ORCA SERVICE & REPAIR MANUAL
LOX

ORCA MICRO-BULK DELIVERY SYSTEM

CHART INC.

DISTRIBUTION AND STORAGE DIVISION
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MANUAL# 13757221 REV 1

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Section 1 Overview

Service

The ORCA Cryogenic System has been designed for years of safe and dependable operation. In the event service is required, contact:

Chart , Inc. at 1.800.400.4683.

Address

The ORCA Micro-Bulk Delivery System is designed and manufactured by:

Chart , Inc.

Distribution & Storage Division

407 Seventh Street Northwest

New Prague, MN 56071

Manual Explanation

This Service & Repair Manual is designed to be used for the **ORCA Models HL-2000, HL-2800, HL-3300 and 4200** and contains information regarding the safe repair and troubleshooting of the ORCA Micro-Bulk Delivery System in Oxygen Service. **It should be thoroughly read and understood by anyone that repairs, operates, or is exposed to this equipment.** This manual is intended to provide the cryogenic service employee with the necessary information needed to troubleshoot, repair, maintain, and operate the ORCA Micro-Bulk Delivery System. The schematics and parts lists refer to reference numbers for each component. The reference numbers will be used throughout this manual to draw specific attention to a component while describing its function, operation, or repair.

Designed Use

The Standard ORCA Micro-Bulk Delivery System is designed for the safe and efficient transport of Oxygen/Nitrogen/Argon.

Design Modification

DO NOT use this product in any manner not consistent with the instructions outlined in the Operation or Service & Repair Manual! NEVER alter the design, or perform service that is not consistent with the instructions outlined in this Manual without the prior written approval of Chart , Inc.!

Compatibility and Cleaning

Always keep the ORCA clean and free from grease and oil. Use care when cleaning the ORCA with high-pressure water or steam cleaning equipment. **DO NOT** direct the cleaning nozzle into the ends of the Alternator or Pump Motor. When replacing ORCA Components, use only parts which are considered compatible with Liquid Oxygen. Do not use regulators, fittings, or hoses, which were previously used in Compressed Air or Carbon Dioxide Environments on the ORCA. Use only Oxygen Compatible Sealants on threaded connections. All new joints should be leak tested with an Oxygen Compatible Leak Test Solution at a minimum of 35 psig. Failure to comply with these instructions may result in serious personal injury, death, or damage to the container. Once a system has been contaminated, the vessel may not be returned to Oxygen without extremely extensive cleaning methods.

Safety Summary

While every possible safety precaution has been taken to ensure safe operation and maintenance of the ORCA Delivery Vessel, it is imperative that all persons having contact with the ORCA become thoroughly familiar with all maintenance, safety precautions, and procedures contained in this Operation Manual. **If for any reason any part or parts of this manual becomes confusing or the information provided is not completely understood contact a Technical Service Representative at Chart , Inc. 1.800.400.4683 before proceeding with the operation or repair of the vessel.**

General

The ORCA Tank consists of an inner pressure vessel encased within an outer carbon steel vacuum shell. The container operates under low to medium pressure (0-50psi), and is protected from over-pressurization by use of a Safety Relief Valve System. Safety relief devices are used to protect the inner vessel and vacuum casing, sized and manufactured in accordance with ASME and other standards.

Cryogenic

A product retaining a temperature of **-150o F or colder**. ORCA Systems maintain gases efficiently in a cryogenic liquid state. Gases can be most efficiently stored as liquids. **For example, Liquid Nitrogen will expand in volume 750 times when warmed to a gaseous state.** Gases may be liquefied by compression or cooling them until they liquefy (see Vaporization/Condensation). In order to be maintained in a liquid state, each gas must be kept at or below their respective boiling temperatures.

Cryogenic Temperatures

The ORCA System employs Cryogenic Temperatures to store the product in its liquid state.

Gas-Boiling Temperatures (at 0 psig):

Argon **-302° F**

Nitrogen **-320° F**

Oxygen **-297° F**

Warnings

Fatal of severe injury, fire, explosion, or suffocation may result depending on the type of liquid used in this system if the operating personnel fail to observe the safety precautions.

Nitrogen and Argon Vapors in the air may dilute the concentration necessary to support or sustain life. Exposure to such an Oxygen Deficient Atmosphere can lead to unconsciousness, serious injury, or even death. 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. Inhalation of high concentrations of these gases can cause anoxia, resulting in dizziness, nausea, vomiting, unconsciousness, and possibly death! Unconsciousness and death may occur with virtually no warning if the oxygen content is below 8%.

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

Handle liquid so that it will not splash or spill. Protect your eyes and cover skin where the possibility of contact with liquid, cold pipes, cold equipment, or cold gas exists. Safety goggles and/or a face shield should be worn if liquid ejection, splashing, or cold gas contact is possible. Clean, insulated gloves that can easily be removed and long sleeves are mandatory for arm protection. Cuff-less trousers should be worn over the shoes to shed any spilled liquid.

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.**

In the event of known or suspected container vacuum problems (even if an extraordinary circumstance such as those noted above have not occurred), do not continue to use the unit.

Continued use of a cryogenic container that has a vacuum problem can lead to Carbon Steel 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 by qualified personnel. The remainder of this safety bulletin addresses those adverse environments that may be encountered when a cryogenic container has been severely damaged. These are Oxygen Deficient Atmospheres, Oxygen Enriched Atmospheres, and Exposure to Inert Gasses.

Oxygen Deficient Atmospheres

The normal oxygen content of air is approximately **21%**. Depletion of oxygen content in air, either by combustion or by displacement with inert gas, is a potential hazard and users should exercise suitable precautions. One aspect of this possible hazard is the response of humans when exposed to an atmosphere containing only **8** to **12%** Oxygen. In this environment, unconsciousness can be immediate with virtually no warning. When the oxygen content of air is reduced to about **15** or **16%**, the flame of ordinary combustible materials, including those commonly used as a fuel for heat or light, may be extinguished. Somewhat below this concentration, an individual breathing the air is mentally incapable of diagnosing the situation because the onset of symptoms such as sleepiness, fatigue, lassitude, loss of coordination, errors in judgment, and confusion.

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

Most individuals in or around Oxygen Deficient Atmospheres rely on the "Buddy System" for protection. Obviously, the "Buddy" is equally susceptible to asphyxiation if he or she enters the area to assist an unconscious partner unless equipped with a portable air supply. Equipping all individuals with a portable supply of respirable air ensures best protection.

DO NOT attempt to remove an individual without utilizing proper rescue equipment or you may also become a casualty. If the exposed person is unconscious, obtain assistance and put into effect the established emergency procedures. Lifelines are acceptable only if the area is essentially free of obstructions and individuals can assist one another without constraint.

All new piping joints should be leak tested with a compatible leak-test solution. Once a system has been contaminated through improper or careless parts cleaning or replacement, the vessel may not be returned to service without extremely extensive and complex cleaning methods. If oxygen deficient atmosphere is suspected or known to exist: Use the "Buddy System". Use more than one "Buddy" if necessary to remove a fellow worker in an emergency. Both the worker and "Buddy" should be equipped with self-contained breathing equipment.

If an Oxygen deficient atmosphere is suspected or known to exist: Use the "Buddy System." Use more than one "Buddy" if necessary to remove a fellow worker in and emergency. Both the "Worker and the Buddy" should be equipped with a Self-Contained Breathing Equipment. Persons suffering from lack of oxygen should be immediately moved to areas with normal atmospheres. **A 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.

Oxygen Enriched Atmospheres

An Oxygen Enriched Atmosphere occurs whenever the normal oxygen content of air is allowed to rise above **23%**. While oxygen is non-flammable, ignition of combustible materials can occur more readily in an Oxygen-Rich Atmosphere than in air; and combustion proceeds at a faster rate. Oxygen system components, including but not limited to, containers, valves, valve seats, lubricants, fittings, gaskets, and interconnecting equipment including hoses, shall have adequate compatibility with oxygen under conditions of temperature and pressure to which the c In an oxygen-enriched atmosphere, flammable items burn vigorously and can explode. Excess accumulation of oxygen creates an Oxygen-Enriched Atmosphere (defined by the Compressed Gas Association as an oxygen concentration above **23%**). Certain items considered non-combustible in air might burn rapidly in such an environment. Keep all organic materials and other flammable substances away from possible contact with oxygen; particularly oil, grease, kerosene, cloth, wood, paint, tar, coal, dust, and dirt which may contain oil or grease. Do not permit smoking or open flame in any area where oxygen is stored, handled, or used. Failure to comply with this warning may result in serious personal injury including death. Components may be exposed in the containment and use of oxygen. Compatibility involves both combustibility and ease of ignition. Materials that burn in air may burn violently in pure oxygen at normal pressure, and explosively in pressurized oxygen. In addition, many materials that do not burn in air may do so in pure oxygen, particularly when under pressure. Metals for containers and piping must be carefully selected, depending on service conditions. The various steels are acceptable for many applications, but some service conditions may call for other materials (usually copper or its alloys) because of their greater resistance to ignition and lower rate of combustion. Similarly, materials that can be ignited in air have lower ignition energies in oxygen. Many such materials may be ignited by friction at a valve seat or stem packing, or by adiabatic compression produced when oxygen at high pressure is rapidly introduced into a system initially at low pressure.

ORCA Theory of Operation

Although the Orca System can have a variety of pump options for output pressure capability and can be truck or trailer mounted, all units have the same general functional operating characteristics. They have the ability to be filled with a cryogenic product, transport and deliver that product to the end customer safely and efficiently.

One key feature of the ORCA System is the "SMART" Flow Meter that is designed to sense the filling status of Perma-Cyls and terminate the delivery automatically when filling is completed. This provides the benefit of greater safety and operator freedom during the filling process.

The ORCA System leverages the principles of cryogenics to minimize losses in delivering gas molecules to the use point. The following section of this manual will discuss the theory behind the ORCA System by explaining the principles of cryogenics and provide the user with information necessary to properly understand and identify components and system functions.

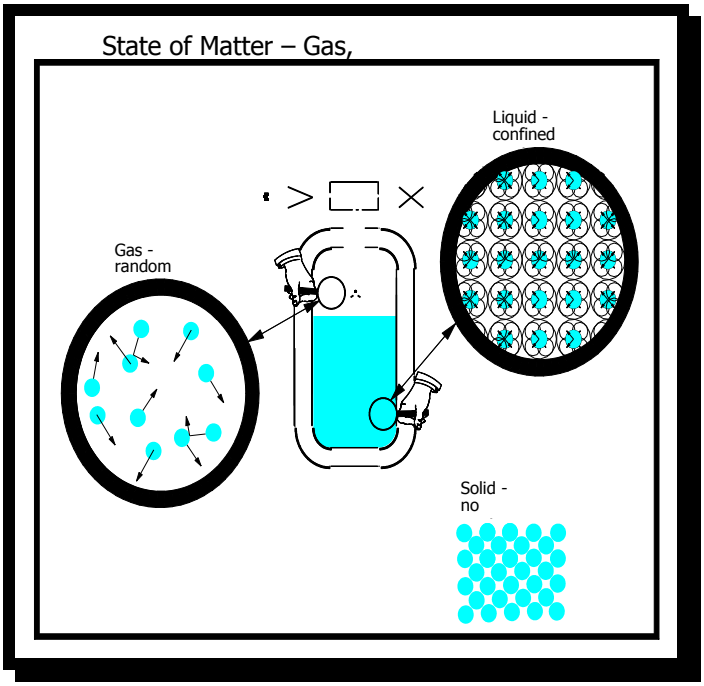
Terminology of Cryogenics

States of Matter

Matter can exist as a gas, liquid, or a solid. Two phase liquid is a liquid with gas bubbles or slugs of gas, due to lack of pressure to maintain equilibrium. Gas and liquid can exist at a range of temperatures. Temperature is a measure of the amount of energy within the solid, liquid, or gas.

Gas is molecules in random motion, liquid is molecules in confined motion, and solid is molecules with no motion (see figure 1).

Figure 1 - States of Matter (Gas, Liquid, and Solid)



Saturation

Defined as point at which liquid and vapor co-exist at the same pressure (temperature).

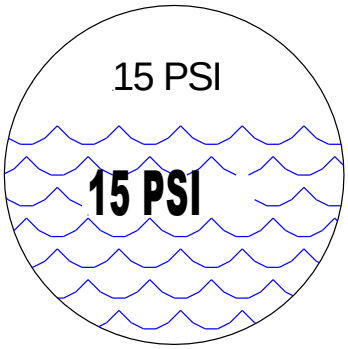
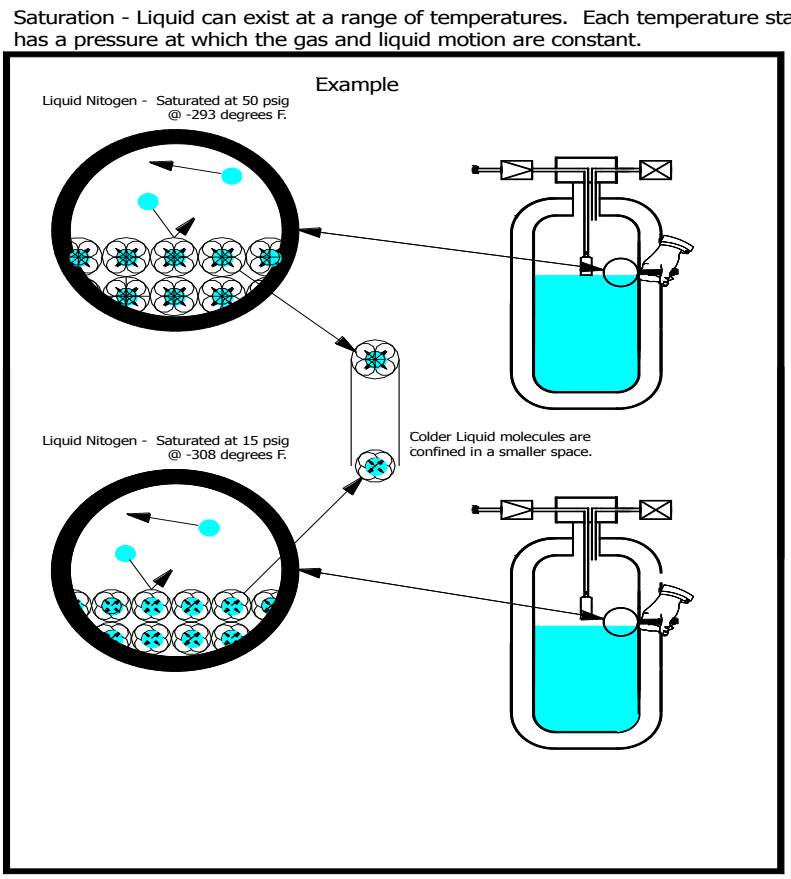


Figure 2

Liquid density, temperature, and equilibrium pressure change with the saturation level of the liquid.

Saturation can also be described as an energy state. Liquid molecules at a higher energy state (warmer) take up more space. Figure 3 depicts liquid nitrogen at 50psig saturation and 15psig saturation.

Figure 3-Liquid Saturation



Equilibrium

In a closed vessel 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 there temperatures until they are equal.

Saturation Pressure

Pressure (usually in PSI) that is used to describe the current condition of a liquid and gas within a closed container.

Subcool

Raising the Vapor (gas) space pressure above the normal vapor pressure of a saturated liquid, creating **N**et **P**ositive **S**uction **H**ead or **NPSH**.

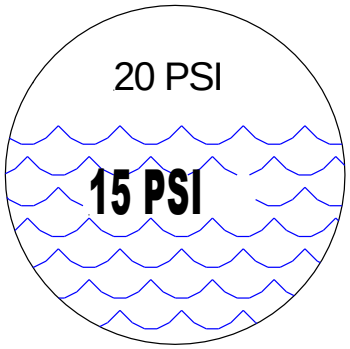


Figure 4

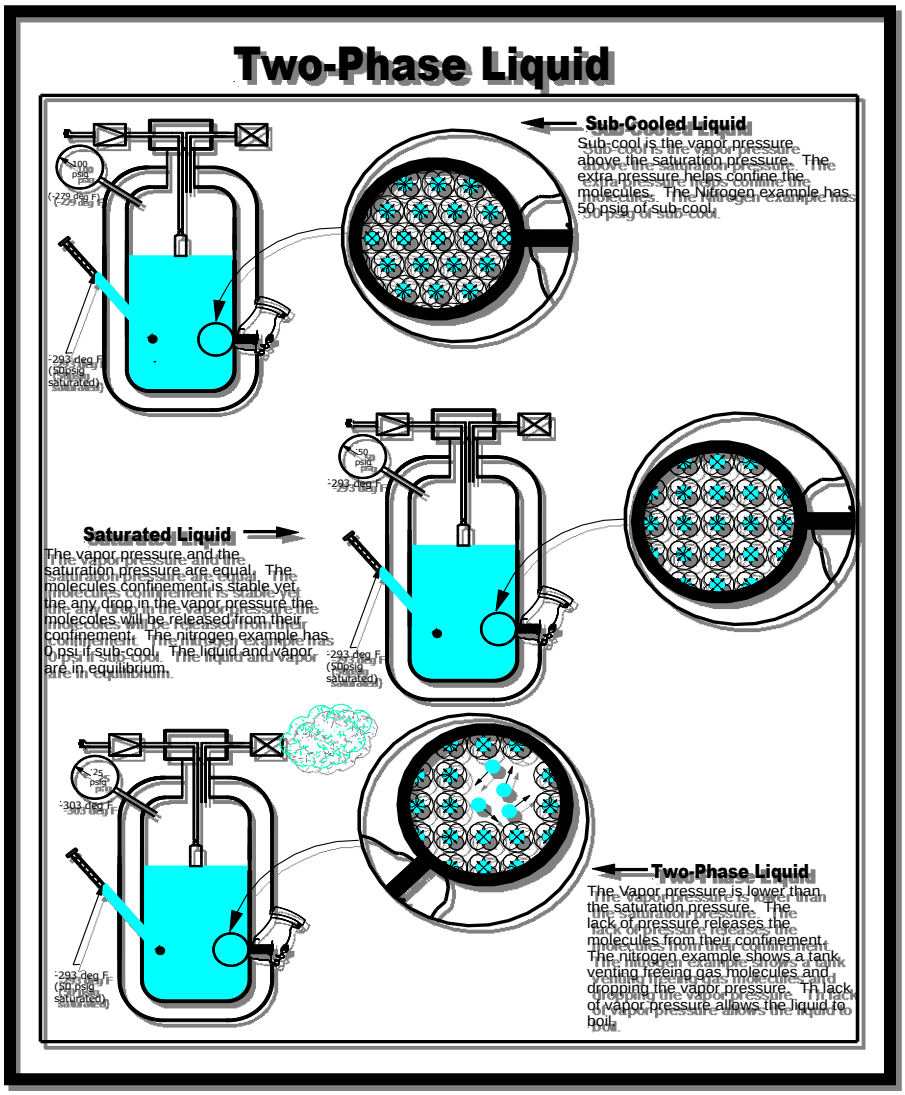
When transferring liquid from a vessel, sub-cool is important to maintain the liquid in the liquid state as it travels from the tank through the piping circuit (See figure 4).

In the case of the ORCA system, 5 psi of sub-cool is required for Oxygen delivery to prevent two-phase liquid. Liquid leaving the pump must be replaced in the sump at the same rate. Liquid flowing creates pressure drop as it travels through the feed line. If the pressure drops below the saturation pressure of the liquid it will begin to boil.

Two-Phase Liquid

The mix of liquid and gas due to the pressure dropping below the saturation pressure of the liquid caused by the lack of proper Subcool. **This will cause damage to the pump!** Figure 5 illustrates two-phase liquid.

Figure 5-Two Phase Liquid



Cavitation

Defined as partial or full loss of pump prime due to the lack of proper **SUB-COOL.** 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 not stop pumping during full loss of prime.**

Caution **Cavitation will cause damage to the pump. The Orca system pump requires a minimum of 5 PSI subcool Oxygen delivery.**

Vaporization

Changing liquid into vapor by warming the liquid for the purpose of sub-cooling or for gas use. The Orca System uses a pressure building coil, shown in Figure 6, located on the roadside of the vessel to accomplish this.

Figure 6-Orca Pressure Building Coil

Vapor Pressure

Pressure of the vapor space within the tank. Measured by reading the tank pressure gauge.

Condensation

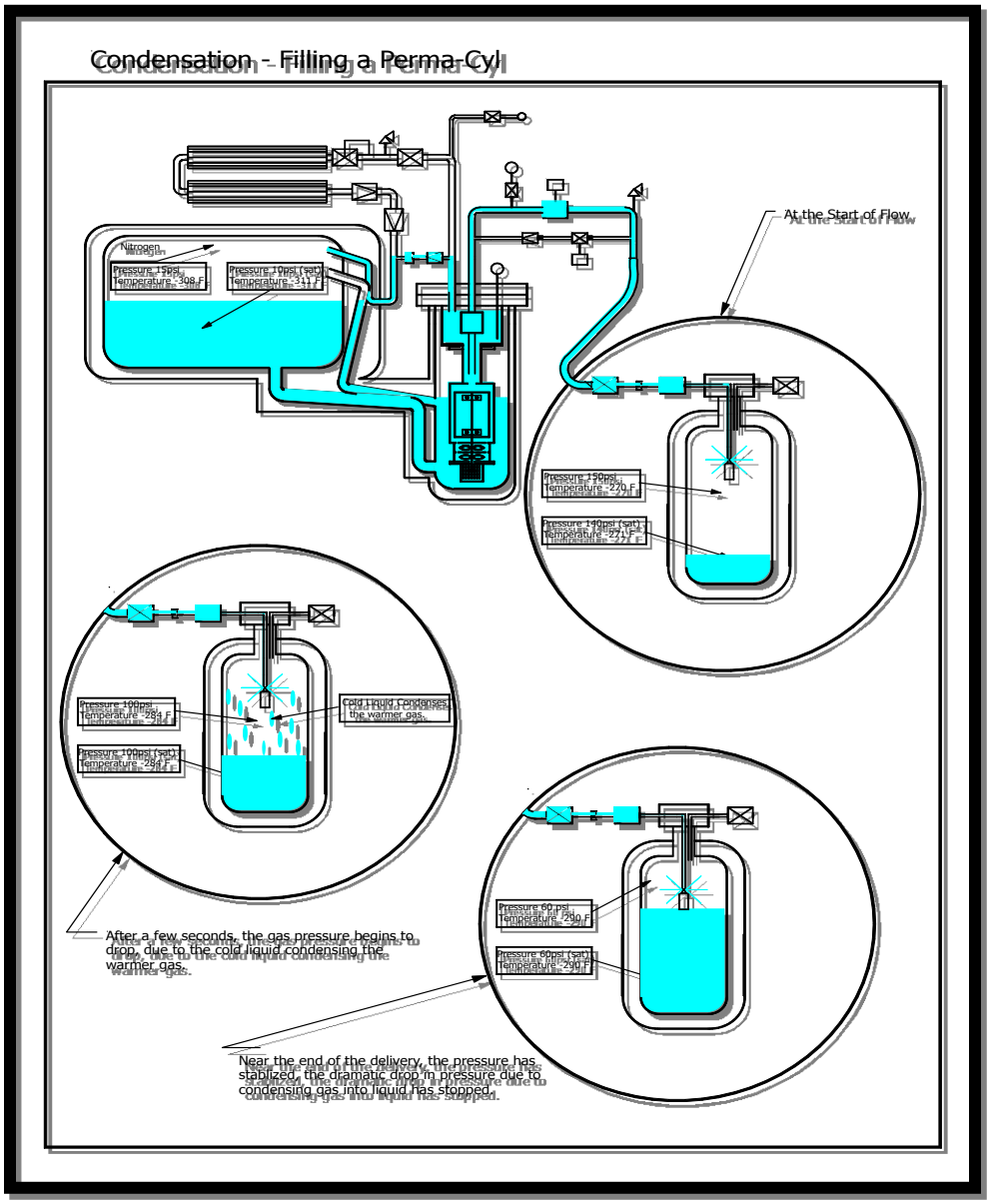
The conversion of vapors into liquid by cooling the vapors.

The ORCA Storage Vessel pressure 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. The splashing condenses the gas and drops the pressure. This is known as “splashdown.”

Condensation and the Perma-Cyl

An example of condensation can be seen in the filling theory of a Perma-Cyl. Top filling a Perma-Cyl without venting is possible due to condensing warmer gas into liquid. Figure 7 explains the filling of the Perma-Cyl and how condensation makes filling without venting possible.

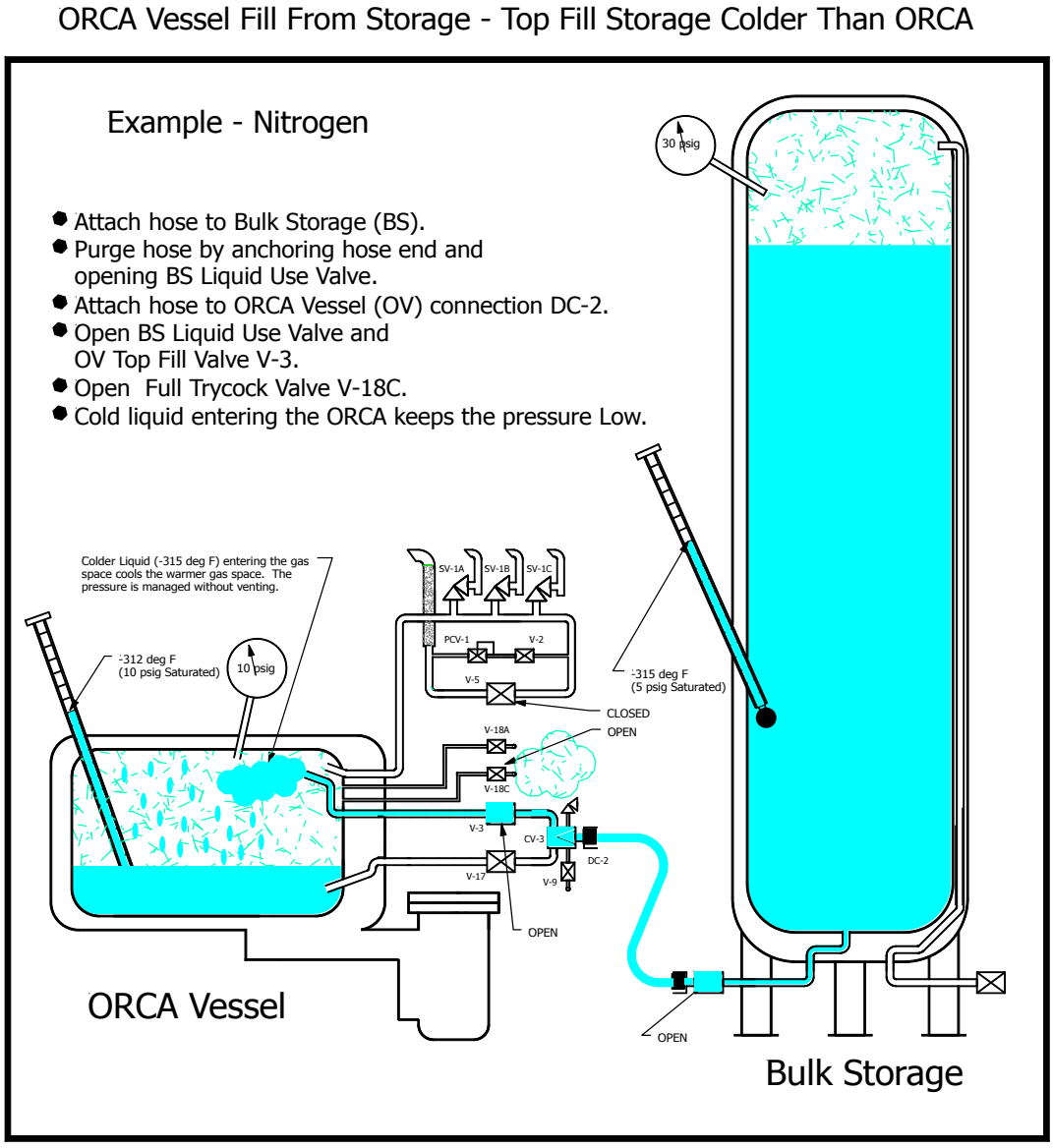
Figure 7 - Condensation top filling a Perma-Cyl



Condensation and the Orca

Just like Top filling of a Perma-Cyl, Top filling the ORCA vessel allows filling without venting. Figure 8 Describes the conditions at which the ORCA can be filled without venting using the condensation principle.

Figure 8 - Condensation top filling the ORCA Vessel



Depressurization Flash Losses

Dropping the vapor space pressure below the saturation pressure of the liquid causing the liquid to boil. During the venting of the tank below the saturation pressure of the liquid, the liquid temperature will drop, the density will increase, weight of the liquid will decreases, and the saturation pressure will drop.

Product losses due to venting are summarized in the following figures (figure 9 and figure 10). The starting and ending pressures in the charts within the figures are saturation pressures not to be confused with vapor pressures. For example, if the ORCA has a starting pressure (saturation) of 40 psig and is vented down to 10 psig the product lost during venting is 10%.

Figure 9 - Flash Losses ORCA

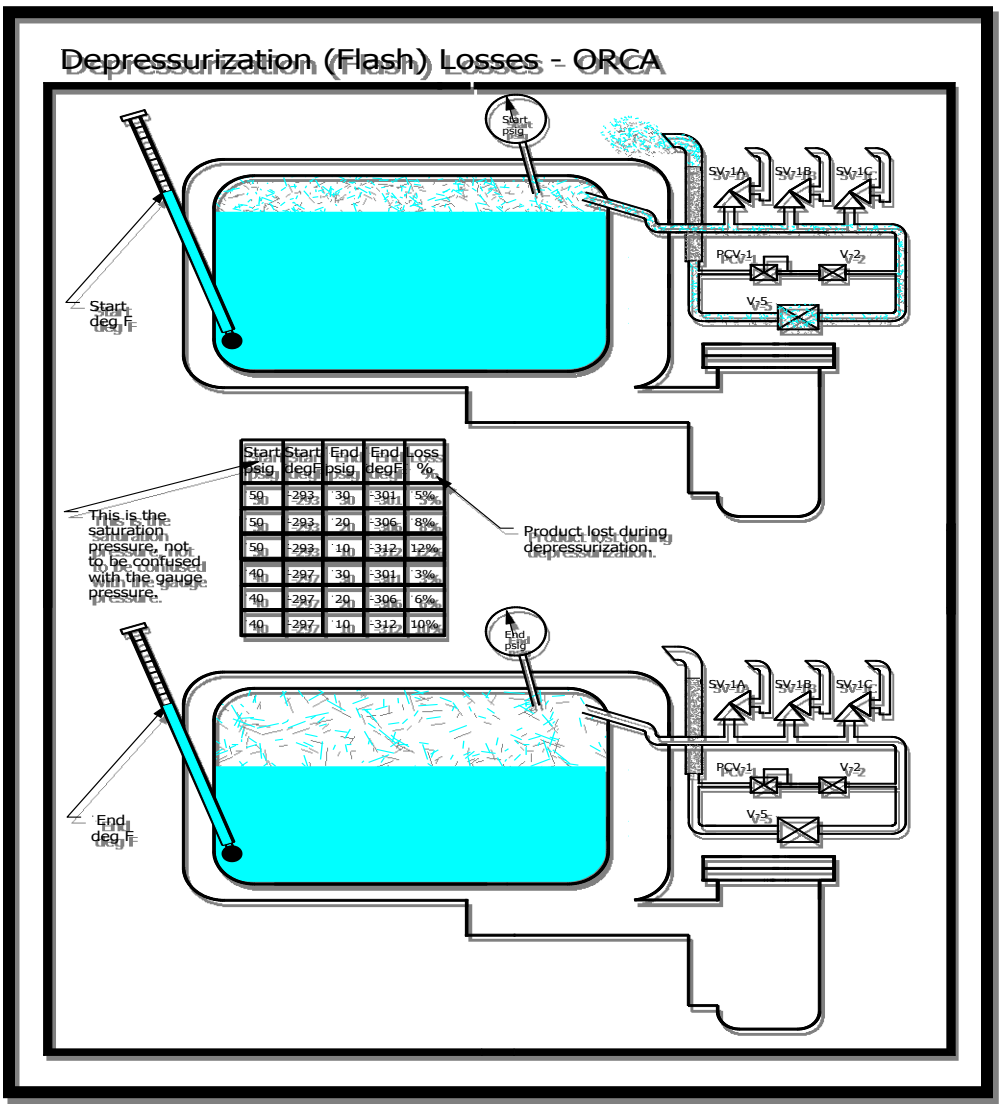
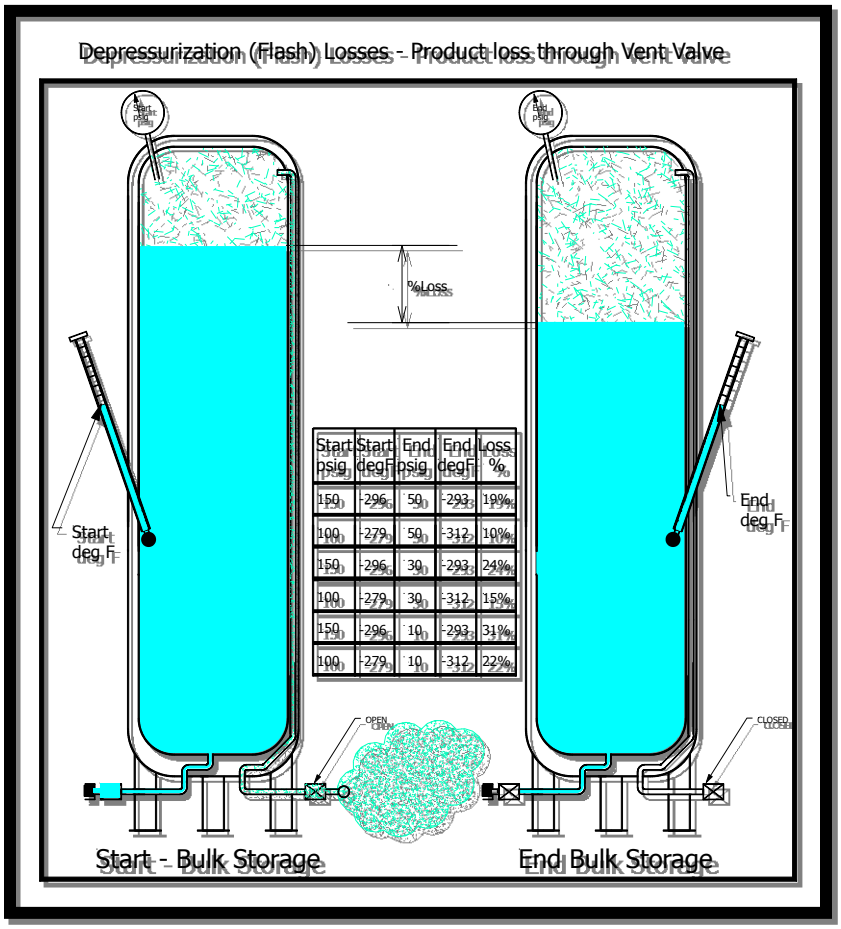


Figure 10 - Flash Losses Bulk Storage



Start psig	Start degF	End psig	End degF	Loss %
150	-296	50	-293	19%
100	-279	50	-312	10%
150	-296	30	-293	24%
100	-279	30	-312	15%
150	-296	10	-293	31%
100	-279	10	-312	22%

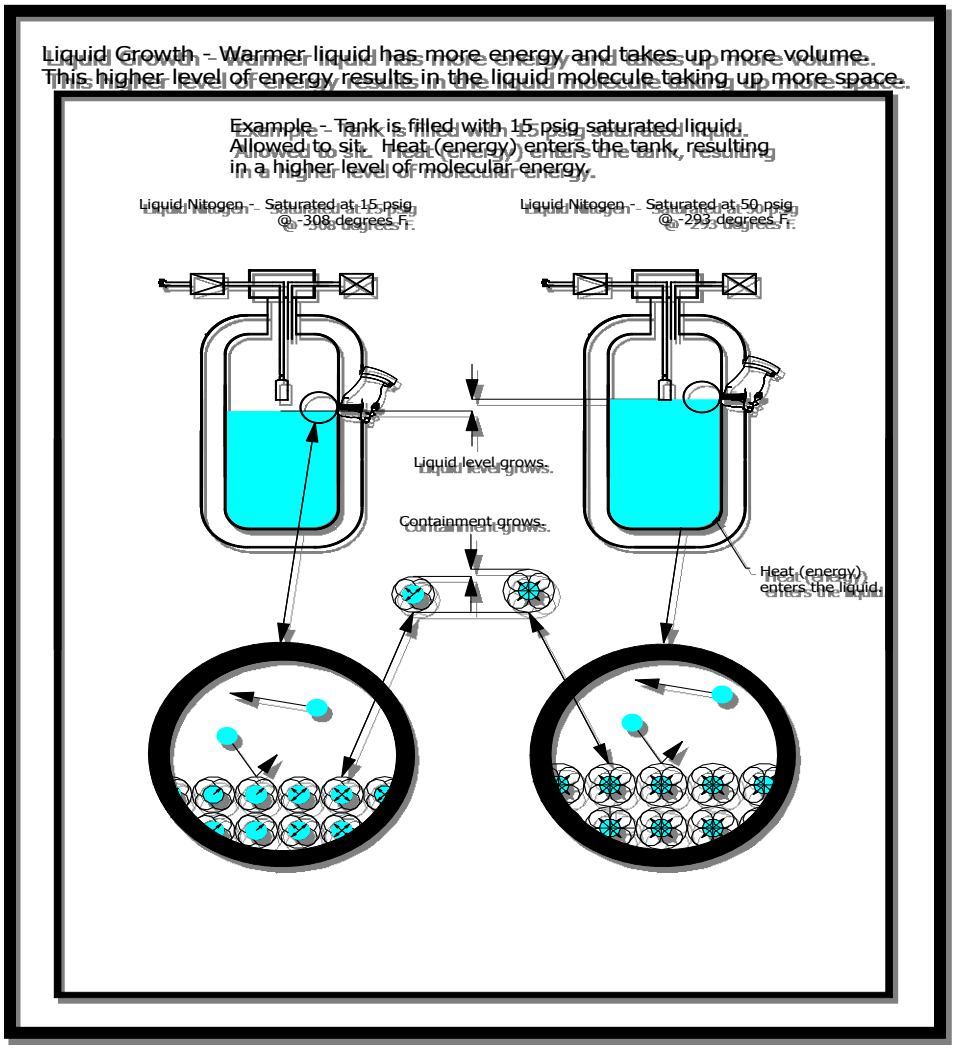
Entrainment

Liquid carried along with venting gas. This can occur during violent depressurization of a tank and during the top filling of a tank 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. Figure 11 illustrates the growth of liquid at the molecular level.

Figure 11- Liquid Growth



Pressure Drop

Pressure lost due to the flow of liquid. The faster 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 change of temperature from top to bottom is called Stratification.

ORCA System Components/Terms

12-24 VDC Electrical System

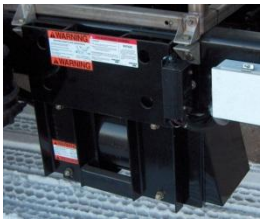
The 12-24 VDC (Low Voltage) Electrical System is powered by the 12 VDC Systems (Truck Mounted Orca) or from the battery (Trailer Mounted Orca) located inside the MQ WhisperWatt Generator cabinet. (See Figures 10-11)

480 VAC Electrical System

The 440-480 VAC (High Voltage) Electrical System is powered by the PTO/Alternator System (Truck Mounted Orca) or by the MQ WhisperWatt Generator (Trailer Mounted Orca). (See Figures 12-13)

FIGURE 12 – TRUCK MOUNTED ORCA

480 VAC – PTO system (WEG Alternator)



12 VDC – Supplied by Truck 12 VDC System

FIGURE 13 – TRAILER MOUNTED ORCA

12 VDC – Supplied by Battery of MQ Whisperwatt

480 VAC – MQ Whisperwatt Generator

Inner Cylinder

The Inner Cylinder is the container in which the liquid product is stored. It is constructed of high quality alloy steel and its exterior is wrapped with a multi-layered insulation.

Outer Cylinder

The Outer Vessel houses the Inner Cylinder and serves as the chamber in which a vacuum is drawn to minimize the transfer of heat from the Outer Cylinder to the Inner Cylinder where the product is stored.

Annulus

The Annulus Volume of space is between the outer and inner cylinders that minimize the transfer of heat from the outer cylinder to the inner cylinder where the product is stored.

Plumbing Cabinet

The Plumbing Cabinet houses the Electronics and plumbing components for the ORCA. It is also referred to as the "Dog House." For a Pump change out the Plumbing cabinet will need to be removed. See picture below for mounting bolt locations.

Section 2 General Maintenance

Overview

In this section we will introduce information applicable to ORCA vessel maintenance. In addition, the differences between Truck and Trailer mounted units will be described and discussed. When performing a procedure described in this section, refer to the Parts List for the pertinent parts locations and views.

Before implementing any procedure described below, it is recommended that the Safety Summary and Product Safety Bulletins be reviewed and understood fully.

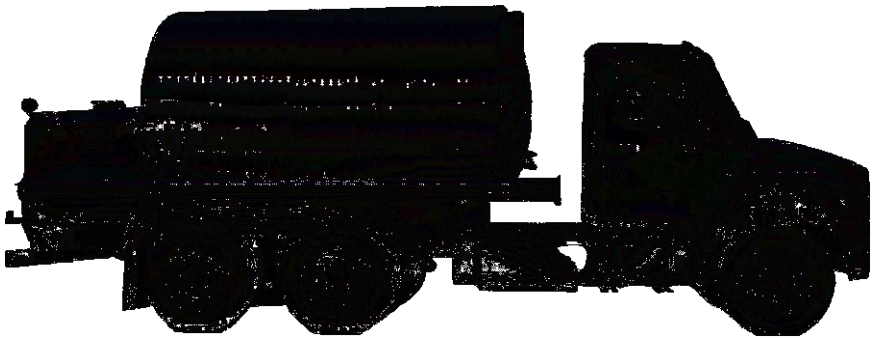
Required maintenance usually becomes apparent during inspection, before a fill routine, observations during and after a fill, and from improper performance of components. Proper and immediate action to correct any damage or malfunction is advised.

Persons making repairs to piping, valves, and gauges should be fully familiar with cleanliness requirements for components. It is recommended that all parts be kept clean for oxygen service, even if being used with other cryogens.

Truck / Trailer Mount

As described earlier, the Orca vessel can be mounted on a truck chassis or trailer depending on the desire of the customer. The system function is the same; with the primary difference being that the trailer has an onboard MQ WhisperWatt Generator supplying the electrical power to the Orca control system while the truck mount has a PTO system driving a truck mounted Alternator. Figure 14 shows typical examples of Truck and Trailer mounts.

FIGURE 14– TYPICAL TRUCK AND TRAILER MOUNTS



Typical Truck Mount (HL-2000)

Typical Trailer Mount (HL-3300)

Truck Maintenance

Figure 15

Establish a regular maintenance and service schedule for the truck following the Manufactures recommendations.

