User's Manual

LDCO$_2$

2.5 Ton
3 Ton
3.75 Ton

CO_2 Delivery Units

Part No. 10944697
Rev E

Table of Contents

Revision Log	Description
Rev A (3/19/03)	Updated schematic, Sec. 7 #12 & Brought to New Prague
Rev B (4/29/03)	Changed 11657956 BRS to 10938203 SS in Sec VII Item 12
Rev C (8/15/03)	Updated schematic Sec. 4
Rev D (12/12/03)	Updated schematic Sec. 4
Rev E (1/26/04)	Updated schematic Sec. 4

I. Warranty

A. Terms and Scope of Warranty

CHART, Inc. (CHART) warrants the $LDCO_2$ delivery system equipment for one (1) year from CHART invoice date, that said equipment shall be free from any defects in workmanship and materials.

B. Conditions of Warranty

Purchaser agrees that as a pre-condition to any CHART liability thereunder, Purchaser or its appointed agents shall fully inspect all goods immediately upon delivery and shall give CHART written notice of any claim or purported defect within ten (10) days after discovery of such defect. As a further pre-condition to any CHART liability thereunder, both part replacement and labor must be supplied by an approved CHART service company. CHART may elect to repair or replace such equipment or any defective component or part thereof which proves to be defective, or to refund the purchase price paid by the original Purchaser. Alterations or repair by others or operation of such equipment in a manner inconsistent with CHART accepted practices and all operating instructions, unless pre-authorized in writing by CHART, shall void this Warranty. CHART shall not be liable for defects caused by the effects of normal wear and tear, erosion, corrosion, fire, explosion, misuse, or unauthorized modification.

C. Limitation of Liability

CHART's sole and exclusive liability under this Warranty is to the Purchaser and shall not exceed the lesser of the cost of repair, cost of replacement, or refund of the net purchase price paid by the original Purchaser. CHART is not liable for any losses, damages, or costs of delays, including incidental or consequential damages. CHART specifically makes no warranties or guarantees, expressed or implied, including the warranties of merchantability or fitness for a particular purpose or use, other than those warranties expressed herein.

D. Warranty Claims Procedure

All warranty claims must be previously authorized by: CHART, Inc.

Telephone, electronic or written approval may be obtained by contacting CHART's Technical Service Department at:

CHART, Inc.
407 Seventh Street N.W.
New Prague, MN 56071-1000
Telephone: 952-758-4484
Facsimile: 952-758-8293

Authorization must be obtained from CHART prior to shipment of any equipment to our facilities. The purchaser must provide the serial number of any or all items to be repaired or returned to CHART. Once approved a return management and authorization (RMA) number will be provided to the purchaser. The RMA number must be included in the packing slip of any or all equipment to be shipped to CHART.

II. Safety

ALL PERSONS RESPONSIBLE FOR THE USE AND MONITORING OF THIS EQUIPMENT MUST READ AND FULLY UNDERSTAND THE SAFETY AND OPERATING INFORMATION CONTAINED IN THIS MANUAL.

A. Important Safety Precautions

WARNING: This tank holds and dispenses liquid carbon cioxide (CO_2) under pressure. Avoid breathing CO_2 or direct contact with CO_2 in any form: gas, liquid or solid. CO_2 gas displaces oxygen and will not support life.

CO_2 is a colorless tasteless gas with only a slight pungent odor and is, therefore, very difficult to detect without proper equipment.

Exposure to concentrations of less than 10% can cause unconsciousness, injuries or death. Even low concentrations of CO_2 can cause:

- Dizziness, headaches, nausea or disorientation
- Increased respiration or heart rate
- Shortness of breath or rapid suffocation.

CO_2 is *heavier* than air and can collect in low areas, such as basements, stairwells, and confined spaces. Avoid entry and use caution in such areas if high concentrations of CO_2 or CO_2 leaks are suspected.

B. First Aid

If inhaled:

- Remove to fresh air immediately
- If not breathing, give artificial respiration
- If breathing is difficult, give oxygen
- Get immediate medical attention

In case of frostbite:

- End exposure at once
- Do not rub or pour water on area
- Get immediate medical attention

C. Rescue, Spills & Leaks

Rescue

- Do not attempt a rescue in areas of high CO_2 concentrations without proper life-support or rescue equipment. Do not become the next victim.
- Thoroughly ventilate areas of possible CO_2 concentration before entering.

Spills or Leaks

- Evacuate all personnel immediately from affected areas.
- Thoroughly ventilate the area of the spill or leak before entering.

For More Information, Contact:

- Local CO_2 supplier or
- Compressed Gas Association
  725 Jefferson Davis Highway, Suite 1004
  Arlington, VA 22202-4100 USA
  Telephone: (703) 412-0900

D. On-Site Restaurant Tanks

Installation and service of equipment and deliveries of CO_2 should *only* be performed by qualified professional personnel familiar with CO_2, mini-bulk liquid CO_2 pressure vessels and all pertinent safety procedures.

Fill Box and/or filling operation must be located and/or completed outdoors and not in confined spaces.

The fill box must not be located below grade or above confined below ground spaces such as stairwells, tunnels or caves.

CHART Liquid Delivery CO_2 ($LDCO_2$) containers consist of a carbon steel inner pressure vessel encased within an aluminum outer jacket. The container is insulated with a layer of foam between the inner vessel and the outer jacket.

The container operates under moderate pressure (approx. 300 psi.) and is protected from over-pressurization by the use of an ASME-coded 350 psi relief valve. The pressure is controlled by an auxiliary relief valve which is factory set at 325 - 340 psi. The Liquid Delivery CO_2 tanks are designed and engineered for safe, reliable operations and are durable to provide many years of trouble-free operation. While every possible safety feature has been designed into the units and safe operations are anticipated, it is essential that every user of the Liquid Delivery CO_2 containers carefully read all **WARNINGS** and *Cautions* listed in this safety section and this manual. Periodic review of this safety summary is recommended.

E. Training Requirements

The single best investment in safety is the training of personnel operating the equipment.
The following subjects should be explained to all persons who will be working with CO_2 and the CO_2 Delivery units.

- Nature and properties of Carbon Dioxide in liquid, gaseous and solid states.
- Specific instructions on the equipment being used and the equipment being filled.
- Materials compatible with liquid CO_2.
- Use and care of protective equipment and clothing.
- Safety, first-aid, and self-aid when first-aid is not immediately available.
- Handling emergency situations such as accidents, leaks and spills.
- Good housekeeping practices.

F. In Case of Damage

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 or rectified. Incidents which require that such practices be followed include: highway accidents, immersion of a container 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.

