Product Manual

Carbon Dioxide Storage Tank

Designed and Built by:

Chart Inc.

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Part Number 11650869 Rev. J

Contents

Revision Log

Revision Level	Date	Description
A	04/17/2002	Add HS-6TON O&D to manual
B	05/02/2002	Add HS-30/50TON O&D to manual
C	06/03/2002	Add HS-14TON O&D to manual and also HS-30/50TON w/Skid O&D
D	08/21/2002	Updated O&D C-11694141-A and C-11642957-A
E	09/19/2002	Add spare parts lists, update all O&Ds to include N2O and remove HS-30/50TON w/skid O&D
F	12/12/2002	Update O&Ds
G	04/30/2003	Remove spare parts list
H	04/29/2013	Add O&D C-20675488 for FNL HS-30TON-CC-ALAC-W/SKID
I	06/18/2013	Add O&D C-20693088 for FNL VS-35TON-CC-350-AL-GLBL
J	07/01/2014	Reformat

Preface

General

Our VS-CO_2 and HS-CO_2 Series of Bulk Carbon Dioxide Storage Tanks continue our pioneering of user-friendly engineered products. This product series offers strength and durability in an all-welded outer container, while maintaining lower life-cycle costs. Utilizing our proprietary composite insulation system along with superior vacuum technology, we are able to offer:

- An ultra-low heat leak, eliminating the need for a costly refrigeration system in most applications.
- No costly down time to refurbish water-soaked or deteriorated foam insulation.

Product Advantages

- Stainless steel piping for greater strength and durability
- Stainless steel ball valves standard on all fill and process lines
- Minimum number of piping joints, reducing potential piping leaks and maintenance costs
- CGA fill and return fittings with drain valves standard on all models
- Optimum piping design results in flexible equipment connection
- Dual vent regulator system standard, eliminating any safety concerns
- Pressure building and vaporizer options available, inquire with Chart for more details
- Interchangeable gauge systems with a choice of analog or digital telemetry capable system are available with flexible stainless-steel interconnecting lines
- Refrigeration systems including internal coil available as options
- Lowest life-cycle costs for bulk CO_2 storage
- Superior functional performance
- Increased reliability and ease of repair
- High-strength, dent resistant outer jacket eliminates deterioration of insulation, costly repairs, down-time
- Reduce potential of CO_2 solidification due to refrigeration failure (power failure)
- Eliminate product loss due to venting
- Hold time is eight times longer than foam
- Refrigeration system not required for maintaining heat leak
- No monthly maintenance or electrical charge
- Two-year payback vs. foam tank
- Backed by an industry-leading five-year warranty

Product Manual

The Carbon Dioxide Storage Tank product 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 (CO_2) with the Carbon Dioxide Storage Tank. 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.

The safety requirements for operating the CO_2 Storage Tank and handling or transporting extremely cold liquid products are shown in the Safety section. Use this safety section as a "Safety Check-List" each time the equipment is being used.

The Introduction section discusses the general features of the tank and the theory of operation.

In the Installation section there are illustrations for how to uncrate and install the CO_2 Storage Tank.

The Operations section gives a step by step procedure for the basic operation of the tank.

For information on how to maintain and repair a CO_2 Storage Tank refer to the Maintenance section.

Schematics included in the Specifications section show a reference number for each component used on the CO_2 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.

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 / Acronyms

The following abbreviations / acronyms are used throughout this manual:

ASME	American Society of Mechanical Engineers
BAR	Pressure (Metric)
CGA	Compressed Gas Association
DOT	Department of Transportation
CO_2	Carbon Dioxide
GPM	Gallons per minute
KG	Kilogram
Kg/cm^2	Kilogram-force per square centimeter
KPA	Kilopascal
MAWP	Maximum Allowable Working Pressure
MM	Millimeters
NER	Normal Evaporation Rate
NFPA	National Fire Protection Association
PB	Pressure Builder
PN	Part Number
PSI	Pounds per Square Inch
PSIG	Pounds per Square Inch (Gauge)
SCF	Standard Cubic Feet
SCM	Standard Cubic Meters
Tonne	Metric unit of mass equal to 1,000 kg

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 lift plate to protect the vacuum casing (outer vessel). The CO_2 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 CO_2 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 unit and safe operations are anticipated, it is essential that every user of the CO_2 Storage Tank carefully read all WARNINGS and CAUTIONS listed and enumerated in this safety section 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 CO_2 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 CO_2 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 if 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 CO_2 service. Failure to comply with these instructions may result in serious damage to the container.***

Safety Bulletin

Portions of the following information are 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 or go to https://www.cganet.com/.

