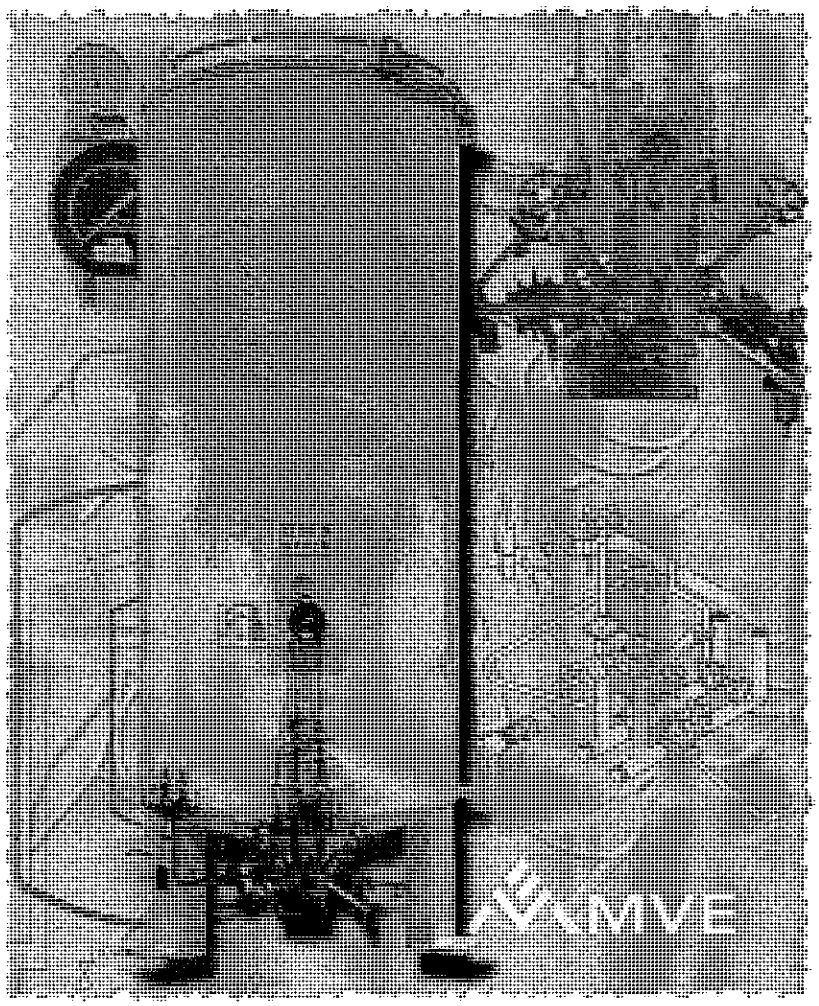
VERTICAL BULK STORAGE TANKS



WOLVERINE PLUMBING
USER MANUAL

- VCS-525
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MVE

PREFACE 1

General

The Wolverine Storage Tank users manual is designed to be used in conjunction with all vertical cryogenic storage tanks provided by MVE, Inc. This manual contains information regarding the safe operation and handling of liquid nitrogen, argon, and oxygen with the Wolverine Storage Tankage. It should be thoroughly read and understood by anyone that operates the equipment. If there are any questions regarding the operation of the Wolverine Storage Tank, contact MVE's Technical Service division at:

MVE, Inc.
407 Seventh St. NW
New Prague, MN 56071
(800) 400-4MVE

This manual is intended to provide the user with all the necessary information needed to install, operate and maintain the Wolverine Storage Tank.

The schematics, piping illustrations, and parts list shows a reference number for each component used on the Wolverine Storage Tank. The reference numbers may refer to the same functional component between the various models. The reference numbers will be used throughout this manual to draw specific attention to a component while describing it's function, operation, or repair.

The safety requirements for operating the Wolverine Storage Tank and handling and transporting cryogenic products are shown in sections 3. Use this safety section as a "Safety Check-List" each time the equipment is being used.

Section 4 discusses the general features of the tank and the theory of operation.

Section 5 illustrates how to uncrate and install the Wolverine Storage Tank.

Section 6 shows how to remove and relocate a tank.

Section 7 gives a step by step procedure for the basic operation of the tank.

Section 8 indicates how to maintain and repair the Wolverine Storage Tank.

Sections 9 through 12 describe the specific Wolverine Storage Tank models covered by this manual. It has general information, technical specifications, plumbing schematics, pad layout and parts list. It should be reviewed first and referred to as the rest of the manual is read.

Terms

Throughout this manual safety precautions will be designated as follows:

WARNING – Description of a condition that can result in personal injury or death.

CAUTION – Description of a condition that can result in equipment or component damage.

NOTE – A statement that contains information that is important enough to emphasize or repeat.

Abbreviations

The following abbreviations and acronyms are used throughout this manual:

CGA	Compressed Gas Association
FPT	Female Pipe Thread
MPT	Male Pipe Thread
MVE	MVE, Inc.
NPT	National Pipe Thread
NER	Normal Evaporation Rate
NR	Not Required
ODT	Outside Diameter Tube Size
P/N	Part Number
PPM	Parts per Million
PSI	Pounds per Square Inch
PSIG	Pounds per Square Inch (Gauge)
SCF	Standard Cubic Feet
SS	Stainless Steel
PB	Pressure Builder
Nm^3	Normal Cubic Meters
GAL	Gallons
MM	Millimeters
KG	Kilogram
LB	Pound
ASME	American Society of Mechanical Engineers

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The Wolverine Storage Tank consists of an inner pressure vessel encased within an outer carbon steel vacuum shell. The container operates under low-to-medium pressure, but is protected from over pressurization by use of a rupture disc and a safety relief valve. Safety relief devices are used to protect the pressure vessel and vacuum casing, sized and selected in accordance with ASME standards to include a dual relief valve and rupture disc system to protect the pressure vessel, and a reverse buckling rupture disc or lift plate to protect the vacuum casing (outer vessel). The Wolverine Storage Tanks are designed and engineered for safe, reliable operations, and are durable enough to provide many years of trouble-free operation. Strict compliance with proper safety and handling practices is necessary when using a Wolverine Storage Tank. We recommend that all our customers re-emphasize safety and safe handling practices to all their employees and customers. While every possible safety feature has been designed into the units and safe operations are anticipated, it is essential that every user of the Wolverine Storage Tank carefully read all **WARNINGS** and *CAUTIONS* listed and enumerated in this safety section sheet and contained in the manual itself. Also read the information provided in the safety bulletins for oxygen and inert gases. Periodic review of this safety summary is recommended

WARNING

In an oxygen enriched atmosphere, flammable items burn vigorously and could explode. Excess accumulation of oxygen creates an oxygen enriched atmosphere (defined by the Compressed Gas Association as an oxygen concentration above 23%). Certain items considered non-combustible in air may burn rapidly in such an environment. Keep all organic materials and other flammable substances away from possible contact with oxygen; particularly oil, grease, kerosene, cloth, wood, paint, tar, coal, dust, and dirt which may contain oil or grease. Do not permit smoking or open flame in any area where oxygen is stored, handled, or used. Failure to comply with this warning may result in serious personal injury.

WARNING

Nitrogen and argon vapors in air may dilute the concentration of oxygen necessary to support or sustain life. Exposure to such an oxygen deficient atmosphere can lead to unconsciousness and serious injury, including death.

WARNING

Before removing any parts or loosening fittings, empty a cryogenic container of liquid contents and release any vapor pressure in a safe manner. External valves and fittings can become extremely cold and may cause painful burns to personnel unless properly protected. Personnel must wear protective gloves and eye protection whenever removing parts or loosening fittings. Failure to do so may result in personal injury due to the extreme cold and pressure in the tank.

WARNING

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

WARNING

If clothing should be splashed with liquid oxygen it will become highly flammable and easily ignited while concentrated oxygen remains. Such clothing must be aired out immediately, removing the clothing if possible, and should not be considered safe for at least 30 minutes.

Caution

Use only replacement parts that are compatible with liquid oxygen and have been cleaned for oxygen use. Do not use regulators, fittings, hoses, etc., which have been previously used in a compressed air environment. Similarly, do not use oxygen equipment for compressed air. Failure to comply with these instructions may result in serious damage to the container.

Caution

Before locating oxygen equipment, become familiar with the National Fire Protection Association (NFPA) standard No. 50, "Bulk Oxygen Systems at Customer Sites", and with all local safety codes. The NFPA standard cover general principles recommended for installing bulk oxygen systems on industrial and institutional consumer premises.

Caution

To prevent possible tip over, do not leave tank standing upright unless it is secured to its foundation (bolted down). Transporting and erection of the tank should be performed in accordance with rigging instructions available from MVE. Failure to comply with these instructions may result in serious damage to the container.

3 SAFETY

Safety Bulletin

Portions of the following information is extracted from Safety Bulletin SB-2 from the Compressed Gas Association, Inc. Additional information on oxygen, nitrogen, argon, and cryogenics is available from the CGA. Write to the (CGA) Compressed Gas Association, Inc., 1235 Jefferson Davis Highway, Arlington, VA 22202.

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

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

Incidents which require that such practices be followed include: highway accidents, immersion in water, exposure to extreme heat or fire, and exposure to most adverse weather conditions (earthquakes, tornadoes, etc.). As a rule of thumb, when ever a container is suspected of abnormal operation, or has sustained actual damage, good safety practices must be followed.

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

Prior to reusing damaged container, the unit must be tested, evaluated, and repaired as necessary. It is highly recommended that any damaged container be returned to MVE for repair and recertification.

The remainder of this safety bulletin addresses those adverse environments that may be encountered when a cryogenic container has been severely damaged. These are oxygen deficient atmospheres, oxygen enriched atmospheres, and exposure to inert gases.

Oxygen Deficient Atmospheres

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

One aspect of this possible hazard is the response of humans when exposed to an atmosphere containing only 8 to 12% oxygen. In this environment, unconsciousness can be immediate with virtually no warning.

When the oxygen content of air is reduced to about 15 or 16%, the flame of ordinary combustible materials, including those commonly used as fuel for heat or light, may be extinguished. Somewhat below this concentration, an individual breathing the air is mentally incapable of diagnosing the situation because the onset of symptoms such as sleepiness, fatigue, lassitude, loss of coordination, errors in judgment and confusion.

Human exposure to atmosphere containing 12% or less oxygen leads to rapid unconsciousness. Unconsciousness can occur so rapidly that the user is rendered essentially helpless. This can occur if the condition is reached by an immediate change in 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 enter the area to assist an unconscious partner unless equipped with a portable air supply. Best protection is obtainable by equipping all individuals with a portable supply of respirable air. Life lines are acceptable only if the area is essentially free of obstructions and individuals can assist one another without constraint.

Oxygen Cleaning

When replacing components, only use parts which are considered compatible with liquid oxygen and have been properly cleaned for oxygen service. (Refer to CGA Bulletin G.4.1 "Equipment Cleaned for Oxygen Service"). Do not use regulators, fittings, or hoses which were previously used in a compressed air environment on these tanks. Only oxygen compatible sealants or Teflon tape should be used on threaded fittings. Only Teflon tape should be used on aluminum threads. All new piping joints should be leak tested with an oxygen compatible leak-test solution. When degreasing, a compatible solvent should be used.

If 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 air line breathing equipment.

Oxygen Enriched Atmosphere

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

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

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

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

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

Nitrogen and Argon

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

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

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

4 INTRODUCTION

General

The MVE Wolverine Storage Tanks are a compact and self-contained cryogenic system designed for the economical storage of liquid nitrogen, oxygen, or argon with the ability to provide it to the application as either liquid or gas.

The MVE model designation for a particular tank can be found on the tank data plate and its associated paper work. The model designation shows the following information about the Wolverine Storage Tank.

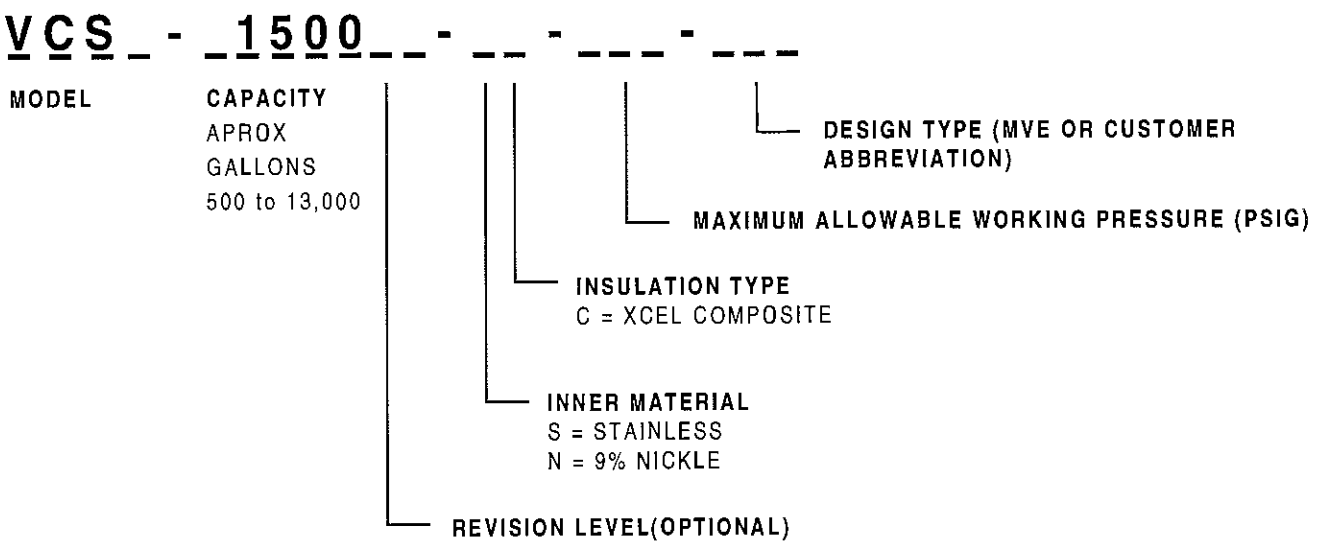
The first two sections of the model designation are used throughout section 9 and 10 of this manual for specific information.

