Product Manual

Orca™ MicroBulk Delivery System
HL Series (LN_2/LAR) Gen 3



Designed and Built by:

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Revision Log

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Preface

General

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

Chart offers the complete MicroBulk delivery system as a solution to reliably and effortlessly manage a diverse range of applications. At the foundation of the MicroBulk system, the Orca HL Series delivery unit offers fast, reliable and accurate on-site delivery to Perma-Cyl storage vessels or small bulk tanks. Next the Perma-Cyl line offers the widest range of sizes and piping options and the greatest flexibility with accommodations for indoor and outdoor installation. Finally, the innovative Cyl-Tel® Liquid Level Gauge accurately monitors liquid contents and provides a seamless connection to a variety of Chart telemetry platforms.

Product Highlights

- Fast on-site filling of the Perma-Cyl storage system with auto shut-off
- Exclusive low maintenance submerged pump for instant starts and continuous delivery (LN_2 or LAR service)
- Single hose delivery system minimizes contamination, cool down losses and pressure drop
- Push-button Flowcom® 3000 Flow Meter System with manual override to simplify operator training
- Electronic pump speed control allows driver to safely optimize delivery rate
- National Institute of Standards & Technology (NIST) and California Weights and Measures approved metering system
- Auto Subcool − standard on all pump models, simplifies operator training and reduces product loss
- Updated electronics for operations to -40°F / -40°C
- Large cabinet with removable access panels for ease of maintenance and servicing
- Calibrated meter section system that can be easily removed for recalibration or service
- Vessel designed with robust inner support system for rugged road conditions
- Stainless steel plumbing with bronze valves for long service life and reliability
- All hand valves low and accessible for streamlined and ergonomic operation.
- Uptime remote monitoring for a detailed fleet management solution and accelerated troubleshooting

Product Manual

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

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

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

For detailed information on how to operate the Orca system, refer to the Operations section. Here you will find the various filling procedures as well as pressure transfer instructions.

In the Components & Systems section you will find photos and description of all working parts of the Orca system.

The Troubleshooting section will become an invaluable tool for answering various possible questions that may arise while using the Orca system.

Reference the Preventative Maintenance section for a schedule of maintenance to follow to keep your Orca system running smoothly.

Please refer to the Specifications section for a complete listing of part numbers, liquid level charts, drawings and other technical information.

Terms

Throughout this manual safety precautions will be designated as follows:



Warning! Description of a condition that can result in personal injury or death.



Caution! Description of a condition that can result in equipment or component damage.



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

Acronyms / Abbreviations

The following acronyms / abbreviations are used throughout this manual:

ASME	American Society of Mechanical Engineers
BAR	Pressure (Metric)
CGA	Compressed Gas Association
DOT	Department of Transportation
GAWR	Gross Axle Weight Rating
GPM	Gallons Per Minute
GVWR	Gross Vehicle Weight Rating
LAR	Liquid Argon
LN_2/LIN	Liquid Nitrogen
LPM	Liters Per Minute
MAWP	Maximum Allowable Working Pressure
NIST	National Institute of Standards and Tech.
NPSH	Net Positive Suction Head
OE	Original Equipment
PB	Pressure Builder
PN	Part Number
PSI	Pounds per Square Inch
PSIG	Pounds per Square Inch (Gauge)
PTO	Power Take-Off
RV	Relief Valve
RTD	Resistance Temperature Device
VAC	Voltage - Alternating Current
VDC	Voltage - Direct Current
VFD	Variable Frequency Drive

Safety

Safety Summary

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

Compatibility and Cleaning

Always keep the Orca delivery system clean and free from grease and oil. Use care when cleaning with high-pressure water or steam cleaning equipment. DO NOT direct the cleaning nozzle into the electronic components. When replacing 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. 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 service without extremely extensive cleaning methods.



Caution! ***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. 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.***



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

Safety Bulletin

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

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

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

Incidents which require that such practices be followed include: highway accidents, immersion of a container in water, exposure to extreme heat or fire, and exposure to most adverse weather conditions (earthquake, tornadoes, etc.) As a general rule, whenever a container is suspected of abnormal operation, or has sustained actual damage, good safety practices must be followed.

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

Prior to reusing a damaged container, the unit must be tested, evaluated, and repaired as necessary. It is highly recommended that any damaged container be returned to Chart for repair and re-certification.

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

Oxygen Deficient Atmospheres



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

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

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

When the oxygen content of air is reduced to about 15 to 16%, the flame of ordinary combustible materials, including those commonly used as fuel for heat or light, may be extinguished. Somewhat below this concentration, an individual breathing the air is mentally incapable of diagnosing the situation because the onset of symptoms such as sleepiness, fatigue, lassitude, loss of coordination, errors in judgment and confusion can be masked by a state of "euphoria," leaving the victim with a false sense of security and well being.

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

Most individuals working in or around oxygen deficient atmospheres rely on the "buddy system" for protection - obviously the "buddy" is equally susceptible to asphyxiation if he or she enters the area to assist the unconscious partner unless equipped with a portable air supply. Best protection is obtainable by equipping all individuals with a portable supply of respirable air. Life lines are acceptable only if the area is essentially free of obstructions and individuals can assist one another without constraint.

If an oxygen deficient atmosphere is suspected or known to exist:

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

Oxygen Enriched Atmospheres

An oxygen-enriched atmosphere occurs whenever the normal oxygen content of air is allowed to rise above 23%. While oxygen is nonflammable, ignition of combustible materials can occur more readily in an oxygen-rich atmosphere than in air; and combustion proceeds at a faster rate although no more heat is released.

It is important to locate an oxygen system in a well ventilated location since oxygen-rich atmospheres may collect temporarily in confined areas during the functioning of a safety relief device or leakage from the system.

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 the conditions of temperature and pressure to which the components may be exposed in the containment and use of oxygen. Easily ignitable materials shall be avoided unless they are parts of equipment or systems that are approved, listed, or proven suitable by tests or by past experience.

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 alloy) 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.



Warning! ***If clothing should be splashed with liquid oxygen it will become highly flammable and easily ignited while concentrated oxygen remains. Such clothing must be aired out immediately, removing the clothing if possible, and should not be considered safe for at least 30 minutes.***

Nitrogen and Argon

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

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

Persons suffering from lack of oxygen should be immediately moved to areas with normal atmospheres. SELF-CONTAINED BREATHING APPARATUS MAY BE REQUIRED TO PREVENT ASPHYXIATION OF RESCUE WORKERS. Assisted respiration and supplemental oxygen should be given if the victim is not breathing. If cryogenic liquid or cold boil-off gas contacts worker's skin or eyes, the affected tissue should be flooded or soaked with tepid water (105-115ºF or 41-46ºC). DO NOT USE HOT WATER. Cryogenic burns that result in blistering or deeper tissue freezing should be examined promptly by a physician.

