
Model:		VS-525 / 900 / 1500		
MAWP:	PSIG	250	400	500
	barg	17.24	27.58	34.47
DESIGN PRESSURE	PSIG	264.7	414.7	514.7
	barg	18.25	28.59	35.49
CODE COMPLIANCE:		ASME SECTION VIII DIVISION 1		
DESIGN TEMPERATURE	°F	-320° TO 100°		
	°C	-196° TO 38°		
MATERIAL OF CONSTRUCTION:		SA353/553 9% NICKEL STEEL		

OUTER VESSEL DATA		
CODE COMPLIANCE:		FULL VACUUM PER CGA-341
DESIGN TEMPERATURE	°F	-20° TO 300°
	°C	-29° TO 149°
MATERIAL OF CONSTRUCTION:		A36 CARBON STEEL
INSULATION TYPE:		VACUUM AND MULTILAYER INSULATION
EVACUATION CONNECTION:		3-1/2" PUMPOUT PORT
VACUUM GAUGE CONNECTION:		HASTINGS DV6R

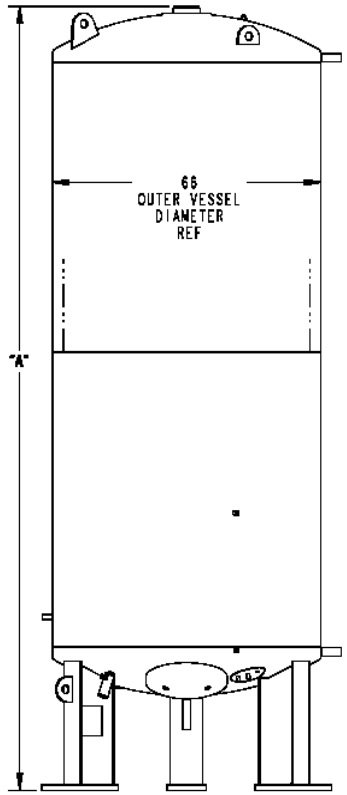
BUILDING CODE:
DESIGNED FOR CURRENT BUILDING CODE SEE MVE
UBC POLICY #NP-180



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



BOLT HOLE LAYOUT
TOP VIEW
SCALE: N/A



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

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

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

IN[mm]

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

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

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

MAT'L: SEE B.O.M.

PART NUMBER 11534201

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

CHART Storage Systems Division New Program Operations

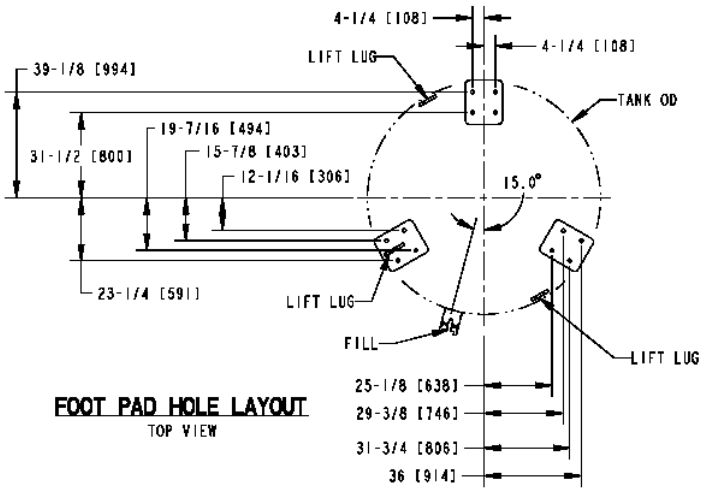
TITLE O&D VS-525/900/1500
9% NI 250/400/500 ASME

DRAWING NO. C-11534201 REV B

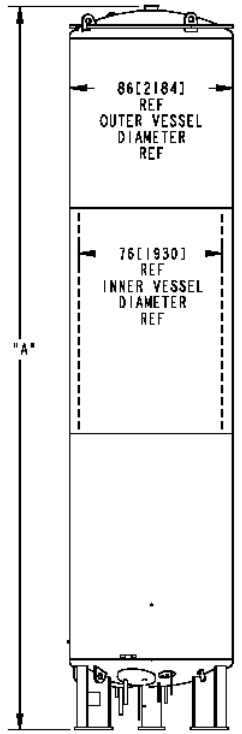
SCALE N/A | DO NOT SCALE DRAWING | SHEET 1 OF 1

DRAWING NO. C-11517988

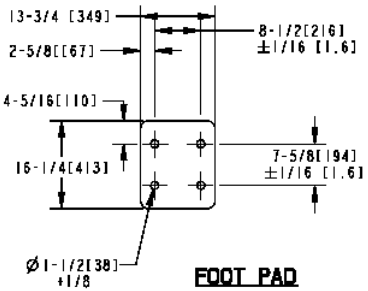
INNER VESSEL DESIGN DATA					
Model:		VS-3000 THRU 6000			
MAWP:	PSIG	175	250	400	500
	barg	12.07	17.24	27.58	34.47
DESIGN PRESSURE	PSIG	189.7	264.7	414.7	514.7
	barg	13.08	18.25	28.59	35.49
CODE COMPLIANCE:		ASME SECTION VIII DIVISION 1			
DESIGN TEMPERATURE	°F	-320° TO 100°			
	°C	-195.56° TO 37.78°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



FOOT PAD HOLE LAYOUT
TOP VIEW



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



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

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

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

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

	APPROVED	DATE
DRAWN BY	MO	01-29-01
CHK'D BY	MMK	2-8-01
APPR'D	KJR	2-06-01
PROJ. ENG.	MDS	2-08-01
APPR. ENG.	FAS	2-07-01
QUAL. CONT.	GHE	2-6-01

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

MAT'L: SEE B.O.M.

PART NUMBER 11517988

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

CHART Storage Systems Division New Program Operations

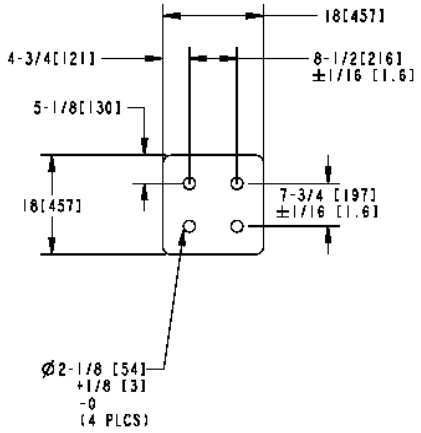
TITLE O&D VS-3000 THRU 6000 9% NI 175/250/400/500 ASME

DRAWING NO. C-11517988 REV B

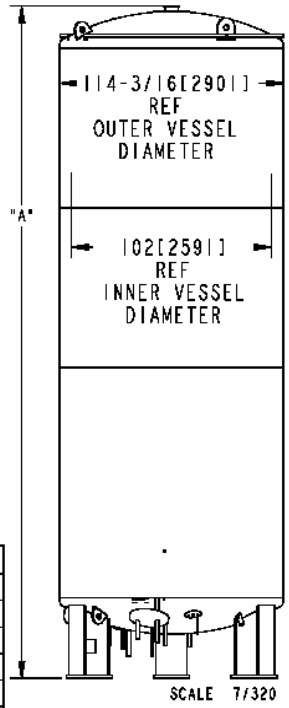
SCALE N/A DO NOT SCALE DRAWING SHEET 1 OF 1

DRAWING NO. C-11502954

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



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



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

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

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

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

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

MAT'L: SEE B.O.M.

