Product Manual

Orca™ MicroBulk Delivery System
VHP Series

Nitrogen/Argon

Designed and Built by:

Chart Inc.

407 7th Street NW
New Prague, MN 56071 USA
(800) 400-4683

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Contents

Revision Log

Revision Level	Date	Description
A	12/04/2019	Initial Publication
B	09/03/2021	Update specs, components
C	05/03/2022	Included HL-3500 model information
D	07/25/2022	Included Generator Engine information

Preface

General

Chart's MicroBulk delivery system has revolutionized the gas industry by making on-site distribution for smaller accounts a profitable reality. The Orca VHP Series delivery unit has been designed to flow up to 180 gallons-per-minute or maximum 540 psig with minimal product loss under normal conditions. The Orca VHP Series delivery unit has been designed to complete a MicroBulk fill in 3-15 minutes (depending on storage volume) with no pump cooling or product loss (inert service) under normal conditions. Automatic fill termination with the Perma-Cyl® MicroBulk Storage System vessels eliminates safety hazards and lost product associated with overfilling. In total, the Chart VHP MicroBulk system increases asset utilization, reduces labor costs and maximizes distribution efficiency.

Chart offers the complete MicroBulk VHP delivery system as a solution to reliably and effortlessly manage a diverse range of applications. The Orca VHP Series delivery unit offers fast, reliable and accurate on-site delivery to high- and low-pressure Perma-Cyl tanks, as well as bulk tanks. The Perma-Cyl line offers the widest range of sizes and piping options and the greatest flexibility with accommodations for indoor and outdoor installation.

Product Highlights

Fast on-site filling of the Perma-Cyl storage system with automatic shut off.

Fast-filling VHP tanks without venting

Competes with transport trailer flow rates to bulk tanks

Exclusive low maintenance submerged pump for instant starts and continuous delivery (N^2 or Ar service)

Push-button Flowcom® 3000 Flowmeter System with dial potentiometer to optimize delivery rate

National Institute of Standards & Technology (NIST) and California Weights and Measures approved metering system

Large cabinet with removable access panels for ease of maintenance and servicing

Low maintenance seal-less submerged cryogenic pump magnetically coupled to hydraulic motor

Hydraulic drive similar to existing transport systems

Automatic pressure building maintains optimal subcool for delivery and minimal product loss

Vessel designed with robust inner support system for rugged road conditions

Stainless steel plumbing with stainless steel and brass valves for long service life and reliability

Product Manual

This Product Manual is designed to be used in conjunction with Orca VHP Series models. It should be thoroughly read and understood by anyone who operates or is exposed to this equipment. If there are any questions regarding the operation of the tank, contact Chart's Technical Service division at 1-800-400-4683.

The safety requirements for operating the tank and handling or transporting extremely cold liquid products are shown in the Safety section. It is imperative that all persons having contact with an Orca Delivery System become thoroughly familiar with all maintenance, safety precautions, and procedures contained in this product manual.

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

For detailed information on how to operate the Orca system, refer to the Operation section. This section includes various filling, pressure dispense and pump dispense instructions.

The Components and Systems section contains photos and descriptions of all working parts of the Orca system.

The Troubleshooting section contains information for answering possible questions that may arise while using the Orca system.

The Preventive Maintenance section contains a schedule of maintenance to keep the Orca system running smoothly.

Refer to the Specifications section for a list of part numbers, liquid level charts, schematics and other technical information.

Danger, Warning and Caution Symbols

This manual uses the symbols below to signal potentially dangerous conditions. Read this information carefully and take the necessary steps to protect Personnel and property.

Danger! ***Is used to warn of immediate hazards that will cause severe personal injury or death.***

Warning! ***Is used to call attention to a situation that could cause severe personal injury.***

Caution! ***Is used to call attention to a situation that could cause minor personal injury, or damage to the equipment or other property.***

Note: *A statement that contains information that is important enough to emphasize or repeat.*

Acronyms & Abbreviations

The following acronyms, abbreviations and initialisms are used throughout this manual:

ASME..... American Society of Mechanical Engineers

BAR..... Metric Unit of Pressure

BARG..... Metric Unit of Gauge Pressure

CGA..... Compressed Gas Association

DOT..... Department of Transportation

NER ..... Normal Evaporation Rate

GAWR..... Gross Axle Weight Rating

GPM..... Gallons Per Minute

GVWR..... Gross Vehicle Weight Rating

LAR..... Liquid Argon

LN_2/LIN .... Liquid Nitrogen

LPM ..... Liters Per Minute

MAWP..... Maximum Allowable Working Pressure

NIST ..... National Institute of Standards and Technology.

NPSH..... Net Positive Suction Head

OEM..... Original Equipment Manufacturer

PB..... Pressure-builder

PN ..... Part Number

PSI ..... Pounds per Square Inch

PSIA..... Pounds per Square Inch Absolute

PSIG..... Pounds per Square Inch Gauge

PSID..... Pounds per Square Inch Differential

PTO ..... Power Take-off

RV ..... Relief Valve

RTD..... Resistance Temperature Device

SS ..... Stainless Steel

VAC..... Voltage - Alternating Current

VDC..... Voltage - Direct Current

VFD..... Variable Frequency Drive

VHP..... Very High Pressure

Safety

Safety Summary

While every possible safety precaution has been taken to ensure safe operation and maintenance of the Orca VHP, it is imperative that all persons having contact with the Orca delivery systems become thoroughly familiar with all maintenance, safety precautions and procedures contained in this Product manual. If for any reason any part or parts of this manual become confusing, or the information provided is not completely understood, contact a Chart Technical Service Representative at 1-800-400-4683 before proceeding with the operation or repair of this equipment.

Compatibility and Cleaning

Always keep the Orca delivery system clean and free from grease and oil. Use care when cleaning with high-pressure water or steam cleaning equipment. DO NOT direct the cleaning nozzle into the electronic components. All new joints should be leak-tested with a compatible leak-test solution at a minimum of 35 psig (242 kPa). Failure to comply with these instructions can result in serious personal injury, death, or damage to the container. Once a system has been contaminated, the vessel cannot be returned to service without extremely extensive cleaning methods.

Caution! ***Empty the cryogenic container of liquid contents and release any vapor pressure in a safe manner before removing any parts or loosening fittings. External valves and fittings can become extremely cold. Personnel must wear protective gloves, face protection and eye protection whenever removing parts or loosening fittings. Failure to do so can result in personal injury due to the extreme cold and tank pressure. Accidental contact of liquid gases to skin or eyes can cause a freezing injury similar to a burn.***

Warning! ***If cryogenic liquid or cold boil-off gas contacts a worker's skin or eyes, the affected tissues should be promptly flooded or soaked with tepid water (105-115°F; 41-46°C). DO NOT USE HOT WATER. A physician should examine cryogenic burns that result in blistering or deeper tissue freezing promptly.***

Safety Bulletin

Portions of the following information are extracted from Safety Bulletin SB-2 from the Compressed Gas Association, Inc. Additional information nitrogen, argon and cryogenics is available from the CGA at www.cganet.com.

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

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

Incidents which require that such practices be followed include: highway accidents, immersion of a container in water, exposure to extreme heat or fire, and exposure to most adverse weather conditions (earthquake, tornadoes, etc.) As a general rule 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 re-certification.

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

Oxygen-deficient Atmospheres

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

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

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

When the oxygen content of air is reduced to about 15 to 16%, the flame of ordinary combustible materials, including those commonly used as fuel for heat or light, may be extinguished.

Somewhat below this concentration, an individual breathing the air is mentally incapable of diagnosing the situation because the onset of symptoms such as sleepiness, fatigue, lassitude, loss of coordination, errors in judgment and confusion can be masked by a state of "euphoria," leaving the victim with a false sense of security and well-being.

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

Refer to the following table for symptoms associated with percent (%) values of oxygen deficiency.

% (Percent) Oxygen Content	Symptoms
16-21	No signs or symptoms
14-16	Increase in rate and depth of breathing
12-14	Deep respiration, quickened pulse, loss of coordination
10-12	Irregular breathing, poor judgment, blue lips
8-10	Nausea, loss of consciousness, ashen face
6-8	Loss of consciousness, death (if not promptly moved to safety)
4-6	Coma, convulsions, respiration ceases, death

Most individuals working in or around oxygen-deficient atmospheres rely on the "buddy system" for protection - obviously the "buddy" is equally susceptible to asphyxiation if he or she enters the area to assist the unconscious partner unless equipped with a portable air supply. The best protection is obtained 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:

Use the "buddy system." Use more than one "buddy" if necessary to move a fellow worker in an emergency.

Both the worker and "buddy" should be equipped with self-contained or air line breathing equipment.

Nitrogen and Argon

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

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

Persons suffering from lack of oxygen should be immediately moved to areas with normal atmospheres. Self-contained Breathing Apparatus May be Required to Prevent Asphyxiation of Rescue Workers. Assisted respiration and supplemental oxygen should be given if the victim is not breathing.

Contact with cold nitrogen or argon gas or liquid can cause cryogenic (extreme low temperature) burns and freeze body tissue.

If cryogenic liquid or cold boil-off gas contacts worker's skin or eyes, the affected tissue should be flooded or soaked with tepid water (105-115ºF or 41-46ºC). Do Not Use Hot Water. Cryogenic burns that result in blistering or deeper tissue freezing should be examined promptly by a physician.

Personal Protective Equipment (PPE)

The following personal protective equipment is recommended when working around cryogenic liquid:

Safety glasses with side shields to prevent cryogenic liquid from splashing into the eyes

Chemical / Liquid-resistant gloves to prevent cryogenic burns on exposed hands

Long sleeve shirts to protect the arms

Cuff-less trousers worn over closed shoes

Face shield

Introduction

Theory of Operation

The Orca VHP Series uses a common submerged pump for all product deliveries. All VHP series operate the same, with the exception of power take-off variations. They have the ability to be filled with liquid Nitrogen or Argon and deliver that product to the end customer safely and efficiently.

Terminology of Cryogenics

Cryogenic

A cryogenic product is a product retaining a temperature of -238°F (-150°C) or colder. Orca delivery systems maintain gases efficiently in a cryogenic liquid state. Gases can be most efficiently stored as liquids. Gases can be liquefied by compression or by cooling them until they liquefy. In order to be maintained in a liquid state, each gas must be kept at or below its respective boiling temperature.

States of Matter

Matter can exist as a gas, liquid or solid. Two-phase liquid is a liquid with gas bubbles or slugs of gas due to lack of pressure (subcool) to maintain equilibrium. Gas and liquid can exist at a range of temperatures.

Saturation

Saturation is defined as the point at which liquid and vapor coexist at the same pressure and temperature.

Liquid density, temperature, and equilibrium pressure change with the saturation condition of the liquid. Saturation can also be described as an energy state. Liquid molecules at a higher energy state (warmer) take up more space, which is often referred to as liquid growth.

Equilibrium

Equilibrium exists in a closed vessel when the gas and liquid temperatures are the same. If there is a temperature difference between the gas and liquid (with the tank closed), the gas and liquid will change their temperatures until they are equal. In stationary tanks, stratification can take place creating a temperature gradient across the liquid and vapor. However, the temperature at the liquid/vapor interface is the same for both.

Saturation Pressure

The saturation pressure is the pressure (usually in psig) that is used to describe the current saturation condition of a liquid and gas within a closed container.

Subcool

Raising the vapor space pressure above the current boiling pressure of a saturated liquid is called subcool. This contributes to the Net Positive Suction Head (NPSH) to the pump. The higher the subcool the less susceptible the liquid will be to two-phase flow and pump cavitation.

Two-phase Liquid

Two-phase liquid is the mix of liquid and gas due to the pressure dropping below the saturation pressure of the liquid caused by the lack of adequate subcool. This can damage the pump and cause meter inaccuracy.

Cavitation

Cavitation is defined as the formation of vapor bubbles in a liquid. It manifests itself as partial or full loss of pump prime due to the lack of adequate subcool. The pressure of the liquid flowing to the pump has dropped below the saturation pressure. Audible changes in the pump often are an indication of partial loss of prime. The pump will stop pumping during full loss of prime. Cryogenic pumps will be damaged by cavitation and it should always be avoided.

Vaporization

Vaporization is changing liquid into vapor by warming the liquid for the purpose of subcooling, or for gas use. The HL and ST Series Gen 3 Orca delivery system uses a pressure-building coil inside of a propylene glycol/water bath heat exchanger in the cabinet.

Vapor Pressure

Vapor pressure is the pressure of the vapor space within the tank. Vapor pressure is displayed on tank pressure gauge or on the Flowcom® Flowmeter System.

Condensation

Condensation is the conversion of vapor into liquid by cooling the vapor. The inner vessel pressure of the HL and ST Series Gen 3 Orca delivery system during normal operation will rise above the saturation pressure of the liquid. This warmer gas will condense to the colder liquid pressure during transit. The liquid splashes into the gas space during normal movement of the truck/trailer. The splashing condenses the gas and drops the pressure. This is known as "splash-down."

Top Fill Condensation

An example of condensation can be seen in the filling theory of a Perma-Cyl® tank. Top filling a Perma-Cyl® tank without venting is possible due to condensing warmer gas into liquid.

Depressurization Flash Losses

Depressurization flash loss occurs when dropping the vapor space pressure below the liquid saturation pressure, causing the liquid to boil. During tank venting below the liquid saturation pressure, the liquid temperature will drop, the density will increase, the weight of the liquid will decrease and the saturation pressure will drop.

Entrainment

Entrainment is liquid carried along with venting gas. This can occur during violent tank depressurization, and during tank top filling with the vent valve open. Large product losses will occur during this event.

Liquid Growth

As liquid warms to higher saturation pressures the volume increases. Warm liquid is less dense. Less dense liquid takes up more volume. Liquid growth is a safety concern if the liquid is allowed to grow until it fills the storage vessel. This condition is called liquid full or hydraulically full. During this condition the pressure rises rapidly, the safeties will relieve, and the tank will vent liquid.

Pressure Drop

Pressure drop is pressure lost due to the flow of liquid. The faster the liquid flows through the piping circuit the higher the pressure drop.