Personal Protective Equipment (PPE)

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

- Safety glasses with side shields to prevent cryogenic liquid from splashing into the eyes
- Chemical / Liquid resistant gloves to prevent cryogenic burns on exposed hands
- Long sleeve shirts to protect the arms
- Cuffless trousers worn over closed shoes
- Face shield

Introduction

Theory of Operation

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

Terminology of Cryogenics

Cryogenic

A product retaining a temperature of -238°F (-150°C) or colder. Orca delivery systems maintain gases efficiently in a cryogenic liquid state. Gases can be most efficiently stored as liquids. Gases may be liquefied by compression or cooling them until they liquefy. 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 HL Series delivery systems employ cryogenic temperatures to store the product in its liquid state.

Gas-Boiling Temperatures (at 0 psig/kPa)

Argon -302° F / -186° C
Nitrogen -320° F / -196° C
Oxygen -297° F / -183° C

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.

Saturation

Defined as the point at which liquid and vapor coexist at the same pressure (temperature).

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.

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 their 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 Net Positive Suction Head or NPSH.

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!

Cavitation

Defined as the formation of vapor bubbles in a liquid, it manifests as partial or full loss of pump prime due to the lack of proper subcool. The pressure of the liquid flowing to the pump has dropped below the saturation pressure. Audible changes in the pump often are an indication of partial loss of prime. The pump will stop pumping during full loss of prime.

Vaporization

Changing liquid into vapor by warming the liquid for the purpose of subcooling or for gas use. The Orca HL Series delivery system uses a pressure building coil, located on the roadside of the vessel to accomplish this.

Vapor Pressure

Pressure of the vapor space within the tank. Measured by reading the tank pressure gauge or the Flowcom® Flow Meter System.

Condensation

The conversion of vapors into liquid by cooling the vapors. The Orca HL Series 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/trailer. The splashing condenses the gas and drops the pressure. This is know as "splashdown."

Condensation and the Perma-Cyl® MicroBulk Storage System

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

Condensation and the Orca System

Just like top filling of a Perma-Cyl tank, top filling the HL Series tank allows filling without venting.

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 decrease, and the saturation pressure will drop.

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.

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 layering of temperature zones from top to bottom is called stratification.

Operations

Filling the Orca Delivery System - First Use

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

A bottom fill method is recommended the first time the Orca delivery system is filled and any other time the tank is "warm" (warmer than the boiling temperature of the product you will be dispensing). Precool the Orca tank by blowing cold gas from the source tank into the bottom fill line (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 the vapor vent valve (V-5) open to manage tank pressure.



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

1. Attach the source of liquid or gas purge product to the top and bottom fill CGA connection (DC-2) on the Orca tank.
2. Open the source tank feed valve and the bottom fill valve (V-17) on the Orca tank allowing gas to flow slowly into the tank. Allow the tank to build pressure to 30 psi (207 kPa).
3. Close the bottom fill valve (V-17) on the Orca tank and close the source tank feed valve. Purge the trapped space by opening the fill line drain (V-9) on the tank.
4. Crack the compression fittings on either side of the liquid level gauge (Ll-1), allowing gas to flow. Terminate the purge prior to the line getting cold. Tighten compression fittings and leak check.
5. With the bottom fill valve (V-17) closed, open the fill line drain (V-9) and the top fill valve (V-3). Purge for two minutes. Close the top fill valve and the fill line drain.



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

6. Open the bottom fill valve (V-17) and the fill line drain (V-9). Purge for two minutes. Close the bottom fill valve and the fill line drain.



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

7. Open the trycock (V-18). Purge for two minutes. Close trycock valves.
8. With the recirculation valve (AOV-2) closed, crack the compression fitting at the outlet of the pressure building coil, and purge for two minutes. Tighten the compression fitting and leak check.
9. Manually open the dispense valve (AOV-1) by opening the dispense valve pneumatic override valve (V-51) and open hose valve (V-41).
10. Purge for two minutes. Close the low flow dispense valve (V-41) and manually close dispense valve (AOV-1) by closing dispense valve pneumatic override valve (V-51).
11. Vent tank to 5 psi (34 kPa) using the vapor vent valve (V-5).
12. Repeat steps 7 and 8 three times.
13. After purging 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 tank are open:
    a. V-11 Vapor Phase Valve
    b. V-12 Liquid Phase Valve
    c. V-13 Pump Discharge Isolation Valve
    d. AOV-2 Recirculation Valve (confirm visually by description on top of AOV)

    Additionally, verify the following valves on the Orca tank are closed:
    a. V-10 Equalization Valve
    b. AOV-1 Dispense Valve (confirm visually by description on top of AOV)
    c. AOV-3 Force Feed Pressure Build Valve (confirm visually by description on top of AOV)

    Confirm manual override handles are in the horizontal position.

Filling the Orca Delivery System - Normal Use

The piping has a top and bottom fill circuit (DC-2). If filling the Orca tank with liquid saturated at a higher pressure (temperature) than what currently is in the tank, bottom filling is recommended. If filling the Orca tank with liquid saturated at a lower pressure (temperature) than what currently is in the tank top filling is recommended. This will minimize the tank pressure rise and minimize the venting required to manage the Orca tank pressure. Filling the tank with liquid saturated at pressures at or above the tank pressure rating (50 psig / 345 kPa) will require excessive venting.

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



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

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

Purging the Fill Line

Connect the fill hose from the supply tank to the Orca tank fill connection.

1. Open the fill line drain valve (V-9) on the Orca tank.
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 tank and bottom fill valve on the supply tank until ready to commence filling of the Orca tank.

Top Filling the Orca Delivery System

If the source liquid is cold (less than 25 psig/172 kPa), top filling lowers the product losses during filling. The top fill valve (V-3) on the Orca tank 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 tank pressure. Check the tank. If the tank is cold (less than 15 psig/103 kPa), top filling is recommended. This will result in the pressure in the tank being reduced.