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, whenever a container is suspected of abnormal operation, or has sustained actual damage, good safety practices must be followed.

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

Prior to reusing a damaged container, the unit must be tested, evaluated, and repaired as necessary. It is highly recommended that any damaged container be returned to Chart for repair and 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 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 enters the area to assist an unconscious partner unless equipped with a portable air supply. Best protection is obtainable by equipping all individuals with a portable supply of respirable air. Life lines are acceptable only if the area is essentially free of obstructions and individuals can assist one another without constraint. If an oxygen deficient atmosphere is suspected or known to exist:

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

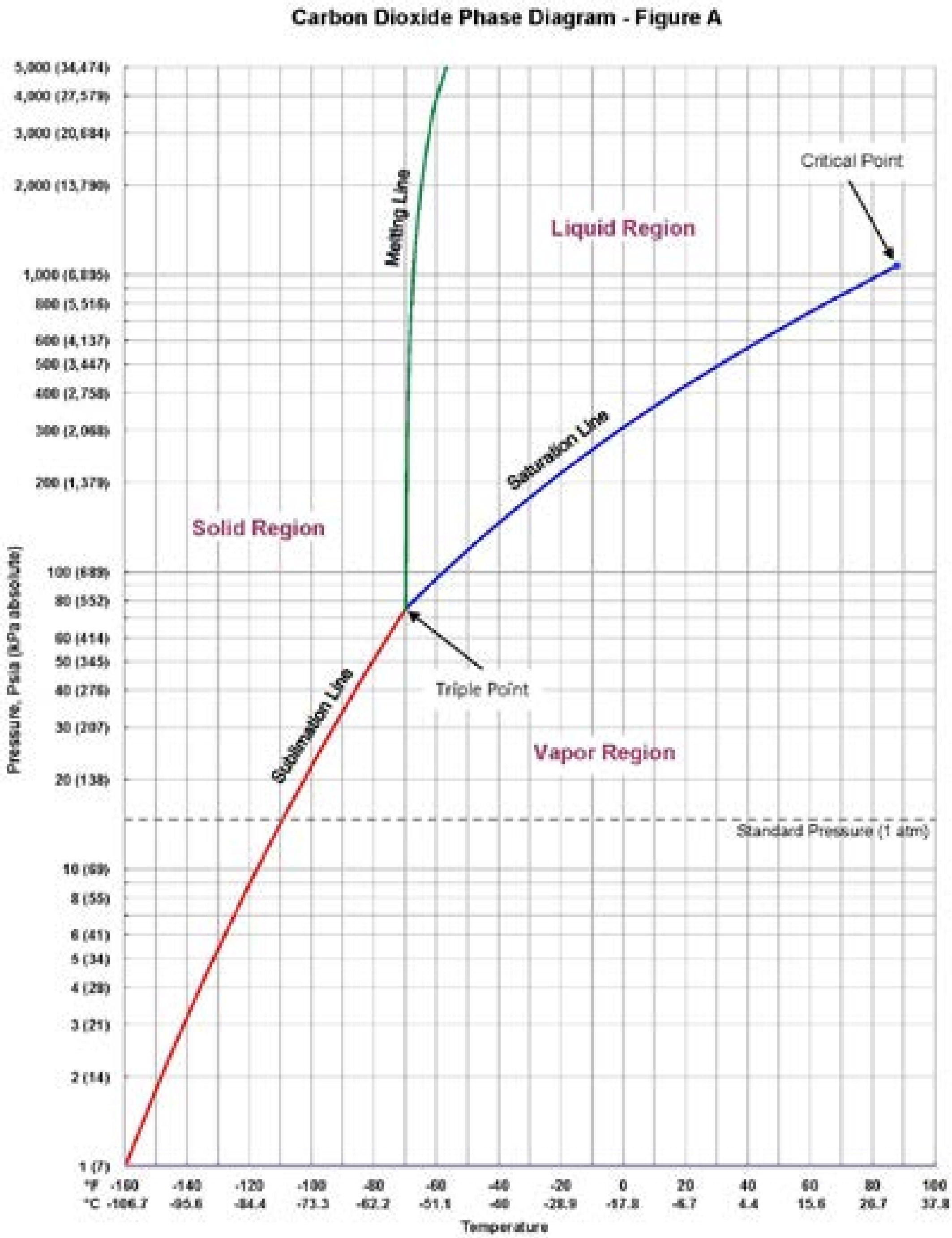
Carbon Dioxide

Carbon dioxide is a compound formed by the combination of carbon and oxygen atoms in a 1:2 ratio expressed by the chemical symbol CO_2. 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 -69.90°F (56.60°C) and a pressure of 60.43 psig (417 kPa) CO_2 can exist simultaneously in all three phases. This condition is known as the triple point. The phase diagram for CO_2 is shown in Figure A.

At temperatures above 87.90°F (31.10°C), carbon dioxide can exist only as a gas, regardless of the pressure. This is known as its critical temperature. As shown in Figure 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.



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.

There are two styles of Carbon Dioxide Storage Tanks currently available. The VS model (Vertical Carbon Dioxide Storage Tank or VS-CO_2) and the HS model (Horizontal Carbon Dioxide Storage Tank or HS-CO_2) are medium pressure tanks designed to store liquid and provide it as liquid or gas, to a customer application. These tanks 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 is broken down as Model (VS), Capacity (6TON), Inner Material (C), Insulation Type (C), MAWP (350).

Note: *Refer to the Specifications section of this manual to see the specific model specification, charts, schematics, and parts covered by the contents of this manual.*