Stratification

Warm liquid is less dense. In a tall vertical tank this less dense liquid will find its way to the top of the tank. Colder, more dense liquid will remain at the bottom. The layering of temperature zones from top to bottom is called stratification.

Pump Overfill

Warning! ***The Orca VHP cryogenic delivery system is equipped with a high-performance pump capable of delivering pressures in excess of 530 psig at the pump discharge. Many pressure vessels are not rated for pressures this high. The Orca VHP is equipped with delivery termination features such as automatic shut-down upon unstable or stopped flow and safety devices such as line relief valves. These safety features are dependent on the operator to input the appropriate values into the Flowcom. It is imperative that the operator of the Orca VHP evaluate each receiving vessel's maximum allowable working pressure, fill circuit restriction, and relief circuit flow rating per publication CGA-P59 to ensure each receiving vessel cannot be excessively pressurized. Review the Delivery section (page 14) and the Flow Termination Methods section (page 16) for further details.***

Operations

Modes of Operation

First Use Purge

The Orca VHP Series delivery system is shipped under pressure with a low purity nitrogen atmosphere to keep out moisture. IT MUST BE PURGED PRIOR TO USE. While purging through the various lines, observe the tank pressure indicating gauge (PI-1). Make sure that the tank pressure does not go below 5 psig (34 kPa). Before filling, be sure that protective eyeglasses and gloves are being worn.

A bottom fill method is recommended the first time the Orca delivery system is filled and any other time the tank is "warm" (warmer than the boiling temperature of the product you will be dispensing). Precool the Orca tank by blowing cold gas from the source tank into the bottom fill line (AOV-7). Open the vapor vent valve (V-5) and check the temperature of the exit gas. When the exit gas is cold enough to frost the vent assembly stop the flow of gas from the source tank and slowly start the flow of liquid. Keep the vapor vent valve (V-5) open to manage tank pressure.

Note: *Cooling the tank slowly will prevent uneven cooling and uneven contraction. Stainless steel from ambient to cryogenic temperatures will shrink 1/32" per 12" of length (3mm per m). Uneven shrinking can cause high stresses in supports and attachments, resulting in damage to the tank.*

1. Attach the source of liquid or gas purge product to the Orca CGA fill connection (DC-2).
2. Open the Orca bottom fill valve (AOV-7) using pneumatic valve "Bottom Fill" (V-52) and then the source feed to slowly fill the Orca to 30 psig (207 kPa)
3. Close the source feed and then close the Orca bottom fill valve (AOV-7). Purge the trapped space by opening the fill line drain (V-9) on the tank.
4. Slightly open the compression fittings on either side of the liquid level gauge (Ll-1), allowing gas to flow. Terminate the purge prior to the line getting cold. Tighten compression fittings and leak check.
5. With the bottom fill valve (AOV-7) closed, open the fill line drain (V-9) and the top fill valve (V-3). Purge for two minutes. Close the top fill valve and the fill line drain.

Note: *Build pressure by repeating steps 1 and 2 when the Orca tank pressure drops below 20 psi (138 kPa).*

6. Open the bottom fill valve (AOV-7) and the fill line drain (V-9). Purge for two minutes. Close the bottom fill valve and the fill line drain.
7. Open the trycocks as equipped. Purge for two minutes. Close trycock valves.
8. With the recirculation valve (AOV-2) closed, slightly open the compression fitting at the outlet of the pressure building coil and purge for two minutes. Tighten the compression fitting and leak check.
9. Manually open the dispense valve (AOV-1) and sump isolation valves (AOV-4) by opening the pneumatic override valves (V-50 and V-51).
10. Slowly open transfer hose end valve (V-41) and purge for 2 minutes. Close the transfer hose end valve (V-41) and close dispense and sump isolation valves (AOV-1, AOV-4).
11. Vent tank to 5 psi (34 kPa) using the vapor vent valve (V-5).
12. After purging is complete, check the gas in the Orca tank for purity.
13. After purging the tank, but before filling, verify that the following valves on the Orca tank are open:
    a. V-11 Vapor Phase Valve
    b. V-12 Liquid Phase Valve
    c. AOV-2 Recirculation Valve

Additionally, verify the following valves on the Orca tank are closed:

a. V-10 Equalization Valve
b. AOV-1 Dispense Valve
c. AOV-3 Force Feed Pressure Build
d. AOV-4 Sump Isolation/Pump Discharge valves.

Confirm manual override handles are in the horizontal position.

Filling the Orca Delivery System - Normal Use

The piping has a top and bottom fill circuit. If filling the Orca tank with liquid saturated at a higher pressure (temperature) than what currently is in the tank, bottom filling is recommended. If filling the Orca tank with liquid saturated at a lower pressure (temperature) than what currently is in the tank top filling is recommended. This will minimize the tank pressure rise and minimize the venting required to manage the Orca tank pressure. Filling the tank with liquid saturated at pressures at or above the tank pressure rating (50 psig / 345 kPa) will require excessive venting.

Lowering the saturation pressure of a liquid will require the liquid to boil. Cold gas is heavy! Minimize venting during filling. Try to use as cold a source of liquid as possible.

Note: *Either pressure transfer or pump filling can accomplish filling the Orca system. The best results will be obtained when the pressure in the supply unit is at least 25 psig (172 kPa) more than the receiving unit (Orca tank). As pressure fluctuates, adjusting the vapor vent valve (V-5) on the Orca tank and the fill/drain valve on the supply unit may regulate the pressure.*

Whenever possible, the Orca unit should be on a level surface when filling. If the vehicle is not level, instrument readings as well as the full trycock points may not be accurate. Wear gloves and protective goggles when working with any cryogenic material. Contact with cryogenic materials can result in severe frostbite and injuries similar to burns. If equipped with a vessel pressure control valve (V-2) make sure it is closed prior to filling the Orca tank.

Filling

The Orca can be filled via the bottom fill, top fill or both circuits concurrently. Adjust during filling as required to maintain vessel pressure. The top fill circuit on the Orca tank has a spray header that will spray the incoming cold liquid onto the somewhat warmer gas in the tank. The cold liquid will condense the warmer gas reducing the tank pressure.

1. Open doors and power off Flowcom if cabinet is powered up.

Note: *Powering Flowcom off keeps sump vapor return valve closed, minimizing pressure building.*

2. Check the liquid level chart (typically inside the rear door) for product specifications and recommended fill levels.

Note: *There are two sample valves. DC-4 is for liquid samples while V-24 is for vapor samples.*

3. Remove pressure cap from DC-2, connect the liquid supply, purge the fill hose with the Orca line drain valve (V-9) and then open the bottom fill (AOV-7) via V-52 and top fill (V-3) as required.

Note: *The engine may need to remain running to maintain air supply to AOV-7 if there are air system leaks.*

4. When the liquid level in the Orca tank reaches the halfway point, open the appropriate full trycock valve.
5. When the Orca tank is full, liquid will vent out of the full trycock valve. Close the full trycock valve and close the liquid supply tank fill/drain valves.
6. Close the bottom and top fill valves (AOV-7 & V-3). Open the fill line drain valve (V-9).
7. When all pressure is removed from the hose, close the fill line drain (V-9) and remove the hose from the CGA fill connection (DC-2).
8. Replace the CGA pressure cap onto the fill connection (DC-2) and stow the delivery hose.
9. Vent the vessel pressure with the manual vent (V-5) and open the vessel pressure control valve (V-2), per the code requirements described below.
10. Power up the Flowcom so it is ready for the next delivery and close the plumbing cabinet doors.

Filling Levels - CGA-341

The Orca delivery system can be filled using the 95% full trycock method as the full indication if the weight doesn't exceed the road weight limits or the truck gross vehicle weight rating and the gross axle weight rating (GVWR/GAWR). Tanks operating under CGA-341 must have a relief system that prevents the tank pressure from exceeding 25.3 psig (174 kPa). The Orca delivery system is supplied with a road relief system that can be used to maintain the tank pressure at or below 25.3 psig/174 kPa (typical cracking pressure is 17 psig / 117 kPa).

Filling Levels - MC-338

The DOT regulations limit the fill levels based on the tank's pressure control valve settings. This volume assures that when the pressure control valve discharges the tank is not liquid full. This fill volume varies with the starting saturation pressure of the liquid. DOT fill levels are based on the weight of the liquid. Differential liquid level gauges are an acceptable means of weight determination along with the full trycock.

Maintaining Cold Liquid

Cold liquid is liquid saturated at 15 psig (103 kPa) or less

Saturation Pressure psi / kPa	Liquid Nitrogen Temp °F / °C	Liquid Oxygen Temp °F / °C	Liquid Argon Temp °F / °C
0 / 10	-320 / -196	-297 / -183	-303 / -186
10 / 69	-312 / -191	-288 / -178	-293 / -181
15 / 103	-309 / -189	-284 / -176	-289 / -178

Reasons for Cold Liquid

1. Cold liquid is denser. Denser liquid has more cubic feet of gas per gallon of liquid.
2. Filling low-pressure cylinders (22 psig / 152 kPa) with warm liquid (above 15 psig / 103 kPa) results in the main safety venting for extended periods of time after the fill is complete.
3. Cold liquid (10 psig / 69 kPa or less) is essential if filling open dewars. Cold liquid will minimize vent losses, optimize fill times, and improve safety.
4. Collapsing of vapor space in receiving tank is achieved.

How to Maintain Cold Liquid

The Orca delivery system can be supplied with an optional secondary relief system (vessel pressure control valve). This secondary relief system will maintain the liquid at a specified saturation by setting the regulator to the desired saturation pressure. It is recommended to set the secondary relief system to 10 psig (69 kPa) if open dewars or low pressure cylinders are to be filled. After filling the Orca tank, vent the contents to the desired pressure. During daily operation, if equipped with a vessel pressure control valve (V-2) and coded to CGA-341, keep it open during transit. It is extremely important to close the pressure control valve before performing a delivery. It is also best to vent the tank to below the cracking setting (typically 17 psig (117 kPa).

Current Saturation of Liquid

Upon arriving at your delivery site, the Orca tank pressure indicator (PI-1) will reflect the current saturation pressure. During travel the liquid splashes condensing the warmer vapor. This is referred to as "shake down." During normal delivery operations the tank pressure will rise. This is not an increase in the saturation but an increase in the subcool. During normal deliveries, the saturation pressure will remain the same as at arrival.

Hydraulic Power Supply

With the Orca VHP securely positioned and ready for delivery, follow these steps to start and use either the power take-off or the generator.

Note: *Tractor only: Connect Stucchi block to provide hydraulic, pneumatic and electric power.*

Caution: Review entire system for leaks, wear points or possible points of failure.

PTO Operation

1. Engage PTO per heavy duty truck OEM's recommendation (if unknown, consult your local OEM truck dealership). The following is one example, different systems may vary.

a. Confirm provided instructions meet OEM truck recommendations and can be easily understood by all operators.

Note: *Damage may occur to PTO system or transmission if proper PTO engagement is not followed. It is highly recommended to develop instructions and place a label on the dash.*

2. Push in clutch and keep held in for minimum 5 seconds to ensure transmission stops spinning. Pull out PTO switch.

   a. Waiting allows time for transmission to stop moving.

   b. If a grinding noise is heard, wait longer to engage PTO.

3. Once the red light comes on, a beep will indicate the PTO is engaged. Let clutch out slowly.

4. Increase engine idle speed to set speed via cruise control. If cruise does not engage, ensure brake and clutch pedals are all the way up.

Note: *Label in cab should determine the correct engine speed setting, likely between 1300-1600 engine RPM.*

Note: *Many OEM trucks have different ways to achieve operating speed. Confirm provided instructions meet OEM truck recommendations and can be easily understood by all operators.*

Caution: ***Engine set speed can be manually overridden with accelerator pedal. DO NOT DO THIS. The hydraulic system is designed to run at 2300-2400 PTO/hydraulic pump RPM. Exceeding this may cause hydraulic system damage.***

Warning! ***If excessive vibration is noticed, contact your local heavy duty truck service provider. Failure to do so may result in additional damage or loosening of moving components.***

Hydraulics Stop - PTO

1. Disengage engine set speed by turning off cruise control or depressing clutch or brake pedals.

2. Push in and hold clutch for a minimum 5 seconds then push in the PTO switch.

   a. If switched too soon, gear grinding will be heard.

3. Release clutch.

Generator Engine Operation

With the Orca delivery system securely positioned and ready for delivery, follow these steps and use the engine.

1. Ensure the speed control is in the tortoise position

2. Turn the key to the one position and wait for count down to 0.

3. Turn key and hold in crank position until the engine starts.

4. Wait 2-4 minutes to warm the engine.

5. Set speed to high (hare) position and wait until the engine coolant temp is 180°F (82°C) for 1-2 minutes.

6. Monitor display for engine loading.

7. When delivery is completed, turn speed to tortoise for 1-2 minutes to cool the engine.

Operating in Temps Below 32°F

1. See generator engine manual for recommended oil weight and change if needed.

2. Plug in the block heater for 3 hours minimum before operating the engine.

3. Start engine to ensure system is charging. Run for 10 minutes.

Note: *The electrical panel heater is thermostatically controlled and has power anytime the engine is running.*

4. Start the engine following the Generator Engine Operation steps.

If system operates in temps below 32°F (0°C) for more than 1 month, contact your Chart representative for disel operated block heater option.

Delivery

1. Open cabinet doors, which triggers anti-tow valve (AI-1) to lock the trailer brakes and provide air to the plumbing cabinet.
   a. The control panel will power up, booting up the Flowcom.
   b. When the Flowcom boots up to the Orca VHP screen, it will open the sump vapor return valve.
2. Close vessel pressure control valve (V-2). Ensure manual vent valve (V-5) is closed.
3. Enter maximum pump discharge pressure based on receiving vessel type.
   a. See the warning on Page 9 to mitigatethe risk of pump overfill
4. Press “info” on Flowcom to view information screen.
5. Dump air bags, allowing trailer to drop down and make controls more accessible.

Note: *This will allow liquid to flow better into sump and is required for low liquid levels.*

6. Remove necessary Bulk or MicroBulk transfer hose from storage tube, remove dust cap and set in place
7. Connect transfer hose to dispense connection (DC-1) and receiving vessel. Ensure gasket is in place at CGA connection, hand tighten and tighten with hammer tap as needed.
8. Make connection to receiving vessel fill connection, hammer tap to tighten as needed.

