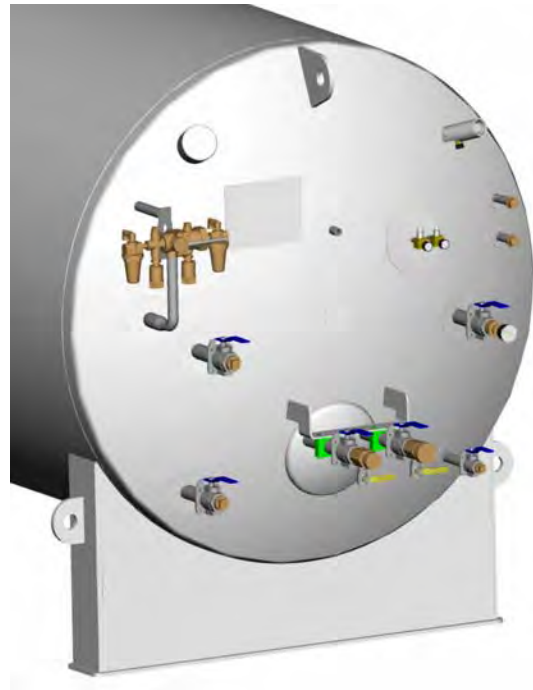




TECHNICAL MANUAL CARBON DIOXIDE STORAGE TANK



**MANUAL # 11650869
Rev G**

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REVISION LOG	
Rev A (04/17/02)	Add HS-6Ton O&D to manual.
Rev B (05/02/02)	Add HS-30/50Ton O&D to manual
Rev C (06/03/02)	Add HS-14Ton O&D to manual and also HS-30/50Ton w/Skid O&D
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Rev F (12/12/02)	Update O&Ds
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SECTION 1 PREFACE

GENERAL

The Carbon Dioxide Storage Tank technical manual is designed to be used in conjunction with Carbon Dioxide Storage Tanks provided by Chart. This manual contains information regarding the safe operation and handling of liquid Carbon Dioxide (CO₂) with the Carbon Dioxide 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 Carbon Dioxide Storage Tank, contact Chart's Technical Service division at 1-800-400-4683.

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

The schematics, piping illustrations, and parts list shows a reference number for each component used on the Carbon Dioxide 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 its function, operation, or repair.

The safety requirements for operating the Carbon Dioxide Storage Tank and handling or transporting extremely cold liquid products are shown in Sections 2. Use this safety section as a "Safety Check-List" each time the equipment is being used.

Section 3 discusses the general features of the tank and the theory of operation.

Section 4 illustrates how to uncrate and install the Carbon Dioxide Storage Tank.

Section 5 gives a step by step procedure for the basic operation of the tank.

Section 6 indicates how to maintain and repair the Carbon Dioxide Storage Tank.

Section 7 contains Outline & Dimension drawings and P&ID drawing for the specific tank models covered by this manual. It has general information, technical specifications, plumbing schematics, 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:

BAR	Pressure (Metric)
CBM	Center Back Mount Gauge
CGA	Compressed Gas Association
CO ₂	Carbon Dioxide
FPT	Female Pipe Thread
MPT	Male Pipe Thread
NPT	National Pipe Thread
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
SCM	Standard Cubic Meters
PB	Pressure Builder
Nm ₃	Normal Cubic Meters

SECTION 2 SAFETY

GENERAL

The Carbon Dioxide Storage Tank consists of an inner pressure vessel encased within an outer carbon steel vacuum shell. The container operates under low-to-medium pressure. Safety relief devices are used to protect the pressure vessel and vacuum casing, sized and selected in accordance with ASME standards they include a dual relief valve system to protect the pressure vessel, and a reverse buckling rupture disc or lift plate to protect the vacuum casing (outer vessel). The Carbon Dioxide 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 Carbon Dioxide 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 Carbon Dioxide 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 Carbon Dioxide gas. Periodic review of this safety summary is recommended.

WARNING: Carbon Dioxide 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 the 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 or solid CO₂ with the 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 CO₂ 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 of 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.

CAUTION: Do not use oxygen equipment that is marked "For Oxygen Use" in CO₂ service. Failure to comply with these instructions may result in serious damage to the container.

SAFETY BULLETIN

Portions of the following information is extracted from Safety Bulletin SB-2 from the Compressed Gas Association, Inc. Additional information on carbon dioxide 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, inversion 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 Chart 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, such as an oxygen deficient atmosphere.

OXYGEN DEFICIENT ATMOSPHERES

Carbon Dioxide is colorless and odorless. It can replace the oxygen in the air when released in confined areas.

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 can be masked by a state of "euphoria" leaving the victim with a false sense of security and well being.

Human exposure to atmosphere containing 12% or less oxygen leads to rapid unconsciousness. Unconsciousness can occur so rapidly that the user is rendered essentially helpless. This can occur if the condition is reached by immediate change 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 constrain. 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.

CARBON DIOXIDE

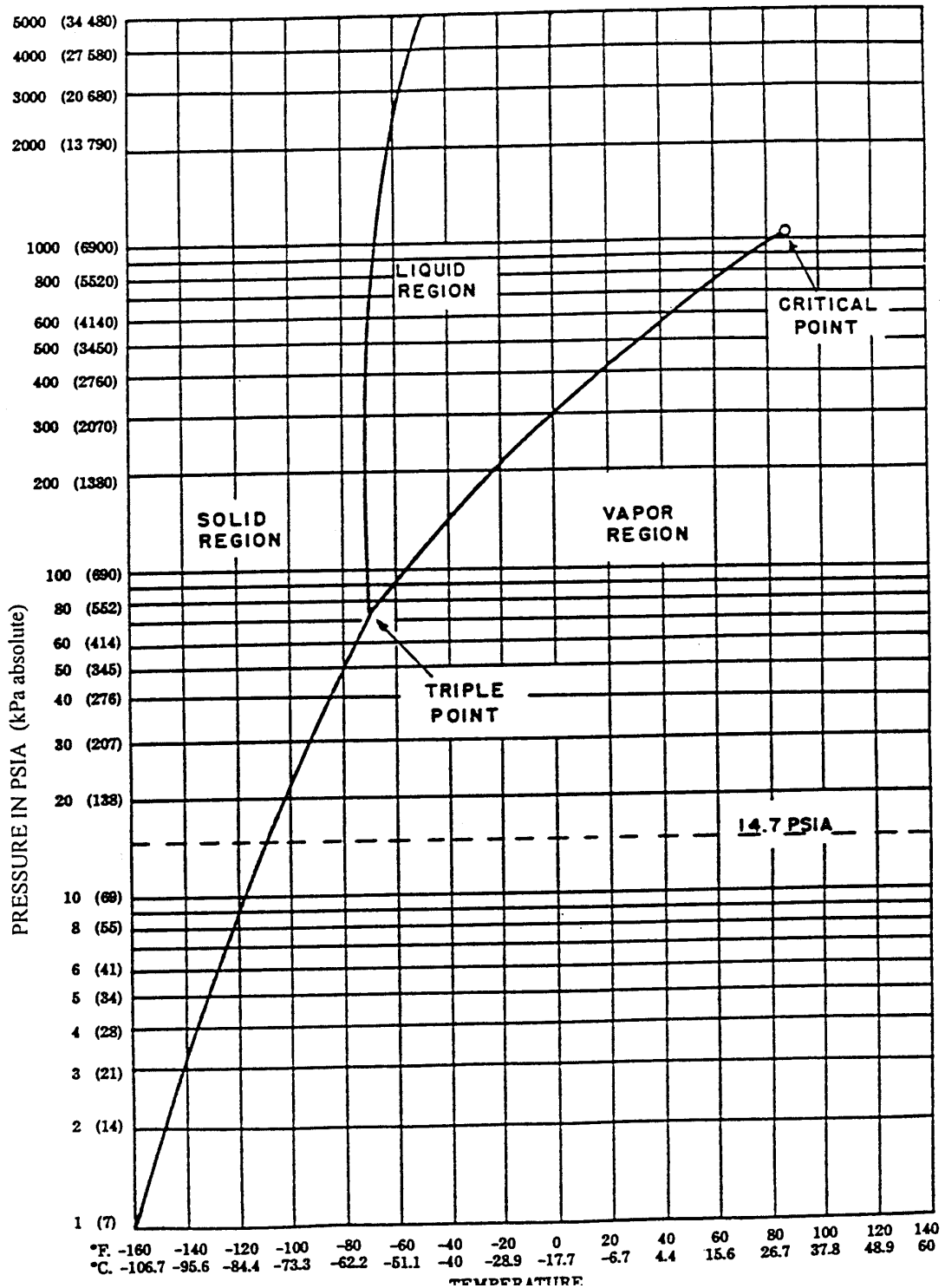
Carbon dioxide is a compound formed by the combination of carbon and oxygen atoms in a 1:2 ratio expressed by the chemical symbol CO₂. The weight percentages of carbon and oxygen are 27.3% and 72.7% respectively.

Carbon dioxide is a gas at normal atmospheric temperature and pressure. It is colorless and somewhat pungent although essentially odorless and is about 1.5 times more dense than air.