Orca Vessel Mounting Brackets and Bolts

The mounting brackets from just in front of the suspension cross members to the rear most are rigged mounted. The mounts to the front are designed to flex. Periodic inspection of the brackets and bolt torque's is recommended. The bolts at the flex mounts should be tightened until they are in contact then tighten and compress the springs an additional 3/16" to 1/4".

Figure 16

CAUTION!

Before conducting maintenance or replacing parts on the ORCA system, release container pressure in a safe manner. Replacement of certain parts may require that the entire contents be completely emptied.

Orca Periodic Inspection

In order to maintain the Orca unit in good operating condition, certain system components must be inspected on a periodic basis. These components requiring periodic inspection are listed in Table 1 - Periodic Inspection.

ORCA PERIODIC INSPECTION

Inspection Item	Interval
Valves and fittings for leaks, malfunction etc.	**Monthly and during operation**
Control Wiring	**2 months**
Indicating gauges for malfunction	**6 months**
Relief valves to verify proper settings	**1 year**

Table 1 - Periodic Inspection

Pumping System

The system components are designed to give long trouble-free service. The long life of the components will be assured if a regular maintenance inspection schedule is followed.

Prior to Each Operation - Inspect for loose or damaged cabling, piping and connections, cooling obstructions, etc. Check for proper pre-start conditions.

Every Three Months - Visually inspect all components of the system. Clean and inspect all connections, electrical cabling and instrument console.

Every Twelve Months - Thoroughly check entire system. Disassemble pump completely; inspect all parts for wear and replace as necessary. Clean and repair all electrical components as needed. Repair or replace worn or damaged cabling and connectors.

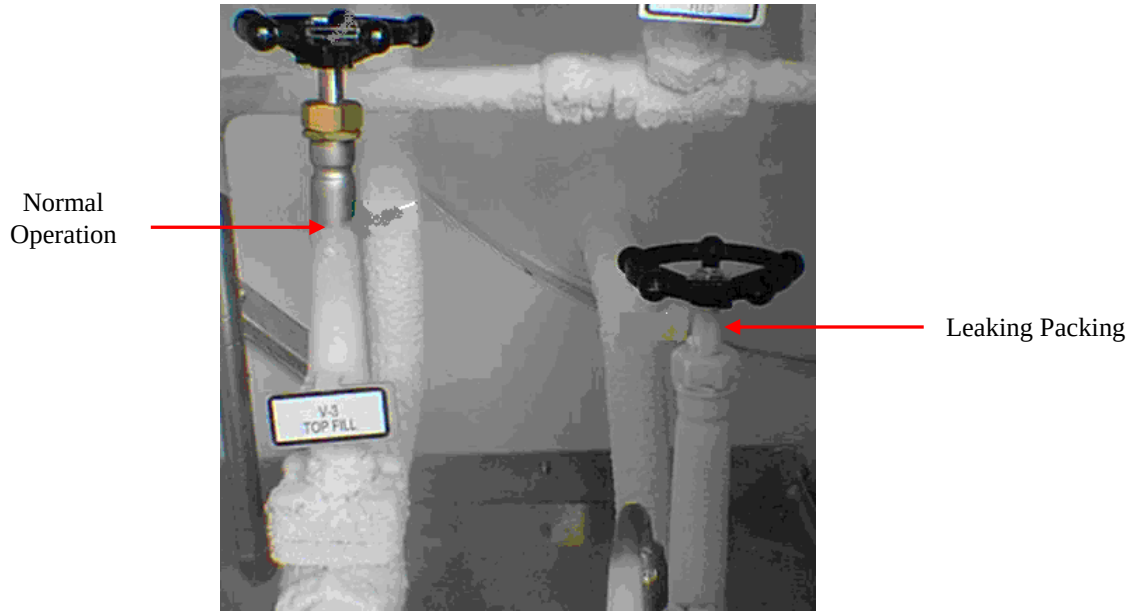
Valve Service and Maintenance

There are two leak points on a valve, through the stem packing and past the seat. Packing creates a seal between the valve stem and the valve bonnet. Cryogenic valves have an extended bonnet and stem to allow a gas trap in the bonnet. This gas trap keeps liquid from coming in contact with the packing material. A properly operating valve will have a frost line about 2/3 of the way up the stem, as shown on the top fill valve in figure 16 below. However, if there is a leak in the packing, cold gas or liquid can pass across the packing material causing it to shrink and leak more. This packing leak is evident by the frost line extending up to the top of the stem. An example of this is shown on the valve on the right side of figure 14.

Leaks through the packing will be evident at the valve stem just above the bonnet and packing nut. If this has happened, repairs are necessary to restore the valve's original functionality.

Before the valve can be repaired, it must be warmed. Tightening the packing while the packing is cold (cryogenic temperature) can damage the packing material and will not stop the leaking.

Figure 17 Frost Line Comparison.



Once the valve stem has warmed (frost has melted), proceed with the following steps:

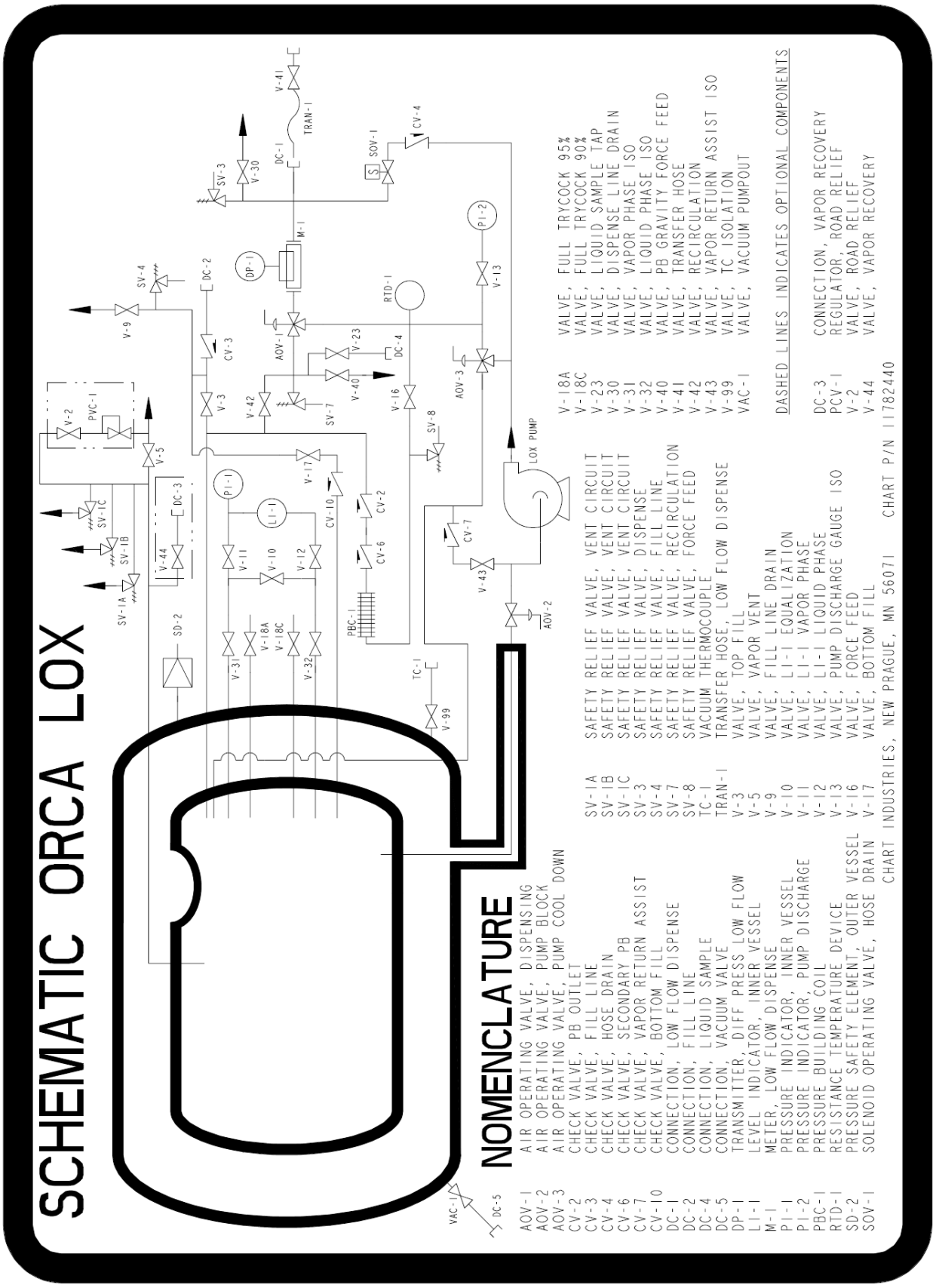
1. Loosen the packing lock nut (nut directly below the packing nut)
2. Tighten the packing nut approximately 1/8 of a turn.
3. Operate the valve to assure the packing is not too tight (over tightened packing will make operation of the valve difficult).

If leaks persist repeat above, if the leak is not fixed the packing may be damaged and should be replaced. Refer to the Repair Section of this manual.

Section 3 Plumbing Cabinet Components & Systems

Roadside Center Curbside

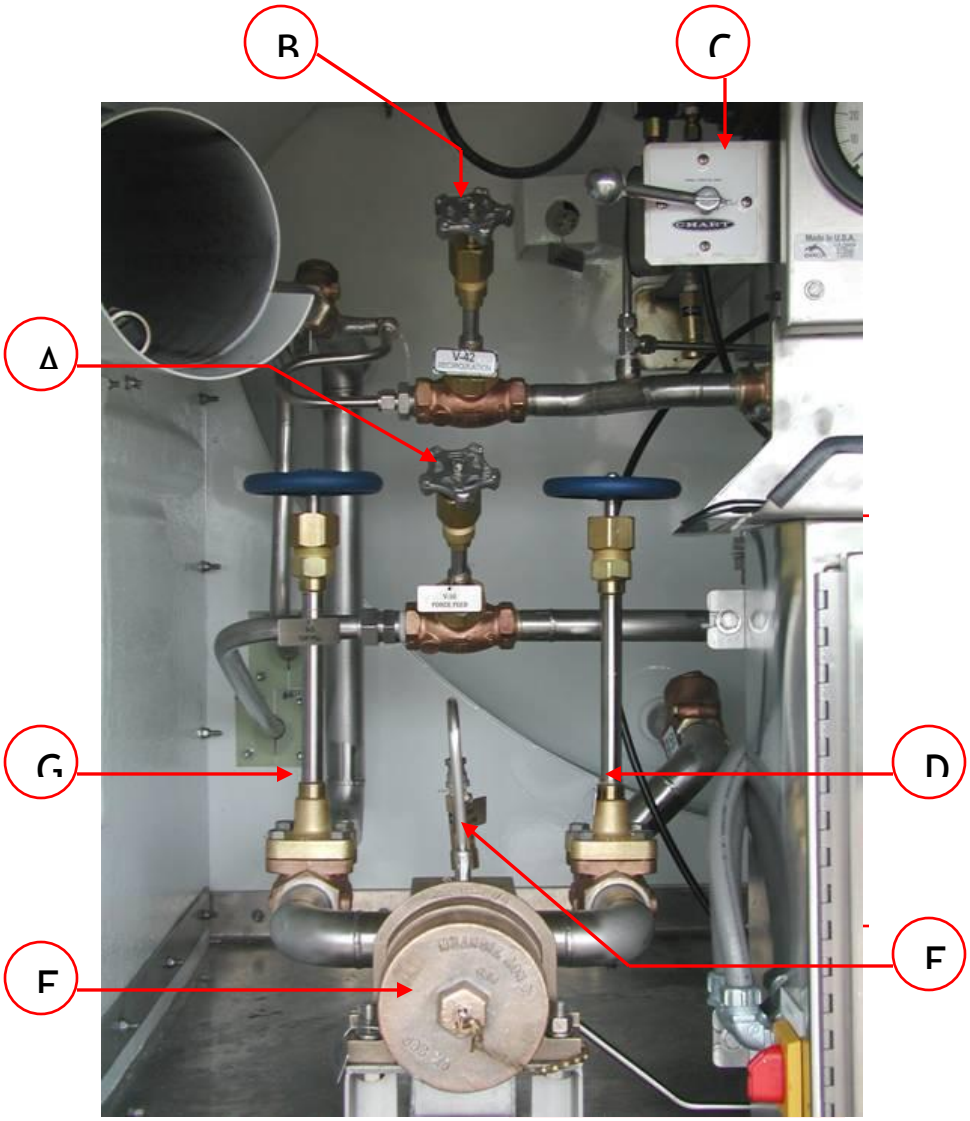
This is a view of an External Pump Orca plumbing Cabinet. In this section we will discuss in detail, Plumbing cabinet components and systems. To aid in this we will break the Cabinet into 3 areas. Roadside, Center (system control and monitoring), and Curbside.



DESIGNATOR	DESCRIPTION	MANUFACTURER	P/N
AOV-1	AIR OPERATING VALVE, DISPENSING	WORCESTER VALVE BALL W/ACTUATOR 1039SW 90D N.C. 12VDC COIL	10800108
AOV-2	AIR OPERATING VALVE, PUMP BLOCK	CRYOLAB VALVE GLOBE SS VJ 2NPS T-PAT W/PNEUMATIC ACTUATOR	11832304
AOV-3	AIR OPERATING VALVE, PUMP COOL DOWN	VALVE BALL DIV BRS 1FPT WORCESTER #1" W/ACTUATOR 1039SW 90D N.C. 12VDC COIL	10800108
CV-2	CHECK VALVE, PB OUTLET	VALVE SWING CHECK BRZ 1NPT POWELL #560Y CL 200 MSS-SP80	1712152
CV-3	CHECK VALVE, FILL LINE	VALVE TEE CHECK BRS ASSY REGO #CRT000001 W/TCV8512-8	259106
CV-4	CHECK VALVE, HOSE DRAIN	VALVE CHECK BRS 1/2FPT*1/2FPT GENERANT CV-503B-T-5 O2 CLN	11051090
CV-6	CHECK VALVE, SECONDARY PB	VALVE SWING CHECK BRZ 1NPT POWELL #560Y CL 200 MSS-SP80	1712152
CV-7	CHECK VALVE, VAPOR RETURN ASSIST	VALVE SWING CHECK BRZ 1NPT POWELL #560Y CL 200 MSS-SP80	1712152
CV-10	CHECK VALVE, BOTTOM FILL	VALVE CHECK BRZ 1-1/2NPT FEI#M507J MILWAUKEE BRAND	11721655
DC-1	CONNECTION, LOW FLOW DISPENSE	SPIN ADPTR ASSY OXYGEN	11751424
DC-2	CONNECTION, FILL LINE	SERVICE ASSY ORCA OXY 1-1/2CGA	10889448
DC-4	CONNECTION, LIQUID SAMPLE	ADDED BY CUSTOMER	
DP-1	TRANSMITTER, DIFF PRESS LOW FLOW	TRANSMITTER DP 160 TO 1600MBAR SIEMENS #7MF4433-3FA22-1NC1-Z-	10945294
LI-1	LEVEL INDICATOR, INNER VESSEL	DIFF PG 6"D 0-100"H2O/CM MW MIDWEST #116 O2 CLN 3/4" CBM	13541771
M-1	METER, LOW FLOW DISPENSE	METER ELEMENT ASSY ORCA LOX	257905
PI-1	PRESSURE INDICATOR INNER VESSEL	PG 4-1/2"DIAL 0-100PSI 1/4"LBM AMETEK U.S. GAUGE #1903 B31.31	11707191
PI-2	PRESSURE INDICATOR PUMP DISCHARGE	PG 4-1/2"DIAL 0-600PSI 1/4"LBM AMETEK U.S. GAUGE #1903 B31.3	11702121
PBC-1	PRESSURE BUILDING COIL	PB COIL ORCA	11739450
RTD-1	RESISTANCE TEMPERATURE DEVICE	TEMPERATURE SENSOR 3.5" LG RTD BURNS #200A10BN035	11783362
SD-2	PRESSURE SAFETY ELEMENT, OUTER VESSEL	PLATE VACUUM LIFT 6"	4410611
SOV-1	SOLENOID OPERATNG VALVE, HOSE DRAIN	VALVE SOLENOID 1/2FPT NO 12VDC MAGNATROL #E29LR62Z W/CL H	10856531
	SAFETY RELIEF VALVE, VENT CIRCUIT	SPENCE #710NACD-A050 ASME RV BRZ 1/2MPT*3/4FPT 50PSI	1810732
	SAFETY RELIEF VALVE, VENT CIRCUIT	SPENCE #710NACD-A050 ASME RV BRZ 1/2MPT*3/4FPT 50PSI	1810732
	SAFETY RELIEF VALVE, VENT CIRCUIT	SPENCE #710NBCE-A070 ASME RV BRZ 1/2MPT*1FPT 70PSI	12908411
SV-3	SAFETY RELIEF VALVE, DISPENSE	RV BRS 1/4MPT*1/2FPT 400PSI O2 GENERANT #CRVP4-250-B-K-400	11670000
SV-4	SAFETY RELIEF VALVE, FILL LINE	RV BRS 1/4MPT*1/2FPT 400PSI O2 GENERANT #CRVP4-250-B-K-400	11670000
SV-7	SAFETY RELIEF VALVE, RECIRCULATION	RV BRS 1/4MPT*1/2FPT 400PSI O2 GENERANT #CRVP4-250-B-K-400	11670000
SV-8	SAFETY RELIEF VALVE, FORCE FEED	RV BRS 1/4MPT*1/2FPT 400PSI O2 GENERANT #CRVP4-250-B-K-400	11670000
TC-1	VACUUM THEROCOUPLE	TC GAUGE S/A HASTINGS DV-6R	5519819
TRAN-1	TRANSFER HOSE, LOW FLOW DISPENSE	TRANS HOSE LINED 1"ID*16'OAL 1"FPT*1"MPT WITH 3/4" LINER	11702585
V-3	VALVE, TOP FILL	VALVE GLOBE BRZ 1-1/2PS W/3"SS STUBS REGO #BK9412T-PC	10927184
V-5	VALVE, VAPOR VENT	VALVE GLOBE BRZ 1PS W/3"STUBS REGO #BK9408T-PC	10927192
V-9	VALVE, FILL LINE DRAIN	VALVE SHUTOFF 3/8FPT REGO #T9453	11905981
V-10	VALVE, LI-1 EQUALIZATION	VALVE SHUTOFF SS 1/4OD*1/4ODT WHITEY #SS-1VS4-SC-11	11701435
V-11	VALVE, LI-1 VAPOR PHASE	VALVE SHUTOFF SS 1/4OD*1/4ODT WHITEY #SS-1VS4-A-SC11	11701443
V-12	VALVE, LI-1 LIQUID PHASE	VALVE SHUTOFF SS 1/4OD*1/4ODT WHITEY #SS-1VS4-A-SC11	11701443
V-13	VALVE, PUMP DISCHARGE GAUGE ISO	VALVE SHUTOFF SS 1/4OD*1/4ODT WHITEY #SS-1VS4-A-SC11	11701443
V-16	VALVE, FORCE FEED	VALVE GLOBE BRS 1FPT REGO #BK8408T B31.3	1718772

DESIGNATOR	DESCRIPTION	MANUFACTURER	P/N
V-17	VALVE, BOTTOM FILL	VALVE GLOBE BRZ 1-1/2PS W/3"SS STUBS REGO #BK9412T-PC	10927184
V-18A	VALVE, FULL TRYCOCK 95%	VALVE SHUTOFF 3/8FPT REGO #T9453	11905981
V-18C	VALVE, FULL TRYCOCK 90%	VALVE SHUTOFF 3/8FPT REGO #T9453	11905981
V-23	VALVE, LIQUID SAMPLE TAP	VALVE SHUTOFF 3/8FPT REGO #T9453	11905981
V-30	VALVE, DISPENSE LINE DRAIN	VALVE SHUTOFF 3/8FPT REGO #T9453	11905981
V-31	VALVE, VAPOR PHASE ISO	VALVE ANGLE BRS 1/4ODT*1/4MPT NUPRO #B-4JNA1- B31.3	1711862
V-32	VALVE, LIQUID PHASE	VALVE ANGLE BRS 1/4ODT*1/4MPT NUPRO #B-4JNA1- B31.3	1711862
V-40	VALVE, PB GRAVITY FORCE FEED	VALVE SHUTOFF 3/8FPT REGO #T9453	11905981
V-41	VALVE, TRANSFER HOSE	VALVE BALL BRS 1FPT WORCESTER 1NC4416PM-SE-V32 W/	11007881
V-42	VALVE, RECIRCULATION	VALVE GLOBE BRS 1FPT REGO #BK8408T B31.3	1718772
V-43	VALVE, VAPOR RETURN ASSIST ISO	VALVE GLOBE BRS 1FPT REGO #BK8408T B31.3	1718772
V-99	VALVE, TC ISOLATION		10482381

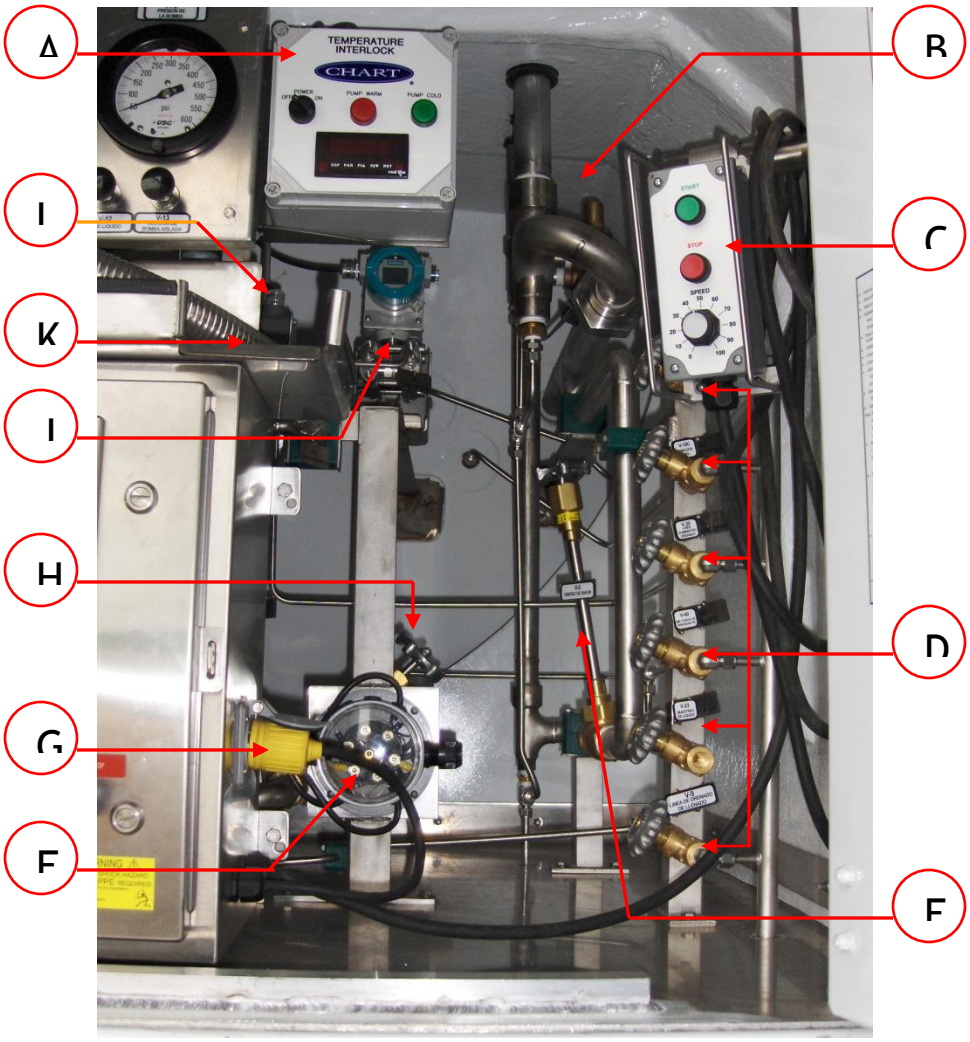
Plumbing Cabinet-Roadside



Plumbing Cabinet Roadside				
Item	Tag	Part No	Qty	Description
A	V-16	1718772	1	Valve, Force Feed (REGO#BK8408T, 1" Globe Valve)
B	V-42	1718772	1	Valve, Recirculation (REGO#BK8408T, 1" Globe Valve
C		1711312	1	Valve Manual 4-Way BARKSDALE #9021-M-Z
D	V-17	10927184	1	Valve, Bottom Fill REGO#BKA9412, 1 1/2"Globe Valve
E	SV-4	11670000	1	Safety Relief Valve, Fill Line

Plumbing Cabinet Roadside				
Item	**Tag**	**Part No**	**Qty**	**Description**
F	DC-2	10889448	1	1-1/2" CGA Fill Assy. Oxygen Service
F-1	DC-2	11708776	1	2" CGA Fill Assy. Oxygen Service
F-2	DC-2	11704572	1	3" CGA Fill Assy. Oxygen Service
F-3	DC-2	11816321	1	3" CGA Fill Assy. Oxygen Service
G	V-3	10927184	1	Valve, Top Fill (REGO#BKA9412, 1 1/2" Globe Valve)

Plumbing Cabinet Curbside

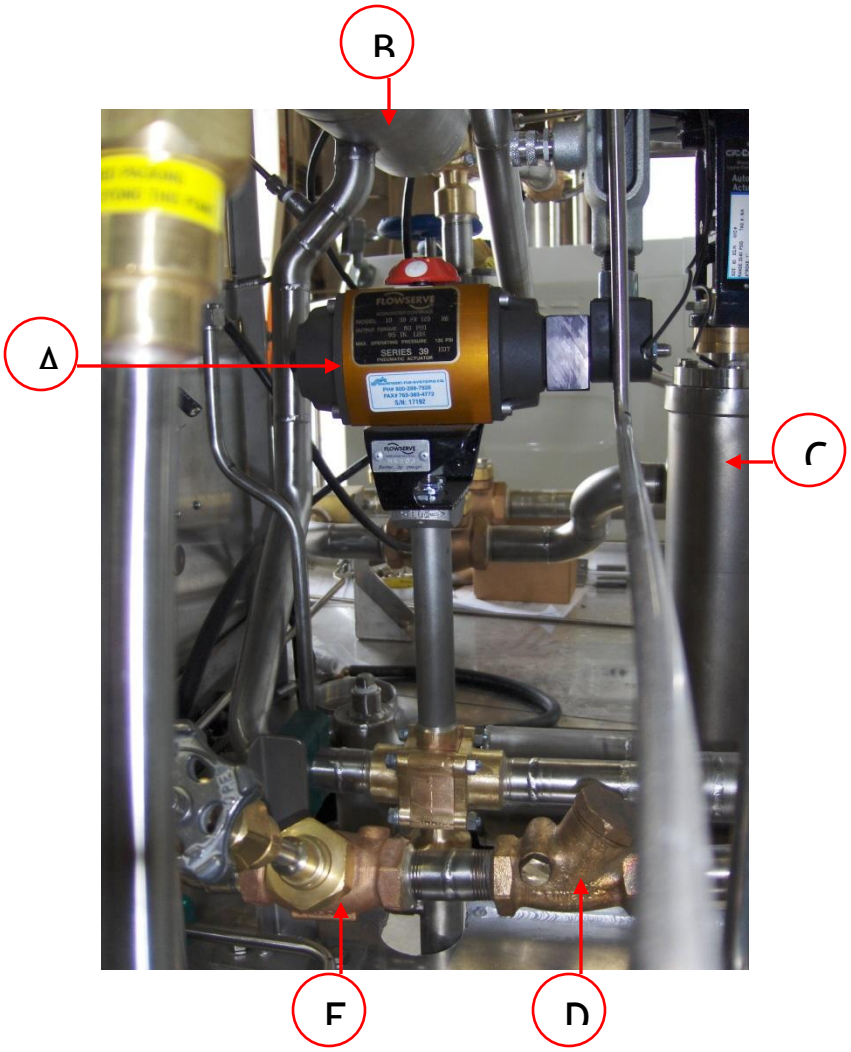


* Contact Chart 1-800-400-4683

Plumbing Cabinet Curbside				
Item	**Tag**	**Part No**	**Qty**	**Description**
A		11803503	1	Temperature Interlock Assy
B	SV-1A/1B	1810732	2	Relief Valve 1/2 x 3/4 50 PSI Spence
B-1	SV-1C	1811812	1	Relief Valve 1/2 x 3/4 70 PSI Spence
C		11694600	1	Remote Pendant
C-1		11911213	1	Remote Pendant Enclosure
C-2		11911248	1	Remote Pendant Cord-16'
C-3		11911256	1	Start Button-Green

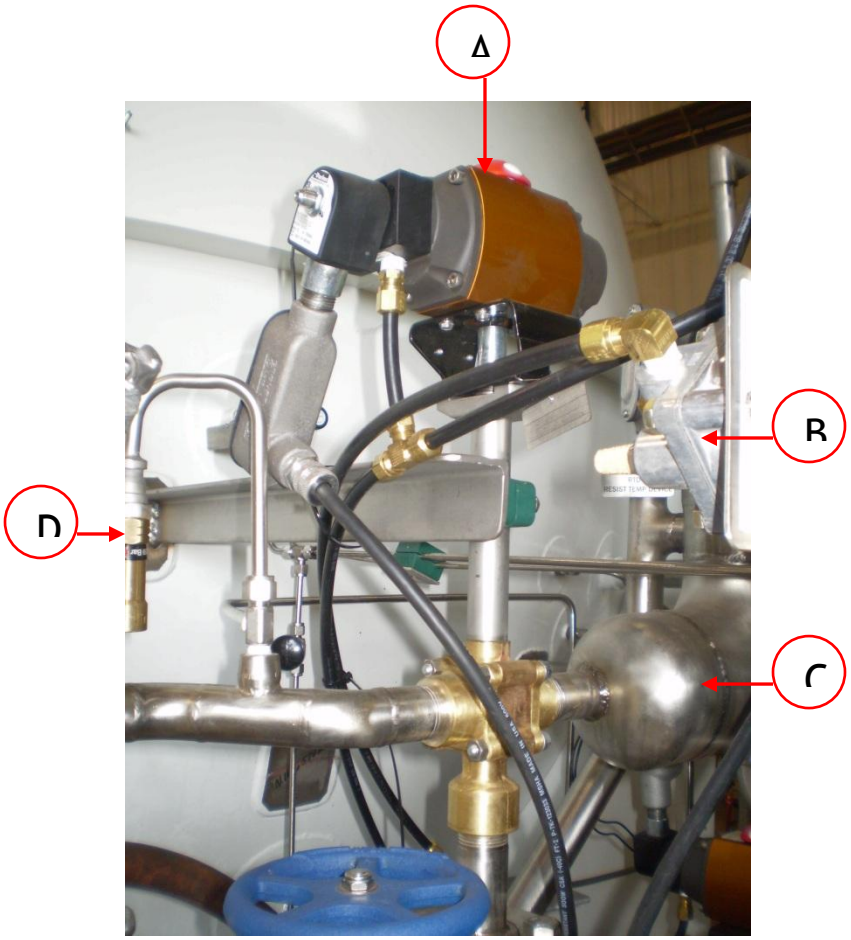
Plumbing Cabinet Curbside				
Item	**Tag**	**Part No**	**Qty**	**Description**
C-4		11912339	1	Start Button Contact Block-NO
C-5		11911281	1	Stop Button-Red
C-6		11912399	1	Stop Button Contact Block-NO
C-7		11911301	1	Pump Speed Control Dial
C-8		11911088	1	Remote Pendant Locknut
C-9		11911096	1	Remote Pendant Strain Relief
D-1	V-18a	1713202	1	95% Trycock Valve (REGO #T9453, 3/8")
D-2	V-18c	1713202	1	90% Trycock Valve (REGO #T9453, 3/8")
D-3	V-40	1713202	1	P.B. Force Feed Drain Valve
D-4	V-33	1713202	1	Sump Purge Valve
D-5	V-23	1713202	1	Liquid Sample Valve (REGO #T9453, 3/8")
D-6	V-9	11905981	1	Valve, Fill Line Drain (REGO #T9453, 3/8")
E	V-5	10927192	1	Vapor Vent Valve (REGO #BKY8408, 1" Globe Valve)
E-1	V-5	10997801	1	Globe Valve Packing Kit
E-2	V-5	10997844	1	Globe Valve O-Ring Kit
E-3	V-5	10997895	1	Globe Valve Seat Kit
F		913746	1	Box Junction BETTS #470041
G		11910958	1	Heater Plug 120VAC
G-1		11910982	1	Heater Cord120VAC 16-3
G-2		11910991	1	Heater Cord Locknut
G-3		11911002	1	Heater Cord Strain Relief
H	V-43	1718772		Valve, Vapor Return Assist ISO GLOBE BRS 1FPT REGO #BK8408T
J	DP-1	10945294	1	Transmitter DP 160 TO 1600MBAR SIEMENS
K		11702585	1	Dispense Hose Lined 3/4" I.D. 16' OAL
L	SOV-1	10856531		Hose Drain Solenoid

Plumbing Cabinet Cont.



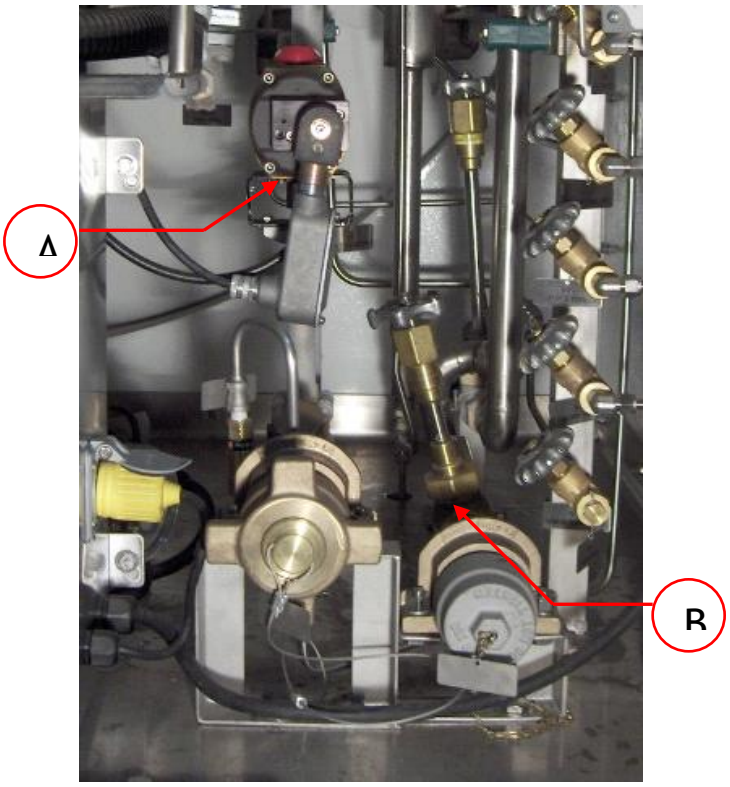
Plumbing Cabinet Cont.				
Item	**Tag**	**Part No**	**Qty**	**Description**
A	AOV-3	10800108	1	Air Operating Valve, Pump Cool Down (Valve Ball Div BRS 1FPT WORCESTER #1" W/ACTUATOR 1039SW 90D N.C. 12VDC COIL
A-1	RK	10802445	1	Kit Repair Ball Valve 1"Series WORCESTER #CRK44PM-1
A-2	RK	11890061	1	Repair Part Coupling Actuator WORCESTER
B	M-1	257905	1	Meter Element Assy ORCA LOX
C	AOV-2	11832304	1	AOV Pump Block Valve, (CRYOLAB VALVE GLOBE)
D	CV-7	1712152	1	Check Valve, Vapor Return Assist (1NPT POWELL)
E	V-43	1718772	1	Valve, Vapor Return Assist ISO VALVE GLOBE BRS 1FPT REGO #BK8408T B31.3
E-1	RK	10752601	1	Kit Valve Repair for #1718782 & #1718772 REGO #BK8400-80BJ **SEAT DISC ASSY REPAIR KIT**
E-2	RK	10997895	1	Valve PT Seat #BK8400-80BJ FOR REGO #BK9408 1" VALVE **For Valves Built After 1-1-91**
E-3	RK	10997924	1	Valve PT Top Works #BK8408-KIT FOR REGO #BK8408

Plumbing Cabinet Cont.



Plumbing Cabinet Roadside				
Item	**Tag**	**Part No**	**Qty**	**Description**
A	AOV-1	10800108	1	Air Operating Valve, Dispense Valve (Valve Ball DIV BRS 1FPT WORCESTER #1" W/ACTUATOR 1039SW 90D N.C. 12VDC COIL
A-1	RK	10802445	1	Kit Repair Ball Valve 1"Series WORCESTER #CRK44PM-1
A-2	RK	11890061	1	Repair Part Coupling Actuator WORCESTER
B		1711312	1	Valve Manual 4-Way BARKSDALE #9021-M-Z
C	M-1	257905	1	Meter Element Assy ORCA LOX
D	SV-7	11670000	1	Safety Relief Valve, Recirculation

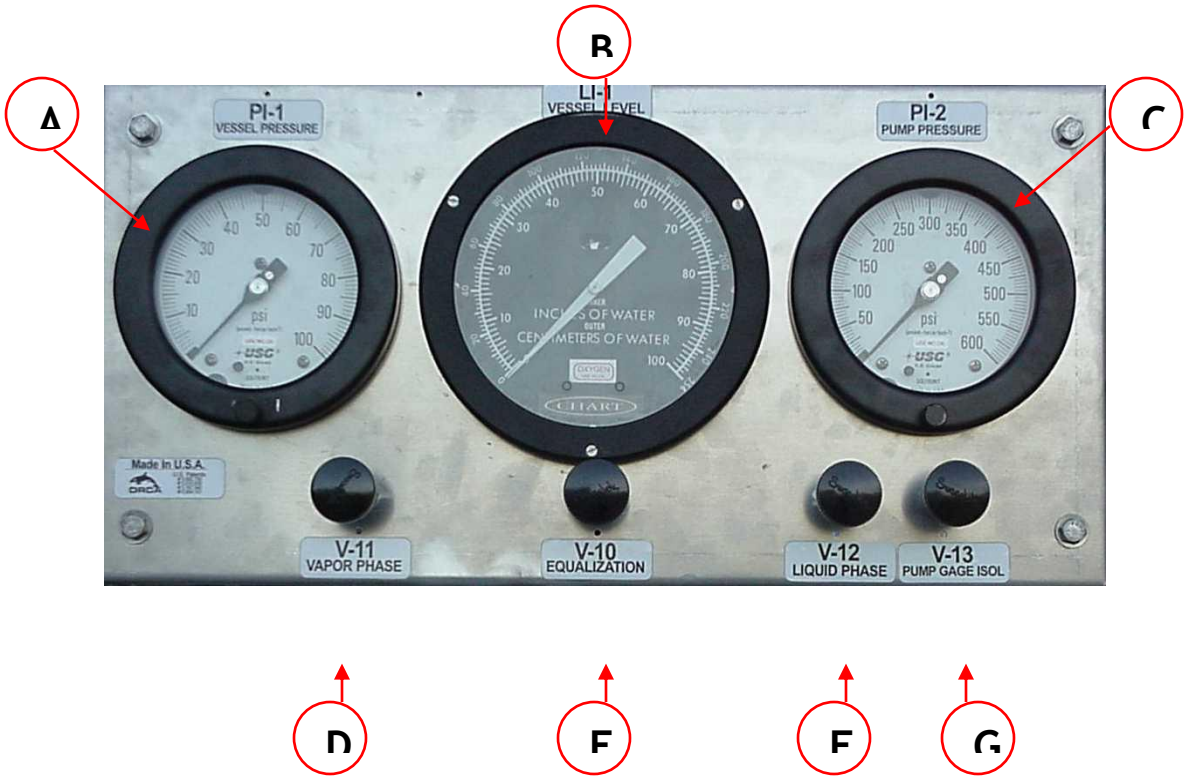
Curbside – Plumbing Cabinet (Optional Components)



Optional Components				
Item	Tag	Part No	Qty	Description
A		*	1	Air Operated Dispense Valve (High Flow)
A-1	AOV	11939460	1	Coil Only 12VDC
A-2	AOV	11879583	1	Actuator w/Solenoid & Coil 12VDC
A-3	AOV	11890061	1	Repair Kit, Actuator Coupling
B		10532924	1	Vapor Recovery Kit

* Contact Chart 1-800-400-4683

Control Gauge Panel



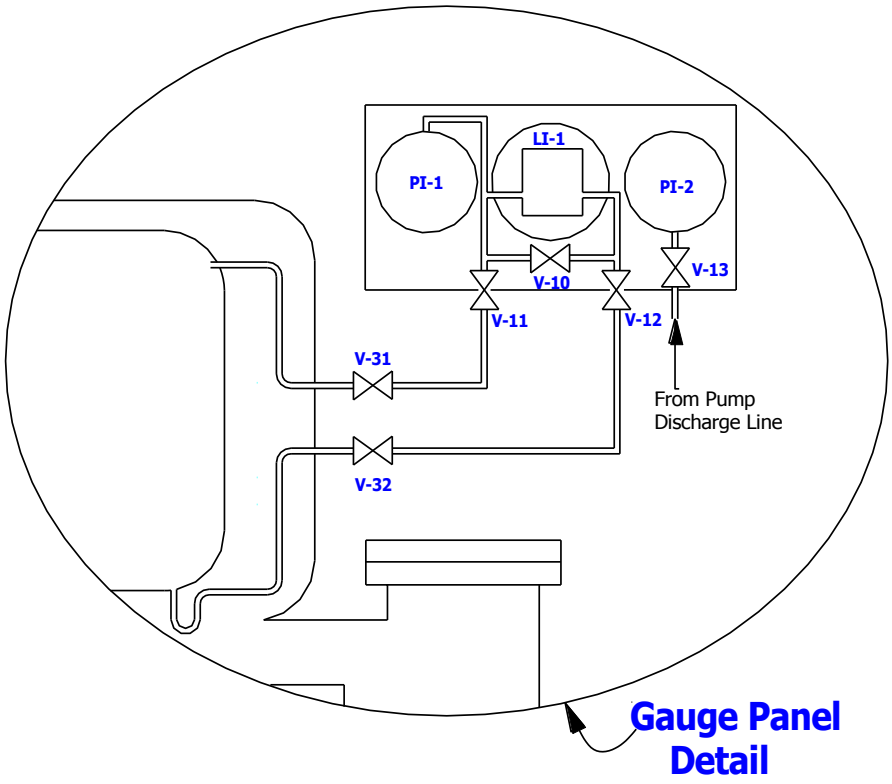
Gauge Panel				
Item	Tag	Part No	Qty	Description
A	PI-1	11707191	1	Pressure Indicator, Inner Vessel
B	LI-1	11532088	1	Liquid Level Indicator, Inner Vessel
C	PI-2	11702121	1	Pressure Indicator, Pump Discharge
D	V-11	11701443	1	Valve Shutoff, Vapor Phase
E	V-10	11701435	1	Valve Shutoff, Equalization
F	V-12	11701443	1	Valve Shutoff, Liquid Phase
G	V-13	11701443	1	Valve Shutoff, Pump Gauge Isolation

With normal use, the gauge panel will not require any regular maintenance. However, in the event that the differential pressure gauge becomes stuck, complete the following steps to reset the gauge.