Note: *Be sure to check pressure on receiving vessel prior to filling.*

9. Start purge process by opening line drain on receiving vessel.
   a. Open Orca sump isolation valves (AOV-4) via manual valve V-51 and dispense valve (AOV-1) via manual valve V-50.
   b. Allow pressure to purge the hose. Once purged, close receiving vessel line drain.
   c. Close Orca sump isolation valve (AOV-4) via manual valve V-51 and dispense valve (AOV-1) via manual valve V-50.

Note: *Purging may not be necessary for transfer hoses that remain connected and have an end valve that is kept closed when not in use.*

10. Press start on the Flowcom or pendant to start pump.
    a. The pump will start at its default setting of 4000 RPM.
    b. The pressure build valve will open automatically and build subcool as needed.
    c. If the pump does not catch prime or loses prime, the Flowcom will stop the pump. Press “info” to clear the warning and then restart the pump.
    d. Once the necessary subcool is built, the Flowcom will allow the delivery to start.
11. Use the potentiometer to increase pump speed to a minimum of 50 psi greater than the receiving vessel, or 150 psi, whichever is greater.
    a. Ensure the potentiometer commanded speed matches the Flowcom commanded speed until the actual speed is achieved.

Note: *The Flowcom will not allow user control of the pump speed until pump actual speed and potentiometer commanded speed both match Flowcom commanded speed. “FC CmdSpd” will turn green.*

12. Open transfer hose (TRAN-1) end valve (V-41) at receiving vessel.
13. Press “start” on the Flowcom or pendant to commence dispensing.

Note: *If despense pressure is too low, the flow rate will be below minimum and the Flowcom will terminate delivery.*

14. Increase fill rate if required by slowly turning the potentiometer up.

Caution ***If potentiometer is increased too quickly, the pump won’t be able to keep up.***

15. Terminate the delivery based on the aforementioned “Flow Termination Methods” section.

16. Once the delivery is terminated, return the potentiometer to 4000 rpm to prepare for next pump start.

17. Exit out of delivery screen and print ticket if equipped to do so.

18. Clear the total by selecting "clear" twice to prepare Flowcom for next delivery.

19. Close transfer hose end valve (V-41), close receiving vessel valves and open receiving vessel line drain valve.

20. **Optional:** The hydraulic system can be shut down at this point by slowing the engine and disengaging the PTO.

Note: *If engine key is turned off, all power to cabinet, including work lights, will be turned off.*

21. Disconnect hose from receiving vessel, replace dust cap on hose end and store in hose tube.

22. Keep transfer hose (TRAN-1) connected to dispense connection (DC-1) until next delivery. This allows remaining product to return to the Orca tank.

23. Move air bag switch to "Fill." Vent vessel with manual vent (V-5) and open vessel pressure control valve (V-2) as needed. Flowcom should remain on.

24. Close and latch doors, depressing the anti-tow valve (AI-1)

    a. This provides air to release the locked brakes.

    b. This removes air supply to the plumbing cabinet and removes electricity from the Flowcom and all other electrical components **except** for the work lights.

Note: *Work lights are the only electric accessory not killed by closing cabinet doors or hitting one of the several E-Stops.*

Note: *There are two pneumatic E-Stops on both sides of the trailer, which remove all air and electricity from the cabinet as well.*

25. Shut down hydraulic system per the aforementioned "Hydraulic Power Supply" section.

Flow Termination Methods

A typical Perma-Cyl® MicroBulk Storage System tank fill is terminated by the Flowcom® Flow Meter System. Listed below are methods available for the operator to terminate the flow.

- Perma-Cyl internal float closes fill circuit, slowing flow and triggering Flowcom automatic shut down. Preferred for Perma-Cyl.
- Perma-Cyl equipped with ullage tank temporarily goes liquid full, slowing flow and triggering Flowcom automatic shut-down. Preferred for Perma-Cyl.

Note: *Liquid will then flow from main tank into internal ullage tank, allowing for adequate head space.*

- Close the dispense valve on the hose — preferred for bulk tanks and liquid cylinders.
- Press the "Stop" button on the Flowcom meter display or on the pendant
- Press the "E-Stop" button

Note: *Pressing the "E-Stop" button should only be used in an emergency situation.* ***DO NOT*** *use this method on a regular basis. Examples of appropriate E-stop usage include Pump overfill events (see warning on Page 9), hose rupture or other substantial leaks.*

The Flowcom will stop the pump and return all AOVs to normal positions if any of the following situations arise:

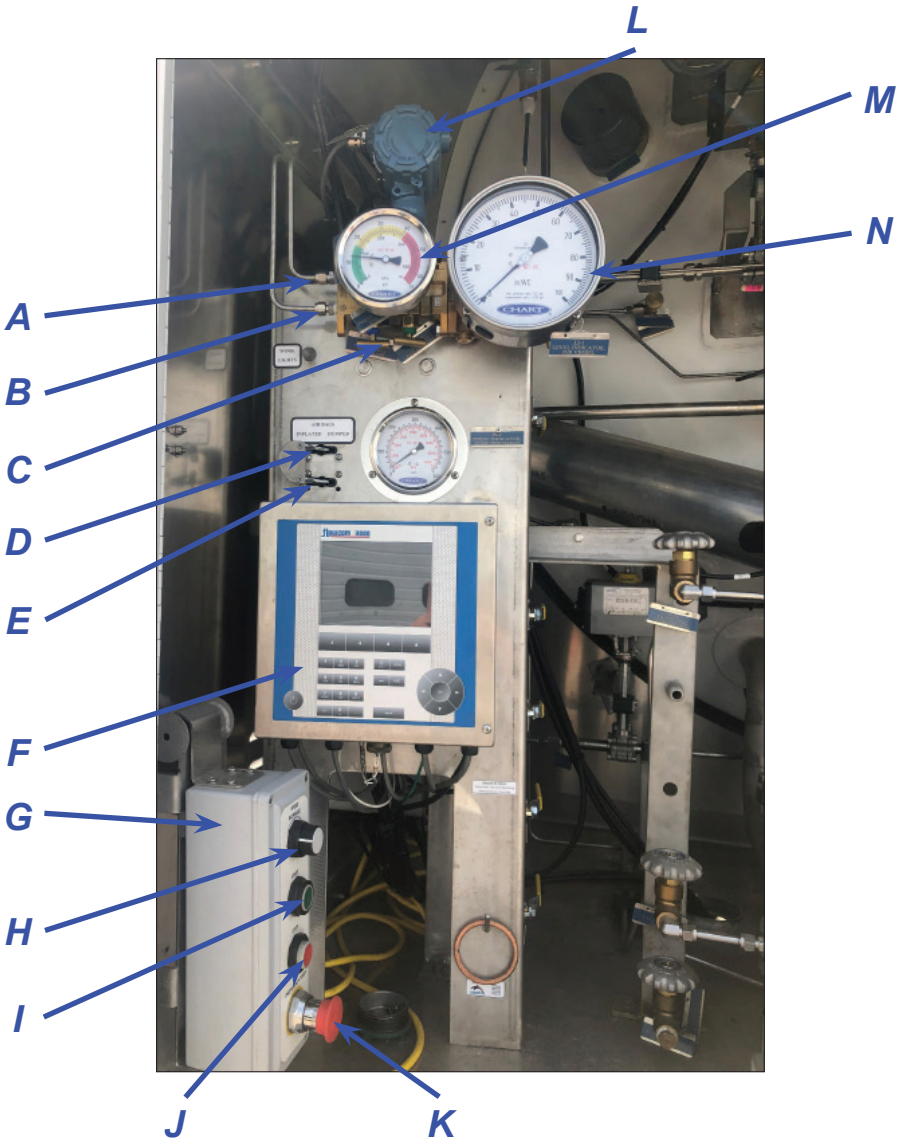
- Flow rate drops faster than the flow drop setting over time - "unstable flow rate" (e.g. Perma-Cyl tank float closes)
- Flow rate is lower than minimum flow rate allowed
- Flow rate is higher than maximum flow rate allowed
- Pump pressure drops below 80 psig - "Loss of Prime"
- Pump pressure exceeds 550 psig (3800 kPa)
- Flow rate rises faster than the flow rise setting - "Flow Rise" (e.g. delivery hose breaks)
- Unable to maintain subcool - "insufficient subcool"
- Pump speed exceeds 8200 rpm for 2 seconds
- Pump speed differs from commanded speed by more than 5% for 12 seconds
- Tank pressure exceeds 38 psig

Components & Systems

Roadside **Center** **Curbside**

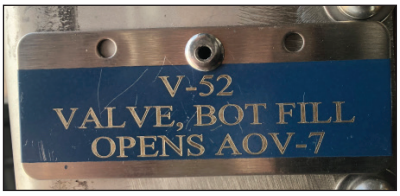
This is the view of the Orca VHP Series delivery system cabinet. This section will discuss in detail the plumbing cabinet components and systems.

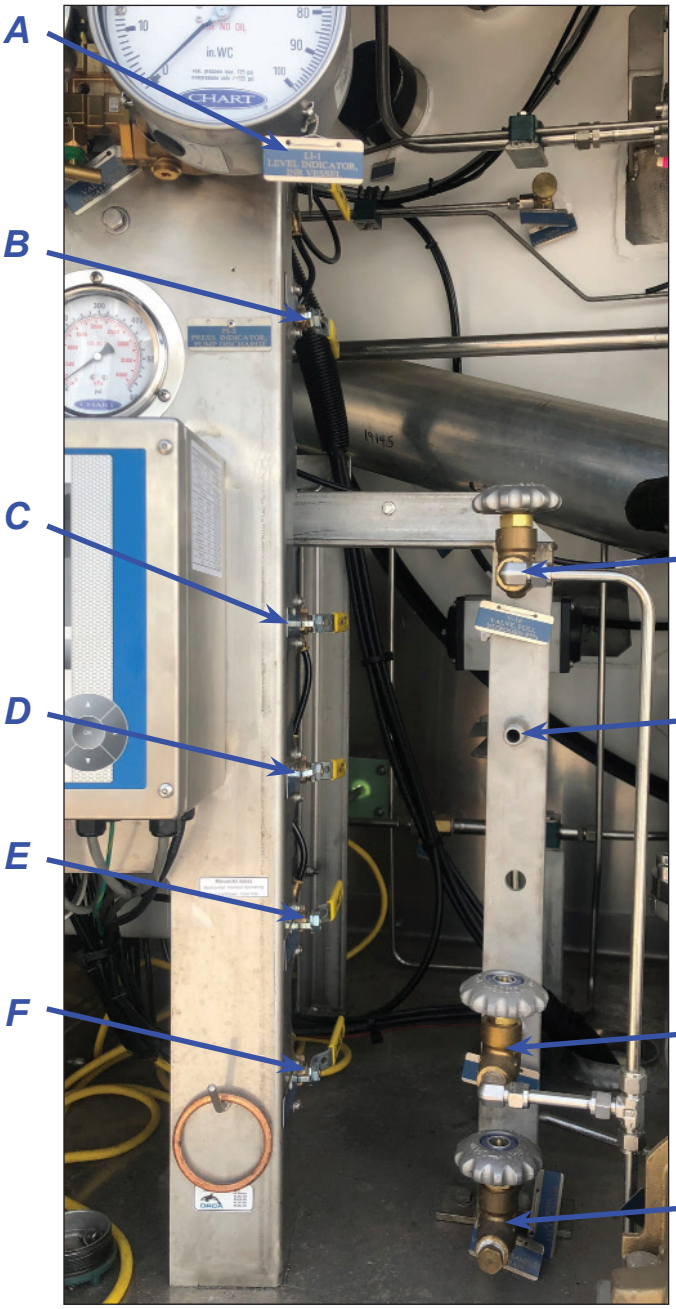
Plumbing Cabinet - Roadside



Item	Tag	Description
A	V-11	Valve, LI-1 Vapor Phase
B	V-12	Valve, LI-1 Liquid Phase
C	V-10	Valve, LI-1 Equalization
D	-	Work Lights Switch
E	-	Air Bag Valve
F	-	Flowcom
G	-	Pendant
H	-	Potentiometer
I	-	Start Button
J	-	Stop Button
K	-	E-Stop, Electrical
L	PT-1	Pressure Transmitter, Inner Vessel
M	LI-1	Level Indicator, Inner Vessel
N	PI-2	Pressure Indicator, Pump Discharge