G. Driving Safety

The $LDCO_2$ Tanks are Carbon Dioxide Cargo tanks built in accordance with the ASME Boiler and Pressure Vessel Code and the U.S. DOT MC-331 specifications. Operation of this equipment is covered by the U.S. Code of Federal Regulations (CFR) 49. Operators of this equipment are urged to obtain a copy of the CFR 49 to assist them in safe and legal operation.

H. Personnel Protection

- Safety glasses are recommended during the transfer of Carbon Dioxide. A face shield or chemical glasses may be worn for additional protection.
- Clean, dry, loose fitting insulated gloves should always be worn when handling anything that comes in contact with the cold liquid. *Caution Never allow unprotected skin come in contact with uninsulated pipes. The unprotected skin may stick to the surface and tear when released*.
- Hearing protection should always be used while transferring liquid. Venting of hoses and tanks may be quite loud.
- Long trousers should be worn and left outside of boots or work shoes.

I. Safety While Filling

- Deliveries should only be made at locations where the fill box is correctly installed in the proper location.
- **WARNING: Threads and mating surfaces of the fill fittings *must* be inspected before each delivery. Damaged fittings *must* be replaced *prior* to making the connection and fill.**
- ***All*** locations ***must*** be vented outdoors. All portable tanks must be brought outside for filling.
- All safety devices supplied and/or installed on the delivery equipment, store tank or fill box must be used.
- Should a large amount of CO2 be released into the atmosphere, a fog may reduce visibility. Be aware of the immediate surroundings.

III. Introduction

A. General

The CHART $LDCO_2$ delivery unit is designed for the storage, transport and delivery of Carbon Dioxide Refrigerated Liquid at a pressure of approximately 300 psig. The $LDCO_2$ is a Cargo Tank built in accordance with the ASME Boiler and Pressure Vessel Code and the U.S. DOT MC-331 Specification. The system is ideally and suited for the medium pressure filling of Mini-Bulk CO_2 tanks used in the carbonation of beverages.

There are three different sizes of the $LDCO_2$ delivery units. The models are $LDCO_2$ - 2.5 Ton, $LDCO_2$ - 3.0 Ton and $LDCO_2$ - 3.75 Ton. The designation LD indicates the container is a "Liquid Delivery" container intended for liquid withdrawal. CO_2 is the product the unit is designed to carry and the "Tonnage" indicates the liquid capacity of the units.

B. Features

The $LDCO_2$ container is designed to provide a convenient, reliable and economical method for the storage and delivery of Liquid Carbon Dioxide. Important features of this container include:

- A pressure building system that utilizes the trucks engine coolant to warm gas increasing internal head pressure, rather than the liquid saturation pressure.
- Advanced inner vessel support system designed to minimize heat transfer thus lowering the Normal Evaporation Rate (NER).
- Rail mounted inner vessel increases versatility and adds to better shock absorption.
- Inner vessel equipped with 16" manway which by DOT specifications and MC_331 standards only requires re-testing every five years.
- Totally sealed out jacket minimizing the entry of moisture into the insulation space.
- Relief valves vent outside of the plumbing compartment.
- Simple and convenient piping controls.

C. Physical Description

The CHART $LDCO_2$ container is designed for the storage, transportation and the delivery of Liquid Carbon Dioxide. Each tank is comprised `of an inner carbon steel vessel encased in a aluminum outer jacket. The insulation between the inner and outer is a flourocarbon based polyurethane foam. The outer jacket is sealed reducing moisture that may enter the insulation space, extending its life.

The $LDCO_2$ is skid mounted which is the standard vehicle frame width of 34 inches. The mounting hardware includes a combination of brackets, bolts and washers which provide the necessary spring action. To facilitate safe handling the tank is equipped with permanent lifting lugs attached directly to the inner vessel and hidden from view. The $LDCO_2$ can be supplied with a combination body including storage areas for 2-400 lb. restaurant CO_2 mini-bulk tanks, 16-50 lb. high pressure cylinders and 10-20 lb. high pressure cylinders. A storage box is also included for tools, safety equipment and spare parts.

The $LDCO_2$ is equipped with a Flow liquid measuring meter. The meter is complete with a ticket printer. The Flow meter uses differential pressure to determine the amount of liquid delivered. Some characteristics:

- No moving parts
- No cool down time
- Delivery speed of 65 lbs. per minute
- Accuracy within 1%
- Calibration recommended every two years
- Calibration by a laptop computer with a calibration cable and software

D. Safety Devices

The internal vessels are protected from overpressurization by a tank relief device. The relief valve is set at 350psig, which is also the Maximum Allowable Working Pressure (MAWP). Where there is a possibility of trapping liquid CO_2 between two valves in the piping components, there are additional relief valves. These relief valves are set at 450 psig.

E. Pressure Building

The internal tank pressure is maintained primarily by the Normal Evaporation Rate (NER), or the amount of liquid CO_2 inside the vessel that changes phases (liquid to gas) during a given period, i.e. pounds per day. See Specification Section.

The internal tank pressure is controlled by an economizer style regulator. Above it's set point, the pressure control regulator relieves excess gas pressure to atmosphere. The pressure control regulator is factory set at 325 to 340 psi.

As an option, the $LDCO_2$ tank can be supplied with a factory installed Pressure Building System. During periods of inclement (cold) weather or numerous large deliveries the internal tank pressure may be lower than necessary for timely liquid transfer operations. The pressure building system consists of a heat exchanger and isolation valves.

Liquid CO_2 flows from the tank into the external heat exchanger, it changes from liquid to gas and is returned to the head space. The heat exchanger uses warm engine coolant as a heat source. The isolation valves act as P.B. on/off valves and also isolate the heat exchanger from the tank and/or engine. To build pressure the PB on/off valves are in the on (parallel with valve body). Once desired pressure is gained the valves should be turned off. The rate of pressure built may be slowed by "throttling" the PB valves. The quick response time of the PB System is favorable because it will increase the tank head pressure rather than changing the saturation pressure of the liquid CO_2.