Depending on the temperature and pressure to which it is subjected, carbon dioxide may exist in the form of a solid, a liquid, or a gas. At a temperature of -69.9°F (56.6°C) and a pressure of 60.43 psig (417 kPa) carbon dioxide can exist simultaneously in all three phases. This condition is known as the triple point. The phase diagram for carbon dioxide is shown in Fig. A.

At temperatures above 87.9°F (31.1°C), carbon dioxide can exist only as a gas, regardless of the pressure. This is known as its critical temperature. As shown in Fig. A, liquefied carbon dioxide can only exist in a sealed container between the triple point and critical point temperatures under pressure. There is a definite pressure-temperature relationship of the liquid and gas in equilibrium.

CARBON DIOXIDE PHASE CHART FIGURE A



SECTION 3 INTRODUCTION

GENERAL

The Chart Carbon Dioxide Storage Tanks are a compact and self-contained system designed for the economical storage of liquid carbon dioxide with the ability to provide it to the application as either liquid or gas.

The VS model (Vertical Carbon Dioxide Storage Tank or VS-CO₂) is a medium pressure tank designed to store liquid and provide it as liquid or gas, to a customer application. This tank can also be connected to pumps for high pressure cylinder filling.

The Chart 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 Carbon Dioxide Storage Tank.

The first two sections of the model designation (i.e., VS-14) are used throughout section 8 and 9 of this manual for specific information.

NOTE: Refer to chapters 8 and 9 of this manual to see the specific model specification, Charts, schematics, and parts covered by the contents of this manual.

RECEIVING CHECK POINTS

1. Check braces, skids, wooden chocks, and other shipping supports. Damage or deformation would indicate the possibility of mishandling during shipment.
2. Examine welded or brazed joints on plumbing for cracks or deformation, especially near valves and fittings.
3. Check points where pipes exit the tank for cracks or breaks.
4. Check relief valves and burst discs for dirt or damage.
5. Check pressure within vessel on PI-1. If pressure is zero, extra precautions against contamination and impurities must be taken.
6. Examine the 5g impactograph. If it has sprung, damage may have occurred during shipment. Notify your company's tank specialist and/or CHART.
7. Check the container vacuum.
 - a) If warm vacuum for "NC" models is above 20 microns, consult factory.

VACUUM CHECK PROCEDURES

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

1. The standard CHART vacuum probe is a Teledyne-Hastings DV-6R probe. Select a compatible instrument to read the output of the vacuum probe.
2. Remove the rubber cap on probe outlet to expose contact. Note that probe housing need not be opened to do this.
3. Plug the instrument to the probe and calibrate the instrument.
4. Open the vacuum probe isolation valve. Wait for 5 minutes and take vacuum reading. Note that valve handle protrudes through protective housing and can be turned without opening the housing.
5. Close the isolation valve and take a second reading. Monitor the rate of rise in vacuum probe with isolation valve closed. If the vacuum continues to rise at a constant rate, it is possible that the probe assembly is leaking. Consult the factory.
6. Verify that the isolation valve is closed.
7. Replace the rubber probe cap.
8. Compare the vacuum reading obtained now to reading taken prior to shipping.

FEATURES

The Carbon Dioxide Storage Tanks are designed to provide a convenient, reliable, and economical method for the storage and delivery of CO₂. Important features of these containers include:

1. Long-term hold time due to highly efficient multi layer composite insulation system with low vacuum.
2. An optional pressure building system that can be used to maintain working pressure during high withdrawal operations.
3. An optional final line vaporizer system that can be used to vaporize liquid and warm the gas for gas use applications.
4. An optional refrigeration coil that allows a refrigeration system to be used to lower tank pressure during low withdrawal operations to prevent the loss of product when used in high process heat input applications.
5. A bottom fill line and vapor return line that allow the tank to be refilled from a liquid supply unit by pump transfer. The vapor return line also serves as the full trycock.

6. Simple and convenient piping controls.
7. Rugged carbon steel outer vessel.

PHYSICAL DESCRIPTION

Carbon Dioxide Storage Tanks are designed for long-term storage of liquefied carbon dioxide under pressure in the range of 165 to 350 psig (11.6 to 24.6 Kg/cm₂). Operation of the tank is fully automatic with the optional pressure building and/or refrigeration systems set to maintain preset pressure and flow conditions into customers' pipeline. While hardware may vary slightly from model to model, each unit essentially performs the same functions.

The Carbon Dioxide Storage Tank is comprised of a steel inner tank encased in an outer carbon steel vacuum shell. The insulation system between the inner and outer containers consists of multiple layer composite insulation and high vacuum to ensure long holding time. The insulation system, designed for long-term vacuum retention, is permanently sealed at the factory to ensure vacuum integrity.

The VS-CO2 is 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 Chart. Failure to comply with these instructions may result in serious damage to the container.

Lifting lugs are located on the tank. The lifting lugs are provided to facilitate handling. Moving requires the use of a crane and adherence to specific rigging instructions (see section 4 in this manual for details on handling).

SAFETY DEVICES

The vessels are protected from over-pressurization with a tank pressure relief device. The normal relief device pressure setting is at the maximum allowable working pressure of the inner vessel.

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

NOTE: Safety devices meet all of the requirements of CGA Pamphlet S-1.3, *Safety Relief Device Standards, Part 3, Compressed Gas Storage Containers*.

OPERATIONAL SYSTEMS

The various models have the same general operating system. Each model has the ability to be filled with product and deliver either liquid or gas for a specific application.

The following section will discuss the theory behind these operations.

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, and nomenclature show how the plumbing circuitry operates for the specific model. It is important that the operators be familiar with the plumbing control valves and their functions as shown in section 7.

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.
4. Do not let the pressure in the filling system drop below 165 psig (11.6 Kg/cm₂) to prevent the liquid CO₂ temperature from dropping below minimum vessel design temperature.

The vessel 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.

Chart VS-CO₂ units 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 the unit with liquid, the transfer should be made with a centrifugal pump.

PUMP TRANSFER

Liquid carbon dioxide is transferred into the VS-CO₂ unit with a two hose pumping system. Liquid is pumped into the bottom of the vessel while gas is recovered from the top. The pressure in the vessel remains constant during the pump transfer.

PRESSURE BUILDING (Optional)

When a VS-CO₂ model is used for either liquid or gas withdrawal, the normal operating pressure

range is controlled by the pressure setting of the pressure building system.

Pressure building systems can be added to the VS-CO₂ models and should be sized to the expected gas withdrawal rate of the application. Pressure building systems remove liquid from the bottom of the tank and vaporize it into gas by adding heat to it. The warmed gas is then returned to the top of the vessel where it raises the pressure in the tank. All pressure building systems need to have pressure switches to automatically turn on and off the flow of liquid into the pressure builder. Safety relief devices should be installed in the components lines wherever liquid can be trapped between valves.

PRESSURE REDUCTION

The pressure building system will increase tank pressure to maintain the proper operating conditions for the tank. In a direct gas use application where the tank pressure is reduced by the withdrawal of gas from the top of the tank. The heat input through the insulation and the pressure building system are used to maintain operating pressure.

Liquid withdrawal applications do not reduce tank pressure as rapidly as gas withdrawal. High volume liquid applications will normally keep the tank pressure down, however heat input through the insulation can increase the tank pressure to the relief valve setting if the liquid withdrawal application is small.

An optional refrigeration coil can be built into the vessel that will recondense the gas in the top of the tank and reduce the pressure, when used with a mechanical refrigeration system. This system works automatically with the pressure building system to maintain tank pressure as desired.

LIQUID WITHDRAWAL

If the VS-CO₂ model tank is to be placed in permanent liquid withdrawal service, it is recommended that all liquid withdrawal lines are insulated with urethane foam. The piping will efficiently bring the liquid to the application with the least amount of pressure rise.

Normal liquid withdrawal operations need to be performed at pressure above 165 psig (11.60Kg/cm²) to prevent the liquid CO₂ temperature from dropping below minimum vessel design temperature. Transfer of liquid at high pressure can lead to excessive splashing of the cold liquid which could result in burns to the operator and or nearby personnel. Personnel should be fully instructed in the cautions associated with handling extremely cold 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.

GAS WITHDRAWAL

When the supply of gaseous product is the primary operation of the tank, external vaporizers and an additional regulator must be added after the withdrawal valve to regulate the temperature and to step down the pressure to the gas application. Very small gas use rates may be supported by direct withdrawal of gas from the tank. However, most gas use rates require that liquid be withdrawn from the tank and vaporized to provide gas supply.