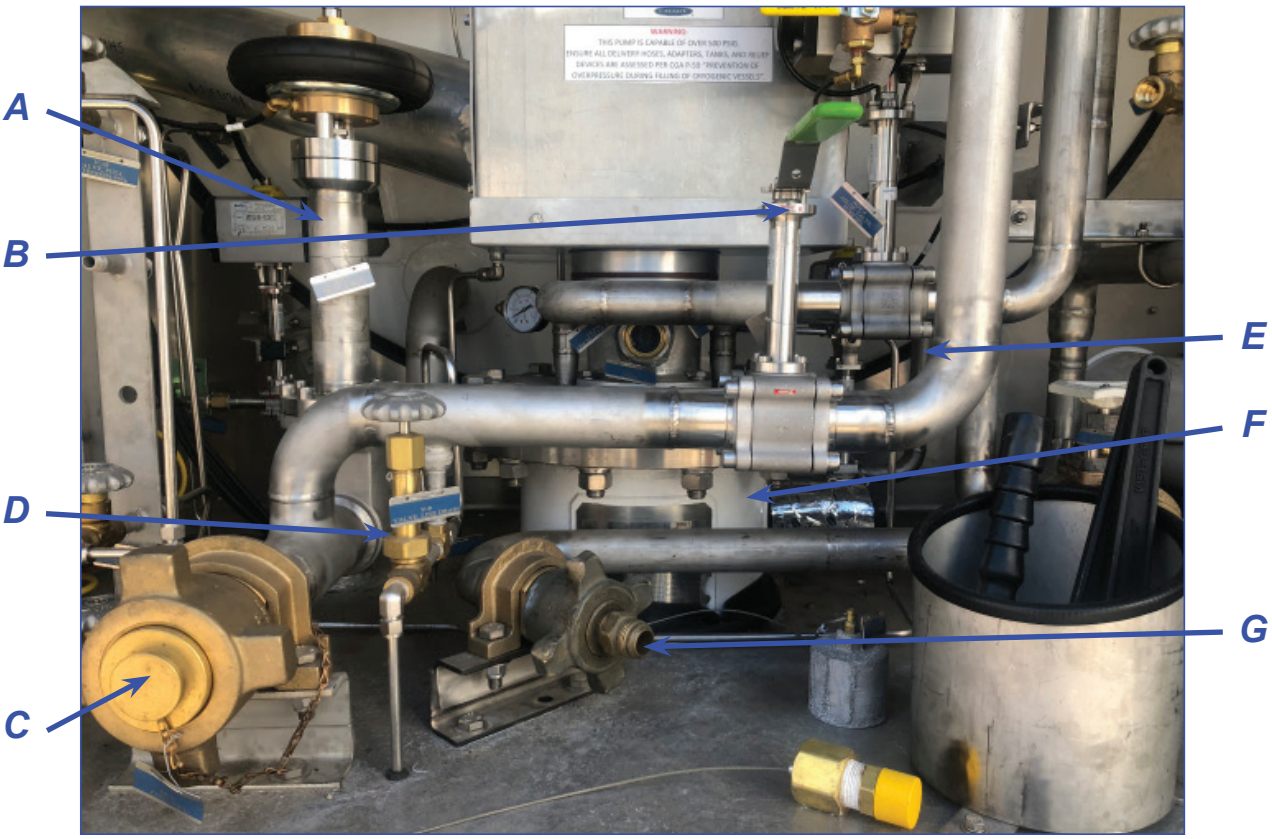
Plumbing Cabinet - Valve Tags

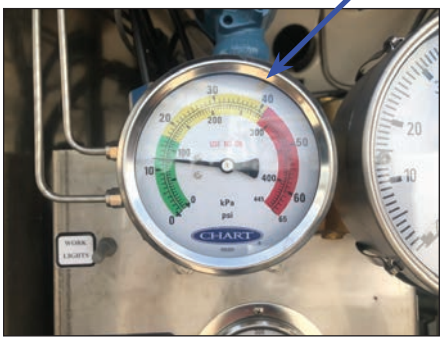




Item	Tag	Description
A	V-55	Sump Return Air, Opens AOV
B	V-54	Force Feed Air, Opens AOV
C	V-53	Recirculation Air, Closed AOV
D	V-52	Bottom Fill Air, Opens AOV
E	V-51	Sump/Pump Isolation, Opens AOV
F	V-50	Dispense Air, Opens AOV
G	V-18	Full Nitrogen 95%
H	V-19	Full Nitrogren 90%
I	V-20	Full Argon
J	V-23	Liquid Sample/Sump Drain

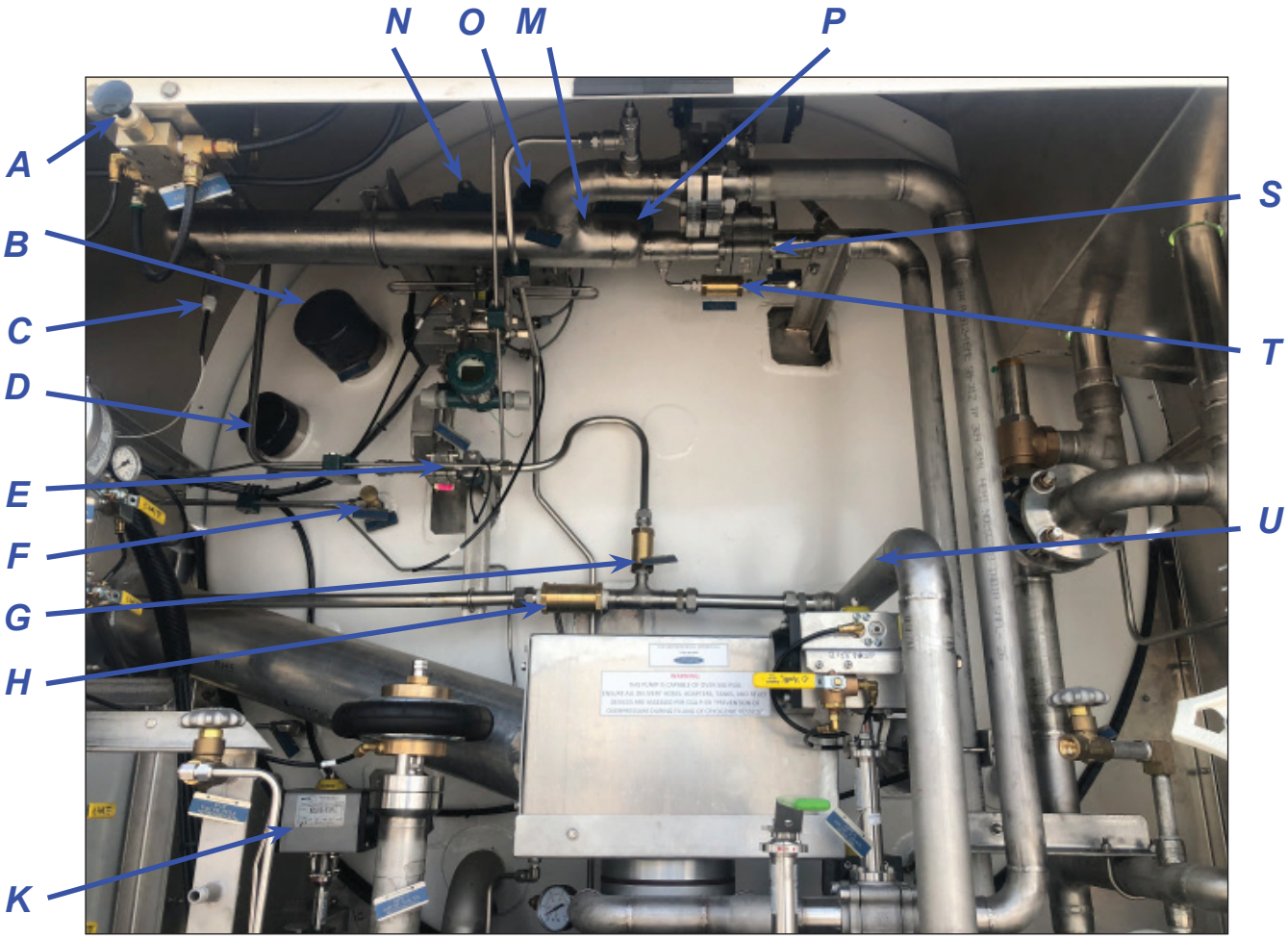
Plumbing Cabinet - Bottom Center





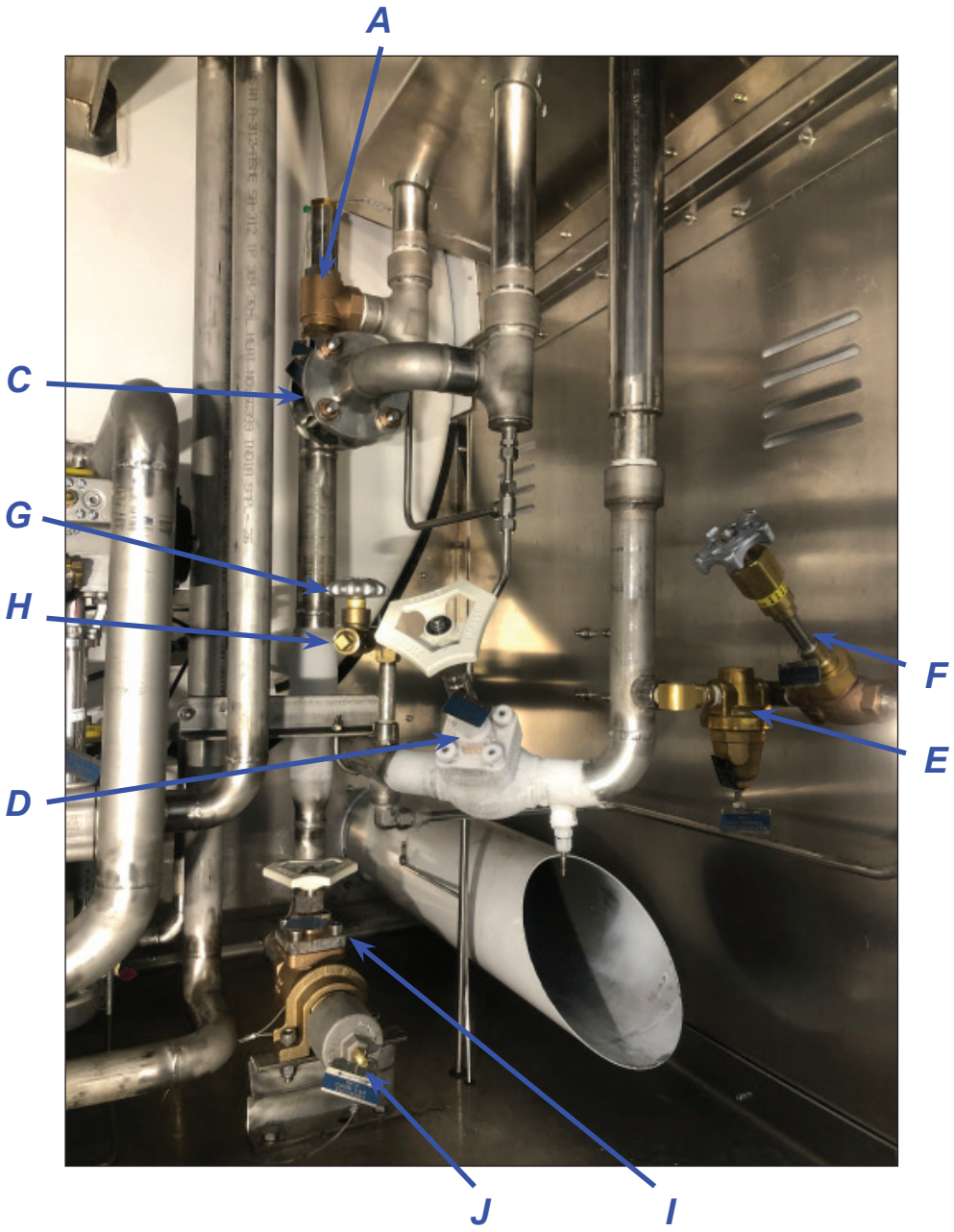
Item	Tag	Description
A	AOV-7	Air Operated Valve, Bottom Fill
B	V-3	Valve, Top Fill
C	DC-2	Connection, Fill
D	V-9	Valve, Line Drain
E	AOV-6	Air Operated Valve, Sump Vapor Return
F	P-1	Pump (In Sump)
G	DC-1	Connection, Dispense
H	PI-3	Pressure Indicator, Inner Vessel
I	V-14	Valve, Vapor Phase

Plumbing Cabinet - Top Center



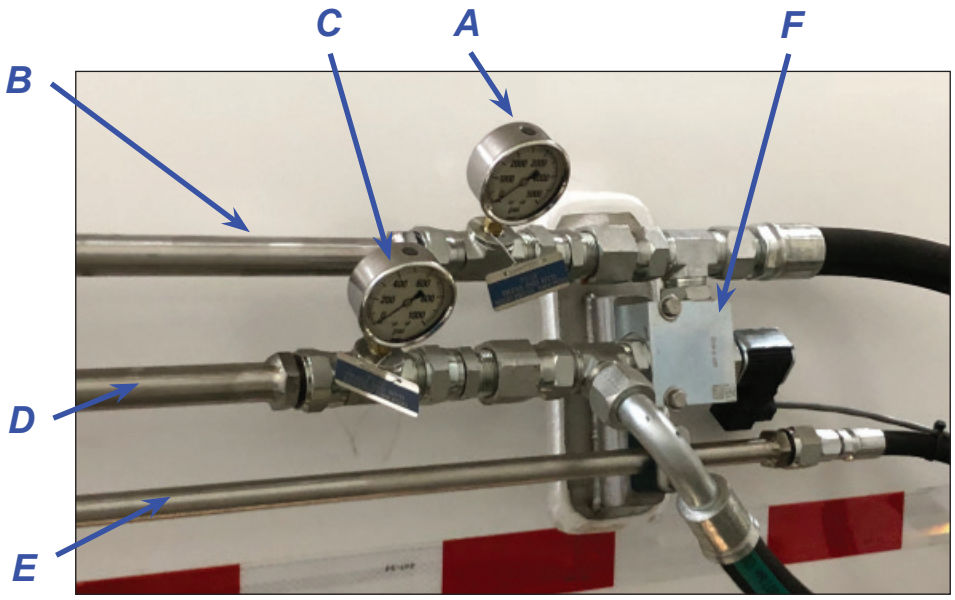
Item	Tag	Description
A	AI-1	Air Interlock, Anti-Tow
B	PSE-3	Pressure Safety Element, Outer Vessel
C	RTD-1	Resistance Temperature Device
D	VP-1	Vacuum Port, Outer Vessel
E	AOV-2	Air Operated Valve, Recirculation
F	V-31	Valve, Vapor Phase
G	CV-7	Check Valve, Recirculation
H	CV-2	Check Valve, Pressure Build
I	AOV-4	Air Operated Valve, Sump/Pump Isolation
J	V-32	Valve, Liquid Phase
K	AOV-3	Air Operated Valve, Force Feed
L	OR-1	Orifice, Force Feed Pressure Build
M	M-1	Meter
N	DP-1	Transmitter, Differential Pressure Low Flow
O	DP-2	Transmitter, Differential Pressure High Flow
P	PT-2	Pressure Transmitter, Pump Discharge
Q	V-57	Sump/Pump Isolation Dump
R	V-58	Sump/Pump Isolation Dump
S	AOV-1	Air Operated Valve, Dispense
T	CV-4	Check Valve, Dispense
U	AOV-5	Air Operated Valve, Sump/Pump Isolation

Plumbing Cabinet - Curb Side



Item	Tag	Description
A	SV-1	Safety Valve, Inner Vessel
B	SV-2	Safety Valve, Inner Vessel
C	PSE-1	Pressure Safety Element, Inner Vessel
D	V-5	Valve, Vapor Vent
E	PCV-1	Pressure Control Valve, Regulator
F	V-2	Valve, Pressure Control
G	V-24	Valve, Vapor Sample
H	DC-5	Connection, Vapor Sample
I	V-44	Valve, Vapor Recover
J	DC-3	Connection, Vapor Recovery

Plumbing Cabinet - Other Piping



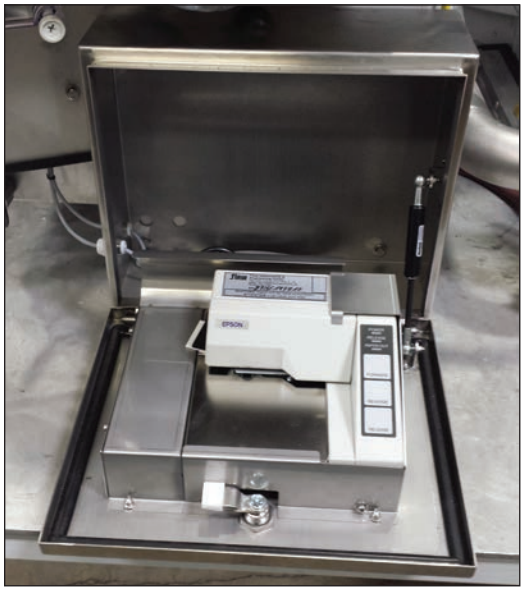
Item	*Description*
A	Gauge, High Pressure
B	High Pressure to Motor
C	Gauge, Return
D	Return from Motor
E	Case Drain from Motor
F	Hydraulic Bypass Valve

Cabinet Components

Anti-Tow Valve

Located at the top of the piping cabinet, the Anti-Tow Valve is pneumatically connected to the air brakes and can only be released when the Plumbing Cabinet Doors are closed. The plumbing cabinet doors can only be closed when the delivery hoses are stowed back in the storage tubes.