F. Indicators

The $LDCO_2$ gauging includes:

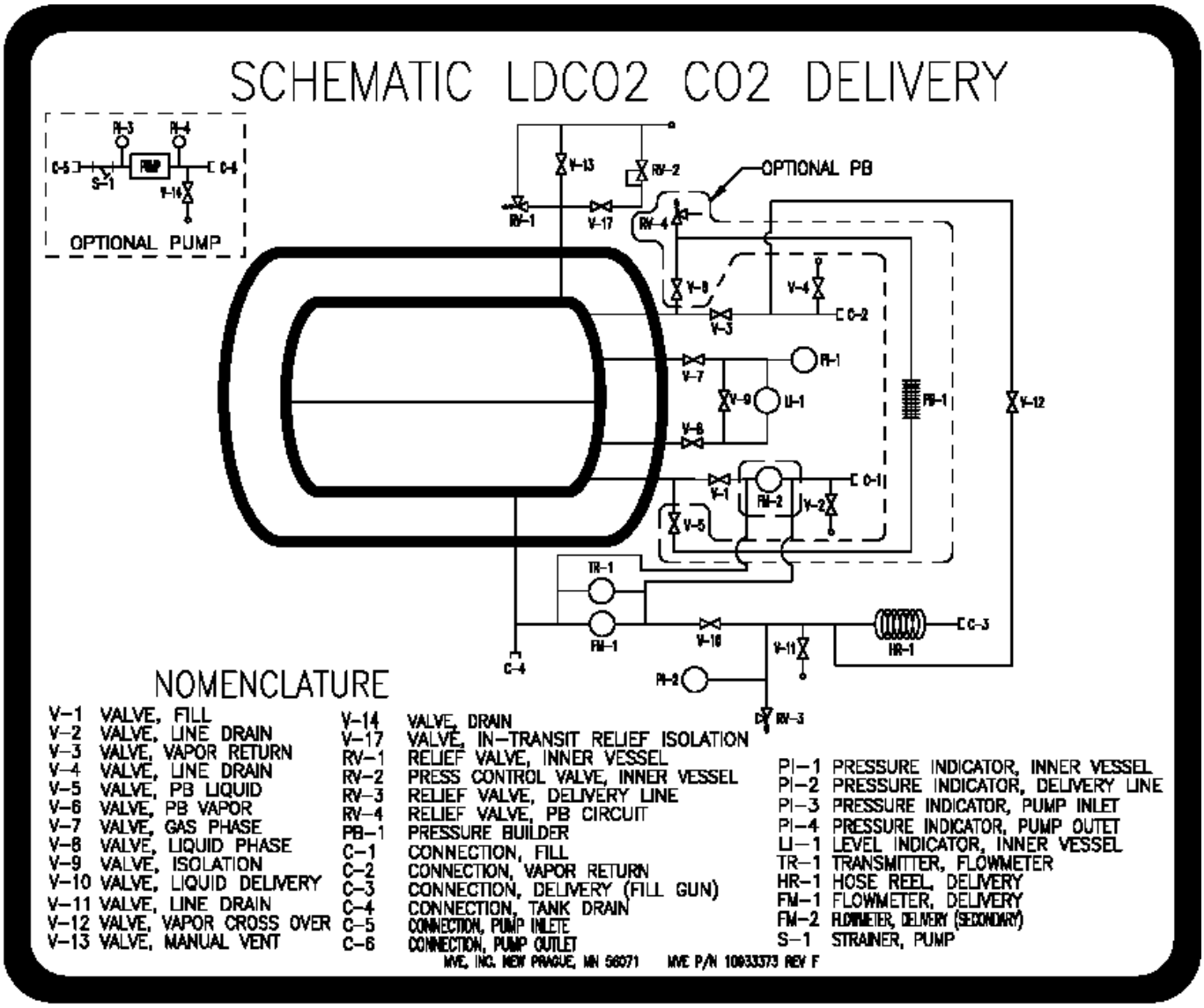
- Liquid Level Indicator
  Differential Pressure gauge which takes a gas sample from the top and bottom of the inner vessel. The pressure differential is indicated in inches of water.
- Internal Tank Pressure Indicator
  Indicates internal tank pressure in PSI.
- Line Pressure Indicator
  Indicates pressure in the delivery transfer line and can be isolated from the delivery tank indicating approximate pressure of the tank being filled in PSI.
- Equalization Valve
  Enables calibration of the differential pressure gauge in field.
- Flowmeter, FLOWCOM LC
  Indicates the amount of liquid CO2 delivered as well as accumulated totals. A printer is also provided.

G. Piping Configurations

The $LDCO_2$ delivery containers are constructed with all operating controls and indicators situated at the back of the container/vehicle. All valves and connectors are located in the lower portion of the tank allowing safe and convenient liquid dispensing operations. The plumbing controls have been simplified enabling the user, through the use of system valves, to easily control the container and transfer operations

All controls are protected from the environment by a removable compartment. The relief valve is vented outside the "dog-house". The oversized door allows the operator easy access to all components.