SECTION 4 INSTALLATION

GENERAL

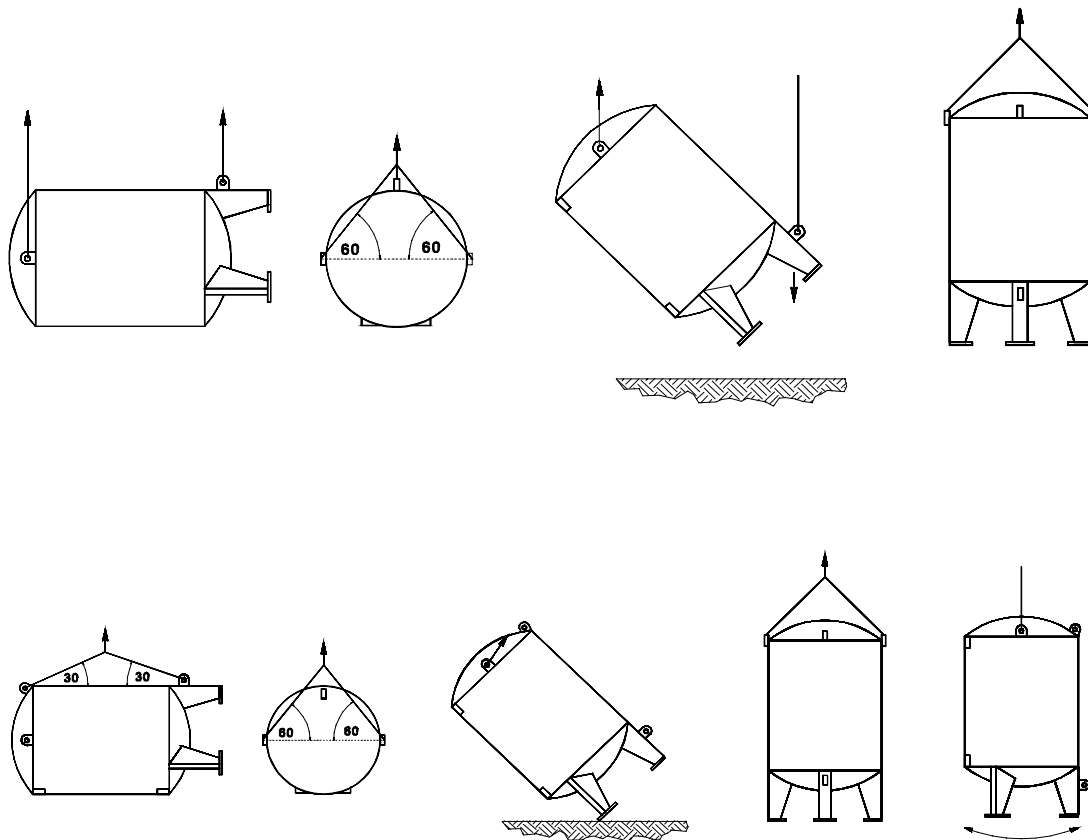
This section deals with the receiving and uncrating the VS-CO2 model tank. It explains how to connect to the tank and unload it from the truck or shipping container. It provides the owner with a list of inspections that should be done before receiving the tank. It discusses general considerations for the tank final location.

RIGGING

GENERAL HANDLING INSTRUCTIONS

Installation of a VS-CO2 unit at the storage site requires the use of a lift crane. For 6T models a crane with one hoist maybe used. For models 14T and larger, the crane must be configured with two hoists. See diagram below.

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.



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

Container packaged tanks are shipped in 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.

Carbon Dioxide 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 tank lifted only a few inches off the cargo container 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 Chart.

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 be checked 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 for dirt damage.
5. Check the pressure in the vessel with the pressure gauge (PI-1). If pressure is "0" then extra precautions against contamination and impurities must be taken.
6. Examine the 5g impactograph located on the inside 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 Chart.
7. Check the vacuum level using the vacuum test procedure.

VACUUM TEST PROCEDURE

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

1. The standard Chart 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 (HCV-5). 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 (HCV-5) 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 is above 20 microns, consult factory.
- b. If your last vacuum reading shows a steady increase from the first, consult the factory.

SITE CONSIDERATIONS

If the Carbon Dioxide Storage Tank is 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 VS-CO₂ 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 VS-CO₂ model 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

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 VS-CO2 model 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 Carbon Dioxide Storage Tank should be supervised by personnel familiar with the tank's 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.

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

SECTION 5 OPERATIONS

GENERAL

This chapter provides the preparation, initial fill, gas use, liquid delivery, and refilling procedures for a Carbon Dioxide 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 7 and 8 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 should be filled by two hose transfer. Internal tank pressure of at least 165 psi (11.6Kg/cm₂) must be maintained.

CAUTION: Failure to maintain a minimum tank pressure of 165 PSIG (11.6 Kg/cm₂) in a vessel containing liquid CO₂ will result in liquid CO₂ temperature dropping below minimum vessel design temperature. This can result in damage to the vessel.

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.

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 gas purge product to the vapor return (FC-2).

NOTE: Chart CO₂ tanks ship with brass plugs in the following valves: Pressure building inlet and outlet valves (HCV-3 and HCV-11) and Aux. liquid and vapor valves (HCV-18 and HCV-19). These plugs are to be removed at time of installation.

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

NOTE: When a solenoid valve is used to control the pressure building circuit, it must be energized.

3. Open the vapor recovery valve (HCV-4) to allow gas to flow into the tank.
4. Shut off the gas supply source (HCV-4) when pressure in the tank reaches the maximum purge pressure as indicated on tank pressure gauge (PI-1).
5. Open the equalization valve (HCV-9), to prevent damage to the gauge before closing valves (HCV-8 and HCV-10). Close HCV-8/HCV-10.
6. 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 stream visually checked for signs for 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: 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.

7. Remove the pressure control regulator PCV-3A/B toggle the safety relief selector (HCV-15) both sides to purge entire circuit.
8. Open the fill valve (HCV-1) and reduce the tank pressure to 5 psi.

Warning: Hearing protection must be worn while tank is venting.

9. Close the fill valve (HCV-1) and replace the pressure control regulators (PCV-3A/B)
10. Repeat purge procedures steps 2 through 4 and 8 & 9 at least five times until product purity has been obtained.
11. 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).
12. Reinstall the pressure control regulator (PCV-3A/B).

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

<u>Valve</u>	<u>Position</u>
Vapor Recovery Valve (HCV-4)	Closed
Bottom Fill Valve (HCV-1)	Closed
Equalization Valve (HCV-9)	Closed
Pressure Building Inlet Valve (HCV-3)	Closed
Pressure building Outlet Valve (HCV-11)	Closed
Liquid Phase (high) Valve (HCV-10)	Open
Gas Phase (low) Valve (HCV-8)	Open
All other tank valves	Closed

INITIAL (WARM TANK) FILLING PROCEDURES

It is recommended that upon first fill the Chart CO₂ Cleaning Procedure be implemented to ensure cleanliness of tank.

1. Purge tank to assure product purity.
2. Verify that the supply unit contains the proper product to be transferred and that the supply unit and tank fill fitting are for CO₂ service.
3. Verify that all valves except liquid phase high (HCV-10) and gas phase low (HCV-8) are closed.
4. Connect the supply unit liquid transfer hose to the tank fill connection (FC-1).
5. Connect the vapor recovery transfer hose to the tank vapor recovery connection (FC-2).
6. Open vapor valve (HCV-4) slowly. Allow the tank and supply unit to equalize in pressure.
7. Open the fill valve (HCV-1) and begin to pump fill the tank.
8. Monitor tank pressure (PI-1) during fill.
9. Monitor liquid level contents gauge (LI-1) during filling.
10. When tank nears full, open vapor return/full trycock line drain valve (HCV-4A).
11. Stop the filling operation when liquid begins to discharge from drain valve (HCV-4A).

CAUTION: Do not overfill

12. Close the fill valve (HCV-1) and the vapor recovery valve (HCV-4).
13. Open fill line drain valve (HCV-1A) to relieve hose pressure.

14. Disconnect supply unit from tank at fill and return hose fittings (FC-1 and FC-2). It is recommended that the fill hose be allowed to defrost before removing.
15. Close drain valves (HCV-1A and HCV-4A) and replace caps on fill fittings.
16. Unit is now ready to place into service.

PREPARING THE STATION FOR OPERATION

Preparing the VS-CO₂ model tank for operation consists of adjusting the pressure control valves for automatic operation and then valving open the circuits used to supply the gas requirements of the customer.

Normal operating valve position for a VS-CO₂ tank is as follows.

Valve	Position
Bottom Fill Valve (HCV-1)(HCV-1A)	Closed
Vapor Recovery Valve (HCV-4) (HCV-4A)	Closed
Equalization Valve (HCV-9)	Closed
Pressure Building Inlet Valve (HCV-3)	Open
Pressure Building Outlet Valve (HCV-11)	Open
Liquid Phase (high) Valve (HCV-10)	Open
Gas Phase (low) Valve (HCV-8)	Open
Aux Liquid Valve (HCV-18)	Open/Closed
Aux Vapor Valve (HCV-19)	Open/Closed

TANK VENT PRESSURE CONTROL

1. The tank operating pressure should never be vented below 165 psig (11.6 Kg/cm²) while liquid is in the vessel, in order to prevent liquid CO₂ temperature dropping below minimum vessel design temperature
2. Regulator (PCV-3A/B) are used to keep tank pressure from rising above maximum desired pressure. It is factory set at 340 PSI so that normal venting will not be done by tank safety valves (PSV-1A/1B).

REFILLING

A vessel that is in service must be refilled using bottom fill and vapor return valves (HCV-1 and HCV-4). 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

1. Verify that the contents of the supply unit is the proper product to be transferred.
2. Verify that fill and vapor valve (HCV-1 and HCV-4) are closed.
3. Verify that all other valves are in normal operating positions.