NOTE: Refer to chapters 9 and 10 of this manual to see the specific model specification, charts, schematics, and parts covered by the contents of this manual.

Features

The Wolverine Storage Tanks are designed to provide a convenient, reliable, and economical method for the storage and delivery of liquid oxygen, nitrogen, and argon. Important features of these containers include:

1. Long-term hold time due to highly efficient multilayer insulation systems.
2. A pressure building system that can be used to increase working pressure during high withdrawal operations.
3. An economizer system that lowers tank pressure during normal operations to prevent the loss of product through the relief valve (VCS/HCS only).
4. A top and bottom fill line that allows the tank to be refilled from a liquid supply unit by either pumping or pressure transfer.
5. Simple and convenient piping controls to reduce the number of fittings and components. The control valves are modular units. The fill module has top, bottom and pressure control isolation valves. The pressure control regulator acts as the Pressure Builder and economizer with a built-in isolation valve. The vent module has a dual safety valve and manual vent valve.
6. Auxiliary liquid and gas use.



Physical Description

The Wolverine Storage Tank is designed for long-term storage of cryogenic liquefied gases under pressure in the range of 5 to 250 psig (.35 to 17.6 Kg/cm^2). Operation of the tank is fully automatic with the unit's regulator systems set to maintain preset pressure and flow conditions into a customer's pipeline. While hardware may vary slightly from model to model, each unit essentially performs the same functions.

The Wolverine Storage Tank 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 multiple layer 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 Wolverine Storage Tanks are provided with legs for mounting. The legs have mounting holes for attachment to the facility pad.

Caution

To prevent possible tip over, do not leave tank standing upright unless it is secured to its foundation (bolted down) Transporting and erection of the tank should be performed in accordance with rigging instructions available from MVE. Failure to comply with these instructions may result in serious damage to the container.

On the smaller tanks (300-1500 gallon), lifting lugs are secured to one leg and to the top head of the container. On units larger than 1500 gallons, the lifting lugs are located on the top and bottom heads. The lifting lugs are provided to facilitate handling. Moving requires the use of a crane and adherence to specific rigging instructions (see section 5 in this manual for details on handling).

Caution

MVE Wolverine vessels are not designed to be moved with liquid in the inner container. Vessels must be drained completely before being lifted or moved.

Safety Devices

The vessels are protected from over-pressurization with a tank pressure relief device. The normal relief device pressure setting is at the operating pressure of the inner vessel. Other relief valve pressure settings are available as long as they are not greater than the operating pressure of the inner vessel.

Each container is further protected from over-pressurization by a secondary rupture disc assembly. This 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.

Caution

The vacuum space is protected from over-pressurization by use of a tank annular space rupture disc assembly.

NOTE: Safety devices meet all of the requirements of CGA Pamphlet S-1.2, *Safety Relief Device Standards, Part 2, Cargo and Portable Tanks for Compressed Gases.*

Operational Systems

The Wolverine Storage Tank has the ability to be filled with a cryogenic product, build pressure inside the vessel, and deliver either liquid or gas for a specific application.

The following section will discuss the theory behind these operations. The illustrations show a vertically configured tank with the Wolverine piping modules.

All operations are done completely with the control valves located on the underside of the tank. The valves are labeled for easy identification.

The schematic, illustrations, and table (figure H) show how the plumbing circuitry operates for the Wolverine Storage Tank. It is important that the operators be familiar with the plumbing control valves and their functions as shown in section 9.

4 INTRODUCTION

Filling

The following recommendations should be used to optimize tank filling:

1. Keep the transfer lines as short as possible. Long uninsulated transfer lines will result in higher fill losses and longer fill times.
2. Anytime liquid can be entrapped in a line between two valves, the line must be equipped with a safety relief device.
3. Conduct the filling operation in as short a time as possible.

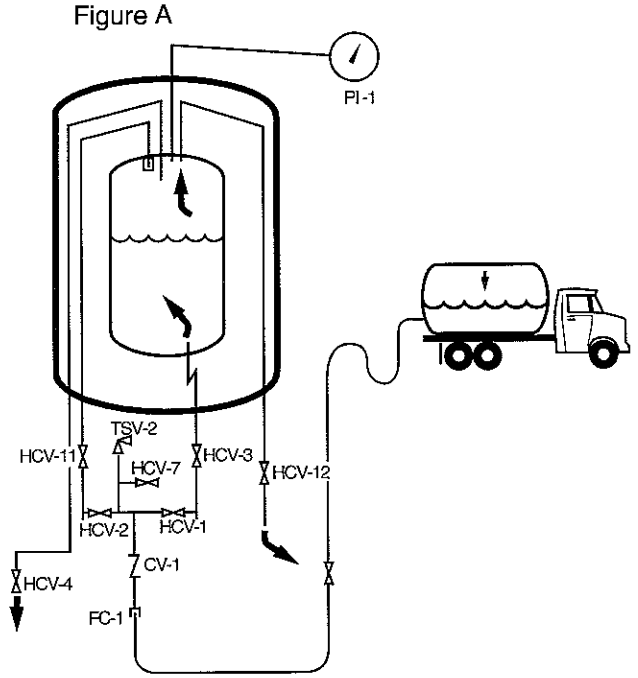
The Wolverine Storage Tank should be visually inspected before every fill for possible damage, cleanliness, and suitability for its intended gas service. If damage is detected (i.e., serious dents, loose fittings, etc.) repair the unit as soon as possible.

All MVE Wolverine Storage Tanks are shipped with low-purity gaseous nitrogen to prevent moisture from entering the tank. For this reason the tank should be thoroughly purged with the applicable gas prior to filling.

When filling a Wolverine Storage Tank with a cryogenic liquid, the transfer may be made with a centrifugal pump or through a pressure transfer operation.

Pressure Transfer

Figure A



Pressure Transfer Filling (Figure A)

Liquid will always flow from a vessel of higher pressure to one with low pressure. This method is commonly used to fill a small Wolverine Storage Tank by connecting a transfer line between the delivery source and the top fill valve (HCV-2) of the Wolverine Storage Tank.

Liquid may be transferred into the tank so that venting is not necessary. The top fill valve (HCV-2) on the Wolverine Storage Tank has a spray header that will splash the incoming cold liquid onto the somewhat warmer gas in the tank. The cold liquid will actually collapse the vessel pressure while being sprayed into the warmer gas. The bottom fill valve allows liquid to be transferred into the tank at a fast rate. The tank pressure can be maintained at a constant pressure level (PI-1) by opening the bottom fill valve (HCV-1) completely and throttling open the top fill valve to lower and maintain a constant pressure. The full trycock valve (HCV-4) spits liquid when the vessel becomes full.

If the pressure in the receiving tank is higher than the transport, blow down of the pressure in the receiving tank may be required.

Since there are many variables in pressure transfer deliveries, it is also possible to connect a transfer line between the delivery source and the bottom fill valve (HCV-1) of the Wolverine Storage Tank. The transfer takes place as the vent valve (HCV-12) of the Wolverine Storage Tank is opened. This allows gas to escape and lowers the pressure in the receiving tank. The full trycock valve (HCV-4) spits liquid when the vessel becomes full.

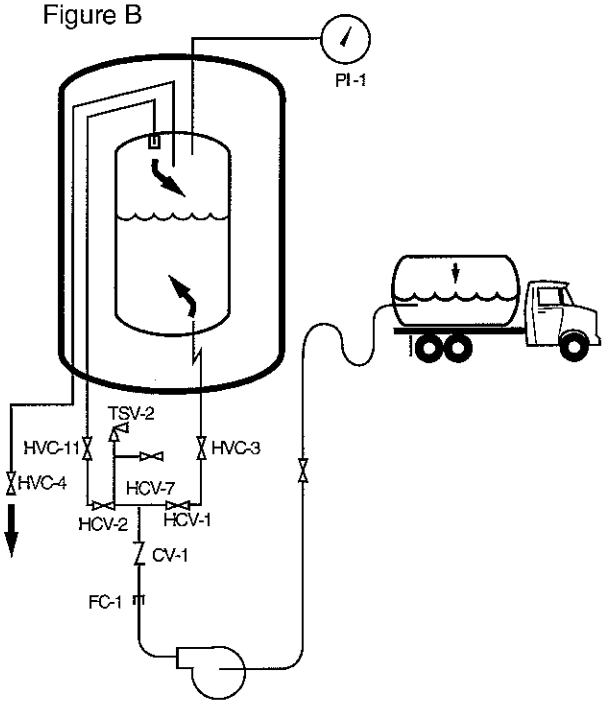
NOTE: (HCV-3) PB inlet and (HCV-11) PB outlet must remain fully open during fill operation.

Pump Transfer (Figure B)

The pump transfer method is the most commonly used to fill the Wolverine Storage Tank. Top and bottom filling lowers the product losses associated with filling. Liquid may be pumped into the tank so that venting is not necessary. The top fill valve (HCV-2) on the Wolverine Storage Tank has a spray header that will splash the incoming cold liquid onto the somewhat warmer gas in the tank. The cold liquid will actually collapse the vessel pressure while being sprayed into the warmer gas. The bottom fill valve allows liquid to be pumped into the tank at a fast rate. The tank pressure can be maintained at a constant pressure level (P1-1) by opening the bottom fill valve (HCV-1) completely

Pump Transfer

Figure B



and throttling open the top fill valve to lower and maintain a constant pressure. The full trycock valve (HCV-4) spits liquid when the vessel becomes full.

Gas Withdrawal (Figure C)

When a Wolverine model is used for gas withdrawal, the normal operating pressure range is controlled by the pressure settings of both the pressure building and economizer functions of the pressure control valve (PCV-1). The economizer regulator is set approximately 7-8 psi (1.0 kg/cm²) higher than the pressure building portion of the pressure control valve (PCV-1).

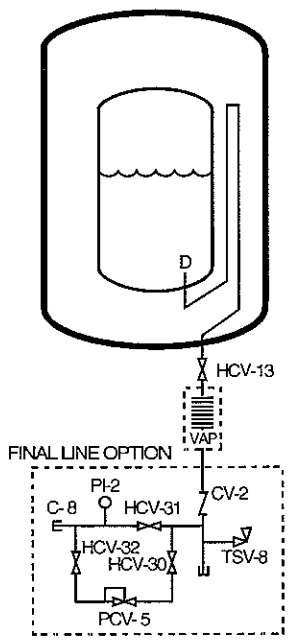
When the supply of gaseous product is the primary operation of the tank, external vaporizers and an additional regulator must be added after the gas use valve (HCV-13) to step down the pressure to the gas application. This regulator (PCV-5) is found in the final line option provided by MVE.

When the operating pressure of the tank is above the economizer setting the regulator will open and the gas that is being supplied to the application will be pulled out of the vapor space in the top of the tank (A). It will travel through the pressure control valve (PCV-1) and then back into the tank where it connects to the gas use line (K) before it reaches the final line valve (HCV-13). The action of removing gas from the tank reduces the tank's pressure.

When the operating pressure is reduced to the economizer setting, the pressure control valve (PCV-1) will close. Gas is still required by the application and will pull liquid up the dip tube (D) and into the gas use line (see Figure C). It will then go through an external

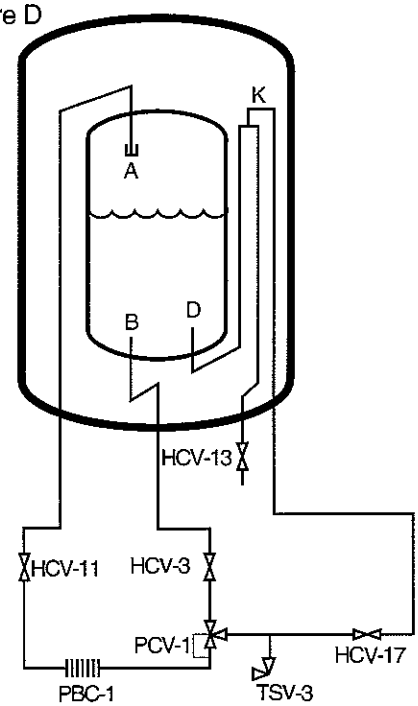
Gas Withdrawal

Figure C



Pressure Building & Economizer

Figure D



vaporizer that turns the liquid into gas and warms it before it is delivered to the final line regulator. The pressure decay will be much slower since a small amount of liquid can be vaporized into a large amount of gas.

When the pressure falls below the pressure building setting, the pressure control valve (PCV-1) will open for pressure building. This will allow liquid from the bottom of the tank to run into the pressure builder vaporizer (PB-1). The liquid will turn into gas and be delivered back into the top vapor space of the tank (A). The results of this operation is a rise in pressure in the tank.

Liquid Withdrawal

If the Wolverine tank is to be placed in permanent liquid withdrawal service, it is recommended that the liquid withdrawal line be connected to vacuum jacketed piping. The piping will efficiently bring the liquid to the application with the least amount of pressure rise.

Normal liquid withdrawal operations are performed at lower pressure (approx. 22 psig) (1.5 Kg/cm²) to reduce flash-off losses and splashing. For this reason, the pressure building valve is customarily closed during liquid withdrawals. Transfer of liquid at higher pressure can lead to excessive splashing of the cryogenic liquid which could result in burns to the operator and/or nearby personnel. All personnel should be fully instructed in the cautions associated with handling cryogenic fluids and the proper clothing and protective gear to be used.