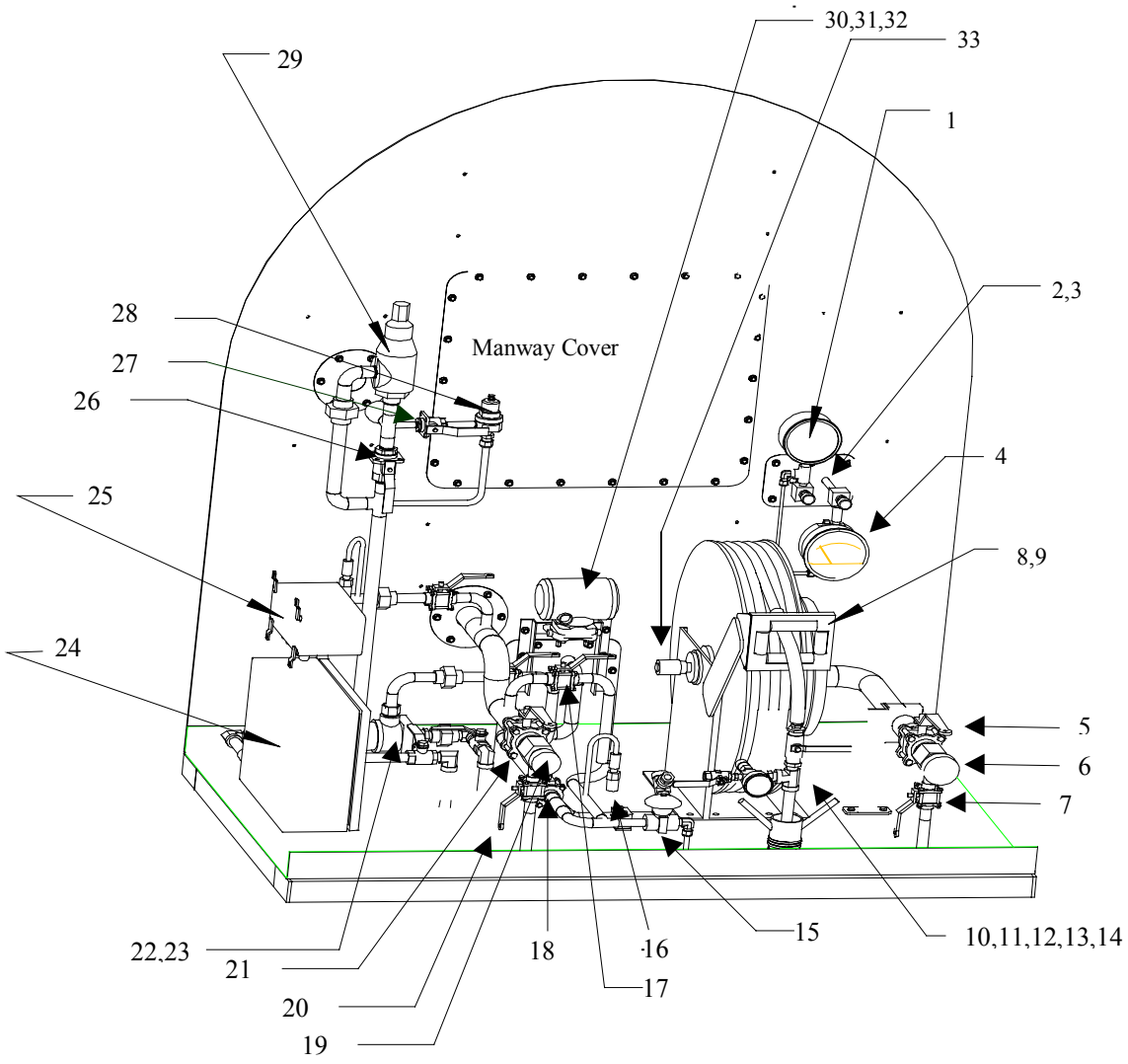
IV. Flow Schematic



V. Schematic Parts Identification

Tag No.	CHART Part No	Description	Nomenclature
V-1	10938254	Valve, Ball 1 ½" NPT	Liquid fill isolation valve
V-2	10938211	Valve, Ball 1 ½" NPT	Line drain isolation valve, fill line
V-3	10938254	Valve, Ball 1 ½" NPT	Vapor return isolation valve
V-4	10938211	Valve, Ball 1 ½" NPT	Line drain isolation valve, vapor return line
V-5	10938211	Valve, Ball 1 ½" NPT	PB isolation valve, liquid
V-6	10938211	Valve, Ball 1 ½" NPT	PB isolation valve, vapor
V-7	10522144	Valve, Angle ¼"	Gas Phase isolation valve, liq level gauge
V-8	10522144	Valve, Angle ¼"	Liquid Phase isolation valve, liq level gauge
V-9	10522152	Valve, Straight ¼"	Equalization valve, liquid level gauge
V-10	10938203	Valve, Ball 1 ¾" NPT	Liquid delivery isolation valve
V-11	10938211	Valve, Ball 1 ½" NPT	Line drain isolation valve, liquid delivery line
V-12	10938211	Valve, Ball 1 ½" NPT	Vapor crossover isolation valve
V-13	10938203	Valve, Ball 1 ¾" NPT	Manual vent isolation valve
V-14	172027	Valve, Straight ¼" NPT	PG isolation valve, liquid delivery line
V-15	1713502	Valve, Angle ¼" NPT	Meter transmitter isolation valve
V-16	1713502	Valve, Angle ¼" NPT	Meter transmitter isolation valve
RV-1	1811462	Relief Valve, ¾" FPT 350PSIG	Primary inner vessel relief valve
RV-2	2110892	Regulator, 3/8" NPT 325 PSIG	Inner vessel pressure control regulator
RV-3	1811472	Relief valve, ¼" MPT 450 PSIG	Line relief, delivery line
RV-4	1811472	Relief valve, ¼" MPT 450 PSIG	Line relief, pressure builder
PB-1	10932549	Pressure Builder Vaporizer	Pressure builder heat exchanger, optional
	10958520	Installation Kit	Installation kit, pressure building vaporizer
C-1	10715026	CO_2 Fitting 1 ½" W/ cap	Delivery tank liquid fill connection
C-2	10715018	CO_2 Fitting 1" W/cap	Delivery tank vapor return connection
C-3	10848224	Quick Coupler ¾"	Fill fitting on end of delivery hose
C-4	1210972	Cap, Brass ½" FPT	Drain connection for draining and cleaning
C-5	10848224	Quick Cplg, ¾" Female	Liquid delivery quick coupling
PI-1	10874545	PG 0-600 PSIG, 4 ½" Dial LBM	Internal vessel pressure gauge
PI-2	10874545	PG 0-600 PSIG, 4 ½" Dial LBM	Liquid delivery line pressure gauge
LI-1	202038	Diff PG, 0-100" H_2O, 6" Dial	Internal vessel liquid level differential pressure gauge
HR-1	10875652	Hose Reel, ½" FPT, 75' Cap.	Spring retractable reel, delivery hose
LD-1	11744267	Liquid CO2 Transfer Hose	Liquid delivery hose, 75'
LD-2	9720959	Fill Fitting Wrench Assy	Liquid delivery wrench assembly
FM-1	10945876	Flowcom LC	Liquid delivery flowmeter, processor
FM-2	10949631	Metering Section, ¾" NPS (inside outer jacket, can't see)	Differential pressure sensor, sends pneumatic signal to transmitter
FM-3	10673778	DP Transmitter, Rosemnt 2024	Converts pneumatic dp signal to electric sig
FM-4	10918587	Epson TM 295 Printer	Ticket printer
	10958052	RS 232 Cable W/ Interface	Calibration cable
	10962844	Telix Software	Calibration software