1. If necessary, start the pressure-building device on the supply unit.
2. Check the chart on the inside back door of the cabinet for specifications for each type of gas and the recommended filling levels for the product you are about to fill. With the supply tank connected open the top fill valve (V-3) on the Orca tank fill circuit.
3. When the liquid level in the Orca tank is at the halfway point, open the full trycock valve (V-18).
4. When the Orca tank is full, liquid will vent out of the full trycock valve (V-18). Close the full trycock valve and close the liquid supply tank fill/drain valves. Open the fill line drain valve (V-9).
5. Close the full trycock (V-18) and allow the hose to drain into the Orca system for five minutes.
6. Close the top fill valve (V-3).
7. When the hose indicates no pressure, close the fill line drain (V-9) and remove the hose from the CGA fill connection (DC-2).
8. Replace the CGA fill fitting cover onto the Orca tank fill connection (DC-2) and stow the delivery hose.
9. If equipped with a inner vessel regulator valve (V-2), open it to vent vessel below set point (typically 17 psig/117 kPa).
10. Close the plumbing cabinet doors.

Filling Levels - CGA-341

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

Filling Levels - MC-338

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

Maintaining Cold Liquid

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

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

Reasons for Cold Liquid

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

How to Maintain Cold Liquid

The Orca delivery system can be supplied with an optional secondary relief system (inner vessel regulator circuit). This secondary relief system will maintain the liquid at a specified saturation by setting the inner vessel regulator to your required saturation pressure. It is recommended to set the secondary relief system to 10 psi (69 kPa) if open dewars or low pressure cylinders are to be filled. After filling the Orca tank, vent the contents to your desired pressure. During daily operation, if equipped with a inner vessel regulator valve (V-2), keep it open during transit. It is extremely important to close the inner vessel regulator valve before performing a delivery. It is also best to vent the tank to 5 psi (84 kPa) below the inner vessel regulator setting (typically under 15 psi (103 kPa).

Current Saturation of Liquid

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

Flow Termination Methods

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

- Close the dispense valve on the hose - preferred for both bulk tank and liquid cylinder.
- Press the "Stop" button on the Flowcom meter display or on the pendant.
- Press the "E-Stop" button, on the pendant or on the road side of the cabinet.



Note: *Pressing the "E-Stop" button should only be used in an emergency situation.* ***DO NOT*** *use this method on a regular basis.*

The Flowcom meter will initiate flow termination if any of the following situations arise:

- Flow rate change is greater than the flow drop setting with the flow drop/rise time (e.g. Perma-Cyl tank float closes, preferred method).
- Flow rate is lower than the flow rate set point.
- Flow rate change is greater than the flow rise setting. within the flow rise/drop time (e.g. leak or sudden receiving vessel venting occurs).
- Flow rate is higher than the high flow rate set point.
- Maximum total threshold has been exceeded.
- Tank pressure above 48 psi (331 kPa).
- Max dispense pressure setting.
- Not enough subcool.
- Flow rate is unstable.
- System alarm reached on the control panel (VFD)

Power Supply

PTO (480V) - Chassis Mounted

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

1. Engage PTO per heavy duty truck OE's recommendation (if unknown, consult your local OE truck dealership)

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

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

Note: *Safety interlocks need to be in place to prevent the PTO shaft from spinning above 1800 RPM or while traveling down the road.*

Caution! Avoid PTO driveline area while truck engine is running. Even if PTO is not engaged, some transmissions allow for the PTO to spin.

2. Set speed to desired operating speed.

Note: *Label in cab should determine the max speed (typically 1100 engine RPM) 1800 RPM is the required PTO shaft speed.*

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

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

Generator (480V) - Trailer Mounted



Figure 1 - Generator Control

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

1. Ensure the speed control is in the tortoise position.
2. Turn the key to the one position and wait for count down to 0.
3. Turn key and hold in crank position until the engine starts.
4. Wait 2-4 minutes to warm the engine.
5. Set speed to high (hare) position and wait until the enginer coolant temp is 180°F (82°C) for 1 to 2 minutes.
6. Monitor display for engine loading.
7. When delivery is completed, turn speed to tortoise for 1-2 minutes to cool the engine.

Operating in Temperatures Below 32° F (0° C)

1. See generator manual for recommended oil weight and change if needed.
2. Plug in the block heater for 3 hours minimum before operating the generator or use easy start Espar block heater
3. Start engine to ensure system is charging. Run for 10 minutes.

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

4. Start the engine following the Generator Operation steps.

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

Pendant Operation



Figure 2 - Control Pendant

Speed Selection Dial

- Always start the pump in recirculation mode at 40 - 50% on the potentiometer dial
- Adjust speed to 50 - 75 psi (345 - 517 kPa) over receiving tank pressure
- When finished with delivery, set back to 40 - 50%

Note: At 80 - 100% audible noise may be heard. This noise is from over spinning the pump. Back down until the noise stops. Preventing this condition will ensure longer pump life.

Caution: The pump can take up to 15 seconds to come up to set speed. DO NOT start dispense until the discharge pressure reading (PI-2) has stopped deviating more than 10 psi (69 kPa) for at least 5 seconds. Dispensing before the pump is up to speed may induce excessive stress on the pump and reduce pump life.

Start Button

- Press the start button once - pump will start-up and recirculate
- Press the start button again - pump will deliver liquid (assuming sufficient subcool has been achieved)
- After pressing the stop button a ticket can be printed by pressing the start button

Stop Button

- Pressing the stop button, while delivering, will end the delivery and puts the Flowcom® Flow Meter System interface into print mode

Note: *If the stop button is pushed, the totalizer needs to be zeroed prior to restarting the pump.*

Note: Pressing the stop button while in recirculation mode will stop the pump and terminate recirculation.

Emergency Stop Button

- Pushing in an emergency stop button will cut 480V power to the control panel, thus the pump and VFD will immediately terminate
- Twist and pull out button to disengage

Delivery Operation - Auto Mode: Perma-Cyl® MicroBulk Storage System Tank, Liquid Cylinder, or Bulk Tank

1. Position the Orca delivery system and secure the unit with the appropriate safety equipment.
2. Follow the Power Supply section of this manual for how to start either the PTO or Generator.
3. Open the plumbing cabinet doors.

Note: Opening the cabinet doors engages the anti-tow valve, locks the brakes, and supplies air to the plumbing cabinet. The Flowcom® Flow Meter System will also automatically power up when the cabinet doors are opened.

4. Close Inner Vessel Regulator Valve (V-2), if equipped.

Caution! If the Inner Vessel Regulator Valve (V-2) was not open during transit or vessel pressure upon arrival is over 35 psi (240 kPa), the pump cool down and subcool build may exceed 50 psi (345 kPa), MAWP. Open the main Vapor Vent Valve (V-5) and vent down to at least 17 psi (117 kPa), then close the Vapor Vent Valve (V-5). Turn off the Flowcom® meter system, wait one minute, and turn the power back on (this allows the liquid to re-stabilize and the Flowcom® meter system to re-establish pSat).