Ticket Printer



Bluetooth Printing

Bluetooth printing is available via kit part number 21244207. For more information, see the following documents:

- FLOW_BTP-II - V2_0
- PR8000-V1_0-EN-PRINTER_ COMPATIBILITY_DATA_COMMUNICATION

Metering System

The metering system provides an accurate and calibrated means for measuring the amount of product dispensed from the Orca tank to the customer. The system is made up of five components: the Meter Section, two Differential Pressure Transmitters, Resistance Temperature Device and the Flowcom® Flow Meter System.

Meter Section

The Orca system incorporates an Orifice type meter section, which unlike turbine meters, has no moving parts to wear out or be damaged by gas. This unique feature makes the meter section a low maintenance item. As the liquid flows to the tapered orifice, a high pressure zone is created. Once the liquid flows through this restriction and reaches the larger “back side” of the restricted orifice, a drop in pressure occurs. This difference of pressure is the beginning of how product is metered. A 1/4” (6mm) line is plumbed into each side of the meter section. These two lines are then plumbed to the Differential Pressure Transmitters which make this differential pressure an electronic signal.

Differential Pressure Transmitter (DP Transmitter)

These are Rosemount Pre-Set Differential Pressure Transmitters used on the Orca system. They are connected to the meter section and the Flowcom meter system. The DP transmitters measure a change in pressure (pressure drop) across the meter section and relay this information to the Flowcom meter system in a 4-20 milliamp signal.

RTD - Resistance Temperature Device

The resistance temperature device (RTD) is located upstream of the meter. The probe is threaded into a port so it can accurately measure the temperature of the liquid. The resistance of the element at the end of the probe varies with temperature. The RTD is used to measure accurately the temperature of the liquid being metered. Based on this temperature, a density is assigned.

Hose Drain Check Valve

Following a delivery, the hose drain check valve allows a path for product left in the dispense hose to return to the sump. This valve closes when the pump starts and pressurizes the delivery system. It opens after the pump is shut down and the pressure in the dispense hose increases due to warming and vaporizing of the liquid in the dispense hose.

Flowcom Flow Meter System

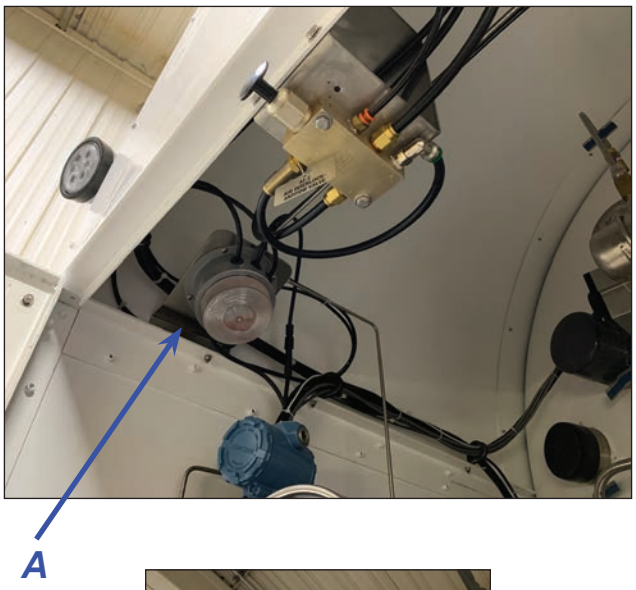
The Flowcom® Flow Meter System is used for calculating, integrating, system controlling, and displaying the mass flow. The push button controls allow the operator to start and stop the delivery, to view information, initiate the print out of the delivery ticket and to clear the total.

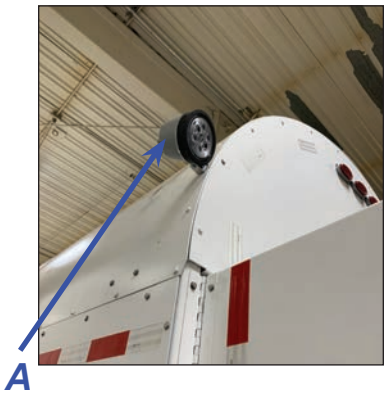
Note: *If programming assistance is required, refer to Flowcom manual or contact a technical service representative at Chart Inc. at 1.800.400.4683.*

Note: *See the Flowcom manuals for preference changes such as date, time, units of measure, printing options, password settings, etc.*

Work Lights

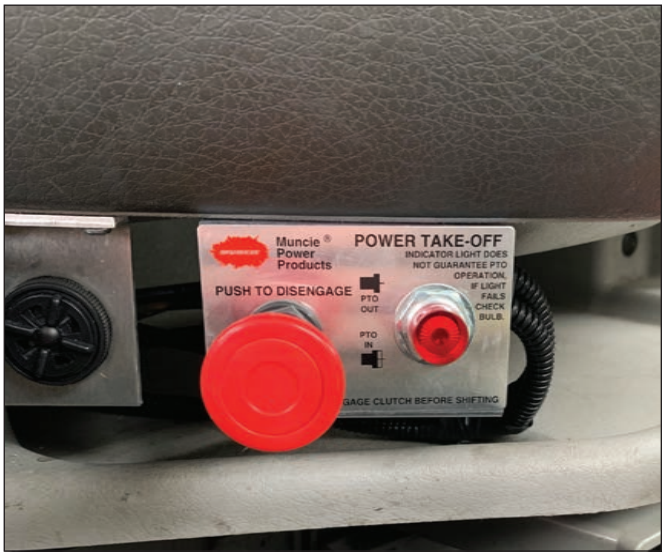
Three LED work lights are located on the back of the Orca. The dome light in the cabinet has a switch (A) that powers all three. The dome light also acts as a junction box for 12-volt power into the cabinet.





Power Take-Off

PTO engagement: Below is a typical power take-off engagement switch with warning light and chime.



Note: *The engine RPM set speed will vary based on transmission and PTO ratios, likely between 1300-1600 RPM. It is important that the PTO output speed is 2300-2400 RPM for proper hydraulic pump operation.*

Hydraulic System - Truck

Power Take-Off is connected to hydraulic pump. Ensure reservoir is filled to proper height. Filter is located in the reservoir.

Hydraulic System cont.

The electrical junction box contains a relay that provides cabinet power when the key is in the “On” or “ACC” position. A 20 amp breaker protects the circuit.

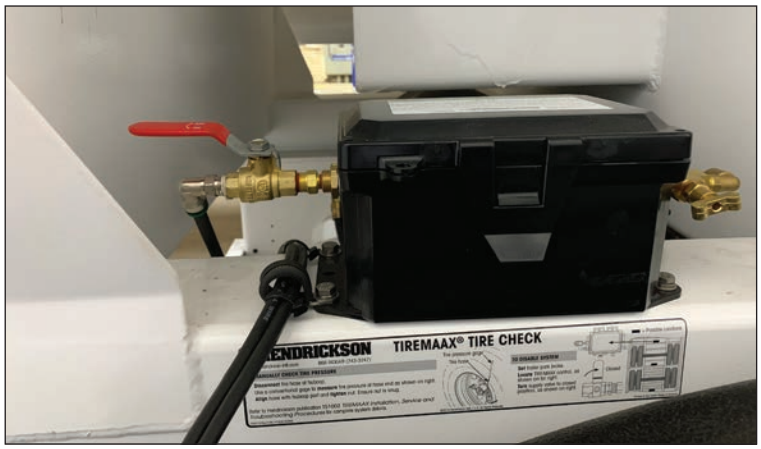
See OEM manuals for further information.

Gladhand and trailer electrical connection. This does NOT provide plumbing cabinet electrical or pneumatic power. Both air lines have filters that should be serviced based on manufacturer recommendations.

Safety Equipment

Safety cones (B) may be located anywhere on the truck frame. Wheel chocks (C) and safety flares (D) are located in a toolbox (E) if equipped or in a separate holder or in the cab.

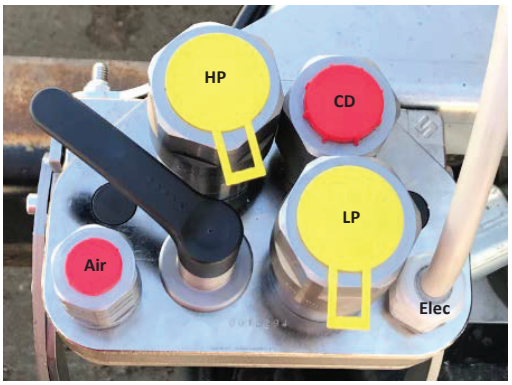
The fire extinguisher (F) is located road side of the cabinet. Two pneumatic E-Stops (A) are located on each side of the Orca, one at the front road side and the other at the rear curb side.

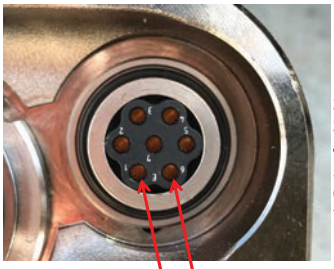


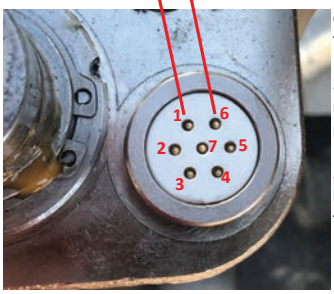
STUCCHI HYDRAULIC CONN. COMPONENTS - ST Trailer Connections

Note: These same circuits exist on the HL-Truck and HL-Trailer versions, they just do not utilize a Stucchi disconnecting device.

Air: Pneumatic Supply
HP: High Pressure to Motor
LP: Low Pressure Return
CD: Case Drain from Motor
Elec: Electrical, 12VDC Supply and Pump Control







1: Pump Control
2: Pump Control
3: B+
4: B+
5: B-
6: B-
7: Not Used

1&2: Connect to 14 AWG cable to valve driver card terminals in panel, no polarity

3&4: solder and heat shrink to red 6 AWG wire connected to power terminal in panel

5&6: solder and hear shrink to black 6 AWG wire connected to ground terminal in panel

1 & 2: Solenoid Coil Resistance

3 & 5: B+ to B-

4 & 6: B+ to B-

Flowcom Overview

This is a brief overview of the Orca VHP Flowcom Delivery screen. Reference the Flowcom manual for full details.

Prior to entering the Delivery screen, a maximum discharge pressure must be entered. Range is 145 psig to 537 psig.

Item	Description	Item	Description
A	Current Time	J	Total Delivered
B	% of Maximum Flow Rate	K	Delivered Units
C	Current Flow Rate	L	Product Delivered
D	Product Density	M	Meter Differential Pressure
E	Pump Pressure	N	Product Temperature at Meter
F	Vessel Pressure	O	Vessel Subcool
G	Saturation Pressure	P	Potentiometer Commanded Speed
H	Stop Indication Line	Q	Flowcom Commanded Speed
I	Current Date	R	Actual Speed

Preventive Maintenance

General

This section contains maintenance information. 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 controls and indicators discussed in other sections. 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 a fill routine, observations during and after a fill, and from improper performance of components. Proper and immediate action to correct any damage or malfunction is advised.

Persons making repairs to piping, valves, and gauges must be familiar with cleanliness requirements for components used in nitrogen, oxygen, argon or carbon dioxide service.

Note: During first-ever load, it's recommended to check mounting hardward once loaded.

Daily Observation Checks by Operator

Beginning of the Day Checks

1. Observe pressure in tank, pressure should not rise much in tank without the delivery systems operating (5-8 psi is typical).
2. Ensure safety reliefs are not leaking (frost on safety vent pipes is an indicator of a leak).
3. If ice forms around valves, ensure the valves are fully operational. If not, defrost with water.
4. Check for loose hardware, hydraulic oil leaks, glycol system leaks, and in general, items out of place.

During PTO (Power Take Off) Operation

1. Verify engine speed meets desired speed based on PTO type.
2. Check that there is no vibration from PTO driveline.

Caution: *If there is any vibration, the unit must be reviewed by a mechanic prior to making another delivery. Major damage may occur to equipment.*

During Deliveries

1. Review all plumbing and PB for any possible leaks.
2. Valves should open and close freely.
3. Check for pump noise or lack of building pressure.