1. Crack the equalizer gauge line valve.
2. Close the vapor and liquid level valves.

Note: The gauge should read zero. If the gauge does not read zero, please refer to the gauge maintenance section of this manual.

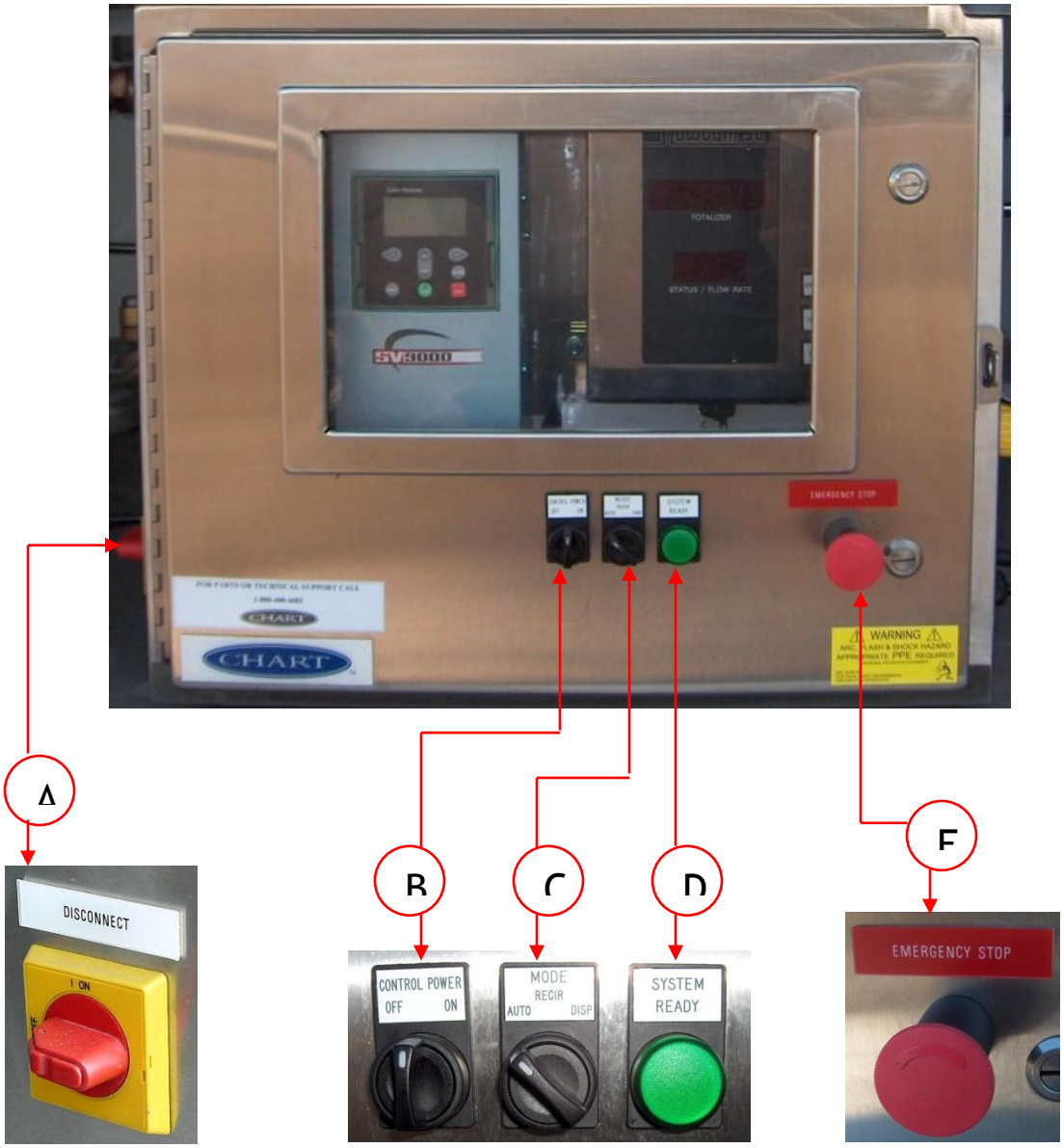
3. Open the vapor and liquid level valves.
4. Close the equalizer valve.



PI-1	Inner Vessel Pressure Indicator
LI-1	Inner Vessel Level Indicator
PI-2	Pump Discharge Pressure Indicator
V-10	Equalization Valve
V-11	Vapor Phase Valve
V-12	Liquid Phase Valve
V-13	Pump Discharge Gauge Isolation Valve
V-31	Vapor Phase Isolation Valve
V-32	Liquid Phase Isolation Valve

Control Panel

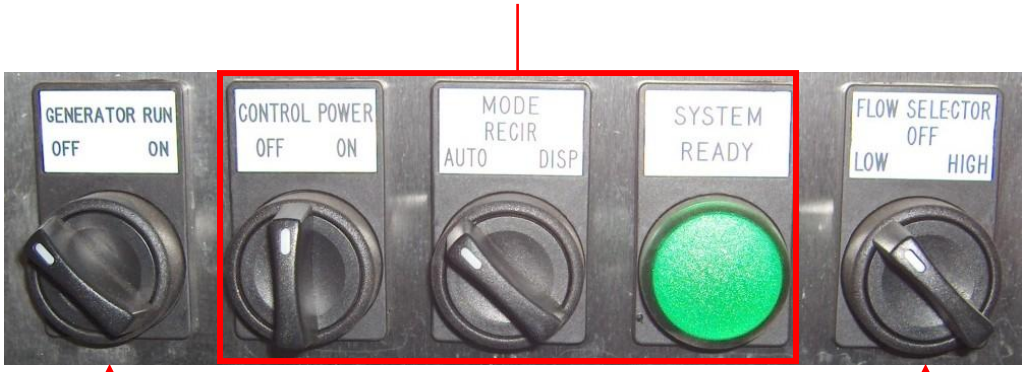
The Control Panel is protected against electrical sparking, is enclosed in a NEMA X4 Enclosure, and is UL Listed. Components include a Variable Frequency Drive (VFD), Flow Processor, and various Control Switches. The primary controls (440 Power Disconnect, Control Power, Emergency Stop, Mode Selection Switch and System Ready Light) are located on the face of the Control Panel.



Control Panel				
Item	**Part No**	**Tag**	**Qty**	**Description**
A	11910632		1	440 Pump Disconnect Switch
B	11910704		1	Control Power Switch 12VDC
B-1	11912321		1	Control Power Switch Contact Block - NC
B-2	11912339		1	Control Power Switch Contact Block - NO
C	11910691		1	Mode Selection Switch - 3 pos. Selector
C-1	11912321		1	Mode Selection Switch - Contact Block NC
C-2	11912339		1	Mode Selection Switch - Contact Block NO
D	119110616		1	System Ready Light - Green
D-1	11910624		1	System Ready Light Wiring Harness
E	11910712		1	E-Stop Push Button
E-1	11912321		1	E-Stop Contact Block-NC

Control panel Switches (Cont.)

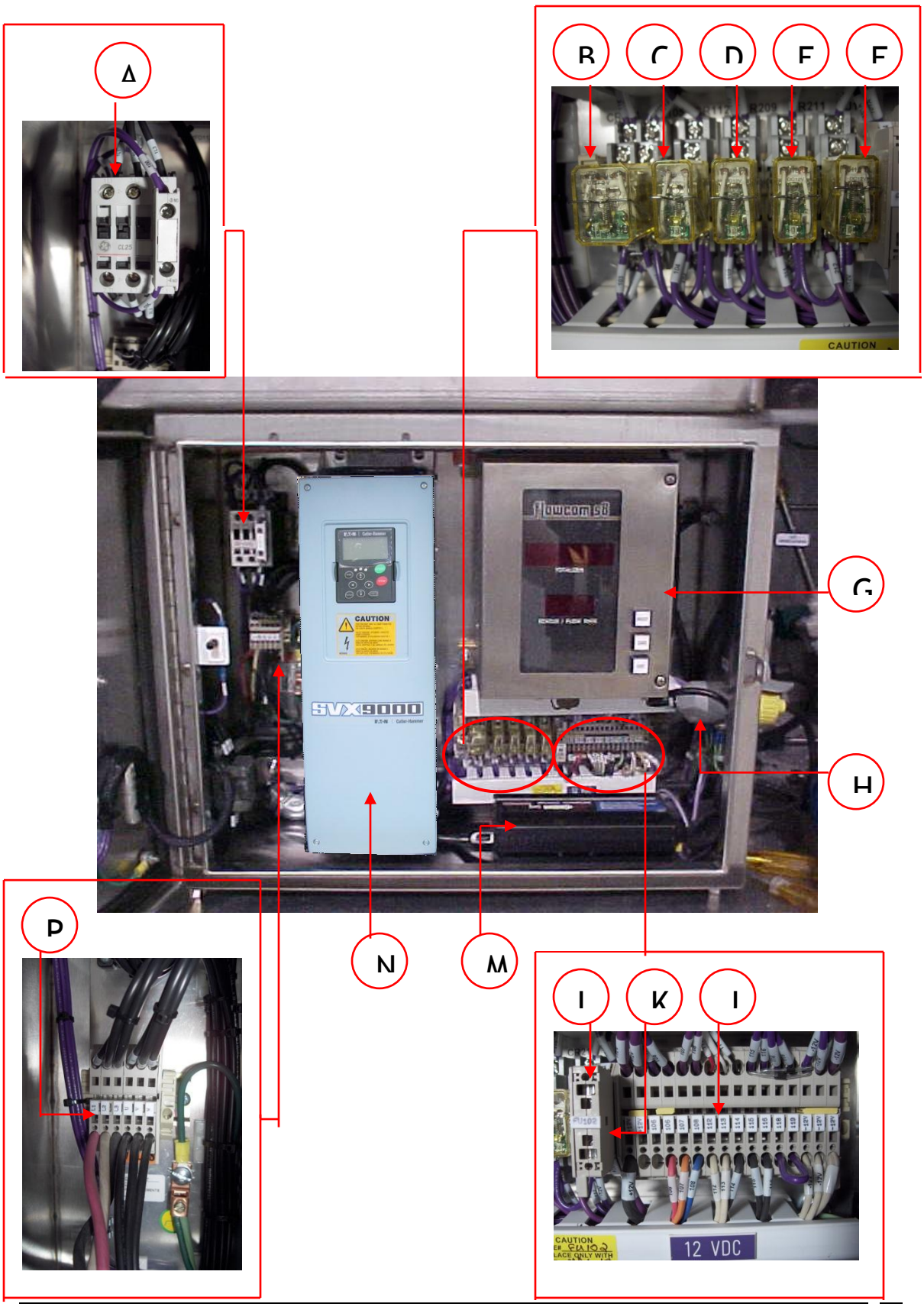
Standard Orca



Generator Run switch for Trailer mounted Orca Unit with MQ Generator

Flow Selector Switch for (Optional) Dual Dispense Orca Unit

Control Panel (Inside)



Control Panel (Inside)				
Item	**Part No**	**Tag**	**Qty**	**Description**
A	11910763	C107	1	Main Contactor 440 VAC
B	11910801	CR104	1	Contact Relay
C	11910835	CR105	1	Contact Relay
D	11910923	CR112	1	Contact Relay
E	11910860	CR209	1	Contact Relay
F	11910894	CR211	1	Contact Relay
G	10918561		1	Flowcom S8
H	11910966	RE224	1	Heater Plug Receptacle
J	11910747	TB-2	1	Terminal Block 12 VDC
K	11910798	FU102	1	Fuse Terminal
L	11910780		1	Fuse 10 Amp 32 VDC
M	11510241		1	Heater Power Inverter
N	11758925	VFD112	1	Variable Frequency Drive (LIN)
N*	11664881	VFD112*	1	Variable Frequency Drive (LAR)*
P	11910747	TB-1	1	Terminal Block
R	119010510		1	Door Interlock Switch

480 Disconnect Switch

When the 480 Disconnect switch is turned to the “ON” position, the 480VAC from the Alternator is supplied to the 480VAC Contact Block in the control cabinet. Will this switch in the “OFF” position, it is not possible to power the VFD or the Pump.

Emergency Stop Button

The Emergency Stop or “E-Stop” is located on the front of the control panel and provides an immediate way to stop the system from operating in the event should an emergency occur. When the Red Plunger is depressed, the system power will be shut off and all Air operated Valves will close. To de-activate the E-Stop button, turn the red plunger to the right until the plunger moves out.

480 VAC Control Block

U-V-W
480VAC to the Pump

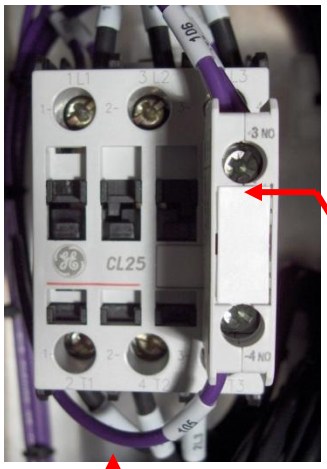
L1-L2-L3
Incoming 480VAC from
Alternator

Located to the left of the Variable Frequency Drive, is the 480VAC Control Block. The Red (L1), White (L2), and Black (L3) wires are the Three incoming legs of 480 VAC supplied from the Alternator to the Control Box.

Always be systematic when troubleshooting the 480VAC system. Use a voltmeter to measure the voltage across the Three legs in pairs. For example, measure across L1-L2, L2-L3, L1-L3.

The voltage should be near 480 Volts AC, and consistent across each pairing. Using this systematic approach, measuring at different locations in the 480 VAC loop, the technician can quickly isolate the source of the problem, whether it be between the Alternator and Control Block, or up versus downstream of the Variable frequency Drive.

Main Contactor 480VAC (With 12VDC Coil)



The Main Contactor receives 480VAC from the 480VAC Disconnect Switch. The 480VAC can only move through the Contactor when it is pulled in by activating the 12VDC Coil. When the Control Power is turned to the "ON" position via the switch on the front of the Control Panel, the 12VDC Coil is activated and pulls in the 480 Contactor, thus allowing 480VAC to travel to the Variable Frequency Drive.

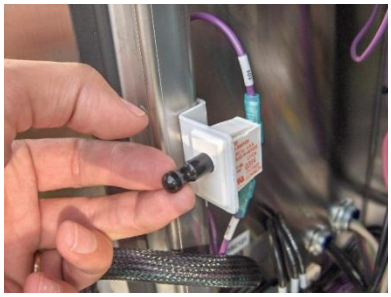
12VDC Block

480VAC Contactor

Control Power Switch

Door Interlock Switch

(P/N 11910510)



Whenever it is necessary for the Technician to have the system powered up with the Control Box door open, the Door Interlock Switch must be pulled out. Gently pull out the center pin as shown to over-ride this switch.

WARNING!

Warning: Operating the Orca system with the control box door open should only be done by qualified personnel for maintenance purposes. **440 volts is extremely deadly.** Only qualified personnel should attempt service the electrical system.

Dome Light/Work Lights

Two features of the lighting system are a Dome Light to provide light to the Plumbing Cabinet and two work lights that can be directed while making a delivery. To operate the Dome Light and Work Lights, turn on the switch located on the Plumbing Cabinet Dome Light must be turned on.

Service Lights Switch (Interior Cabinet)

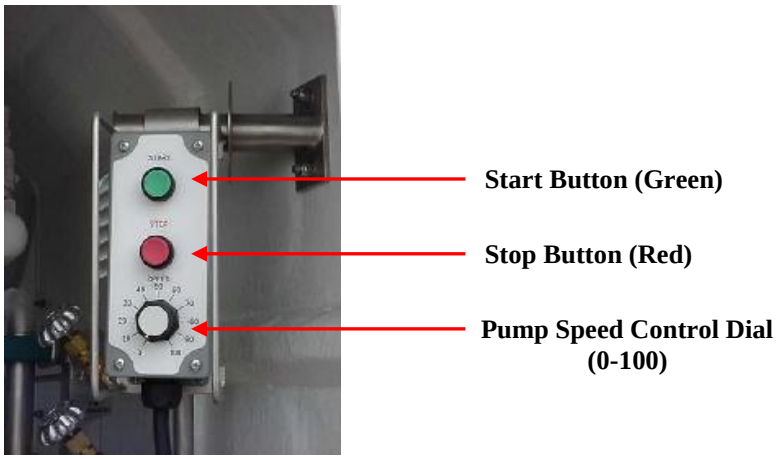
Service Lights
(Exterior Cabinet Road &Curbside)

Plumbing Cabinet Doors

The interior of the Plumbing Cabinet Doors have numerous labels which include FlowcomS8 Fault Code Chart, Variable Frequency Drive Fault Code Chart, Liquid Level Chart, Plumbing Schematic, Technical Service Data, General Troubleshooting Table, Printer, Sub-Cool Warning, and Standard Operating Procedures.

Remote Pendant

The Remote Pendant allows the operator the flexibility of system control up to 15 feet away. Loading docks and other site constraints make the Remote Pendant invaluable. The remote from the top down includes the following controls: **Start Button**-**Stop Button**-**Pump Speed Dial-15' Remote Cable**. Located inside the piping cabinet above the Remote Pendant is a hook to stow the Remote Pendant and cable. Stowing the cable in this location will minimize contact to any cryogens. This will keep the cable flexible and will prevent damage during removal.

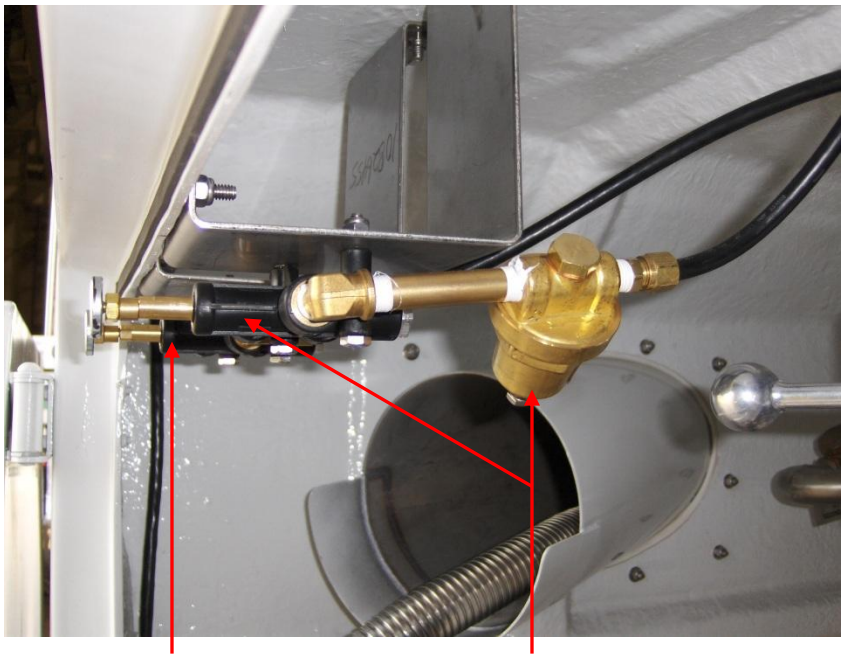


Anti-Tow Valve P/N 10469961

Located at the top of the piping cabinet and positioned to be operated when the doors close, is the Anti-Tow Valve. It is pneumatically connected to the air brakes and which can only be released when the Plumbing Cabinet Doors are closed. The Plumbing Cabinet Doors can only be closed when the Delivery Hose and Remote Pendant are stowed back in the cabinet. **This feature protects the equipment from damage in the event of a drive away accident due to the equipment not being properly stowed.** **Under no circumstances should the Anti-Tow Valve be disconnected or altered in any way!**

Pump Flood/Maintenance Valve P/N 10469961

The pump Flood Valve allows liquid to flow to the pump through the Block Valve when the Plumbing Cabinet Doors are open. This valve is pneumatically connected to the Air Brake System and can only be released when the Plumbing Cabinet Doors are closed or the Maintenance Valve is in the Maintenance position. A regulator is located downstream of the Flood Valve which allows 55 PSI to reach the Block Valve.

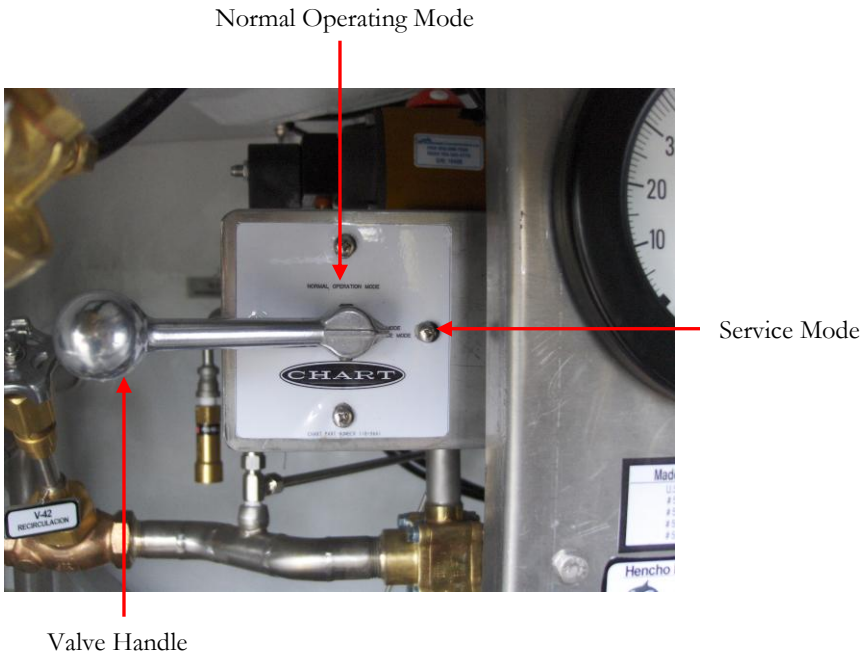


Anti-Tow Valve

Pump Flood Valve & Regulator

Maintenance Valve

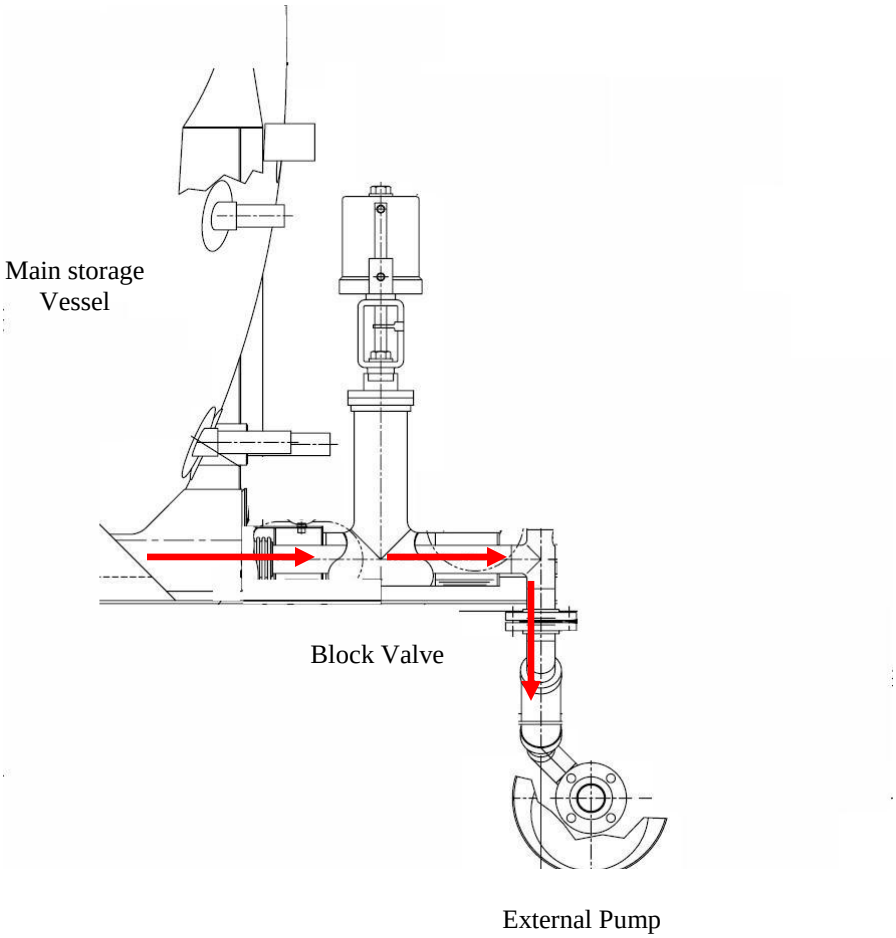
The Maintenance Valve is positioned between the Pump Flood Valve and the Block Valve in the Air supply system to the Block Valve. The Maintenance Valve has a manual handle and 2 positions that can be selected. During normal operations, the “Normal Operating Mode” is selected. With the valve in this position, air will be supplied to the Block Valve when the plumbing cabinet doors are opened, via the Pump Flood Valve. The other position that can be selected on the Maintenance Valve is the “Service Mode.” With this position selected, the rear plumbing cabinet doors can be opened without supplying air to the Block Valve and beginning the cool down of the pump.

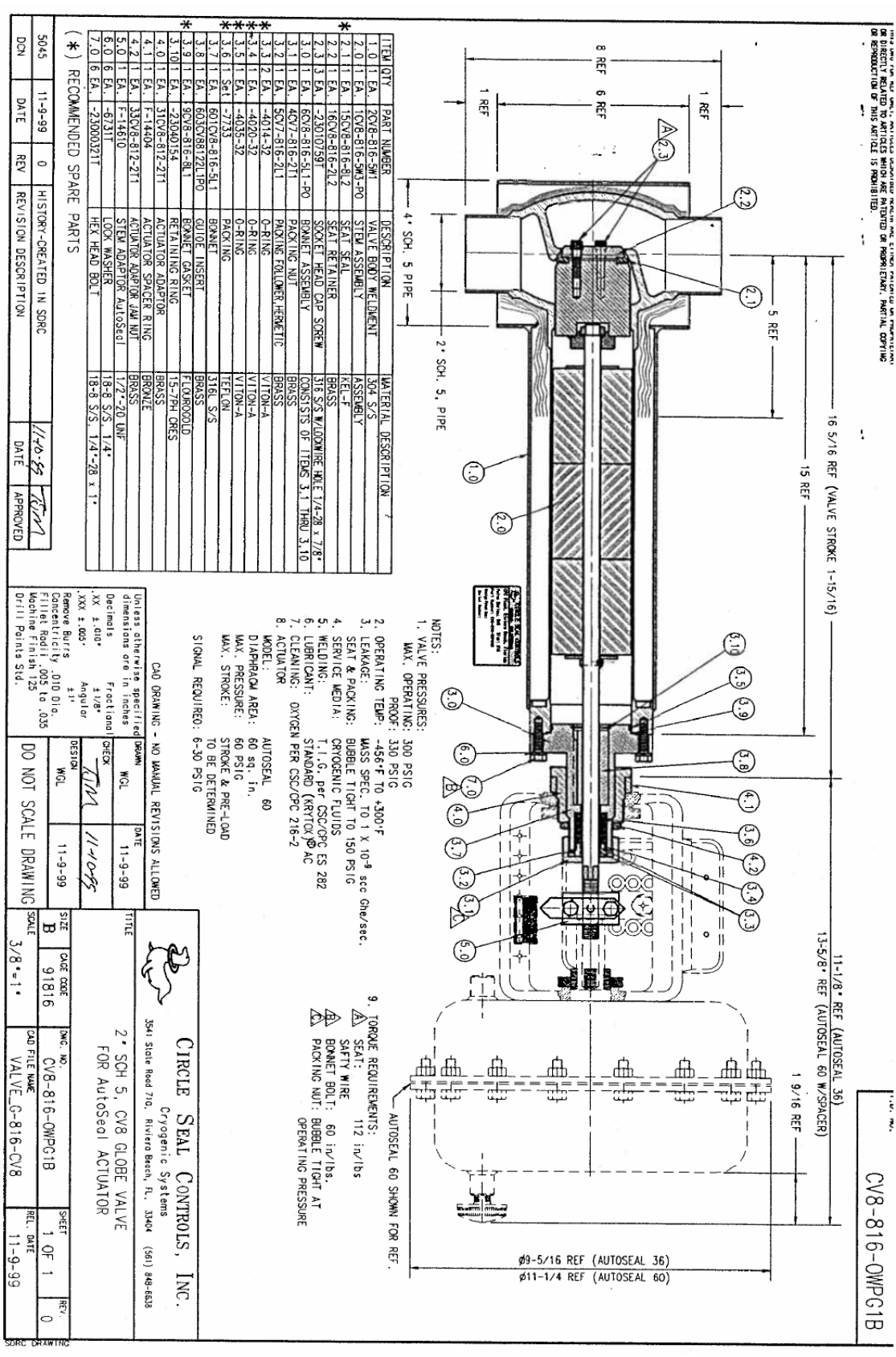


Block Valve P/N 11832304

The Block Valve is an Air Actuated Vacuum jacketed Valve manufactured by Cryolab. When opened, the Block valve provides a pathway for product to flow from the main storage vessel to the pump. When the rear cabinet doors of the Orca unit are opened, air is supplied through the Flood valve located at the upper cabinet door opening, and the Block Valve opens. The valve can be adjusted to ensure a good tight seal at the valve seat by following the manufactures instructions at:

http://www.cpc-cryolab.com/iomindex/17_0_5_1.pdf





ITEM	QTY	PART NUMBER	DESCRIPTION	MATERIAL DESCRIPTION
1.0	1 EA.	2CV8-816-SW1	VALVE BODY WELDMENT	304 S/S
2.0	1 EA.	1CV8-816-SW3-PO	STEM ASSEMBLY	ASSEMBLY
2.1	1 EA.	1SCV8-816-BL2	SEAT SEAL	KEL-F
2.2	1 EA.	16CV8-816-2L2	SEAT RETAINER	BRASS
2.3	3 EA.	-2301075BT	SOCKET HEAD CAP SCREW	316 S/S W/LOCKWIRE HOLE 1/4-28 x 7/8"
3.0	1 EA.	6CV8-816-SL1-PO	BONNET ASSEMBLY	CONSISTS OF ITEMS 3.1 THRU 3.10
3.1	1 EA.	4CV7-816-2T1	PACKING NUT	BRASS
3.2	1 EA.	5CV7-816-2L1	PACKING FOLLOWER, HERMETIC	BRASS
3.3	2 EA.	-4014-32	O-RING	VITON-A
*3.4	1 EA.	-4020-32	O-RING	VITON-A
*3.5	1 EA.	-4035-32	O-RING	VITON-A
3.6	1 Set	-7733	PACKING	TEFLON
3.7	1 EA.	6O1CV8-816-SL1	BONNET	316L S/S
3.8	1 EA.	6O3CV8822LIPO	GUIDE INSERT	BRASS
*3.9	1 EA.	9CV8-816-BL1	BONNET GASKET	FLUOROGOLD
3.10	1 EA.	-2304015A	RETAINING RING	15-7PH CRES
4.0	1 EA.	31CV8-812-2T1	ACTUATOR ADAPTOR	BRASS
4.1	1 EA.	F-14404	ACTUATOR SPACER RING	BRONZE
4.2	1 EA.	33CV8-812-2T1	ACTUATOR ADAPTOR JAM NUT	BRASS
5.0	1 EA.	F-14610	STEM ADAPTOR AutoSeal	1/2"-20 UNF
6.0	6 EA.	-67311	LOCK WASHER	18-8 S/S, 1/4"
7.0	6 EA.	-2300321T	HEX HEAD BOLT	18-8 S/S, 1/4"-28 x 1"

(*) RECOMMENDED SPARE PARTS

NOTES:
1. VALVE PRESSURES:
   MAX. OPERATING: 300 PSIG
   PROOF: 330 PSIG
2. OPERATING TEMP: -456°F TO +300°F
3. LEAKAGE:
   SEAT & PACKING: BUBBLE TIGHT TO 150 PSIG
   MASS SPEC. TO 1 X 10^{-9} scc Ghe/sec.
4. SERVICE MEDIA: CRYOGENIC FLUIDS
5. WELDING: T.I.G. per CSC/CPC ES 282
6. LUBRICANT: STANDARD (KRYTOX® AC
7. CLEANING: OXYGEN PER CSC/CPC 216-2
8. ACTUATOR
   MODEL: AUTOSEAL 60
   DIAPHRAGM AREA: 60 sq. in.
   MAX. PRESSURE: 60 PSIG
   MAX. STROKE: STROKE & PRE-LOAD TO BE DETERMINED
   SIGNAL REQUIRED: 6-30 PSIG
9. TORQUE REQUIREMENTS:
   SEAT: 112 in/lbs
   A SAFTY WIRE
   B BONNET BOLT: 60 in/lbs.
   C PACKING NUT: BUBBLE TIGHT AT OPERATING PRESSURE

DCN	DATE	REV	REVISION DESCRIPTION	DATE	APPROVED
5045	11-9-99	0	HISTORY-CREATED IN SDRC	11-10-99	

CAD DRAWING - NO MANUAL REVISIONS ALLOWED

Unless otherwise specified dimensions are in inches
Decimals Fractional ± 1/8"
.XX ± .010" Angular ± 1°
.XXX ± .005"
Remove Burrs
Concentricity .010 Dia.
Fillet Radii .005 to .035
Machine Finish 125
Drill Points Std.

DRAWN WGL 11-9-99
CHECK
DESIGN WGL 11-9-99

DO NOT SCALE DRAWING

CIRCLE SEAL CONTROLS, INC.
Cryogenic Systems
3541 State Road 710, Riviera Beach, FL. 33404 (561) 848-6638

TITLE
2" SCH 5, CV8 GLOBE VALVE
FOR AutoSeal ACTUATOR

SIZE	CAGE CODE	DWG. NO.	SHEET	REV.
B	91816	CV8-816-OWPC1B	1 OF 1	0
SCALE		CAD FILE NAME	REL. DATE	
3/8"=1"		VALVE_G-816-CV8	11-9-99	

SDRC DRAWING

Heater/Inverter

The Cutler-Hammer Variable Frequency Drive (VFD) has internal temperature switches that do not allow the VFD to operate at temperatures **below 20° degrees F. It is recommended plugging the heater into the 120 VAC External Plug in on nights that drop below 32° degrees F. During the days deliveries the Power Inverter can be used to power the heater by utilizing the Power Inverter On/Off Switch. The Power Inverter can be left on during deliveries or in-transit due to the fact of the Panel Heater being thermostatically controlled.** The inverter can be used to power any 120 VAC device requiring less than 350 watts of power using the additional 120VAC Receptacles on the side of the Power Inverter.

Control Panel Heater

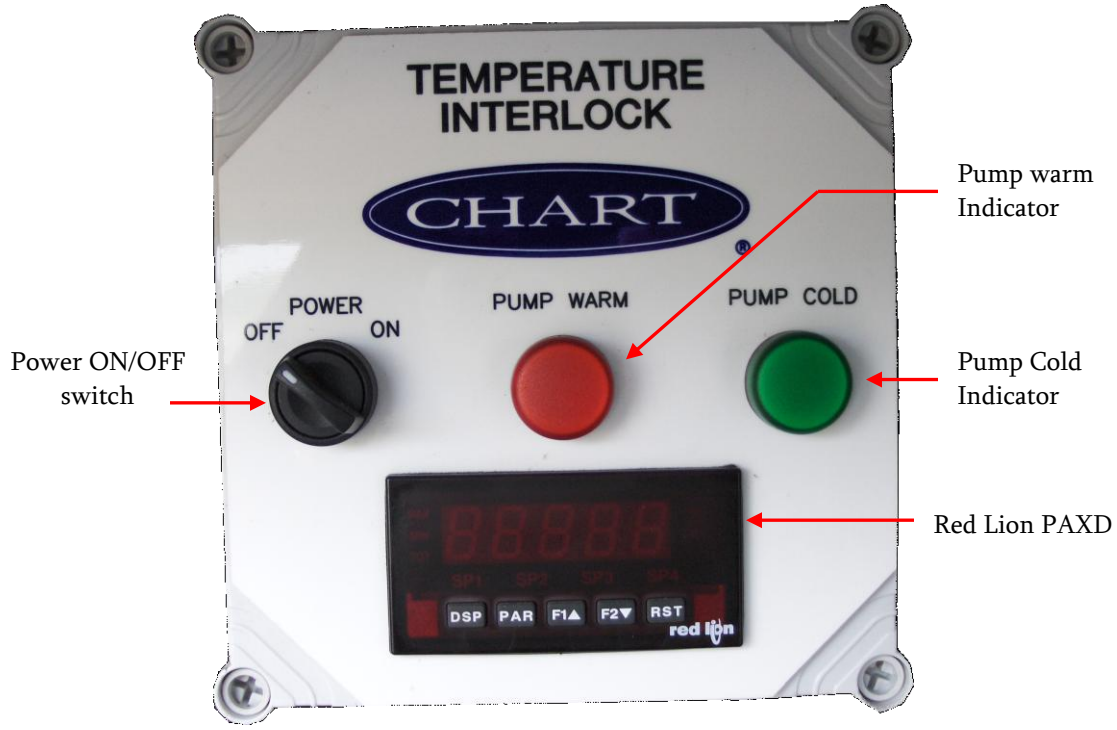
Power Inverter

Heater Bypass Plug

Temperature Interlock (Optional) P/N 11803503

The Temperature Interlock is an optional feature designed to ensure proper pump cool down before operating. The Temperature Interlock takes the away the guesswork of pump cool down time and in doing so, protects the pump from needless damage caused by a lack of pump prime.

To start the system the operator simply turns the power switch to the ON position. If the Pump is above the preset temperature for pump operation, the RED "PUMP WARM" light will be illuminated. A temperature value will appear on the Red Lion screen on the lower front face on the Temperature Interlock panel. This value, measured by a thermocouple reflects the temperature at the discharge side of the pump. During the factory calibration process, a temperature value is programmed into the Red Lion which reflects adequate cool down of the pump for operation. This is determined by flooding the pump with product through the Block Valve until and monitoring the temperature value on the Red Lion.



When the temperature will not drop any further, this Value is entered into the Red Lion Programming. The total time of the cool down is also recorded. This time, plus an additional 5 minute delay is entered into the Red Lion Programming to ensure proper and adequate cool down before the GREEN "PUMP COLD" light illuminates. Once these conditions have been met, the pump can be operated.

The Temperature Interlock is a 12 VDC component and is wired into the Variable Frequency Drive. Because of this, until the Pump preset conditions are met, the Variable Frequency Drive will not operate to power the Pump.

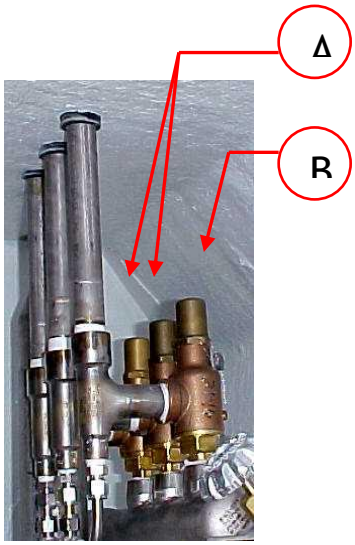
For information on programming, visit the following web site.

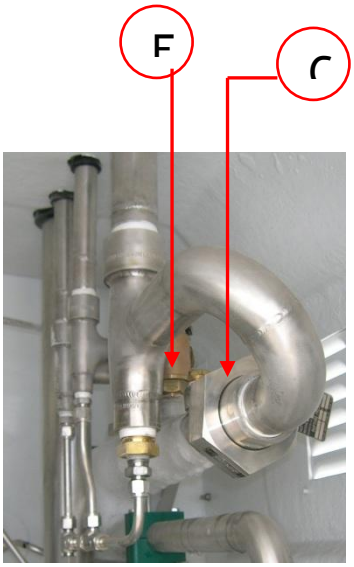
http://www.redlion.net/Products/Groups/DCVolt/PAXD/Docs/04024.pdf

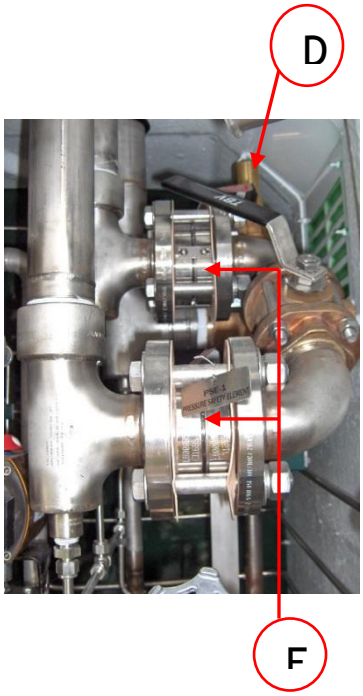
Temperature Interlock	
Item	**Part Number**
Temperature Interlock Assy.	11803503
Thermocouple probe	11804389
Red Lion	11798185
Enclosure	11803706
Switch 2 Position	11758811
Light green	11804362
Light Red	11804371

Vent Circuit

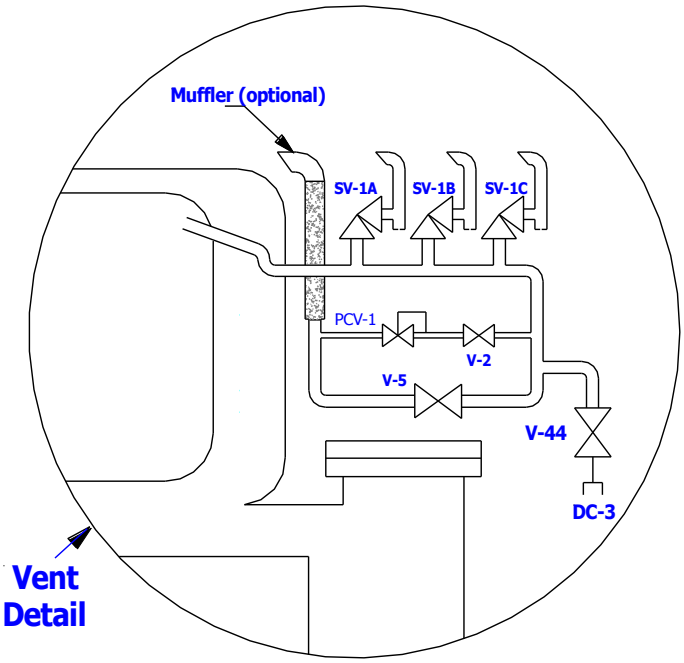
The Vapor Vent Valve (V-5), when open, relieves the vapor pressure in the ORCA Tank. The Vent Circuit includes a Primary Safety Relief Valve (SV-1), Secondary Relief Valve (SV-2) , and a third Safety Relief (SV-3) The Primary relief valves (SV-1, SV-2) are set at the maximum allowable working pressure (MAWP), which is 50psi. The Third (SV-3) is set at 70 psi. These valves are sized to safely relieve the tank during a loss of vacuum. The Main storage tank is coded either DOT MC-338 which allows the pressure limit in transit to be MAWP (50-psi) or coded CGA-341 which requires a Road Relief Circuit to Maintain an in transit pressure limit of 22.5 psi. The DOT fill level is based on this relief setting. At a relief setting of 50 psi the ORCA can be filled to 90%. Some Customers request variants in the relief system, such as Burst Discs. Below are pictures of different Relief circuit designs.