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

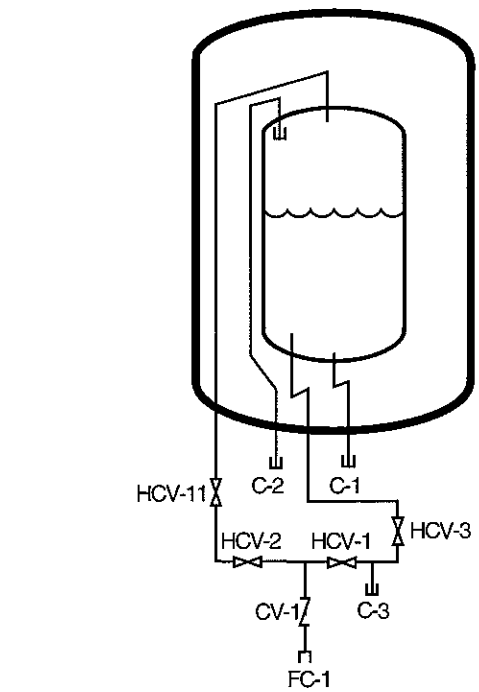
If a higher operating pressure is desired (other than that available through normal heat leak), the pressure building valve may be opened for a short time until the preferred pressure has been obtained. If automatic pressure building for liquid service is necessary, a low pressure spring may be installed to replace the existing spring in the pressure building regulator supplied with the unit. Liquid withdrawal applications can be attached to either the C-1 or C-3 connection.

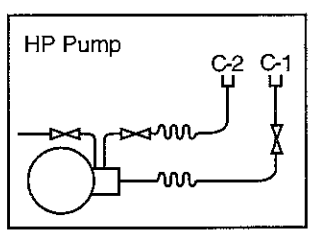
Liquid Withdrawal (For Pumping)

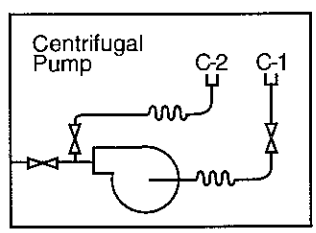
The Wolverine Storage Tank has a set of capped ports for pump connections. The auxiliary liquid line (C-1) can be used to feed liquid into a cryogenic pump. The auxiliary vapor line (C-2) can be used as a pump vapor return line that aides pump cool-down. Consult the pump manufactures for recommended connections to these auxiliary pump connectors.

Liquid Withdrawal

Figure E







General

This section deals with the receiving and uncrating the Wolverine Storage Tank. It explains how to connect to the tank and unload it from the truck or shipping container. It provides the owner with a list of inspections that should be done before receiving the tank. It discusses general considerations for the tank's final location.

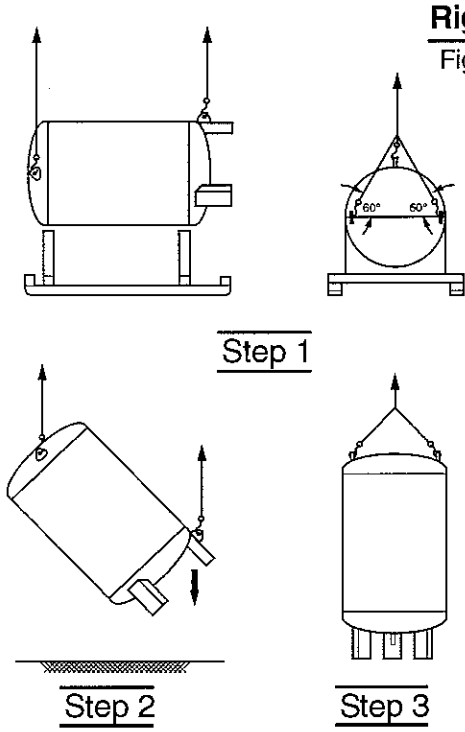
Rigging General Handling Instructions

Installation of a Wolverine Storage Tank at the storage site requires the use of a lift crane. For tank models through 1500, a crane with one hoist maybe used. For models 3000 and larger, it is recommended that two cranes be used.

NOTE: If the pad is not completed when the tank arrives, arrangements should be made to have the unit taken from the truck and stored in a protected area.

Rigging Details

The illustrations in figures F and G show the proper methods for handling and erecting the Wolverine Storage Tank.



Rigging
Figure F

Unloading

1. Connect to the lifting lug on the top of the tank and on the leg as shown in the rigging illustration.
2. Disconnect any chains, straps, or shipping braces that may have been used to hold the tank to the truck bed.
3. Lift the tank only a few inches and check to make sure there are no additional connections between the tank and trailer.
4. Remove the tank from the trailer and place it on the pad or designated hold area while pad is being constructed.

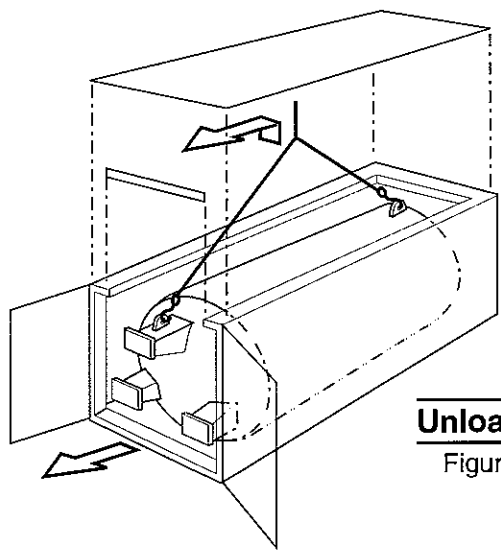
Cargo Container

The Wolverine 2900 is held in the 20 or 40 ft. container on a roller system which is at the front end of the tank.

The following procedure should be followed for removal of the tank.

1. Remove banding from vessel.
2. Connect chains to forklift and vessel.
3. Use forklift to slide vessel out of container. Lift back end of tank and remove with two (2) front shipping legs resting on rollers.

   Note: If two vessels are in shipping container, two (2) steel blocks must be removed from the two front shipping legs of the rear vessel. Blocks are bolted to shipping container floor.



Unloading
Figure G

5 INSTALLATION (Tank)

Wolverine Storage Tanks shipped in convertible top cargo containers should be unloaded as follows:

1. Remove the convertible top and end rail from the cargo container.
2. Connect chains to tank.
3. With the tank lifted only a few inches off the cargo container's floor, slide the tank horizontally out the end of the cargo container.
4. Lift the tank and place it on the pad or the designated hold area while the pad is being constructed.

Inspection

A receiving inspection is one of the most important operations in the life of the tank, and should be done thoroughly and conscientiously. Any indications of damage should be immediately reported to the freight company and MVE.

Receiving Checkpoints

1. Check braces, skids, wooden chocks, and other supports shipped with the tank. Damage or deformation would indicate the possibility of mishandling during shipment.
2. Examine welded or brazed joints on plumbing for cracks or deformation. Areas to check in particular are near valves and fittings.
3. Check the area where pipes exit from the tank for cracks or breaks.
4. Check the relief valves and burst discs for dirt damage.
5. Check the pressure in the vessel with the pressure gauge (P1-1). If pressure is "0" then extra precautions against contamination and impurities must be taken.
6. Examine the 5g impactograph located on the inside on one of the tank legs attached to the vessel head. If it has sprung, damage may have occurred during shipment. Notify your company's tank specialist and/or MVE.
7. Check the tank vacuum level using the vacuum test procedure.

Vacuum Test Procedure

CAUTION: Unauthorized changing of the vacuum probe (TC-1) will void vessel warranty.

1. The standard MVE probe (VR-1) is the Hastings DV-6R probe. Select a compatible instrument to match this type of probe.
2. Remove the rubber cap on the probe outlet to expose the contacts. Note that the probe housing need not be removed for this step.
3. Plug the instrument to the probe and calibrate the instrument.
4. Open the vacuum probe isolation valve. Wait for 5 minutes and take and record a vacuum reading. Note that the valve handle protrudes through the protective housing and can be turned without opening the housing.
5. Close the isolation valve and take a second reading. Monitor the rate of vacuum pressure rise in the vacuum probe with the isolation valve closed. If the vacuum continues to rise at a constant rate, it is possible that probe assembly is leaking. Consult the factory.
6. Verify that the isolation valve (HCV-5) is closed.
7. Replace rubber cap on probe.
8. Review the vacuum reading you recorded.
   a. If the first vacuum reading on "SP" and "NP" models is above 200 microns, consult factory.
   b. If the first vacuum reading for "SC" and "NC" models is above 20 microns, consult factory.
   c. If your last vacuum reading shows a steady increase from the first, consult the factory.

Site Considerations

If the Wolverine Storage Tank (particularly the larger units) are to be installed at the user's site, the following should be considered prior to the installation.

Prime considerations in choosing a site for the Wolverine Storage Tank are soil stability of the location, accessibility for servicing, and proximity to the liquid dispensing point.

Firm soil conditions are desirable to protect against settling of the facility and possible station damage. The foundation site must also be located such that drainage away from the foundation is ensured.

Since the Wolverine Storage Tank will be filled from a truck, it must be readily accessible. Generally, a location adjacent to a parking lot is most suitable. Since many liquid delivery hoses are at least 14 feet long, the container should be situated no more than 10 feet from the closest possible access.

If the tank is to be located out-of doors, the site selected should be such that the container and associated equipment (if any) will not be beneath or exposed by the failure of electric power lines, flammable or combustible liquid lines, or flammable gas lines.

Should the tank be located indoors, the building must be of noncombustible construction, be adequately vented and be used exclusively for gas storage.

Site Preparation (See Pad Layout, page 34)

Site preparation considerations include selecting the proper foundation. However, before the foundation is laid, it may be necessary to clear the site of all organic material and topsoil. Concrete pads are the most common foundations on which cryogenic containers are installed. They provide a highly stable, permanent location for the unit, as well as any other on-site support equipment that may be required (i.e., reserve cylinders, vaporizers, etc.). The construction of a firm base or foundation for the concrete pad is also important. A bed consisting of gravel or crushed stone may be required for the foundation to rest on.

Consultation with a local qualified engineer is suggested to recommend a pad design that meets local and state requirements for soil and climactic conditions, as well as seismic load requirements.

Site Protection

In many situations, the Wolverine Storage Tank is vulnerable to damage. This may be due to tampering by unauthorized personnel, other equipment moving in the area, or a combination of these. Depending on the exposure, protection should be provided by either a fence or pylons.

Other Site Considerations

Installation of a Wolverine Storage Tank should be supervised by personnel familiar with the tanks construction and intended use.

Following installation, all field erected piping and connect points to the tank should be tested at the maximum operating pressure to check for leaks.

When oxygen is the product, the tank location site must be permanently placarded to indicate the following, or an equivalent type warning:

OXYGEN

NO SMOKING

NO OPEN FLAMES

Each oxygen system installed should be inspected periodically. Weeds and long dry grass should be cut back within 15 feet of any bulk oxygen storage container.

If during site preparation, any questions arise concerning foundation, location, etc., it is advised that your local MVE distributor or the factory be consulted.

6 REMOVING AND TRANSPORTING TANK

General

This section deals with removing the Wolverine Storage Tank from an existing site and preparing it for transport. Section 5 should be used for the "Rigging and Handling Instructions" to remove the tank from the pad and place it on the transport trailer.

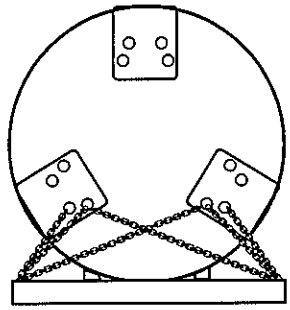
Disconnecting the system

When removing the Bulk Storage Tank from an existing application it is very important that all of the liquid is withdrawn from the vessel before the tank is removed.

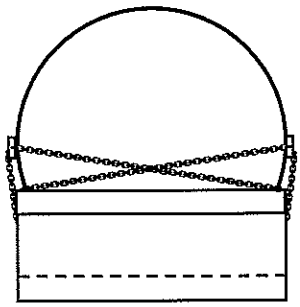
WARNING

Wolverine Storage Tanks are not designed to be transported with any liquid in them. Bulk Storage Tanks are not approved by the DOT for over the road transport of any product. Failure to remove the liquid from the Bulk Storage Tank prior to transport may result in permanent damage to the tank and personal injury.

The tank should be left with 10 to 20 psig of gas pressure and all of the valves shut off. This will keep moisture out of the cold vessel where it could freeze and block piping. All of the safety relief valves and burst discs should be loosely covered with plastic bags and taped so that dirt will not damage the component but in the event of over pressurization the relief valve will still function. Other plumbing components should be protected as needed.