Features

The Carbon Dioxide Storage Tanks are designed to provide a convenient, reliable, and economical method for the storage and delivery of CO_2. Important features of these containers include:

- Long-term hold time due to highly efficient multi-layer composite insulation system with low vacuum.
- An optional pressure building system that can be used to maintain working pressure during high withdrawal operations.
- An optional final line vaporizer system that can be used to vaporize liquid and warm the gas for gas use applications.
- 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.
- A bottom fill line and vapor return line which allow the tank to be refilled from a liquid supply unit by pump transfer. The vapor return line also serves as the full trycock.
- Simple and convenient piping controls.
- Rugged carbon steel outer vessel.

Physical Description

Carbon Dioxide Storage Tanks are designed for long-term storage of liquefied carbon dioxide. Normal operational pressures should remain above 165 psig (11.6 kg/cm^2) to prevent the liquid CO_2 temperature from dropping below the minimum vessel design temperature. Liquid CO_2 should never be stored at pressures below 60.5 psig (4.3 kg/cm^2) to prevent the formation of solid CO_2 or dry ice.

The CO_2 Storage Tank is comprised of a carbon steel or stainless 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 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 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 the Installation Section of 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 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 the Specifications section of this manual.

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. Any time 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/cm^2) to prevent the liquid CO_2 from dropping below the 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.

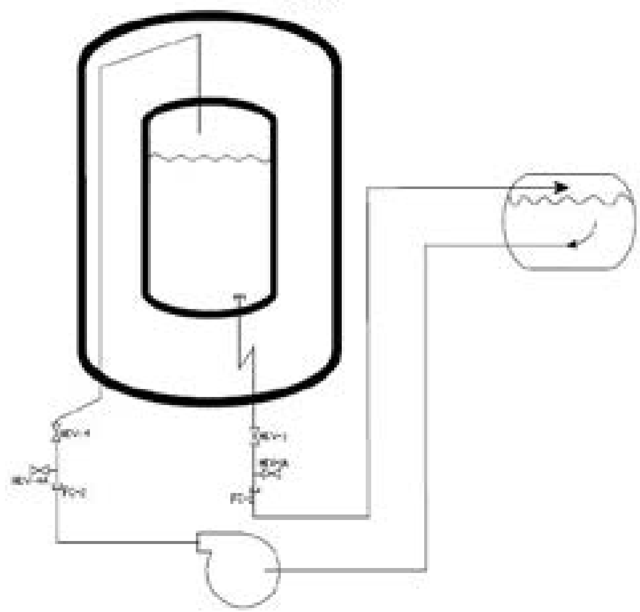
Chart CO_2 units are shipped with low-purity gaseous nitrogen to prevent moisture from entering the tank. For this reason the tank should be thoroughly purged with the applicable gas prior to filling.

When filling the unit with liquid, the transfer should be made with a centrifugal pump.