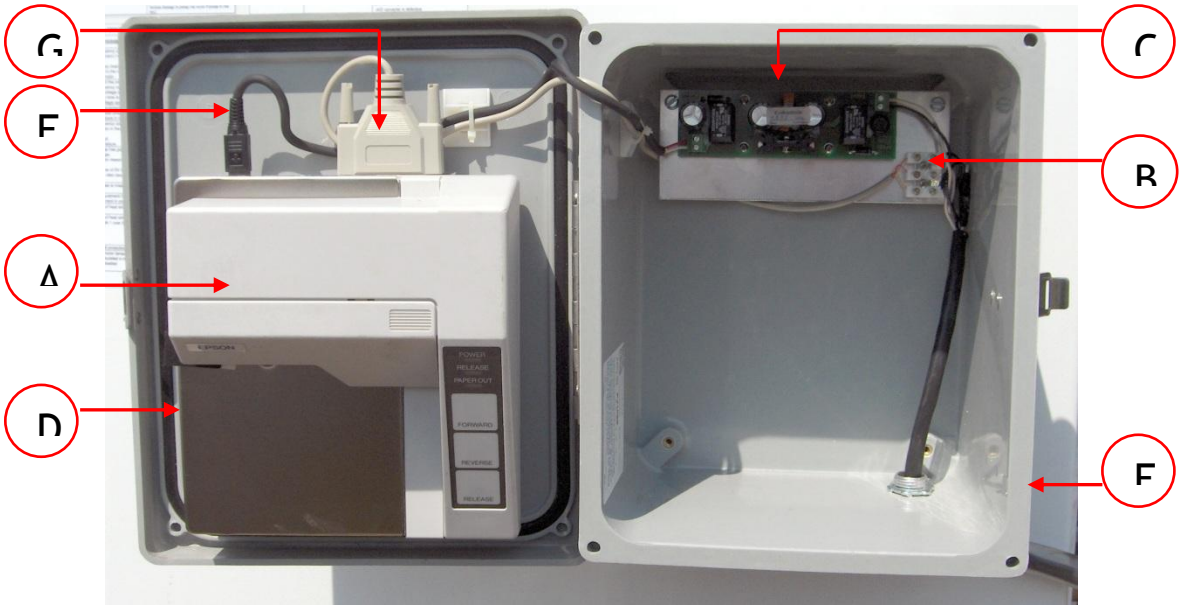
Safety Reliefs			
Item	**Part No**	**Qty**	**Description**
A	1810732	2	50 PSI Relief
B	1811812	1	70 PSI Relief
C	11899437	1	Burst Disc 1 ½” BS&B
D	12930310	1	Relief Primary
E	12930133	2	Burst Disc 2” BS&B
F	14282707	1	RV 1-1/2MPT x 1-1/2FPR 50 PSI



SV-1A	Vent Circuit Safety Relief Valve (50 psi)
SV-1B	Vent Circuit Safety Relief Valve (50 psi)
SV-1C	Vent Circuit Safety Relief Valve (70 psi)
PCV-1	Road Relief Regulator (optional)
V-2	Road Relief Valve (optional)
V-5	Vapor Vent Valve
V-44	Vapor Recovery Valve (optional)
DC-3	Vapor Recovery Connection (optional)

Ticket Printer

The Ticket Printer (EPSON TM295) is directly connected to the flow processor via a serial data link. The printer requires a 24-volt power source. A DC/DC converter is supplied to convert the truck or trailer 12-volt power to 24 volts. The system allows printing in a customized ticket form as well as a standard ticket on a plain sheet of paper. Additionally, it can also be used to print the system's parameter and audit trail information.



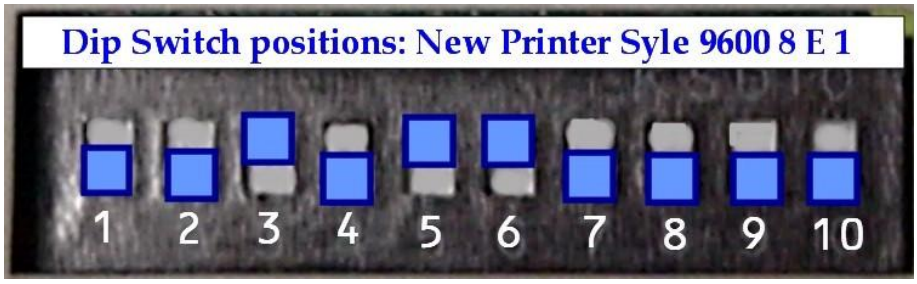
Printer and Components			
Item	**Description**	**Part Number**	**Qty**
A	Printer Ribbon	11693421	1
B	Terminal Block	outside supplier	1
C	DC/DC 12-24 VDC Converter	10963978	1
D	Printer - Epson	913700	1
E	Printer Box	11720142	1
F	Printer Power Cord 6'	11764428	1
G	Printer Data Cable	11764436	1

Printer Dip Switches

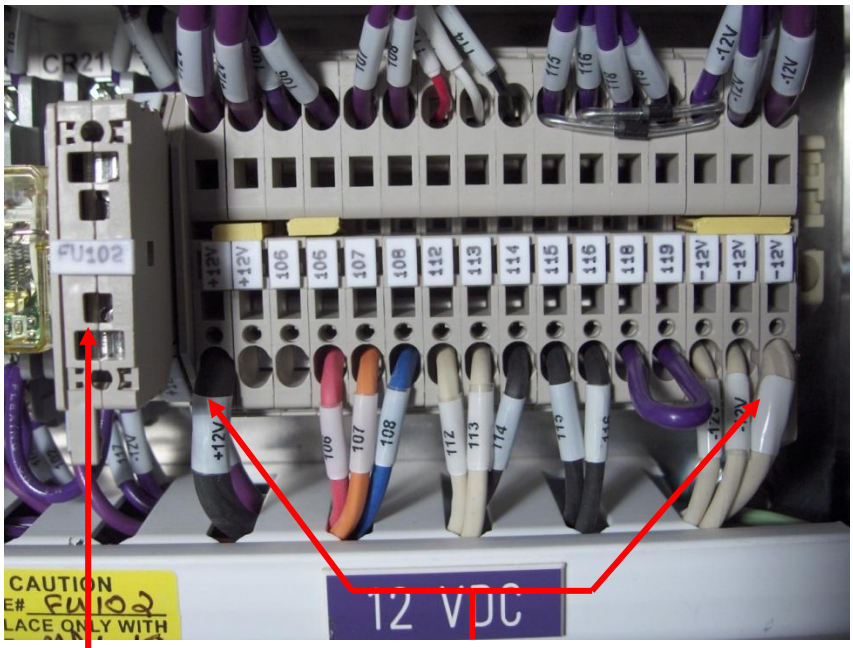
Due to a design change of the EPSON printer TM295, the so called FWD protocol is not available on the new style printer model. In order to use these printers in the same way with our flow meters, a software update in the Flowcom S8 may be necessary.
The new printer model can be identified by its serial number which starts with "F7…." These printers will be supported by the following software releases or a later version:

- V6.73.1 or later (runs on CPU02 and supports most applications) - works with both printer models.
- V2.78.1 or later for standard applications except Orca (runs on CPU01) - works with new printer style only.
- V2.08.2 or later for Orca (runs CPU01) - works with new style printer only.

The new printer model also requires different interface settings to be adjusted via DIP switches:



12 VDC Terminal Block and Fuse FU102



Incoming 12VDC from
Junction Box

Fuse FU102

12VDC Junction Box located behind Control Box
Curbside

MQ Battery provides 12VDC power for
Trailer Mounts

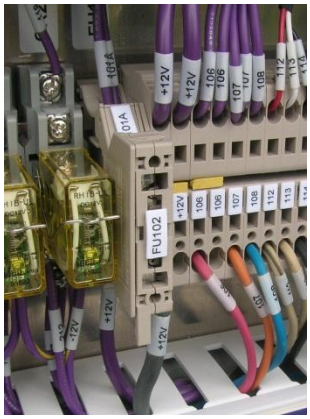
Truck Battery Provides 12VDC power
for Truck Mounts

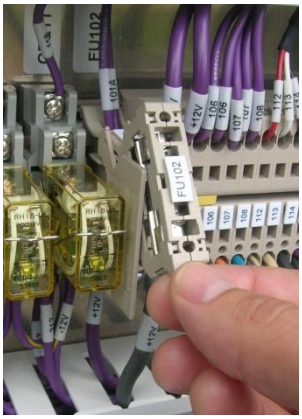
The Matrix above shows the flow of the 12VDC power through the Orca System. Trailer mounted units utilize the battery located inside of the MQ WhisperWatt while Truck mounted units utilize the battery under the hood of the truck. The Circular junction box is common to both mounting configurations and is located behind the control cabinet in the rear Plumbing Cabinet. Inside of the 12VDC junction box you will find wires affixed to four of the six lugs. The lower two are the positive and negative feeds from the (truck or MQ) battery to the Control Box located in the plumbing cabinet. the top two feed power to the rear running lights of the Orca unit.

From the 12VDC junction box, the power is fed into the control cabinet of the Orca directly to the 12VDC terminal block, located just below the FlowcomS8. The large Black and White wires attached to the lower block are the Positive and Negative leads respectively. Fuse 102 protects the system at this entrance point to the cabinet system from any surge or spike in power.

Understanding this flow of power in the 12VDC system can greatly assist the technician in troubleshooting problems in the 12VDC system and help to isolate there origin.

Fuse FU102 Removal





Fuse FU102 protects the 12VDC circuits and components downstream of the 12VDC terminal block from over voltage conditions. The fuse can be accessed by lifting up on the tab and giving a slight twist to the fuse holder as shown in figure XX. The fuse used for the system is a BUSS MDL-10. For more details of the 12 VDC system, see Section 4 of this manual for complete electrical schematics.

480 VAC System

The Orca requires a 440 System to power the on-board external ACD Pump. The 440 system is made up of 3 main components, the Alternator/Generator, Variable Frequency Drive, and the Pump/Motor.

ALTERNATOR (TRUCK MOUNT) – 26 KVA WEG P/N 11872285
ALTERNATOR (TRAILER MOUNT) – MQ WHISPERWATT DCA 25 P/N 11801524
VARIABLE FREQUENCY DRIVE (LOX) – SVX9000 P/N 11758933 (NEW)
VARIABLE FREQUENCY DRIVE (LOX) – SVX9000 P/N 11758933R (REPAIRED)
PUMP – ACD TC-30 P/N 11844567

MQ WhisperWatt Generator

DCA-25SSIU

The DCA-25SSIU sports 27kVA/22kW standby output and 25kVA/20kW prime output. The generator is powered by a 4-cylinder, 31-horsepower Isuzu C240 diesel engine and the unit controls voltage regulation to +/-1 percent no load to full load. Sound level is an impressive 65dBA full load at 23 feet while the generator has a 17-gallon (65 liters) fuel tank.

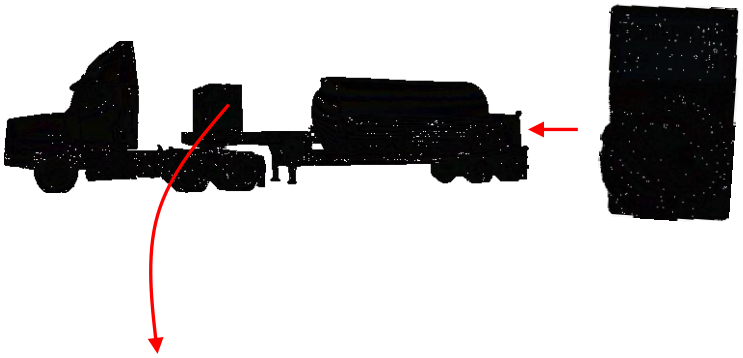
Performance Data

Standby Output	22 kW , 27 kVA
Prime Output	20 kW , 25 kVA
Generator RPM	1800 RPMs
Generator Design	Revolving Field Self-Ventilated Dip-Proof Single Bearing
Voltage Regulation - (No Load to Full Load)	1 %
Power Factor	0.8
Armature Connection	Star with Neutral / Zigzag
Excitation	Brushless with AVR
No. Poles	4 Pole
Frequency	60 Hz
Available Voltages - 3 Phase	208, 220, 240, 416, 440, 460, 480V Switchable Volts
Available Voltages - Single Phase	120, 127, 139, 240, 254, 277 Switchable Volts
Amps - Single Phase 120V	55.5 (4 Wire) 60x2(Zigzg) Amps
Amps - Single Phase 240V	27.8 (4 Wire) 60 (Zigzg) Amps
Amps - Three Phase 240V	60 Amps
Amps - Three Phase 480V	30 Amps
Insulation	Class F
Sound Level dB(A) - Full Load at 23 feet	67 dB(A)

Power Source

Dimensions

Engine Make / Model	Isuzu C240
Overall Length	77 in. , 195 cm
Overall Width	30 in. , 75 cm
Overall Height	39 in. , 100 cm
Approx. Net Wt. Dry	1543 lbs. , 700 kg.



To start the MQ WhisperWatt simply turn on the switch identified as "Generator Run." This switch is located on the front of the control box in the Rear plumbing cabinet.

Located on the Road-Side of the MQ WhisperWatt is a control panel. When operating, the Circuit breaker must be ON, and the mode switch must be in AUTO.

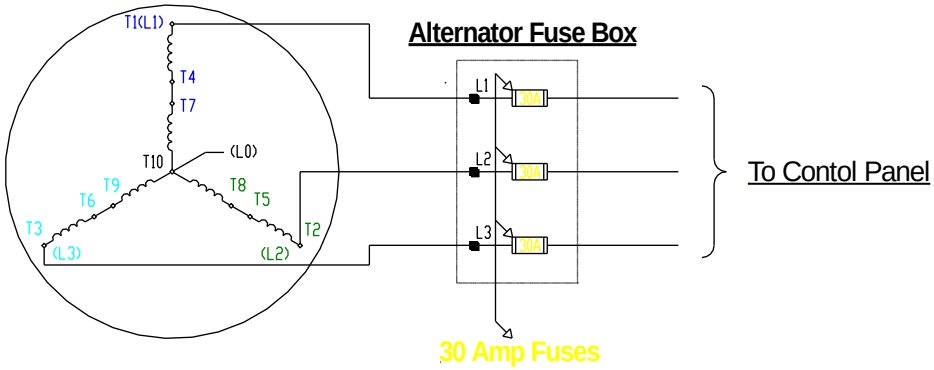
For more information on MQ, visit the following web address:

http://www.mqpower.com/

WEG Alternator

The WEG 26KVA Alternator is driven by a PTO shaft connected to the Truck engine. The PTO shaft spins at 1800 RPM producing 480 VAC.

Alternator Wiring-Internal Connections



Caution: Properly Insulate all unused terminals

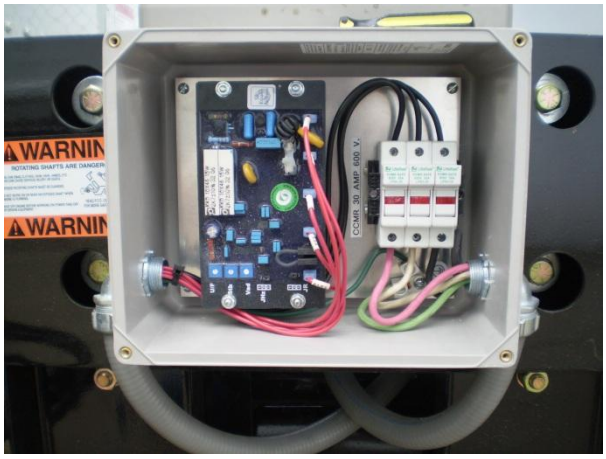
Connect together the following Terminals:

T4 & T7
T5 & T8
T6 & T9
L1,L2,L3 are alternator outputs

Output = L1 to L2 = **440-480 VAC**
L1 to L3 = **440-480 VAC**
L2 to L3 = **440-480 VAC**

Alternator Fuse Panel

The Alternator Fuse Panel is located on the frame rail of the truck. It is mounted on the opposite side of the fuel tank for safety reasons. It is a junction point for 480 VAC Power from the Alternator/Generator to the Control Panel.

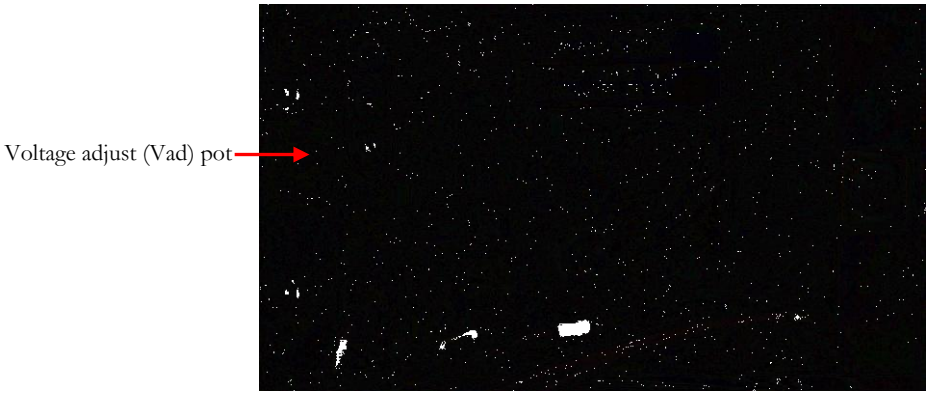


Truck mount Orca 440VAC Fuse
enclosure 26 KVA WEG (30 AMP Fuses)

Alternator Regulator Board

P/N 13015851

Adjustments can be made to the output voltage of the alternator via the Voltage adjustment pot, located on the Alternator Regulator Board



SVX 9000 Variable Frequency Drive

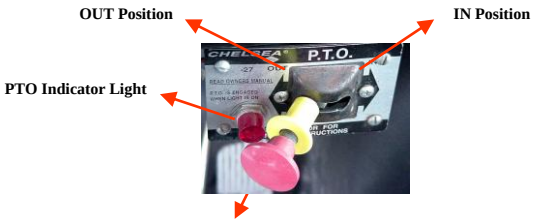
SVX 9000 VFD

Pendant W/ Speed Control

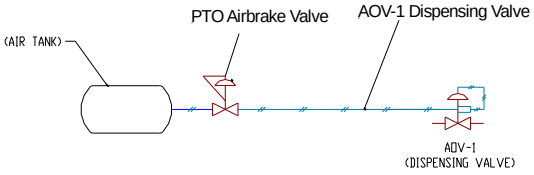
The VFD when supplied with **480 VAC, Three-Phase Power** from the Alternator/Generator, provides an output of voltage and frequency that correspond to the pump speed selected on the Remote Pendant Pump Speed Dial. See the Troubleshooting section of this manual for programming of the VFD.

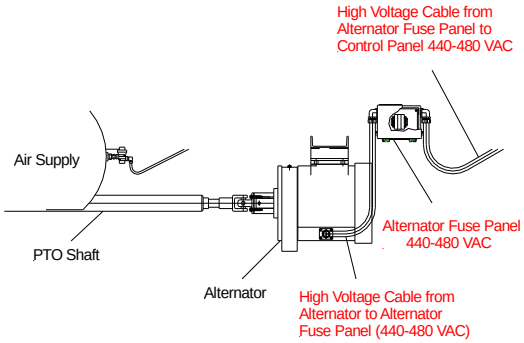
PTO/PTO Engagement Lever

The PTO Engagement Lever is designed to engage/disengage the PTO. There are two positions-**OUT/IN**. In the **OUT Position the PTO is not engaged**, **IN Position the PTO is engaged**. Once the PTO is engaged the **Red Indicator Light** will illuminate. **The PTO will not engage unless the air brakes are set.** The type of PTO used (there are different ratios available) will determine the high idle speed (rpm). The high idle speed (rpm) is determined during the initial testing and is labeled in the cab of the truck (**common rpm speed is 1100 RPM**). **Exceeding the pre-determined High Idle Speed will result in the Alternator spinning to fast and generating excessive voltage. Over-spinning the Alternator can result in damage to the bearings or windings or damage to the Control Panel. It is recommended to disengage the PTO by manually disengaging the PTO lever to the off position and deactivating the PP-5 Valve before driving the vehicle.**



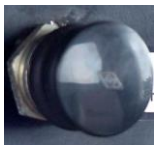
Pneumatic Schematic





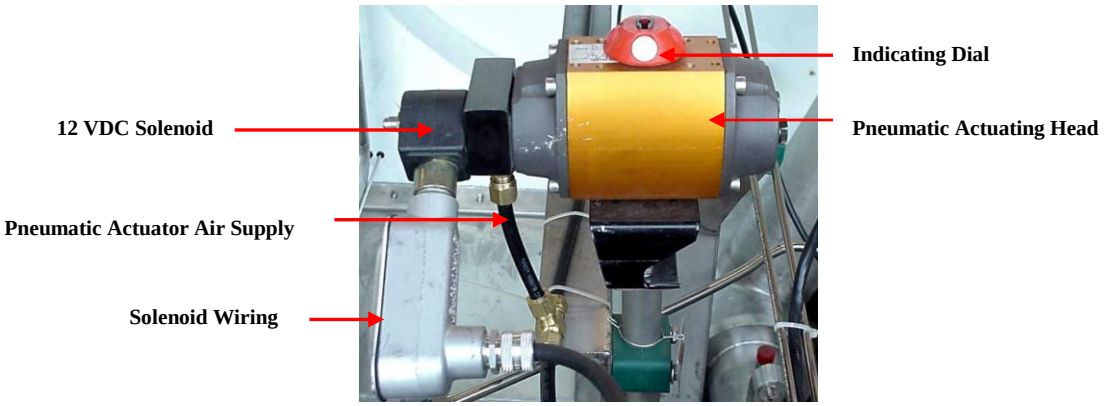
PP-5 Valve/High Idle Speed

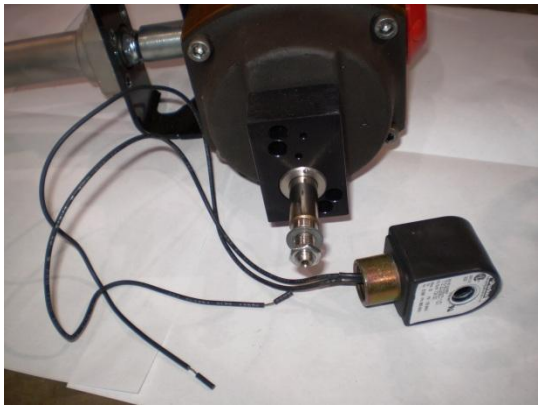
This valve is designed to disengage the PTO in the event of driver error. The PP-5 Valve (located on the dashboard of the truck) is a piloted valve that is pneumatically tied into the air brakes. Any time the air brakes are released the piloted valve closes. This is to assure that the PTO is not engaged during transit. At the end of the delivery, the PTO will automatically disengage when the air brakes are released. **It is recommended to disengage the PTO by manually disengaging the PTO lever to the off position and deactivating the PP-5 Valve. Exceeding the pre-determined High Idle Speed will result in the Alternator spinning to fast and generating excessive voltage. Over-spinning the Alternator can result in damage to the bearings or windings or damage to the Control Panel.**



AOV-1 Air Operated Dispense Valve

AOV-1 is an air operated dispense valve that opens to allow liquid out the delivery hose. An additional AOV is used with Orca systems incorporating a High Flow Dispense circuit. The Air Operated Valves are connected into the truck/trailer air system and also has a low-voltage solenoid (12 VDC). It is imperative that there is an adequate air supply to this valve. **A minimum of 90 psi of air is required for this valve to function properly.**





Solenoid Removed

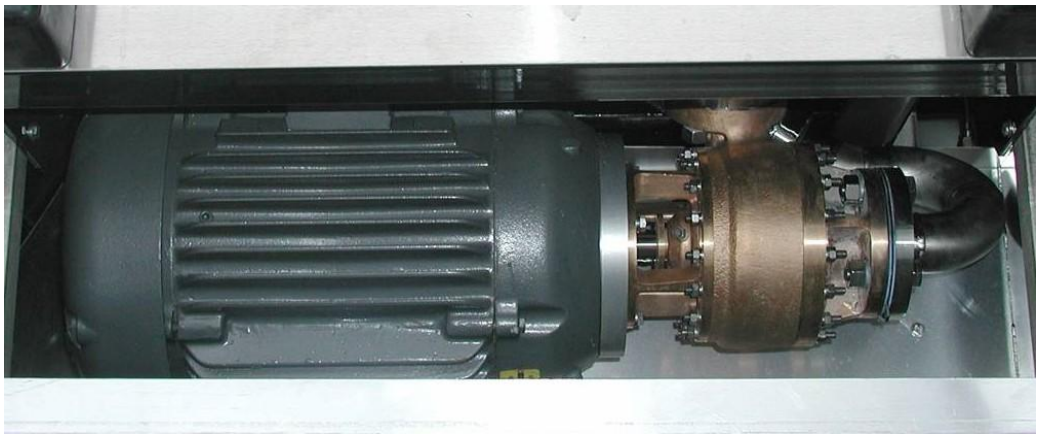
Head and Coupling removed

Air Operated Valve Parts				
Item	Tag	Part No	Qty	Description
A	AOV	10917761	1	Air Operated Dispense Valve
A-1	AOV	11939460	1	Coil Only 12VDC
A-2	AOV	11879583	1	Actuator w/Solenoid & Coil 12VDC
A-3	AOV	11890061	1	Repair Kit, Actuator Coupling

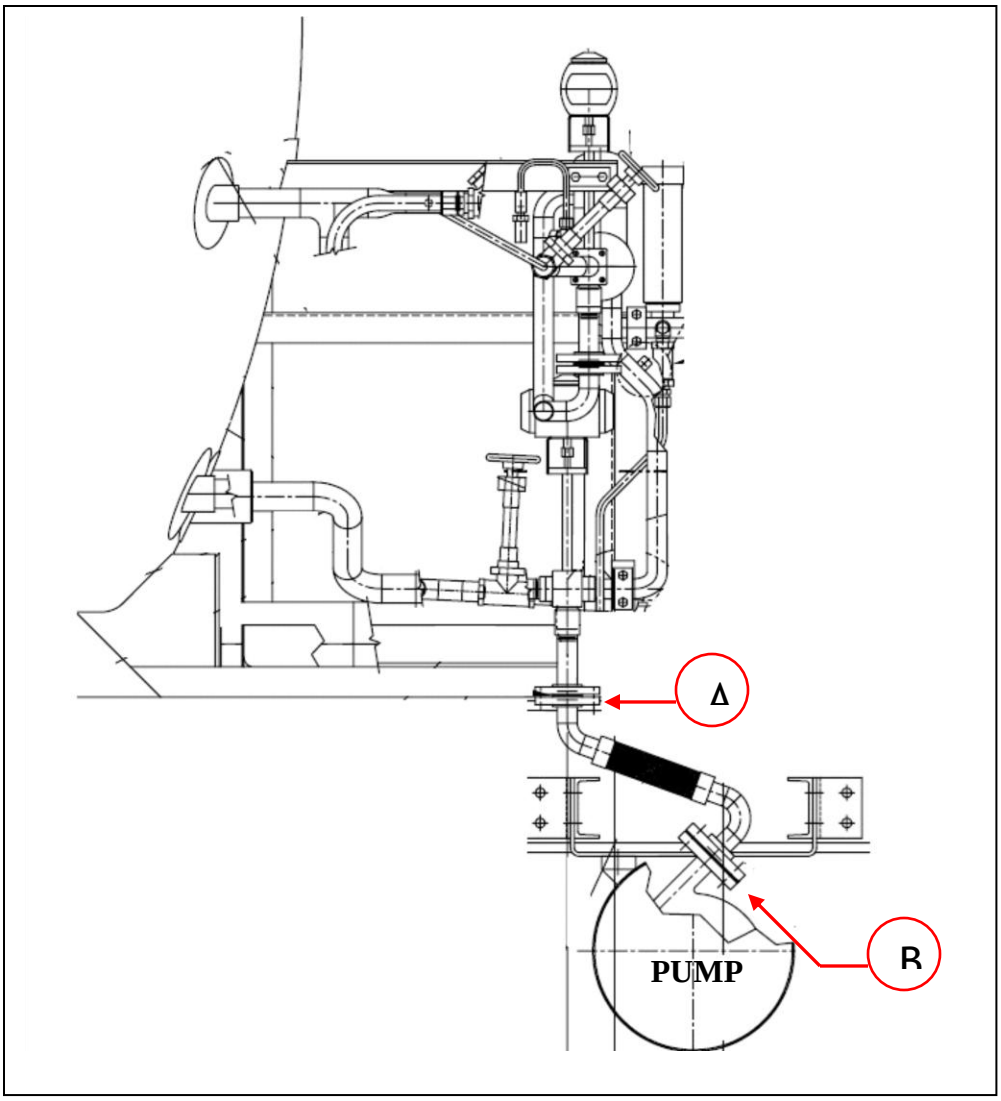
External Pump ACD TC-30

The pump on an Oxygen ORCA is mounted external and is not submerged in Cryogenic Liquid so a proper Pump Cool-Down is essential. There is a Temperature Interlock System incorporated into the system that will not allow the operator to perform a function if the pump is not cooled down to the proper set temperature. The External Pump is designed to operate throughout the pressure range of the ORCA Vessel (0-225 psi) in Oxygen Service.

Manufactured by ACD



TC-30 Pump Seals



Pump Seal TC-30		
Item	**Part Number**	**Description**
A	11816443	GASKET .063*1PS CL150 FF GARLOCK GYLON 3505 B16.21
B	11735580	GASKET .063*1PS CL300 FF GARLOCK GYLON 3505 B16.21

CENTRIFUGAL PUMP DATA SHEET

Page: 1 of 1

Category	1 PM
Quantity	1 PMT
Order Date	6/9/2004
Date Issued	6/10/2004
Ship Date	8/31/2004
Customer Name	CHART INC
Customer P.O.	2474740
Sales Order	13015
Revision	
Rev Date	

Sales: DOD Engineer: AM

Arturo Martinez 2004.06.10 16:18:21 -07'00'

REASON FOR REVISION

NAMEPLATE DATA

Model	TC30	Duty	CONTINUOUS	
Assy PN	3406309-300XX	Service	LO2	
Pump Size	1x2x6-2S	Capacity	40	GPM
PumpSpeed	4700	Head	506	Feet
Impeller Dia	6.00	Power	12.5	HP
Serial No.	04130151	NPSHR	3.0	Feet
Through	-	Suc Press	10	PSIG
Case Matl	BRONZE	Disch Press	260	PSIG
Hydro Test	800 PSIG	Max Suc Pr	50	PSIG
		Date Of Mfg		

MOTOR DATA

HP	12.5	Speed	4750	Voltage	460
Phase	3	Poles	2	Amps	15.3
Hz	81	AK	8.5	Frame	254TCZ
Insul	H	Code	G	S.F.	1.0
Design	B	Enclosure		TEFC/CHEM PLANT	
ACD PN	54534-4			Auth Vendors	
Coml PN	08031-122-ALT			BALDOR	
Alt Mtr PN					

BEARING	Drive End	Fan End
Description	6309-JC3	6208-Z-JC3
ACD PN	54678-3	54678-18
Grease Type	Mobil 28	Mobil 28
Quantity, oz	0.44	0.22
Interval (hrs)	2000	2000

Lubrication Schedule Label P/N 55039-1

Documents and Submittals

Manual Code	C330FL21	Pump Code	21
Install Dwg	51720sh21	Send Thru Sales	0
Curve No	04-130151	Ship With Pump	2

TEST ☐ YES ☑ NO TEST USING EMS DRIVE ☐ YES ☐ NO

Test Per ETP-053	Qty	Witness
Functional/Performance		
Npsh Test		

Laby Run In Per EAP-093: No

Disch Pr	PSIG	Voltage	Volts		
Suc Pr	PSIG	Pipe Size	Inch		
Delta Pr	PSI	Orifice Dia	Inch		
HP	BHP	Orifice K			

	GPM	PSI
Point1		
Point2		
Point3		
Point4		
Point5		
Point6		
Point7		
Point8		

Attach Motor Rotation Label ACD P/N 56589-1 To Fan End Of Motor

☑ CW Rotation ☐ CCW Rotation

◉ Oxygen Clean ○ Motor Purge

○ Oil Tag ◉ Lube NamePl

DRIVE TYPE

○ Direct ○ Belted

◉ VFD ○ Geared

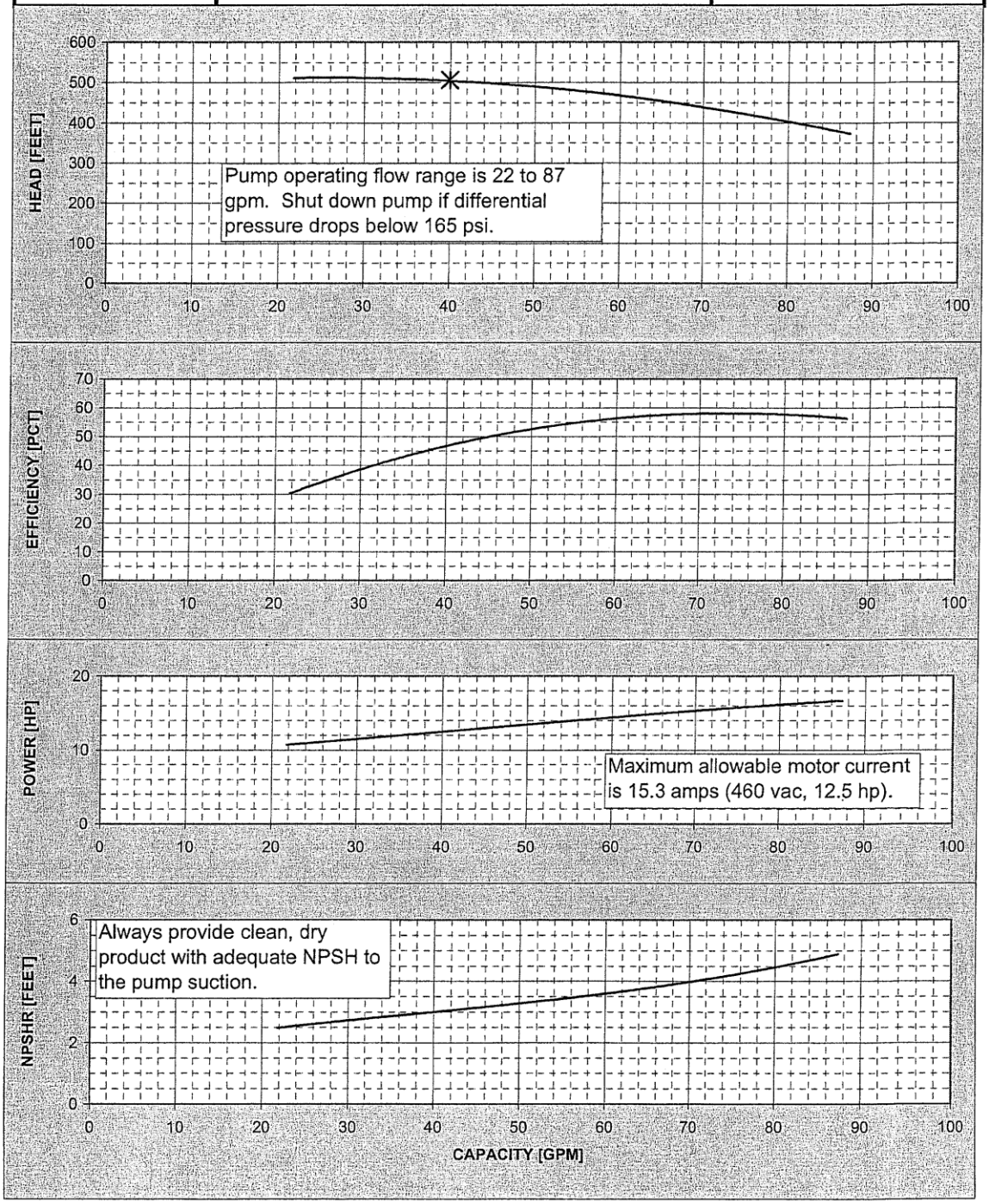
Ratio : 0.000 : 1

TEST INSTRUCTIONS

SPECIAL INSTRUCTIONS

Volute position to be 45 deg. Between P3 and P4.

ACD	SIZE / MODEL	1 x 2 x 6 -2S	TC-30F	PUMP PERFORMANCE CURVE
	APPLICATION	TRANSFER		CURVE NO. 04-130151
	DRIVE	VFD		
	CUSTOMER	CHART, INC.		PUMP RPM 4700
	PROJECT/ITEM NOS.	2474740		LO2 1.141
FSCM NO. 15275	CONDITIONS	40 GPM	506 FEET	IMPELLER DIA." 6.00

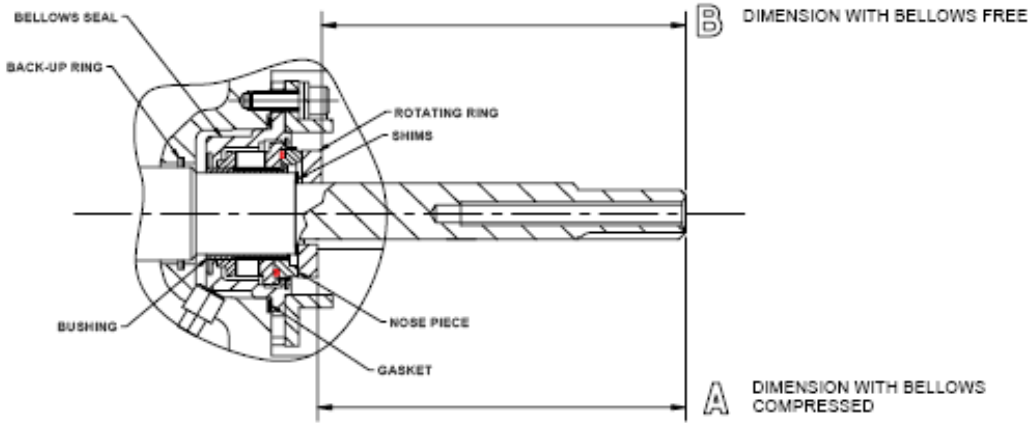


Composite Face Seal (CFS)

1. The CFS must be installed with more seal compression than the seal it replaces. Set the seal compression as noted below.
2. The CFS is resistant to damage from cavitation and operation at non-cryogenic temperature. However, operation at non-cryogenic temperature for longer than two (2) minutes will generate excessive heat and damage the seal.
3. *Minor leakage is normal at the first cool-down, which stops after few minutes of the initial run.*

Prior to Installation of the Composite Face Seal

DO	DO NOT
• Read all instructions before proceeding.	• Touch seal face or lapped face of rotating ring
• Work in clean area, wear clean rubber gloves (surgical type) and clean all parts for service intended	• Repeatedly push on seal face to check spring force of bellows (bellows has some preset compression)
• Refer to pump assembly drawing for pump internal details and actual seal geometry	• Set compression exceeding amount of seal face extending beyond the face of the metal holder.
• For 1x2x6-2 stage only, have impeller retaining tool 402330-12 ready	



58643-DWG 1 of 2

ACD 2321 S. Pullman Street Santa Ana, CA USA Tel: 949.261.7533 Fax: 949.261.6285

Installing the Seal

1. Ensure the chamfer on the inner diameter of the rotating ring is facing toward the nose piece.
2. Ensure the intermediate, insulator and backplate are squarely seated and tightened.
3. Set the seal compression as follows:

Setting Compression

CAUTION

Place seven (7) shims on shaft to start. This will ensure that welded bellows does not bottom on internal stop and give false reading. Initial seal compression check must not exceed 0.120 in (3 mm).

1. **Determine Dimension A**

   Compress the bellows squarely by pressing on each side of the rotating ring until it bottoms in the compressed position. Measure the distance from the surface of the rotating ring to the end of the shaft to the nearest thousandth of an inch (0.025mm).

2. **Determine Dimension B**

   Without pressing on the rotating ring, measure the distance from the surface of the rotating ring to the end of the shaft to the nearest thousandth of an inch (0.025mm).

A - B = seal compression. Set compression to 0.050 to 0.070 inches (1.27 to 1.78 mm). Remove shims between rotating ring and shaft shoulder to increase compression.

*On first check for setting compression, the gasket may be left out to make it easier to install and remove seal. After shims are determined gasket must be installed. **PERFORM FINAL SEAL COMPRESSION CHECK BEFORE COMPLETING INSTALLATION.**

If impeller must be heated to fit on shaft, tighten and re-tighten attachment bolt (nut) as impeller cools to ambient temperature.

For additional installation instructions or if there are problems installing your *CFS* seal, contact one of our service centers for further assistance. Authorized service centers include:

ACD CRYO Germany	CryoCal, Inc. USA	CryoCanada, Inc. Canada
IWI Cryoquip Australia	CryoAtlanta, Inc. USA	Cryogenic Industries Malaysia
Pittsburgh Cryogenics USA	Hangzhou Cryogenics China	Cryogenic Industries Houston, TX

Please visit us at www.acdcom.com for contact information.