4. Connect the supply unit liquid transfer hose to tank fill connection (FC-1).
5. Connect the vapor recovery hose to the vapor connection (FC-2).
6. Open vapor valve (HCV-4) slowly. Allow the tank and supply unit to equalize in pressure.
7. Open the fill valve (HCV-1) and begin to pump fill the tank.
8. Monitor tank pressure (PI-1) during filling.
9. Monitor liquid level contents gauge (LI-1) and stop the filling operation when the gauge reads full.
10. When tank nears full, open vapor return/full trycock line drain valve (HCV-4A).
11. Stop the filling operation when liquid begins to discharge from drain valve (HCV-4A).

CAUTION: Do not overfill

12. Close the fill valve (HCV-1) and the vapor recovery valve (HCV-4).
13. Open fill line drain valve (HCV-1A) to relieve hose pressure.
14. Disconnect supply unit from tank at fill and return hose fittings (FC-1 and FC-2). It is recommended that the fill hose be allowed to defrost before removing.
15. Close drain valves (HCV-1A and HCV-4A) and replace caps on fill fittings.
16. Verify that all other valves remain in normal operating positions.

VAPOR WITHDRAWAL PROCEDURE

1. Connect the customer line to the VS-CO₂ vapor connection.
2. Verify that all valves except liquid phase (high) (HCV-10) and gas phase (low) (HCV-8), are closed.
3. Open vapor valve (HCV-19), pressure building liquid valve (HCV-3), and pressure building vapor valve (HCV-11) to start gas flow. Customer line and system will deliver gas until stopped.

CAUTION: Controls must be in place to stop gas flow if tank pressure falls below 165 PSIG (11.6 Kg/cm₂).

4. Once the required amount to product has been delivered (or to close the tank down for an extended period of time), stop gas flow by closing vapor valve (HCV-19).

LIQUID WITHDRAWAL PROCEDURE

1. Connect customer line to liquid withdrawal connection.
2. Verify that all valves except liquid phase high valve (HCV-10), gas phase low valve (HCV-8) are closed.
3. Open liquid valve (HCV-18), pressure building liquid valve (HCV-3), and pressure building vapor valve (HCV-11) slowly to begin liquid flow.

CAUTION: Controls must be in place to stop gas flow if tank pressure falls below 165 PSIG (11.6 Kg/cm₂).

4. Once the desired amount of liquid has been delivered, close the liquid withdrawal valve (HCV-18).

WARNING:

Anytime a pump is used for product withdrawal, there must be a vibration eliminator kit installed. Failure to do this may result in lost of tank vacuum. Contact your sales personnel for kit part number

SECTION 6 MAINTENANCE

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 7. Note that supporting parts location instructions are provided in Section 8.

Before implementing any procedure described in this section, it is recommended that the Safety Summary and Product Safety Bulletins (Section 2) 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.

Person making repairs to piping, valves, and gauges must be familiar with cleanliness requirements for components used in carbon dioxide service (see *Cleaning* below for further details).

COMPATIBILITY AND CLEANING

It is essential to always keep the Carbon Dioxide Storage Tank clean and free of grease and oil.

When replacing components, only use parts which are considered compatible with the product.

WARNING: Before conducting maintenance or replacing parts on Carbon Dioxide Storage Tank, remove all liquid and release container pressure in a safe manner.

CLEANING PROCEDURE FOR BULK CO₂ STORAGE TANKS

Normally Carbon Dioxide bulk tanks that receive and deliver carbon dioxide in liquid form do not require routine cleaning. Normal trace impurities are not concentrated by distillation in the tank and are simply passed on as product flows in and out of the tank.

In the event that contamination of the tank is suspected, the following cleaning procedure is suggested.

The CO₂ tanks can best be cleaned by spraying clean CO₂ liquid from a delivery transport pumped into the tank at a rapid rate into an empty or nearly empty tank and flushing the effluent out of the bottom of the tank.

Note: CGA pamphlet G-6.4 should be used as a guideline for all transfer of carbon dioxide into and out of bulk carbon dioxide storage tanks.

The Cleaning procedure consists of:

1. Emptying all or most of the liquid from the tank, as any product left in the tank will be lost in the cleaning procedure. Reduce tank pressure to approximately 165 psig to insure sufficient pressure differential between tank and delivery unit to cause a high flow through the cleaning nozzle.
2. Connect transport pump hose to appropriate connection on the bulk tank and start transferring liquid. Recommended flow is approximately 50 GPM.
3. Slowly open Bottom Fill valve to discharge sediment and liquid CO₂ from tank.
4. This procedure should be run until acceptable levels of cleanliness of the effluent are obtained.

PROCEDURE

1. Bulk CO₂ tank contents should be reduced to approximately 500 pounds or less as any remaining product will be discharged or lost in the cleaning and flushing procedure.
2. Reduce Bulk CO₂ tank pressure to approximately 150 PSI below transport pump capability to insure vigorous flow into the tank. Do not reduce Bulk CO₂ tank pressure below 165 PSI to maintain the tank temperature above -30 degrees F. **Caution: Liquid carbon dioxide begins conversion to dry ice at 60.4 psig.**
3. Connect transport liquid pump hose to Aux. Vapor connection (C-2) for 14, 30 and 50Ton tanks or PB Vapor connection (C-4) for 6Ton. It may be necessary to add a CGA CO₂ fitting to make connection. Transport vapor return pump hose will not be used for this cleaning procedure.
4. Open Aux. Vapor valve (HCV-19) for 14, 30 and 50Ton tanks or PB Vapor valve (HCV-11) for 6Ton and start filling procedure.
5. Monitor tank pressure during cleaning procedure, top filling may tend to collapse or reduce tank pressure. If pressure drops below 165 PSI, stop cleaning procedure and allow pressure to build to acceptable level before continuing.
6. Slowly open Bottom Fill valve (HCV-1) to discharge sediment and liquid CO₂ from tank. Continue to monitor tank pressure and if pressure drops below 165 PSI shut Bottom Fill valve (HCV-1) and allow pressure to build to acceptable level before continuing.
7. Let cleaning cycle run for 3-5 minutes. Monitor discharged CO₂ until an acceptable level of cleanliness has been achieved.
8. When tank has reached acceptable cleanliness levels, close Bottom Fill valve (HCV-1) and shut down transport pump. Close Aux. Vapor valve (HCV-19) for 14, 30 and 50Ton tanks or PB Vapor valve (HCV-11) for 6Ton.

9. Blow down hose using procedures described in CGA pamphlet G-6.4.
10. Reconnect all previous connections that were removed during the cleaning procedure.
11. Follow standard filling procedure found in CGA pamphlet G-6.4. **Caution: Discharging liquid CO₂ into the atmosphere can produce high velocity dry ice particles which must be directed away from people or anything else that might be damaged in the process. A restricted valve may also become blocked with dry ice that may be ejected at anytime at high velocity.**

PERIODIC INSPECTIONS

In order to maintain the VS-CO₂ tank 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

<u>Item</u>	<u>Interval</u>
Valves and fittings for leaks and other malfunctions	Quarterly
Indicating gauges formal function	Annually
Relief valves to verify proper settings	2 years

SOLDERING/WELDING

Before performing any soldering or welding work on a Carbon Dioxide Storage Tank always exhaust any product from lines and purge thoroughly with nitrogen gas. Refer to the purging instructions in Section 5.

MAINTENANCE CHECKS AND ADJUSTMENTS

The paragraphs to follow provide instructions for performing the various VS-CO₂ model tank checks and adjustments. Only perform the procedure(s) if the unit is suspect of faulty operation.

VACUUM INTEGRITY CHECK

Since all Carbon Dioxide 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.

PRESSURE AND LIQUID LEVEL GAUGES 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 Chart 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 gauge lines are leak tight. Other gauge checks include:

1. Checking the gauge lines for obstructions.
2. Checking for a leak at the liquid phase valve (HCV-10) and at the gas phase valve (HCV-8).
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 (HCV-9) 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 Chart 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 liquid phase gauge valve (HCV-10) and the gas phase gauge valve (HCV-8) are closed.

TROUBLESHOOTING

The Troubleshooting table is arranged in a “Trouble/Probable Cause/Remedy” format. The probable cause 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 8 as required to locate system components identified in the troubleshooting guide.)

Trouble	Probable Cause	Remedy
Excessive tank pressure	Pressure building system is not function properly	Pressure switch or regulator is adjusted too high. (Re-adjust)
		PB unit won't shut off. (Consult PB manufacturer.)
	Tank was just filled with higher pressure (warm) liquid.	Vent Pressure (HCV-4) to restabilize at a lower pressure.
	Excessive shutdown time, low withdrawal rate, or excessive process heat input.	Vent tank properly to desired operating pressure. Investigate process system.
	Tank pressure gauge (PI-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 system is not functioning properly.	Isolation valves (HCV-3 & HCV-11) are closed. (Open them.)
		Pressure switch (or regulator) is adjusted too low. (Readjust it.)
		PB unit is faulty. (Consult PB manufacturer.)
	Relief valve (PSV-1A/1B) or control valve (PCV-3A/B) leaking or frozen open.	Replace defective valve.
	Piping leak.	Soap test and repair.
	Low liquid level.	Refill tank.
	Excessive withdrawal rate.	Consult factory (Chart).