Pump Transfer

Liquid carbon dioxide is transferred into the CO_2 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.

Pump Transfer
Figure B



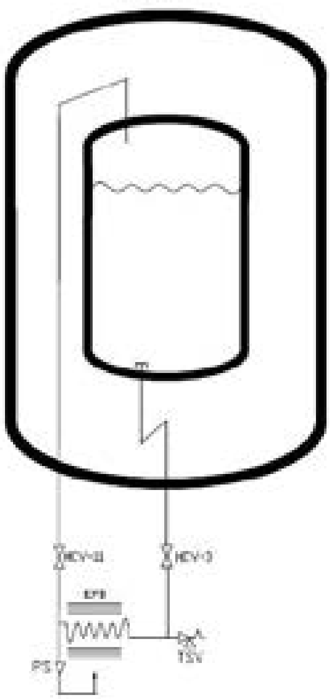
Pressure Building (Optional)

When a VS-CO_2 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-CO_2 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 Building

Figure C



Pressure Reduction

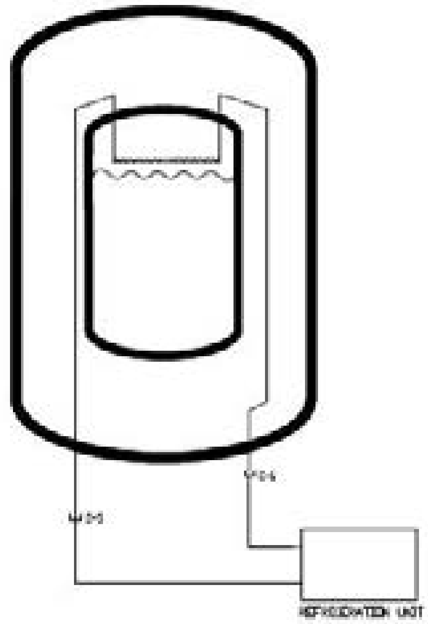
The pressure building system will increase tank pressure to maintain the proper operating conditions for the tank. In a direct gas use application, where the tank pressure is reduced by the withdrawal of gas from the top of the tank, the heat input through the insulation and the pressure building system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

Pressure Reduction

Figure D



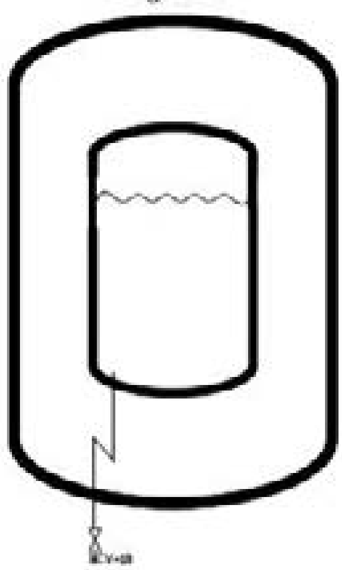
Liquid Withdrawal

If the 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 operational pressures should remain above 165 psig (11.6 kg/cm^2) to prevent formation of solid CO_2. Liquid CO_2 should never be stored at pressures below 60.5 psig (4.3 kg/cm^2). 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, 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.***

Liquid Withdrawal
Figure E



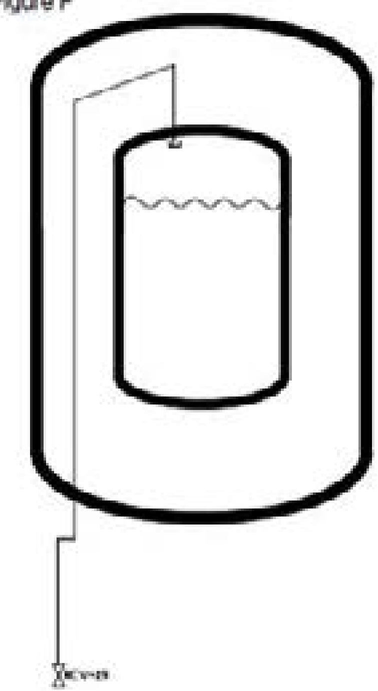
Liquid Withdrawal (For Pumping)

The CO_2 tank has a set of capped ports for pump connections. The auxiliary liquid line (C-7 or C-8) can be used to feed liquid into a cryogenic pump. The auxiliary vapor line (C-3 or C-4) 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.