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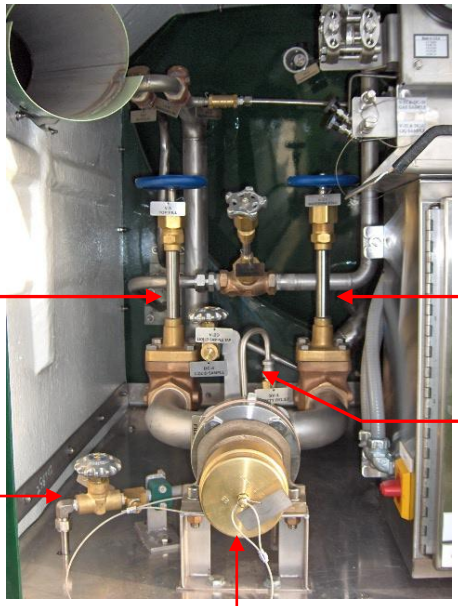
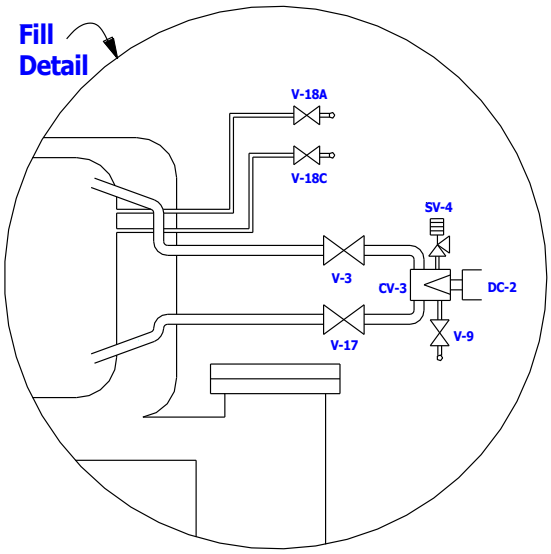
ACD 2321 S. Pullman Street Santa Ana, CA USA Tel: 949.261.7533 Fax: 949.261.6285

Fill Circuit

The ORCA is filled through the Top and Bottom Fill Circuit (DC-2). Using the Top and Bottom Fill Circuits properly will minimize vent losses during filling. The Fill Line Drain (V-9) should be used to vent the Fill Hose after filling to relieve any pressure. The check valve (CV-3) is designed to prevent the reverse of flow during filling. **The Full trycock (V-18C) is your DOT MC-338 fill level.**



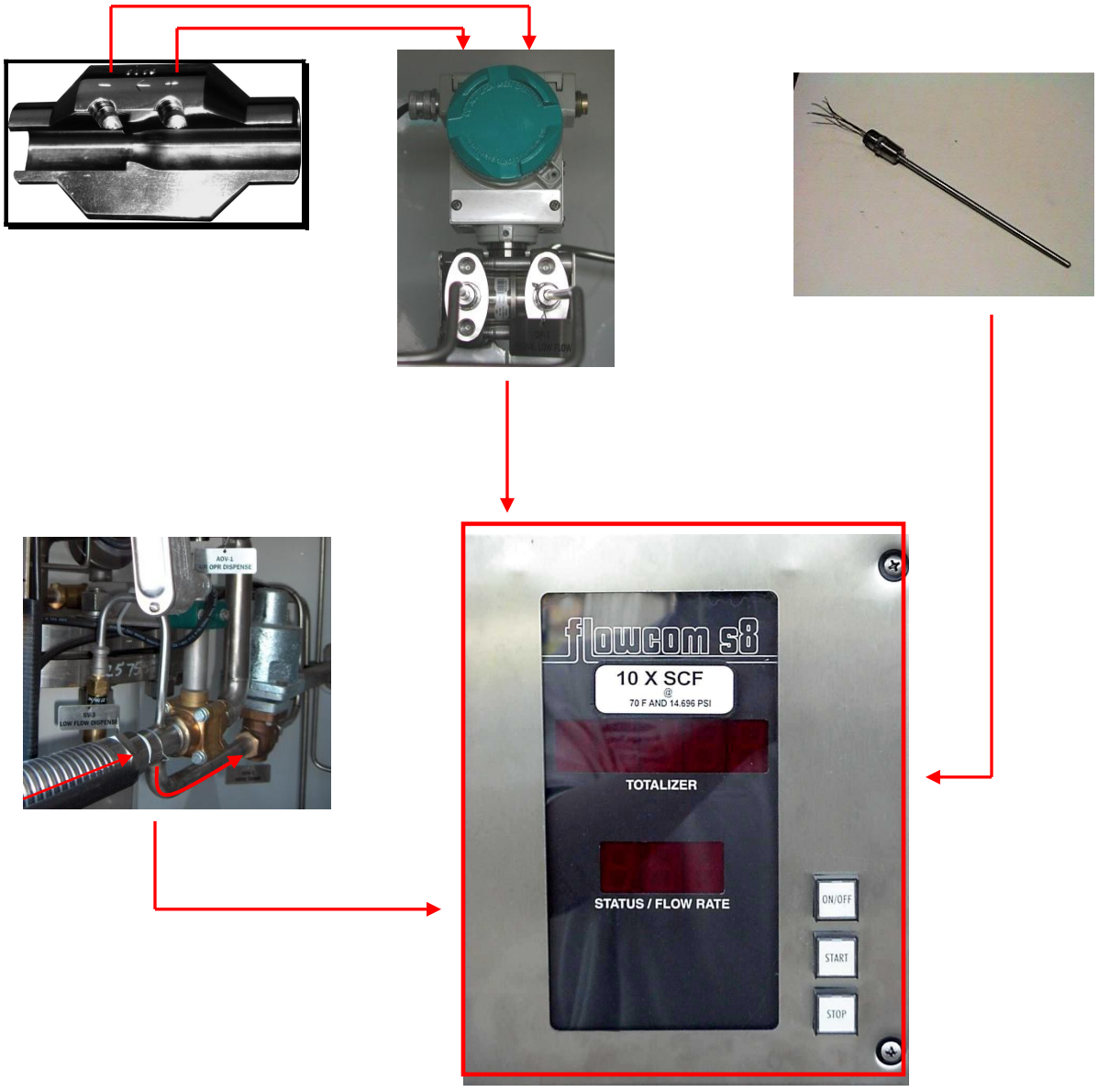


V-18A	95% Trycock Valve
V-18C	90% Trycock Valve
V-3	Top Fill Valve
V-17	Bottom Fill Valve
CV-3	Fill Line Check Valve
V-9	Fill Line Drain Valve
SV-4	Fill Line Safety Relief Valve
DC-2	Fill Line Connection

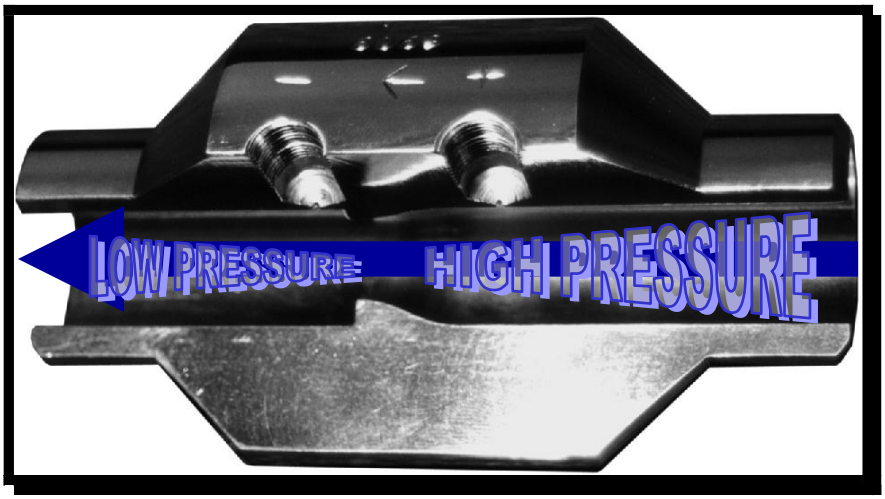
Metering System

The metering system provides an accurate and calibrated means for measuring the amount of product dispensed from the Orca vessel to the customer. The system is made up of 5 components. The Meter Section, Differential Pressure Transmitter, PT 100 Temperature probe, Hose Drain Solenoid, and the FlowComS8 Flow processor. Below we will go into each of these components in detail.

Metering Theory



Meter Section

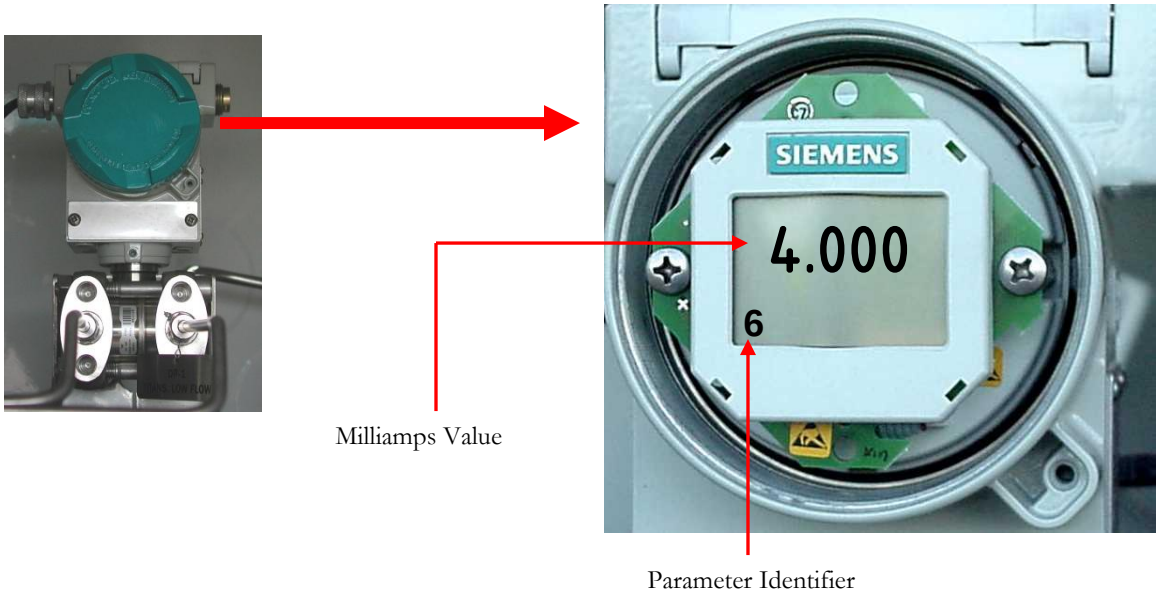


The Orca system incorporates an Orifice type Meter Section, which unlike turbine meters, has no moving parts to be damaged by gas. This Unique feature makes the Meter Section a low maintenance item. As the liquid flows to the tapered orifice, a high pressure zone is created. Once the liquid flows through 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 ¼" line is plumbed into each side of the Meter Section (one to the High Pressure side and one to the Low Pressure side). These two lines are then plumbed to the Differential Pressure Transmitter which makes this differential pressure an electronic signal.

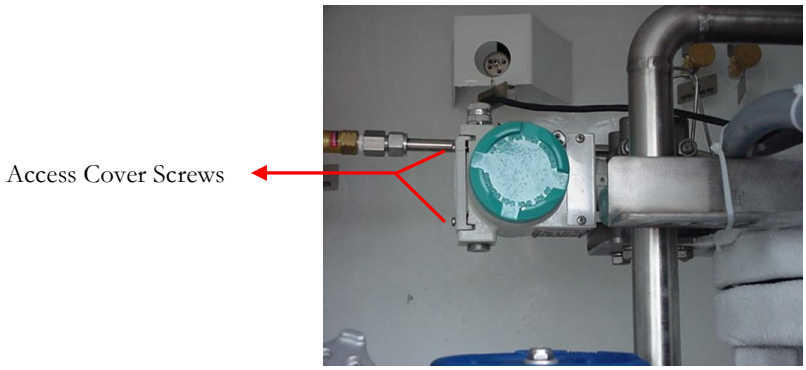
The Primary Meter section of the Orca system (External Pump) is located inside of a meter chamber. This chamber is flooded with cold product when the unit is the recirculating mode. Once the meter is properly cooled, the system will allow the operator to dispense product through the meter section. Below is a picture of a Orca Meter Chamber.

Meter Chamber

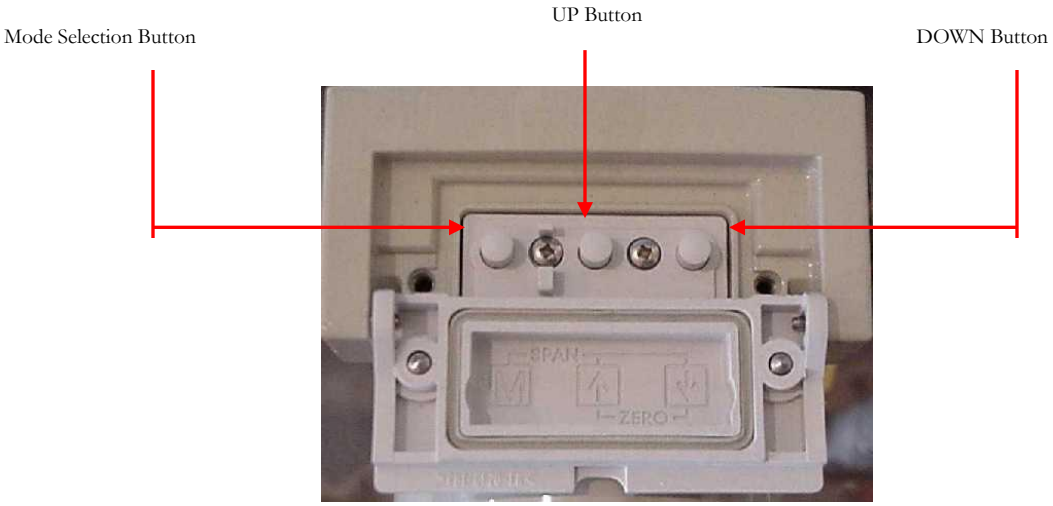
Differential Pressure Transmitter (DP Transmitter)



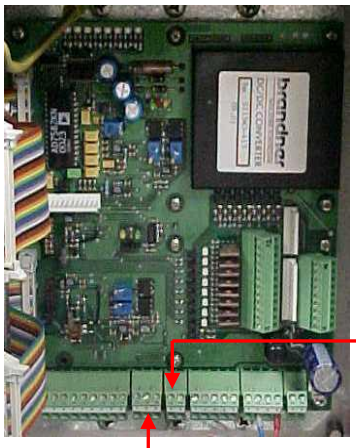
This is a SIEMENS Differential Pressure Transmitter used on the ORCA System. It is connected to the Meter Section, and the FlowcomS8 Flow processor. The DP Transmitter measures a change in pressure (pressure drop) across the meter section and relays this information to the Flow Processor in an electrical signal. The signal sent to the Flow processor is a **4-20 milliamp signal**. At an idle state the DP Transmitter should read approximately **4 milliamps**. At a maximum run state the DP Transmitter should read approximately **18 milliamps**. Connected to the DP Transmitter are two ¼" airlines (high/low flow) that are also plumbed to the Meter Section.



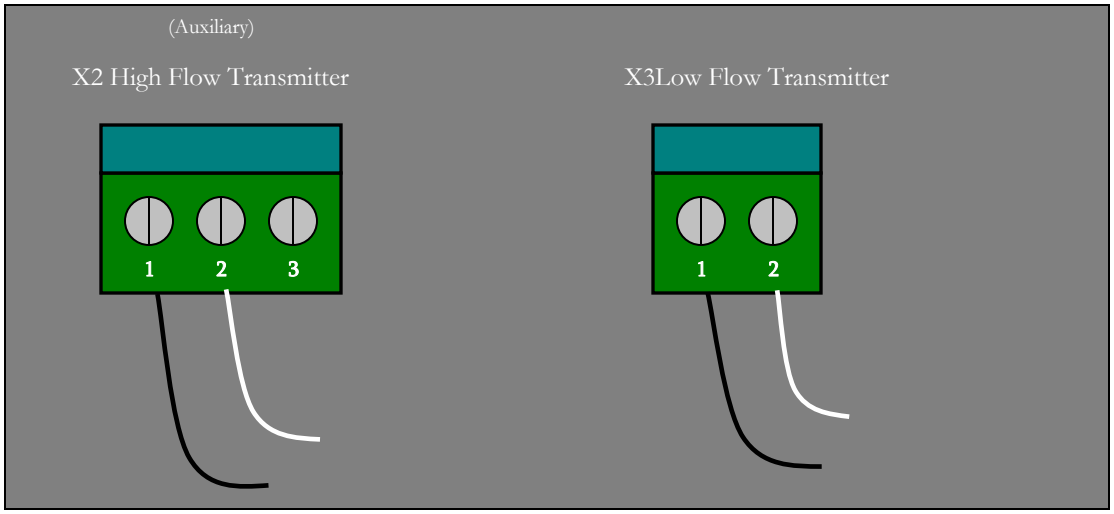
Differential Pressure Transmitter (Cont.)



While the standard Orca System uses one Differential Pressure transmitter in its Metering system, a second transmitter is required for Dual flow Systems. It is also important to note that the D.P. Transmitters on your Orca system may not be interchangeable with each other. Systems with One Meter Section and Dual dispense capability utilize Transmitters with different internal spans. If you have questions regarding your system, call a Chart Representative for assistance at **1-800-400-4683**.



Left shows the wiring location of the Differential Pressure Transmitters inside of the FlowcomS8. For Troubleshooting the D.P. Transmitter, see section 6 of this manual. Electrical Schematics for the Orca system can be found at the rear of this manual.

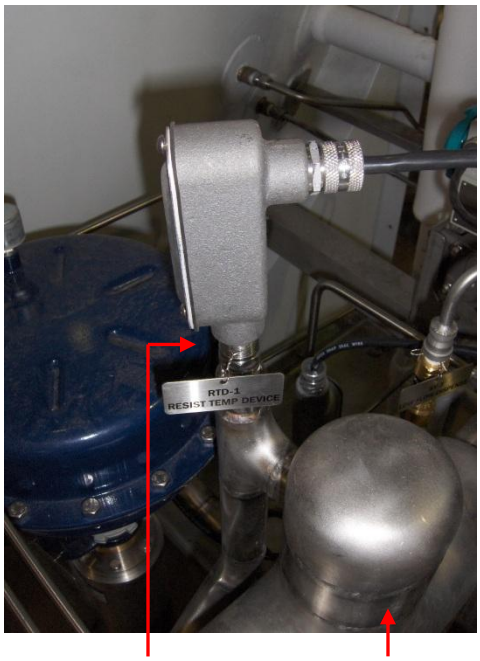


Above is a detailed view of X2 (Auxiliary) and X3 Low Flow Transmitter terminal blocks in the FlowcomS8. Using a Voltmeter and measuring across 1 and 2 of Block X2 or X3 should give a voltage reading of 24 Volts DC.

Siemens Differential Pressure Transmitter Programming

1. Remove the cover for the LCR Screen
2. Loosen the two (2) Phillips Head Screws to access the Programming Buttons
3. Push the Mode Button to move to Parameter #6
4. Push the Up/Down Button to enter the appropriate value for P6
   LOX - 1000
5. Push the Mode Button to move to Parameter #7
6. Push the Up/Down Button simultaneously to zero the value for P7
   a) P7 = zero value
7. Push the Mode Button to move to Parameter #11
8. Push the Up/Down Button to enter the appropriate value for P11
   a) P11 = SR Linear
9. Push the Mode Button to move out of the Parameter Setting Mode (one beyond 14)

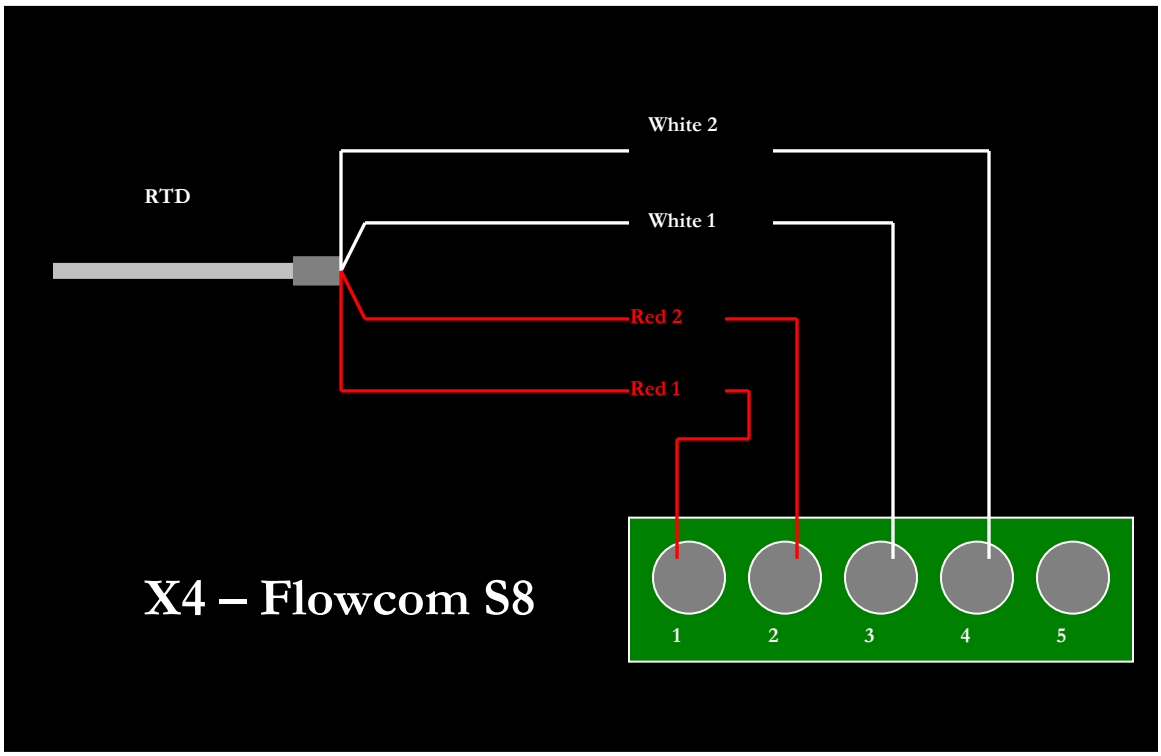
RTD – Resistance Temperature Device (P/N 10929382)



RTD Meter Section Chamber

The Resistance Temperature Device (RTD) is located upstream of the meter section and measures the temperature of the liquid being metered. Based on this temperature a density is assigned. The resistance of the element at the end of the probe varies with temperature. This temperature value is communicated to the FlowcomS8 programming and by this means an accurate amount of metered product can be calculated. The temperature probe is a 4-wire Resistance Temperature Device (RTD). They are also referred to as PT 100.

RTD – Resistance Temperature Device (Temperature Probe Cont.)



Resistance Check – RTD Troubleshooting (E31 Error)

Resistance between common colors = 0 ohms
Resistance between Different colors = > 0 ohms (approx. 60 ohms circuit warm)
Resistance to Ground = Infinite

Remember to check for continuity in the Junction Box at the RTD location.

Hose Drain Solenoid

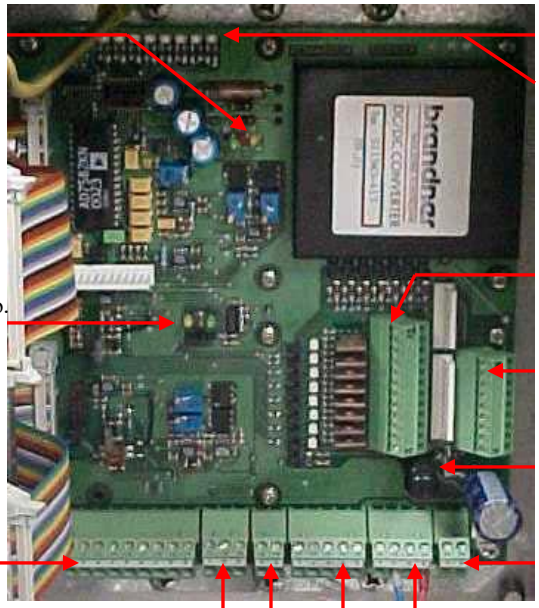
The Hose Drain Solenoid, located behind the Low Flow dispense valve, is a Normally Open Solenoid. This allows a path for product left in the dispense hose following a delivery, to return to the sump. This solenoid becomes active and closes off the path in unison with the dispense valve opening when dispensing product. The Hose Drain Solenoid is part of the 12 Volt DC system and receives a power signal from the FlowcomS8. No maintenance is required for this part.

FlowcomS8 Flow Processor

The Flow Processor 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 audit trail information, initiate the print out of the delivery ticket and to clear the counter. The buttons on the face of the Flow Processor can be used as a back up to the Remote Pendant. The Totalizer Window displays the amount of product dispensed. The Status/Flow Rate Window displays the Mode the Flow Processor is in and a percentage of the Flow Rate while the product is being dispensed. **Note:** If programming assistance is required contact a **Technical Service Representative at Chart , Inc. at 1.800.400.4683**.

FlowcomS8 Flow Processor (Inside)

FlowcomS8 Backboard P/N 913677



Green, Red and Yellow LED will illuminate when FlowcomS8 is powered up.

When Stop Button is depressed 2nd LED from the left will illuminate

When Start Button is depressed 3rd LED from the left will illuminate

Yellow LED will illuminate when FlowcomS8 is powered up.

Terminal Block ST4

Terminal Block ST5

Fuse 250VDC 15 Amps

Terminal Block X1
Printer

Terminal Block X6
12VDC Power In

Terminal Block X2
Auxiliary D.P.
Transmitter

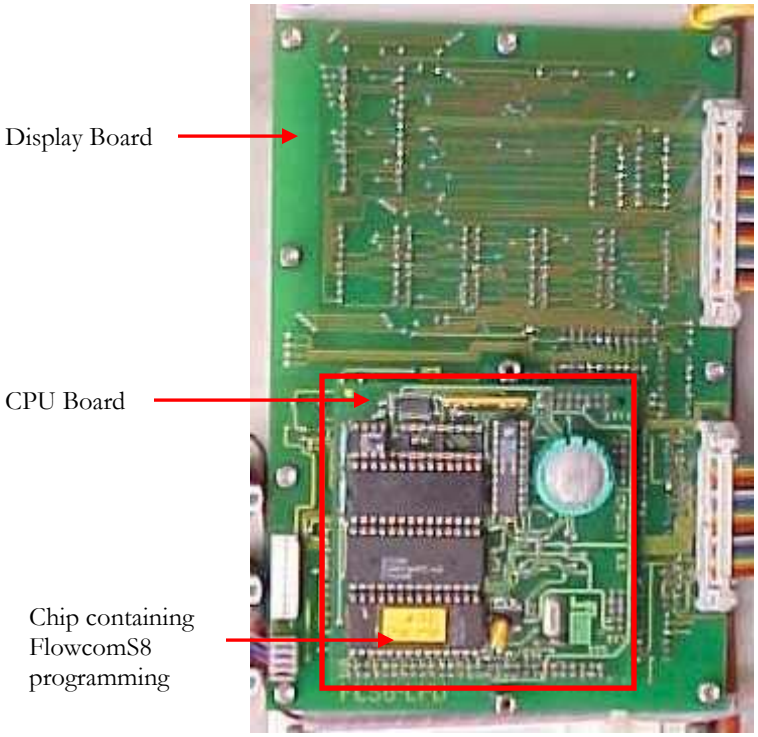
Terminal Block X5
Security Switch

Terminal Block X3
Primary D.P.
Transmitter

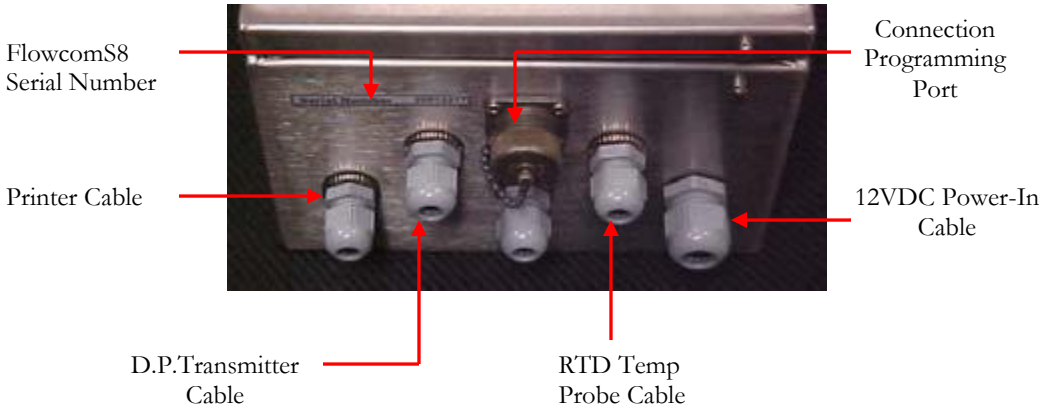
Terminal Block X4
RTD Temp Probe

FlowcomS8 Flow Processor (Inside)

FlowcomS8 Display P/N 913678 /CPU Board P/N 913679



FlowcomS8 Box Connections



Section 4 FlowcomS8

FlowcomS8 – Modes of Operation

There are two modes in which the flowcomS8 can be operated, Automatic and Manual. In the "Automatic Mode" the flowcomS8 is given control over the system functions. It allows for "Automatic Shutoff" of the discharge process upon sensing an error condition as well as a drop in the flow rate. While in the "Manual/Dispense Mode" the flowcomS8 waits for commands from the operator. **It does not change states automatically.** Switching modes is accomplished by activating the Mode Selection Switch located on the face of the Control Panel.

Automatic Mode

This mode allows for using the flowcomS8 to control pump and recirculation functions, discharge, and drain valves. Once the operator activates the "START" Button on the Remote Pendant or the "START" Button on the face of the FlowcomS8, the pump starts running and performs the "RECIRCULATION" process where the pump catches prime, builds pump pressure, and cools down the Meter Section. The flowcomS8 indicates "GO" in the Flow rate/Status window and allows the operator to begin the delivery process without the need to operate any valves manually. During the delivery process, the flowcomS8 detects the change of the flow rate as the receiving tank gets full. This change in flow will increase as the receiving tank gets fuller and will raise the pressure. As the flowcomS8 detects this change in flow/pressure, it will automatically shut off the pump and close the discharge valve. Once the pump and corresponding valves are closed, the flowcomS8 will return to a "STANDBY" State.

Manual Mode/Recirculation

This mode allows the operator to have complete control of the system and its functions. The flowcomS8 does not control the pump and recirculation functions, discharge and drain valves (equipped with pneumatic actuators). To activate the pump, the operator must switch the Mode Selection Switch on the face of the Control Panel to the "RECIRC" (Recirculation) position. In addition, to activate the flowcomS8 to meter product, the operator must activate the "START" Button on the Remote Pendant or the "START" Button the face of the FlowcomS8 (a 10-0 Countdown will commence). Once the pump has caught prime and the flowcomS8 has been activated (10-0 Countdown, GO Status), the Mode Selection Switch should be moved the "DISPENSE" position. This will open the dispense valve and begin the delivery. The "START" Button should be pushed for a second time and the flowcomS8 will begin to meter the product.

IMPORTANT: Pushing the "STOP" Button will not stop the pump. In order to stop the pump the Mode Selection Switch must be put in the "AUTOMATIC" Mode position.

FlowcomS8 – States of Operation (Status)

-S- Standby Status (Automatic Mode)

Being is this state, the Orca system is powered up and waiting for the operator to initiate an action. The pump and discharge valve are in an idle state.

Recirculation (Automatic Mode)

Being in this state the flowcomS8 is in the "RECIRCULATION" Mode. The pump is running and the flowcomS8 is counting down (10-0) as the system cools. The discharge valves are closed.

Recirculation State (Manual Mode)

Being in this state the flowcomS8 is in the "RECIRCULATION" Mode. The pump is running and the FlowcomS8 is **NOT** counting down. In order to achieve the "COUNTDOWN" Status, the operator must push the "START" Button on the Remote Pendant or on the face of the FlowcomS8. The discharge valves are closed.

GO Status (Automatic Mode)

After the Recirculation (10-0 Countdown) has finished, the system is ready to "GO," or ready to discharge. The discharge can be accomplished by pushing the "START" Button on the Remote Pendant or the face of the FlowcomS8. The flowcomS8 is now metering product.

GO Status (Manual Mode)

After the Recirculation (10-0 Countdown) has finished, the system is ready to "GO," or ready to discharge. The discharge can be accomplished by pushing the "START" Button on the Remote Pendant or the face of the FlowcomS8.

IMPORTANT: In order to meter product with the flowcomS8, the operator must push the "START" Button a second time.

Start Discharge (Automatic Mode)

To start the discharge, the Meter must be in the "STANDBY" State indicated by a "-S-" in the Flow Rate/Status display on the FlowcomS8. Pressing the "START" button on the Remote Pendant or the face of the FlowcomS8 activates the FlowcomS8 to enter the "RECIRCULATION" Mode, from where an actual product delivery can be achieved. Once the countdown has elapsed and a "GO' is in the Status display of the FlowcomS8 indicating that the system is properly cooled and ready, a delivery can be initiated by depressing the "START" button.

Start Discharge (Manual Mode)

In this state, the Mode Selection Switch is in the "RECIRCULATION" position which activates the pump and cools down the Meter Section. A "GO" State can be achieved by the operator depressing the "START" Button on the Remote Pendant or the face of the FlowcomS8 after selecting "RECIRCULATION" on the Mode Selection Switch. This will activate the flowcomS8 to begin the 10-0 Countdown and eventually reach a "GO" Status once the Meter Section has reached the proper set temperature. Once a "GO" Status is achieved the operator simply depresses the "START" Button on the Remote Pendant or the face of the FlowomS8 to open the Dispense Valve and begin a delivery.

Resume Delivery after Interruption State (Automatic Mode)

If a discharge has been interrupted and needs to be resumed, follow the steps in **FlowcomS8 Modes of Operation-Automatic Mode**.

IMPORTANT: If a delivery has been terminated and the FlowcomS8 Flow Rate/Status Window is reading an "-E-"the delivery cannot be resumed.

Resume Delivery after Interruption State (Manual Mode)

If a discharge has been interrupted and needs to resumed, follow the steps in **FlowcomS8 Modes of Operation-Manual Mode**.

IMPORTANT: If a delivery has been terminated and the FlowcomS8 Flow rate/Status Window is reading an "-E-" the delivery cannot be resumed.

Stop Discharge State (Automatic Mode)

The discharge process can be terminated by simply pressing the "STOP" Button which stops the pump, and closes the dispense valves. Once this is done the FlowcomS8 enters the "STANDBY" State (-S). To resume a delivery follow steps in **Resume Delivery after Interruption State (Automatic Mode)**.

Stop Discharge State (Manual Mode)

The discharge process can be terminated by selecting "AUTOMATIC" with the Mode Selection Switch on the face of the Control Panel. Once this is done the FlowcomS8 enters the "STANDBY" State (-S). To resume a delivery follow steps in **Resume Delivery after Interruption State (Manual Mode)**.

Print Delivery Ticket State (Automatic/Manual Mode)

Once the delivery has been terminated, the FlowcomS8 can be put into the Print mode by depressing and holding the "STOP" button on the Remote Pendant until an "-E-" is indicated in the Status/Flow rate display on the FlowcomS8. A delivery ticket may be printed by simply loading paper into the printer and pressing the "START" Button on the Remote Pendant or on the face of the FlowcomS8. The first ticket is the original and any ticket printed subsequently is marked "Duplicate." The standard delivery ticket contains the following information:

1. Number of Starts if the delivery process has been interrupted

2. Transaction Number

3. Date/Time

4. Product

5. Quantity

Clear Total State (Automatic/Manual Mode)

In order to clear the Totalizer amount after printing a ticket, simply depress and hold the "STOP" button until the –E- leaves the Status Display and an –S- (STANDBY) appears." The previous delivery total is now cleared and ready for the next delivery.

FlowcomS8 – Parameters

The parameter settings are product sensitive. **Consult a Technical Service Representative for assistance in programming at 1.800.400.4683.**

Printing FlowcomS8 Programmed Parameters

Printing of the current Parameter settings is achieved by powering down the FlowcomS8. Depress the "STOP" Button and hold while depressing the "ON" Button and allow the FlowcomS8 to complete the diagnostic checks. Hold the "STOP" button until 1-0 is appears in the Status Display of the FlowcomS8. Load the Printer with paper and press the "START" button on the Remote Pendant to begin printing the parameters. When complete, turning the FlowcomS8 off and back on will put the FlowcomS8 back into normal operation.

Calibration of FlowcomS8

The FlowcomS8 is calibrated at the factory to California Weights & Measures Standards, which is +/- 1.5%. The following is the procedure to properly calibrate the FlowcomS8. The equipment needed is as follows:

1. Terminal Software Program

2. FlowcomS8 Programming Cable

3. Laptop Computer

4. Certified Scale

5. Prover Calculation Sheet

To order a calibration kit P/N 12998576, visit ChartParts.com. Included in the kit; Terminal Software program on CD, Calibration Cable, and calibration Manual P/N 13355732

Calibration Instructions for Low Flow

1. Attach Orca low flow delivery hose to prover.

2. Ensure that the Flow Selector switch is in the "LOW" position.

3. Recirculate liquid through the system by turning the "Mode" switch on the control panel to the "Recirc" position to allow the pump to ramp up to speed, then to "Dispense", to start the flow of the liquid. Recirculate the liquid to allow the entire calibration circuit to cool down thoroughly. (Approx. 5 minutes.)

4. Start the metering of the liquid by pressing the "Start" button on the remote pendant once to start the count-down, then again once the "GO" is displayed the bottom line of the Flowcom. The flow rate will then be displayed on the bottom line of the Flowcom. Throttle the fill valve (V-3, or V-17, depending on which is being used) to regulate the flow rate, until you've reached the desired rate.

5. Press the "Stop" button on the remote pendant to terminate metering.

6. Press and hold the "Stop" button until an "E" appears on the status window of the Flowcom.

7. Press and hold the "Stop" button until the Totalizer window of the Flowcom displays 0.0

8. Press the "Start" button once, and the Flowcom will count down, and the Status window will display "GO".

9. Ensure that the prover meter is zeroed.

10. Press the "Start" button on the remote pendant while simultaneously starting the prover meter.

11. Meter the product for approximately 2 minutes, or according to INTERNAL procedures.

12. Stop both meters simultaneously.

13. Compare Flowcom total to prover total, and record the results.

14. Repeat the process at several flow rates, i.e. 8, 12, 20, 28, and 36 GPM, recording the results at each flow rate. (These rates should be used because the calibration portion of the Flowcom program uses percentage of maximum flow rate. The mentioned rates correspond to 20, 30, 50, 70, and 90 percent of the maximum rate, which is 40 GPM in the Low Flow mode.) Clear the totals of both meters between proving runs.

15. Turn "Mode" switch to "Auto". This will stop the pump.

16. Enter the results in the Excel spreadsheet provided on the Calibration CD.

If the deviation at each respective flow rate exceeds INTERNAL specifications, adjustments can be made by using the following procedure.

Entering Deviations into the Flowcom Flow meter (Low Flow) Requirements

In order to calibrate the system, a computer with a serial port (RS232), a special interface cable and terminal software are required. Cable and terminal software are supplied with the system. To ensure that both the flow processor and the computer send data at the same speed and format, the com port parameter of the computer needs to be set accordingly. The correct settings are as follows:

- COM... Baud Rate: 9600
- Data Bits: 8
- Parity: NONE
- Stop Bits: 1

Menu Access

With the Flowcom turned on, connect the laptop computer to the system using the interface cable.
Start the terminal software (Terminal Software, Hyper-Terminal, etc.) and make sure that the communication parameter are set to 9600,8,N,1, and that the program is configured for the proper COM port.

You will be able to verify communication by pressing the space bar. The programming menu should appear. If it does not, press <ALT> O. A configuration menu will appear. Press "T" to access the terminal configuration screen. Press "B" to access COM port selection. Choose a different COM port, and <enter>. <Enter> again, then press "E". Press the space bar to access the Flowcom menu. Repeat the configuration process until the correct COM port is selected. If the Flowcom still cannot be accessed, contact your IT department to troubleshoot the computer. Once the Flowcom is accessed by pressing the spacebar, a "P" will appear in the totalizer window.
1. The Setup menu can be entered by depressing "+" on the computer. The screen should respond with information as shown below.
2. Press "3" to access the calibration menu. The following will appear on the screen.
Calibration Setup
>1< Channel #1
>2< Channel #2
>X< Exit
3. Press "1".
Parameter Channel #1
Calibration Mode : Multipoint <enter>

****** MENU *******
`D` Hex Dump
`F` Format EEPROM
`I` Show Corr.Fact.
`L` List Data
`P` Print
`R` Reset
`T` Set Time/Date
`+` SetUp
`S` Service
`C` Dynamic Calibr.

```
SetUp FCS8
>0< Conf.Hardware
>1< Conf.Miscellaneous
>2< Conf.Printer/Pulse Output
```

```
>3< Calibration
>D< Download Parameters
>U< Upload Parameters
>X< Store and Exit
```

Calibration Factor : 1.00000 <enter>
Multipoint Calibration Main Menu
>S< Show list of all data points of active and new curve
>D< Delete data points from new curve (that have not been saved)
>A< Add/Edit Data Points to/of new curve
>O< Modify (Edit, Delete) data points of active curve
>H< Help
>X< Exit
4. Press "O" to edit the data points.
Multipoint Calibration Menu for Active Curve
>S< Show list of data points
>C< Delete all data points
>D< Delete individual data points
>E< Enter/Edit data points
>H< Help
>X< Exit
5. Press "S". A screen similar to what is shown below will appear, showing the current deviations that are entered into the Flowcom. (Notice that the flow rates are in percentages).
----------Active Curve------
Flow Rate[%]: 1 :Deviat.[%]: 0.00
Flow Rate[%]: 100 :Deviat.[%]: 0.00
6. To edit any deviation percentages, press "E". You will be prompted for a flow rate. Enter the rate you want to change, and press <enter>. You will be prompted for the deviation percentage. Enter the calculated deviation and press <enter>. **IMPORTANT!! The deviations will be additive! For example, if at 20% there is deviation of -1.5, and you calculate a deviation of .75, then you would add the deviations together and enter the sum, which in this case would be -.75.**
Enter Flow Rate [%]:Type in "20" <enter>
Enter Deviation [%]: -1.5 The current deviation will appear. Simply type in -.75. <enter>
7. Repeat the process for all of the flow rates. Remember to enter the **SUMS** of the new deviation values and the existing deviation values for each flow rate!
8. Once all deviations are edited, press "X" to exit.
Multipoint Calibration Main Menu
>S< Show list of all data points of active and new curve
>D< Delete data points from new curve (that have not been saved)
>A< Add/Edit Data Points to/of new curve
>O< Modify (Edit, Delete) data points of active curve

>H< Help
>X< Exit
9. Press "X" again to exit.
Calibration Setup
>1< Channel #1
>2< Channel #2
>X< Exit
10. Press "X" again.
>0< Conf.Hardware
>1< Conf.Miscellaneous
>2< Conf.Printer/Pulse Output
>3< Calibration
>D< Download Parameters
>U< Upload Parameters
>X< Store and Exit
11. Press "X" one more time…
Store Data? Y/N Press "Y"
The changes will then be saved, and the Flowcom will return to the "Standby" state. Press <ALT> X to exit the Terminal Software program.
Once the changes have been entered, it is advisable to compare the Flowcom meter to the prover meter again, to verify the accuracy. Follow Steps 6-14 in the Calibration Instructions for Low Flow.

Calibration Instructions for High Flow

1. Attach Orca high flow delivery hose to prover, per INTERNAL procedures.

2. Ensure that the Flow Selector switch is in the "High" position.

3. Follow Low Flow instructions Steps 3-16. For Step 14, use flow rates of 12, 18, 30, 42, and 54 GPM.

Entering Deviations into the Flowcom Flow meter (High Flow)

1. Follow Steps 1and 2 from the low flow section.
Calibration Setup
>1< Channel #1
>2< Channel #2
>X< Exit
2. Press "2"
Parameter Channel #2
Calibration Mode : Multipoint <enter>
Calibration Factor : 1.00000 <enter>
Multipoint Calibration Main Menu
>S< Show list of all data points of active and new curve
>D< Delete data points from new curve (that have not been saved)
>A< Add/Edit Data Points to/of new curve
>O< Modify (Edit, Delete) data points of active curve
>H< Help
>X< Exit
3. Follow steps 4-11 from the low flow section.

Section 5 - Operation of the ORCA

Filling the ORCA-First use

Filling the ORCA-Warm Tank/Purge

The ORCA 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 ORCA Tank Pressure Indicating Gauge (PI-1). Make sure that the ORCA Tank Pressure does not go below 5 PSIG. Before making filling the ORCA, be sure that protective eyeglasses and gloves are being worn.

A Bottom Fill method is recommended the first time the ORCA System is filled and any other time the tank is "warm" (warmer than the boiling temperature of the product you will be dispensing). Pre-Cool the ORCA Tank by blowing cold gas from the source tank into the Bottom Fill Line (V-17). 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 open the Vapor Vent Valve

(V-5) to manage ORCA Vessel Pressure. Important: Cooling the tank down slowly will prevent uneven cooling and uneven contraction. Stainless Steel from ambient to cryogenic temperatures will shrink 1/32" per 12" of length. Uneven shrinking can cause high stresses in supports and attachments, resulting in damage to the vessel.