VI. Component Illustration



VII. Component Identification

Item	Description	CHART P/N	Function
1	Pressure gauge 4” dial 0-400psi	10700596	Displays quantity of CO2 in tank
2&3	Valve angle 1/4"MPT x 1/4"MPT	1713502	Isolates high/low phase of LL gauge
4	Liquid level gauge 0-50” H2O	2012219	Shows quantity of CO2 in tank
5	Valve ball ss 1-1/2”NPT	10938254	Controls CO2 flow in fill line
6	CO2 fitting 1-1/2”MPT” x 1-1/2CGA	10715026	Allows connection to CO2 transfer hoses
7	Valve ball ss 1/2"NPT	10938211	Allows fill line to vent
8	Hose reel 75' capacity	10875652	Extends and retracts fill hose
9	Flex hose 75' long	11744267	Allows flexibility in making CO2 deliveries
10	Quick coupler 3/4"F repairable	10848224	Connects fill hose to fill box fitting
11	Quick connect wrench	9720959	Assists in turning the quick coupler
12	Valve ball SS 3/4NPT	10938203	Allows CO2 to be delivered
13	Pressure gauge 2” dial 0-400psi	2015179	Displays line pressure
14	Valve ball brs 1/4"NPT	1716182	Purging and venting
15	Valve brs sh 3/8FPT*3/8 sch 10	1710012	Draining liquid delivery line
16	RV brs 1/4MPT 450psi	1811472	Allows excess vapor to vent
17	Valve ball ss ½” NPT	10938211	Allows gas to push liquid out of hose
18	Valve ball ss 3/4"NPT	10938203	Allows CO2 flow to delivery hose
19	CO2 fitting 1-1/2”NPT x 1”CGA	10715018	Allows connection to vapor return hoses
20	Valve ball ss ½” NPT	10938211	Allows vapor return line to be vented
21	Valve ball ss 1-1/2”NPT	10938254	Controls CO2 gas flow in vapor return line
22	Heat Exchanger	10932549	Builds tank pressure
23	Valve ball bronze ½”NPT	1711152	Controls engine coolant thru. Heat x-er
24	Ticket printer w/ss housing	10918587	Prints quantity of CO2 delivered
25	Meter processor Flowcom LC	10945876	Displays flow rate and amount delivered
26	Valve ball ss 3/4NPT	10700991	Allows manual venting of tank
27	Valve ball ss 1/4NPT	10674501	Isolates economizer regulator
28	Economizer regulator @325psi	2110752	Preserves primary relief's valve seals
29	Relief valve brass 3/4"FPT 350 psi	1811462	Provides primary tank pressure relief
30	Differential pressure transmitter	10673778	Converts pneumatic signal to electric
31	Conn. ss ¼”MPT x 1/8”ODT	10501554	Connects dp transmitter to dp lines
32	Union ss 1/8”ODT x 4mm ODT	10958132	Connects 4mm dp lines to 1/8”OD lines
33	Hose reel swivel	11539968	Connects delivery line to hose reel

VIII. Specifications

Description		2.5 Ton	3.0 Ton	3.75 Ton
Diameter	(in.)	58	58	58
	(cm)	1473	1473	1473
Unit Height	(in.)	67	67	67
	(cm)	1702	1702	1702
Tank Length	(in.)	111	129	156
	(cm)	2819	3277	3962
Unit Length	(in.)	144	162	189
	(cm)	3658	4115	4801
Skid Width	(in.)	34	34	34
	(cm)	864	864	864
Empty Weight	(lb.)	3450	3900	5600
	(kg)	1560	1770	2540
Filled Weight	(lb.)	8450	9900	13100
	(kg)	3830	4500	5900
Gross Capacity	(Gal)	620	744	929
	(Liters)	2346	2815	3518
Net Capacity	(Gal)	589	706	883
	(Liters)	2228	2674	3343
Maximum Allowable Working Pressure (MAWP)	(PSIG)	350		
	(Bars)	24.1		
Relief Valve	(PSIG)	350		
	(Bar)	24.1		
Pressure Control	(PSIG)	325		
	(Bar)	22.4		
Design Temperature	(° F)	-40 To +100		
	(° C)	-40 To +37		
Inner Vessel		SA612 Normalized Carbon Steel		
Outer Jacket		5052 - H32 Aluminum		
Design Specifications		D.O.T. MC-331		
Inner Vessel		ASME Section VIII. Div I		
Outer Jacket		ASME Section VIII. Div I		
Insulation		Flourocarbon based Polyurethane Foam		
Protective Coating		DuPont Imron System, White		

IX. Operating Procedures

A. General Operating Information

This section provides information to familiarize the operator with the controls and operating procedures for the $LDCO_2$ Tank. Procedures for purging the container, filling the container, and transferring liquid from the container are given below.

It is recommended that the user read and fully understand all safety information provided and become familiar with the location and function of all controls, indicators and devices prior to performing any operations described in this section. Prior to operating the container, it is important that the user read and understand all the information provided in this manual.

B. Controls & Indicators

The $LDCO_2$ controls and indicators are illustrated on the following diagrams. Each plumbing component is referenced on the illustration by a "Tag" or item number followed by a chart which provides the corresponding CHART part number, item description and the function of each.

NOTE: If a procedure in this section specifies the use of a particular valve or operation that is not on your delivery vessel, or can not be completed disregard that portion of the procedure.

C. Initial Fill Considerations

The initial fill is usually performed on a new or warm tank that has not been used for an extended period of time. Tanks not being used should always be stored with positive pressure, preferably with CO_2 gas. Although the $LDCO_2$ tank is tested and shipped with a gaseous CO_2, the container should be purged to insure product purity and to cool the inner.

When preparing the $LDCO_2$ tank for filling the following considerations should be taken:

1. Inspect vessel and/or combo body for any possible damage. If damage is detected and the tank is new contact CHART Technical Service at 1-800-253-1769 immediately. If the tank is coming out of storage, correct any deficiencies before filling.
2. To remove moisture or contamination from the tank the vessel must be purged before filling. See Purge procedure.
3. The vessel must be cooled down by purging and adding small amounts of cold gas and liquid before filling. *Caution: Failure to cool inner vessel before filling may cause serious damage.*
4. The $LDCO_2$ tank may be filled by pumping or pressure transfer. The internal pressure of the vessel must be raised to at least 60 psi with dry CO_2 gas before filling with liquid CO_2.

Operating Procedures (continued)

D. Purging

To purge the LDCO2 tank, use the following procedure:
Caution: The maximum purge pressure should be equal to 50 percent of the maximum operating pressure , or 175 psi. To prevent drawing atmospheric contaminants into the tank while purging, a positive pressure of at least 60 psi must always be maintained.

Note: When operating the $LDCO_2$ isolation valves you must first lift up to release the locking collar which is located on valve handle where it is connected to valve stem.