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.

Gas Withdrawal
Figure F



Installation

General

This section deals with the receiving and uncrating of the CO_2 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 CO_2 unit at the storage site requires the use of a lift crane. For 6TON models a crane with one hoist maybe used. For models 14TON and larger, the crane must be configured with two hoists. See diagrams below.

Note: *If the pad has not been completed by the time the tank arrives, arrangements should be made to have the unit taken from the truck and stored in a protected area.*

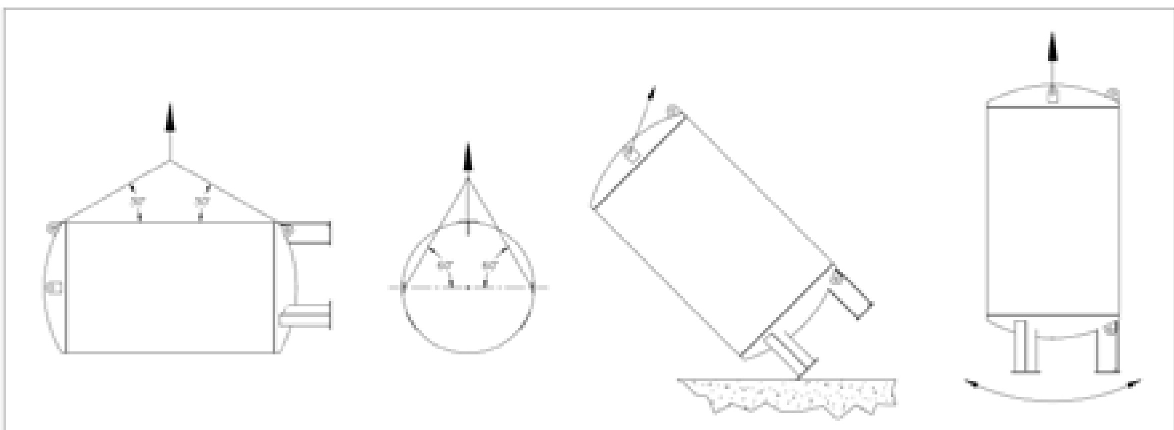


Figure 1 - Single Crane Installation Method

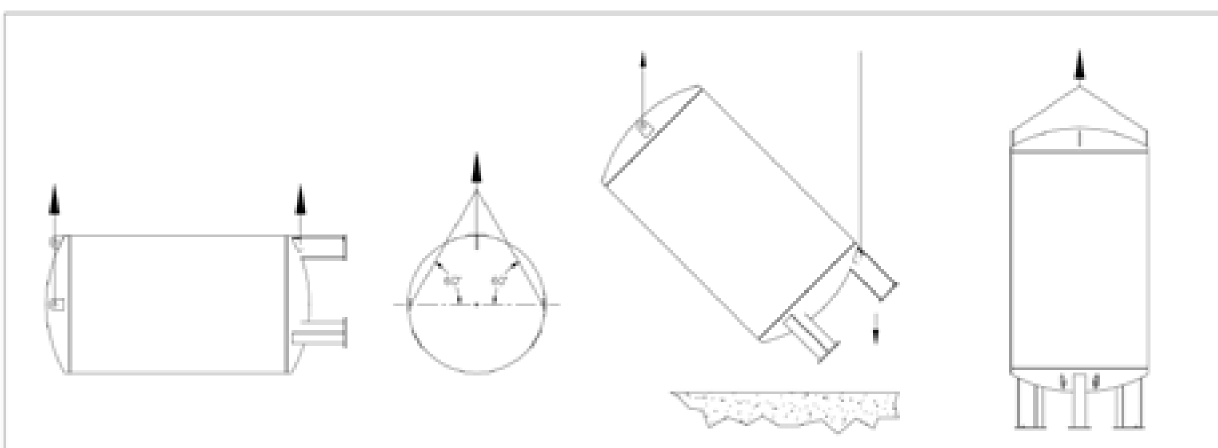


Figure 2 - Two Crane Installation Method (recommended)