5. Ensure 'Auto' mode is selected on the Control Mode Switch (SW210).

Note: Control mode switch and panel relays enable Flowcom® system control of the pump and control valves. 12-volt power flows through control mode switch to "Auto Mode" relay (CR216), closing a normally open contact (CR216), allowing pump control from the Flowcom® meter system.

Caution! Manual mode is ONLY for service or troubleshooting. Using Manual mode for normal operation may lead to unintended excessive pressure building in piping or damage to the pump if not operated correctly.

6. Turn on Control Power by momentarily turning the Control Power Switch (SW206) to the 'ON' position. When successfully 'ON', the switch will illuminate green.

Note: With no active VFD faults (VFD contacts 24/25 closed), 12-volt power closes the main 480-volt contacts.

7. Remove the stowed Dispense Hose (Tran-1) and remove dust plug from the end of the hose. Connect to the receiving tank using an appropriate adapter end (if required).

   a. Hose flare connection: start with fingers, then tighten threads with wrench.

   b. Fill gun connection: rotate grab handles until tight, no wrench needed.

Note: If needed, attach Extension Hose (TRAN-1X) to the Delivery Hose (TRAN-1) for added length. Follow the hose flare connection procedures.

8. Prepare for purging and cooling the Dispense Hose (Tran-1).

   a. If the receiving vessel does not have a fill circuit drain, back off tightening the fill connection 1/4-1/2 turn.

   b. If the receiving vessel has a fill circuit drain, open the drain valve, keep the top and bottom (if applicable) fill valves closed.

9. Purge the Dispense Hose (Tran-1) and receiving vessel's fill manifold (if applicable) by opening the Delivery Hose End Valve (V-41).

   a. If it is not desired to totalize the amount of product used during purging, open the Manual Override Dispense Valve (V-51), which forces open the Dispense Air Operated Valve (AOV-1). After 30-60 seconds, close the Manual Override Dispense Valve (V-51). Tighten any loose fittings and/or close the receiving vessel fill circuit drain.

   b. If the desire is to totalize during the purging process, follow operation steps 10 through 16. On step 13, set the discharge pressure to 100 psi (689 kPa). Close the Delivery Hose End Valve (V-41) after 30-60 seconds. Then return to step 10 to follow dispense procedures.

Note: The Flowcom® Flow Meter System may terminate the purge dispense due to unstable or high flow rate, restart the dispense until the hose is sufficiently purged and cooled.

Caution! Keep the receiving vessel fill valves closed during the purging process, failure to do so may lead to impurities and contaminants entering the vessel.

10. Set pump speed to 50% on the Speed Select Dial (POT107).

11. Ensure all manual override valves (V-51, V-52, & V-53) are in the normal operation mode (handles are horizontal).

12. Press 'Delivery' on the Flowcom® interface. 'Confirm' understanding of fill requirements/limits of the receiving vessel per CGA-59. Then press 'Start' on the Flowcom® Flow Meter System interface or the remote pendant to start the pump in recirculation mode.



Note: This action closes the pump run output (OUT#5) starting the pump in recirculation mode. The normally open pump run relay closes (CR328), energizing pump input (VFD contact 8) starting the pump which will ramp to speed based on speed selection (POT107).

13. Adjust the pump discharge pressure by adjusting pump speed with speed select dial (POT107). The pump discharge pressure needs to be 50-75 psi (345-517 kPa) above the receiving vessel pressure and no lower than 100 psi (689 kPa) total.



Note: If an unexpected audible tone is heard, reduce pump discharge pressure.



Warning! The Orca cryogenic delivery system can be equipped with a pump that can generate high discharge pressures. It is imperative to understand the receiving vessel properties per CGA-P59 guidelines to ensure the receiving vessel cannot be excessively filled or pressurized.

14. The Flowcom® meter automatically opens and closes the PB Force Feed Valve (AOV-3) as needed to satisfy the subcool requirement of 5 psi (34 kPa) during the dispense process (Current Vessel Pressure - Saturation Pressure = Subcool) (p VTank - pSat V Tank = pSub VTank).

15. After the system automatically generates sufficient subcool, the Flowcom® interface will display another start button. Confirm hose connections, open desired receiving vessel fill valves, and press 'Start' to initiate dispensing.



Note: The dispense valve output energizes (OUT#1) which energizes the control panel valve relay (CR320). This closes the dispense valve normally open relay contact (CR320), powering the dispense valve solenoid (SV210), which supplies air to the dispense valve pneumatic actuator opening the Dispense Valve (AOV-1) and closing the Recirculation Valve (AOV-2).

16. Open Delivery Hose End Valve (V-41) within 5 seconds of pressing 'Start', if not already open.



Note: This is done after starting the pump and adjusting pressure in case the receiving vessel does not have a check valve in the fill circuit. If confirmed that a check valve is in the fill circuit, the Delivery Hose End Valve (V-41) can be opened earlier.

17. Monitor the receiving vessel filling conditions.

    a. If equipped with a bottom fill valve, utilize both top and bottom fill valves to maintain desired pressure (if needed).

    b. If filling a bulk tank with a full trycock, open it and keep it open to determine whether the vessel is full.



Note: If the receiving vessel is warm, venting of the receiving vessel may be needed initially until the vessel cools to maintain proper pressure.

18. Terminate the dispense.

    a. If dispensing to a Perma-Cyl, the Flowcom® will sense flow rate drops and pressure spikes and auto-stop the pump when the Perma-Cyl is full.

    b. If dispensing to a bulk tank, when the full trycock dispenses liquid (not vapor), close the Delivery Hose End Valve (V-41), press Stop on the Control Pendant, or press Stop on the Flowcom®.



Note: At any time during the dispense, it can be terminated by closing the Delivery Hose End Valve (V-41), pressing Stop on the Control Pendant, or pressing Stop on the Flowcom®.



Warning! Do NOT restart the dispense and continue to fill the Perma-Cyl if the Flowcom® auto-shuts off the dispense towards the end of the delivery. This means the Perma-Cyl is full! "Topping Off" may lead to overfilling!

19. Close the Delivery Hose End Valve (V-41) if not already closed. Close any fill valves on the receiving vessel.

20. Disconnect the Dispense Hose (Tran-1) (and adapters) from the receiving tank, install the dust plugs, and stow the hose.



Note: The Dispense Hose (TRAN-1) will automatically drain back into the Meter Section (M-1) via the Dispense Hose Drain Check Valve (CV-4) to ensure no loss of product when disconnecting.

21. Connect to another receiving vessel or proceed to the section titled "Printing A Ticket" in this manual if delivery at this site is complete.

22. Once delivery at this site is complete, proceed to the section titled "Securing the Orca Delivery System for Movement" in this manual.