PART NUMBER 11502954

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

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

Storage Systems Division New Prague Operations

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

DRAWING NO. C-11502954 REV C

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

DWG NO. C-11682254

SPECIFICATIONS & NOTES

1. THE SCHEDULES ON THIS SHEET SHALL BE USED FOR REFERENCE PURPOSES ONLY, AND CANNOT SUBSTITUTE FOR STRUCTURAL DESIGN FOR PARTICULAR SITE CONDITIONS.

2. THE DATA IN THE SCHEDULES IS VALID ONLY WITHIN THE FOLLOWING (OR ANY LESS STRINGENT) DESIGN ASSUMPTIONS (1997 UBC-1998 CBC):

   a. FOR SEISMIC ZONES 1, 2A, 2B, 3, AND 4 - FOR OXYGEN-FILLED TANKS OR PER 1997 UBC WITH IMPORTANCE FACTORS OF 1.25/1.5 (UNC).

   b. DESIGNATION "4" PERTAINS TO SEISMIC ZONE 4, OXYGEN-FILLED TANKS PER 1998 CBC TITLE 24 VOL. 2A WITH IMPORTANCE FACTORS OF 1.5/1.5.

   c. DESIGNATION "4LIN" PERTAINS TO SEISMIC ZONE 4, NITROGEN-FILLED TANKS PER 1997 UBC WITH IMPORTANCE FACTORS OF 1.0/1.0.

   d. FOR SEISMIC 4, THE DESIGN SITE HAS SOIL PROFILE "SD", AS IS NO CLOSER THAN 10 KM FROM FAULT TYPE "A", AND NO CLOSER THAN 5 KM FROM FAULT TYPE "B".

   e. MAXIMUM WIND SPEED 110 MPH, EXPOSURE "C".

   f. ALLOWABLE BEARING CAPACITY OF SOIL 1500 PSF WITH 1.33 INCREASE FOR TRANSIENT LOADS.

3. THE SPECIFIED BEARING CAPACITY OF SOIL REQUIRES GEOTECHNICAL INVESTIGATION.

4. ACTUAL INSTALLATION MAY REQUIRE SOIL IMPROVEMENT, INCLUDING SOIL REPLACEMENT, OVEREXCAVATION, SCARIFYING, RECOMPACTION, ETC. SOME INSTALLATIONS REQUIRE ANTI-FROST MEASURES. REFER TO LOCAL CODES, GEOTECHNICAL REPORT, AND STRUCTURAL DESIGN DOCUMENTATION FOR SPECIFIC REQUIREMENTS.

5. THE INSTALLATION SITE SHALL BE SUPPLIED WITH ADEQUATE DRAINAGE (BY OTHERS) PREVENTING WATER PONDING/ACCUMULATION ON, AROUND, AND UNDER THE NEW CONCRETE.

6. ALL CONCRETE IS AT LEAST 2500 PSI NORMAL WEIGHT CONCRETE. SPECIAL INSPECTION NOT REQUIRED BY DESIGN.

7. ALL REBARS ARE PER ASTM A615 Gr.60.

8. FOR INSTALLATIONS UNDER PER CBC TITLE 24, USE DETAIL (1/S3) TO ASSURE 1/8" MAX. GAP BETWEEN THE BASEPLATE/SHEAR PLATE.

9. FOR ALL INSTALLATIONS OTHER THAN PER ITEM 8, THE DIFFERENCE BETWEEN THE DIAMETER OF THE BASEPLATE HOLES AND THE SPECIFIED ANCHOR SHOULD NOT EXCEED THE "DD" VALUE PROVIDED BELOW.

ANCHOR DIAMETER	DD
5/16" TO 1"	5/16" MAX
1" TO 2"	1/2" MAX
OVER 2"	1"

10. IF THE DIFFERENCE BETWEEN THE DIAMETER OF THE BASEPLATE HOLES AND THE SPECIFIED ANCHOR EXCEEDS THE "DD" VALUE, INSTALL THE TANK ACCORDING TO THE FOLLOWING SPECIFICATION.

    a. PLACE THE TANK ON THE ANCHORS.
    b. OIL THE INNER SURFACES OF ALL BASEPLATE HOLES.
    c. FILL THE HOLES TO TOP OF BASEPLATES WITH SIKAGROUT 212 OR OTHER NON-SHRINK DRYPACK.
    d. IF GROUT IS TO BE USED IN POURABLE FORM, SEAL THE HOLES TO PREVENT LOSS OF GROUT.
    e. INSTALL A 1/4" THICK A36 SQUARE WASHER (EA. SIDE TO MEASURE NOT LESS THAN 1.5 HOLES DIAMETER) UNDER EACH NUT.
    f. TIGHTEN ALL NUTS TO SNUG CONDITION.

11. ALTERNATIVELY TO ITEM 10, ITEM 9 SPEC9 MAY BE USED FOR OVERSIZED (NON-CONFORMING TO ITEM 9) HOLES.

12. ANCHOR RODS MADE OF QUENCHED AND TEMPERED STEEL (DESIGNATED AS "QT") SHALL NOT BE SUBJECTED TO WELDING OR HEATING AND SHOULD BE SUPPLIED WITH DOUBLE BOTTOM NUTS. ANCHOR RODS MADE OF CARBON ("C") OR HIGH-STRENGTH LOW-ALLOW ("HSLA") STEELS MAY HAVE SINGLE TACK-WELDED BOTTOM NUTS. (3/S3)

FOR SCHEDULES REFER TO SHEETS S4 AND S5. FOR DETAILS REFER TO SHEETS S2 AND S3

REV.	SIZE	REVISION DESCRIPTION	BY	DATE

APPROVED DATE

MATL.