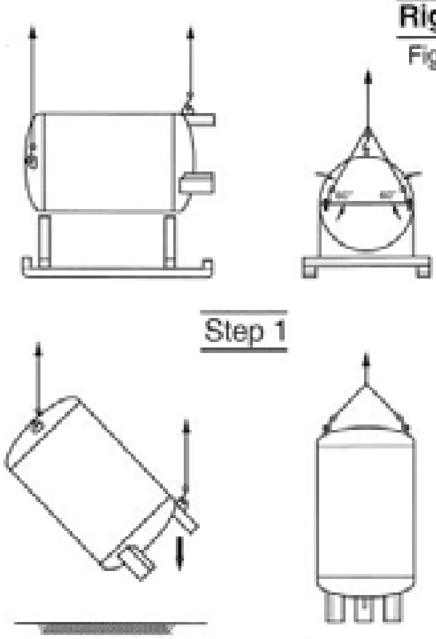
Rigging Details

The illustrations in Figures G and H show the proper methods for handling and erecting the Carbon Dioxide Storage Tank.

Note: *Since the 14TON through 50TON units have the bottom lifting lug on the bottom head, when lifting, vessel will roll slightly until the legs make contact with ground.*

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.



Rigging
Figure G

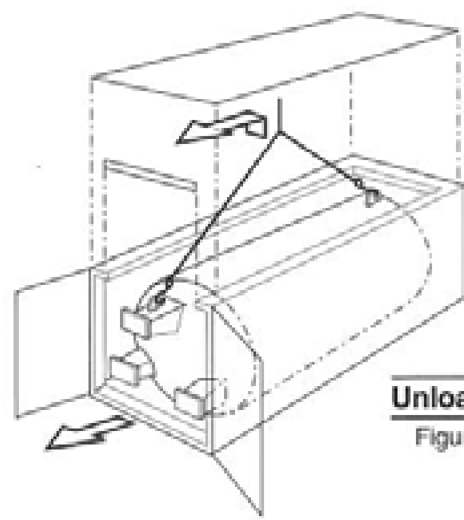
Cargo Container

Container packaged tanks are shipped in 20' or 40' 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 steel blocks must be removed from the two front shipping legs of the rear vessel. Blocks are bolted to shipping container floor.*


Unloading
Figure H

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: *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: *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 the 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 CO_2 unit 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 CO_2 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' long, the container should be situated no more than 10' from the closet 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 CO_2 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.

Operations

General

This chapter provides the preparation, initial fill, gas use, liquid delivery, and refilling procedures for a CO_2 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 schematic and legend in the Specifications section 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 vessel should be kept at normal operating pressures above 165 psig (11.6 kg/cm^2) to prevent the liquid CO_2 temperature from dropping below the minimum vessel design temperature.

Caution! ***Liquid CO_2 should never be stored at pressures below 60.5 psig (4.3 kg/cm^2) as this will result in the formation of solid CO_2 which can be very difficult to remove from 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.

Tank Purging Procedure

Caution! ***The maximum purge pressure should be equal to 50% 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 CO_2 storage tanks ship with brass plugs in the following valves: Pressure building inlet and outlet valves (HCV-3 and HCV-11) and auxiliary 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 and 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: *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.*

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, 3, 4, 8 and 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.

Valve	Position
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 before the first fill, the following steps are taken to ensure cleanliness of the 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 CO_2 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 CO_2 storage 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 CO_2 storage 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/cm^2) while liquid is in the vessel, in order to prevent liquid CO_2 temperature dropping below minimum vessel design temperature.
2. Regulators (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 content of the supply unit is the proper product to be transferred.
2. Verify that fill and vapor valves (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 CO2 Storage Tanks 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 of product has been delivered (or to close the tank down for an extended period of time), stop gas flow by closing the 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! ***Any time a pump is used for product withdrawal, there must be a vibration eliminator kit installed. Failure to do this may result in loss of tank vacuum. Contact your sales personnel for kit part number.***

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 the Specifications section of this manual.

Before implementing any procedure described in this section, it is recommended that the Safety section of this manual be reviewed and understood fully.

Maintenance required usually becomes apparent during inspection of units before, during, after a fill routine. It also becomes apparent 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 CO_2 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 the CO_2 storage tank, remove all liquid and release container pressure in a safe manner.***

Cleaning Procedure for Bulk CO_2 Storage Tanks

Normally Carbon Dioxide bulk tanks that receive and deliver CO_2 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 CO_2 storage tanks can best be cleaned by spraying clean CO_2 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 80 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 CO_2 from tank.
4. This procedure should be run until acceptable levels of cleanliness of the effluent are obtained.