Trouble	Probable Cause	Remedy
Vacuum Loss	Ruptured annular space burst disc (Item PSE-3 or PSE-5/VP)	Inner vessel or piping leak. Remove all product from the container and return to Chart.
	Leak in the burst disc caused by corrosion	Remove all product from the container and return to Chart.
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-1B/1A) or pressure control valve (PCV-3A/B).	Dirt or ice under disc.	Reseat or replace valve as required.
	Valve improperly seated.	
	Damaged seat or disc.	Replace valve.

REPAIR

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

CAUTION: The VS-CO₂ should always be allowed to return to ambient temperature before repair work is performed. Remove all liquid and release pressure from the tank as necessary before replacing any component(s) exposed to pressure or to liquid CO₂.

When disassembly of a VS-CO₂ 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 VS-CO2, 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 VS-CO2 spare parts in your inventory; refer to Section 8 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.
2. Release pressure in the tank by slowly opening vapor recovery valve (HCV-4) until venting stops, and gauge (PI-1) reads 0 psig.
3. Remove the defective valve from the container.
4. Disassemble the valve and inspect all piece parts.
5. Clean all metal parts in a suitable solvent and other parts in a warm soap solution followed by a thorough warm water rinse.
6. Air dry all components using a clean, low pressure air source.
7. Replace all worn, deformed or damaged parts.
8. 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.
9. Reassemble the valve. Make sure that mating surfaces are clean and properly seated. If the repaired valve is not to be reinstalled immediately, seal it in a polyethylene bag for storage. Apply a label to the bag such as "CLEAN VALVE - DO NOT OPEN BAG UNLESS UNIT IS TO BE INSTALLED".

TANK SAFETY RELIEF VALVE (PSV-1A/1B)

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 VS-C02 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. Contact Chart customer service at (1-800-247-4446 or 1-800-241-7452) prior to any component return.

SECTION 8 SPARE PARTS LISTS

CO2-01 Spare Parts Kits

See page 2 of P&ID

SECTION 7 ILLUSTRATIONS

OUTLINE & DIMENSION DRAWINGS

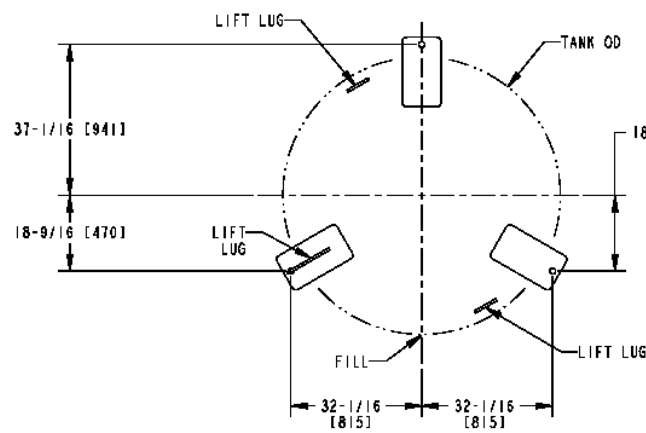
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VS-14TON	C-11640935
VS-30/50TON	C-11639707
HS-6TON	C-11694141
HS-14TON	C-11666801
HS-30/50TON	C-11681649

P&ID DRAWING For Specific Tank

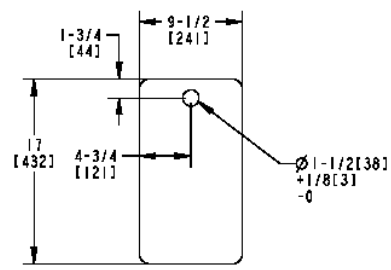
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MAWP:	PSIG	350
	barg	24.13
DESIGN PRESSURE	PSIG	370
	barg	25.51
CODE COMPLIANCE: ASME SECTION VIII DIVISION I		
DESIGN TEMPERATURE	°F	-30° TO 100°
	°C	-34° TO 38°
MATERIAL OF CONSTRUCTION: SA612 CARBON STEEL		
OUTER VESSEL DATA		
CODE COMPLIANCE: FULL VACUUM PER CGA-341		
DESIGN TEMPERATURE	°F	-20° TO 300°
	°C	-29° TO 149°
MATERIAL OF CONSTRUCTION: A36 CARBON STEEL		
INSULATION TYPE: VACUUM AND MULTILAYER INSULATION		
EVACUATION CONNECTION: 3-1/2" PUMPOUT PORT		
VACUUM GAUGE CONNECTION: HASTINGS DV6R		
BUILDING CODE:		
DESIGNED FOR CURRENT BUILDING CODE SEE MVE UBC POLICY #NP-180		

WEIGHTS AND SHIPPING DATA			
MODEL:		VS-6TON	
WEIGHT EMPTY	POUNDS	9,000	
	KILOGRAMS	4,080	
WEIGHT FULL	CO2/N2O POUNDS	21,800	
	KILOGRAMS	9,890	
SHIPPING DIMENSIONS	INCHES	187X75X75	
	MM'S	4750 X 1905 X 1905	

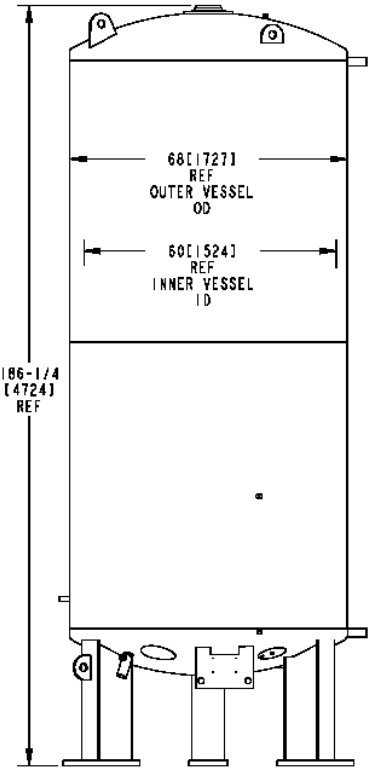
CAPACITIES			
MODEL:		VS-6TON	
CAPACITY	GROSS (COLD)	GALLONS	1,595
		LITERS	6,038
		TON	6.8
	NET (COLD)	TONNE	6.2
		GALLONS	1,519
		LITERS	5,750
		TON	6.4
TONNE		5.8	
	GASES EQUIVALENT AT 1 ATM AND 70°F / 1 ATM AND 0°C		
CO2	SCF	112,000	
	NM3	2,900	
N2O	SCF	135,300	
	NM3	3,800	



BOLT HOLE LAYOUT
TOP VIEW
SCALE: N/A



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



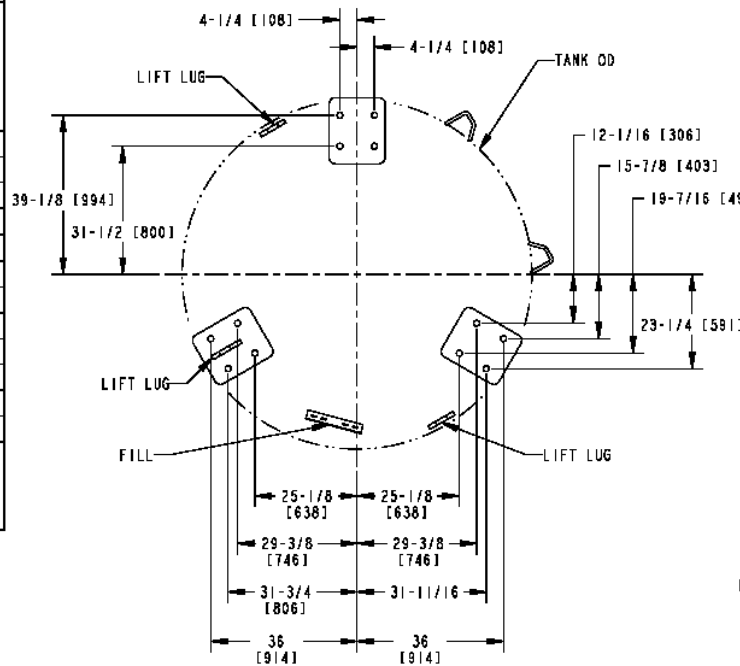
REV	ECR NO	REVISION DESCRIPTION	BY	DATE	APPROVED	DATE	APPLICATION	QUANTITY REQ'D
C	12022	CHG BLT HL DIM SCHEME	RDW	12/9/02	JJS	10/8/01		
B	-	ADDED N2O	JJS	9/9/02	KMJ	11/7/01	NEXT ASS'T	USED ON
A	11942	UPDATE WEIGHTS	JJC	6-21-02				NEXT ASS'T
REV	ECR NO	REVISION DESCRIPTION	BY	DATE	MDS	10/18/01		QUANTITY REQ'D

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				SCALE 1/16"=1"		DO NOT SCALE DRAWING		SHEET 1 OF 1			