1. Observe all normal safety precautions, including adequate ventilation, protective clothing and eye/face and ear protection.
2. Add dry CO_2 gas through connections (C-1, if empty) or (C-2) until the internal tank pressure reaches at least 60 psi.
3. Attach source of liquid purge product (CO_2) to the fill connection (C-1).
4. Verify that all valves are closed except the pressure building valves (V-5 & 6) when equipped with the PB vaporizer and the liquid level gauge valves (V 7 & 8).
5. Open the liquid fill line drain valve (V-4) slightly and the source valve. Allow the source liquid to vent through the fill hose until slight frosting appears on the hose. Close drain valve (V-4)
6. Open the liquid fill (V-1) enough to allow a small amount of gas/liquid to flow slowly into the pressure building coil and the tank. By adding liquid slowly it will vaporize in the hose and PB, before entering the inner vessel and will slowly build pressure in the inner vessel.
7. *Caution: Failure to cool inner vessel before filling may cause serious damage.*
8. Close the liquid fill valve (V-1) when the internal tank pressure gauge (PI-1) reaches the maximum purge pressure (175psig).
9. Close purge source valve and open liquid fill drain valve (V-2) slightly draining any liquid from tank. The drain valve will have to be throttled to maintain a minimum of 60 psig in the line. The absence of snow at the drain valve indicates all liquid has been drained.
10. Close drain valve (V-2) and liquid fill valve (V-1). Open liquid level equalization valve (V-9) before closing liquid level gas & liquid phase lines. Close phase line valves (V-7&8).
11. Loosen the compression fittings on either side of the liquid level gauge (LI-1). Open level gauge phase lines fully and observe the exiting gas for signs of water vapor. If there is no water vapor present after blowing gas through both lines for approximately two minutes, close both valves
12. If water vapor is present continue gas discharge until clear of moisture
13. Open vapor return line (V-3) and liquid delivery (V-10) along with vapor crossover valve (V-12) and delivery drain valve (V-11). Relieve gas until the internal pressure gauge (PI-1) is approximately 70 psig.
14. Repeat purge procedure steps 2 through 6 and 9 three times to insure product purity.
15. Reconnect and tighten fittings. Open valves and close equalization valve. Leak check fittings.

Operating Procedures (continued)

E. Filling the Delivery Unit

The intended delivery tank pressure is 300 psi using liquid that is saturated at 250 psi or greater.

Caution: Failure to cool inner vessel before filling may cause serious damage.

Observe all normal safety precautions, including adequate ventilation, protective clothing and eye/face and ear protection.

1. Purge tank to assure product purity (see Purge Procedure).
2. Verify that all valves are closed except the gauge lines (liquid phase V-8 and gas phase V-7).
3. Add dry CO_2 gas through connections (C-1, if empty) or (C-2) until the internal tank pressure reaches at least 60 psi.
4. Connect a liquid transfer hose from the supply (mother) tank to the delivery tank fill connection (C-1). If using the vapor return option connect return hose to the vapor return connection (C-2).
5. Allow the transfer hose to cool down by slightly opening both the fill drain valve (V-2) and the supply valve on mother tank.
6. After the transfer hose has been cooled, close the mother tank supply valve and then the line drain valve (V-2).
7. Open the liquid fill valve (V-1) on the delivery unit to pressurize the transfer hose.
8. Open the liquid discharge valve on mother tank slowly at first and check for leaks in the transfer hose connections.
9. Stop and fix leaks if necessary, otherwise, continue to open the valve further. Liquid will begin to flow from the mother tank into the delivery vessel.
10. If a pump transfer is to be made, make the required connections to the pump. A vapor return line must be used while operating the pump! Open mother tank discharge valve slowly allowing liquid CO_2 to flow into the pump. The pressure in both tanks must be equalized before the pumping process is to begin. Turn on the pump after the liquid reaches the pump and both tanks have equal pressure. Do not allow the pressure readings on the two pump gauges to exceed 100 psi. (In other words if one pump gauge reads 300 psi, don't allow the other one to go below 200 psi. If it reaches this point, slow down or stop the pump to allow the system to equalize.
11. Monitor the internal pressure (PI-1) of the delivery tank. As the pressure in the delivery unit rises to the mother tank pressure the fill process will slow down. Excess pressure can be vented by opening the vent valve (V-13). If using the vapor return line and the tank pressures equalize, excess pressure may be vented through the vapor return drain valve (V-4). If the pressure is too great, the fill may need to be interrupted to allow the pressure to drop.
12. Monitor the liquid level gauge (LI-1). When the gauge indicates approximately three-quarters full open the vapor return valve (V-3) and vapor return drain valve (V-4). The vapor return line of the delivery tank also acts as the full trycock line to indicate when the tank is full. A small amount of snow spurts from the vapor return / trycock valve indicating the delivery tank is full. If using the vapor return line simply open the vapor return drain valve (V-4).
13. When the delivery tank is full close the liquid discharge valve on mother tank. Close the liquid fill valve (V-1) on the delivery tank and open the liquid hose drain valve (V-2) allowing excess liquid and pressure to be relieved. Disconnect the liquid transfer hose. If using the vapor return line close vapor line on mother tank. Close vapor return valve (V-3) on delivery tank, open vapor return drain line to relieve pressure. Disconnect vapor return line.

Operating Procedures (continued)

F. Making CO_2 Deliveries

1. Locate the delivery unit as near as possible to the fill station.
2. Put on work gloves and safety goggles.
3. Make sure there is power to the flow meter.
4. Unlock the fill station and inspect the fill fitting and the box's general condition.
5. Do not attempt to make a delivery if the fill fitting is damaged, the box is in poor condition or if the box is located below grade or in a confined space.
6. Exercise good judgment and do not underestimate the physiological effects CO_2 may have on you.
7. Unhook the store tank and move it outside if it is a portable model.
8. Once satisfied with the appearance and condition of the fill fitting inspect the contents gauge on the store tank to predict the amount of product that will be delivered.
9. Retract the fill hose from the hose reel and connect the fill hose fitting to the fill box fitting.
10. Make sure the fittings are completely tight such that the circular slot on the fill fitting is even with the end of the hose fitting.
11. Check the line pressure gauge (PI-2) to determine the store tank pressure.
12. If the line pressure gauge reads zero the store tank either has a one way check valve or a fill line isolation valve which is closed.
13. Open the store tank's fill line isolation valve if necessary and check the pressure once again.
14. Once satisfied that the delivery unit has approximately 300 psi and the store tank fill line is open and has approximately 125 psi switch on the flow processor and open the printer cabinet. Press the "Release" button on the printer and insert a ticket form.
15. Press the "Forward" button briefly to lock the ticket into place.
16. Open the delivery unit's liquid delivery valve slowly at first and then open it further gradually while monitoring the flow processor.
17. If the processor reads "H98" partially close the valve until the error message ceases.
18. Keep the flow rate between 20% and 95% of maximum as shown on the processor.
19. At any point in the fill process you may close the liquid delivery valve and check the pressure or liquid contents of either tank.
20. If the flow rate drops below 20% close the liquid delivery valve.
21. Vent the store tank outdoors down to 100 psi if possible.
22. If the store tank cannot be vented down and the maximum flow rate drops below 20% discontinue filling.
23. Close the liquid delivery valve.
24. Open the line drain valve allowing the liquid trapped in the hose to escape.
25. Once the escaping fluid in the hose changes from a liquid to a gas close the line drain valve.
26. Press print on the flow processor briefly to print out a ticket.
27. Insert another ticket and press print again if a duplicate is required.
28. Disconnect the fill fitting from the fill box slowly allowing gas to escape.
29. Return the fill hose to the hose reel.
30. Open the line drain valve to allow any gas left in the hose to escape.
31. Switch off the flow processor, close the printer box and store the key.
32. Close and lock the fill box.
33. Turn off the flow meter.
34. Remove safety goggles and gloves.