Procedure:

1. Bulk CO_2 storage 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 tank pressure to approximately 150 psi below transport pump capability to insure vigorous flow into the tank. Do not reduce tank pressure below 80 psig.

Caution! ***Normal operational pressures should remain above 165 psig (11.6 kg/cm^2). Liquid CO_2 should never be stored at pressures below 60.5 psig (4.3 kg/cm^2) to prevent the formation of solid CO_2 which can be very difficult to remove from the tank.***

3. Connect transport liquid pump hose to Auxiliary Vapor line. It may be may be necessary to add a CGA CO_2 fitting to make connection. Transport vapor return pump hose will not be used for this cleaning procedure.

4. Open Auxiliary Vapor valve (HCV-19) for 14TON, 30TON 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 80 psig, 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 CO_2 from tank. Continue to monitor tank pressure and if pressure drops below 80 psig 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 CO_2 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 Auxiliary Vapor valve (HCV-19) for 14TON, 30TON 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 CO_2 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 CO_2 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

Item	Interval
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 the Operations section of this manual.

Maintenance Checks and Adjustments

The following paragraphs provide instructions for performing the various CO_2 tank checks and adjustments. Only perform the procedure(s) if the unit is suspect of faulty operation.

Vacuum Integrity Check

Since all CO_2 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 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 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/Possible Cause/Remedy" format. The possible 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 the Specifications section of this manual as required to locate system components identified in the troubleshooting guide.)

Trouble	Possible Cause	Remedy
Excessive tank pressure.	Pressure building system is not functioning 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 restablize 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.

Trouble	Possible Cause	Remedy
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).
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, of damaged components with Chart approved parts is recommended. However, when repair of damaged components is required, follow the instructions below.

Caution! ***The CO_2 storage tank 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 CO_2.***

When disassembly of a CO_2 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 CO_2 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 CO_2 spare parts in your inventory; refer to the Specifications section of this manual 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 CO_2 storage tank 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 1-800-400-4683 prior to any component return.

Specifications

Model	Gross Capacity		Net Capacity		MAWP		Height		Diameter		Weight*		NER
	Ton	Tonne	Ton	Tonne	PSIG	bar	in	mm	in	mm	lbs	kg	%/day in CO_2
VS-6TON	6.8	6.2	6.4	5.8	350	24.1	188	4,775	68	1,728	9,400	4,270	.15
VS-14TON	13.2	12.0	12.6	11.4	350	24.1	228	5,791	86	2,184	17,400	7,900	.08
VS-30TON	31.1	28.2	29.6	26.9	350	24.1	287	7,290	114	2,900	39,600	17,970	.05
VS-50TON	48.1	43.6	45.8	41.5	350	24.1	406	10,312	114	2,900	56,900	25,810	.04

*Tare weight

Model	Gross Capacity		Net Capacity		MAWP		Width		Height		Length		Weight*		NER
	Ton	Tonne	Ton	Tonne	PSIG	bar	in	mm	in	mm	in	mm	lbs	kg	%/day in CO_2
HS-6TON	6.8	6.2	6.4	5.8	350	24.1	68	1,728	80	2,032	188	4,775	9,300	4,130	.24
HS-14TON	13.2	12.0	12.6	11.4	350	24.1	86	2,184	95	2,184	233	5,913	17,400	7,890	.12
HS-30TON	31.3	28.4	29.8	27.0	350	24.1	114	2,900	127	3,226	280	7,112	39,700	18,008	.08
HS-50TON	48.1	43.6	45.8	41.5	350	24.1	114	2,900	127	3,226	396	10,058	56,900	25,800	.06

*Tare weight

Liquid Level Charts

In the print version of this manual, liquid level charts follow this section. They are also available on Chart's website (http://literature.chart-ind.com/) click on Bulk Storage and then Software Programs. If reading this manual on-line, Click Here for instructions on downloading the application.