Note: *If loud grinding noise is observed, contact Chart for proper diagnosis.*

4. Check that printer is operational (if equipped).
5. Check that the Flowcom® Flow Meter System has correct units, service, product type and no fault codes (this should not change, but could if service work has been performed).

Weekly Preventive Maintenance

Plumbing Inspection

1. Check that valves and piping are not leaking.
2. Tighten nuts, bolts, seals and gaskets.

Note: *Ice balls may be a sign of a possible issue.*

Power Take Off & Hydraulic System Inspection

1. Check hydraulic oil level.Top off with ECOSafe FR-46 oil as needed.
2. Ensure that transmission has no leaks around PTO housing.
3. Run PTO, ensure a smooth engagement (no grinding/clunking).
4. Inspect hydraulic lines for leaks or damage.

Every Three Months Preventive Maintenance

Electrical Connection Inspection (12v)

1. Check voltage at the batteries.
2. Check voltage at the relay box.
3. Check voltage in the control panel
4. Check electrical connections at the Flowcom® Flow Meter System and electrical control box.

Every Six Months Preventive Maintenance

Tank-to-Frame Mounting Hardware

1. Bolts/nuts present and torqued.

Note: *Check within first month of use. If nuts continue to loosen replace the set. After 5-7 years, it is recommended to replace washer set and nuts.*

2. **HL Series Truck:** Spring "Belleville" washers are present forward of the rear suspension mounting
   - **HL Series Truck & Trailer:** Spring washers not cracked or deteriorated.
3. Inspect all hardware and replace or tighten as needed.
4. Torque all PTO housing bolts (connection from PTO to transmission)

Note: See original equipment manufacturer (OEM) for maintenance and torque requirements.

5. Change hydraulic system filters

Yearly Preventive Maintenance

1. Ensure proper service in all programmable settings.
2. Drain the air tank(s) every year before the winter months.
3. Perform a DOT inspection.
4. Test anti-tow system.
5. Get on-site meter calibration verification.
6. Change hydraulic system filters and oil
7. Torque all PTO housing bolts (connection form PTO to transmission).

Note: *See original equpment manufacturer (OEM) for maintenance and torque requirements.*

8. Inspect line safety and main tank relief valves. Replace if leaking.

Every Five Years Preventive Maintenance

1. Replace main tank safety relief valves.
2. Replace line safety valves.

Vacuum Integrity Check (as required)

Since all transport 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 build-up. 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.

Preventive Maintenance Log

Date	Preventive Maintenance Performed	Notes

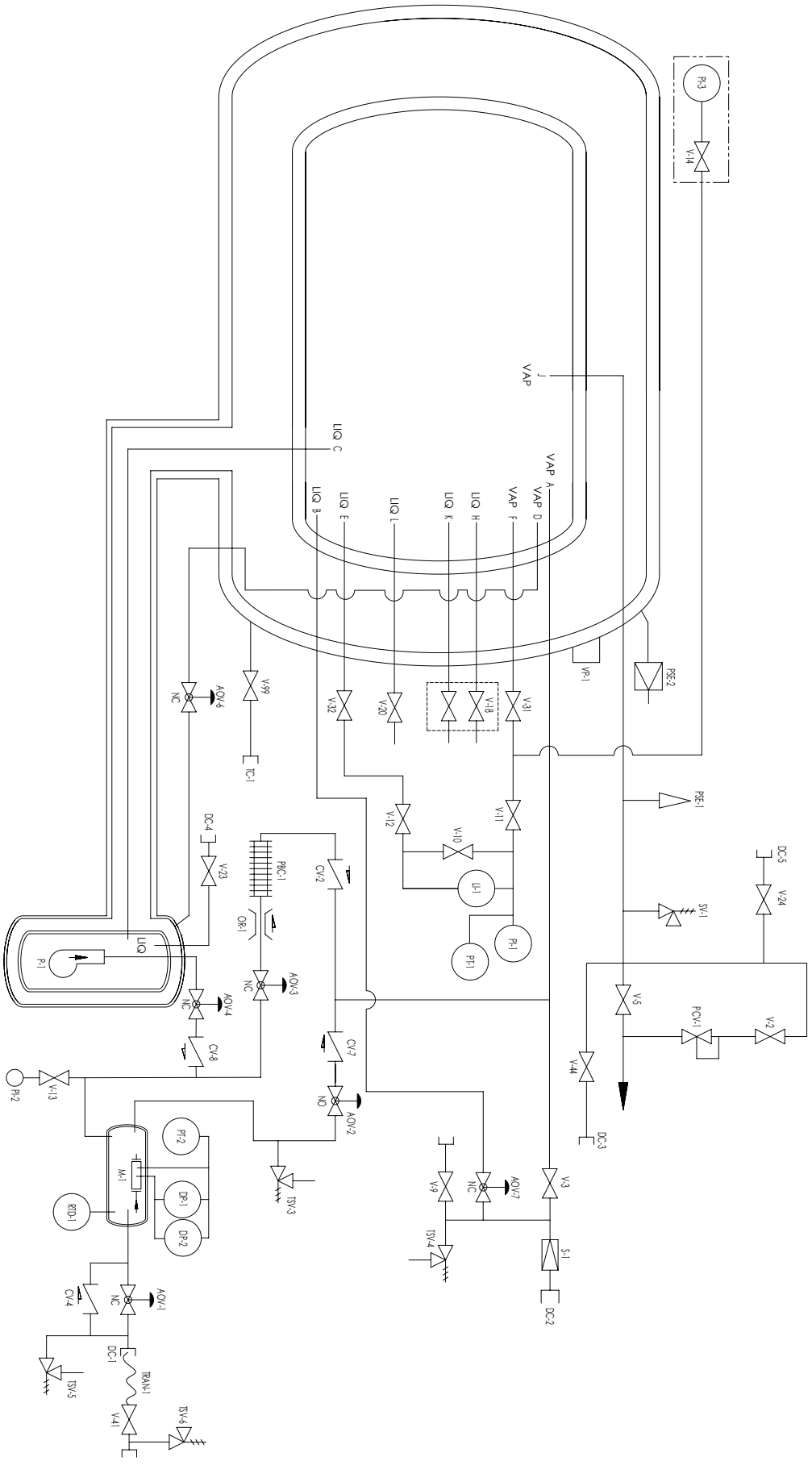
Date	Preventive Maintenance Performed	Notes

Specifications

Model	*ST-7200*	*HL-3500*
Type	Trailer	Truck
Real Axle	Tandem	Tandem
Over 33,000# FET	Yes	Yes
Design Codes	ASME, MC-338, CGA-341	ASME, CGA-341
Flow Meter Type	Flowcom® Flow Meter System	Flowcom® Flow Meter System
Pressure Build Type	Pump force-feed, Auto-Subcool	Pump force-feed, Auto-Subcool
Specifications		
Gross Capacity (gal/L)	7220 / 27,331	3550 / 13,438
Capacity* ** - CGA-341 (gal/L)	6800 / 25,741	3380 / 12,795
Capacity** - MC338 (gal/L)	6350 / 24,037	-
MAWP psig/bar	50 / 3.4	50 / 3.4
Overall Length (in/cm)	504 / 1280	277 / 704
Overall Height (in/cm)	135 / 343	87 / 221
Overall Width (in/cm)	102 / 259	85 / 216
Tank Diameter (in/cm)	80 / 203	80 / 203
Tare Weight (lbs/kg)	19,000 / 8618	8370 / 3797
Performance		
Pump Drive Technology	Hydraulic, Magnetic Coupling	Hydraulic, Magnetic Coupling
Pump	Submerged VHP	Submerged VHP
Min Dispense Rate* (gpm/lpm)	20 / 76	20 / 76
Max Dispense Rate* (gpm/lpm)	160 / 606	160 / 606
Max Dispense Pressure (psig/barg)	525 / 36.2	525 / 36.2
Max Receiving Tank Pressure (psig/barg)	475 / 32.7	475 / 32.7

**** Min and Max Dispense Rates are based on NTEP approval and dependant on many variables: Orca pressure, receiving vessel pressure, liquid temperature, flow circuit restriction, etc.***
*****Tare weights are estimated***

Piping Schematic



REV	APPV	ECR	DESCRIPTION	BY	DATE
A		25464	EDITED TABLES TO INCLUDE V-57 & 58	PMK	08/10/2021
B		26823	ADDED CV-8	PMK	01/25/2022

Material Required

SEE BOM UNLESS OTHERWISE STATED

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	APPROVED	DATE
DRAWN	EF	7/30/2020
ENGR	GS	8/06/2020
PROJ. MGR.	JG	8/06/2020

DESIGN CRITERIA
NOTE REFERENCE
PROJECTION
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES.
TOLERANCES:
FRACTIONS ± 1/64
ANGLES ± 1°
2 PLACE DECIMALS ± 0.03
3 PLACE DECIMALS ± 0.015

CHART

Chart Inc.
Distribution & Storage

TITLE
P&ID ORCA VHP LIN/LAR

DRAWING NUMBER D-21544835 REV B

SCALE 1:96 SIZE D SHEET 1 OF 4

Nomenclature

TAG#	DESCRIPTION	CHART PN
AOV-1	AIR OP. VALVE, DISPENSE	21526183
AOV-2	AIR OP. VALVE, RECIRCULATION	21526184
AOV-3	AIR OP. VALVE, FORCE FEED PRESSURE BUILD	21526185
AOV-4	AIR OP. VALVE, SUMP/ PUMP ISOLATION	21526183
AOV-6	AIR OP. VALVE, SUMP VAPOR RETURN	21526186
AOV-7	AIR OP. VALVE, BOTTOM FILL	21505164
CV-2	CHECK VALVE, PBC-1 OUTLET	11051090
CV-4	CHECK VALVE, DISPENSE	11051090
CV-7	CHECK VALVE, RECIRCULATION	20896229
CV-8	CHECK VALVE, PUMP OUTPUT	21554053
DC-4	CONN. LIQ. SAMPLE/SUMP DRAIN	N/A
DC-5	CONN. VAPOR SAMPLE	N/A
DP-1	DIFF. PRESS. TRANSMITTER, LOW FLOW	21352346
DP-2	DIFF. PRESS. TRANSMITTER, HIGH FLOW	21352345
LI-1	LEVEL INDICATOR, INNER VESSEL	21535070
M-1	METER, DISPENSE	21367527
OR-1	ORIFICE, FORCE FEED PRESSURE BUILD	21496490
PCV-1	PRESS. CONTROL VALVE, REGULATOR	1720412
P-1	PUMP	21436868
PBC-1	PRESS. BUILDING COIL	21386019
PI-1	PRESS. INDICATOR, INR VESSEL	20890787
PI-2	PRESS. INDICATOR, PUMP DISCHARGE	20860869
PSE-1	PRESS. SAFETY ELEMENT, INR VESSEL	21544481
PSE-2	PRESS. SAFETY ELEMENT, OTR VESSEL	10899110
PT-1	PRESS. TRANSMITTER, INNER VESSEL	21070134
PT-2	PRESS. TRANSMITTER, PUMP DISCHARGE	21352375
RTD-1	RESISTANCE TEMPERATURE DEVICE	FL1145110
S-1	STRAINER, FILL	20898282
SV-1	SAFETY VALVE, INR VESSEL	21540900
TC-1	THERMOCOUPLE, VACUUM	4210049
TSV-3	THERMAL SAFETY VALVE, PUMP DISCHARGE	11505995
TSV-4	THERMAL SAFETY VALVE, FILL	1810802
TSV-5	THERMAL SAFETY VALVE, DISPENSE	11505995
V-2	VALVE, PRESSURE CONTROL	1718802
V-3	VALVE, TOP FILL	21526187
V-5	VALVE, VAPOR VENT	13410261
V-9	VALVE, LINE DRAIN	11677367
V-10	VALVE, LI-1 EQUALIZATION	20890787
V-11	VALVE, LI-1 VAP PHASE	20890787
V-12	VALVE, LI-1 LIQ PHASE	20890787
V-13	VALVE, PI-2	11701435
V-18	VALVE, FULL NITROGEN 95%	1713202
V-20	VALVE, FULL ARGON	1713202
V-23	VALVE, LIQ. SAMPLE/SUMP DRAIN	1713202
V-24	VALVE, VAPOR SAMPLE	10502848
V-31	VALVE, VAPOR PHASE	10907239
V-32	VALVE, LIQUID PHASE	10907239
V-99	VALVE, TC-1	11671045
VP-1	VACUUM PORT, OUTER VESSEL	10826172

PNEUMATIC AND HYDRAULIC VALVES		
AI-1	AIR INTERLOCK/ANTI-TOW	20626286
ASF-1	AIR SUPPLY FILTER	21194902
P1-4	PRESS. INDICATOR, CABINET AIR	20937291
PI-10	PRESS. INDICATOR HYD. HIGH PRESS. 5000 PSIG	21577273
PI-11	PRESS. INDICATOR HYD. RETURN 1000 PSIG	21577274
V-50	VALVE, DISPENSE; OPENS AOV-1	11809868
V-51	VALVE, SUMP/PUMP ISOLATION; OPENS AOV-4	11809868
V-52	VALVE, BOTTOM FILL; OPENS AOV-7	11809868
V-53	VALVE, PUMP RECIRCULATION; CLOSES AOV-2	11809868
V-54	VALVE, FORCE FEED PB; OPENS AOV-3	11809868
V-55	VALVE, SUMP VAPOR RETURN; OPENS AOV-6	11809868
V-56	VALVE, SUMP/PUMP ISOLATION; CLOSES AOV-4	11809868
V-57	VALVE, AIR BAG DUMP	11917674
V-58	VALVE, ANTITOW LOCK	11917674
V-60	VALVE, EMERGENCY STOP FRONT	21011772
V-61	VALVE, EMERGENCY STOP REAR	21011772
V-70	VALVE, HYDRAULIC BYPASS	21381443

DASHED LINES INDICATE OPTIONAL COMPONENTS		
P1-3	PRESSURE INDICATOR INNER VESSEL	20860869
V-14	VALVE, VAPOR PHASE	11701435