1. Attach the source of liquid or gas purge product to the Top and Bottom Fill CGA Connection (DC-2) on the ORCA Vessel.
2. Open the source tank feed valve and the Bottom Fill Valve (V-17) on the ORCA allowing gas to flow slowly into the tank. Build the ORCA Tank Pressure to 40 psi.
3. Close the Bottom Fill Valve (V-17) on the ORCA and the close the source tank feed valve. Purge the trapped space by opening the Fill Line Drain (V-9) on the ORCA.
4. Crack the compression fittings on either side of the Liquid Level Gauge (L1-1), 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 (V-17) on the ORCA closed, open the Fill Line Drain (V-9) and the Top Fill valve (V-3). Purge for two minutes. Close the Top Fill Valve (V-3) and the Fill Line Drain (V-9).
6. Open the Bottom Fill Valve (V-17) and the Fill Line Drain (V-9). Purge for two minutes. Close the Bottom Fill Valve (V-17) and the Fill Line Drain (V-9). Note: **Build pressure by repeating steps 1 and 2, when the ORCA Tank Pressure drops below 20psi.**
7. Open the 90% (V-18C) and the 95% (V-18A) Trycocks. Purge for two minutes. Close Trycock Valves.
8. With the Re-circulation Valve (V-42) closed, crack the compression fitting at the outlet of the Pressure Building Coil and open the PB Gravity Force Feed Valve (V-16), and purge for two minutes. Tighten the compression fitting and leak check.
9. With the Mode Selection Switch on the Control Panel in the "DISPENSE" position, open the Low Flow Dispense Valve (V-41) on the end of the ORCA Delivery Hose.

10. Purge for two minutes. Close Low Flow Dispense Valve (V-41) and return the Mode Selection Switch on the face of the Control Panel to the "Auto" position.
11. Vent tank to 5 psi using the Vapor Vent Valve (V-5).
12. Repeat steps 7 and 8 three times.
13. After purge is complete, check the gas in the ORCA Tank for purity.
14. After purging the tank, but before filling, verify that the following valves on the ORCA Vessel are open:

    V-11 Vapor Phase Valve

    V-12 Liquid Phase Valve

    V-13 Pump Discharge Isolation Valve

Filling the ORCA-Normal Use

Filling the ORCA (after initial Fill/Purge)

The piping has a Top and Bottom Fill Circuit (DC-2). If filling the ORCA Tank with liquid saturated at a higher pressure (temperature) than what currently is in the ORCA, Bottom Filling is recommended. If filling the ORCA Tank with liquid saturated at a lower pressure (temperature) than what currently is in the ORCA Top Filling is recommended. This will minimize the tank pressure rise and minimize the venting required to manage the ORCA Tank Pressure. Filling the ORCA with liquid saturated at pressure at or above the tank pressure rating (50psi) 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 pounds 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 truck 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. Make sure that the Road Relief Valve (V-2) is closed prior to filling the ORCA Vessel.**

Purging the Fill Line

Connect the fill hose from the supply vessel to the ORCA Fill Connection (DC-2).

1. Open the Fill Line Drain Valve (V-9) on the ORCA.
2. Slightly open the bottom fill valve on the supply tank.
3. Run product through the line to thoroughly purge the fill hose for 2-3 minutes.
4. Once the Fill Hose is purged, close the Fill Line Drain (V-9) on the ORCA and the bottom fill valve on the supply tank until the ready to commence filling of the ORCA Tank.

Top Filling the ORCA

If the source liquid is cold, Top Filling lowers the product losses during filling. The Top Fill Valve (V-3) on the ORCA Vessel has a spray header that will splash the incoming cold liquid onto the somewhat warmer gas in the tank. The cold liquid will condense the warmer gas reducing the ORCA Vessel Tank Pressure. Check the ORCA Tank. If the ORCA Tank is cold, Top Filling is recommended. This will result in the pressure in the ORCA Tank being reduced.

1. If necessary, start the pressure-building device on the supply unit.
2. Check the chart on inside back door of ORCA Doghouse for specifications for each type of gas and the recommended filling levels for the product you are about to fill with (pages 38-40).
3. With the Supply Tank connected open the Top Fill Valve (V-3) on the ORCA Fill Circuit.
4. When the liquid level in the ORCA Tank is at the halfway point, open the Full Trycock Valve (V-18).
5. When the ORCA Tank is full, liquid will vent out of the Full Trycock Valve (V-18). Close the Full Trycock Valve V-18) and close the liquid supply tank fill and drain valves. Open the Fill Line Drain Valve (V-9).
6. Close the Full Trycock (V-18) and allow the hose to drain into the ORCA Truck for five minutes.
7. Close the Top Fill Valve (V-3) on the ORCA Truck.
8. When the hose indicates no pressure, close the Fill Line Drain (V-9) and remove the hose from the CGA Fill Connection (DC-2) on the ORCA Vessel.
9. Replace the CGA Fill Fitting Cover onto the ORCA Fill Connection (DC-2) and stow the Delivery Hose.
10. Open Road Relief Valve (V-2) if applicable.
11. Close the Plumbing Cabinet Doors.

Filling Levels-CGA 341

The ORCA 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 vehicle axle rating (GVWR/GVAR). Tanks operating under CGA 341 must have a relief system that prevents the vessel pressure from exceeding 25.3psig. The ORCA is supplied with a Road Relief System that can be used to maintain the vessel pressure at or below 25.3psig.

Filling Levels-MCC 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 valves 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

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-psi) with warm liquid (above 15-psi) results in the main safety venting for extended periods of time after the fill is complete.
3. Cold liquid (10-psi or less) is essential in filling open dewars. Cold liquid will minimize vent losses, optimize fill times, and improves safety.
4. Collapsing of vapor space in Receiving Tank is achieved.
5.

What is Cold Liquid

Cold liquid is liquid saturated at 15-psi or less.

Saturation Pressure psi	Liquid Nitrogen Temperature Deg F	Liquid Oxygen Temperature Deg F	Liquid Argon Temperature Deg F
0	-320	-297	-303
10	-311	-288	-293
15	-308	-284	-289

How to Maintain Cold Liquid

The ORCA can be supplied with an optional secondary relief system (Road Relief Circuit). This secondary relief system will maintain the liquid at a specified Saturation by setting the Road Relief Regulator to your required Saturation Pressure. It is recommended to set the secondary relief system to 10 psi if open Dewar's or low-pressure cylinders are to be filled. After filling the ORCA Storage Vessel, vent the contents to your desired pressure. During daily operation, keep the Road Relief Valve (V-2) open during transit. It is extremely important to close the Road Relief Valve before performing a delivery.

Current Saturation of Liquid:

Upon arriving at your delivery site, the ORCA Inner Vessel 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 vessel pressure will rise. This is not an increase in your saturation but an increase in your sub-cool. During normal deliveries your saturation pressure will remain the same as at arrival.

Engaging the PTO/Alternator

Engaging the PTO/Alternator Manual Transmission

To engage PTO/Alternator:

Push in the Clutch

Push in the PP-5 Valve (located on the dashboard of the truck)

Put the truck into gear

Slide the PTO Engagement Lever to the "IN" Position (located on the dashboard of the truck)

Take the truck out of gear

Slowly let out the Clutch (red indicator light will illuminate indicating engagement)

Set the Rpm's to the required value (1100 RPM) using the Cruise Control

To Disengage the PTO/Alternator:

Push in the Clutch

Slide the PTO Engagement Lever to the "Out" Position (located on the dashboard of the truck)

Pull out the PP-5 Valve (located on the dashboard of the truck)

Slowly let out the Clutch (red indicator light will go out indicating disengagement)

De-activate the Cruise Control

Engaging the PTO/Alternator Automatic Transmission

To engage the PTO/Alternator:

Have truck in Neutral and brakes set.

Activate the PTO Switch on dashboard of the truck (red indicator light will light up)

Set the Rpm's to the required value (1100RPM) using the Cruise Control

To disengage the PTO/Alternator:

Apply the Brake Pedal

De-activate the PTO Switch on dashboard of the truck (red indicator light will go out indicating disengagement)

De-activate the Cruise Control

Powering Up the ORCA

Control Panel-Standby State

The operator activates the power to the Control Panel by turning the 12VDC Control Power On/Off Switch and the Pump Disconnect Switch (440 VAC) on the side of the Control Panel to the "ON" Position. The Cutler Hammer VFD and the Flow processor will then power up and the System "Ready" Light on the Control Panel will illuminate. The pump and valves will remain in an Idle State as long as the Mode Selection Switch on the Control Panel is in the "AUTO" Mode Position. The VFD will display "Output Frequency 0.00 Hz". The Flow Processor will display "0.0" in the upper display (Totalizer Window) and "-S-" in the lower display (Status/Flow rate Window). The "-S-" stands for "Standby" Mode and ready to start. The "Frequency 0.00 Hz and –S- will be displayed after the required diagnostic checks are performed by the Flow Processor and VFD.

Automatic Mode

Automatic Mode-Recirculation

With the Mode Selection Switch in the "AUTO" position, the operator presses the "START" Button. The pump ramps up to speed and the Flow Processor Status Window displays the Countdown (10-0), then displays "GO" Status (lower display). If the Flow Processor Status Window does not display the "GO" Status (lower display), try opening V-16 (Force Feed Valve) until the "GO" appears. If the Flow Processor detects a problem while performing its diagnostic check it will display an Error Code (see Flow processor Troubleshooting Guide). The unit is now in the "Recirculation Mode" and liquid is being drawn into the pump and recirculated back into the ORCA Tank. During Recirculation, the operator can adjust the pump speed by using the Pump Speed Control Dial on the Remote Pendant. The operator should adjust the speed until the Pump Pressure (PI-1) is at least 50psi above the Receiving Tank Pressure.

Automatic Mode-adding Sub-Cool

Pumping boiling liquid will damage the pump! At least 5-psi of Sub-Cool is required to deliver liquid oxygen from the storage tank to the pump. Upon arrival the operator must assess the liquid's current condition (Saturation Pressure). The arrival pressure is the Saturation Pressure of the liquid. The operator must maintain a minimum of 5-psi of Sub-Cool during the entire delivery. This is accomplished by opening the manual force feed valve V-16, which allows liquid to be pumped into the Pressure Building Coil, located Roadside of Orca Vessel. Liquid is routed into the PB Circuit, which is warmer than the cryogenic liquid. When the cold liquid enters the warmer PB Circuit it vaporizes and turns to gas and is routed back into the ORCA Tank and builds ORCA Vessel Pressure. For extended deliveries the PB Circuit can be used to add additional Sub-Cool during the filling process

Automatic Mode-Dispense (10-0/"GO")

At the completion of the Count Down (10-0), the Flow Processor confirms that the Temperature Probe (RTD-1) is indicating the required cryogenic temperatures, and the Flow Processor displays a "GO" in the Status display (lower display). If the Flow Processor senses the Temperature Probe (RTD-1) is not to the proper temperature, there will be no "GO" Status in the Flow Processor Window (lower display). Instead, three horizontal dashes will appear in the Status display. Should this occur, Open V-16 (Force Feed Valve) until --the "GO" appears. If the problem persists call Technical Support at 1-800-400-4683. With the Transfer Hose attached to the Receiving Tank, the "V-41" valve at the end of the delivery hose open, and the "GO" indication in the status display, the operator simply presses the "Start" Button on the Remote Pendant to begin the delivery. The Control System

opens the Air Operated Dispense Valve AOV-1 and product is directed out the Transfer Hose. The Flow Processor will totalize the delivery and will show the Flow Rate in the Flow Rate/Status display of the FlowcomS8. The VFD status will be "RUN" and show a Hertz Reading (this value will vary depending on the product being delivered and the setting of the Pump Speed Dial). The Flow Processor starts totaling once the Transfer Hose is filled with Product.

Automatic Mode-Fill Termination

The delivery can be stopped by pressing the "STOP" Button, by Auto Tank Shut-off while filling a Perma-Cyl, or by closing the Transfer Hose Dispense Valve (V-41). Upon completion of the delivery, the VFD will ramp the Pump down. The Pump continues to run but is "Decelerating". The Hose Drain Valve (SOV-1) remains closed until the Pump has finished its Deceleration. The FlowcomS8 displays the total amount of product delivered and an "-S-" in the Status Display Window. The FlowcomS8 is now in a "Standby Status" where additional product can be metered/delivered and added to this total.

After termination of the fill cycle, the SOV-1 (Hose Drain Valve) opens allowing pressure in the Transfer Hose to equalize with the storage tank. CV-4 is a 5-psi Check Valve. The Transfer Hose pressure will be 5-psi higher than the ORCA Vessel Pressure. The Transfer Hose Connection can be removed from the tank that has been filled and the hose may be stowed. When the hose is stored in the Hose Tube, the remaining liquid in the hose will drain into the Sump via the Hose drain solenoid.

Filling a Perma-Cyl-Automatic Mode *(Chart suggested procedure)*

The ORCA System has been specially engineered to make filling of a Perma-Cyl Container a quick, one-stop operation. In addition when filling containers other than Perma-Cyl's not all of the systems safety features are active. The operator must closely monitor the Receiving Tank Pressure, ORCA Pump Discharge Pressure (PI-1), and Receiving Tank Fill Level.

Filling a Perma-Cyl (First Fill/ Warm Tank):

Fill the Perma-Cyl until the tank pressure reaches 40 psi

Open the Main Vent Valve on the Perma-Cyl and vent the tank to 10 psi

Close the Main Vent Valve on the Perma-Cyl

Fill the Perma-Cyl until the tank pressure reaches 40 psi

Open the Main Vent Valve on the Perma-Cyl and vent the tank to 10 psi

Close the Main Vent Valve on the Perma-Cyl

Repeat this procedure a minimum of FOUR TIMES

The Perma-Cyl is now purged and cooled

Note: The Perma-Cyl is shipped with low purity Nitrogen gas. Purging is necessary prior to filling. During first fill, only fill the vessel to 75% full to allow for liquid expansion experienced with a new (warm) tank. Each fill there after it can be filled to 100% full. All valves on an empty Perma-Cyl should always be kept closed to prevent the inner vessel and plumbing from being contaminated.

Operating Procedures for LOX ORCA Automatic Mode:

Engage the PTO (Power Take Off).

Activate AOV-2 Pump Flood Valve (this will automatically open when the Plumbing Cabinet Doors are opened)

Note the Inner Vessel Pressure (PI-1 Inner Vessel Pressure Indicator). This is the Saturation Pressure of the Liquid

Vent the ORCA Tank if needed using V-5 Vapor Vent Valve

Activate the 12 VDC Control Panel Switch (Flow processor should light up/verify 0.0, **-S-** in display)

Activate the 440 VAC Pump Disconnect Switch (VFD should light up/verify Output Frequency=0.00 in display)

Attach the ORCA Transfer Hose to the Receiving Tank

Record the Receiving Tank Vessel Pressure

Verify V-5 Vapor Vent Valve on ORCA is closed

Verify V-42 Recirculation Valve is open ¼ to ½ turn

Push the "Start" Button to begin the Recirculation Process

Open V-16 PB Force Feed Valve to build a **Minimum of 5 psi of Sub-Cool** .

Monitor the PI-1 Pump Discharge Pressure Gauge to verify pump has caught prime

Close V-16 PB Force Feed Valve after achieving a **Minimum of 5 psi of Sub-Cool**

Adjust ORCA Pump Pressure using the Pump Speed Dial on the Remote Pendant to 50 psi > than Receiving Tank Pressure

Open the V-41 Transfer Hose Valve

Verify "GO" Status in the Flow processor Flow rate/Status Window

Push the "Start" Button to begin the Delivery

Verify a steady Flow rate in the Flow processor Flow rate/Status Window

Monitor ORCA Tank Pressure PI-1 Inner Vessel Pressure Indicator to maintain a **Minimum of 5 psi of Sub-Cool above the initial Saturation Pressure.** Open V-16 PB Force Feed Valve to replenish the **Minimum of 5 psi of Sub-Cool above the initial Saturation Pressure. Caution: Do not allow the ORCA Tank Pressure to reach the Relief Valve Settings while the Pump is running! This will cause damage to the Pump!**

Monitor PI-2 Pump Discharge Pressure Indicator (PI-2) to maintain a Minimum of 50-psi differential between the ORCA Pump Discharge Pressure (PI-2) and the Receiving Tank.

Monitor the Receiving Tank Pressure and Fill Level

Push the "Stop" Button on the Remote Pendant to stop the Delivery

Close the V-41 Transfer Hose Valve

Push and hold the "Stop" Button on the Remote Pendant until an –E- appears in the Flow rate/Status Window of the Flow processor

Push the "Release" Button on the Printer and load the Delivery Ticket into the Printer

Push the "Forward" Button to lock the Delivery Ticket into the Printer

Push the "Forward/Reverse" Button to position the Delivery Ticket

Push the "Start" Button to begin Printing. (Push the "Start" Button a second time to print additional Tickets)

Push the "Release" Button to remove the Delivery Ticket from the Printer

Push and Hold the "Stop" Button for 5-10 seconds to clear the Delivery Total from the Flow processor

Disconnect the Transfer Hose

Slowly loosen the Spin-on-Adaptor to relieve any pressure

Stow the Transfer Hose

De-activate the 12 VDC Control Power Switch (Flow processor should power down)

De-activate the 440 VAC Pump Disconnect Switch

Disengage the PTO (Power Take Off).

Manual Mode-Recirculation

Recirculation of the Liquid

In the Manual Mode the FlowcomS8 has to be initiated as a separate activity. With the Mode Selector Switch in the "RECIRC" position (starts the pump Recirculating), press the "START" Button. The meter will then count down (10-0) and check the temperature of the liquid. If the diagnostic checks are verified a "GO" Status will appear in the Status/Flow Rate Window of the Flow Processor. If the Flow Processor Status Window does not display the "GO" (lower display) Status, push the "STOP" Button, which stops the Pump from Recirculating. If the Flow Processor detects a problem while performing its diagnostic check it will display an Error Code (see Flow processor Troubleshooting Guide). The unit is now in the "Recirculation Mode" and liquid is being drawn into the pump and recirculated back into the ORCA Tank. During the Recirculation, the operator can adjust the pump speed by using the Pump Speed Control Dial on the Remote Pendant. **The operator should adjust the speed until the pump pressure (PI-1) is at least 50psi above the receiving tank pressure**.

Manual Mode (adding Sub-Cool)

Pumping boiling liquid will damage the pump! At least **5 psi of Sub-Cool** is required to deliver the liquid from the ORCA Tank to the Pump. Upon arrival the operator must access the liquids current condition. The arrival pressure is the Saturation Pressure of the liquid. **The operator must maintain a minimum of 5psi Sub-Cool**

during the delivery. For extended deliveries the PB Circuit can be used to add additional Sub-Cool during the filling process. Initiate the FlowcomS8 by pressing the "START" Button on the Remote Pendant.

Manual Mode-Dispense (10-0, "GO")

The operator switches the Mode Selection Switch on the Control Panel to the "DISPENSE" position. This opens the Air Operated Dispense Valve (AOV-1) and allows liquid to flow out the Delivery Hose. The FlowcomS8 totalizes and displays the flow rate. **During the Manual Mode many of the systems safety features are not active. The Auto Shut-Off feature is not active in the Manual Mode. The pump and valve controls are up to the operator and are completely controlled by the Mode Selection Switch on the Control Panel.** To end the flow of liquid, switch the Mode Selection Switch to the "RECIRC" position. **The VFD will display "RUN" which means the pump will still be running.** The Flow Processor Status Display will show the Low Flow warning "L10.". Additional deliveries can be added to the total by connecting to the next tank and switching the Mode Selection Switch on the Control Panel to the "DISPENSE" Mode and then the "Automatic" Mode to completely terminate the delivery. At the end of the deliveries, turn the Mode Selection Switch to the "AUTO" position. The pump will ramp down with the VFD Display "DEC" (decelerating) and the Flow Processor status will be at standby ("-S-"). After the ramp down, the Hose Drain Valve SOV-1 will open equalizing the pressure in the hose with the ORCA and allowing the hose to drain. At this time the ticket printing procedure can be completed.

Operating Procedures for LOX ORCA Manual Mode:

Engage the PTO (Power Take Off)

Activate AOV-2 Pump Flood Valve (this will automatically open when the Plumbing Cabinet Doors are opened)

Note the ORCA Inner Vessel Pressure (PI-1 Inner Vessel Pressure Indicator). This is the Saturation Pressure of the Liquid

Vent the ORCA Tank if needed using V-5 Vapor Vent Valve

Activate the 12 VDC Control Power Switch (FlowcomS8 should light up/verify 0.0/-S- in display)

Activate the 440 VAC Pump Disconnect Switch (VFD should light up/verify Output Frequency=0.00 in display)

Attach the ORCA Transfer Hose to the Receiving Tank

Record the Receiving Tank Vessel Pressure

Verify V-5 Vapor Vent Valve on the ORCA is closed

Verify V-42 Recirculation Valve is open ¼ to ½ turn

Activate the Mode Selection Switch on the Remote Pendant to the "Recirculation" Mode

Open V-16 PB Force Feed Valve to build a Minimum of 5 psi of Sub-Cool if needed

Monitor the PI-1 Pump Discharge Pressure Gauge to verify pump has caught prime

Close V-16 PB Force Feed Valve after achieving a Minimum of 5 psi of Sub-Cool

Adjust the Pump Pressure using the Pump Speed Dial on the Remote Pendant to 50 psi> than Receiving Tank Pressure

Open the V-41 Transfer Hose Valve

Push the "Start" Button to activate the FlowcomS8 Countdown (10-0/"GO")

Verify a "GO" Status in the FlowcomS8 Flow rate Status Window

Push the "Start" Button to begin the FlowcomS8 Metering

Switch the Mode Selection Switch to the "Dispense" Mode (this will start the Delivery)

Verify a steady Flow rate in the FlowcomS8 Flow rate Status Window

Monitor ORCA Tank Pressure PI-1 Inner Vessel Pressure Indicator to maintain a Minimum of 5 psi of Sub-Cool above the initial Saturation Pressure. Open V-16 PB Force Feed Valve to replenish the Minimum of 5 psi of Sub-Cool above the initial Saturation Pressure. Caution: Do not allow the ORCA Tank Pressure to reach the Relief Valve Settings while the pump is running! This will cause damage to the pump!

Monitor PI-2 Pump Discharge Pressure Indicator to maintain a Minimum of 50-psi differential between the ORCA Pump Discharge Pressure PI-1 and the Receiving Tank

Monitor the Receiving Tank Pressure and Fill Level

Switch the Mode Selection Switch to "Recirculation" Mode (the pump is still activated at this time)

Switch the Mode Selection Switch on the face of the Control Panel to "Automatic" Mode

Close V-41 Transfer Hose Valve

Push and hold the "Stop" Button until an –E- appears in the FlowcomS8 Flow rate/Status Window of the FlowcomS8

Push the "Release" Button on the Printer and load the Delivery Ticket into the Printer

Push the "Forward" Button to lock the Delivery Ticket into the Printer

Push the "Forward/Reverse" Button to position the Delivery Ticket

Push the "Start" Button to begin printing. (push the "Start" Button a second time to print additional tickets)

Push the "Release" Button to remove the Delivery Ticket from the Printer

Push and hold the "Stop" Button for 5-10 seconds to clear the Delivery Total from the FlowcomS8

Slowly open the Spin-on-Adaptor on the Transfer Hose to relieve any pressure

Remove the Transfer Hose

Stow the Transfer Hose

Pressure Transfer Mode

As a backup to the pump transfer method, liquid can be transferred from the ORCA Vessel by the Pressure Transfer method. This is accomplished by building pressure in the ORCA Vessel and minimizing pressure in the receiving tank. The vessel to be filled will have to be vented to less than 5 psi with the ORCA Saturation Pressure at 10 psi and ORCA Vessel Vapor Pressure raised to 40-45psi. The standard ORCA Vessel has a MAWP of 50psi. The Flow Processor has a metering range of 4 to 40 gallons per minute so it is important to create the maximum amount of pressure difference between the ORCA Tank and the receiving tank. If the Saturation Pressure of the liquid in the ORCA Vessel is above 10psi the Vapor Vent Valve (V-5) should be opened and the ORCA Tank De-Saturated to 10psi. The receiving tank must be at less than 5 psi and the receiving tank vent must be left open during the delivery.

Standby Mode

The 440VAC Pump Disconnect switch should be switched to the "OFF" position. In the "OFF" position the pump cannot accidentally be started. The operator manually opens the Gravity Force Feed Valve (V-16), drawing liquid into the Pressure Building Coil. The PB Regulator (PCV-2) is set just below 50 psi and will limit the pressure building in the ORCA Vessel. The PB Force Feed Valve (V-16) should be left open during the Pressure Transfer delivery to maintain a high ORCA Vessel Pressure (45-50 psi). To improve the Pressure Transfer, it is recommended that the ORCA Pump is operated in the Recirculation Mode and the PB Force Feed (V-16) is opened to help boost the ORCA Tank Pressure to 40-45 psi. Once the optimum pressure is achieved the pump should be turned off before the Pressure Transfer is initiated.

Dispensing Mode

With 12VDC Control Power Switch on the Control Panel in the "ON" position, the Flow Processor will power up and begin its self-diagnostic check. If the Flow Processor completes the diagnostic check a –S- will appear in the Status/Flow Rate Window (lower window) indicating a "STANDBY STATE". To initiate the Flow Processor to meter the product being delivered push the "START" Button on the Remote Pendant. The Flow Processor will indicate the "Count Down" (10-0) in the Status/Flow Rate Window (lower window). Once a "GO" Status is achieved in the Flow Processor Status Window the delivery can be initiated by activating the Air Operated Dispensing Valve (AOV-1). Selecting "DISPENSE" with Mode Selection Switch on the Control Panel opens AOV-1. As the liquid flows from the ORCA Vessel, the vapor space increases and the pressure decreases in the ORCA Tank. To maintain the ORCA Vessel Pressure, keep the PB Force Feed Valve (V-16) open until the delivery is completed. The delivery is terminated by: moving the Mode Selection Switch on the Control Panel to the "AUTO" position, closing the PB Force Feed Valve (V-16) on the ORCA Vessel, closing the receiving tank vent valve, closing the Dispense Valve (V-41) on the ORCA Delivery Hose, switching "OFF" the 12 VDC Control Power Switch on the Control Panel, and removing the Delivery Hose. Stow the Delivery Hose, close the Plumbing Cabinet Doors, and proceed to the next stop.

Operating Procedures for LOX ORCA Pressure Transfer Mode

Verify 12 VDC Power is supplied to Control Panel

Vent the Receiving Tank pressure to 5 psi

Note the ORCA Saturation Pressure/Vessel Pressure (Arrival Pressure)

Optimum ORCA Saturation Pressure is 10 psi

Open Vapor Vent Valve (V-5) on the ORCA to De-Saturate the liquid if necessary

Optimum ORCA Tank Pressure is 40-45 psi

Open the PB Force Feed Valve (V-16) on the ORCA to build ORCA Tank Pressure to 45-50 psi

Open the Pump Block Valve (AOV-3) on the ORCA

Build the required Sub-Cool (Maximum ORCA Tank Pressure 40-45 psi)

Activate the 12 VDC Control Power Switch on the face of the Control Panel (FlowcomS8 should light up/verify 0.0/-S- in display)

Verify the 440 VAC Pump Disconnect Switch on the side of the Control Panel is Off

Verify the Mode Selection Switch on the face of the Control Panel is in the "Auto" Mode

Push the "Stop" Button on the Remote Pendant (activates the FlowcomS8 10-0 Countdown)

Connect the ORCA Transfer Hose to the Receiving Tank

Open the Dispense Valve (V-41) on the Transfer Hose

Turn the Mode Selection Switch on the face of the Control Panel to the "Auto" Mode

Activate the "Start" Button to open the AOV-1 Dispense Valve and begin Metering Product

Monitor FlowcomS8 on the ORCA for Flow Rate

Monitor ORCA Tank/Receiving Tank Pressure

Open PB Force Feed Valve (V-16) on the ORCA to maintain ORCA Tank Pressure if necessary

Open Vent Valve on Receiving Tank to maintain a Low Pressure (5 psi)

When the Receiving Tank is full or to Terminate the Delivery turn the Mode Selection Switch on the face of the Control Panel to the "Auto" Position

Push and hold the "Stop" Button until an –E- appears in the FlowcomS8 Flow rate/Status Window of the FlowcomS8

Push the "Release" Button on the Printer and load the Delivery Ticket into the Printer

Push the "Forward" Button to lock the Delivery Ticket into the Printer

Push the “Forward/Reverse” Button to position the Delivery Ticket

Push the “Start” Button to begin printing (push the “Start” Button a second time to print additional tickets)

Push the “Release” Button on the Remote Pendant to remove the Delivery Ticket from the Printer

Push and hold the “Stop” Button for 5-10 seconds to clear the Delivery Total from the FlowcomS8

Close the Dispense Valve (V-41) on the ORCA

Close the PB Force Feed Valve (V-16) on the ORCA

Close the Receiving Tank Vent Valve

Disconnect the ORCA Transfer Hose

Section 6 Systems Troubleshooting

Differential Pressure Transmitter Troubleshooting

DP Transmitter will not power up:

No 12 VDC Power- The DP Transmitter is connected to the 12 VDC Circuit via the truck/trailer battery. The truck mount is connected to the chassis battery with an in-line relay and 30-amp fuse. The trailer mount is connected to the generator battery. If the DP Transmitter does not power up follow the steps below to troubleshoot.

1. Is the truck Ignition on? The truck ignition must be on to provide 12 VDC Power to the FlowcomS8 and Control Panel.

2. Is the Control Power Switch on? This is located on the face of the Control Panel.

Control Power Switch

3. Check Emergency Stop to ensure it is not activated. It is spring loaded and must be de-activated if depressed by turning to the right.

4. Is the Control Panel Door open? There is a Door Interlock Switch that will disengage the power to the Control Panel if the door is open. The Door Interlock Switch must be pulled out if the door of the Control Panel is open while troubleshooting.

Door Interlock Switch

5. Is there 12 VDC Power to Terminal Strip 1? Use a Voltmeter to check the 12 VDC Power-in to Terminal Strip 1.

+ 12 VDC Power-in

-12 VDC Power-in

6. Is the 12 VDC Fuse FU102 blown? Open Fuse access and ohms check the fuse. The replacement fuse is a BUSS MDL-10.

E12-E13 DP Transmitter Error Codes

The Error codes associated with the DP Transmitters are the E12 and E13. E12 reflects a fault with the Primary or "Low Flow Transmitter which is connected to Terminal Block X3 on the FlowcomS8 Back Board. An E13 reflects a fault with the Auxiliary or "High Flow" Transmitter which is connected to Terminal Block X2 on the FlowcomS8 Back Board. Use a DMM meter to check the current reading at Terminal Block X2 or X3 as required. This reading should be 4 ma at idle. If the signal is less than 3.8 ma or higher than 19.9 ma when the system is powered up in "LOW FLOW "Mode, E12 will be displayed. If the signal is less than 3.8 ma or higher than 19.9 ma when the system is powered up in "HIGH FLOW" Mode, E13 will be displayed. If E12/E13 is displayed check the following:

1. Leaks in the sensor lines to the DP Transmitter. Even a small leak in a line connection will allow a flow of gas. If the FlowcomS8 is powered on and a leak is present, the system will not get a steady reading for start-up. An E12 or E13 will appear in the Status Display of the FlowcomS8. Pressing the STOP button on the remote pendant will clear this code but not correct the problem. If allowed to continue, the Error code will continually appear at start-up. "Snoop" may be required to identify the leaking fitting.

FlowcomS8 Troubleshooting

FlowcomS8 will not power up:

No 12 VDC Power - The FlowcomS8 is connected to the 12VDC Circuit via the truck/trailer battery. The truck mount is connected to the chassis battery with an in-line relay and 30-amp fuse. The trailer mount is connected to the generator battery. If the FlowcomS8 does not power up follow the steps below to troubleshoot.

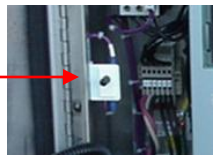
1. Is the truck Ignition on? The truck ignition must be on to provide 12 VDC Power to the FlowcomS8 and Control Panel.

2. Is the Control Power Switch on? This is located on the face of the Control Panel.

Control Power Switch 

3. Check Emergency Stop to ensure it is not activated. It is spring loaded and must be de-activated if depressed by turning to the right.

4. Is the Control Panel Door open? There is a Door Interlock Switch that will disengage the power to the Control Panel if the door is open. The Door Interlock Switch must be pulled out if the door of the Control Panel is open while troubleshooting.

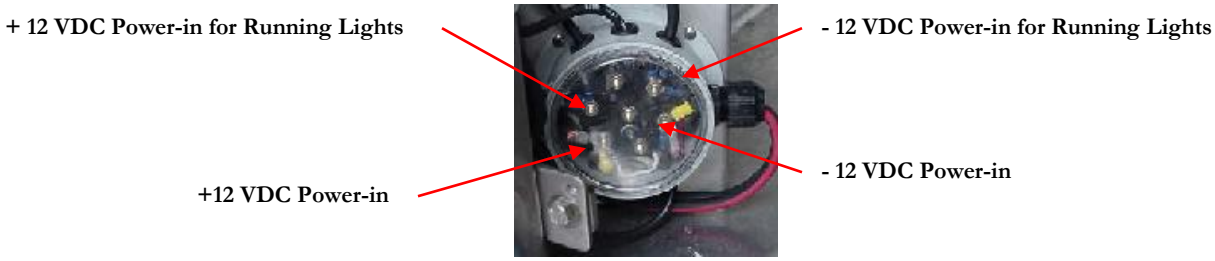
Door Interlock Switch 

5. Is there 12 VDC Power to Terminal Strip 1? Use a Voltmeter to check the 12 VDC Power-in to Terminal Strip 1.

6. Is the 12 VDC Fuse FU102 blown? Open Fuse access and ohms check the fuse.

   The replacement fuse is a BUSS MDL-10.

7. Is there 12 VDC Power to the Low Voltage Junction Box? Use a Voltmeter to check the 12 VDC Power to the Low Voltage Junction Box.



8. Is there power to the FlowcomS8? Use a Voltmeter to check the 12 VDC Power-in to the FlowcomS8 at the Main Board Terminal Strip X6. The Main Board is located at the rear of FlowcomS8 Stainless Steel Enclosure (see picture below).

Green, Red, yellow LED will illuminate

Yellow LED will illuminate

Terminal Block X6 12 VDC

For Further Troubleshooting of the FlowcomS8, contact Chart for Technical Support.

SVX 9000 Variable Frequency Drive Troubleshooting

The Variable Frequency Drive is powered by the High Voltage Circuit (440-480 VAC) from the Generator (Trailer Mount) or Alternator (Truck Mount). It requires Three Phase Power 440-480 VAC to function properly. If an under voltage/overvoltage situation occurs it will dramatically affect the operation of the Variable Frequency Drive and can potentially damage internal components. There is an Over-Voltage Protection Circuit wired into the Control Panel for additional protection.

VFD will not power up:

No 440-480 VAC Power- The VFD is connected to the High Voltage Circuit via the Alternator. If the VFD does not power-up follow the steps below to troubleshoot.

1. Is the Low Voltage Circuit on? The Low Voltage Circuit must be on before the High Voltage Circuit can be energized. Make sure the truck ignition, Control Power Switch, and FlowcomS8 is on.

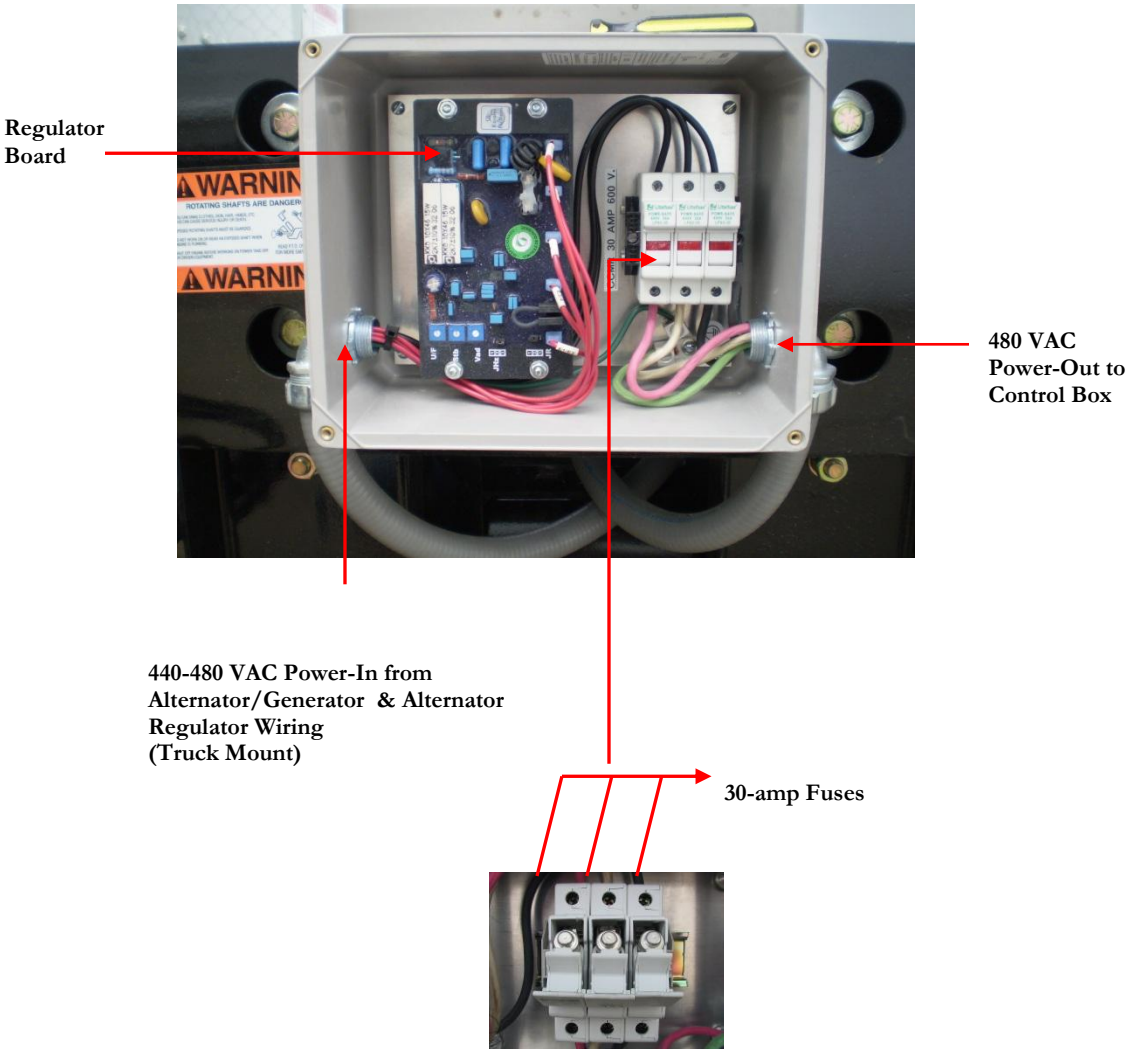
Control Power Switch

Flow processor ON/OFF Button

Is the Alternator/Generator providing the proper amount of power to the VFD? Check the Alternator Fuse Box Panel located Roadside just behind the Alternator, with a Voltmeter to ensure there is 480 VAC supplied from the Alternator. Verify all three legs of the Three Phase Power:

L1 to L3
L2 to L3
L1 to L2

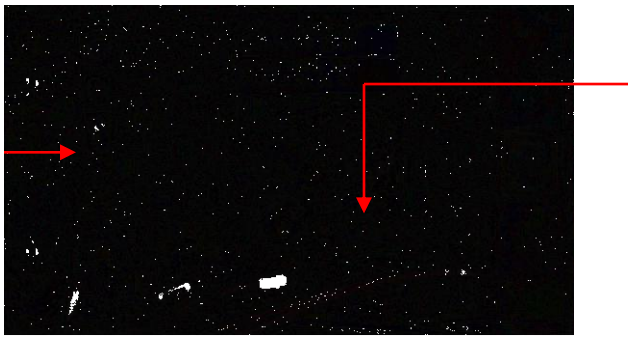
2. Verify Alternator/Generator Fuse Panel three 30 amp Fuses for integrity. Use a Voltmeter that has the ability to read in OHMS. The value of a good fuse should be 0.00 OHMS. If the fuse is no longer useable the reading will be Infinite or Open.



3. Is PTO engaged and spinning at the Correct Speed/RPM? The PTO Shaft should be rotating at 1800 RPM, which usually translates to a Truck engine speed of 1100 RPM.

5. If the PTO Shaft is spinning at the correct speed, the regulator board in the Alternator/Generator fuse panel can be adjusted for power output. An adjustment pot (Marked Vad) is located on the regulator board. The correct output should be 480 VAC. Turn the pot while checking the voltage at the fuse block with a volt meter. the Regulator Board has a fuse mounted to the board itself. Verify that the fuse is not blown. A voltage output of Approximately 130 VAC across any two legs of the 480 VAC wiring can indicate a failed Regulator Board.

Voltage adjust (Vad) pot



Fuse Location (Fuse – 3.0A 250V 5mm x 20mm fast blow) MFG Little fuse P/N 235003

WEG Alternator Regulator Board

6, Is the Generator running?

7. Is the Emergency Stop activated?

8. Verify RPM Setting (truck mount) is set to the required value (1100 RPM=480 VAC).
    a. Verify Generator (trailer mount) is ramping up to speed.

9. Are there visible signs of Overvoltage/Overcurrent at VFD?

10. Check the Output Voltage of the Alternator/Generator at the Pump Disconnect Switch located in the Control Panel. The value should be 480 VAC. Verify all three legs of the Three Phase Power:

    L1 to L3
    L2 to L3
    L1 to L2

11. Check the Input Voltage to the Variable Frequency Drive. VAC is located at the lower left hand corner of the Variable Frequency Drive. The access panel must be removed to accomplish checking the Input Voltage. The value should be 480 VAC. Verify all three legs of the Three Phase Power:

    L1 to L3
    L2 to L3
    L1 to L2

Variable Frequency Drive is powered but will not run.

1. Activate the Start Button on the Remote Pendant to begin the Recirculation Countdown and check the Output Voltage of the Variable Frequency Drive at L1-L2-L3. The value should be 440-480 VAC. Verify all three legs of the Three Phase Power:
   L1 to L3
   L2 to L3
   L1 to L2
2. Verify all Parameter Settings of Variable Frequency Drive.

SVX 9000 PARAMETER SETTINGS

PARAMETER	TC-30 External Pump LIN
MIN. FREQUENCY	40 Hz
MAX. FREQUENCY	81 Hz
ACCEL. TIME	7s
DECEL TIME	10s
CURRENT LIMIT	31.5 A
NOM. VOLTAGE	460 V
NOM. FREQUENCY	120 Hz
NOM. SPEED	5400 RPM
NOM. CURRENT	19.5 A
POWER FACTOR	0.85

SVX 9000 Variable Frequency Drive Programming

The VFD when supplied with between **470 and 480 VAC, Three-Phase Power** from the Alternator/Generator, provides an output of voltage and frequency that correspond to the pump speed selected on the Remote Pendant Pump Speed Dial.