Vertical Rear View
Figure 2



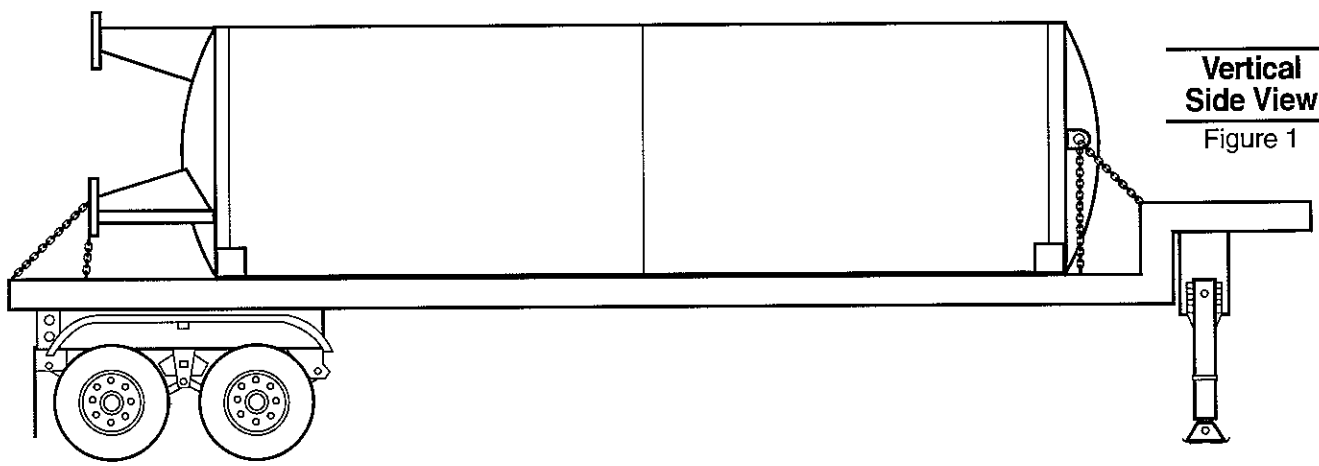
Vertical Front View
Figure 3

Transporting

The following are guidelines for securing an MVE vessel for shipping:

1. Lay the vessel on corrugated cardboard or plastic to prevent damage to the finish.
2. The tank should be oriented with the plumbed head pointing backward. The plumbing is less likely to be damaged during shipping in this orientation.
3. Place supports or saddles on the head-shell seam, never in the middle of the head.
4. Using appropriately sized log chain, 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".

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



Vertical Side View
Figure 1

5. 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 chains to the vessel as close to the head as possible. If possible, avoid attaching chains to the outer part of the leg.

6. A minimum of six chains should be used to secure any vessel. The chains should be situated such that the tank cannot slide or roll in any direction.

7. Straps can cause damage to the tank finish. Avoid using straps to secure the vessel.

8. 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 corrugated cardboard or a similar material to protect the tank in areas where contact may occur.

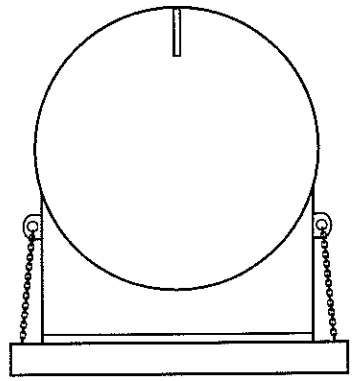
9. All pressure relief devices including rupture disks and relief valves must be adequately protected from road grit using pipe caps or duct tape.

10. Protruding assemblies may require separate bracing.

Figures 2 and 3, on previous page, show frontal and rear views corresponding to the side view.

Horizontal End View

Figure 5



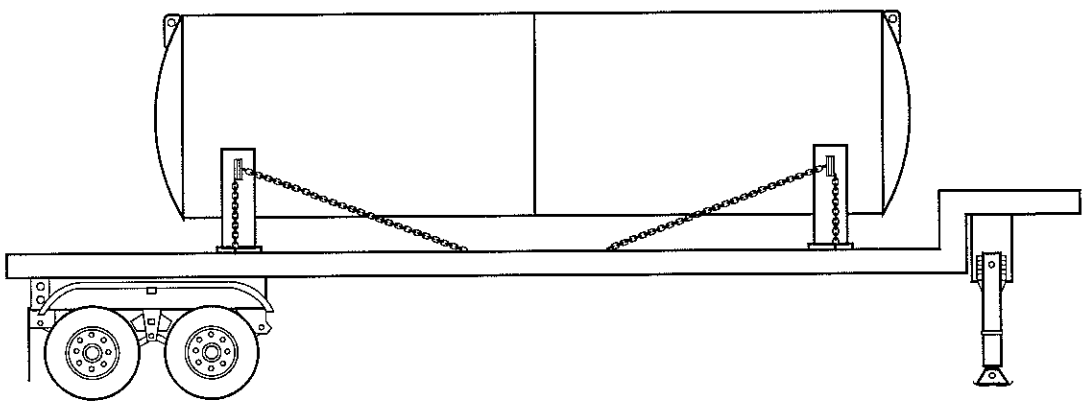
Figures 4 and 5 show side and end views of a horizontal tank with tie down lugs on the saddle supports. The chain configuration shown is acceptable for this type of vessel. If a tank is not equipped with tie down lugs on the saddle supports, use the holes in the saddle supports as tie down points. Use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

The table below gives the approximate empty weights of standard sized MVE vessels. These weights should be used to determine the size and number of chains used to secure a vessel during shipping.

MVE, Inc. accepts no responsibility for damage occurring to vessels during shipping. The above listed guidelines are general. Use caution and judgment when making decisions on securing vessels in specific situations.

Horizontal Side View

Figure 4



Wolverine Tanks														
Model	**525**	**900**	**1500**		**3000**		**6000**		**9000**		**11000**		**13000**	
Rating	250 psi	250 psi	175 psi	250 psi	175 psi	250 psi	175 psi	250 psi	175 psi	250 psi	175 psi	250 psi	175 psi	250 psi
Weight (lbs)	3500	5400	6600	7500	12,800	14,400	22,900	26,300	36,400	42,300	46,600	53,200	52,600	58,700

7 OPERATIONS

General

This chapter provides the preparation, initial fill, gas use, liquid delivery, and refilling procedures for a Wolverine Storage Tank. Before performing any of the procedures contained in this chapter, become familiar with the location and function of tank controls and indicators by studying the plumbing schematic and legend in section 8 and 9 of this manual.

Purging and Fill Considerations

The initial fill is usually performed on a warm tank – one that has not been in use for an extended period of time prior to filling. 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 the intended use. If damage is detected (i.e., 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. If internal tank pressure is at least 50 psi less than the maximum allowable pressure of the supply unit, liquid may be transferred by pressure transfer. If the normal working pressure of the station is equal to or greater than the maximum allowable pressure of the supply unit, liquid must be pumped into the tank.

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

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

Tank Purging Procedure

CAUTION: The maximum purge pressure should be equal to 50 percent of the maximum operating pressure of the tank or 30 psig, whichever is less. The maximum purge pressure must be determined before starting the purge operation to prevent drawing atmospheric contaminants back into the tank. A positive pressure of at least 5 psig must always be maintained in the tank.

1. Attach the source of liquid purge product to the fill connection (FC-1).

2. Close all valves except the pressure building inlet and outlet valves (HCV-3 and HCV-11) and liquid phase (high) and gas phase (low) valves (HCV-8 and HCV-10).

   NOTE: The pressure regulator is normally set to build pressure to 120 psig (8.4 Kg/cm^2). When this pressure is used as the purge pressure, ***Do Not*** adjust the regulator adjusting screw. When a solenoid valve is used to control the pressure building circuit, it must be energized.

3. Open drain valve (HCV-7) and allow the liquid source connection to vent through the hose. Vent until a slight frosting appears on hose. Close (HCV-7).

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

5. Shut off the liquid supply source when pressure in the tank reaches the maximum purge pressure as indicated on tank pressure gauge (P1-1).

6 Open the 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.

7. Close drain valve (HCV-7) and bottom fill valve (HCV-1).

8. When all liquid is drained, open the equalization valve (HCV-9), to prevent damage to the gauge before closing valves (HCV-8 and HCV-10).

9. Loosen the unions on either side of the liquid level gauge (LI-1). Both the high and low gauge valves should be opened wide and gas streams visually checked for signs of moisture. Provided no moisture is observed after blowing the lines for approximately two minutes, both valves should be closed. If moisture is observed in the gas stream, the gas should be discharged until it is clear of all moisture.

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

10. Open the vent valve (HCV-12) and full trycock valve (HCV-4). The top fill valve (HCV-2) will have to be vented by opening the drain valve (HCV-7).

11. Repeat purge procedure steps 2 through 6 and 10 at least three times until product purity has been obtained.

12. Reconnect the liquid level gauge (LI-1), and open the liquid level control valves (HCV-8 and HCV-10), then close the equalization valve (HCV-9).

13. After purging the tank, but before filling, verify that the following valves are open or closed as indicated:

Valve	Position
Top Fill Valve (HCV-2)	Closed
Bottom Fill Valve (HCV-1)	Closed
Vent Valve (HCV12)	Closed
Full Trycock Valve (HCV-4)	Closed
Equalization Valve (HCV-9)	Closed
Gas Use Valve (HCV-13)	Closed
Pressure Building Inlet Valve (HCV-3)	Closed
Press Building Outlet Valve (HCV-11)	Closed
Economizer Isolation Valve (HCV-17)	Closed
Liquid Phase (high) Valve (HCV-8)	Open
Gas Phase (low) Valve (HCV-10)	Open

Initial (Warm Tank) Filling Procedure

1. Purge tank to assure product purity.

2. Verify that the supply unit contains the proper product to be transferred.

3. Verify that all valves except liquid phase high (HCV-8) and liquid phase low (HCV-10) are closed.

4. Connect the supply unit transfer hose to tank fill connection (FC-1).

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

5. Open top fill valve (HCV-2) slowly.

6. 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 higher than the tank pressure. Open the discharge valve on the supply unit to begin flow.

or

   If a pump transfer is to be made, make the required connections to the pump. Open the supply unit transport discharge valve slowly. Maintain pump discharge pressure from 50 to 100 psi higher than tank pressure.

7. Monitor tank pressure (P1-1) during filling. If pressure rises above supply pressure, or near tank relief valve pressure (PSV-1 A&B)), the tank may have to be vented through (HCV-12). Should pressure continue to rise, the fill may have to be interrupted to allow pressure to drop.

8. Monitor liquid level contents gauge (LI-1). When the gauge indicates approximately three-quarters full, open full trycock valve. (HCV-4).

9. When liquid spurts from trycock valve (HCV-4), stop the fill at the supply source and close the trycock valve. (HCV-4).

10. Close the top fill valve (HCV-2).

11 Drain residual liquid in the fill line via drain valve (HCV-7).

12. Relieve fill hose pressure by loosening the hose at fill connection (FC-1), then disconnect the hose. It is recommended that the fill hose be allowed to defrost.

13. Open valves (HCV-3, HCV-11, HCV-13, and HCV-17) as required to place the unit into service.

Preparing The Station For Operation

Preparing the Wolverine Storage Tank for operation consists of adjusting the pressure control valves for automatic operation and then valving open the circuits so that liquid will automatically be vaporized to supply the gas requirements of the customer.

Tank Pressure Control

The tank operation pressure, both pressure building and economizer, is controlled by the Pressure Control Valve (PCV-1). All adjustments to the tank operating pressure can be made on the tank without having to remove components.

Increasing Tank Pressure

The manual operating pressure can be increased by:

1. Note the existing tank pressure (P1-1)

2. Adjust the pressure control valve (PCV-1) by turning the adjustment screw clockwise

   NOTE: 1/4 turn clockwise equals approximately 10 psig or pressure rise.

3. Confirm new pressure setting (P1-1) after allowing tank pressure to rise for 30 minutes.

4. Repeat steps 2 and 3 as needed.

Decreasing Tank Pressure

The manual operating pressure can be decreased by:

1. Vent the tank to 10 psig lower than the new desired setting by opening HCV-12. Close HCV-12 when lower pressure is reached.

2. Adjust the pressure control valve (PCV-1) by turning the adjusting screw counter clockwise.

   NOTE: 1/4 turn counter clockwise will reduce the pressure by 10 psig.

3. Confirm the new pressure setting (P1-1) after allowing the tank pressure to equalize for 30 minutes.

4. Repeat steps 1, 2 and 3 as needed.

Refilling

A vessel that is in service must be refilled using top and bottom fill valves (HCV-2 and HCV-1). Bottom filling causes an increase in tank pressure since the warm vapor above the liquid will be compressed. Proper filling procedures will ensure that there is no interruption of service or supply. Generally it is not necessary to vent the vessel down prior to filling.

Tank Refilling Procedure

NOTE: Filling a cryogenic vessel through the bottom tends to raise pressure in the vessel, as gases in vapor space are compressed. Filling through the top tends to lower pressure, as gases in head space are cooled down and re-liquefied.

1. Verify that the contents of the supply unit is the proper product to be transferred.

2. Verify that top and bottom fill valve (HCV-2 and HCV-1) are closed.

3. Verify minimum required operating pressure in vessel.

4. Verify that all other valves are in normal operating positions (HCV-3, HCV-11, HCV-8, HCV-10, HCV-13 and HCV-17 are open).

NOTE: If tank is not in operation, HCV-3, HCV-11, HCV-13, and HCV-17 are closed.

5. Connect the supply unit transfer hose to tank fill connection (FC-1).

   NOTE: Cool and purge the transfer hose prior to filling by opening 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).

6. Open top fill valve (HCV-2) completely.

7. 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 higher than tank 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 recirculating valve slowly, so as not to lose pump prime. Maintain pump discharge pressure from 50 to 100 psi higher than tank pressure.

8. Monitor pressure in vessel as indicated by (P1-1). If pressure begins to drop to near the minimum operating pressure, begin to open bottom fill valve (HCV-1) and throttle top fill valve (HCV-2) until pressure stabilizes.

9. Monitor liquid level contents gauge (LI-1). When the gauge indicates approximately three-quarters full, open full trycock valve (HCV-4).

10. When liquid spurts from trycock valve (HCV-4), stop the fill at the supply source and close the trycock valve (HCV-4).

11. Close top and bottom fill valves (HCV-2 and HCV-1).

12. Drain residual liquid in the fill line via drain valve (HCV-7).

13. Relieve fill hose pressure by loosening the hose at fill connection (FC-1), then disconnect the hose.

Gas Withdrawal Procedure

1. Connect the customer line to the Wolverine gas use connection (HCV-13).

2. Verify that all valves except liquid phase (high) (HCV-8) and gas phase (low) (HCV-10) are closed.

3. Open gas use valve (HCV-13), pressure building inlet valve (HCV-3), and pressure building outlet valve (HCV-11) to start gas flow. At this time, the final line pressure gauge will be indicating pressure in the customer line and the system will automatically deliver gas until stopped, or until vessel is empty.