ACCESSORY ITEMS		
DC-1	CONN. DISPENSE, 1-1/2" CGA NITROGEN	10891417
DC-1	CONN. DISPENSE, 1-1/2" CGA ARGON	10584011
DC-2	CONN. FILL, 2-1/2" CGA NITROGEN	10858668
DC-2	CONN. FILL, 2-1/2" CGA ARGON	10858650
DC-3	CONN. VAPOR RECOVERY, 1-1/2" CGA NITROGEN	10891417
DC-3	CONN. VAPOR RECOVERY, 1-1/2" CGA ARGON	10584011
TRAN-1	HOSE, TRANSFER, 1-1/2" BULK	21494890
TRAN-1	HOSE, TRANSFER, 1" MICROBULK	21673735
TSV-6	THERMAL SAFETY VALVE, DISPENSE CONN. (MICROBULK ONLY)	13618395
V-41	VALVE, DISPENSE BULK	21437064
V-41	VALVE, DISPENSE MICROBULK	11007881
V-44	VALVE, VAPOR RECOVERY	20937308
N/A	BULK HOSE AY NITROGEN	21494888
N/A	BULK HOSE AY ARGON	21560355
N/A	MICROBULK HOSE AY NITROGEN 1/2" CONNECTION	21490913
N/A	MICROBULK HOSE AY ARGON 1/2" CONNECTION	21560356
N/A	MICROBULK HOSE AY ARGON 3/4" CONNECTION	21577166

INTERNAL LINE SIZES		
A	TOP FILL	2" PS
B	BOTTOM FILL	2-1/2" PS
C	PUMP FEED	3" PS
D	SUMP VAPOR RETURN	1" PS
E	LIQUID PHASE	1/4" ODT
F	GAS PHASE	1/4" ODT
H	FULL NITROGEN 95%	1/2" ODT
J	VENT	2" PS
K	FULL NITROGEN 90%	1/2" ODT
L	FULL ARGON	1/2" ODT

Liquid Level Charts

NITROGEN @ 0 PSIG SATURATION PRESSURE - ST-7200						
Level	Volume		Weight		Gas Volume	
Inches W.C.	Gallons	Liters	Pounds	Kilograms	Cubic Feet	Cubic Meters
0.3	**0**	0	**240**	109	**3,307**	87
2	**64**	242	**666**	302	**9,192**	242
4	**195**	738	**1,543**	700	**21,299**	560
6	**365**	1,382	**2,684**	1,217	**37,053**	974
8	**566**	2,143	**4,027**	1,827	**55,582**	1,461
10	**790**	2,990	**5,532**	2,509	**76,358**	2,007
12	**1035**	3,918	**7,172**	3,253	**98,999**	2,602
14	**1297**	4,910	**8,926**	4,049	**123,204**	3,239
16	**1573**	5,954	**10,775**	4,887	**148,723**	3,909
18	**1861**	7,045	**12,703**	5,762	**175,336**	4,609
20	**2,159**	8,173	**14,696**	6,666	**202,847**	5,332
22	**2,464**	9,327	**16,742**	7,594	**231,077**	6,074
24	**2,775**	10,505	**18,827**	8,540	**259,857**	6,831
26	**3,091**	11,701	**20,940**	9,498	**289,027**	7,598
28	**3,409**	12,904	**23,070**	10,464	**318,431**	8,370
30	**3,728**	14,112	**25,207**	11,434	**347,916**	9,146
32	**4,046**	15,316	**27,338**	12,400	**377,332**	9,919
34	**4,362**	16,512	**29,453**	13,360	**406,527**	10,686
36	**4,674**	17,693	**31,541**	14,307	**435,344**	11,444
38	**4,980**	18,851	**33,590**	15,236	**463,625**	12,187
40	**5,278**	19,979	**35,588**	16,142	**491,201**	12,912
42	**5,567**	21,073	**37,521**	17,019	**517,893**	13,614
44	**5,844**	22,122	**39,377**	17,861	**543,508**	14,287
46	**6,107**	23,118	**41,139**	18,660	**567,828**	14,926
47.9 (89%)	**6,346**	24,022	**42,739**	19,386	**589,915**	15,507
48	**6,354**	24,053	**42,789**	19,409	**590,606**	15,525
50	**6,580**	24,908	**44,306**	20,097	**611,545**	16,075
52	**6,783**	25,676	**45,663**	20,712	**630,273**	16,568
52.2 (95%)	**6,804**	25,756	**45,807**	20,778	**632,258**	16,620
54	**6,956**	26,331	**46,823**	21,239	**646,276**	16,988
56	**7,091**	26,842	**47,725**	21,648	**658,727**	17,316
58	**7,163**	27,115	**48,210**	21,868	**665,421**	17,492

NITROGEN @ 15 PSIG SATURATION PRESSURE - ST-7200						
Level	Volume		Weight		Gas Volume	
Inches W.C.	Gallons	Liters	Pounds	Kilograms	Cubic Feet	Cubic Meters
0.6	**0**	0	**531**	241	**7,326**	193
2	**54**	204	**876**	397	**12,085**	318
4	**186**	704	**1,728**	784	**23,848**	627
6	**362**	1,370	**2,861**	1,298	**39,487**	1,038
8	**571**	2,161	**4,204**	1,907	**58,029**	1,525
10	**806**	3,051	**5,716**	2,593	**78,899**	2,074
12	**1063**	4,024	**7,367**	3,342	**101,688**	2,673
14	**1338**	5,065	**9,134**	4,143	**126,076**	3,314
16	**1627**	6,159	**10,998**	4,989	**151,795**	3,990
18	**1930**	7,306	**12,941**	5,870	**178,614**	4,695
20	**2,242**	8,487	**14,948**	6,780	**206,323**	5,424
22	**2,562**	9,698	**17,006**	7,714	**234,732**	6,170
24	**2,888**	10,932	**19,102**	8,665	**263,660**	6,931
26	**3,217**	12,178	**21,223**	9,627	**292,935**	7,700
28	**3,549**	13,434	**23,357**	10,595	**322,391**	8,475
30	**3,881**	14,691	**25,492**	11,563	**351,863**	9,249
32	**4,212**	15,944	**27,617**	12,527	**381,187**	10,020
34	**4,538**	17,178	**29,719**	13,480	**410,196**	10,783
36	**4,860**	18,397	**31,785**	14,417	**438,719**	11,532
38	**5,174**	19,586	**33,804**	15,333	**466,579**	12,265
40	**5,478**	20,736	**35,760**	16,220	**493,587**	12,975
42	**5,770**	21,842	**37,640**	17,073	**519,537**	13,657
44	**6,048**	22,894	**39,428**	17,884	**544,203**	14,305
46	**6,308**	23,878	**41,103**	18,644	**567,326**	14,913
46.3 (89%)	**6,346**	24,022	**41,346**	18,754	**570,679**	15,001
48	**6,548**	24,787	**42,644**	19,343	**588,598**	15,472
50	**6,762**	25,597	**44,023**	19,968	**607,631**	15,973
50.4 (95%)	**6,804**	25,756	**44,292**	20,091	**611,343**	16,070
52	**6,946**	26,293	**45,201**	20,503	**623,892**	16,400
54	**7,088**	26,831	**46,116**	20,918	**636,523**	16,732
56	**7,163**	27,115	**46,599**	21,137	**643,191**	16,907

NITROGEN @ 0 PSIG SATURATION PRESSUER - HL-3500 VHP						
Level	Voume		Weight		Gas Volume	
Inches W.C.	Gallons	Liters	Pounds	Kilograms	Cubic Feet	Cubic Meters
0	0	0.0	0	0.0	0	0.0
0.3	0	0.0	119	54.0	1,636	46.3
2	29	109.8	315	142.9	4,354	123.3
4	91	344.5	727	329.8	10,041	284.3
6	172	651.1	1,269	575.6	17,520	496.1
8	268	1014.5	1,912	867.3	26,384	747.1
10	376	1423.3	2,636	1195.7	36,386	1030.3
12	494	1870.0	3,430	1555.8	47,340	1340.5
14	622	2354.5	4,282	1942.3	59,102	1673.6
16	756	2861.8	5,184	2351.4	71,546	2026.0
18	897	3395.5	6,127	2779.1	84,565	2394.6
20	1,043	3948.2	7,104	3222.3	98,058	2776.7
22	1,193	4516.0	8,110	3678.6	111,936	3169.7
24	1,347	5098.9	9,137	4144.5	126,110	3571.1
26	1,502	5685.7	10,179	4617.1	140,500	3978.5
28	1,659	6280.0	11,231	5094.3	155,024	4389.8
30	1,817	6878.1	12,288	5573.7	169,604	4802.7
32	1,975	7476.2	13,343	6052.3	184,162	5214.9
34	2,131	8066.7	14,390	6527.2	198,619	5624.3
36	2,286	8653.4	15,424	6996.2	212,897	6028.6
38	2,437	9225.0	16,440	7457.0	226,913	6425.5
40	2,585	9785.3	17,430	7906.1	240,584	6812.6
42	2,728	10326.6	18,389	8341.1	253,820	7187.4
44	2,866	10849.0	19,310	8758.8	266,525	7547.2
46	2,996	11341.1	20,184	9155.3	278,597	7889.0
48	3,119	11806.7	21,004	9527.2	289,917	8209.6
50	3,232	12234.4	21,760	9870.1	300,350	8505.0
52	3,333	12616.8	22,440	10178.6	309,733	8770.7
52.7	3,367	12745.5	22,669	10282.4	312,889	8860.1

NITROGEN @ 15 PSIG SATURATION PRESSUER - HL-3500 VHP						
Level	Voume		Weight		Gas Volume	
Inches W.C.	Gallons	Liters	Pounds	Kilograms	Cubic Feet	Cubic Meters
0	0	0.0	0	0.0	0	0.0
0.6	0	0.0	263	119.3	3,625	102.6
2	25	94.6	421	191.0	5,814	164.6
4	87	329.3	821	372.4	11,331	320.9
6	170	643.5	1,358	616.0	18,750	530.9
8	270	1022.1	2,001	907.6	27,620	782.1
10	383	1449.8	2,729	1237.8	37,668	1066.6
12	508	1923.0	3,528	1600.3	48,697	1379.0
14	641	2426.4	4,387	1989.9	60,552	1714.7
16	783	2964.0	5,296	2402.2	73,101	2070.0
18	931	3524.2	6,247	2833.6	86,227	2441.7
20	1,084	4103.4	7,232	3280.4	99,826	2826.8
22	1,241	4697.7	8,245	3739.8	113,799	3222.4
24	1,402	5307.1	9,278	4208.4	128,054	3626.1
26	1,564	5920.4	10,324	4682.9	142,503	4035.3
28	1,728	6541.2	11,379	5161.4	157,060	4447.5
30	1,893	7165.8	12,435	5640.4	171,639	4860.3
32	2,056	7782.8	13,487	6117.6	186,156	5271.4
34	2,218	8396.0	14,528	6589.8	200,526	5678.3
36	2,377	8997.9	15,552	7054.2	214,661	6078.6
38	2,533	9588.4	16,553	7508.3	228,472	6469.6
40	2,684	10160.0	17,523	7948.3	241,863	6848.8
42	2,829	10708.9	18,456	8371.5	254,735	7213.3
44	2,967	11231.3	19,342	8773.3	266,976	7560.0
46	3,096	11719.6	20,175	9151.2	278,465	7885.3
48	3,215	12170.1	20,942	9499.1	289,060	8185.3
50	3,323	12578.9	21,633	9812.5	298,588	8455.1
50.9	3,367	12745.5	21,919	9942.2	302,539	8567.0

Troubleshooting

Use the following troubleshooting table as a guideline to diagnose your Orca system should problems develop. This table cannot replace the knowledge that an experienced operator or cryogenic technician has, and should be considered as a guide only. The table consists of the Symptom, Probable Cause and Remedy columns. Probable causes for a specific problem are listed in a descending order of significance. That is, check out the first cause listed before proceeding to the next. The error codes reference the Flowcom® Flow Meter System Installation and Sevice Manual.

Symptom	*Probable Cause*	*Remedy*
No control panel power (light not on)	Breaker blown in 12 volt control circuit. 12 volt circuit open. .	Replace breaker / reset breaker in fuse block in truck. Verify connector is plugged in at front of tank. Also inspect wires from connector to control panel for break, cuts, etc. Repair if necessary.
Control valves do not open.	No air supply to the valve or low air. System in manual mode. No 12 volt power to the solenoid. Actuator failure.	Verify that there is sufficient air in air tanks. Valve requires 100 psi to operate. Verify solenoid is plugged into junction box, and that wires are not broken. Thaw out valve. ***Caution!*** ***Do not use fire or flame to thaw valve on an oxygen unit!!!***
Error E009 Error E010	Measured temperature is too low. PT100 low signal voltage. PT100 excitation current out of range.	May be caused by any of the following: -Temperature sensor PT100 is not connected properly. -Temperature range switching is defective. -Constant current source is defective. The product parameter does not match the actual product being metered.
Errors on boot-up. Error E011 Error E012 Error E013 Error E014 Error E015	Liquid flows through meter section before meter is turned on. DP transmitter defective. Wiring defective. Leak in DP lines.	Press “STOP” button on control pendant. Verify transmitter is plugged into junction box JB1, and that wires are not broken. Voltage across contacts 1 & 2 on block X7 should measure between 18 & 26 VDC. If not, front board needs to be replaced. Tighten fittings.