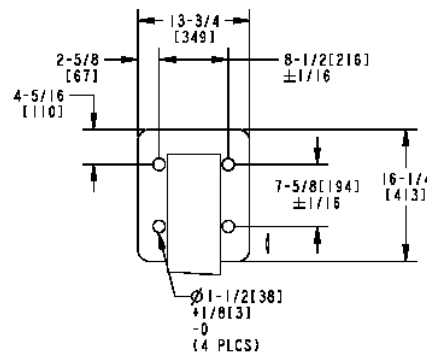
INNER VESSEL DESIGN DATA		
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MAWP:	PSIG	350
	barg	24.13
DESIGN PRESSURE	PSIG	377
	barg	26.01
CODE COMPLIANCE: ASME SECTION VIII DIVISION I		
DESIGN TEMPERATURE	°F	-30° TO 100°
	°C	-34° TO 38°
MATERIAL OF CONSTRUCTION: SA612 CARBON STEEL		
OUTER VESSEL DATA		
CODE COMPLIANCE: FULL VACUUM PER CGA-341		
DESIGN TEMPERATURE	°F	-20° TO 300°
	°C	-29° TO 149°
MATERIAL OF CONSTRUCTION: A36 CARBON STEEL		
INSULATION TYPE: VACUUM AND MULTILAYER INSULATION		
EVACUATION CONNECTION: 3-1/2" PUMPOUT PORT		
VACUUM GAUGE CONNECTION: HASTINGS DV6R		
BUILDING CODE		
DESIGNED FOR CURRENT BUILDING CODE SEE MVE UBC POLICY #NP-180		

WEIGHTS AND SHIPPING DATA		
MODEL:	VS-14TON	
WEIGHT EMPTY	POUNDS	17,400
	KILOGRAMS	7,900
WEIGHT FULL	POUNDS	42,600
	KILOGRAMS	19,330
SHIPPING DIMENSIONS	INCHES	228 X 86 X 86
	MM'S	5791 X 2184 X 2184

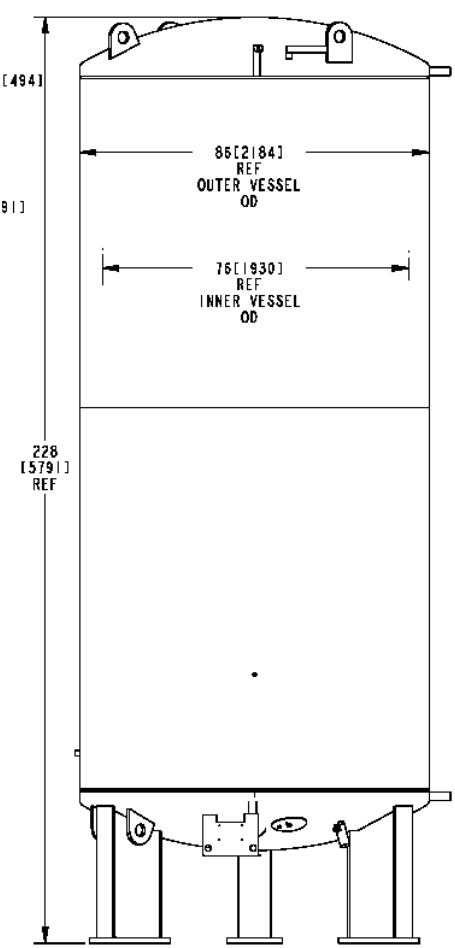
CAPACITIES			
MODEL:	VS-14TON		
CAPACITY	GROSS (COLD)	GALLONS	3,126
		LITERS	11,833
		TON	13.2
	NET (COLD)	GALLONS	2,977
		LITERS	11,269
		TON	12.6
GASES EQUIVALENT AT 1 ATM AND 70°F/ 1 ATM AND 0°C	CO2	SCF	220,000
		NM3	5,700
	N2O	SCF	265,200
		NM3	7,450



BOLT HOLE LAYOUT
TOP VIEW
SCALE: N/A



FOOT PAD
1-3/8 [35] THK
TYP (3) PLCS



APPROVED	DATE	REV	DATE	BY	DATE	DESCRIPTION	BY	DATE	DESCRIPTION
JJS	10/2/01	1	10/2/01	JJS	10/2/01	REV BLT HOLE DIM SCHM	RDW	12/6/02	
KNJ	11/7/01	2	11/7/01	JJS	9/9/02	ADDED N2O	JJS	9/9/02	
MDS	10/18/01	3	10/18/01						

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES.
TOLERANCES:
FRACTIONS ± 1/8
ANGLES ± 1°
2 PLACE DECIMALS ± .005
3 PLACE DECIMALS ± .001

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PART NUMBER
11640935

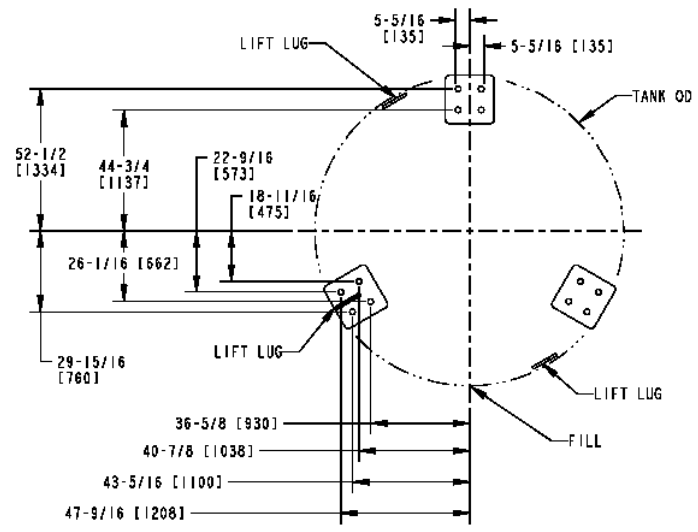
TITLE
O & D VS-14TON CO2 N2O 350 PSI ASME

DRAWING NO. **C-11640935** REV **B**

SCALE **1/16"=1"** SHEET **1** OF **1**

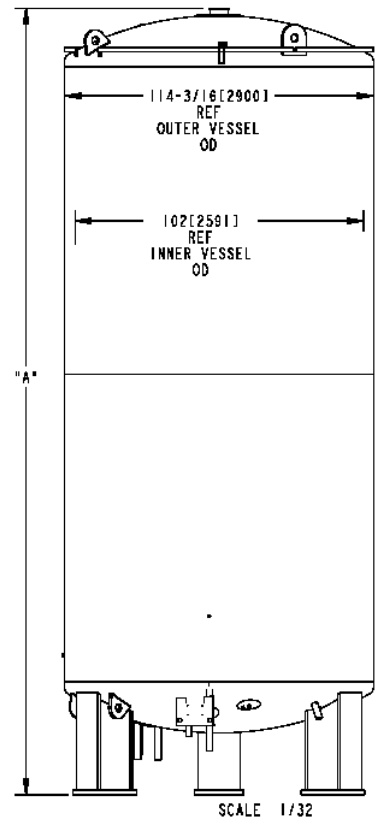
DRAWING NO. C-11639707

INNER VESSEL DESIGN DATA		
Model:	VS-30/50TON CO2/N2O	
MAWP:	PSIG	350
	barg	24.13
DESIGN PRESSURE	PSIG	378
	barg	26.03
CODE COMPLIANCE: ASME SECTION VIII DIVISION I		
DESIGN TEMPERATURE	°F	-30° TO 100°
	°C	-34° TO 38°
MATERIAL OF CONSTRUCTION: SA612 CARBON STEEL		
OUTER VESSEL DATA		
CODE COMPLIANCE: FULL VACUUM PER CGA-341		
DESIGN TEMPERATURE	°F	-20° TO 300°
	°C	-29° TO 149°
MATERIAL OF CONSTRUCTION: A36 CARBON STEEL		
INSULATION TYPE: VACUUM AND MULTILAYER INSULATION		
EVACUATION CONNECTION: 3-1/2" PUMPOUT PORT		
VACUUM GAUGE CONNECTION: HASTINGS DV6R		
BUILDING CODE:		
DESIGNED FOR CURRENT BUILDING CODE SEE MVE UBC POLICY #NP-180		

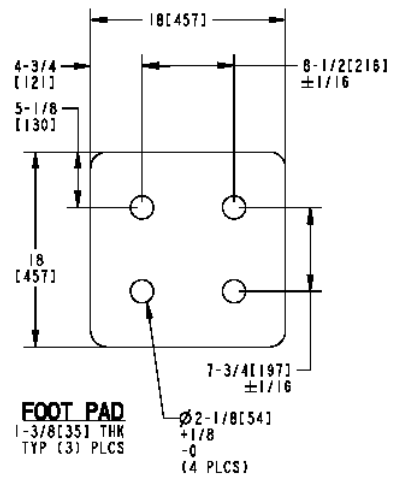


BOLT HOLE LAYOUT
TOP VIEW
SCALE: N/A

TANK HEIGHT	
MODEL	DIM "A" REF
VS-30TON	287 [7290]
VS-50TON	406 [10312]