PART NUMBER 11682254

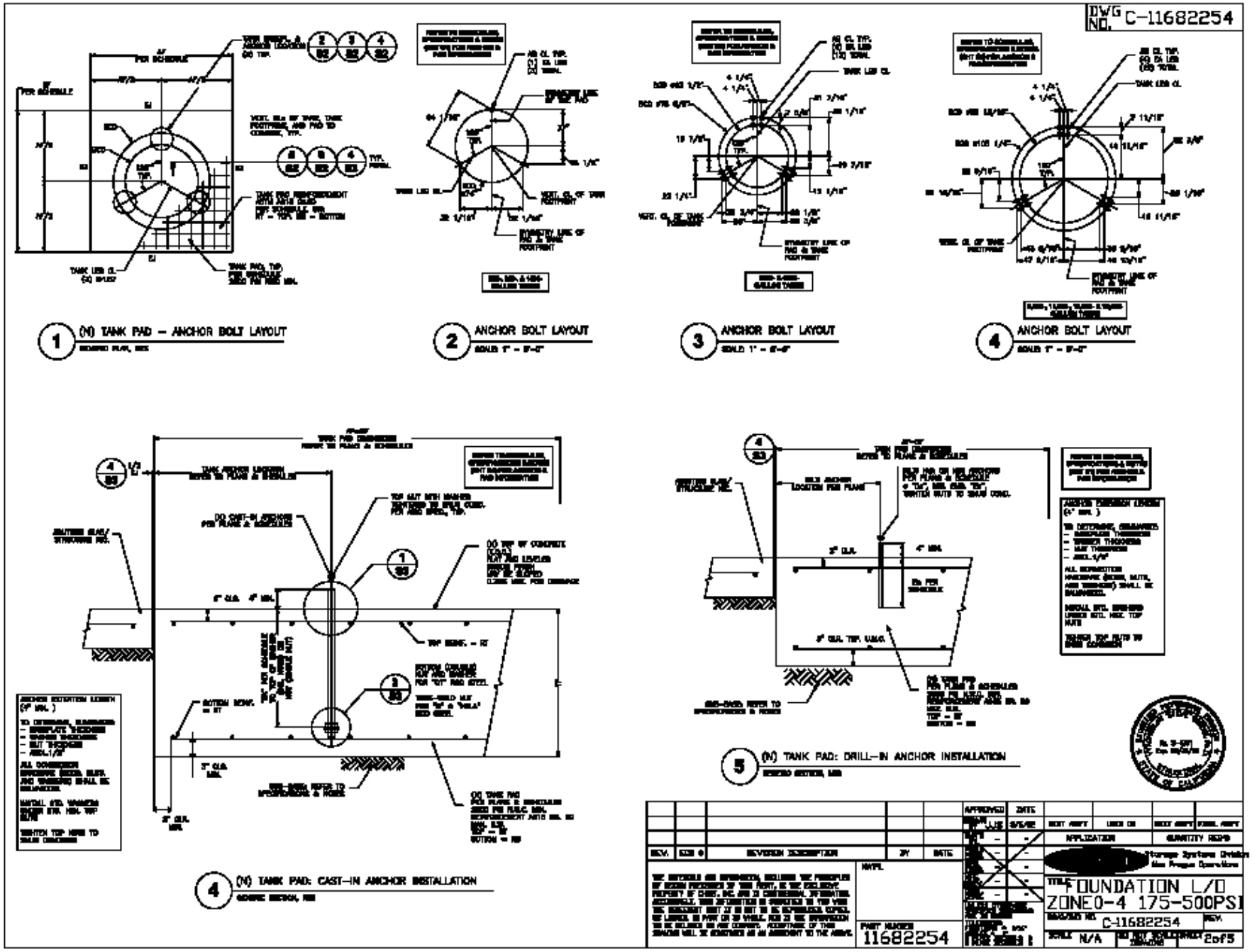
APPLICATION

QUANTITY REQ'D

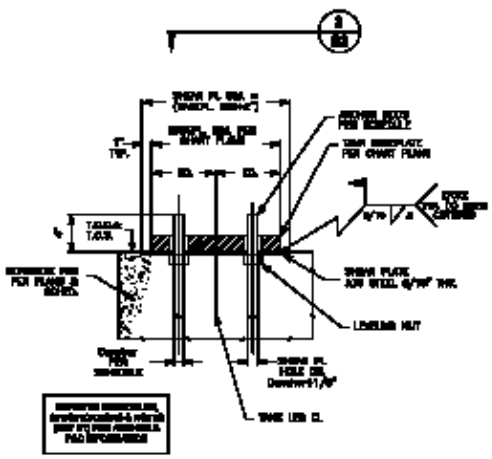
TITLE FOUNDATION L/D ZONE0/4 175-500PSI

DRAWING NO. C-11682254 REV.

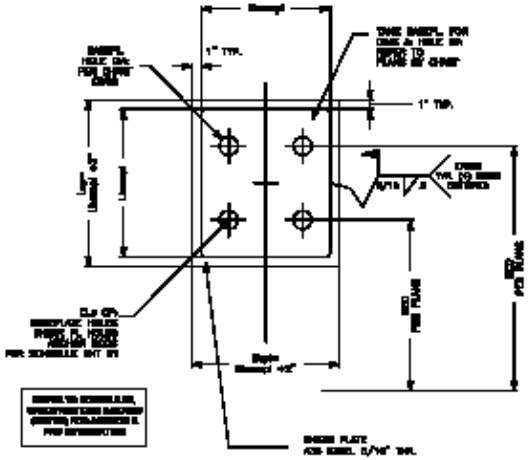
SCALE N/A SHEET 1of5



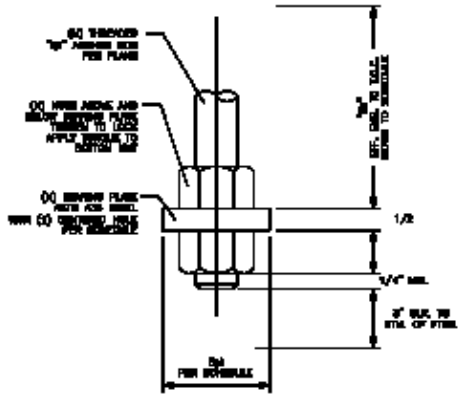
DWG NO. C-11682254



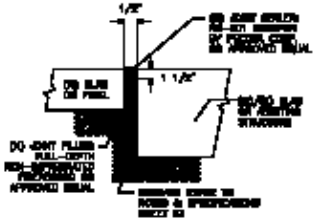
1 SUPPORT WITH SHEAR PLATE



2 SUPPORT WITH SHEAR PLATE



3 BOTTOM BEARING ANCHOR ASSEMBLY



4 EXPANSION JOINT (EJ)

REV.	DCN #	REVISION DESCRIPTION	BY	DATE

APPROVED J.S 3/5/03

APPLICATION

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PART NUMBER 11682254

Storage Systems Division
Ion Process Operations

TITLE FOUNDATION L/D
ZONE 0-4 175-500PSI

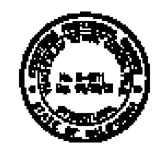
DRAWING NO. C-11682254 REV.

SCALE N/A DO NOT SCALE DRAWING SHEET 3 of 4

DWG NO. C-11682254

SCHEDULES FOR TANK PADS FOR, AMD ANCHORAGE OF, CRYOGENIC VESSELS

	Tank Capacity, Gallons	525	900			1500					3000					6000				
	Seis. Zone	0-4*	0-3	4	4*	0-2A	2B-3	4	4*	4 LIN	0-2A	2B-3	4	4*	4 LIN	0-2A	2B-3	4	4*	4 LIN
Fdng. Dims.	AF, ft	5	6	8	8	8'-6"	9	10	10'-3"	8'-3"	10	12	13	13'-3"	11	15	17	18	18'-9"	18
	BF, ft	5	6	8	8	8'-6"	9	10	10'-3"	8'-8"	10	12	13	13'-3"	11	15	17	18	18'-6"	16
	TF, in	12	12	18	18	18	18	18	18	18	18	18	20	18	18	18	24	26	30	28
Fdng. Reinf.	Rt	4@18	4@18	4@14	4@14	4@14	4@14	6@16	6@18	6@16	5@18	5@18	6@16	6@18	6@16	6@16	6@18	6@18	6@16	6@16
	Rb	4@18	4@18	4@14	4@14	4@14	4@14	5@18	5@18	5@18	5@18	5@18	5@16	6@18	5@18	6@12	8@12	8@18	8@18	6@16
Anchors, Cast-in	# per leg	1	1	1	1	1	1	1	1	1	4	4	4	4	4	4	4	4	4	4
	Da, in	0.625	0.625	0.875	0.875	0.875	0.875	1.000	1.000	1.000	0.875	0.875	0.875	0.875	0.875	1.000	1.125	1.000	1.000	1.000
	Ea, in	7.50	7.50	10.50	10.50	10.50	10.50	12.00	12.00	12.00	10.50	12.00	14.00	12.00	11.00	13.00	18.00	21.00	24.00	21.00
	Steel ASTM Material	A36 C	A36 C	A36 C	A36 C	A36 C	A36 C	A36 C	A36 C	A36 C	A36 C	A36 C	A36 C	A36 C	A36 C	A36 C	A36 C	A449 QT	A449 QT	A449 QT
	Btm nut	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	DBL	DBL	DBL
	Plate: Bpl, in	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.00	3.00	3.00
	Plate: Tpl, in	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.500	0.625	0.500
	Plate: Dia hole, in	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.0625	1.0625	1.0625
	Sp. Insp.	No	No	No	No	No	Yes	Yes	Yes	No	No	No	No	Yes	No	Yes	Yes	Yes	Yes	No
Anchors, HILTI HVA	# per leg	1	1	1	-	1	1	-	-	1	4	4	4	4	4	4	4	-	-	4
	Dae, in	0.625	0.625	1.000	-	1.000	1.000	-	-	1.000	1.000	1.250	1.250	1.250	1.250	1.250	1.250	-	-	1.250
	Eae, in	8.000	8.000	6.250	-	6.625	12.375	-	-	12.375	6.625	12	12	12	8	12	16	-	-	16
	Steel ASTM	A36	A36	A36	-	A36	A193	-	-	A36	A36	A36	A36	A36	A36	A36	A193	-	-	A36
	Sp. Insp.	Yes	Yes	Yes	-	Yes	Yes	-	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-	-	Yes
Anchors, HILTI KB3	# per leg	1	1	-	-	1	-	-	-	-	4	-	-	-	-	-	-	-	-	-
	Dam, in	0.625	0.625	-	-	1.000	-	-	-	-	1.000	-	-	-	-	-	-	-	-	-
	Eam, in	4.00	4.00	-	-	6.00	-	-	-	-	6.00	-	-	-	-	-	-	-	-	-
	Sp. Insp.	No	No	-	-	No	-	-	-	-	No	-	-	-	-	-	-	-	-	-
Calc. Sheet		C1	D1	D2	D3	E1	E2	E3	E4	E5	F1	F2	F3	F4	F5	G1	G2	G3	G4	G5