Symptom	Probable Cause	Remedy
Unstable flow of product.	Depletion of subcool.	Add subcool by opening pressure building coil. Required pressure is 4.3 psi above saturation pressure.
	Auto subcool valve not opening.	 ***Caution! Do not use fire or flame to thaw valve on an oxygen unit!!!***
	Vessel transmitter fault.	Ensure all valves are open.
	Manual valves closed.	Check liquid level gauge. Delivery of product should not be attempted at low liquid levels.
	Liquid level low.	 ***Caution! Serious damage to pump can occur if pump is run dry!***
	AOV-1 not opening.	Increase subcool. If the saturation pressure is high, the vessel may have to be blown down, then subcool added.
	Two-phase flow. This occurs when a combination of liquid and gas flows through the pump.	
Insufficient subcool.	Delivery started without sufficient subcool.	Add subcool while monitoring subcool pressure prior to initial delivery. Required pressure is 4.3 psi above saturation pressure.
Audible change in pump.	Liquid level low.	Check liquid level gauge. Delivery of product should not be attempted at low liquid levels.
	Flow rates through restrictive lines.	 ***Caution! Serious damage to pump can occur if pump is run dry!***
	Pump pressure too high.	Reduce pump pressure.
	Worn bearings in pump.	Remove and replace pump.
Pump not catching prime.	Insufficient subcool. AOV-3 not opening. AOV-2 not closing.	Add subcool by opening pressure building coil. Required pressure is 4.3 psi above saturation pressure.
		 ***Caution! Venting during delivery will cause depletion of subcool, and may also cause damage to pump!***
	Liquid level low.	Check liquid level gauge. Delivery of product should not be attempted at low liquid levels.
		 ***Caution! Serious damage to pump can occur if pump is run dry!***
Paper out. (Print / Exit)	Add paper, check cables	Verify that the cables to the printer are plugged in, that the printer is turned on and that there is paper in the printer.
Lower pump speed, lower pressure or recirc is continuous.	AOV-2 valve not operating properly	Adequate air supply 12 volt supply to solenoid Replace actuator/valve.

Error Codes & Warnings

See Service-Manual-FC3000 for details, pages 75-77.

During the switch-on phase, the Flowcom® 3000 Flow Meter System checks the important system functions and the data integrity. The differentiation is made between errors and warnings. Warnings and errors that can be addressed, can be confirmed. The device can then be operated further. In the event of errors that cannot be addressed, the "DELIVERY" function is blocked. Errors and warnings are displayed during the switch on phase.

Overview of Error Codes

Error	Cause	Task
E001	Hardware calibration not yet carried out. Checksum error identified when reading the calibration data.	Perform hardware calibration. See section 3.2.8 "Hardware calibration" on page 20.22. The calibration seal needs to be broken.
E002	Parameters for configuration of the meter system have not been entered yet. Checksum error identified when reading the corresponding settings.	Configure device. See also section 6 "Parameters / Settings" beginning on page 25.27. The calibration seal needs to be broken.
E003	Parameters for calibration of the meter system have not been entered yet. Checksum error identified when reading the corresponding settings.	Calibrate metering system or enter calibration data. See section 6 "Parameters / Settings" beginning on page 25.27. The calibration seal needs to be broken.
E004	User settings #1 of the meter system have not been entered yet. Checksum error identified when reading the corresponding settings.	Configure device. See also section 6 "Parameters / Settings" beginning on page 25.27. The calibration seal does not need to be broken.
E005 - E007	A new mother board has been installed.	Confirm error.
E009 - E010	No PT100 connected. PT100 defective. Broken cable. Device configured incorrectly.	Please use the Inputs/outputs function for diagnosis (see page 21).
E011 - E015	Sensor defective. Broken cable. Device configured incorrectly.	Please use the Inputs/outputs function for diagnosis (see page 21).
E030	User settings #2 of the meter system have not been entered yet. Checksum error identified when reading the corresponding settings.	Configure device. See also section 6 "Parameters / Settings" beginning on page 25.27. The calibration seal does not need to be broken.
E031	PumpSmart settings of the meter system have not been entered yet. Checksum error identified when reading the corresponding settings.	Configure device. See also section 6 "Parameters / Settings" beginning on page 25.27. The calibration seal does not need to be broken.
E032	Meter System serial numbers have not been entered yet. Checksum error identified when reading the corresponding settings.	Configure device. See also section 6 "Parameters / Settings" beginning on page 25.27. The calibration seal does not need to be broken.
E033	General setttings of the meter system have not been entered yet. Checksum error identified when reading the corresponding settings.	Configure device. See also section 6 "Parameters / Settings" beginning on page 25.27. The calibration seal does not need to be broken.
E034	The License Key for the selected application has not been entered.	Enter License Key.
E035	Expansion module not connected or defective.	Check connection cable (ribbon cable) and/or replace. Expansion module.

Error	Cause	Task
E040	Battery voltage lower than 1.82V (Nominal value is 3.0V)	Replace battery. Check date and time of internal clock and set if necessary.
E041 - E047	Main supply voltage too low.	Address fault in main voltage supply. Replacement of mother board (needs recalibration).
E048	Environmental temperature too low.	Address fault in main voltage supply. Replacement of mother board (needs recalibration).

Overview of Warnings

See Service-Manual-FC3000 for details, pages 78-79.

Warning Code	Cause	Task
W040	Battery voltage lower than 2.5V (Nominal value is 3.0V).	Replace battery. Confirm warning (device can be operated further). Check date and time of internal clock and set if necessary.
W041 - W047	Main supply voltage too low.	Confirm warning.
W048	Environmental temperature too low.	Confirm warning.
Circuit boards A, B or C do not pass on power up.	Circuit board is bad or lost program.	Replace board or reload program.

Overview of Operation Error Codes

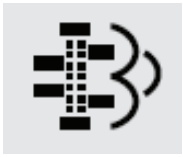
Symptom	Possible Cause	Remedy
Flowcom® Flow Meter System does not power up.	Fuse blown in 12 volt control circuit. Loss of air.	Replace fuse in fuseblock in truck. Truck air system not working or bad air switch PS331 in Control Panel or Rear Door switch not working.
Metering stopped and flashing red on screen, does not stop dispensing.	Temp probe failure Pump pressure transmitter	Flowcom meter connector 1-4, replace temp probe or bypass in settings with preset density. Flowcom meter connector 9,10, wire cut/ disconnected, transmitter bad.
Message “Discharge Pressure to High”	Pump discharge to high, meter warm, dispense valve not open, valve on tank not open. Receiving tank valve closed, dispensing valve closed.	Cool down tank. Open valve.
Flowcom® Flow Meter System cycling screens on startup.	12V supply voltage low.	Check 12V supply.
Dispensing and pump stops.	Stops without errors.	Flowcom meter connector 44.

Symptom	*Possible Cause*	*Remedy*
"Unstable flow rate"	Depletion of sub-cool.	Add sub-cool by opening pressure building coil. 5 - 7 psi (34 - 48 kPa) above saturation pressure is required. ***Caution! Venting during delivery will cause depletion of sub-cool, and may also cause damage to pump!***
	Liquid level low.	Check liquid level gauge. Delivery of product should not be attempted at low liquid levels. ***Caution! Serious damage to pump can occur if pump is run dry!***
	Two-phase flow. This occurs when a combination of liquid and gas flows through the pump.	Increase sub-cool. If the saturation pressure is high, the vessel may have to be blown down, then sub-cool added.
	Loss of air supply, valve closes, pump stops.	Check air supply.
	Dispensing valve closes.	Check output connector 36,37 in Flowcom meter or solenoid. Please use the inputs/ outputs function for diagnosis.
	Low Flow <=400 mbar and reduction in flow, or High Flow >400 mbar and reduction in flow, and Flowcom meter shuts off delivery.	Keep constant flow rate, do not change the VFD Hz fast.
	Wiring to transmitter low pressure transmitter.	Please use the inputs/outputs function for diagnosis. Check input connector 5,6.
Message "Insufficient Subcool", psub Vtank - number in red, system shuts down after about 10 sec.	Tank pressure transmitter defective.	Please use the Inputs/Outputs function for diagnosis.
	Broken cable.	Flowcom connector 11,12.
	Force feed valve closed.	Flowcom connector 40, solenoid bad, loss of air.
Message "Flowrate < Q...min" flashing red on screen.	Leak in the DP Transmitter high line or pressure transmitter pump psi = 0, pump shutdown.	Repair leak.
	Low Flow <=400 mbar and transmitter low failure	Flowcom meter connector 5 and 6 disconnected, wire cut/disconnected, transmitter bad.
	High Flow >400 mbar and transmitter high failure.	Flowcom meter connector 7 and 8 disconnected, wire cut/disconnected, transmitter bad.
	Warm hose.	Cool hose.
Message "Flowrate > Q...max" flashing red on screen.	Leak in the DP Transmitter low line, pump shutdown.	Repair leak.
Loss of VFD information on INFO screen.	Connection loss.	Flowcom meter connector 22,23.
Low voltage or high voltage error messages on VFD.	Alternator spinning too fast or too slow.	Adjust truck engine speed accordingly.
Over current error message on VFD.	Pump drawing too much current.	Slow pump speed down using speed control.
	Worn bearings in pump.	Remove and replace pump.

Symptom	Possible Cause	Remedy
Audible change in pump.	Liquid level low.	Check liquid level gauge. Delivery of product should not be attempted at low liquid levels.  ***Caution! Serious damage to pump can occur if pump is run dry!***
	Worn bearings in pump.	Remove and replace pump.
Pump not catching prime.	Insufficient sub-cool.	Add sub-cool by opening pressure building coil. 5 - 7 psi (34 - 48 kPa) above saturation pressure is required.  ***Caution! Venting during delivery will cause depletion of sub-cool, and may also cause damage to pump!***
	Liquid level low.	Check liquid level gauge. Delivery of product should not be attempted at low liquid levels.  ***Caution! Serious damage to pump can occur if pump is run dry!***
Pump will not start.	Flowcom meter not signaling.	Check connectors 22 thru 44. Reset stop button.
	E-Stop pushed in.	Check block valve manual valve or bad temperature probe.
	Temperature of pump not cold enough.	
Pendant start/stop not working.	Bad cable or connection.	Replace pendant cable, Flowcom meter connector 24 - 31.
Printer error	Power loss.	Check power cable, DC convertor bad, and check connector 46,47.
	Data loss.	Broke cable, check connector 17 - 19.
	Flowcom meter not set up.	Complete setup.
	Paper not inserted.	Insert paper.
Dispense valve does not open.	No air supply to the valve.	Verify that there is sufficient air in air tanks. Valve required 100 psi (689 kPa) to operate.
	No 12 volt power to the solenoid.	Verify solenoid is plugged into junction bax, and that wires are not broken.
	Valve is frozen.	Thaw out valve.  ***Caution! DO NOT use fire or flame to thaw valve on an oxygen unit!***

Optional Onboard Engine Troubleshooting (HL Trailer Units)

For complete troubleshooting and technical assistance, contact your local John Deere dealer.

Indicator	*Description*	*Operator Action*
Exhaust Filter Cleaning Indicator 	Active when: 1. Exhaust gas temperature is high 2. Elevated idle is active 3. Exhaust filter cleaning is in process	Machine can be operated as normal. If operating in an area where high exhaust temperatures may be an issue, abort exhaust filter cleaning by using the disable feature.
Exhaust Filter Indicator 	Active when: Soot level in the exhaust filter indicates need for an exhaust filter cleaning. DTC: 003719.15 will be present.	Enable auto filter cleaning to allow a cleaning cycle. OR Begin a manual / parked cleaning.
Exhaust Filter Indicator 	Active when: Machine performance is reduced due to very high soot level. DTC: 003719.16 will be present.	Begin a manual / parked cleaning.
Exhaust Filter Indicator 	Active when: Exhaust filter requires service. Machine performance is reduced and a sto pengine request is made. DTC: 003719.00 will be present.	Service the exhaust filter. See operator's manual.
Exhaust Filter Indicator 	Active when: Auto exhaust filter cleaning is disabled.	If possible, enable auto cleaning.

When this indicator is on, it means there must be a manual cleaning of the Genset engine:

Manual / Parked Exhaust Filter Cleaning:

1. Press the Menu button
2. Press the arrow keys to scroll up or down to select exhaust filter
3. Press the Enter key
4. Press the arrow keys to scroll up or down and select: 'REQUEST EXH FLT CLEAN' to reques a manual / parked exhaust filter cleaning
5. Press the Enter key
6. Follow the firections on the display and ensure all conditions are met
7. Press the Enter key to CONFIRM all conditions are met.

Warranty Statement

Chart Standard Warranty

Chart Purchased Parts

Chart Inc. will pass on all warranties offered to us by our vendors. This is for those items which Chart Inc. purchases from them directly. Below is a list of the major items with their warranty periods. For the items not listed below, Chart Inc. will warranty the replacement period for a time frame of 90 days after the ship date of the Orca VHP Series unit. If warranty replacement of part is required, the Orca VHP Series unit will be repaired at the nearest Chart Inc. Authorized Service Provider, by the Purchaser, or Chart Inc. personnel in the field. This warranty is subject to the exclusions above.

Major Components

Component	Time Frame*
Resistance Temperature Device (RTD)	1 Year
Differential Pressure Transmitter (DP Transmitter)	1 Year
Spin-on Connections	6 Months
Meter Element	Life of Orca System
Differential Pressure Gauge	1 Year
Orca VHP Series Delivery Hose	1 Year
Flowcom Flow Processor	1 Year
Printer	6 Months
Pump VHP Service	Mfg Warranty
Hydraulic Package	Mfg Warranty
Check Valves	1 Year
Safety Relief Valves, Vent	1 Year
Vacuum	3 Years

*From shipment of Orca VHP Series unit.

Workmanship and Vacuum

Chart Inc. warrants all Orca VHP Series units manufactured to be free from defects in material and workmanship for three years after shipment, subject to the exclusions listed below and statements on the preceding and following pages. Provided neither the evacuation valve nor the vacuum gauge valve has been tampered or disturbed so as to bleed gas into the annulus, and that no other misuse or abuse of the equipment has caused the excessive pressure. If warranty repair is required, the Orca VHP Series unit will be repaired at the nearest Chart Authorized Service Provider, by the Purchaser, or Chart Inc personnel in the field, or at Chart Inc. at the discretion of Chart Inc. and in accordance with the attached Warranty Claims Procedure.

Exclusions

1. Chart Inc. accepts no liability for any work performed or cost incurred by the customer, or others, without Chart Inc. express prior written approval.
2. Chart Inc.'s obligations under this warranty are expressly limited to repair or replacement of any Chart Inc. manufactured component found to be defective within ONE YEAR after ship date of Orca VHP Series unit.
3. Chart Inc. is not liable for any other losses, damages, product losses, cost of delays, freight charges, or excess costs for repairs made outside the 48 adjacent United States, including incidental or consequential damages.
4. For Warranty Claims please call Chart Inc. Customer Service Center at 1-800-400-4683.