   NOTE: In the event tank pressure exceeds the economizer setting of the pressure control valve (PCV-1) after a long shutdown, the regulator will automatically begin to divert vapor from the vapor space into the vaporizer until set pressure of (PCV-1) is reached.

4. Once the required amount of product has been delivered (or to close the tank down for an extended period of time), stop gas flow by closing gas use valve (HCV-13). The operation of an MVE unit is completely automatic; valves need to be opened and closed only during filling and during major maintenance.

5. Normal operating valve position for a Wolverine tank unit are as follows.

Valve	Position
Top Fill Valve (HCV-2)	Closed
Bottom Fill Valve (HCV-1)	Closed
Vent Valve (hCV-12)	Closed
Full Trycock Valve (HCV-4)	Closed
Equalization Valve (HCV-9)	Closed
Drain valve (HCV-7)	Closed
Gas Use Valve (HCV-13)	Open
Pressure Building Inlet Valve (HCV-3)	Open
Pressure Building Outlet Valve (HCV-11)	Open
Economizer Isolation Valve (HCV-17)	Open
Liquid Phase (high) Valve (HCV-8)	Open
Gas Phase (low) Valve (HCV-10)	Open

7 OPERATION

Liquid Withdrawal

Liquid product may be drawn at low pressure from the tank via liquid withdrawal connection (C-1 or C-3).

NOTE: If a tank does not have a liquid draw valve at the connection (C-3), consult the factory for valve installation instructions.

Liquid Withdrawal Procedure

1. Connect customer line and liquid draw valve to liquid withdrawal connection (C-1 or C-3).

2. Verify that all valves except liquid phase high valve (HCV-8) and gas phase low valve (HCV-10) are closed.

3 Observe pressure control valve (PCV-1) setting as indicated on the station pressure gauge (PI-1). If station pressure is too high, open manual valve (HCV-12) to relieve excessive gas. It is possible that regulator springs will require changing for lower operational pressure.

4. Open draw valve slowly to begin flow.

5. Once the desired amount of liquid has been delivered, close the liquid draw valve.

General

This section contains maintenance information, including troubleshooting and repair procedures. Service and/or repairs are not difficult because parts are easily accessible and replaceable. Before performing any of the procedures in this section, be sure you are familiar with the location and function of the controls and indicators shown and described in Section 8. Note that supporting parts location illustrations are provided in Section 9.

Before implementing any procedure described in this section, it is recommended that the Safety Summary and Product Safety Bulletins (Section 3) be reviewed and understood fully.

Maintenance required usually becomes apparent during inspection of units before a fill routine, observations during and after a fill, and from improper performance of components. Proper and immediate action to correct any damage or malfunction is advised.

Persons making repairs to piping, valves, and gauges must be familiar with cleanliness requirements for components used in nitrogen, oxygen, or argon service (see *Cleaning* below for further details).

Compatibility and Cleaning

It is essential to always keep the Wolverine Storage Tanks clean and free of grease and oil. This is particularly important for units used in oxygen service. It is equally important for tanks used in nitrogen or argon since the temperature of liquid nitrogen or argon is below the liquefication temperature of air, thus making it possible to condense liquid air on piping and vaporizer surfaces.

When replacing components, only use parts which are considered compatible with liquid oxygen and have been properly cleaned for oxygen service. (Refer to CGA Bulletin G.4.1 "Equipment Cleaned for Oxygen Service"). Do not use regulators, fittings, or hoses which were previously used in a compressed air environment on these tanks. Only oxygen compatible sealants or Teflon tape should be used on threaded fittings. All new piping joints should be leak tested with an oxygen compatible leak-test solution. When degreasing, a suitable solvent should be used

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

Periodic Inspections

In order to maintain the Wolverine Storage Tanks in good operating condition, certain system components must be inspected on a periodic basis. If the tank is being operated in areas having either extreme hot or cold climates, inspection intervals should be shortened. (Refer to the repair procedures paragraphs in this section for corrective procedures when a malfunctioning component is found during an inspection.)

Periodic Inspection Intervals

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

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

Soldering

Before performing any soldering work on a Wolverine Storage Tank always exhaust oxygen from oxygen lines and purge thoroughly with nitrogen gas. Refer to the purging instructions in Section 6.

Maintenance Checks and Adjustments

The paragraphs to follow provide instructions for performing the various Wolverine Storage Tank's checks and adjustments. Only perform the procedure(s) if the unit is suspect of faulty operation.

8 MAINTENANCE

Vacuum Integrity Check

Since all Wolverine Storage Tanks are vacuum insulated, any deterioration or loss of vacuum will be apparent by cold spots, frost, or condensation on the outside of the tank or evidenced by abnormally rapid pressure buildup. Unless one of these conditions is evidenced, the vacuum level should not be suspect.

In the event one of the above conditions exists, remove the unit from service as soon as possible and contact the factory for advice on vessel vacuum testing.

Normal Evaporation Rate (NER) Test

Testing may be performed to verify that the container evaporation rate is within normal limits. To perform this test, a totalizing gas flow meter and a standard stop watch are required. Use the following procedure to perform the evaporation rate test.

NOTE: To perform this test accurately, the container must be allowed to cool down for four days prior to testing. During the cool-down period, do not withdraw liquid from the container. Also, during the cool-down period, keep the tank vent valve (HCV-12) open.

1. Verify that the container is filled to at least one-third capacity.
2. Using a suitable rubber hose with appropriate adapter fittings, connect the totalizing gas flow meter to the vent line of the tank under test.
3. When the large sweep needle begins to turn, indicating flow through the meter, check all hose connections for leaks by using a leak-test solution (i.e., soapy water).
4. To begin the test, start the stop watch and then record the beginning meter reading.
5. After 30 minutes, record the meter reading and stop watch time.
6. Compare the difference between the start and end values obtained.
7. If the test value is greater than the tabulated value shown on the tank specification chart of Section 8, contact the factory for further instructions.

Pressure and Liquid Level Gauge Checks and Adjustments

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

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

1. Checking the gauge lines for obstructions.
2. Checking for a leak at the low pressure valve (HCV-8) and at the high pressure valve (HCV-10).
3. Verifying that the liquid level gauge is properly zeroed. The liquid level gauge is a differential pressure gauge used to indicate the amount of liquid in the tank. This gauge may occasionally require adjustment. To check and/or adjust the zero setting of this gauge, close the low pressure and high pressure valves (HCV-8 & HCV-10). With these valves closed, open the equalization valve (HCV-9). The gauge pointer should indicate zero. If the gauge pointer does not indicate zero, adjust the gauge until the zero setting is reached. After adjustment, close the equalizer valve (V-10) and slowly open the gauge valves (HCV-8 & HCV-10).

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

CAUTION: Before removing or adjusting either the tank pressure gauge or the liquid level gauge, make sure that the low pressure liquid level gauge valve (HCV-8) and the high pressure liquid level gauge valve (HCV-10) are closed.

Troubleshooting

The Troubleshooting table is arranged in a "Trouble/Probable Cause/Remedy" format. The probable causes for a specific problem are listed in a descending order of significance. That is, check out the first cause listed before proceeding to the next. Repair procedures required, as listed in the remedy column, may be found in the *Repair* portion of this section. Perform all procedures in the order listed and exactly as stated. (Refer to Section 9 as required to locate system components identified in the troubleshooting guide.)

Trouble	Probable Cause	Remedy
Excessive tank pressure	Economizer regulator not functioning.	Valve (HCV-17) is closed. (Open it.)
		Regulator (PCV-1) is stuck closed. (Replace.)
	Pressure building regulator is not functioning. (PB coil is frosted and pressure is above operating pressure.	Regulator (PCV-1) is adjusted too high. (Re-adjust.)
		Regulator (PCV-1) is not closing completely. (Replace it.)
	Tank was just filled with higher pressure (warm) liquid	Vent pressure (HCV-12) to restabilize at a lower pressure.
	Excessive shutdown time or low withdrawal rate.	NER is greater than use rate. Vent tank properly to desired operating pressure.
	Tank pressure gauge (P1-1) in error.	Confirm tank pressure with calibrated test gauge. If wrong, replace defective gauge.
	Inadequate vacuum.	Refer to "vacuum loss" in troubleshooting column.
Failure to maintain tank pressure	Pressure building regulator is not functioning. (PB coil is not frosted and pressure is below operating pressure.)	Isolation valves (HCV-3 & HCV-11) are closed. (Open them.)
		Regulator (PCV-1) is adjusted too low. (Readjust it.)
		Regulator (PCV-1) is not opening properly. (Replace it.)
	Relief valve (PSV-1) leaking or frozen open.	Replace defective valve.
	Tank burst disc (PSE-1) ruptured.	Replace burst disc.
	Piping leak.	Soap test and repair.
	Low liquid level	Refill tank
	Excessive withdrawal rate	Consult factory (MVE).

8 MAINTENANCE

Trouble	Probable Cause	Remedy
Vacuum Loss	Ruptured annular space burst disc (Item PSE-3)	Inner vessel or piping leak. Remove all product from the container and return to MVE.
	Leak in the burst disc caused by corrosion	Remove all product from the container and return to MVE.
	Sweat or frost appears on outer vessel.	Perform a NER test on the container. If unsatisfactory, return the tank to MVE.
Erratic or erroneous contents gauge readings	Leaking gauge lines	Soap test and repair leak.
	Gauge needle is stuck	Tap gauge. If this fails to correct the problem, inspect the needle and bend slightly, if necessary.
	Needle is not zero adjusted	Refer to Gauge Adjustment.
	Gauge damaged or faulty	Replace gauge.
Leaking safety relief valve (PSV-1)	Dirt or ice under disc	Reseat or replace valve as required.
	Valve improperly seated	
	Damaged seat or disc.	Replace valve.
Ruptured tank bursting disc (PSE-1)	Excessive tank pressure	Replace disc.
	Atmospheric corrosion and/or fatigue	Replace disc.
	Interior corrosion	Replace disc after blowing out line.
	Defective disc	Replace disc.

Repair

Replacement, rather than repair, of damaged components with MVE approved parts is recommended. However, when repair of damaged components is required, follow the instructions below.

CAUTION: The Wolverine Storage Tank should always be allowed to return to ambient temperature before repair work is performed. Vent or drain the tank as necessary before replacing any component(s) exposed to pressure or to cryogenic liquid.

When disassembly of a Wolverine Storage Tank assembly is required, removed parts should be coded to facilitate reassembly. Reassembly of parts should always be performed in the reverse manner in which they were 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 soap and warm water solution. Air dry all cleaned parts using a clean, low pressure air source. Before reassembly, make sure that all parts are thoroughly cleaned and have been degreased. Cleaning will prevent valves from freezing while in service and also prevent contamination of the liquid product.

When removing assemblies from the Wolverine Storage Tank, remember to always plug pipe openings as soon as they are exposed. Plastic pipe plugs or a clear plastic film may be used for this purpose.

Valve Repair

NOTE: Always have an adequate supply of Wolverine Storage Tank spare parts in your inventory; refer to Section 9 for recommended components.

When a defective valve is suspect, remove and repair the assembly as described below. If a valve is leaking through the packing, tighten the packing nut first to see if the leakage will stop before removing the valve. NOTE: Unless valve component parts are available in inventory, a defective valve should be replaced with a new assembly.

1. Remove all liquid from the tank if repairing HCV-1, HCV-17, HCV-8, HCV-3, HCV-13 or HCV-7.
2. Release all pressure in the tank by opening vent valve (HCV-12).
3. Remove the bonnet from the defective valve.
4. Remove the valve seat assembly.
5. Disassemble the valve and inspect all piece parts.
6. Clean all metal parts in a suitable chlorinated solvent and other parts in a warm soap solution followed by a thorough warm water rinse.
7. Air dry all components using a clean, low pressure air source.
8. Replace all worn, deformed or damaged parts.
9. Repack the valve. Either preformed or twisted Teflon filament packing can be used. When using twisted Teflon filament packing, untwist the Teflon and use only a single strand. Pack Teflon tightly; otherwise, moisture can get into the valve and freeze when the valve is cold.
10. Reassemble the valve. Make sure that mating surfaces are clean and properly seated.

8 MAINTENANCE

Tank Burst Disc (PSE-1) Repair

The tank burst disc is a safety relief device that will rupture completely to relieve inner tank pressure in the event tank relief valve (PSV-1) fails and pressure exceeds the valve's setting. The tank burst disc should be replaced at least every two (2) years.

1. Open vent valve (HCV-12) to vent pressure from the inner tank vapor space.
2. Remove tank burst disc (PSE-1) from the container
3. Install the new burst disc, making sure that mating surfaces are clean and properly seated. use a Teflon tape or oxygen compatible thread sealant to prevent leaking.

Tank Safety Relief Valve (PSV-1)

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

Testing After Repair

After making repairs requiring disassembly or parts 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 and the tank retested.

Returning Defective Components

If a defective component or assembly is to be returned to the factory for repair, carefully package the unit for shipment in a durable container enclosed in an outer carton to prevent further damage. In your letter of transmittal, state the nature of the problem, checks already made, repairs attempted, etc. This information will enable most repair work to be performed faster and more economically.