Printing a Ticket

Once the delivery is complete the next step is to print a ticket.

1. Open the printer door.

2. Insert paper/ticket into the printer by pressing the 'Release' button on the printer, slide the paper/ticket into position and press the 'Forward' or 'Reverse' buttons to lock the paper/ticket into place.



Note: *There is an arrow on the side of the printer that shows where the printing will start.*

3. On the Flowcom® Flow Meter System interface, exit the 'Delivery' screen by pressing the 'Exit' button and press the 'Print' button. A signal is sent to the printer to print the following: Transaction Number, Vehicle Number, Date, Time at Start, Time at Stop, Product Type and Total.

4. When the printer is finished printing, press the 'Release' button to remove the paper/ticket.



Note: *The operator can print a duplicate ticket if needed by pressing the 'Print' button a second time.*

5. Close the printer door.

Securing the Orca Delivery System for Movement

After filling the tank and printing a ticket, you must follow the steps below to prepare the Orca delivery system for travel.

1. Vent the Orca tank to pressure (PI-1) to 17 psig (117 kPa) if needed by opening the 'Main Vent' valve (V-5). Close this valve when proper pressure has been obtained.

2. Open the Inner Vessel Regulator Valve (V-2) if equipped.

3. Turn off the Control Panel Power by turning momentary Control Power Switch to the "OFF" position (SW206).



Note: *The control mode switch (SW210) can be left in "Auto" or switched off. When switched off, auto mode relay (CR216) de-energizes and returns to normally open.*

4. Clear delivery total by pressing "Clear", "Clear", and "Deliver" to enter delivery mode.

5. Leave Flowcom meter power on, door valve will turn the meter off when the door closes.

6. Close the piping cabinet doors.



Note: *Closing the cabinet doors deactivates the anti-tow valve allowing normal brake operation and stops air supply to the plumbing cabinet.*

7. 480V power down:

   a. PTO: Disengage per OE's recommendation.

   b. Generator: Switch the generator from 'On' to 'Off'. Refer to OE generator recommendations.

8. Stow all safety equipment.

Safety Equipment

The Chart installed fire extinguisher is located on the exterior of the cabinet.



Figure 3 - Fire Extinguisher

Emergency Stop Button

Located just above the fender on the roadside is an Emergency Stop Button (Figure 4). Pushing this button will shut off all 480V power to the system (the generator will remain running).



Figure 4 - Roadside Emergency Stop Button

The emergency stop button in the cabinet is located on the pendant.



Figure 5 - Cabinet Emergency Stop Button

Wheel Chocks

Wheel Chocks are located in the cab of the truck, in the toolbox below the piping cabinet, or in their own dedicated holder mounted to the chassis.



Figure 6 - Wheel Chocks

Safety Cones

Safety Cones are stored on the chassis frame.