SCALE 1/32



FOOT PAD
1-3/8 [35] THK
TYP (3) PLCS

WEIGHTS AND SHIPPING DATA				
MODEL:		VS-30TON	VS-50TON	
WEIGHT EMPTY	POUNDS	39,600	56,900	
	KILOGRAMS	17,970	25,810	
WEIGHT FULL	CO2/N2O POUNDS	98,800	148,600	
	KILOGRAMS	44,820	67,410	
SHIPPING DIMENSIONS	INCHES	287 X 115 X 115	406 X 115 X 115	
	MM'S	7290 X 2921 X 2921	10312 X 2921 X 2921	

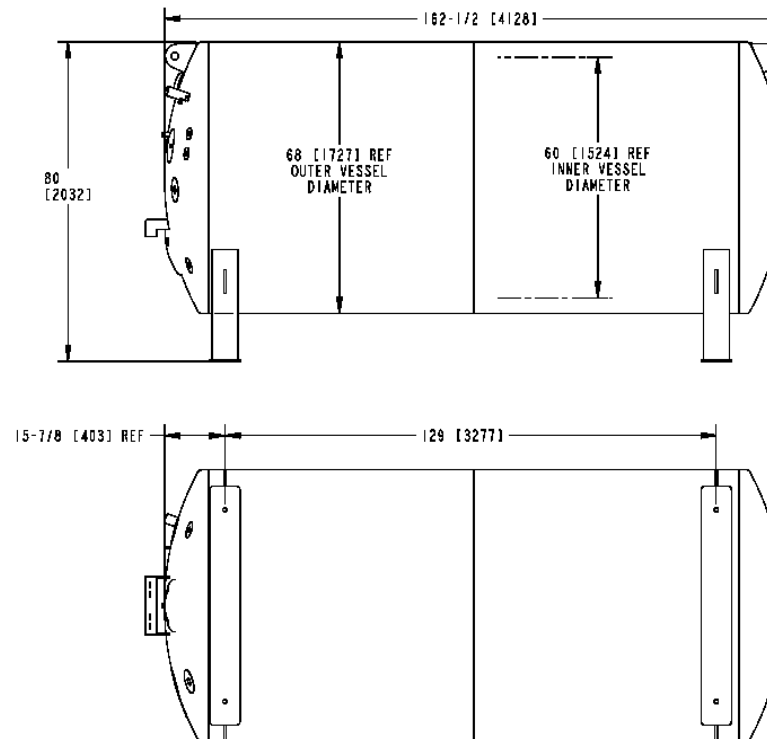
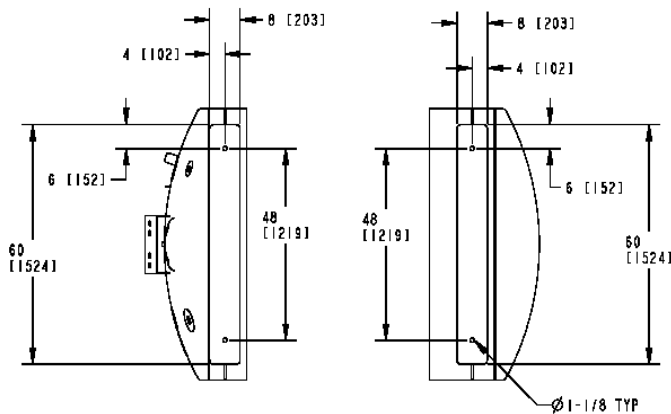
CAPACITIES				
MODEL:		VS-30TON	VS-50TON	
CAPACITY	GROSS (COLD)	GALLONS	7,339	11,367
		LITERS	27,781	43,029
		TONNE	31.1	48.1
	NET (COLD)	GALLONS	6,989	10,826
		LITERS	26,456	40,981
		TONNE	29.6	45.8
GASES EQUIVALENT AT 1 ATM AND 70°F/ 1 ATM AND 0°C	CO2	SCF	517,500	801,000
		NM3	13,590	21,000
		SCF	622,400	964,100
GASES EQUIVALENT AT 1 ATM AND 70°F/ 1 ATM AND 0°C	N2O	SCF	622,400	964,100
		NM3	17,480	27,070

REV	ECR NO	REVISION DESCRIPTION	BY	DATE	APPROVED	DATE	APP	DATE	USED ON	QUANTITY REQ'D	FINAL ASS'T
B	12022	CHG O&D DIM SCHEME	RDW	12-9-02	JJS	9/28/01	KMJ	11/7/01	NEXT ASS'T	USED ON	NEXT ASS'T
A	-	ADDED N2O	JJS	9/9/02	-	-	-	-	APPLICATION	-	QUANTITY REQ'D
REV	ECR NO	REVISION DESCRIPTION	BY	DATE	MDS	10/16/01	MDS	10/16/01	Storage Systems Division	New Prague Operations	
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PART NUMBER 11639707					SCALE 1/16"=1"		DO NOT SCALE DRAWING		SHEET 1 OF 1		

DRAWING NO. **C-11694141**

INNER VESSEL DESIGN DATA		
Model:	HS-6TON CO2/N2O	
MAWP:	PSIG	350
	barg	24.13
DESIGN PRESSURE	PSIG	370
	barg	25.51
CODE COMPLIANCE: ASME SECTION VIII DIVISION I		
DESIGN TEMPERATURE	°F	-30° TO 100°
	°C	-34° TO 38°
MATERIAL OF CONSTRUCTION: SA612 CARBON STEEL		
OUTER VESSEL DATA		
CODE COMPLIANCE: FULL VACUUM PER CGA-341		
DESIGN TEMPERATURE	°F	-20° TO 300°
	°C	-29° TO 149°
MATERIAL OF CONSTRUCTION: A36 CARBON STEEL		
INSULATION TYPE: VACUUM AND MULTILAYER INSULATION		
EVACUATION CONNECTION: 3-1/2" PUMPOUT PORT		
VACUUM GAUGE CONNECTION: HASTINGS DV6R		
BUILDING CODE:		
DESIGNED FOR CURRENT BUILDING CODE SEE MVE UBC POLICY #NP-180		

WEIGHTS AND SHIPPING DATA		
MODEL:		HS-6TON
WEIGHT EMPTY	POUNDS	9,300
	KILOGRAMS	4,130
WEIGHT FULL	POUNDS	21,900
	KILOGRAMS	9,930
SHIPPING DIMENSIONS	INCHES	188 X 85 X 75
	MM'S	4775 X 2159 X 1905



CAPACITIES			
MODEL:		HS-6TON	
CAPACITY	GROSS (COLD)	GALLONS	1,595
		LITERS	6,036
		TON	6.8
	NET (COLD)	GALLONS	1,519
		LITERS	5,750
		TON	6.4
GASES EQUIVALENT AT 1 ATM AND 70°F / 1 ATM AND 0°C	CO2	SCF	112,500
		NM3	2,960
		SCF	135,300
	N2O	SCF	135,300
		NM3	3,800

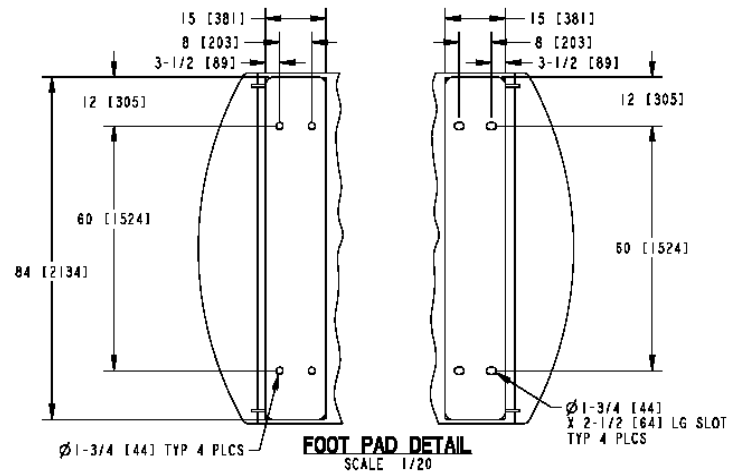
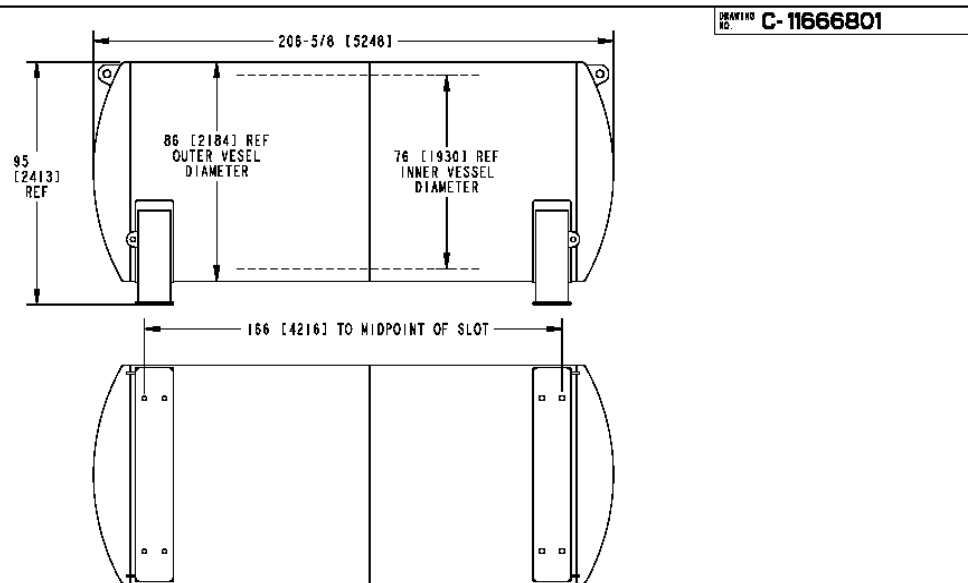
REV	ECR NO	REVISION DESCRIPTION	BY	DATE	APPROVED	DATE	TITLE	QUANTITY REQ'D
B	-	ADDED N2O	JJS	9/9/02	JJS	4/11/02	0+D HS-6TON CO2	
A	11942	UPDATE WEIGHTS	JJC	6-21-02	KNJ	4/14/02	350 PSI ASME	
REV	ECR NO	REVISION DESCRIPTION	BY	DATE	MDS	4/16/02	APPLICATION	
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<p>UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES: FRACTIONS ± 1/4 ANGLES ± 1° 2 PLACE DECIMALS ± .005 3 PLACE DECIMALS ± .001</p>							<p>TITLE: 0+D HS-6TON CO2 350 PSI ASME</p>	
<p>PART NUMBER 11694141</p>							<p>DRAWING NO. C-11694141 REV B SCALE: 3/64"=1" DO NOT SCALE HERE! 1 OF 1</p>	