1. With the VFD powered up and in the idle position the display should read:
   V1
   Output Frequency 0.0 HZ
2. Press the **Left Arrow** and the display should read:
   Programming press Enter
3. Press **Enter** and the display should read:
   M1
   Parameters P1-P22
4. Press the **Right Arrow** and the display should read:
   P1.1
   Min Frequency
   4. Press the **Right Arrow**. Use the **UP** and **Down Arrows** to reflect the appropriate value: Press **Enter**.
   5. Press the **UP Arrow** and the display should read:
      P1.2
      Max Frequency
   6. Press the **Right Arrow**. Use the **UP** and **Down Arrows** to reflect the appropriate value: Press **Enter**.
8. Press the **UP Arrow** and the display should read:
   P1.3
   Acceleration Time
   7. Press the **Right Arrow**. Use the **UP** and **Down Arrows** to reflect the following value:
      7s. Press **Enter**.
   8. Press the **UP Arrow** and the display should read:
      P1.4

Deceleration Time

9. Press the **Right Arrow**. Use the **UP** and **Down Arrows** to reflect the following value: **10s**. Press **Enter**.
10. Press the **UP Arrow** and the display should read:

P1.5

Current Limit

11. Press the **Right Arrow**. Use the **UP** and **Down Arrows** to reflect the appropriate value: Press **Enter**.
13. Press the **UP Arrow** and the display should read:

P1.6

Nominal Voltage of the Motor

14. Press the **Right Arrow**. Use the **UP** and **Down Arrows** to reflect the appropriate value: Press **Enter**.
15. Press the **UP Arrow** and the display should read:

P1.7

Nominal Frequency of the Motor

16. Press the **Right Arrow**. Use the **UP** and **Down Arrows** to reflect the appropriate value: Press **Enter**.
17. Press the **UP Arrow** and the display should read:

P1.8

Nominal Speed of Motor

18. Press the **Right Arrow**. Use the **UP** and **Down Arrows** to reflect the appropriate value: Press **Enter**
19. Press the **UP Arrow** and the display should read:

P1.9

Nominal Current of Motor

20. Press the **Right Arrow**. Use the **UP** and **Down Arrows** to reflect the appropriate value: Press **Enter**.
21. Press the **UP Arrow** and the display should read:

P1.10

Power Factor

22. Press the **Right Arrow**. Use the **UP** and **Down Arrows** to reflect the following value: **0.85**. Press **Enter**.
23. Press the **Left Arrow** and the display should read **Parameters P1-P-22**.
24. Press the **Down Arrow** and the display should read **Operate Mode Press Enter**.
25. Press **Enter** and the display should read **Output Frequency 0.0 Hz**.

THE VFD IS NOW PROGRAMMED AND READY FOR USE.

Trouble Shooting Guide

Use the Troubleshooting table as a guideline to diagnose your ORCA system should problems develop. The table consists of the Trouble, Probable Cause and Remedy columns. This table cannot replace the knowledge that an experienced operator or cryogenic maintenance technician has, and should be considered as a guide only. Note that 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.

Vacuum Integrity

Since all ORCA vessels are super-insulated, any deterioration or loss of vacuum will be apparent by cold spots or frost on the outer shell, or abnormally rapid pressure build up. Unless one of these conditions is evidenced, the vacuum level should not be suspect.

The ORCA vessel is factory equipped with a Hastings DV-6R vacuum probe. In the event that the vacuum becomes suspect, measure the vacuum with the compatible Hastings meter. The cold vacuum level should be under 25 microns of mercury.

Note: Early morning condensation or dew on the tank is normal and may be irregularly distributed on the outer shell.

ORCA Troubleshooting

Symptom	Possible Cause	Remedy
Control panel does not light up.	Fuse blown in 12 volt control circuit. 12 volt circuit open.	Replace fuse in fuse block in truck. Verify connector is plugged in at front of tank. Also inspect wires from connector to control panel for breaks, cuts, etc. Repair if necessary.
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. Worn bearings in pump.	Slow pump speed down using control on pendant. Remove and replace pump.
Dispense valve does not open.	No air supply to the valve. No 12 volt power to the solenoid. Valve is frozen.	Verify that there is sufficient air in air tanks. Valve requires 100psi 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!!**
Flowcom flow meter cycles through boot-up repeatedly.	Defective front board in Flowcom.	Obtain replacement front board from factory and replace.
E 12/13 error code on Flowcom.	Liquid flow through meter section before meter is turned on. DP transmitter defective. Wiring defective. Leak in D.P. 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	Possible Cause	Remedy
Unstable flow of product.	Depletion of sub-cool.	Add sub-cool by opening pressure building coil. 5 to 7 psi 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!**
Unstable flow of product (cont.)	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.
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 to 7 psi 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!**
No "Go" indication on Flowcom. (Flashing "0.0" after countdown.)	Meter section not cooling down.	Open the P.B. Gravity Feed valve located on the valve stand to the right of the control panel, third valve from the top. Leave open until "Go" indication appears.
E01 appears on Flowcom.	Printer error.	Verify that the cables to the printer are plugged in, that the printer is turned on, and that there is paper in the printer.

Meter Troubleshooting Guide

Reference Summary of Meter Error Messages

Screen Display	Status	Description
"-S-"	Standby mode	System is ready for delivery. In the automatic mode, start the delivery pressing start
"-E-"	End of Delivery	Metering is completed. Ticket can be printed at this time.
"LLL"	Low temperature	The liquid temperature has exceeded the lower limit of the current temperature setup. Verify that the temperature limits and that the current product matches parameter settings
"HHH"	High temperature	The liquid temperature has exceeded the upper limit of the current temperature setup. Verify that the temperature limits and that the current product matches parameter settings
"L10"	Metered flow rate below meterable range.	Metering is stopped if "L10" is displayed. In the automatic mode L10 only appears during the start up time out. In the manual mode, "L10" appears any time the flow drops below the meterable range.
"H99"	Metered flow rate above meterable range.	Metering is stopped if flow rate exceeds the meterable range. In the automatic mode the delivery will be terminated and "H99" will be displayed. In the manual mode if the flow rate exceeds the meterable range the totalizing of the delivery is stop until the flow rate is lowered to the acceptable range.
"E01"	Printer Error	If the printer is off, the paper is out or data transfer is interrupted, this message will appear for 5 seconds. Resolve the printer error and press start the ticket will be printed (original).
"E11"	Measured temperature is too low.	This 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.

		-A/D converter is defective
"E12/E13"	DP Transmitter Fault	The controller reads a 4 to 20 ma signal from the DP transmitter. If the signal is less than 3.8 ma or higher than 19.9 ma when the system is powered up, "E12" will be displayed. Check the following: -Leaks in the sensor lines to the DP transmitter. -Dispensing during start up. -Defective DP transmitter. -Defective power supply to DP transmitter.
"E16"	Calibration/Configuration mode	During calibration and configuration, the security switch is removed to allow communication. If the switch is not replaced (delivery position) and a delivery is attempted "E16" is displayed. During this error no metering is possible.
"E20"	Main Setup Fault	The main setup data is lost or not correct due to one of the following: -main setup parameters not entered or entered incorrectly. -EEPROM defective -EEPROM cannot be addressed
"E21"	Ram-Check Fault	RAM data lost. Normal with first operation. This fault can be cleared by pressing the "Stop" button. If this fault occurs with each system power up, the CPU may need to be exchanged.
"E24"	Non-Critical (Public) Data Fault	
"E28"	Time out Fault	Data could not be stored properly in the EEPROM. The EEPROM may be defective.
"E30"	A/D Converter Fault	The program is stopped. The A/D converter may be defective.
"E31"	PT100 Temperature Sensor Fault	The Temperature Sensor is defective or not connected properly. The current is out of tolerance.
"E32"	EEPROM Fault	The memory of the EEPROM could not be read.
"PE 01"	Calculation Fault	General division error
"PE 02"	Calculation Fault	Division of a long variable by zero
"PE 03"	Calculation Fault	Division of a floating variable by zero
"PE 04"	Calculation Fault	Overflow of a floating variable by zero

"PE 05"	Calculation Fault	Underflow of a floating variable by zero

Description of Error Messages and how solve the problem

E01 Printer Error

This error message occurs when the handshake between the Flowcom S8 and the printer does not occur. The message occurs when attempting to print a ticket.

Reasons:

1. Paper not properly inserted (paper out)
2. Printer power off
3. RS232 connection problem
4. Printer DIP switch settings are not correct.

Fixing the Problem:

1. Make sure the printer has power (lights on printer should be lite).
2. Confirm that the paper is properly installed.
3. Check cable which connects flow processor and printer.
4. Check the DIP switches on the printer.

E11 Measured Temperature is too Low

This error message occurs when the calculated temperature is below the preset range determined by the product parameter. At atmospheric pressure the lowest possible temperature (LIN,LOX,LAR) is predictable.

Reasons:

1. Temperature Parameters are wrong for the product being metered.
2. Current Product Parameter does not match actual product being metered.
3. Wiring Problem in the connection of the Temperature Probe (also refer to as PT100 or RTD).
4. FLOWCOM S8 defective
    - Temperature Range Switching is defective.
    - Constant current source is defective
    - A/D converter is defective

Fixing the Problem:

1. Confirm the temperature parameter settings
2. Confirm that the current product parameter matches actual product (check ticket print out or boot up display)
3. Check wiring connections to the RTD.
4. With the above confirmed, determine if the RTD is defective by: Disconnect the RTD wiring to the Flowcom S8 and measure current. If current matches expected values the RTD is OK.
5. If 1-4 are confirmed and do not resolve the problem the Flowcom S8 is defective. Call Chart for a replacement.

E12/E13 Zero Point Error of D.P. Transmitter

This error message occurs when the signal current of the differential pressure transmitter is higher than 4.2 mA or less than 3.8 mA during test mode of
FLOWCOMS8 (for 4 seconds after power on). The signal current at a flow rate of 0 percent is supposed to be 4.00 mA.

Reasons:

1. Product flowing through metering section before the meter has been switched on or when a power fail occurred during delivery and the power has come up again.
2. DP-Transmitter defective
3. Wiring Problem
4. FLOWCOM S8 defective

Fixing the Problem:

1. Check for leaks n D.P. Transmitter lines.
2. Zero out D.P. Transmitter (Page 77 of this manual)

E16 Calibration/Configuration Mode

This error message occurs when a delivery is attempted with the security switch removed. During this error no metering is possible.

Reasons:

1. Security switch is removed.

Fixing the Problem:

1. Confirm settings, power down the system, replace the security switch, power up and restart the delivery.

E20 Checksum Error of Parameters

This error message occurs when the check sum of the set-up parameters has become invalid or parameter are lost.

Reasons:

1. exchanging set-up memory or main PC-board (EEPROM) without entering new data
2. carried out the FORMAT EEPROM instruction (terminal and password required)
3. FLOWCOM defective

Fixing the Problem:

1. Configure the flow processor by reentering all parameters .
2. Configure the flow processor by reentering all parameters.
3. If the flow processor does not allow to be reconfigured the main board needs to be replaced. It is located on the back of the front door.

E21 RAM Supply Error

This error indicates that the quantity variable in the meter´s memory may contain an invalid value when first energized. It may also occur when the FLOWCOM S8 is switched off for more than 7 days. The memory (RAM) is supplied by a large capacitor which discharges after 1 week. This buffering prevents loss of the measured quantities if a power failure has occurred during operation. It does not affect the non resettable totalizer.

Fixing the Problem:

To reset the error message, press and hold STOP

E24 Checksum Error of Public Data

It occurs when the check sum of the general non-critical data has become invalid or data are lost. This could either be the totalizer or the transaction counter. Other data or parameter are not affected.

Fixing the Problem:

To reset the error message, press and hold the STOP button which initializes the internal variables and stores them in the non volatile memory.

E28 Checksum Error of Config Data

This error message occurs when data is not stored properly on the EEPROM.

Fixing the Problem:

1. Reset the error message, press and hold STOP.
2. If the error message does not clear the Flowcom S8 is defective. Call Chart for a replacement.

E30 A/D Converter Fault

This error message occurs when the Flowcom S8 internal diagnostics determines that there A/D converter is malfunctioning.

Fixing the Problem:

1. Reset the error message, press and hold STOP.
2. If the error message does not clear the Flowcom S8 is defective. Call Chart for a replacement.

E31 Temperature Probe is Malfunctioning

This error message occurs when the resistance between the combinations of the 4 wire leads exceed proper values. Measuring resistance only requires 2 wires. 4 wire RTD use duplicate wires.

Reasons:

Resistance between the wires in the pairs varies outside spec.

Measured resistance from pair to pair exceeds spec.

RTD was missed wired.

The Flowcom S8 was damaged such that it cannot interpret the resistance.

Fixing the Problem:

Power down the system, open the Flowcom S8, remove the RTD quick connect terminal block, measure resistance between 1 and 2 then 3 and 4. The resistance should be less than 1 ohm. The wires are paired wrong or the RTD has failed. Change pairing by finding pairs with less than 1 ohm resistance (2 sets).

Using the procedure in 1, confirm that the resistance between 1 and 3 then 2 and 4 matches the expected current temperature.

If 1 or 2 fails than the RTD is defective. Call Chart for a replacement.

If 1 and 2 are confirmed than the Flowcom S8 is defective. Call Chart for a replacement.

E32 EEPROM Fault

This error message occurs when the memory of the EEPROM cannot be read

Fixing the Problem:

Reset the error message, press and hold STOP.

If the error message does not clear the EEPROM is defective. Call Chart for a replacement.

H99 Flow Rate higher than 99%

The message H99 is displayed during discharge when the flow rate exceeds its maximum.

The meter is not counting any liquid being transferred during this condition (Under-registering) and in the automatic mode the system terminates the delivery. H99 will continue to be displayed, clear by holding the stop button. Slow the pump speed down and restart the delivery. The flow range of the meter will only be exceed when the tank being delivered to is at low pressures and has minimal pressure drop in the fill circuit.

Fixing the Problem:

Clear H99 by holding the Stop Button.

Decrease pump speed

Dark Display

Check fuses inside the flow processor. If both the printer and the flow processor is not powered start with the fuse on the bottom board (NT06/NT06A) otherwise the one on the main board (FCLC).

If both fuses are good, check polarity of the power supply and whether the relay, located in the left upper corner of the bottom board, is properly plugged into its socket.

Printer is not working

1. Lamps on the printer are illuminated

   If you have just finished installation, check the wiring of the serial communication port between flow processor and printer. The printer does not work when two or more wires are confused . If the printer has become faulty after it had been working properly, also check the serial communication cable for a broken wire or disruption.

2. Lamps on the Printer are dark

Check if the printer has a power switch on its left side and if it is in on position (the older version TM290 does not have a switch). It can be always left on. Open the flow processor and check if the green lamp, located in the right upper corner of the bottom board, is illuminated while the meter is switched on. It indicates that the printer supply voltage is higher than 20 V. If the lamp is off while the display of the flow processor is working, unplug the printer connector X6, switch the meter off and then on again. If the lamp does not go on check the power supply voltage of the meter across the contacts of connector X5. It must be between 9 VDC and 30 VDC. If the supply voltage is within specs the bottom board needs to be replaced. If the lamp has been illuminated after switching off and on again, check the power supply voltage of the printer. It can be measured on the connector X6 between contacts 5 (positive) and 6 (negative). The multi-meter should read a voltage between 20 VDC and 26 VDC. If the voltage is outside this range the bottom board needs to be replaced. If found within the allowed range, plug in X5 and check the voltage again. In case of the lamp goes out when the X5 is plugged in, check the wiring for a short circuit. If the voltage is found within its range, the green lamp inside the flow processor is illuminated and the wiring is correct check the fuse inside the printer. For example, it burns out if the polarity has been confused.

VFD Troubleshooting Guide

When a fault trip occurs, the fault indicator is illuminated and the fault code and its description are displayed. The fault can be cleared with the Reset button or via an I/O terminal. The faults are stored to the fault history from where they can be viewed. The fault codes are explained in Appendix B, B-1/B-4 **SVX9000** Manual.

Fault codes	Fault	Possible cause	Checking
F1	Over current	SVX9000 frequency converter has measured too high a current (>4*In) in the motor output: - sudden heavy load increase - short circuit in the motor cables unsuitable motor	Check load Check motor size Check cables
F2	Over voltage	The voltage of the internal DC-link of the SVX9000 frequency converter has exceeded the nominal voltage by 35% - deceleration time is too fast - high over voltage spikes at utility	Adjust the deceleration time
F3	Ground fault	Current measurement detected that the sum of the motor phase current is not zero - insulation failure in the motor or the cables	Check the motor cables
F4	Inverter fault	SVX9000 frequency converter has detected faulty operation in the gate drivers or IGBT bridge - interference fault - component failure	Reset the fault and restart again. If the fault occurs again contact your Cutler Hammer distributor.
F5	Charging switch	Charging switch open when START command active - interference fault - component failure	Reset the fault and restart again. If the fault occurs again contact your Cutler Hammer distributor.
F9	Under voltage	DC-bus voltage has gone below 65% of the nominal voltage - most common reason is failure of the utility supply - internal failure of the SVX9000 frequency converter can also cause an under voltage trip	In case of temporary supply voltage break, reset the fault and start again. Check utility input. If utility supply is correct an internal failure has occurred. Contact your Cutler Hammer distributor.
F10	Input line supervision	Input line phase is missing	Check the utility connection
F11	Output phase supervision	Current measurement has detected that there is no current in one motor phase	Check motor cables
F12	Brake chopper supervision	- brake resistor not installed - brake resistor broken - brake chopper broken	Check brake resistor If resistor is OK the chopper is broken. Contact your Cutler Hammer distributor
F13	under temperature	Temperature of heat sink below -10ºC	

Fault codes	Fault	Possible cause	Checking
F14	over temperature	Temperature of heat sink over 75^0C For Compact NEMA 1 over 80^0C	Check the cooling air flow Check that the heat sink is clean Check the ambient temperature Check that the switching frequency is not too high for the ambient temperature and load.
F15	Motor stalled	The motor stall protection has tripped	Check the motor
F16	Motor over temperature	The SVX9000 motor temperature calculating model has calculated a motor over temperature	Decrease motor load Check the temperature model parameters if the motor wasn't too hot.
F17	Motor under load	The motor under load protection has tripped	Check motor and possible belts etc.
F18	Analog input hardware fault	Component failure on the control card	Contact your Cutler Hammer distributor
F19	Option board identification	Reading of the option board has failed	Check the installation of the board. If the installation is OK, contact your Cutler Hammer distributor.
F20	10 V voltage reference	+ 10 V reference shorted on the control card or on an option board	Check the wiring connected to the + 10 V reference
F21	24 V supply	+ 24 V supply shorted on the control card or on an option board	Check the wiring connected to the + 24 V reference
F22 F23	EEPROM Checksum failure	Parameter restoring error – interference – component failure	On resetting this fault, the drive will automatically load the parameter default settings. Check all parameters before restarting the drive. If the fault occurs again, contact your Cutler Hammer distributor
F25	Microprocessor watchdog	– interference – component failure	Reset the fault and restart. If the fault occurs again, contact your Cutler Hammer distributor
F26	Panel communication error	The connection between the drive and the panel doesn't work	Check the panel cable and connectors. If the fault occurs again, contact your Cutler Hammer distributor
F29	Thermistor protection	The thermistor input on the I/O boards has detected a motor temperature increase.	Check the motor load and cooling. Check the thermistor connection. If there are no thermistors, make sure the inputs are short-circuited.
F36	Analog input Im< 4 mA (signal range 4-20 mA selected)	The analog input current is below 4 mA – signal source failed – control cable broken.	Check the current loop circuitry
F41	External fault	An external fault has been detected at the digital input	Check the external fault source.

Flow processor Troubleshooting Table

Flow Meter Status Display and Error Messages - Software Version P.2.08.0		
Screen Display	**Status**	**Description**
"-S-"	Standby mode	System is ready for delivery. In the automatic mode, start the delivery pressing start
"-E-"	End of Delivery	Metering is completed. Ticket can be printed at this time.
"LLL"	Low temperature	The liquid temperature has exceeded the lower limit of the current temperature setup. Verify that the temperature limits and that the current product matches parameter settings
"HHH"	High temperature	The liquid temperature has exceeded the upper limit of the current temperature setup. Verify that the temperature limits and that the current product matches parameter settings
"L10"	Metered flow rate below meterable range.	Metering is stopped if "L10" is displayed. In the automatic mode L10 only appears during the start up time out. In the manual mode, "L10" appears any time the flow drops below the meterable range.
"H99"	Metered flow rate above meterable range.	Metering is stopped if flow rate exceeds the meterable range. In the automatic mode the delivery will be terminated and "H99" will be displayed. In the manual mode if the flow rate exceeds the meterable range the totalizing of the delivery is stop until the flow rate is lowered to the acceptable range.
"E01"	Printer Error	If the printer is off, the paper is out or data transfer is interrupted, this message will appear for 5 seconds. Resolve the printer error and press start the ticket will be printed (original).
"E11"	Measured temperature is too low.	This 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. -A/D converter is defective
"E12"	Low Flow DP Transmitter Fault	The controller reads a 4 to 20 ma signal from the Low Flow DP transmitter. If the signal is less than 3.8 ma or higher than 19.9 ma when the system is powered up, "E12" will be displayed. Check the following: -Leaks in the sensor lines to the Low Flow DP transmitter. -Dispensing during start up. -Defective MAIN DP transmitter. -Defective power supply to MAIN DP transmitter.
"E13"	High Flow DP Transmitter Fault	The controller reads a 4 to 20 ma signal from the High Flow DP transmitter. If the signal is less than 3.8 ma or higher than 19.9 ma when the system is powered up, "E13" will be displayed. Check the following:-Leaks in the sensor lines to the High Flow DP transmitter. -Dispensing during start up. -Defective AUX. DP transmitter. -Defective power supply to AUX. DP transmitter.
"E16"	Calibration/Configuration mode	During calibration and configuration, the security switch is removed to allow

		communication. If the switch is not replaced (delivery position) and a delivery is attempted “E16” is displayed. During this error no metering is possible.
“E20”	Main Setup Fault	The main setup data is lost or not correct due to one of the following: -main setup parameters not entered or entered incorrectly. -EEPROM defective -EEPROM cannot be addressed
“E21”	Ram-Check Fault	RAM data lost. Normal with first operation. This fault can be cleared by pressing the “Stop” button. If this fault occurs with each system power up, the CPU may need to be exchanged.
“E23”	Configuration Data Error	“Public Data Are Missing or Checksum found incorrect during startup.
“E24”	Non-Critical (Public) Data Fault	
“E31”	PT100 Temperature Sensor Fault	The Temperature Sensor is defective or not connected properly. The current is out of tolerance.
“PE 01”	Calculation Fault	General division error
“PE 02”	Calculation Fault	Division of a long variable by zero
“PE 03”	Calculation Fault	Division of a floating variable by zero
“PE 04”	Calculation Fault	Overflow of a floating variable by zero
“PE 05”	Calculation Fault	Underflow of a floating variable by zero

Note: Error messages can be cleared by holding “Stop Button” for 5 seconds. If Error messages do not clear then consult the manual.

Variable Frequency Drive (VFD) Troubleshooting Table

VFD Troubleshooting Table

Fault codes	Fault	Possible cause	Checking
F1	Over current	SV9000 frequency converter has measured too high a current (>4*In) in the motor output: - sudden heavy load increase - short circuit in the motor cables unsuitable motor	Check load Check motor size Check cables
F2	Over voltage	The voltage of the internal DC-link of the SV9000 frequency converter has exceeded the nominal voltage by 35% - deceleration time is too fast - high over voltage spikes at utility	Adjust the deceleration time
F3	Ground fault	Current measurement detected that the sum of the motor phase current is not zero - insulation failure in the motor or the cables	Check the motor cables
F4	Inverter fault	SV9000 frequency converter has detected faulty operation in the gate drivers or IGBT bridge - interference fault - component failure	Reset the fault and restart again. If the fault occurs again contact your Cutler Hammer distributor.
F5	Charging switch	Charging switch open when START command active - interference fault - component failure	Reset the fault and restart again. If the fault occurs again contact your Cutler Hammer distributor.
F9	Under voltage	DC-bus voltage has gone below 65% of the nominal voltage - most common reason is failure of the utility supply - internal failure of the SV9000 frequency converter can also cause an under voltage trip	In case of temporary supply voltage break, reset the fault and start again. Check utility input. If utility supply is correct an internal failure has occurred. Contact your Cutler Hammer distributor.
F10	Input line supervision	Input line phase is missing	Check the utility connection
F11	Output phase supervision	Current measurement has detected that there is no current in one motor phase	Check motor cables
F12	Brake chopper supervision	- brake resistor not installed - brake resistor broken - brake chopper broken	Check brake resistor If resistor is OK the chopper is broken. Contact your Cutler Hammer distributor
F13	SV9000 under temperature	Temperature of heat sink below -10ºC	
F14	SV9000 over temperature	Temperature of heat sink over 75°C For Compact NEMA 1 over 80°C	Check the cooling air flow Check that the heat sink is clean Check the ambient temperature Check that the switching frequency is not too high for the ambient temperature and load.
F15	Motor stalled	The motor stall protection has tripped	Check the motor
F16	Motor over temperature	The SV9000 motor temperature calculating model has calculated a motor over temperature	Decrease motor load Check the temperature model parameters if the motor wasn't too hot.
F17	Motor under load	The motor under load protection has tripped	Check motor and possible belts etc.
F18	Analog input hardware fault	Component failure on the control card	Contact your Cutler Hammer distributor
F19	Option board identification	Reading of the option board has failed	Check the installation of the board. If the installation is OK, contact your Cutler Hammer distributor.
F20	10 V voltage reference	+ 10 V reference shorted on the control card or on an option board	Check the wiring connected to the + 10 V reference
F21	24 V supply	+ 24 V supply shorted on the control card or on an option board	Check the wiring connected to the + 24 V reference
F22 F23	EEPROM Checksum failure	Parameter restoring error – interference – component failure	On resetting this fault, the drive will automatically load the parameter default settings. Check all parameters before restarting the drive. If the fault occurs again, contact your Cutler Hammer distributor
F25	Microprocessor watchdog	– interference – component failure	Reset the fault and restart. If the fault occurs again, contact your Cutler Hammer distributor
F26	Panel communication error	The connection between the drive and the panel doesn't work	Check the panel cable and connectors. If the fault occurs again, contact your Cutler Hammer distributor
F29	Thermistor protection	The thermistor input on the I/O boards has detected a motor temperature increase.	Check the motor load and cooling. Check the thermistor connection. If there are no thermistors, make sure the inputs are short-circuited.
F36	Analog input Im< 4 mA (signal range 4-20 mA selected)	The analog input current is below 4 mA – signal source failed – control cable broken.	Check the current loop circuitry
F41	External fault	An external fault has been detected at the digital input	Check the external fault source.

General Troubleshooting Table

ORCA General Troubleshooting Table

Symptom	Possible Cause	Remedy
Control panel does not light up.	Fuse blown in 12-volt control circuit. 12-volt circuit open.	Replace fuse in fuse panel in truck. Verify connector is plugged in at front of tank. Also inspect wires from connector to control panel for breaks, cuts, etc. Repair if necessary.
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. Worn bearings in pump.	Slow pump speed down using control on pendant. Remove and replace pump.
Dispense valve does not open.	No air supply to the valve. No 12-volt power to the solenoid. Valve is frozen.	Verify that there is sufficient air in air tanks. Valve requires 100psi to operate. Verify solenoid is plugged into junction box, and that the wires are not broken. Thaw out valve. **Caution: Do NOT use fire or flame to thaw valve on an oxygen unit!!**
Flowcom flow meter cycles through boot-up repeatedly.	Defective front board in Flowcom.	Obtain replacement front board from factory and replace.
E 12 error code on Flowcom.	Liquid flow through meter section before meter is turned on. DP transmitter defective. Wiring defective. Flowcom S8 defective.	Press STOP button on control pendant. Verify transmitter is plugged into junction box JB1, and that the 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.
Unstable flow of product.	Depletion of sub-cool. Liquid level low.	Add sub-cool by opening pressure building coil. 5 to 7 psi above saturation pressure is required. **Caution: Venting during delivery will cause depletion of sub-cool, and may also cause damage to pump!** 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!**

Symptom	Possible Cause	Remedy
Unstable flow of product (cont.)	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.
Audible change in pump.	Liquid level low. Worn bearings in pump.	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!** Remove and replace pump.
Pump not catching prime.	Insufficient sub-cool. Liquid level low.	Add sub-cool by opening pressure building coil. 5 to 7 psi above saturation pressure is required. **Caution: Venting during delivery will cause depletion of sub-cool, and may also cause damage to pump!** 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!**
No "Go" indication on Flowcom. (Flashing "0.0" after countdown.)	Meter section not cooling down.	Open the P.B. Gravity Feed valve located on the valve stand to the right of the control panel, third valve from the top. Leave open until "Go" indication appears.
E01 appears on Flowcom.	Printer error.	Verify that the cables to the printer are plugged in, that the printer is turned on, and that there is paper in the printer.

Section 7 Repair

Replacement of damaged components with Chart approved parts, rather than repair, is recommended. However, when repair is required (in those instances when a spare part is not readily available), follow the instructions that follow.

When disassembly of an ORCA vessel is required, parts removed should be coded to facilitate reassemble. To reassemble reverse the order which they were disassembled.

CAUTION!

The ORCA vessel should always be allowed to return to ambient temperature before any maintenance or repair work is performed. Vent or drain the ORCA vessel as necessary before replacing any component(s) exposed to pressure or to cryogenic liquid.

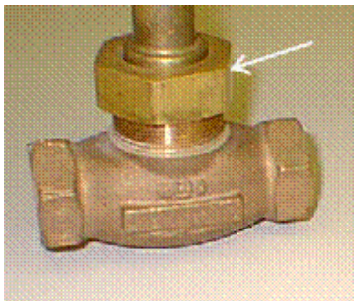
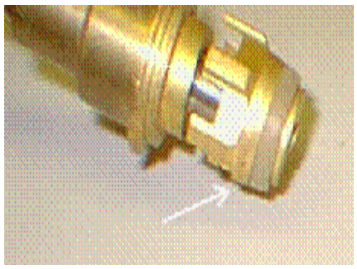
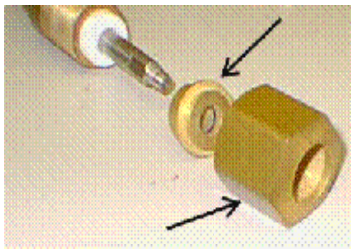
Parts removed during disassembly should be protected from damage, thoroughly cleaned, and stored in protective polyethylene bags if not immediately reinstalled.

Clean all metal parts with a good oxygen compatible cleaning solvent. Air dry all cleaned parts using a clean, low pressure air source. Before assembling, make sure that all parts are thoroughly clean and have been degreased. Cleaning will prevent valves and regulators from freezing while in service, and also prevent contamination of the liquid product. If in doubt about the oxygen cleanliness of a part, inspect with ultraviolet light.

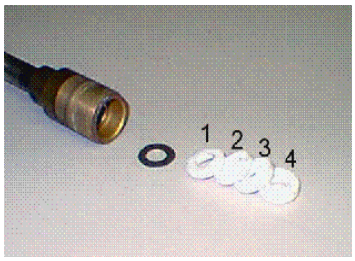
When removing assemblies from an ORCA vessel, remember to always plug pipe openings as soon as they are exposed. Plastic pipe plugs or a clear plastic film may be used for this purpose.

Valve Repair

There are two types of valves covered, ball valves and globe valves. The first step to repair valves is to have the proper seat and packing rebuild kits. With the proper rebuild kit, use the following procedures (which may vary slightly due to size and design of the actual):

Step	Figure	Description
1		To remove the valve stem for repair, loosen the bonnet nut at the base of the stem (valve bonnets maybe flanged). This allows for the removal of the valve stem from the plumbing.
2		After removing the valve stem, carefully set the seat seal aside in a clean dry location to prevent damage and contamination .
3		Remove the valve handle nut and washer and slide the valve handle off of the stem.
4		Loosen and remove the packing nut. Slide off the packing "ram" to expose Teflon packing.
5		Remove the valve stem by unthreading.

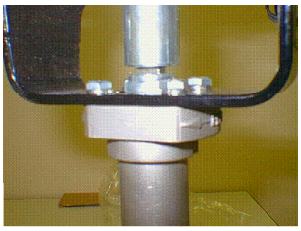
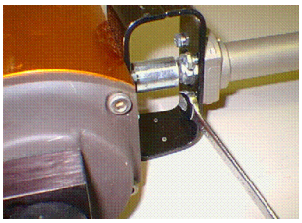
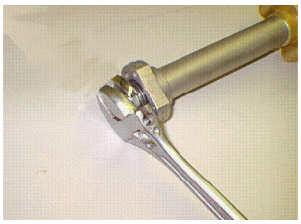
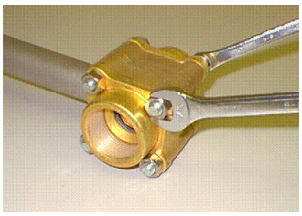
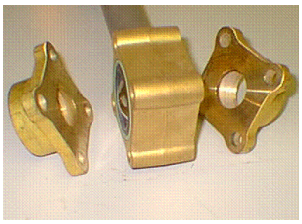
6

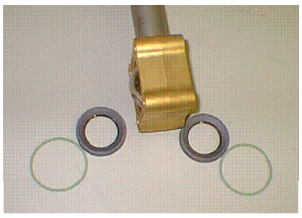
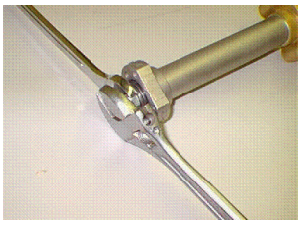
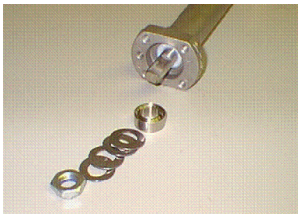
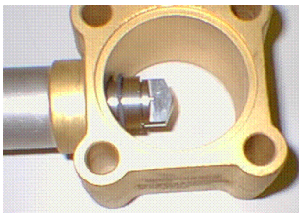
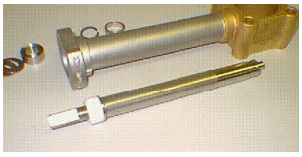


Remove Teflon packing rings (note washer if it comes out), carefully use a screw driver if necessary. When replacing the Teflon rings, make sure to put them back in order such that the one ring with the flat back (no. 1 in figure) goes in first. This one must go against the washer. Simply reverse the steps to re-assemble.

Repairing a Leaking Actuator Ball Valve.

NOTE: *Before the any tightening or adjusting is to be done, the valve needs to warm to ambient temperature.*

Step	Figure	Description
1		The first thing to try is to tighten the self locking nut at the top of the stem, just below the actuator. There are two sets of Belleville washers. Tighten the nut until both sets are *completely* flat. Then back off 1/3 turn. If this doesn't stop the leak, then complete the following:
2		Using a 7/16" wrench, loosen the small bolts holding the actuator to the top of the valve stem.
3		Turn the ball valve to the open position using an adjustable wrench, and turning the top of the valve stem ¼ turn. This relieves stress on the valve body and makes it easier to loosen the body bolts.
4		Using a 1/2" and an 11/16" wrench, loosen and remove all four bolts
5		With the bolts completely out of the holes, remove the pipe ends.

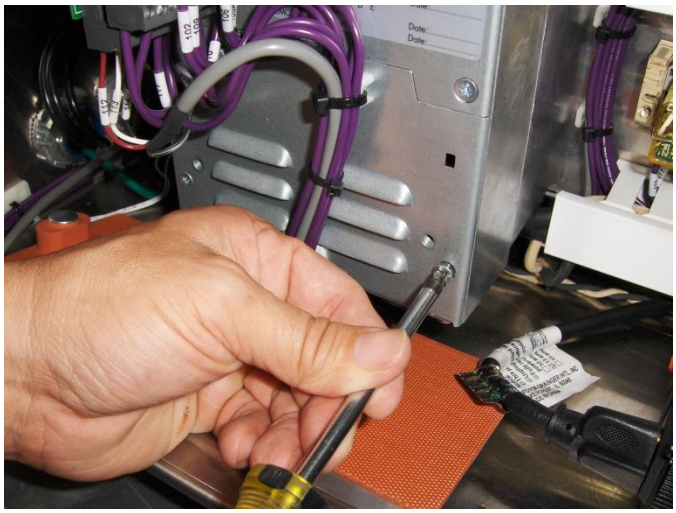
Step	Figure	Description
6		Remove the body seal "s" gasket, the seat. Turn the valve stem back to the closed position, and remove the ball itself.
7		Remove the self locking nut from the top of the valve stem. In order to do this, you will need to use an adjustable wrench to keep the stem from turning. Use a 7/8" wrench to loosen the nut.
8		When removing the nut, all of the Belleville washers and the top packing follower will become free. Take these off, and remember their order.
9		Push the valve stem down a little so that the split ring and the split thrust bearing can come off to allow the stem to be removed.
10		Pull the valve stem out through the top of the extension. It will have the packing rings on it.
11		Remove the packing rings. Replace with new packing rings. Clean off all parts that have to do with the seal, and re-assemble.

Variable Frequency Drive - SVX9000 Removal and Replacement

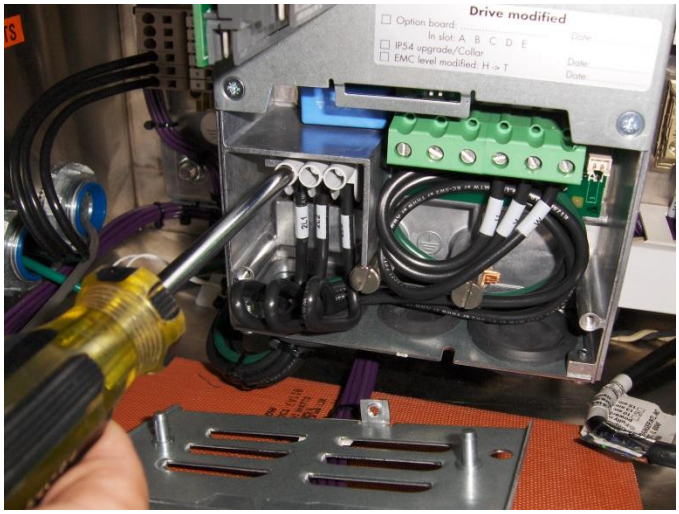
The VFD when supplied with **480 VAC, Three-Phase Power** from the Alternator/Generator, provides an output of voltage and frequency that correspond to the pump speed selected on the Remote Pendant Pump Speed Dial. Removal and replacement of the VFD is a reasonably quick and easy procedure. A new or repaired VFD can be ordered from Chart Parts by calling 1-800-400-4683 or by visiting chartparts.com . A VFD will be shipped out from Chart, pre-programmed, ready to install and operate.

Remove the front cover of the Variable Frequency Drive by loosening the four Phillips head screws, located near the corners as shown.

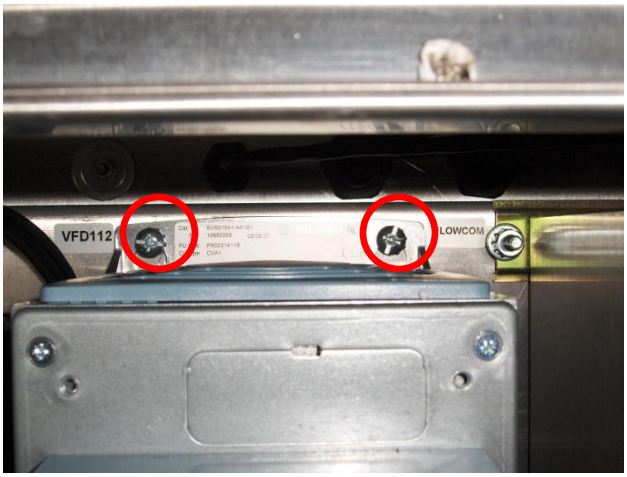
With the front cover removed unplug the 12 Volt wiring as shown, noting the position of each plug for installation into the replacement VFD. The numbers are aligned 1-26,



Remove the small panel on the lower front of the VFD by removing the two screws as shown.



Remove the three incoming 480 VAC wires (2L1,2L2,2L3), and the three outgoing 480 VAC wires (U,V,W), as shown.



Loosen the four VFD mounting bolts located at the four corners of the VFD far enough to allow it to be lifted out of its mounting position. (Upper mounting bolts shown)

The VFD can now be removed from the control cabinet. Replace with the New or Repaired unit by reversing the steps above. As noted earlier, a VFD ordered from Chart will be pre-programmed and ready for use. If you have further technical questions call Chart Technical Support at 1-800-400-4683.

FlowcomS8 – CPU/Display/Mainboard Replacement

CPU Board Replacement P/N 913679

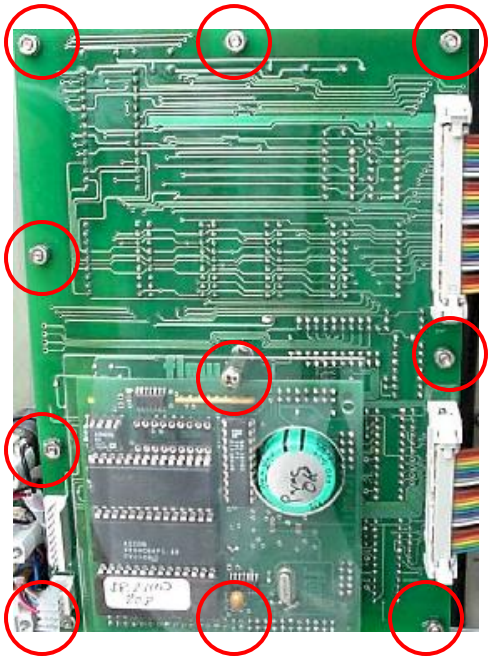
The CPU Board is attached to the Display Board by terminal pins. The clear protective shield must be removed before replacement.

IMPORTANT: The CPU Board is a programmed component. It must be programmed to match the service of product you are using LIN-LAR. If programming assistance is required contact a Technical Service Representative at Chart , Inc. at 1.800.400.4683.

Display Board Replacement P/N 913678

The Display Board is attached to the FlowcomS8 door by mounting bolts-10 Ea. (see picture below).

IMPORTANT: The CPU Board must be removed and re-installed to the new Display Board. Remove and re-attach all cable and wire connections.