SECTION 9 SPECIFICATIONS

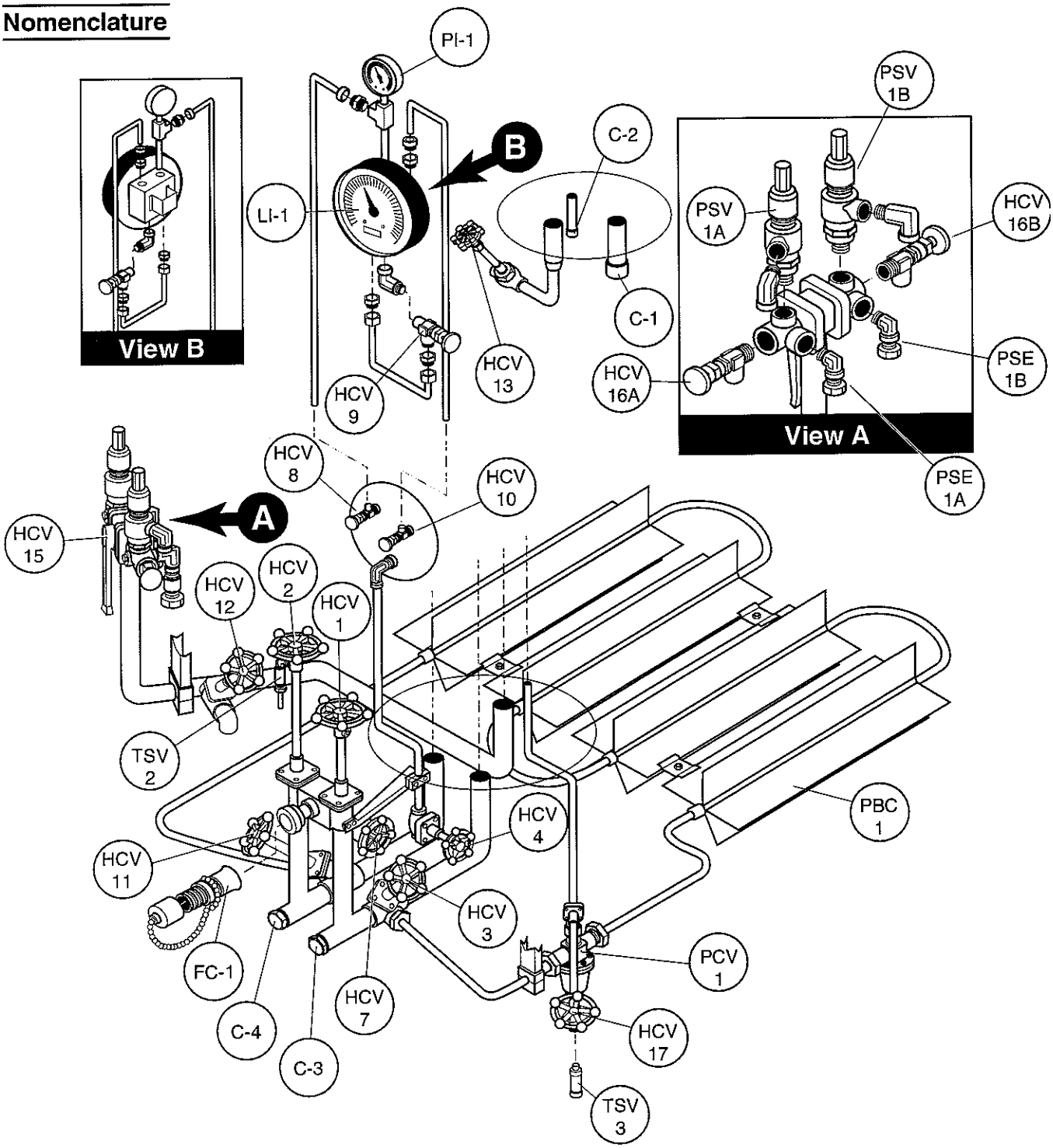
General: Wolverine Storage Tanks

Model VCS	525		900		1500		2900		3000		4000		6000	
CAPACITY														
Net gal. (liters)	525 (1893)		900 (3406)		1541 (5833)		2900 (10976)		3000 (11355)		4000 (15140)		6000 (22710)	
Gross gal. (liters)	555 (2101)		967 (3660)		1639 (6204)		3044 (11355)		3157 (11949)		4172 (16241)		6250 (23656)	
Gas Capacity (In Thousand)														
O^2 scf (Nm^3)	60.4 (1.6)		103.6 (2.7)		177.4 (4.66)		333.8 (8.8)		345.3 (9.07)		460.4 (12.1)		690.6 (18.15)	
N^2 scf (Nm^3)	48.9 (1.3)		83.8 (2.2)		143.5 (3.77)		270.0 (7.1)		279.3 (7.34)		372.4 (9.8)		558.7 (14.68)	
Ar scf (Nm^3)	59.1 (1.6)		101.3 (2.66)		173.4 (4.56)		326.3 (8.6)		337.5 (8.87)		450.0 (11.8)		675 (17.74)	
PERFORMANCE														
NER O^2 (% per day)	.45		.35		.33		.25		.25		.25		.26	
N^2 (% per day)	.72		.56		.53		.37		.37		.37		.37	
DIMENSIONS & PRESSURE RATINGS														
Diameter inches (mm)	48" (1219)		60" (1524)		68" (1727)		86' (2184)		96" (2438)		86" (2184)		96" (2438)	
Height inches (mm)	135" (3429)		142" (3607)		180" (6096)		223" (8664)		192" (6274)		289" (7341)		337" (9728)	
Working Pressure (psig)	175	250	175	250	175	250	175	250	175	250	175	250	175	250
(BAR)	12.1	17.2	12.1	17.2	12.1	17.2	12.1	17.2	12.1	17.2	12.1	17.2	12.1	17.2
Weight (In Thousands)														
Tare lbs	3.5	3.5	4.8	5.5	6.9	7.8	12.4	14.0	12.8	14.6	15.4	17.7	23.5	26.7
(kg)	1.6	1.6	2.2	2.5	3.1	3.5	5.6	6.4	5.8	6.6	7.0	8.0	10.7	12.1
O^2 lbs	8.2	8.2	13.4	14.1	21.6	22.5	40.0	41.6	41.4	43.1	53.5	55.8	80.7	83.8
(kg)	3.7	3.7	6.1	6.4	9.8	10.2	24.9	26.5	18.8	19.6	32.7	35.0	36.6	38.0
N^2 lbs	6.8	6.8	10.9	11.6	17.3	18.2	32.0	33.6	33.0	34.8	42.4	44.7	64.0	67.1
(kg)	3.1	3.1	4.9	5.3	7.9	8.2	21.3	22.9	15.0	15.8	27.7	29.9	29.0	30.5
Ar lbs	9.3	9.3	15.3	16.0	24.8	25.7	46.1	47.7	47.7	49.4	62.0	64.2	93.3	96.4
(kg)	4.2	4.2	6.9	7.2	11.3	11.7	27.7	29.3	21.6	22.4	36.5	38.8	42.3	43.7

Model VCS	6500		9000		11000		13000		15000		20000		25000	
CAPACITY														
Net gal. (liters)	6500 (24731)		9000 (34065)		11000 (41635)		13000 (48459)		15000 (55772)		20000 (75700)		25000 (94625)	
Gross gal. (liters)	6806 (25761)		9375 (35484)		11458 (43369)		13336 (50477)		15191 (57498)		20800 (78728)		26041 (98561)	
Gas Capacity (In Thousands)														
O^2 scf (Nm^3)	748.2 (19.7)		1035.9 (27.22)		1266 (33.27)		1473.6 (38.73)		1726.5 (45.4)		2302.0 (60.5)		2877.5 (75.6)	
N^2 scf (Nm^3)	605.2 (15.9)		838.0 (22.02)		1024.2 (26.92)		1192.1 (31.33)		1396.7 (36.7)		1862.2 (48.9)		2327.8 (61.2)	
Ar scf (Nm^3)	731.3 (19.2)		1012.5 (26.61)		1237.5 (32.52)		1440.3 (37.85)		1687.5 (44.4)		2250.0 (59.1)		2812.5 (73.9)	
PERFORMANCE														
NER O^2 (% per day)	.25		.10		.10		.10		.10		.10		.10	
N^2 (% per day)	.37		.18		.18		.18		.18		.18		.18	
DIMENSIONS & PRESSURE RATINGS														
Diameter inches (mm)	86" (2184)		114" (2896)		114" (2896)		120" (3048)		120" (3048)		132" (3353)		150" (3353)	
Height inches (mm)	419" (10642)		369" (10820)		430" (12370)		441" (11201)		488" (12400)		552" (14021)		520" (13208)	
Working Pressure (psig)	175	250	175	250	175	250	175	250	175	250	175	250	175	
(BAR)	(12.1)	(17.2)	(12.1)	(17.2)	(12.1)	(17.2)	(12.1)	(17.2)	(12.1)	(17.2)	(12.1)	(17.2)	(12.1)	
Weight (In Thousands)														
Tare lbs	27.4	30.6	35.2	40.7	45.3	51.0	50.0	55.0	57.4	70.4	74.9	81.6	89.0	
(kg)	12.4	13.9	16.4	18.5	20.5	23.2	22.7	25.0	26.0	31.9	34.0	37.0	40.4	
O^2 lbs	89.3	92.6	121.7	126.4	104.8	155.8	172.0	177.0	199.2	212.2	265.4	272.1	327.2	
(kg)	55.5	58.7	55.2	57.4	47.5	70.7	78.0	80.3	90.4	96.2	161.3	168.0	197.1	
N^2 lbs	71.2	74.5	96.6	101.4	119.5	129.2	136.4	141.4	157.8	170.8	209.8	216.5	257.6	
(kg)	47.3	50.5	43.8	46.0	54.2	56.8	61.9	64.1	71.6	77.5	136.1	142.8	165.5	
Ar lbs	103.0	106.2	140.6	145.4	173.2	178.9	198.9	203.9	230.5	243.5	307.5	314.2	379.8	
(kg)	61.7	64.9	63.8	65.9	78.6	81.2	90.2	92.5	104.6	110.4	180.4	187.1	220.9	

9 SPECIFICATIONS

Nomenclature



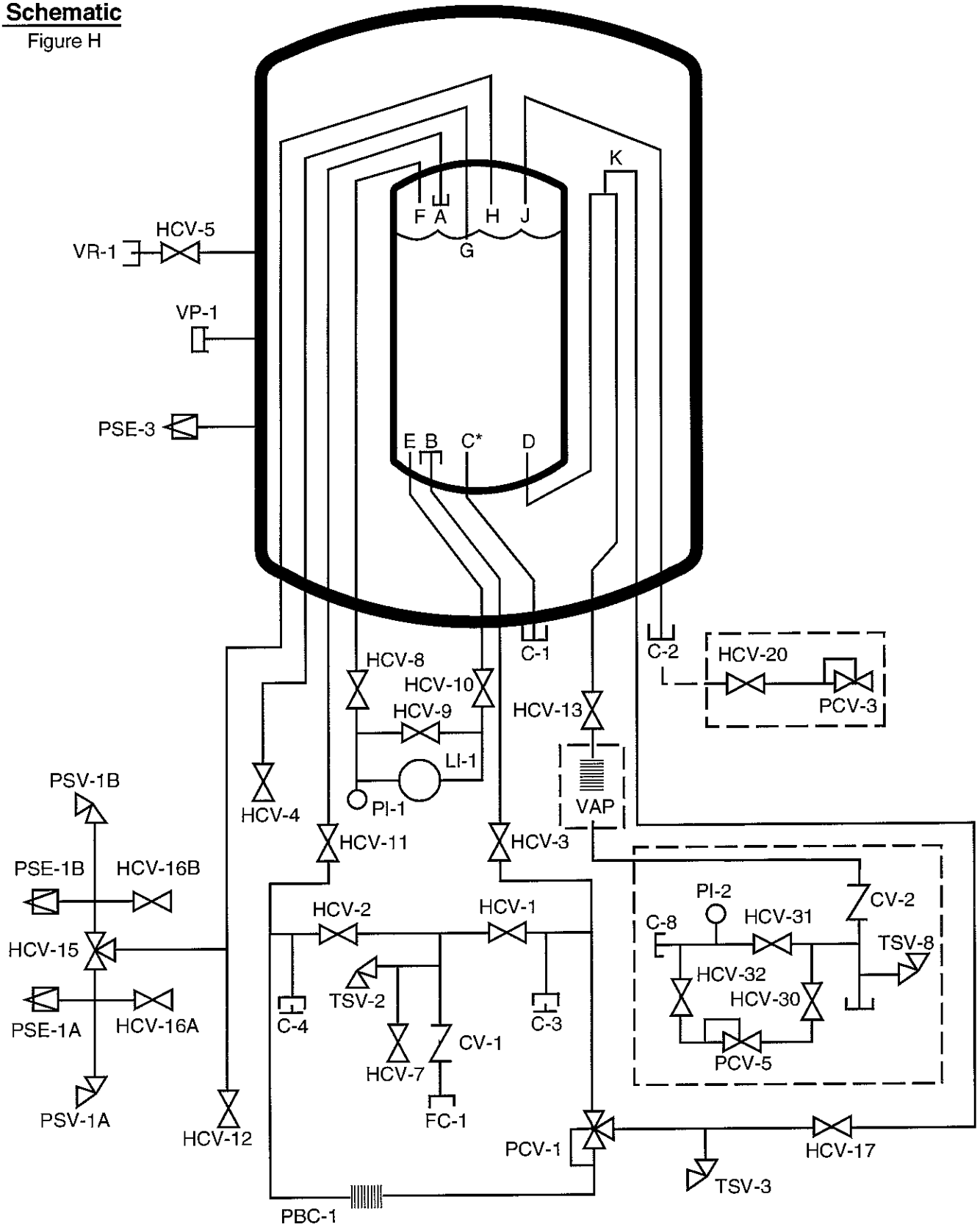
Nomenclature		
C-1	Connection, Aux Liquid	Liquid outlet for pump inlet. *(not available on the VCS 525.)*
C-2	Connection, Aux Vapor	Vapor return from pump. *(not available on the VCS 525.)*
C-3	Connection, Secondary Aux Liquid	Liquid outlet.
C-4	Connection, Secondary Aux Vapor	Vapor outlet.
C-8	Connection, Customer Houseline	Gas use connection.
CV-1	Check Valve, Fill	Keeps liquid in the tank if fill valve is open.
* CV-2	Check Valve, Houseline	Keeps vapor from customer line from returning to tank.
FC-1	Connection Fill	Connection for filling liquid into the tank.
HCV-1	Valve, Bottom Fill	Controls liquid flow into the bottom of the tank.
HCV-2	Valve, Top Fill	Controls liquid flow into the top of the tank.
HCV-3	Valve, PB Inlet	Isolates the PB system for repairs.
HCV-4	Valve, Full Trycock	Vents gas from the tank which changes to liquid when tank becomes full.
HCV-5	Valve, Vacuum Gauge Tube	Valve to isolate vacuum gauge.
VP-1	Valve, Evacuation	Connection to evacuate annular space between inner and outer vessel.
HCV-7	Valve, Fill Line Drain	Allows pressure to be discharged from fill hose.
HCV-8	Valve, LI-1 Vapor Phase	Low phase line to liquid level gauge. Isolates the gauge for repair.
HCV-9	Valve, LI-1 Equalization	Equalizes pressure across the gauge to set the zero.
HCV-10	Valve, LI-1 Liquid Phase	High pressure line from the tank to liquid level gauge. Isolates the gauge for repair.
HCV-11	Valve, PB Outlet	Isolates the PB system for repairs.
HCV-12	Valve, Vapor Vent	Manually vents gas from the tank to reduce pressure.
HCV-13	Valve, Vaporizer Inlet	Isolates gas supplied to customer's equipment.
HCV-15	Valve, Safety Relief Selector	Diverter valve to isolate safety relief valves for repair.
HCV-16A	Valve, Test	Used to pressure test relief valve or gas sample port.
HCV-16B	Valve, Test	Used to pressure test relief valve or gas sample port.
HCV-17	Valve, Economizer	Isolation valve for economizer regulator repair.
LI-1	Level Indicator, Inner Vessel	Differential pressure gauge for reading liquid level in the tank.
PBC-1	Pressure Building Coil Inner Vessel	Ambient air vaporizer to build pressure in tank.
PCV-1	Pressure Control/Econo Valve, Inner Vessel	Pressure control regulator to maintain tank operating pressure.
PI-1	Pressure Indicator, Inner Vessel	Indicates the inner vessel pressure.
PSE-1A	Pressure Safety Element, Inner Vessel	Inner vessel rupture disc to protect the tank from over-pressurization.
PSE-1B	Pressure Safety Element, Inner Vessel	Inner vessel rupture disc to protect the tank from over-pressurization.
PSE-3	Pressure Safety Element, Outer Vessel	Annular space rupture disc to protect outer vessel from over-pressurization.
PSV-1A	Pressure Safety Valve, Inner Vessel	Relief valve to protect the inner vessel from over-pressurization.
PSV-1B	Pressure Safety Valve, Inner Vessel	Relief valve to protect the inner vessel from over-pressurization.
TSV-2	Thermal Safety Valve, Fill	
TSV-3	Thermal Safety Valve, PB Circuit	
VR-1	Vacuum Readout, Outer Vessel	Connection to read vacuum level in tank.
Optional Valves (Not Shown)		
* HCV-18	Valve, Liquid Withdrawal (From C-1)	
* HCV-19	Valve, Vapor Return (From C-2)	
* HCV-20	Valve, Economizer Vent	
* HCV-30	Valve, Inlet Houseline	
* HCV-31	Valve, Bypass Houseline	
* HCV-32	Valve, Outlet Houseline	
* PCV-3	Pressure Control Valve, Econo Vent	
* PCV-5	Pressure Control Valve, Houseline	
* PI-2	Pressure Indicator, Houseline	
* TSV-8	Thermal Safety Valve, Houseline	
* VAP	Vaporizer Product Withdrawal	