TITLE: FOUNDATION L/O ZONE0/4 175-500PSI

DRAWING NO. C-11682254

PART NUMBER 11682254

SCALE N/A

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DWG NO. C-11682254

SCHEDULES FOR TANK PADS FOR, AMD ANCHORAGE OF, CRYOGENIC VESSELS

	Tank Capacity, Gallons	6000					11000					12000					15000				
	Dish. Style	0-2A	2:1-0	4	4*	4 LBR	0-2A	2:1-0	4	4*	4 LBR	0-2A	2:1-0	4	4*	4 LBR	0-2A	2:1-0	4	4*	4 LBR
Plug. Dims.	AF,ft	17	19	21	23	17'-6"	19	22	23	26'-6"	20	21	24	26	27'-6"	21'-6"	23'-9"	25'-6"	29	32'-6"	24
	EF, ft	17	19	21	23	17'-6"	19	22	23	26'-6"	20	21	24	26	27'-6"	21'-6"	23'-6"	25'-6"	29	32'-6"	24
	TF, in	18	24	28	30	28	21	27	28	34	30	24	32	35	39	28	27	37	42	44	32
Plug. Reinf.	RT	6@16	6@15	6@16	6@15	6@15	5@15	6@16	7@16	7@15	6@15	6@16	7@15	7@16	7@16	6@16	6@17	7@16	6@16	6@16	6@15
	RB	5@12	7@15	6@16	5@13	6@15	6@15	6@16	6@16	6@15	7@16	6@16	6@14	6@13	6@13	6@16	5@14	5@12	6@12	6@11	5@15
Anchors, Dwt.Lb	# per leg	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
	Dia, in	1.000	1.000	1.500	1.500	1.250	1.000	1.500	1.500	1.250	1.500	1.000	1.500	1.500	1.500	1.500	1.000	1.500	1.500	1.500	1.500
	Ea, in	12.00	18.00	21.00	24.00	20.00	15.00	22.00	28.00	29.00	25.00	16.00	27.00	30.00	33.00	28.00	22.00	31.00	38.00	35.00	27
	Steel ASTM Material	A36 G	A36 G	A36 G	A36 G	A36 G	A36 G	A36 G	A36 G	A449 QT	A36 G	A449 QT	A36 G	A449 QT	A449 QT	A36 G	A449 QT	A449 QT	A449 QT	A449 QT	A572 Gr.50 HSLA
	Elm nut	W	W	W	W	W	W	W	W	DBL	W	DBL	W	DBL	DBL	W	DBL	DBL	DBL	DBL	W
Washer	Bel, in	-	-	-	-	-	-	-	-	-	-	-	-	3.00	3.00	-	3.00	3.00	3.00	3.00	-
	Tpl, in	-	-	-	-	-	-	-	-	-	-	-	-	0.500	0.500	-	0.500	0.500	0.500	0.500	-
	Dia bore, in	-	-	-	-	-	-	-	-	-	-	-	-	1.6525	1.6525	-	1.6525	1.6525	1.6525	1.6525	-
	Sp. Insp.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Anchors, HILTI HVA	# per leg	4	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Dia, in	1.250	-	-	-	-	1.250	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Ea, in	12.00	-	-	-	-	15.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Steel ASTM	A36	-	-	-	-	A193	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Sp. Insp.	Yes	-	-	-	-	Yes	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anchors, HILTI HSL-3	# per leg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Dia, in	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Ea, in	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Sp. Insp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calc. Sheet		F1	F2	F3	F4	F5	J1	J2	J3	J4	J5	K1	K2	K3	K4	K5	L1	L2	L3	L4	L5