IN[mm]

INNER VESSEL DESIGN DATA		
Model:	HS-14TON CO2/N2O	
MAWP:	PSIG	350
	barg	24.13
DESIGN PRESSURE	PSIG	377
	barg	26.01
CODE COMPLIANCE:	ASME SECTION VIII DIVISION I	
DESIGN TEMPERATURE	°F -30° TO 100°	
TEMPERATURE	°C -34° TO 38°	
MATERIAL OF CONSTRUCTION:	SA612 CARBON STEEL	
OUTER VESSEL DATA		
CODE COMPLIANCE:	FULL VACUUM PER CGA-341	
DESIGN TEMPERATURE	°F -20° TO 300°	
TEMPERATURE	°C -29° TO 149°	
MATERIAL OF CONSTRUCTION:	A36 CARBON STEEL	
INSULATION TYPE:	VACUUM AND MULTILAYER INSULATION	
EVAUATION CONNECTION:	3-1/2" PUMPOUT PORT	
VACUUM GAUGE CONNECTION:	HASTING DV6R	
BUILDING CODE: DESIGNED FOR CURRENT BUILDING CODE SEE MVE UBC POLICY #NP-180		

WEIGHTS AND SHIPPING DATA			
MODEL:		HS-14TON	
WEIGHT EMPTY	POUNDS	17,400	
	KILOGRAMS	7,890	
WEIGHT FULL	CO2/N2O POUNDS	42,600	
	KILOGRAMS	19,320	
SHIPPING DIMENSIONS	INCHES (L * W * H)	233 x 86 x 95	
	MM'S (L * W * H)	5,913 x 2,184 x 2,413	

CAPACITIES			
MODEL:		HS-14TON	
CAPACITY	GROSS (COLD)	GALLONS	3,126
		LITERS	11,833
		TON	13.2
	NET (COLD)	GALLONS	2,977
		LITERS	11,269
		TON	12.6
GASES EQUIVALENT AT 1 ATM AND 70°F/ 1 ATM AND 0°C	CO2	SCF	220,500
		NM3	5,790
	N2O	SCF	265,200
		NM3	7,450



DRAWING NO. C-11666801

REV	ECR NO	REVISION DESCRIPTION	BY	DATE	APPROVED	DATE	USED ON	QUANTITY REQ'D
A	-	ADDED N2O	JJS	9/18/02	JJS	12-19-01	APPLICATION	
					MDS	5/13/02		

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UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES: FRACTIONS ± 1/8 ANGLES ± ° 2 PLACE DECIMALS ± .04 3 PLACE DECIMALS ± .004

SCALE: 1/32" = 1" DO NOT SCALE SHEET

PART NUMBER: 11666801

TITLE: HS-14TON CO2/N2O 350PSI ASME

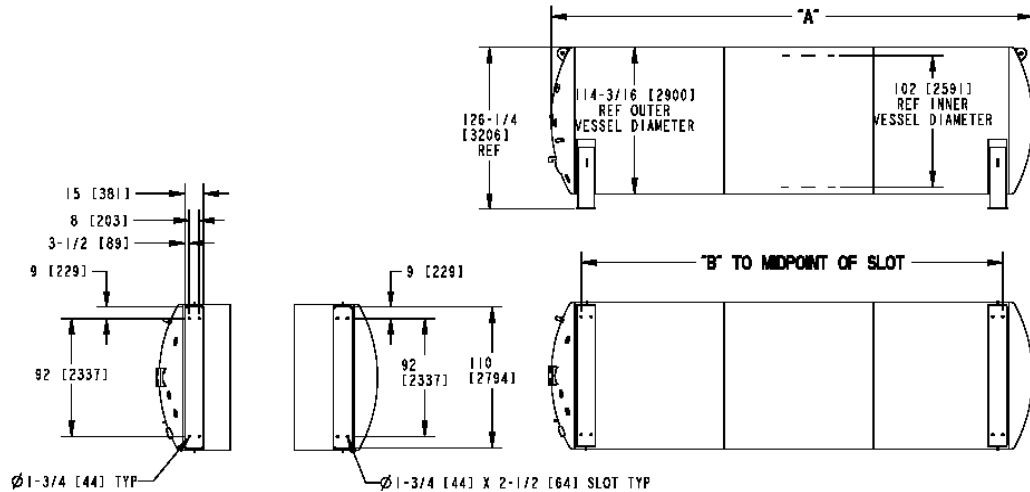
DRAWING NO.: C-11666801

REV: A

DO NOT SCALE SHEET 1 OF 1

DRAWING NO. **C-11681649**

INNER VESSEL DESIGN DATA		
Model:	VS-30/50TON CO2/N2O	
MAWP:	PSIG	350
	barg	24.13
DESIGN PRESSURE	PSIG	378
	barg	26.03
CODE COMPLIANCE: ASME SECTION VIII DIVISION I		
DESIGN TEMPERATURE	°F -30° TO 100°	
TEMPERATURE	°C -34° TO 38°	
MATERIAL OF CONSTRUCTION: SA612 CARBON STEEL		
OUTER VESSEL DATA		
CODE COMPLIANCE: FULL VACUUM PER CGA-341		
DESIGN TEMPERATURE	°F -20° TO 300°	
	°C -29° TO 149°	
MATERIAL OF CONSTRUCTION: A36 CARBON STEEL		
INSULATION TYPE: VACUUM AND MULTILAYER INSULATION		
EVACUATION CONNECTION: 3-1/2" PUMPOUT PORT		
VACUUM GAUGE CONNECTION: HASTINGS DV6R		
BUILDING CODE: DESIGNED FOR CURRENT BUILDING CODE SEE MVE UBC POLICY #NP-180		



WEIGHTS AND SHIPPING DATA			
MODEL:		HS-30TON	HS-50TON
WEIGHT EMPTY	POUNDS	39,700	56,900
	KILOGRAMS	18,008	25,809
WEIGHT FULL	CO2/N2O POUNDS	99,100	148,600
	KILOGRAMS	44,951	67,404
SHIPPING DIMENSIONS	INCHES	280 X 115 X 127	396 X 115 X 127
	MM'S	7112 X 2921 X 3326	10,058 X 2921 X 3326

TANK LENGTH	
MODEL	DIM "A" REF
HS-30TON	267-5/8 [6798]
HS-50TON	383-5/8 [9744]

SADDLE LENGTH	
MODEL	DIM "B" REF
HS-30TON	220 [5588]
HS-50TON	336 [8534]

CAPACITIES			
MODEL:		HS-30TON	HS-50TON
CAPACITY	GROSS (COLD)	GALLONS	7,390
		LITERS	27,973
		TON	31.3
	NET (COLD)	GALLONS	7,038
		LITERS	26,641
		TON	29.8
GASES EQUIVALENT AT 1 ATM AND 70°F/ 1 ATM AND 0°C	CO2	SCF	519,700
		NM3	13,640
	N2O	SCF	625,100
		NM3	17,550

REV	ECR NO	REVISION DESCRIPTION	BY	DATE	APPROVED	DATE	NEXT ASS'T	USED ON	NEXT ASS'T	FINAL ASS'T
A	-	ADDED N2O	JJS	9/18/02	JJS	2/7/02				
REV	ECR NO	REVISION DESCRIPTION	BY	DATE	MDS	2/7/02				
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DESCRIPTION HS-30/50TON CO2/N2O 350PSI ASME							DRAWING NO. C-11681649		REV A	
TOLERANCES: FRACTIONS ± 1/8 ANGLES ± ° 2 PLACE DECIMALS ± .01 3 PLACE DECIMALS ± .001							SCALE 1/64"=1"		DO NOT SCALE DRAWING 1 OF 1	