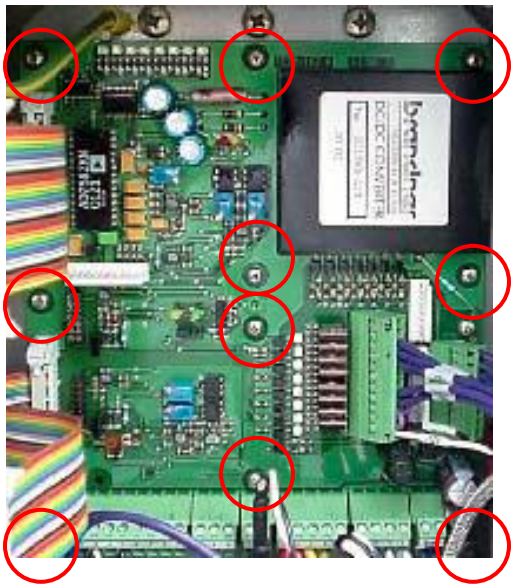


Mounting Bolt Locations

Main Board Replacement 913677

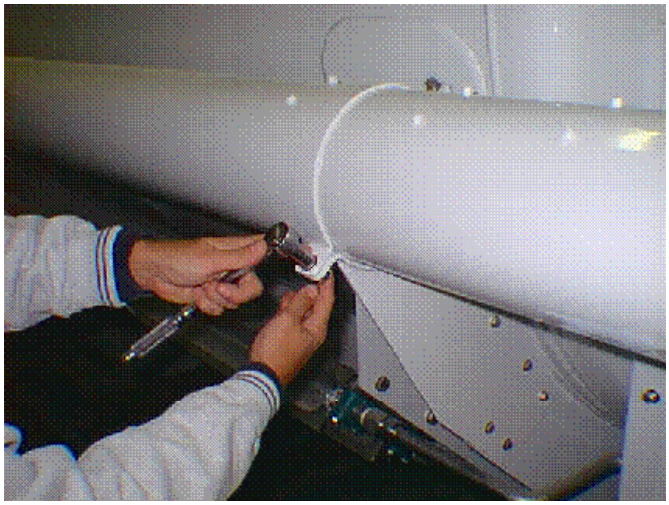
The Main Board is attached to the Flow processor interior by mounting bolts-10 Ea. (see picture below).

IMPORTANT: Remove and re-attach all cable and wire connections.



Hose Tube Removal

The hose tube is designed to be easily removed. Removal of the hose tube is required prior to the removal of the piping cabinet. If damaged, the hose tube can be ordered and easily replaced.



Hose tube removal

- Remove the rear bracket to the hose tube. Remove the bolts using a 9/16" socket and wrench.
- Replace the bolts into the holes so they don't get lost.

With a second person supporting the hose tube:

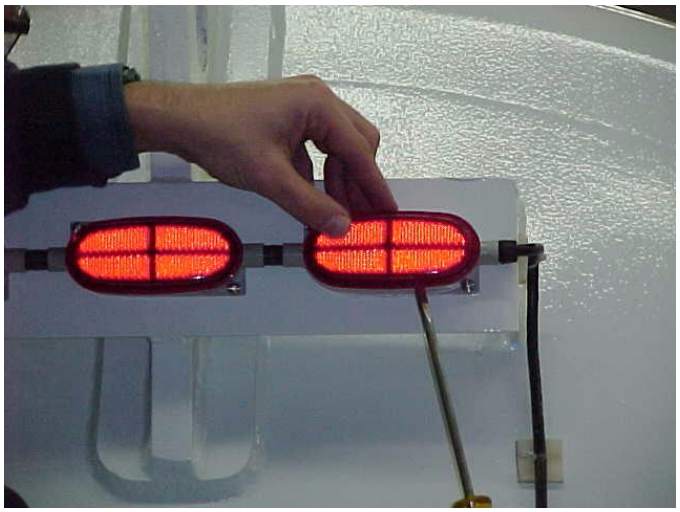
- Remove the front bracket.
- Replacing loose bolts to avoid losing them.

With one person at each end.

- remove the hose tube out by swinging the front end away from the tank and walking the back end out of the cabinet seal.
- Set aside out of the way.

Piping Cabinet Removal

For easy access to the piping and pump sump, it is recommended that the cabinet is removed prior to major maintenance. The removal of the cabinet is simple, however, there are steps that will require more than one person.

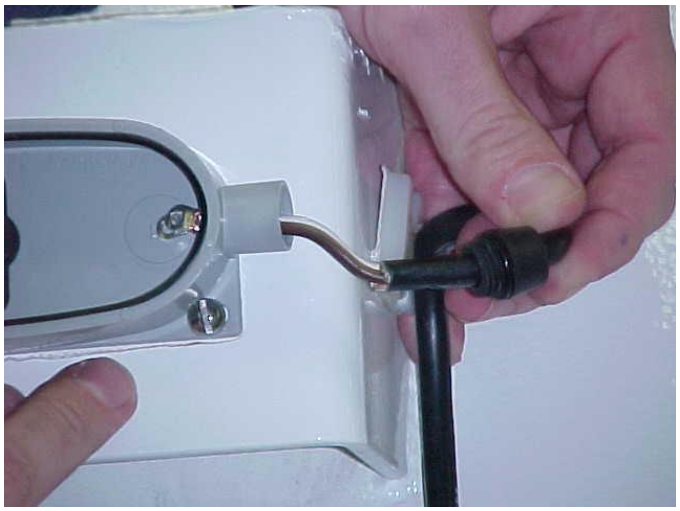


Piping Cabinet Removal

- The rear clearance light is wired to a junction box in the cabinet and must be disconnected.
- Pop the lens with flat head screw driver.

With assurance that the truck lighting is off and can't be accidentally turned on:

- Remove the ground and power wires behind

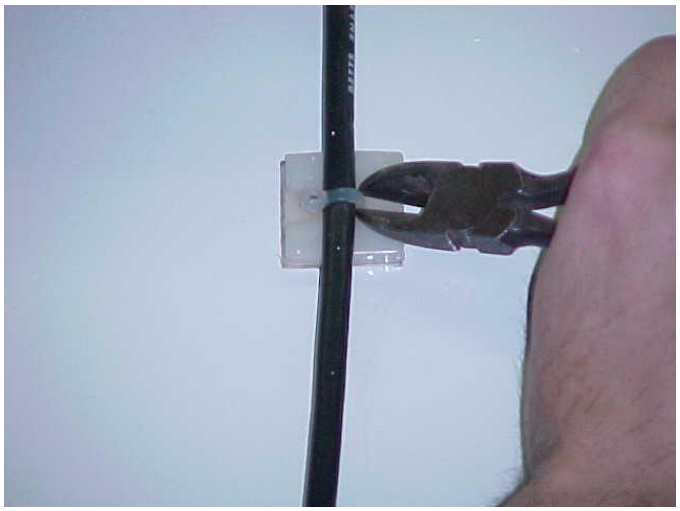


Step 1

- Pull wires out of the light fixture.

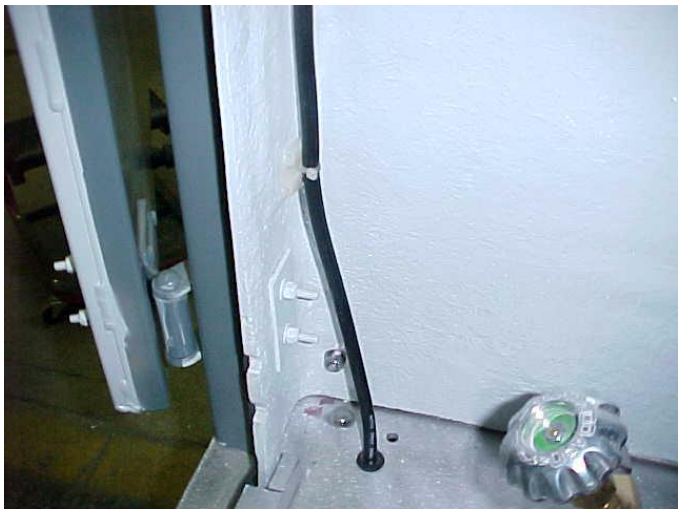
Step 2

- Replace screws so they won't be lost.



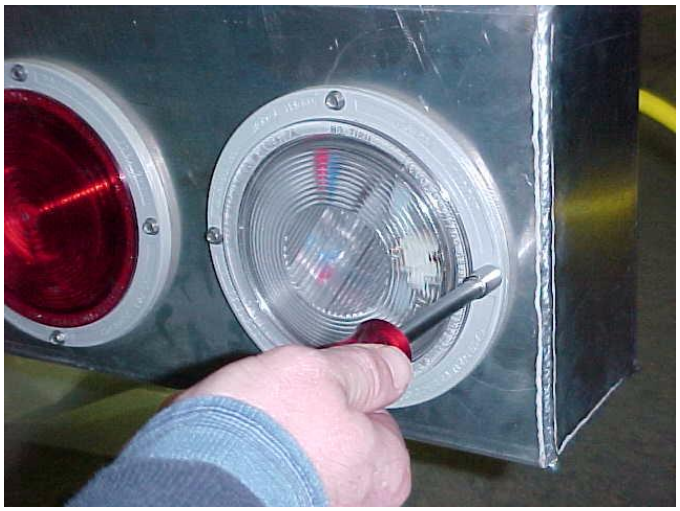
Step 3

- Clip cable ties at bracket and head.



Step 4

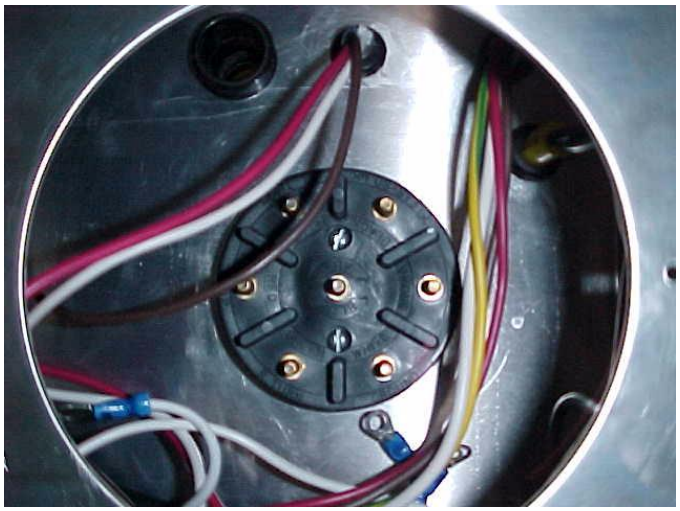
Remove the 12volt running lights wires that are connected through the pan and attached to the cabinet (roadside)



Step 5

Roadside light box houses junction:

- Using a ¼" nut driver remove the backup light fixture.



Step 6

Trace the wires from the cabinet into roadside light box:

- remove wires at junction
- pull wires out of roadside box and through piping pan.

Step 7

Remove Vent Stacks:

- Using a pipe wrench, remove the stack at the head first working towards the rear.

Step 8

Removing the cabinet bolts will require two people:

- Using a ½" wrench remove the attachment bolts.

Step 9

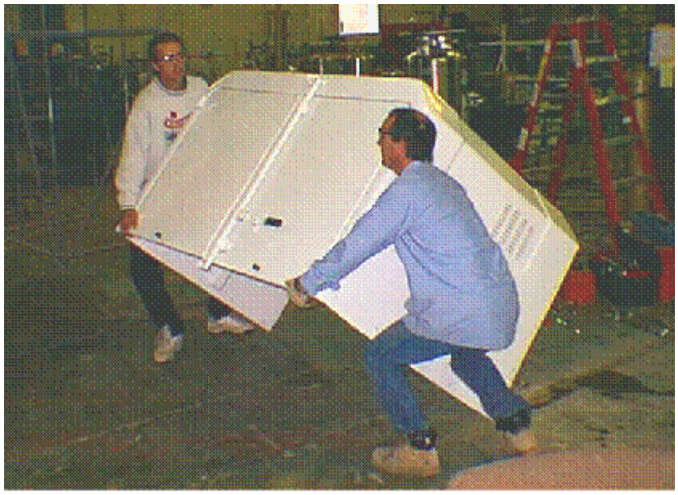
With the 12 volt wiring, vent stacks and the attachment bolts removed:

- Clear a space to set the cabinet. Make sure there is plenty of space to walk and set the cabinet.
- With a person on each side, tip the door side of the cabinet up and slide the cabinet away.

Double check that the cabinet is completely free:

- The door end of the cabinet is the heaviest. Position and lift towards the door end.

Step 10



- Slowly drop the non-door side of the cabinet on the floor.

Step 11

- Carefully rest the door side on the cabinet door latch hardware.

Step 12

Section 8 Parts & Accessories

Suppliers

The components of the ORCA cryogenic system are available directly from the supplier or from Chart. The following listing of parts indicates the part name, number and manufacturer.

For replacement parts listed or not listed in this manual, contact Chart at
1-800-400-46(M)8(V)3(E)

PERMA-CYL®

ON-SITE STORAGE SYSTEM - MICROBULK SOLUTIONS

The Perma-Cyl® storage system allows users to enjoy the benefits of on-site gas delivery. Gone are the hassels, waste, and expense of full-for-empty gas cylinders. Using Perma-Cyls, there are no cylinders to change, no residual gas losses, no back, hand or foot injuries from handling cylinders, and no lost or damaged cylinders.

Perma-Cyls are reliable, efficient, and more economical than comparable transportable cylinders. Designed for a higher level of thermal efficiency, Perma-Cyls can hold their gas contents longer with lower pressure rise than other similar vessels. Their extraordinary thermal quality limits product losses during extended periods of little gas use.

The innovative Perma-Cyl storage system incorporates a top fill float designed to allow single-hose filling without losses. It automatically shuts off the ORCA delivery unit for a safe and reliable fill.

PRODUCT BENEFITS

- The first fill-at-site solution for packaged or cylinder gas users
- Fast filling capable
- Single hose no-loss/low-loss filling
- Automatic fill shutoff when used with ORCA
- Extended holding times
- Telemetry ready with Cyl-Tel® gauge

PRODUCT ADVANTAGES

- Sizes, pressures and configurations to meet most applications
- Capacities from 230 liters to 2,000 liters (60.8 gal to 528.3 gal)
- Pressures from 235 psi to 500 psi (16.2 bar to 34.5 bar)
- Patented automatic fill shut-off feature with optional fill box allows for remote filling from outside the building or compound when a Perma-Cyl is installed indoors
- ORCA automatically safely stops the fill process when Perma-Cyl is full
- Patented Cyl-Tel gauge supports remote alarms or telemetry communications
- High-pressure high flow models for laser assist applications
- Combination pressure control regulators with micrometer adjustment knob or screw
- Outdoor or indoor installation and operation

CHART®

Innovation. Experience. Performance.

PERMA-CYL®

ON-SITE STORAGE SYSTEM - MICROBULK SOLUTIONS

SPECIFICATIONS

DESCRIPTION	230L MP, LCCM Sq/Rnd Base w/Casters	230L HP, LCCM Sq/Rnd Base w/Casters	265L MP, LCCM Sq/Rnd Base w/Casters	265L HP, LCCM Sq/Rnd Base w/Casters	300L MP Plate Base	450L HP Plate Base	450L MP Plate Base	450L HP Plate Base	450L VHP Plate Base	700L HP Plate Base	1000L HP Plate Base	1000L VHP Plate Base	1500L HP Pallet Base	1500L VHP Pallet Base	2000L HP Pallet Base	2000 L VHP Pallet Base
CAPACITY (Liters)																
Gross	240	240	276	276	330	450	450	450	450	688	1,056	1,056	1,550	1,550	2,042	2,042
Net	230	230	265	265	300	420	420	420	420	645	950	950	1,455	1,455	1,945	1,945
CAPACITY (Gallons)																
Gross	63.4	63.4	72.9	72.9	81.2	118.9	118.9	118.9	118.9	181.8	279.0	279.0	409.5	409.5	539.5	539.5
Net	60.8	60.8	70.0	70.0	79.3	111.0	111.0	111.0	111.0	170.4	251.0	251.0	384.4	384.4	513.9	513.9
MAWP																
psig	230	350	230	350	300	350	250	350	500	350	350	500	350	500	350	500
bar	15.9	24.1	15.9	24.1	20.7	24.1	17.2	24.1	34.5	24.1	24.1	34.5	24.1	34.5	24.1	34.5
MAXIMUM PRE-SET OPERATING PRESSURE																
psig	125	300	125	300	250	300	125	300	450	300	300	450	300	450	300	450
bar	8.6	20.7	8.6	20.7	17.2	20.7	8.6	20.7	31.0	20.7	20.7	31.0	20.7	31.0	20.7	31.0
DESIGN SPECIFICATIONS																
	DOT	DOT	DOT	DOT	ASME	DOT	ASME	ASME	ASME	ASME	ASME	ASME	ASME	ASME	ASME	ASME
STORAGE CAPACITY (1)																
Nitrogen																
SCF	5,024	4,734	5,769	5,769	7,380	8,875	10,332	10,332	10,332	15,860	24,350	24,350	35,790	35,790	47,847	47,847
Nm^3	142	134	152	152	193	271	272	272	272	449	689	689	1,013	1,013	1,257	1,257
Oxygen																
SCF	6,244	5,930	7,186	7,186	9,100	11,124	12,760	12,760	12,760	19,600	30,070	30,070	44,220	44,220	59,089	59,089
Nm^3	177	168	189	189	184	315	336	336	336	554	850	850	1,250	1,250	1,553	1,553
Argon																
SCF	6,073	5,763	6,982	6,982	8,850	10,812	12,478	12,478	12,478	19,160	29,400	29,400	43,220	43,220	57,786	57,786
Nm^3	172	163	183	183	234	306	328	328	328	542	832	832	1,223	1,223	1,519	1,519
CO_2																
SCF	N/A	4,500	N/A	N/A	N/A	8,312	N/A	8,200	8,200	12,608	19,960	19,960	29,340	29,340	38,048	38,048
Nm^3	N/A	N/A	N/A	N/A	N/A	235	N/A	232	232	357	564	564	830	830	1,000	1,000
THERMAL PERFORMANCE (2) (NER%/Day)																
N_2	1.8%	1.8%	2%	2%	1.2%	1.9%	1.6%	1.6%	1.6%	1%	1%	1%	1%	1%	1%	1%
O_2-Ar	1.12%	1.12%	1.4%	1.4%	.74%	1.2%	1%	1%	1%	.62%	.62%	.62%	.62%	.62%	.62%	.62%
CO_2	.6%	.6%	N/A	N/A	.4%	.6%	.5%	.5%	.5%	.3%	.3%	.3%	.3%	.3%	.3%	.3%
GAS DELIVERY RATE (LIN/LAR/LOX)																
SCF/H	400	400	400	400	500	575	575	575	575	660	960	960	1,350	1,350	1,350	2,000[3]
Nm^3h	10.5	10.5	10.5	10.5	14.1	15.1	15.1	15.1	15.1	18.6	25.2	25.2	35.4	35.4	35.4	52.4
GAS DELIVERY RATE (CO_2)																
SCF/H	N/A	133	N/A	N/A	N/A	192	192	192	192	220	320	320	450	450	450	667
Nm^3h	N/A	3.8	N/A	N/A	N/A	5.4	5.4	5.4	5.4	6.2	9.0	9.0	12.7	12.7	12.7	17.5
DIMENSIONS																
Diameter																
in	26	26	26	26	26	30	30	30	30	42	42	42	48	48	48	48
mm	660	660	660	660	660	762	762	762	762	1,067	1,067	1,067	1,219	1,219	1,219	1,219
Height																
in	61.8/62	61.8/62	64.6/64.8	64.6/64.8	68	68	68	68	68	60	81	81	91	91	117	117
mm	1,570/1,575	1,570/1,575	1,641/1,646	1,641/1,646	1,727	1,727	1,727	1,727	1,727	1,524	2,058	2,058	2,311	2,311	2,970	2,970
Tare Weight																
lbs	300	340	340	340	450	688	605	688	812	1,065	1,750	2,250	3,080	3,350	3,860	3,860
kg	136	154	154	154	204	312	274	312	368	483	794	1,020	1,395	1,518	1,751	1,751

All specifications are subject to change without prior notice.
1) Values are based on net capacity at 0 psig (0 bar) for ASME vessels. CO_2 vessels are based on net capacity at 300 psi (20.7 bar). DOT vessels are per code.
2) Values are based on gross capacity.
3) Optional 3,500 SCF/H (92 Nm^3h) model available.
All dimensions are measured from the floor to the top of the handling ring. All of the plumbing components fit under the handling ring.

Patents: 5,787,942 • 5,954,101 • 5,136,852 • 6,542,848 - Other Patents Pending
DOT- Department of Transportation, 4L Code
ASME- American Society of Mechanical Engineers, Section VIII, Division 1
Contact Factory for Canadian and New York City Approvals.

Your Local Representative

CHART®
Innovation. Experience. Performance.

Chart Industries, Inc.
U.S.: 1-800-400-4683
Worldwide: 1-952-758-4484
www.chart-ind.com

PN 11000938

CYL-TEL®

DIGITAL ELECTRONIC LIQUID LEVEL GAUGE

Cyl-Tel® is a digital electronic level gauge designed specifically for the Perma-Cyl®. The Cyl-Tel provides an accurate liquid level reading, and the output is available in seven units of measure for user-friendly operation. Designed for rugged applications, it has a water-resistant case suitable for outdoor use. The Cyl-Tel is also telemetry-ready for a wide variety of systems, including OnSite.

CYL-TEL ADVANTAGES

- Improves customer readability by eliminating calibration charts
- Programmable to tank geometry and service for improved accuracy
- Improves customer security
- Telemetry-ready outputs adaptable to many systems
- Optional interface board available for 1-5V DC and 4-20mA outputs
- Battery or 12V DC powered (required for telemetry)
- Accommodates telephone modem board or Cyl-Tel² wireless front panel with internal batteries

Cyl-Tel is standard on 300L and larger Perma-Cyls

Optional Cyl-Tel² for wireless communication with DataOnline

The Cyl-Tel² is a wireless telemetry tank monitoring system designed by Chart in partner with DataOnline exclusively for the MicroBulk market. The Cyl-Tel² is a low cost, reliable, easy to install and user-friendly liquid level gauge with built-in cellular communications. It is powered by a battery pack for installation flexibility.

CYL-TEL² ADVANTAGES

- Integrated cellular wireless communications
- Internal battery-powered for indoor or outdoor installations
- DataOnline managed information
- Front face electronics interchangeable with Cyl-Tel

CHART®

Innovation. Experience. Performance.

CYL-TEL®

DIGITAL ELECTRONIC LIQUID LEVEL GAUGE

Cyl-Tel Gauge Specifications

Physical

- Approximately 4.75"w x 3.25"h x 3.75"d
- Mounting compatible with current differential pressure gauges used on Chart/MVE products
- Gauge is in a water-resistant enclosure (NEMA 4)
- Range - 0-160" H_2O
- Pressure - 500 psig maximum
- Differential Pressure - 30 psig maximum
- CE Listed

Electrical Inputs

- 12VDC at 500mA (AC Adapter)
- Optional battery powered, 9VDC *(level only, inactive Telemetry)*

Outputs

- Two independent programmable alert levels, programmable in 5% increments up to 100% for phone transmitter or local alert relay
- Electronic pulse output connection for interface board, satellite and cellular telemetry systems
- Low battery indicator
- Unit of measure indicator *(See Programmable Features)*
- Large 5 character x 0.4" High LCD Display

Sensor Accuracy

± 2.5% of Full Scale

Operator Interface

Keypad

Operating Temperature

-30°C to +70°C

Display Resolution

% Full = 5%

Gal = 1

L = 1

Lbs = 1

Kg = 1

SCF = 10

NM = 1

Programmable Features

- Product Type: LN_2, N_2O, LAr, O_2, CO_2

Unit of Measure

Gallons (Gal)
Liters (L)
Pounds (Lbs)
Kilograms (Kg)
Standard Cubic Feet (SCF)
Normal Cubic Meters (NM^3)
Inches H_2O (no light indicator)
Percent Full (% Full)

Alert Programmability

- Alert 1 programmable from 0% to 100% in 5% increments
- Alert 2 programmable from 0% to 100% in 5% increments

Interface Board (optional)

- Voltage output
  1-5VDC
- Current output
  4-20mA

Your Local Representative

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Worldwide: 1-952-758-4400
www.chart-ind.com

 PN 11083315

Section 9 Spare Parts

ORCA Spare Parts-LOX

Description:	Part Number:
Temperature Interlock Panel Layout & Electrical Diagram	11898274
Temperature Interlock Control Panel Electrical Diagram	11694589
Anti-tow/Pump Flood Installation Schematic	11782626
Fire Extinguisher	11826377
Fill Hose 1 ½" CGA to 1 ½" CGA LOX	11802084
Adapter 1 ½" CGA to ½" Male Flare LOX	10928996
Adapter 1 ½" CGA Female to Quick Connect LOX	10931642
Extension Hose-Flare 16' LOX	
Extension Hose-Quick Connect 16' LOX	11712353
PP-5 Valve	10601580
PP-5 Button	11720951
PP-5 Pin	11720943
Truck Wiring Harness Low Voltage 12 VDC	11925797
Variable Frequency Drive LOX (new)	11758933
Variable Frequency Drive LOX (rebuilt)	11758933R
Printer-Epson	913700
Printer DC/DC 12-24 VDC Converter	10963978
Printer Ribbon	11693421
Printer Power Cord 6'	11764428
Printer Data Cable	11764436
Flowcom	10918561
Flowcom CPU Board	913679
Flowcom Main Backboard	913677
Flowcom Display Board	913678
Heater Kit Assy.	11498676
Heater Power Inverter	11510241
Heater Strip	11510225
Heater Plug Receptacle	11910966
Heater Plug Receptacle Cover	11910974
Heater Plug 120VAC	11910958
Heater Cord 120 VAC 16-3	11910982
Heater Cord Locknut	11910991
Heater Cord Strain relief	11911002
Remote Pendant	11694600
Remote Pendant Enclosure	11911213
Remote Pendant Cord-16'	11911248
Start Button Green	11911256
Start Button Contact Block-NO	11912339
Stop Button-Red	11911281
Stop Button Contact Block-NO	11912399
Pump Speed Control Dial	11911301
Remote Pendant Locknut	11911088
Remote Pendant Strain relief	11911096
Pump Disconnect Switch	11910632
Pump Disconnect 30 amp	11910641
¾" Conduit Connector-Control Panel	11910675
¾" Conduit Connector Sealing Ring-Control Panel	11910683
½" Conduit Connector-Control Panel	11910659
½" Conduit Connector Sealing Ring-Control Panel	11910667
E-Stop Push Button	11910712
E-Stop Contact Block-NC	11912321
System Ready Light-Green	119110616
System Ready Light Wiring Harness	11910624
Mode Selection Switch-3 pos. Selector	11910691
Mode Selection Switch Contact Block-NC	11912321
Mode Selection Switch Contact Block-NO	11912339
Control Power Switch-12 VDC	11910704

Parts highlighted are commonly used parts or wear items. To order contact Chart Representative for assistance at 1-800-400-4683.

ORCA Spare Parts-LOX

Description:	Part Number:
Control Power Switch Contact Block-NC	11912321
Control Power Switch Contact Block-NO	11912339
Door Interlock Switch	119010510
Door Interlock Switch Bracket	11901608
Printer Locknut	11910991
Printer Strain Relief	11911002
Printer Power Cord	11911133
RTD Locknut	11910991
RTD Strain Relief	11911002
RTD Power Cord	11911109
P/I 209 Locknut	11911176
P/I 209 Strain Relief	11911168
P/I 209 Power Cord	11911168
Power In Locknut	11911088
Power In Strain Relief	11911096
Power In Power Cord	11911133
SV 125 Locknut	11910991
SV 125 Strain Relief	11910002
SV 125 Power Cord	11910982
SV 128 Locknut	11910991
SV 128 Strain Relief	11911002
SV 128 Power Cord	11910982
Main Contactor 440 VAC	11910763
Contact Relay CR104	11910801
Contact Relay Socket	11910819
Contact Relay Hold Down Spring	11910827
Contact Relay CR105	11910801
Contact Relay Socket	11910819
Contact Relay Hold Down Spring	11910827
Contact Relay CR209	11910801
Contact Relay Socket	11910819
Contact Relay Hold Down Spring	11910827
Contact Relay CR211	11910801
Contact Relay Socket	11910891
Contact Relay Hold Down Spring	11910827
Contact Relay CR112	11910923
Contact Relay Socket	11910931
Contact Relay Hold Down Spring	11910827
Fuse 10 amp 32 VDC	11910780
Fuse Terminal	11910798
TB-1Terminal Block Numbered Tags	11912283
TB-1Terminal Block	11910747
TB-1 Terminal Block End Clamp	11910755
TB-1 Terminal Block Jumpers	11926298
TB-1 Terminal Block Mounting Rail	11926301
TB-2 Terminal Block Numbered Tags	11912283
TB-2 Terminal Block	11910747
TB-2 Terminal Block End Clamp	11910755
TB-2 Terminal Block Mounting Rail	11916301
Pump LOX 40 GPM (new w/CFS Seal)	11844567
Pump LOX 40 GPM (rebuilt w/CFS Seal)	11844567R
Composite Face Seal Kit (CFS)	11823580
Alternator, 10KW Marathon (new)	913515
Alternator, 10KW Marathon (rebuilt)	913515R
Alternator Link Board	11708952
Temperature Interlock Kit-complete without Red Lion Set Point Output Card	11801938
Temperature Interlock Box-complete without Thermocouple	11898274
Temperature Interlock Thermocouple	11798193
Temperature Interlock Set Point Output Card (Red Loin)	
Tool Box Assy.	11709795
Service Valve Pneumatic 4-way	1711312
Service Valve Pneumatic 4-way Muffler	9097553
Belleville Spring Washer	10809268
Label, Door Kit HL-2800-LOX	11926749
Label, Door Kit HL-2000-LOX	11926482

Parts highlighted are commonly used parts or wear items. To order

ORCA Spare Parts-LOX

Description:	Part Number:
Label, Door Kit HL-1650-LOX Spanish	11913147
Label, Door Kit HL-2800-LOX	11926749
Label, Door Kit HL-2000-LOX	11926482
Label, Door Kit HL-1650-LOX Spanish	11913147
Label, Door Liquid Level Chart HL-3300-LOX	11926693
Label, Door Liquid Level Chart HL-2800-LOX	11926706
Label, Door Liquid Level Chart HL-2000-LOX	11926685
Label, Door PTO/Alternator	11926757
Label, Door Automatic Mode	11926491
Label, Door Manual Mode	11926626
Label, Door Pressure Transfer	11926634
Label, Door Ticket Printing	11926642
Label, Door VFD Fault Codes	11926503
Label, Door Flowcom Fault Codes	11926651
Label, Door Troubleshooting Guide	11926669
Label, Door Sub-Cool Warning	11926511
Label, Door Emergency Discharge	11926677
Label, Valve Tags	11926520
Label, Door Technical Service	11926925
Label, Service Valve	11819661
Label DOT OXYGEN REFRIGERATED LIQUID	11713049
Label DOT OXYGEN REFRIGERATED LIQUID UN1073	11713006
AOV-1 Dispensing Air Operated Valve (Worcester #CRK44PM-1, 1" Ball Valve)	10800108
AOV-1 Ball Valve Repair Kit	10802445
AOV-2 Pump Flood Air Operated Valve (CVI#V1070-200-J, 2" Globe Valve w/Acct.)	11750069
AOV-2 Globe Valve Repair Kit	
AOV-3 Pump Block Air Operated Ball Valve (Worcester #CRK44PM, 1" Ball Valve)	10800108
AOV-3 Ball Valve Repair Kit	10802445
V-3 Top Fill Valve (REGO #BKA9412, 1 ½" Globe Valve)	10927184
V-3 Globe Valve Seat Kit	10997861
V-3 Globe Valve Packing Kit	10997852
V-3 Globe Valve Hand Wheel	10997801
V-5 Vapor Vent Valve (REGO #BKY8408, 1" Globe Valve)	10927192
V-5 Globe Valve Packing Kit	10997810
V-5 Globe Valve O-Ring Kit	10997844
V-5 Globe Valve Seat Kit	10997895
V-9 Fill Line Drain Valve (REGO #T9453, 3/8")	1713202
V-10 LI-1 Equalization Valve (Whitey #SS-1VS4-SC-11, ¼")	11701435
V-11 LI-1 Vapor Phase Valve (Whitey #SS-1VS4-A-SC-11, ¼")	11701443
V-12 LI-1 Liquid Phase Valve (Whitey #SS-1VS4-A-SC-11, ¼")	11710443
V-13 Pump Discharge Isolation Valve (Whitey #SS-1VS4-A-SC-11, ¼")	11710443
V-16 PB Force Feed Valve (REGO #BK8408T, 1" Globe Valve)	1718772
V-16 Globe Valve Seat Kit	10997895
V-16 Globe Valve Top Works Kit	10997924
V-17 Bottom Fill Valve (REGO #BKA9412, 1 ½" Globe Valve)	10927184
V-17 Globe Valve Seat Kit	10997861
V-17 Globe Valve Seat Kit	10997861
V-17 Globe Valve Packing Kit	10997852
V-17 Globe Valve Hand Wheel	10997801
V-18a 95% Trycock Valve (REGO #T9453, 3/8")	1713202
V-18c 90% Trycock Valve (REGO #T9453, 3/8")	1713202
V-23 Liquid Sample Valve (REGO #T9453, 3/8")	1713202
V-30 Dispense Line Drain Valve (REGO #T9453, 3/8")	1713202
V-31 LI-1 Vapor Phase Isolation Valve	1711862
V-32 LI-1 Liquid Phase Isolation Valve	1711862
V-40 PB Gravity Force Feed Valve	1713202
V-41 Transfer Hose Valve	11007881
V-41 Transfer Hose Valve Handle	259098
V-42 Recirculation Valve (REGO #BK8400-80BJ, 1")	1718772
V-42 Globe Valve Seat Kit	10997895
V-42 Globe Valve Top Works Kit	10997924
V-43 Vapor Return Assist Valve	1718772
V-43 Globe Valve Seat Kit	10997895
V-43 Globe Valve Top Works Kit	10997924
V-45 Pump out Isolation Valve	10562120

Parts highlighted are commonly used parts or wear items. To order contact Chart Representative

ORCA Spare Parts-LOX

Description:	Part Number
V-99 Vacuum/TC Isolation Valve	10482381
DC-1 Dispensing Connection	11751424
DC-2 Fill Line Connection Service Assy LOX (1 ½" CGA)	10889448
DC-2 Fill Line Connection Service Assy LOX (2" CGA)	11708776
DC-2 Fill Line Connection Service Assy LOX (3" CGA)	11704572
DC-5 Pump out Connection	1211571
CV-2 PB Return Secondary Check Valve	259106
CV-4 Hose Drain Check Valve	11051090
CV-6 PB Return Primary Check Valve	1712152
CV-7 Vapor Return Assist Check Valve	1712152
LI-1 Inner Vessel Level Indicator	11532088
PI-1 Inner Vessel Pressure Indicator	11707191
PI-2 Pump Discharge Pressure Indicator	11702121
PBC-1 Pressure Building Coil	11739450
PCV-1 Road Relief Regulator	
RTD-1 Resistance Temperature Device	11783362
SD-2 Outer Vessel Pressure Safety Element (Vacuum Tube Lift-6")	4410621
SD-2 Outer Vessel Pressure Safety Element (Vacuum Lift Plate-6")	4410611
SD-2 Outer Vessel Pressure Safety Element (Safety Chain No. 2-6")	9025782
SD-2 Outer Vessel Pressure Safety Element (O-Ring Viton 5.25ID x 5.75OD)	2324314
SOV-1 Hose Drain Solenoid Operated Valve (MAGNATROL #E29LR62Z, ½")	10856531
SOV-1 Repair Kit (Coil, Gasket)	11879815
SV-1a Vent Circuit Safety Relief Valve (56 psi)	1810732
SV-1b Vent Circuit Safety Relief Valve (56 psi)	1810732
SV-1c Vent Circuit Safety Relief Valve (70 psi)	11815951
SV-3 Dispensing Thermal Relief Valve	11670000
SV-4 Fill Line Thermal Relief Valve	11670000
SV-7 Recirculation Thermal Relief Valve	
TC-1 Thermocouple/Vacuum Connection	4210049
Anti-tow Valve	10469961
Pump Flood Valve	10469961
Anti-Tow Muffler	909755

Section 10 Liquid Level Charts

Liquid Level Chart 2000 Gallon-LOX Service

Liquid Level Chart HL-2000 Oxygen

In H20	Liquid (Gallons)	Weight (Pounds)	Gas (CU Ft)
0	0	0	0
2.5	13	127	1,531
5	44	413	4,986
7.5	84	797	9,620
10	133	1,258	15,186
12.5	188	1,783	21,529
15	250	2,363	21,538
17.5	316	2,991	36,122
20	387	3,661	44,205
22.5	461	4,366	52,719
25	539	5,101	61,602
27.5	619	5,863	70,797
30	702	6,646	80,252
32.5	786	7,446	89,914
35	872	8,259	99,735
37.5	959	9,081	109,666
40	1,047	9,909	119,661
42.5	1,134	10,738	129,673
45	1,221	11,565	139,654
47.5	1,308	12,385	149,558
50	1,394	13,195	159,339
52.5	1,478	13,990	168,947
55	1,560	14,768	178,332
57.5	1,639	15,522	187,443
60	1,716	16,249	196,226
62.5	1,790	16,945	204,622
65	1,859	17,603	212,569
67.5	1,924	18,218	219,996
69 (90%)	1,940	18,366	221,791
70	1,984	18,783	226,824
72.5	2,037	19,291	232,956
74 (95%)	2,047	19,387	234,122
75	2,084	19,731	238,272
77.5	2,122	20,090	242,600
80	2,148	20,341	245,636
81.5	2,155	20,407	246,434

Liquid Level Chart 2800 Gallon-LOX Service

Liquid Level Chart HL-2800 Oxygen

In H20	Liquid (Gallons)	Weight (Pounds)	Gas (CU Ft)
0	0	0	0
2.5	20	187	2,260
5	61	586	7,075
7.5	117	1,311	13,444
10	183	1,742	21,032
12.5	258	2,454	29,630
15	340	3,237	39,087
17.5	428	4,081	49,286
20	523	4,979	60,124
22.5	622	5,922	71,513
25	725	6,904	83,375
27.5	831	7,920	95,635
30	941	8,962	108,227
32.5	1,053	10,027	121,085
35	1,166	11,109	134,146
37.5	1,281	12,202	147,351
40	1,396	13,303	160,640
42.5	1,512	14,405	173,954
45	1,628	15,505	187,236
47.5	1,742	16,597	200,426
50	1,856	17,677	213,466
52.5	1,967	18,739	226,294
55	2,076	19,779	238,848
57.5	2,182	20,791	251,064
60	2,285	21,768	262,871
62.5	2,384	22,706	274,197
65	2,477	23,598	284,961
67.5	2,565	24,435	295,074
69 (90%)	2,604	24,808	299,564
70	2,646	25,210	304,432
72.5	2,720	25,910	312,915
74 (95%)	2,748	26,180	316,130
75	2,785	26,529	320,365
77.5	2,839	27,043	326,565
80	2,879	27,422	331,149
81.5	2,893	27,558	332,488

3300 Gallon-LOX Service

Liquid Level Chart HL-3300 Oxygen

In H20	Liquid (Gallons)	Weight (Pounds)	Gas (CU Ft)
0	0	0	0
2.5	23	231	2,570
5	72	685	8,274
7.5	139	1,311	15,837
10	217	2,057	24,842
12.5	306	2,902	35,039
15	404	3,830	46,254
17.5	510	4,829	58,316
20	622	5,890	71,133
22.5	740	7,005	84,590
25	862	8,165	98,595
27.5	989	9,363	113,062
30	1,119	10,592	127,910
32.5	1,251	11,847	143,062
35	1,386	13,121	158,448
37.5	1,522	14,409	173,995
40	1,659	15,704	189,635
42.5	1,796	17,001	205,299
45	1,932	18,294	220,919
47.5	2,068	19,578	236,426
50	2,202	20,848	251,752
52.5	2,334	22,096	226,825
55	2,463	23,317	281,571
57.5	2,588	24,505	295,913
60	2,709	25,652	309,770
62.5	2,825	26,752	323,053
65	2,936	27,797	335,667
67.5	3,039	28,777	347,502
69 (90%)	3,098	29,330	354,179
70	3,135	29,682	358,434
72.5	3,221	30,500	368,309
74 (95%)	3,268	30,942	373,648
75	3,297	31,214	376,930
77.5	3,359	31,800	384,013
80	3,403	32,217	389,046
81.5	3,414	32,328	390,392

Section 11 ORCA Warranty

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 Unit. If warranty replacement of part is required, the ORCA 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

Resistance Temperature Device (RTD)	1 Year from shipment of ORCA
Differential Pressure Transmitter (DP Transmitter)	1.5 Year from shipment of ORCA
Spin-On Connector	6 Months from date of shipment of ORCA
Meter Element 1"	Life of ORCA
Differential Pressure Gauge 0-100" H20	1 Year from Shipment of ORCA
AOV-1	1 Year form Shipment of ORCA
AOV-2	1 Year from Shipment of ORCA
AOV-3	1 Year from Shipment of ORCA
ORCA Delivery Hose	1 Year from Shipment of ORCA
Flowcom Flow Processor	6 Months from date of shipment of ORCA
Printer	6 Months from date of shipment of ORCA
Alternator	1 Year from shipment of ORCA
Generator	1 Year from shipment of ORCA
Pump Submersible LIN/LAR Service	1 Year from date of shipment of ORCA
Pump External LOX Service	1 Year from date of shipment of ORCA
Composite Face Seal (CFS)	9 Months from date of shipment
Variable Frequency Drive (VFD)	2 Years from date of shipment
Control Panel (440 VAC)	6 Months from date of shipment of ORCA

Standard Warranty

Workmanship and Vacuum

Chart , Inc. warrants all ORCA Delivery Tanks manufactured to be free from defects in material and workmanship for ONE YEAR after shipment, subject to the exclusions listed below and statements on the preceding and following pages. We also guarantee that the Annular Space Pressure will not exceed 20 Microns, when the Inner Vessel is cold, within ONE YEAR of the date of shipment of the ORCA Unit. 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 Unit will be repaired at the nearest Chart Authorized Service Provider, by the Purchaser, or Chart 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 part or workmanship that Chart , Inc. manufactured and found to be defective within ONE YEAR after ship date of ORCA 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.**

Chart Standard Warranty

Claim Procedure

1. **All Warranty Claims are to be requested in writing and previously authorized by Chart . The address to sent the request to is:**

   Chart
   Attn. Customer Service
   407 Seventh Street Northwest
   New Prague, MN 56071

   Telephone approval can be obtained for faster response by contacting Customer Service at 1-800-400-4683. However this warranty claim is to be followed by a letter in writing to Chart within 14 days of the claim. Customer Service will issue a RMA (Returned Merchandise Authorization) Number that is a tracking number that will be required on all documentation, correspondence, and invoices that maybe sent to Chart for payment of credit.
2. **All Warranty Claims submitted to Chart for credit must be submitted within 21 days of the date the purchaser receiving their vendors invoice for services rendered. This Credit Request must include the RMA Number that was provided by Chart otherwise the Credit Request will be considered invalid.**
3. **Documentation, photographs (if applicable) and the RMA Number must accompany any invoice before payment will be made by Chart .**
4. **Vacuum Pumping of any units, requires prior authorization from Chart and all procedures must be adhered to or the warranty will be void.**
5. **On Chart purchased parts, Chart will replace all defective parts at no charge if it is less than 90 days from date of shipment. If the items are listed on the Major Components List and between 90 days and the end of the warranty period stated Chart will replace parts at no charge excluding labor and other items listed in the exclusion section. Chart will send out parts with an invoice at Purchasers full price and will give credit back to your account when the parts in question are received at Chart and determined to be within the warrant period.**
6. **Authorization must be obtained from Chart prior to shipment of any units to our location or any other repair facility for warranty work.**

Section 12 Wiring Schematic