REV.	ECN #	REVISION DESCRIPTION	BY	DATE

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PART NUMBER 11682254

APPROVED	DATE
	5/5/02

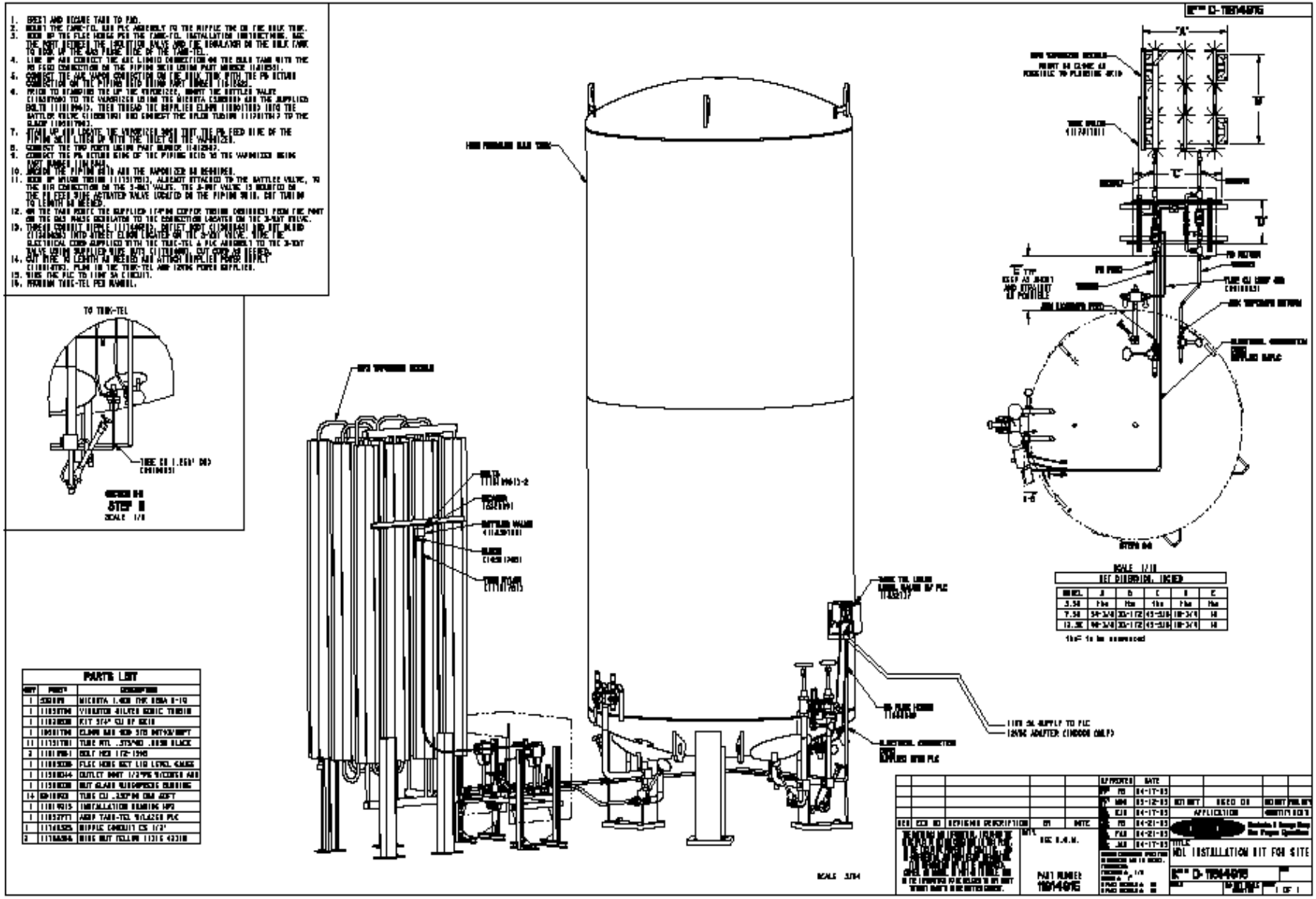
NEXT ASSY	USED ON	NEXT ASSY	FINAL ASSY
APPLICATION		QUANTITY REQ'D	

[redacted] Storage Systems Division Mira Loma Operations

TITLE FOUNDATION L/D ZONE0/4 175-500PSI

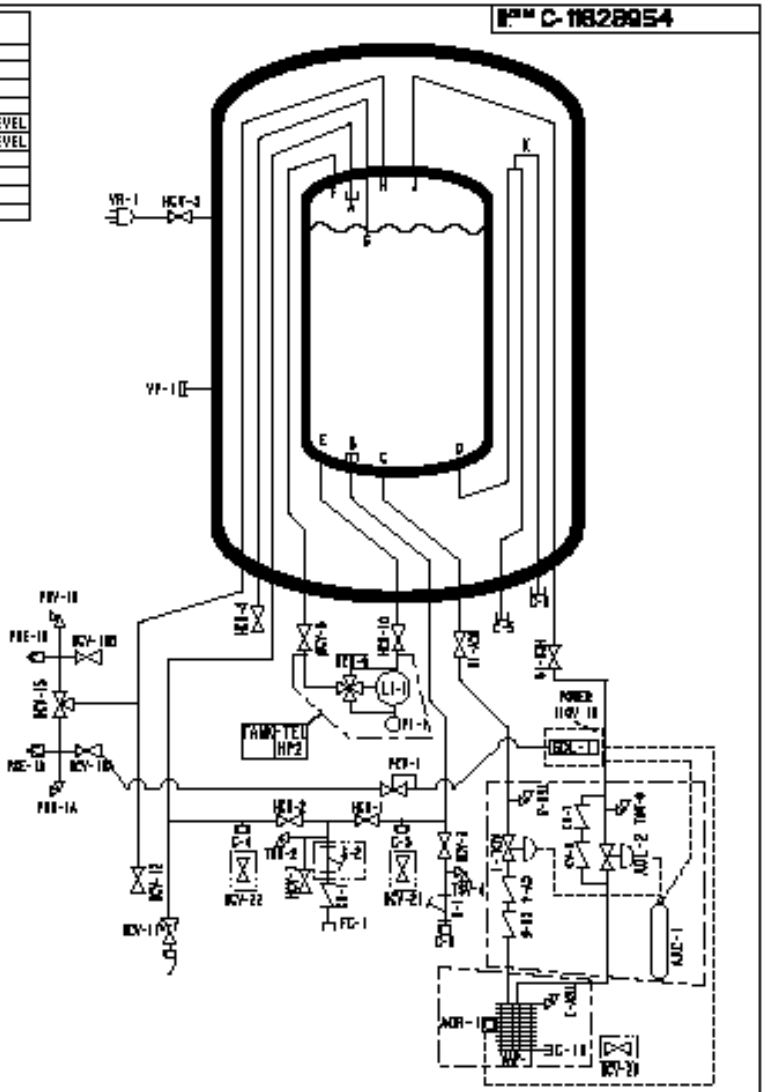
DRAWING NO. C-11682254 REV.

SCALE N/A SHEET 5 OF 5



PIPING LEGEND				
TAG DESIGNATION		CHART NO	VENDOR INFORMATION	SIZE
ANC-1	ACCUMULATOR	11710515	SWAGELOK 304L-HDF4-500	1/4" FPT
AGR-1	RATTLER VALVE	11858700	BLISSELL MANUFACTURING RST-25	3/8" FPT
C-5	CONNECTION, SECONDARY AUX LIQUID			1" MPT
C-6	CONNECTION, SECONDARY AUX VAPOR			1" FPT
C-3	CONNECTION, GAS USE			1" FPT
C-8	CONNECTION, ECONOMIZER			1/2" MPT
C-1	CONNECTION, PB RETURN			1" FPT
C-4	CONNECTION, PB FEED			1/2" FPT
CV-1	FILL LINE CHECK VALVE		REGO BTCV8S1E	1-1/2" MPB
FC-1	FILL CONNECTION	10481803	CGA LIN (ACCESSORY NUMBER)	1-1/2 SAE
		10421813	CGA LOX (ACCESSORY NUMBER)	
		10321821	CGA LAR (ACCESSORY NUMBER)	
BCV-1	BOTTOM FILL VALVE	11388231	REGO B81A1404	1-1/2" MPB
BCV-2	TOP FILL VALVE	11388231	REGO B81A1404	1-1/2" MPS
BCV-3	PB INLET VALVE	11388251	REGO B8164A4	1/2" MPB
BCV-4	FILL TRYCOCK VALVE	11388267	REGO B8184A3FA8	3/8" FPT
BCV-5	VACUUM GAUGE TUBE VALVE	10482301	HOKE 4111L2B	1/8" FPT
BCV-7	FILL LINE DRAIN VALVE	11388231	REGO B8184A0	3/8" FPT
BCV-8	LI-1 VAPOR PHASE VALVE	10187290	REGO BCW82SA	1/4" MPT
BCV-9	LI-1 EQUALIZATION VALVE	10187350	REGO BCW82S0	1/4" MPT
BCV-10	LI-1 LIQUID PHASE VALVE	10187E30	REGO BCW82S0	1/4" MPT
BCV-11	PB OUTLET VALVE	11384231	REGO B8184A4	1/2" MPS
BCV-12	VAPOR VENT VALVE	11375321	REGO B8184A6	1" FPT
BCV-16	SAFETY RELIEF SELECTOR VALVE	11402180	HEROSE BORED PN45	1" BPS
BCV-14	AUXILLARY LIQUID VALVE	11378413	REGO B8184A0	1" FPT
BCV-15	VAPOR RETURN VALVE	11368273	REGO B8184A6	1" FPT
BCV-20	GAS USE VALVE	11657A64	KANTLEAK AV020115-3	1" FPT
PCV-1	PRESSURE CONTROL VALVE	11831723	FOXX EQUIPMENT	1/4" FPT
PSE-1A	PRESSURE SAFETY ELEMENT, INNER	11384321	CONTINENTAL OR BIRAM (1500 PSI)	3/4" MPT x FREE
PSE-1B		11513E74	CONTINENTAL OR BIRAM (1750 PSI)	
PSV-1A	PRESSURE SAFETY VALVE, INNER	11464343	HEROSE 00H300-1000-0440 1400 PSI	3/4" MPT x 1" FPT
PSV-1B		11558348	HEROSE 00H300-1000-0450 1500 PSI	
S-1	STRAINER, PRESSURE BUILDING	11387202	UNITED BRASS 02100H6 6004 BRS	1/2" FPT
TSV-2	FILL LINE THERMAL RELIEF	11565805	REGO BP1V443ET0B0	1/4" MPT
TSV-4	PB CIRCUIT THERMAL RELIEF	11565803	REGO BP1V443ET0B0	1/4" MPT
VP-1	VACUUM PORT	10426172	CHART SUPPLIED	3-1/2" MPS
VR-1	VACUUM READOUT	4210049	HASTINGS 40V-6R	
HP2 SYSTEM				
CV-4	PB SURGE CHECK VALVE			PER ORDER
CV-5	PB SURGE CHECK VALVE			PER ORDER
CV-6	PB SURGE CHECK VALVE			PER ORDER
CV-7	PB SURGE CHECK VALVE			PER ORDER
SOL-1	PRESSURE SWITCH			PER ORDER
AQL-1	PRESSURE CONTROL VALVE			PER ORDER
AQL-2	PRESSURE CONTROL VALVE			PER ORDER
TSV-3	PB CIRCUIT THERMAL RELIEF FEED			PER ORDER
TSV-6	PB CIRCUIT THERMAL RELIEF RTN			PER ORDER
VAP-1	PRESSURE BUILDING END			PER ORDER
	GAS WARMING COIL			
FLO-1	FLOWMETER	11781537	HEDLAND	PER ORDER
HCV-20	BALL VALVE	10822200	WORCESTER	PER ORDER
C-11	CORN GAS USE			
OPTIONAL ON ALL TANK SIZES				
C-9	CONNECTION, CUSTOMER HOSELINE			PER ORDER
CV-2	ROUBELTIE CHECK VALVE			PER ORDER
HCV-16A	RELIEF LINE PURGE VALVE	10187E30	REGO	PER ORDER
HCV-16B	RELIEF LINE PURGE VALVE	10187229	REGO	PER ORDER
HCV-21	SEC AUX LIQUID VALVE		REGO	PER ORDER
HCV-22	SEC AUX VAPOR VALVE		REGO	PER ORDER
S-2	FILL STRAINER	11188263	REGO BTSV8S12-8	PER ORDER