Figure 7 - Safety Cones

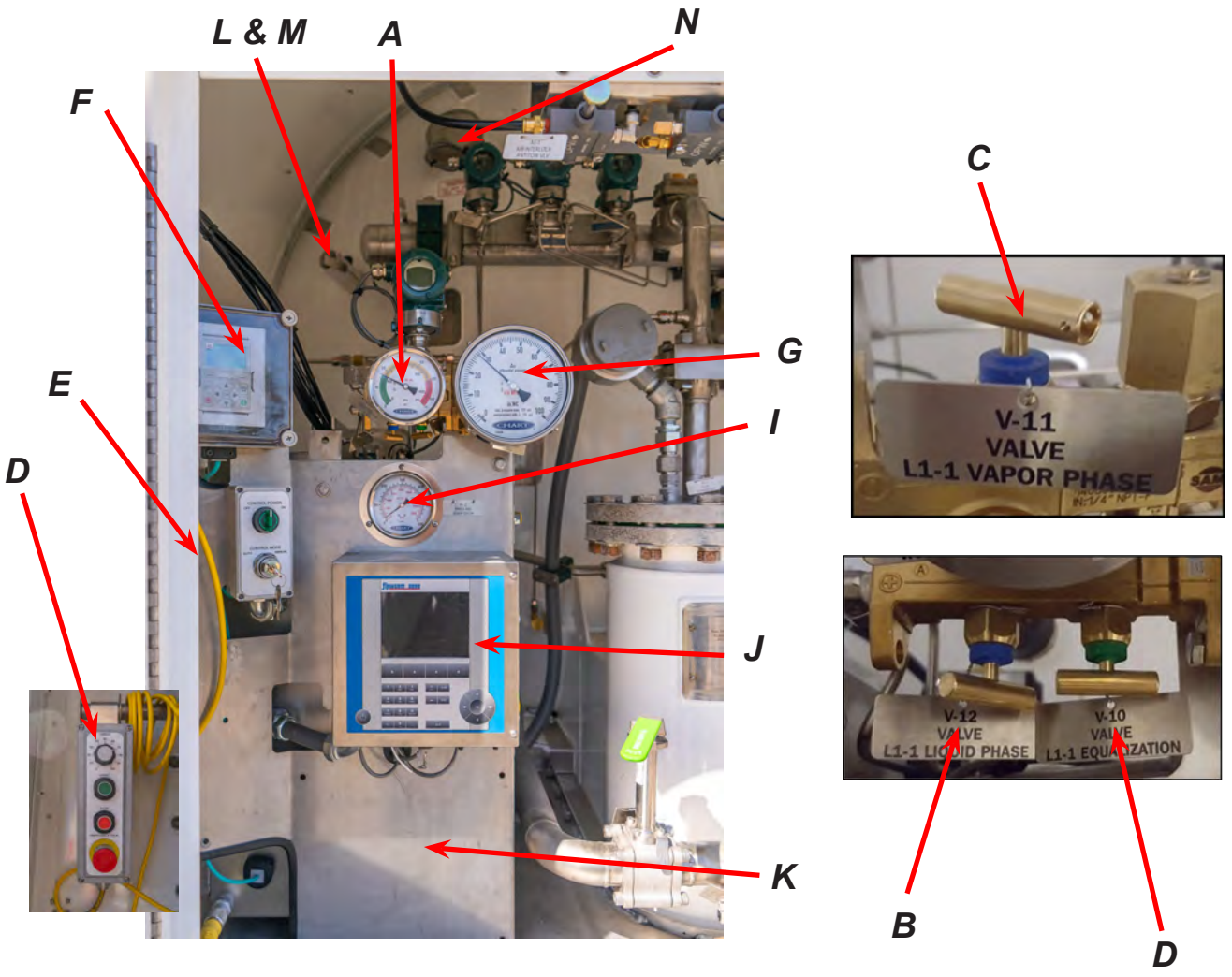
Components & Systems



Roadside **Center** **Curbside**

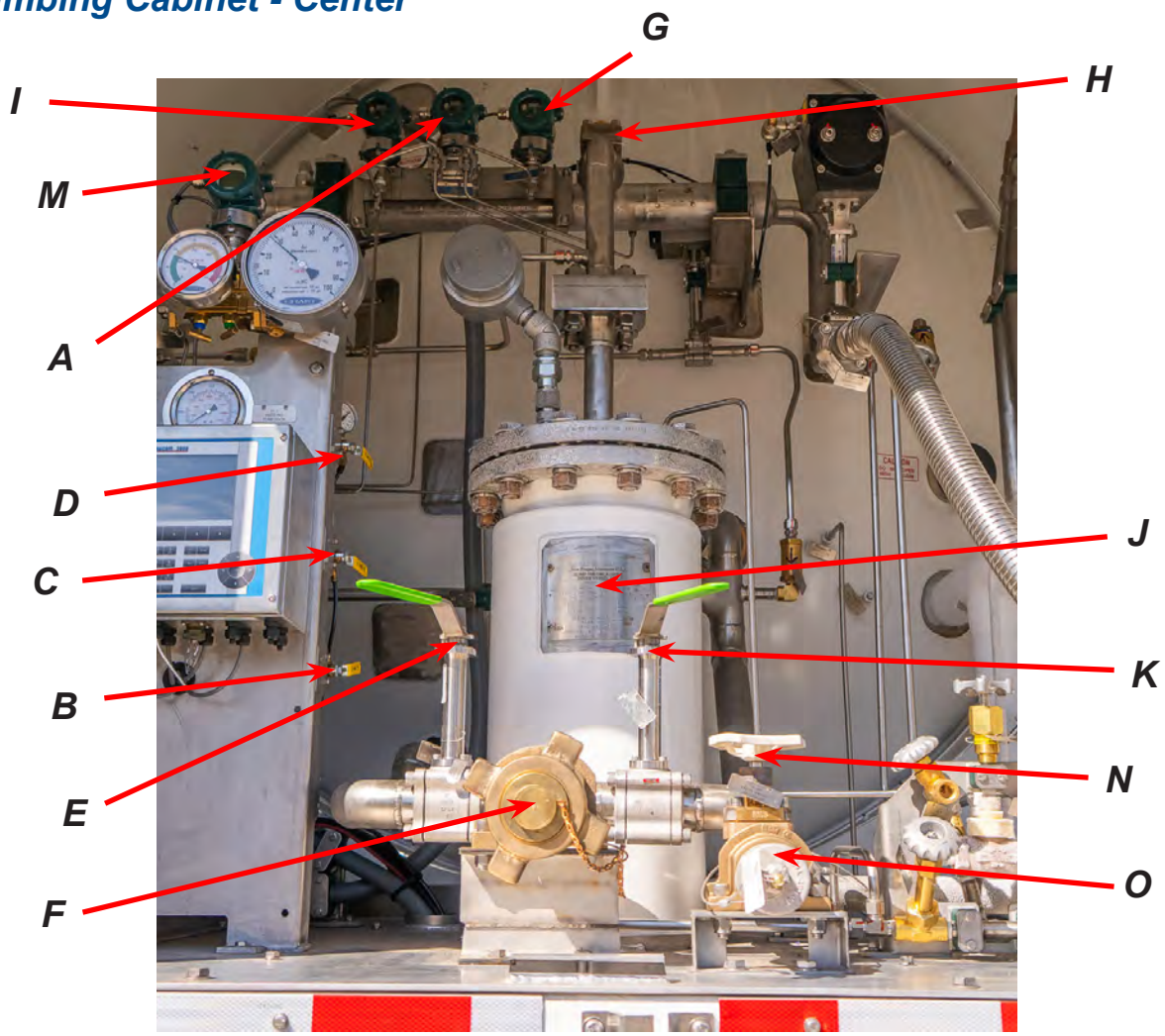
This is the view of the Orca HL Series delivery system cabinet. In this section we will discuss in detail, plumbing cabinet components and systems. To aid in this we will break the cabinet into three areas - Roadside, Center (system control and monitoring), and Curbside.