*Optional (Dashed lines represent optional components)

9 SPECIFICATIONS

Schematic

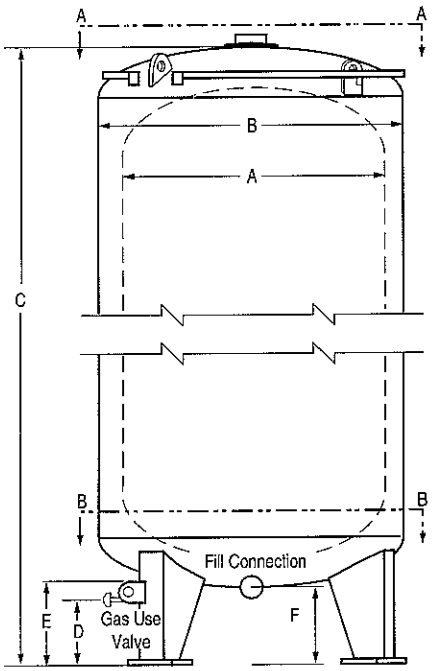
Figure H



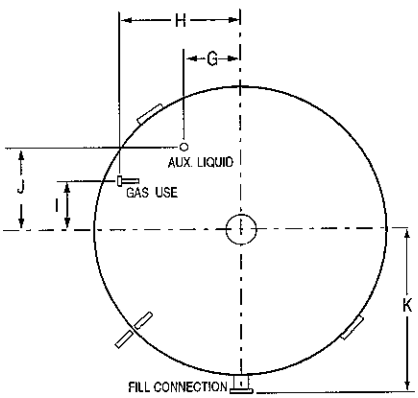
* Line **C** is not included on the VCS-525

General Dimensions Wolverine

Figure H



Note: "E" refers to auxiliary liquid and auxiliary vapor.



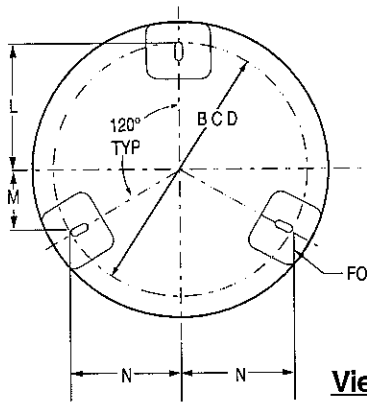
View A-A

Dimensions in Inches / (Millimeters)

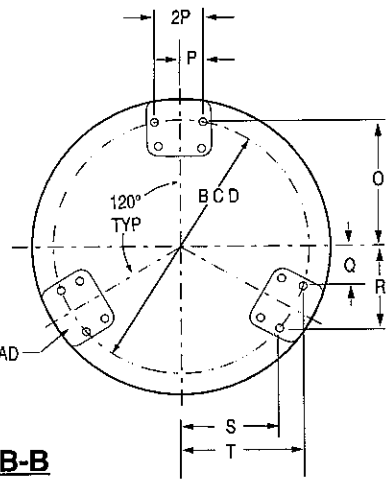
VCS	525	900	1500	2900	3000	4000	6000	6500	9000	11000	13000	15000
A	42 (1067)	54 (1372)	60 (1524)	75 (1905)	84 (2134)	75 (1905)	84 (2134)	75 (1905)	96.375 (2448)	96.375 (2448)	104 (2642)	104 (2642)
B	48 (1219)	60 (1524)	68 (1726)	86 (2184)	96 (2438)	86 (2184)	96 (2438)	86 (2184)	114 (2896)	114 (2896)	120 (3048)	120 (30480
C*	135 (3429)	142 (3607)	180 (4572)	223 (5664)	192 (4877)	289 (7341)	337 (8560)	419 (10643)	369 (9373)	430 (10922)	441 (11201)	488 (12395)
D	**	**	**	15.375 (390)	15.375 (395)	15.375 (390)	15.375 (395)	15.375 (395)	15.375 (395)	15.375 (395)	15.375 (395)	15.375 (395)
E	N/A	18 (457)	18 (457)	18 (457)	18 (457)	18 (457)	18 (457)	18 (457)	18 (457)	18 (457)	19.875 (505)	N/A
F	29.18 (741)	30.12 (765)	31 (787)	35 (889)	35 (889)	35 (889)	35 (889)	35 (889)	36 (914)	36 (914)	38.3 (973)	38.313 (973)
G	N/A	15.125 (384)	18 (457)	26.88 (683)	32.25 (819)	26.88 (683)	32.25 (819)	26.88 (683)	38.625 (981)	38.625 (981)	40.438 (1027)	40.188 (1021)
H	**	**	**	40.688 (1033)	43.375 (1102)	40.688 (1033)	43.375 (1102)	40.688 (1033)	52.375 (1330)	52.375 (1330)	40.625 (1032)	53.875 (1368)
I	**	**	**	14.375 (365)	12.5 (317)	14.375 (365)	12.5 (317)	14.375 (365)	21.875 (556)	21.875 (556)	22.375 (568)	22.375 (568)
J	N/A	11.125 (282)	14.375 (365)	20 (508)	20 (508)	20 (508)	20 (508)	20 (508)	27.5 (698)	27.5 (698)	28.063 (713)	28 (711)
K	43.25 (1098)	49.25 (1251)	52.938 (1345)	62 (1575)	66.875 (1699)	62 (1575)	66.875 (1699)	62 (1575)	76 (1930)	76 (1930)	60.75 (1543)	78.75 (2000)
L	21.5 (546)	27.5 (698)	30.125 (765)	36.563 (929)	42.75 (1086)	36.563 (929)	42.75 (1086)	36.563 (929)	N/A	N/A	N/A	N/A
M	10.875 (276)	13.875 (352)	15.062 (382)	N/A	15.062 (382)	N/A	15.062 (382)	N/A	N/A	N/A	N/A	N/A
N	18.75 (476)	23.938 (608)	26.062 (662)	33.5 (851)	33 (838)	33.5 (851)	33 (838)	33.5 (851)	N/A	N/A	N/A	N/A
O	N/A	N/A	N/A (914)	36.0	N/A (914)	36.0	N/A (914)	36.0 (1194)	47.0 (1194)	47.0 (1194)	47.0 (1194)	47 0
P	N/A	N/A	N/A (203)	8.0	N/A (203)	8.0	N/A (203)	8.0 (203)	8.0 (203)	8.0 (203)	8.0 (203)	8.0
Q	N/A	N/A	N/A (314)	12 375	N/A (314)	12 375	N/A (314)	12.375 (417)	16.438 (417)	16.438 (417)	16.438 (421)	16.563
R	N/A	N/A	N/A (600)	23.625	N/A (600)	23.625	N/A (600)	23.625 (773)	30.438 (773)	30.438 (773)	30.438 (773)	30 438
S	N/A	N/A	N/A (710)	27 938	N/A (710)	27 938	N/A (710)	27.938 (930)	36.625 (930)	36.625 (930)	36.625 (932)	36.688
T	N/A	N/A	N/A (881)	34.688	N/A (881)	34.688	N/A (881)	34.688 (1133)	44.625 (1133)	44.625 (1133)	44.625 (1135)	44 688
BCD	43.25 (1098)	55 (1397)	60.25 (1530)	73.25 (1860)	87 (2210)	73.25 (1860)	87 (2210)	73.25 (1860)	95.375 (2422)	95.375 (2422)	95.375 (2422)	95.375 (2422)
Foot Pad	375x5x 925 (9x127x 235)	625x6x 1125 (16x32x 286)	1x7.125x 13.5 (25x181x 343)	N/A	1 25x12x 12 (32x305x 305)	N/A	1 25x12x 12 (32x305x 305)	N/A	1.625x 22x22 (41x559x 559)	1.625x 22x22 (42x559x 559)	1.625x 22x22 (42x559x 559)	N/A

* "C" dimensions are rounded to the nearest whole number.
** Gas use piped to side mounted vaporizer