INTERNAL LINE SIZES		
A	1-1/2" PS	TOP FILL
B	1-1/2" PS	BOTTOM FILL
C	1-1/2" PS	AUX. LIQUID
D	1" PS	GAS USE
E	1/2" OD	LOWER LIQ. LEVEL
F	3/8" OD	UPPER LIQ. LEVEL
G	3/8" OD	FILL TRYCOCK
H	1" PS	VENT
J	1" PS	AUX. VAPOR
K	5/8" OST	ECONOMIZER



REV	ECR NO	REVISION DESCRIPTION	BY	DATE

APPROVED YB DATE 05-30-03

USED ON APPLICATION

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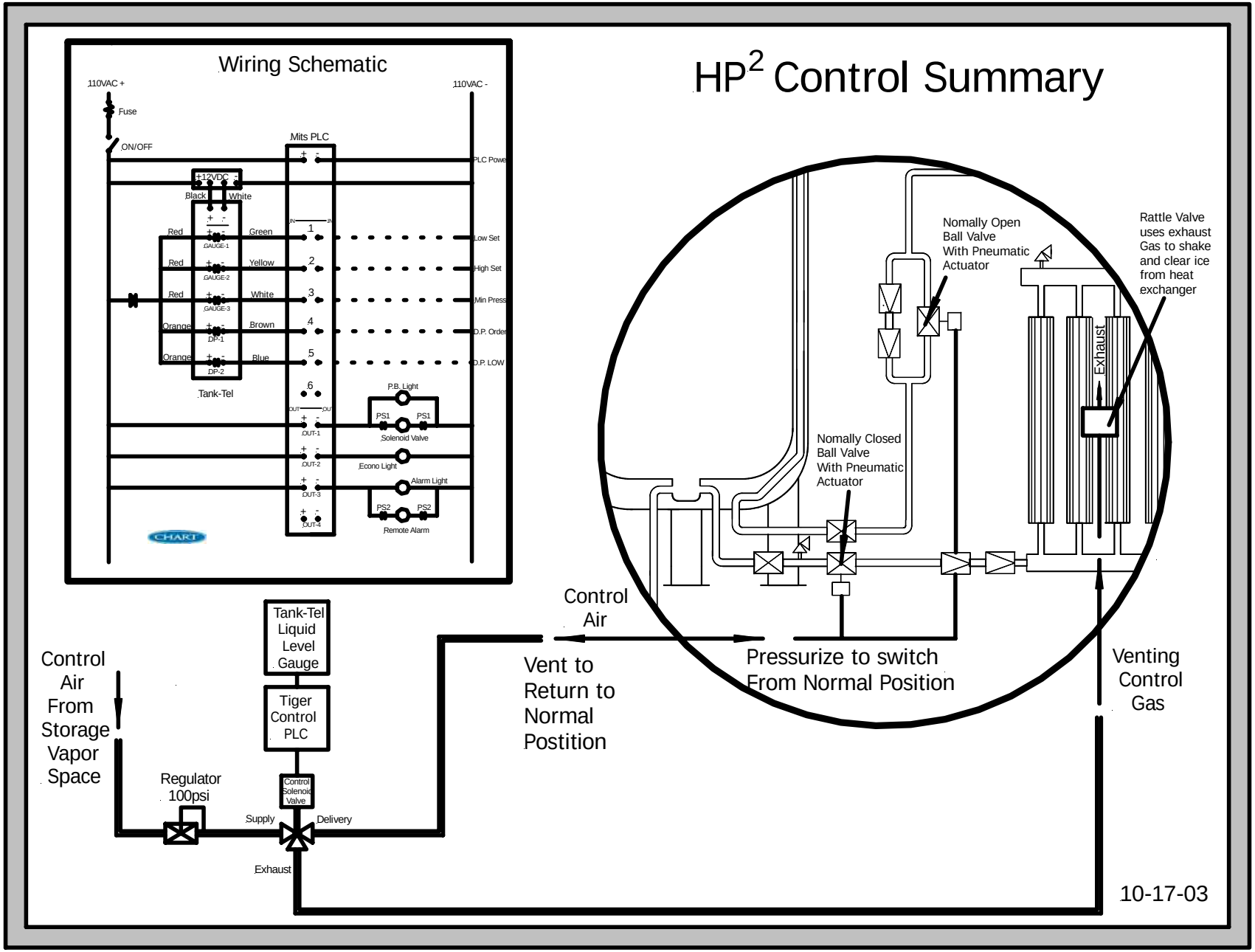
PART NUMBER 11828954