Plumbing Cabinet - Roadside



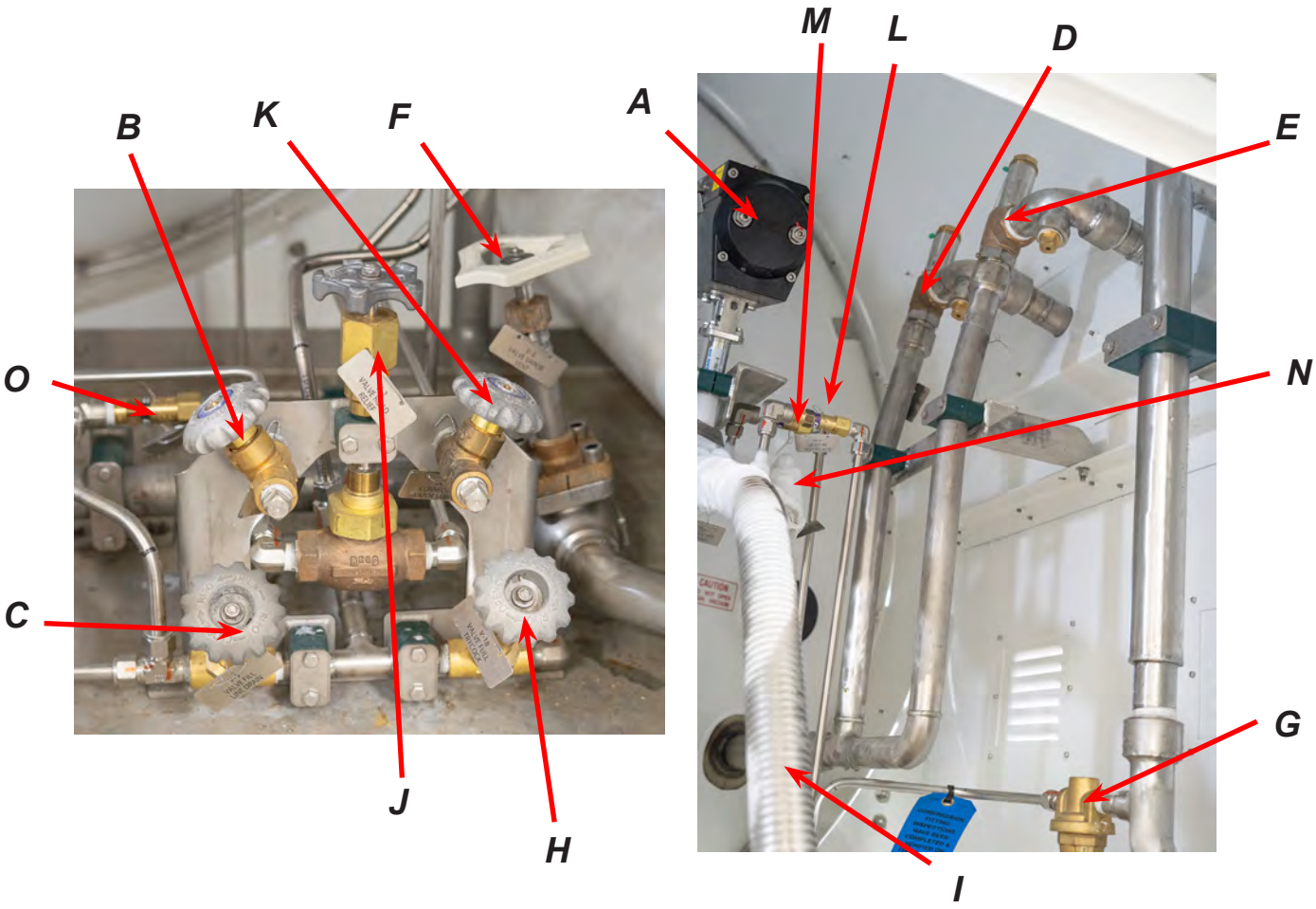
Item	Tag	Part Number	Description
A	PI-1	20890787	Pressure Indicator, Inner Vessel
B	V-12	20890787	Valve, LI-1 Liquid Phase
C	V-11	20890787	Valve, LI-1 Vapor Phase
D	V-10	20890787	Valve, LI-1 Equalization
E		21477403	Pendant Cord
F		22046157	Remote VFD Display
G	LI-1	20890787	Level Indicator, Inner Vessel
H	V-13	14717177	Valve, Pump Discharge Gauge ISO (not shown)
I	PI-2	20860869	Pressure Indicator, Pump Discharge
J		FL1253000	Flowcom® 3000 Flow Meter System
K			Printer Box (Not Shown)
L	V-99	10482381	Valve, TC-1
M	TC-1	4210049	Thermocouple, Vacuum
N	PSE-1	10899110	Pressure Safety Element

Plumbing Cabinet - Center



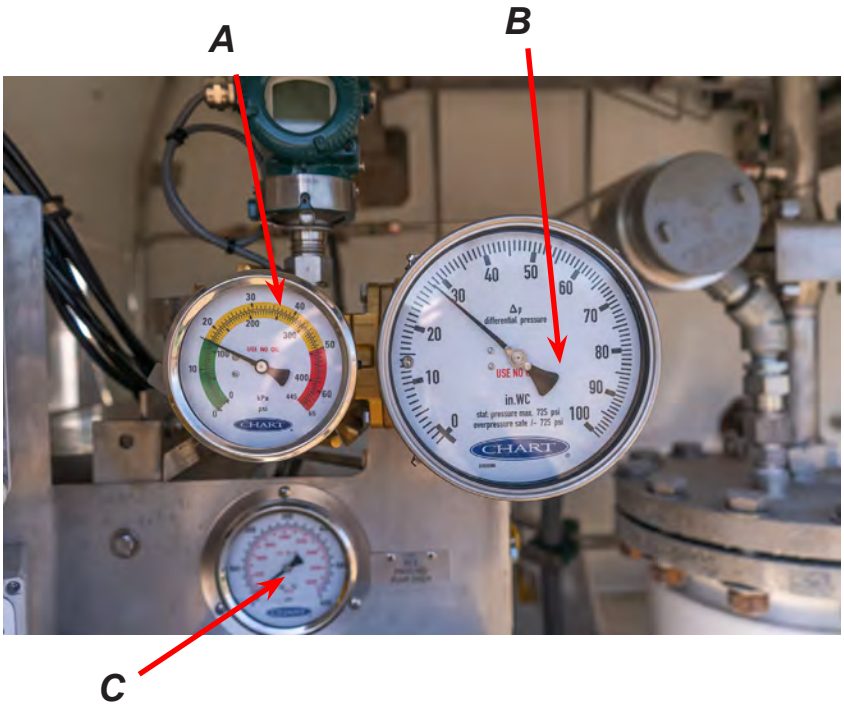
Item	Tag	Part Number	Description
A	DP-3	22450495	Transmitter, Diff. Press. Low Flow
B	V-51	11809868	Manual Override Air Operation Valve, Force Feed
C	V-52	11809868	Manual Override Air Operation Valve, Recirculation
D	V-53	11809868	Manual Override Air Operation Valve, Dispense
E	V-17	21718647	Valve, Bottom Fill
F	DC-2		Connection, Fill Line
G	PT-3	22450496	Transmitter, Guage Press., Low
H	CV-8	20581252	Check Valve, Liquid Feed
I	PT-2	22450496	Transmitter, Guage Press., High, Discharge
J	P-1	13800197	Pump, Submerged
K	V-3	21718647	Valve, Top Fill
L	S-1	20902507	Strainer Fill (Not Shown)
M	PT-1	21974539	Transmitter, Guage Press., Vessel
N	V-44		Valve, Vapor Recovery
O	DC-3		Connection, Vapor Recovery

Plumbing Cabinet - Curbside

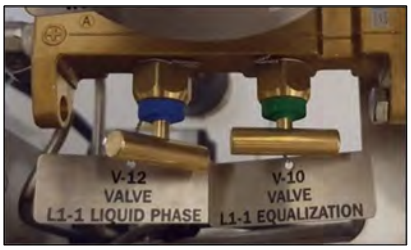


Item	Tag	Part Number	Description
A	AOV-1	21718650	Air Operation Valve, Dispense
B	V-23	10502848	Valve, Liquid Sample/Sump Drain
C	V-9	11625639	Valve, Fill Line Drain
D	SV-1B	22256400	Safety Relief Valve, Vent Circuit
E	SV-1A	22256399	Safety Relief Valve, Vent Circuit
F	V-5	13410261	Valve, Vapor Vent
G	PCV-1	1720412	Pressure Control Valve, Inner Vessel Regulator
H	V-18	11625639	Valve, Full Trycock
I	TRAN-1		Transfer Hose, Dispense
J	V-2	1718802	Valve, Inner Vessel Regulator
K	V-24	10502848	Valve, Gas Sample
L	TSV-5	22236426	Thermal Safety Valve, Dispense Hose
M	TSV-3	22236426	Thermal Safety Valve, Pump Discharge
N	CV-4	11051090	Chack Valve, Dispense Hose Drain
O	TSV-4	11761083	Thermal Safety Valve, Fill Line

Control Gauge Panel







Item	Tag	Part Number	Description
A	PI-1	20860868	Pressure Indicator, Inner Vessel
B	LI-1	20890787	Level Indicator, Inner Vessel
C	PI-2	20860869	Pressure Indicator, Pump Discharge

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 step to reset the gauge.