X. The Two Channel Flow Meter

A. Operating the Meter

As an option this unit can be equipped with a second metering section which allows the operator to measure the quantity of CO_2 delivered either through the fill line with or without the pump. Otherwise metering is achieved through the hose reel. The flow meter is set up such that the operator can switch from one channel to the other depending on which device will be used to deliver CO_2. Channel 1 is the hose reel metering section and channel 2 is the larger fill line metering section. Each metering section can only measure the quantity of product leaving the delivery unit. Running liquid CO_2 backward through either of these metering sections will not harm them in any way but they will not measure fluid flow in that direction.

B. Metering CO2 Through the Hose Reel

The first thing the operator will need to do is to set the meter to channel 1. One achieves this by first holding down the clear/print button on the flowcom LC and then switching on the power.

The first item flashing on the menu will be "SEL." Press the clear/print button briefly to change from channel 2 to channel 1.

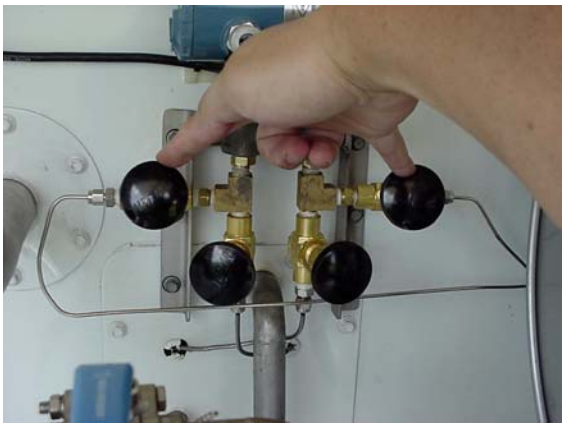
Once set to channel 1 press and hold the clear/print button until the "ex" message appears in the window. Press clear/print briefly while in the "ex" menu to exit out of the start up menu. Once 0.0 lbs appears in the window close the outer set of transmitter isolation valves and open up the inner (lower) two valves.

Once these lower valves are open while the outer ones are closed and the meter is switched to channel 1 the unit is now ready

to deliver and meter CO_2 through the hose reel. The operator may need to reset the meter at this point because the meter will start to count if the valves are not opened and closed simultaneously. Once the meter has been reset follow the instructions on page 16 section F entitled, "Making CO_2 Deliveries."

C. Metering CO2 Through the Fill Line (With or Without Pump)

If the operator wishes to deliver CO_2 through the fill line metering section (with or without the pump) he will need to switch the meter to channel 2. He will do this using the same procedure described above except that he will switch the meter to channel 2 and will open the outer and close the inner transmitter isolation valves.



Once the meter is reset the fill line meter is ready for use. If the operator intends to deliver through the pump the instructions below should be followed carefully.

D. Hydraulic Filter

As with any hydraulic system the hydraulic filter will need to be changed after the first few hours of service. After that it should be changed on an annual basis. CHART recommends using a Donaldson P170894 hydraulic filter.

XI. Using the CO2 Product Pump

A. Introduction

The CO_2 product pump(optional) is intended to transfer liquid CO_2 quickly from a storage tank to the truck and vice versa. The delivery rate is approximately 22 gal/min (200lb/min CO_2 approx.) A hydraulic pump drives the CO_2 product pump. A power take-off (PTO) is used to drive the hydraulic pump.

B. Safety

Follow all safety precautions listed in the user's manual before operating pump.

C. Opening the Pump Cabinet

Unhook the rubber latches from the cabinet door and lift up the cabinet. Prop up the cabinet using the prop rod.

D. Hooking Up Hoses to the Pump Assembly

The hook-up depends on the direction of product flow. The pump inlet is on the right hand side when facing the pump (or the side that has a strainer with a directional arrow). The outlet is the side with a yellow handle purge valve.

E. From Storage Tank to Truck

If product is to be transferred from a stationary storage tank to the truck, connect a hose from storage tank to the pump inlet. Connect the pump outlet and the liquid fill connection on the delivery unit (C-1) with the CHART supplied pump transfer hose (6ft long). Then connect a vapor return line from the storage tank to the delivery unit's vapor return connection (C-2).

Using the CO_2 Product Pump (continued)

F. From Truck to Storage Tank

In this case the storage tank hose connects to the pump outlet (side with the purge valve). The pump transfer hose connects to the delivery unit's fill connection (C-1) to the pump inlet. Then connect the vapor return line as previously described.

G. Running the Pump/PTO

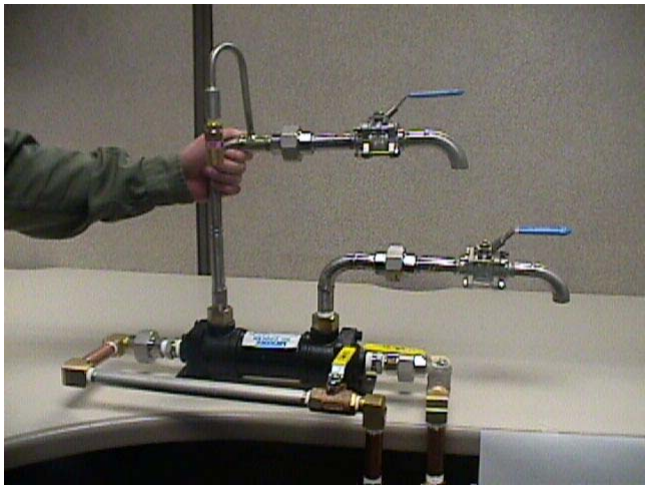
Once the hoses have been properly connected open the receiving tank's fill valve allowing pressure to build in the hoses and pump. Next, open the delivery tank fill valve allowing liquid to fill the hose. Liquid must be presence at all times when running the pump. In order to engage the PTO the truck must be running in neutral with the parking brake on. (**Caution**: Do not engage the PTO when engine exceeds 750 RPM. Operator should engage the PTO, and then increase the engine RPM if desired, but do not exceed over 900 RPM).