O&D Drawings (unit specific)

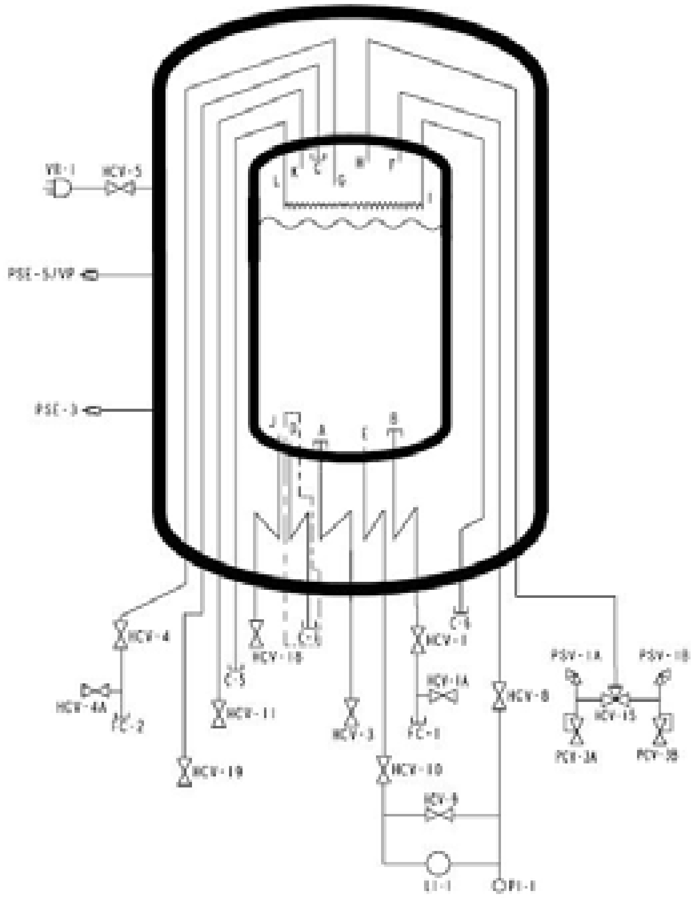
Model	Drawing PN
VS-6TON	11642957
VS-14TON	11640935
VS-30TON	11639707
VS-50TON	11639707
HS-6TON	11694141
HS-14TON	11666801
HS-30TON	11681649
HS-50TON	11681649

P&ID Drawings (unit specific)

Model	Drawing PN
VS-6TON	11837172
VS-14TON	11640927
VS-30TON	11639061
VS-50TON	11639061
HS-6TON	11859646
HS-14TON	11703060
HS-30TON	11704591
HS-50TON	11704591

Nomenclature

Ref. No.	Description
C-1	Connection, Auxiliary Liquid
C-2	Connection, Auxiliary Vapor
C-3	Connection, PB Liquid
C-4	Connection, PB Vapor
FC-1	Connection, Fill
FC-2	Connection, Vapor Return / Full Trycock
HCV-1	Valve, Bottom Fill
HCV-1A	Valve, Drain
HCV-3	Valve, PB Liquid
HCV-4	Valve, Vapor Return / Full Trycock
HCV-4A	Valve, Drain
HCV-5	Valve, Vacuum Gauge Tube
HCV-8	Valve, LI-1 Vapor Phase
HCV-9	Valve, LI-1 Equalization
HCV-10	Valve, LI-1 Liquid Phase
HCV-11	Valve, PB Vapor
HCV-15	Valve, Safety Relief Selector
HCV-18	Valve, Auxiliary Liquid
HCV-19	Valve, Auxiliary Vapor
LI-1	Level Indicator, Inner Vessel
PI-1	Pressure Indicator, Inner Vessel
PCV-3A	Pressure Control Valve, Econ Vent
PCV-3B	Pressure Control Valve, Econ Vent
PSE-3	Pressure Safety Element, Outer Vessel
PSE-5/VP	Pressure Safety Element, Outer Vessel Vacuum Port
PSV-1A	Pressure Safety Valve, Inner Vessel
PSV-1B	Pressure Safety Valve, Inner Vessel
VR-1	Vacuum Readout, Outer Vessel
Refrigeration Option	
C-5	Connection, Auxiliary Refrigeration
C-6	Connection, Auxiliary Refrigeration
Dashed Line represent Additional Line (Standard on 30/50 TON only)	
C-7	Connection, Secondary Auxiliary Liquid


VR-1
HCV-5
PSE-5/VP
PSE-3
HCV-4
HCV-4A
FC-2
C-5
HCV-11
HCV-19
HCV-18
HCV-3
HCV-1
HCV-1A
FC-1
C-6
HCV-8
HCV-10
HCV-9
LI-1
PI-1
PSV-1A
PSV-1B
HCV-15
PCV-2A
PCV-2B