VCS-525 thru VCS-6500



View B-B

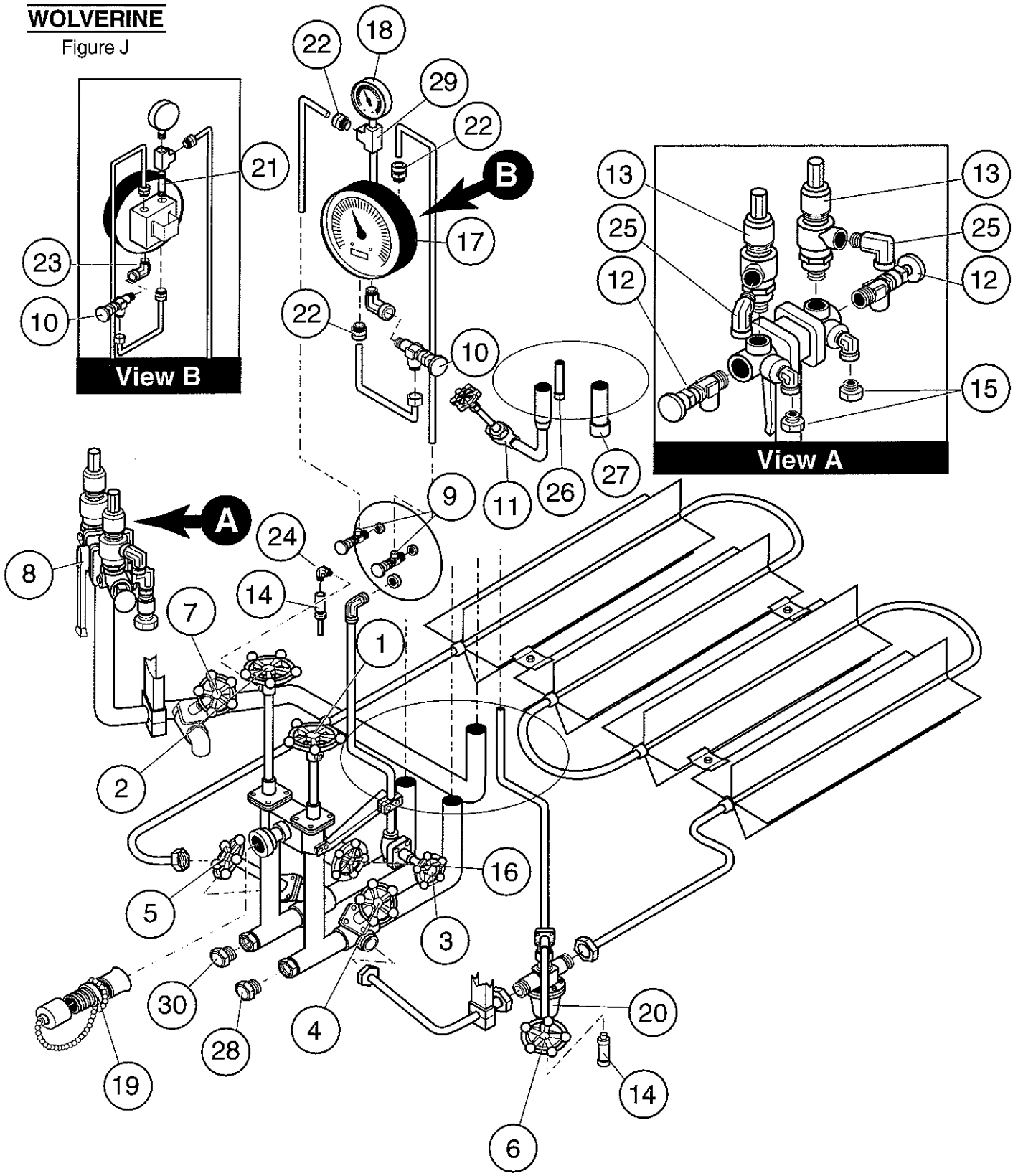


VCS-9000 thru VCS-15,000

10 PARTS LIST

WOLVERINE

Figure J



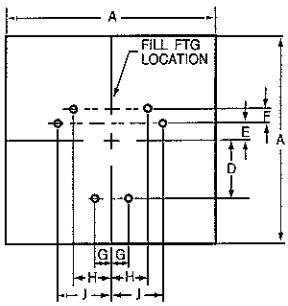
Ref. No.	Item No.	Part No.	Quantity	Spares*	Description
HCV-1	1	10817284	1		Valve (Globe) – Bottom Fill
HCV-2	2	10817284	1		Valve (Globe) – Top Fill
HCV-4	3	10698836	1		Valve (Globe) – Full Trycock
HCV-3	4	10817284			Valve (Globe) – PB Inlet
HCV-11	5	10817284			Valve (Globe) – PB Outlet
HCV-17	6	10817305			Valve (Globe) – Economizer- Isolation
HCV-12	7	10817276			Valve (Globe) – Vapor Vent
HCV-15	8	10817276	1		Valve (Dual Relief) Safety Relief Selector
HCV-8 &10	9	1713502	2		Valve (Angle) – LI-1 Isolation
HCV-9	10	1713502	1		Valve (Angle) – LI-1 Equalization
HCV-13	11	10698844	1		Valve (Globe)–Vaporizer Inlet(525, 900, 1500, 3000 gal.)
HCV-13	11	10698852	1		Valve (Globe) Vaporizer Inlet (6000 gal.& greater)
HCV-16A&B	12	1713502	2		Valve (Angle) – Test 1/4" MPT
PSV-1A/1B	13	1810402	2		Valve Pressure Safety, Inner Vessel (250psi)
PSV-1A/1B	13	10573911	2		Valve Pressure Safety, Inner Vessel (175psi)
TSV-2 & 3	14	1811752	2		Valve Thermal Safety PB Circuit/ Fill Circuit
PSE-1A/1B	15	1911125	2		Burst Disc (3/4" MPT) Inner Vessel (375psi)
PSE-1A/1B	15	10595802	2		Burst Disc (3/4" MPT) Inner Vessel (262psi)
HCV-7	16	10817284	1		Valve (Globe) – Hose Drain
LI-1	17	2012199	1		Gauge (6" Dial) – 1/4"NPT (0-150"H_2O)
LI-1	17	2011679	1		Gauge (6" Dial) – 1/4"NPT (0-200"H_2O)
LI-1	17	2011519	1		Gauge (6" Dial) – 1/4"NPT (0-400"H_2O)
LI-1	17	2011529	1		Gauge (6" Dial) – 1/4"NPT (0-600"H_2O)
PI-1	18	10700596	1		Gauge (4" Dial) – 1/4"NPT (0-400psi)
PI-1	18	10737241	1		Gauge (4" Dial) – 1/4"NPT (ADM BS5500)
FC-1	19		1		Connection Fill – CGA O_2, LOX, LAR
PVC-1	20	10817305	1		Regulator – Pressure/ Economizer
	21	1310152	1		Nipple - 1/4"NPT x 2-1/2" Long
	22	10501589	3		Connector – 3/8"ODT x 1/4" MPT
	23	1210462	1		Elbow – 1/4" NPT Street
	24	1210462	1		Elbow – 1/4" NPT Street
	25	1210512	2		Elbow – 3/4" NPT Street
C-2	26	1211002	1		Cap – 1" FPT
C-1	27**	1211072	1		Cap – 1-1/2" FPT 4000 & less
C-1	27	10673006	1		Cap – 2" FPT 6000 & greater
C-3	28	1210802	1		Plug – 1" MPT
	29	1210622	1		Tee – 1/4" NPT
C-4	30	1210802	1		Plug – 1" MPT

* Recommended spare parts.
** Item 27 is not included on the VCS-525

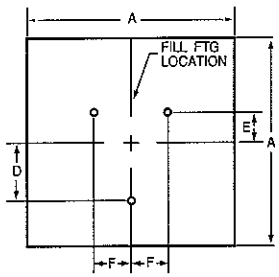
WOLVERINE MANUAL 10798589 9/97 P 33
RELIEF VALVE CHANGE 1/97
CORRECTION FOR 13 SHOULD BE
OLD- 1810402 NEW 1810482 3/4 X 1 (250
OLD- 10573911 NEW 10849534 3/4 X 1 (175

11 PAD LAYOUT

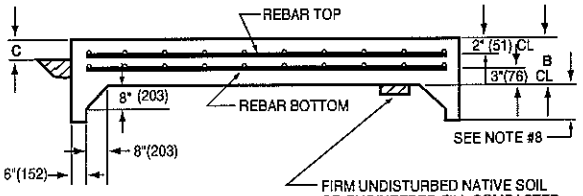
Pad Layout



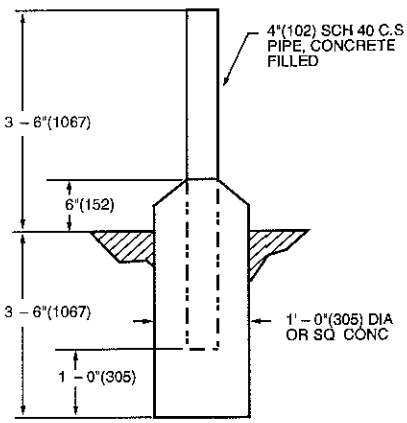
Plan View A



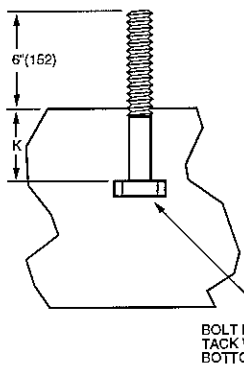
Plan View B



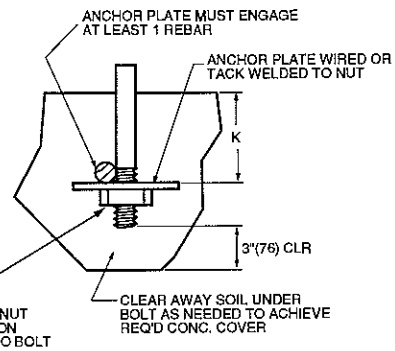
Section View



Bumper Guard Detail



Anchor Bolt Detail C



Anchor Bolt Detail D

NOTES

1. All dimensions are in inches (mm).
2. Tank foundation site shall be located such that drainage away from the foundation is assured.
3. The site shall be cleared of all organic material and topsoil.
4. Soil bearing must be 1500 P.S.F. minimum if that cannot be sustained, consult a professional engineer.
5. All concrete must be in accordance with W/ACI 318.
6. The concrete shall develop a minimum ultimate compressive strength of 2500 psi at 28 days.
7. Reinforcing steel shall be formed and conform to ASTM Spec A-615, GR 60.
8. Anchor bolts, nuts and washers shall be specified by seismic calculations.
9. Use skirted pad only if required by local code
10. The contractor shall verify the anchor bolt locations with the equipment drawings.
11. Special inspection of anchor bolts shall be provided before and during placement of the concrete, per UBC 1701.5.2, when a "Y" is shown in "Inspection" column above.

Model	525	900	1500	3000	6000	9000	11000	13000
Outer Dim	48" (1219)	60" (1524)	66"/68" (1676/1727)	96" (2438)	96" (2438)	114" (2896)	114" (2896)	120" (3048)
Plan View	B	B	B	B	B	A	A	A
A	7'6" (2286)	9' (2743)	11' (3353)	14' (4267)	19' (5791)	22' (6706)	24' (7315)	24' (7315)
B	15" (381)	15" (381)	15" (381)	18" (457)	21" (533)	24" (610)	24" (610)	27" (686)
C	2" Max (51)	2" Max (51)	3" Max (76)	3" Max (76)	6" Max (152)	6" Max (152)	9" Max (229)	12" Max (305)
D	1'9 1/2" (546)	2'3 1/2" (673)	2'6 1/8" (765)	3'7 1/2" (1105)	3'7 1/2" (1105)	3'11" (1194)	3'11" (1194)	3'11" (1194)
E	10 7/8" (276)	1'1 7/8" (352)	1'3" (381)	1'9 3/4" (552)	1'9 3/4" (552)	1'4 9/16" (421)	1'4 9/16" (421)	1'4 9/16" (421)
F	1'6 3/4" (476)	1'11 15/16" (608)	2'2" (660)	3'1 11/16" (957)	3'1 11/16" (957)	1'1 7/8" (352)	1'1 7/8" (352)	1'1 7/8" (352)
G	N/A	N/A	N/A	N/A	N/A	8" (203)	8" (203)	8" (203)
H	N/A	N/A	N/A	N/A	N/A	3'5 5/8" (930)	3'5 5/8" (930)	3'5 5/8" (930)
J	N/A	N/A	N/A	N/A	N/A	3'8 5/8" (1133)	3'8 5/8" (1133)	3'8 5/8" (1133)
ANCHOR BOLT								
Diameter	1"(24)	1"(24)	1 1/4"(32)	1 1/2"(38)	1 1/2"(38)	1 3/4"(44)	1 3/4"(44)	1 3/4"(44)
Mat'l	A325	A325	A325	A325	A687	A687	A687	A687
Det'l	C	C	C	C	D	D	D	D
K	10"(254)	10"(254)	12"(305)	15"(381)	18"(457)	21"(533)	21"(533)	24"(610)
Inspection	N	N	N	Y	Y	Y	Y	Y
ANCHOR PLATES								
Width	N/A	N/A	N/A	N/A	8"x8" (203x203)	8"x8" (203x203)	8"x8" (203x203)	8"x9" (203x229)
Thick	N/A	N/A	N/A	N/A	1 1/2" (38)	1 1/2" (38)	1 1/2" (38)	2" (51)
Rebar Top	#4 @ 12" (305) E.W.	#4 @ 12" (305) E.W.	#4 @ 12" (305) E.W.	#4 @ 12" (305) E.W.	#4 @ 12" (305) E.W.	#5 @ 10" (254) E.W.	#5 @ 10" (254) E.W.	#5 @ 10" (254) E.W.
Rebar Bottom	#5 @ 12" (305) E.W.	#5 @ 12" (305) E.W.	#5 @ 12" (305) E.W.	#6 @ 12" (305) E.W.	#8 @ 12" (305) E.W.	#8 @ 10" (254) E.W.	#8 @ 10" (254) E.W.	#8 @ 10" (254) E.W.

Liquid Level Gauge

The liquid level gauge on the Wolverine Storage Tank is a differential pressure gauge. It measures the difference in pressure between the top and bottom of the inner vessel and the bottom. This pressure difference is due to the column weight of the product. The gauge displays this differential pressure as inches or centimeters of water column.

The computer disk (CalChart Program) provided with this manual, supplies a calibration chart program for all MVE model tanks. The program can be used with metric or english units. To install the program, follow these steps:

Installing the CalChart program in Windows 95:

1. Insert CalChart setup disk into appropriate floppy drive.
2. Hit the Windows 95 Start button.
3. Select run.
4. Type **a:\setup** (if the disk is in a different drive than drive **a:**, then change accordingly).
5. Hit the OK button.
6. Follow the on-screen instructions until finished.

Installing the CalChart program in Windows version previous to Windows 95:

1. Insert CalChart setup disk into appropriate floppy drive.
2. From Program Manager, pull down the file menu.
3. Select Run.
4. Type **a:\setup** (if the disk is in a different drive than drive **a:**, then change accordingly).
5. Hit the OK button.
6. Follow the on-screen instructions until finished.

Minimum System Requirements:

- Intel 386-based PC or higher.
- Microsoft Windows 3.1 or later, 100%-compatible version.
- 2Mb of extended memory or higher.
- 1Mb Hard disk space.

NOTES

REVISION LOG		
LETTER	**DATE**	**DESCRIPTION**
A	6/96	VCS Wolverine User Manual (Rev. 5)
B	9/97	Update

Any comments or suggestions related to this manual are encouraged and should be forwarded in writing to:

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Technical Service Department
407 Seventh Street NW, P.O. Box 234
New Prague, Minnesota 56071

Telephone or fax MVE at one of the numbers listed below.

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P/N 10798589 9/97