The PTO switch is located above the pump assembly as pictured. PTO is activated when the switch is in the ON position. Red light will come on when PTO is engaged. Monitor the two pressure gages on the pump. The pressure indicated by each gage should be between 100 and 300psi. The difference in pressure between the two gages should never exceed 100psi. If the difference does exceed 100psi the pump will start to cavitate which may result in damage. Stop the pump immediately if this occurs. The vapor return line should help keep the pressure difference within range

H. Stopping the Pump

Once the proper amount of CO_2 has been delivered turn OFF the PTO. The light will go off and the pump will come to a stop. Close the truck and storage liquid fill valves. Shut off vapor line valves. First, purge the liquid line slowly to allow remaining liquid to turn vapor. Depressurization too quickly will solidify the line. Then drain the vapor return line. Disconnect the hoses slowly to bleed off any residual pressure. Screw the caps back on the pump connectors and then close the cabinet.

XII. Pressure Building System



1. PB CO2 Gas Outlet Valve
2. PB Liquid CO2 Inlet Valve
3. Engine Coolant Outlet Valve
4. Engine Coolant Inlet Valve
5. Isolation Valve (not shown)
6. Isolation Valve (not shown)

The Pressure Building System is an optional device which uses engine coolant to help build head pressure. The isolation valves #5 and #6 are located under the hood and should remain open. To operate the PB system, the engine must be running and liquid CO2 is available in the tank.

Open both Valve #4 and Valve #3 to circulate the engine coolant through the heat exchanger. Slowly open Valve #1. Wait for a few minutes or until the heat exchanger is hot. Then slowly and gradually open Valve #2 to allow liquid CO2 to flow into the heat exchanger.

Once the desired head pressure is achieved, shut off Valve #2. Close Valve #4 to terminate coolant flow. Then shut off Valve #3. Finally close off Valve #1.

Caution: Do not close off Valve #2 and #3 simultaneously. Trapping liquid Co2 will result in rapid vaporization and high pressure which could damage the heat exchanger.

XIII. Troubleshooting

Problem	Cause	Solution
Tank builds excess pressure or builds pressure too fast	Low usage	If daily usage is less than the n.e.r. the tank will build pressure.
	Tank is over-filled	If the tank is filled past the vent trycock or past the DOT specified fill weight the pressure may rise rapidly after a fill.
	Pressure control is maladjusted	If the pressure builds and stays at a setting higher than desired, adjust the pressure control regulator to a new setting. Turn the adjustment screw counter-clockwise to lower the pressure setting. Each half turn equals approximately 15 psi.
	Pressure control leaks	If the pressure builds to the relief valve setting, frost appears around the relief valves, & the press. control does not respond to adjustment, replace the regulator.
	Insulation is deteriorating	This can be accompanied by cold or frost occurring evenly over the tank's outer surface. Phone CHART for return and repair information
Tank pressure is too low or does not build pressure at a sufficient rate	Press. Control isolation valves are closed	Open the pressure control valve.
	Press. Control regulator is mal- adjusted	If the pressure does not build and stays at a setting lower than desired, adjust the pressure control regulator to a new setting. Turn the adjustment screw clockwise to raise the pressure setting. Each half turn equals approx. 15 psi.
Tank pressure is too low or does not build pressure at a sufficient rate	Tank is leaking	Check for frost anywhere on the plumbing or near the pressure reliefs. Spray soap solution on joints to test for leaks. Repair leaks if possible otherwise call CHART for assistance.
	Energy level of liquid in tank is low.	The pressure building rate for product stored at a lower pressure will be slower than product stored at a higher pressure. To achieve best results maintain the tank pressure at the working pressure of 300 psi.
	Tank is contaminated with moisture or CO2 by-products	Contaminants such as water will freeze in solution with liquid CO_2 preventing adequate flow of product into the pressure building coil. After the VLCD has been emptied purge the tank with 50°C - 100°C nitrogen for 12 hours or more. Purge CO_2 byproducts out through the liquid fill line. After donning safety glasses and gloves place a rag over the fill line outlet and open the valve briefly. Inspect the cloth for discoloration or impurities. Repeat until all impurities are removed.
	Dry ice in tank	If the pressure in the tank drops below 61 psi dry ice slush will form in the tank which will restrict liquid CO_2 from entering the pressure building coil. To liquefy solid CO_2 pressurize the tank using an

Problem	Cause	Solution
		outside source to 300 psi. Each pound of frozen CO_2 will consume one pound of dry CO_2 gas. For example, if the unit had 50 pounds of solid CO_2 it would consume the contents of one 50 lb. high pressure cylinder. Liquefaction is a slow process. It takes 30 minutes to liquefy each pound of solid CO_2.
Frost occurs around the plumbing	Tank is being used	This is normal if the tank is receiving or delivering CO_2.
	Frost is residual from last fill or earlier use	This is normal. Frost may remain on the plumbing for hours after a fill or heavy use.
Frost occurs on hose or hose reel	Residual frost from last fill or recent use	This is normal. Ice may remain for hours after a fill or heavy use.
Frost occurs evenly on outer surface	Tank has lost its insulation	This is accompanied by high pressure and product loss. Phone CHART for return information.
Miscellaneous frost spots	Tank may have internal damage	Call CHART for evaluation or return information.
Flow meter not working	Wiring problem	Inspect the wires to make sure they are in good condition and properly installed. Refer to the Flow Meter manual for more Information
Flow meter not counting	H_2O ice in impulse pipes	If any moisture is found in the CO_2 supply it will make its way to the flow meter's d.p. impulse pipes and immediately block them. To purge the moisture remove each impulse pipe and force warm nitrogen Through them at 1000 psi (70 bars) if possible. This will insure that the impulse pipes are absolutely dry.
	Dry ice in impulse pipes	To avoid dry ice forming in the impulse pipes pressurize the metering section with CO_2 gas above 70 psi before introducing liquid CO_2. This can be done by connecting the delivery hose to the customer station allowing pressure to build back into the metering section.
Flow meter not counting	Impulse pipes crossed	Make sure the impulse pipes are connected properly. The "+" side on the metering section must be connected to the "H" port on the transmitter. In addition, the "-" side on the metering section must be connected to the "L" port on the transmitter. Make sure the fittings are secure and the impulse pipes are not kinked or blocked.

XIV. Service and Maintenance

A. Maintaining the $LDCO_2$ Delivery Unit

Since there is no maintenance schedule for the delivery unit pay attention to the normal operating conditions of the tank. If deviations are encountered repair or replace the affected parts as necessary.

B. Servicing the $LDCO_2$ Delivery Unit

Repairs should only be performed by CHART authorized service agents who use CHART replacement parts. Contact CHART for a list of authorized service agents.

CHART, Inc.
407 Seventh Street N.W.
New Prague, MN 56071-1000
USA

Important Telephone Numbers

Purpose	Contact	Phone Number
Customer Service	CHART Customer Service	(800) 400-4683
Direct Telephone No.	CHART Operator	(952) 758-4484