DRAWING NO. C-11828954

SHEET 2 OF 2

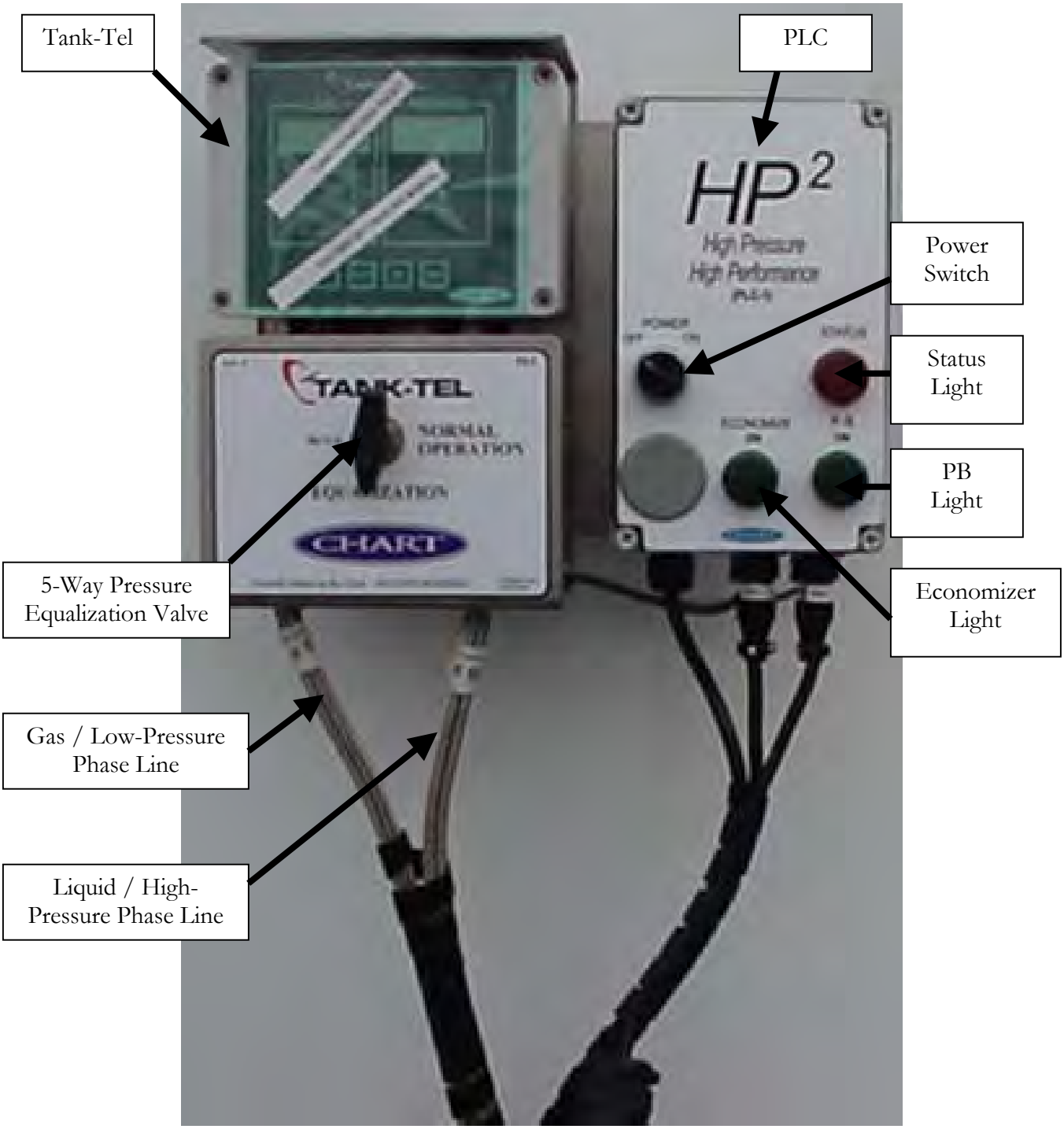


HP^2 System Photographs

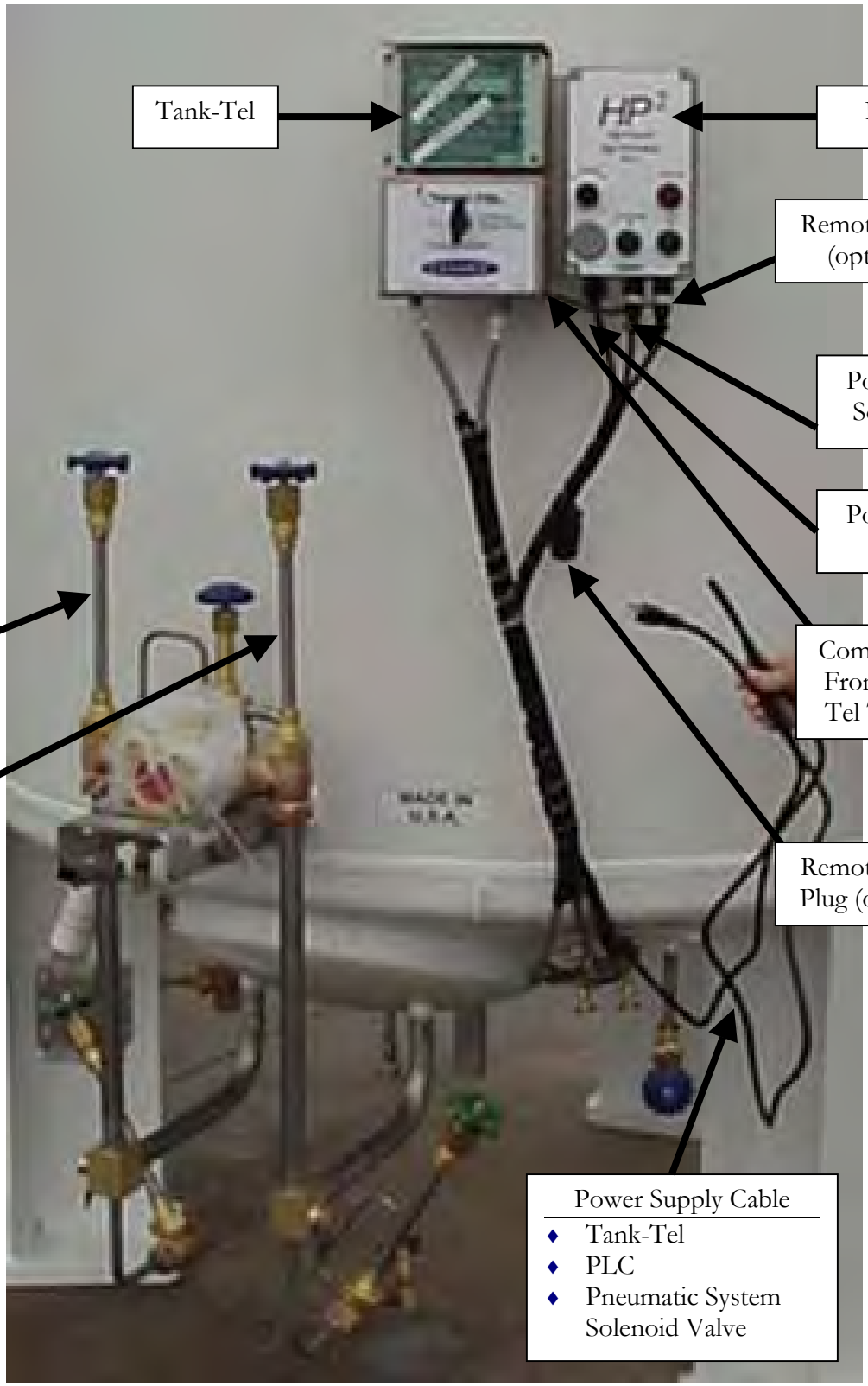
HP^2 Technology is a proprietary product of Chart Industries, Inc. and is protected by pending patents.

Primary Components of HP^2 System

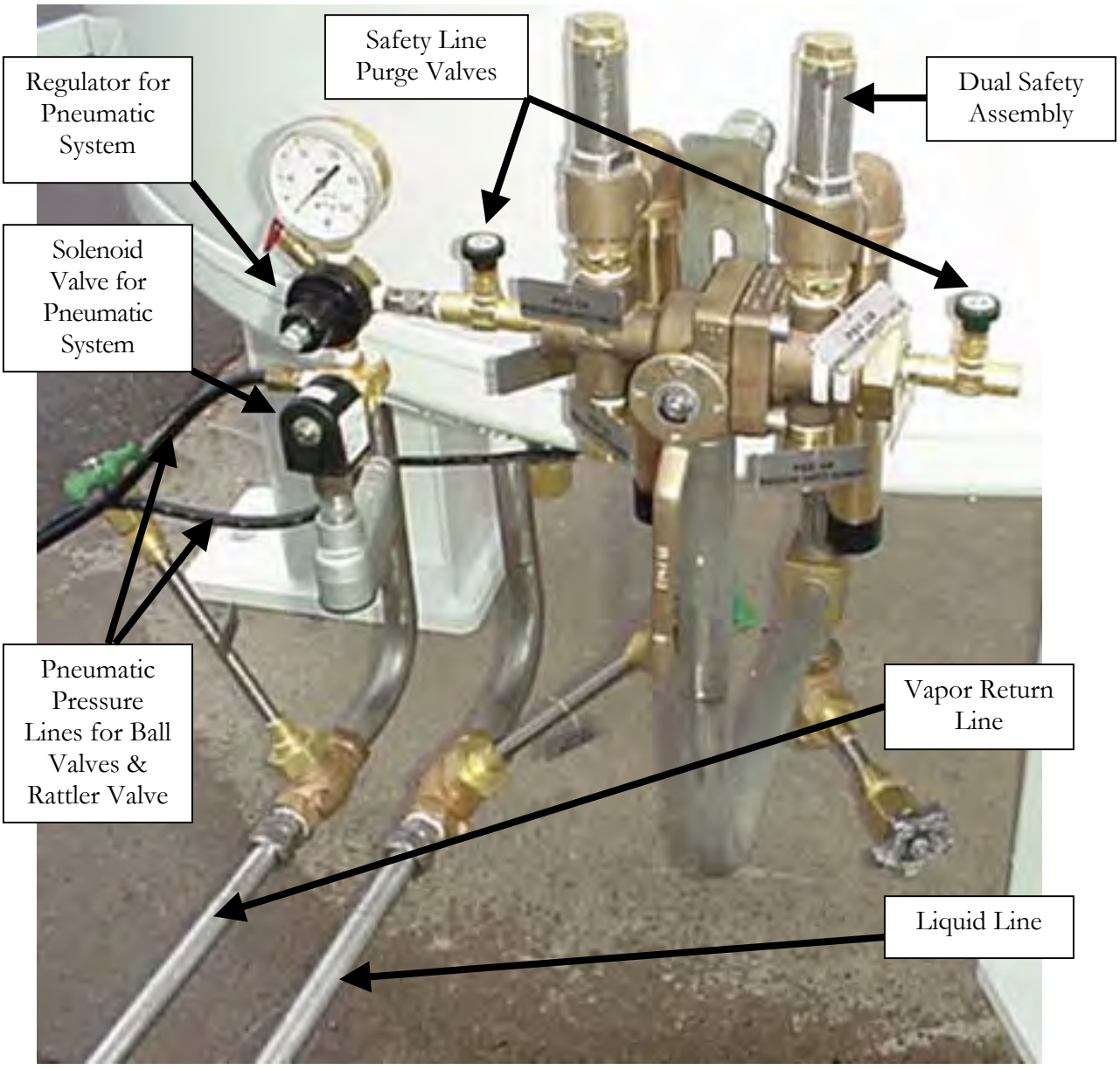
Tank-Tel & PLC



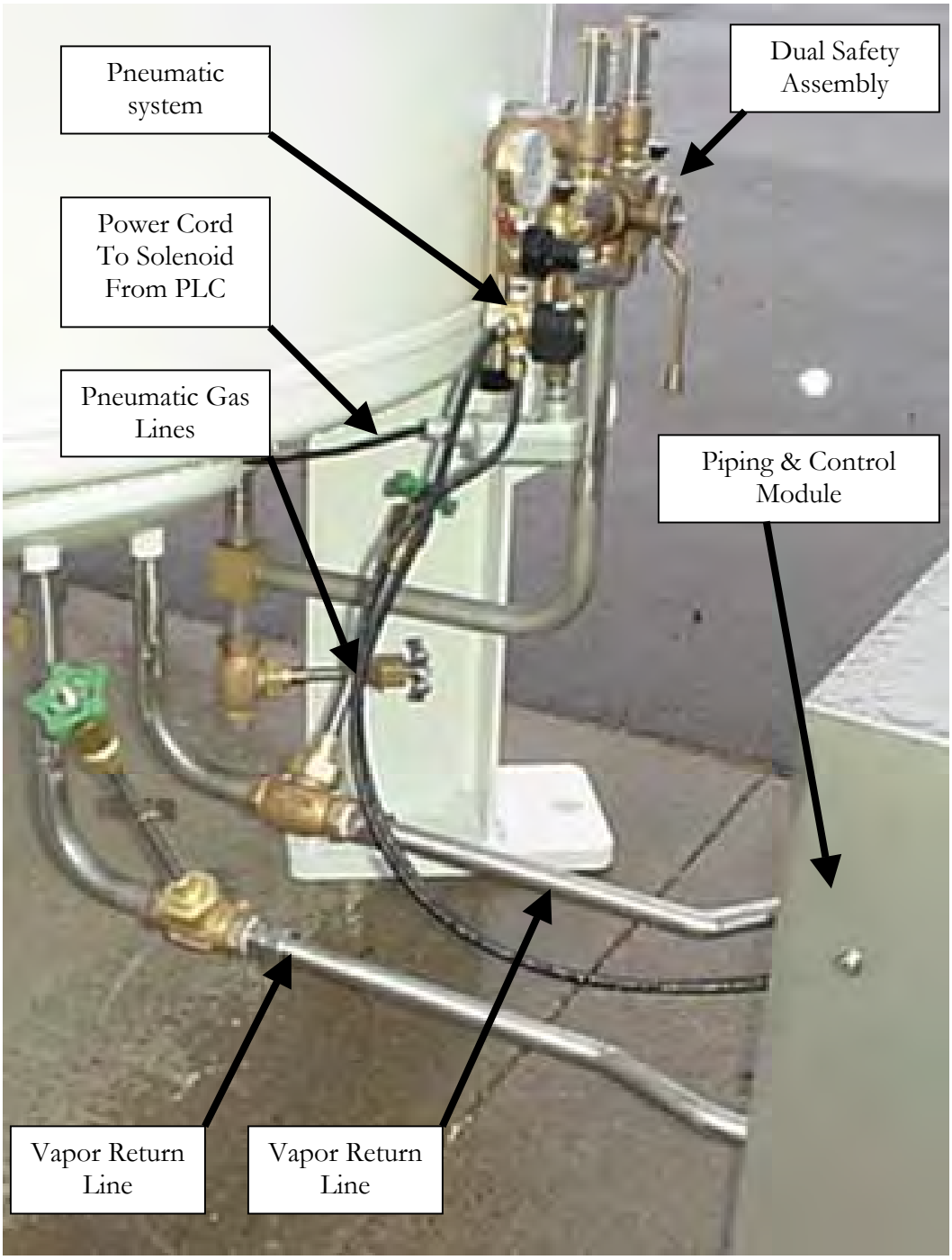
Tank-Tel & PLC



Pneumatic System for Ball Valves & Rattler Valve



Connections From Tank To Piping & Control Module



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Part No. 11828962 Revision 0 Dated 10/2003