1. Crack open 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.

Control Panel





Item	Part Number	Description
A	11410712	E-Stop push button
B	11410632	480V Control Power Switch
C	11410704	Mode Selection Switch Auto / Manual
D	11410641	Pump Speed Dial
E	F11253000	Flowcom® 3000 Flow Meter System

Anti-Tow Valve



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

Electrical Panel/Heater

The Eaton Variable Frequency Drive (VFD) has an internal temperature sensor that does not allow the VFD to operate at temperatures below -20°F / -28°C and will not run the pump if below -4°F / -20°C. If the VFD temperature is between -20°F / -28°C and -4°F / -20°C, the VFD will conduct a self-warming procedure that slowly turns the pump until the VFD warms to -4°F / -20°C. Once -4°F / -20°C is achieved, the pump will automatically ramp up to the selected speed. In some cases, the VFD will cool slightly as the pump just gets started and will cool to below -4°F / -20°C, at which time the pump will stop and the VFD will re-warm itself. The initial warming may take up to one minute and the occasional re-warming another minute.

At temperatures below 40°F / 4°C the heaters in electrical panel will turn on while the truck is in the "key on position". At -40°F / -40°C ambient conditions, it may take up to 15 minutes with the truck in the "key on position" before the unit can make the first delivery. At temperatures above 55°F /13°C the heaters in electrical panel will turn off.

Vent Circuit



The Vent Circuit is located on the curbside of the trailer. A convenient access panel can be removed for access to the vent circuit.



Warning! Keep vent outlets clear of debris and excessive ice buildup to prevent unintentional over pressurization of the vessel. Over pressurization could lead excessive stress on the vessel and a catastrophic depressurization event.

Ticket Printer



Submerged Pump

The submerged pump is a specifically designed variable speed centrifugal pump that is designed to operate while submerged in liquid nitrogen or argon. The pump is inside a flanged sump that is connected to the Orca tank and is always filled with cryogenic fluid. This means that the pump is always cooled-down and can be used to deliver product to the Perma-Cyl® MicroBulk Storage System or other MicroBulk tanks virtually instantaneously.

Fill Circuit



The Orca tank is filled through the top and bottom fill circuit. Using the fill circuits properly will minimize vent losses during filling. The fill line drain should be used to vent the fill hose after filling to relieve any pressure.

Metering System

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

Meter Section



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

Gauge Pressure (P) Transmitters & a Differential Pressure (DP) Transmitter



This is a Yokogawa Pre-Set Differential Pressure Transmitter used on the Orca system. It is connected to the meter section and the Flowcom meter system. The DP transmitter measures a change in pressure (pressure drop) across the meter section and relays this information to the Flowcom meter system for lower flow rates in an electrical signal. The system also uses 2 Yokogawa Pre-Set Gauge Transmitters. Each is connected to one end of the DP transmitter. In tandem, they relay discharge pressures and high flow rates. The signal sent to the flow meter system is a 4-20 milliamp signal.

RTD - Resistance Temperature Device

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



Note: Location of RTD may vary based on production version.

Hose Drain Check Valve



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

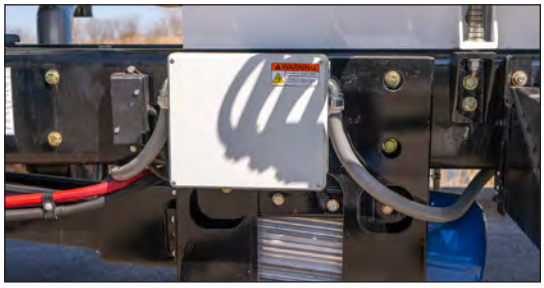
Flowcom Flow Meter System



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

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

Fuse Box (Truck Mounted Units)



The 480V fuse box is located on the road side (typically, truck dependent) of the unit just behind the cab.

Relay Fuse Box



Gauge



Located on the road side front of the Orca tank on MC-338 units only.

Antenna



Located on the road side cabinet panel. This allows remote cellular communication with the Uptime platform. See Orca Uptime Manual for more information.

Troubleshooting

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

Symptom	Probable Cause	Remedy
No control panel power (light not on)	Breaker blown in 12 volt control circuit.	Replace breaker / reset breaker in fuse block in truck.
	12 volt circuit open. E-Stop accidentally engaged Panel door open / panel door switch off.	Verify connector is plugged in at front of tank. Also inspect wires from connector to control panel for break, cuts, etc. Repair if necessary. Twist and pullout E-stop if safe to do so.
Low voltage or high voltage error messages on VFD display.	Alternator spinning too fast or too slow.	Adjust generator voltage accordingly.
Over current error message on VFD remote display.	Pump drawing too much current.	Slow pump speed down using control on pendant. Do not start at maximum speed.
	Worn bearings in pump.	Remove and replace pump.
Control valves do not open.	No air supply to the valve or low air.	Verify that there is sufficient air in air tanks. Valve requires 100 psi (689 kPa) to operate.
	System in manual mode.	
	No 12 volt power to the solenoid.	Verify solenoid is plugged into junction box, and that wires are not broken.
	Actuator failure.	Thaw out valve. ***Caution!*** ***Do not use fire or flame to thaw valve on an oxygen unit!!!***
Error E009 Error E010	Measured temperature is too low. PT100 low signal voltage. PT100 excitation current out of range.	May be caused by any of the following: -Temperature sensor PT100 is not connected properly. -Temperature range switching is defective. -Constant current source is defective. The product parameter does not match the actual product being metered.
Errors on boot-up. Error E011 Error E012 Error E013 Error E014 Error E015	Liquid flow through meter section before meter is turned on. DP transmitter defective. Wiring defective. Leak in DP lines.	Press “STOP” button on control pendant. Verify transmitter is plugged into junction box JB1, and that wires are not broken. Voltage across contacts 1 & 2 on block X7 should measure between 18 & 26 VDC. If not, front board needs to be replaced. Tighten fittings.

Symptom	Probable Cause	Remedy
Unstable flow of product.	Depletion of subcool.	Add subcool by opening pressure building coil. Required pressure is 5 psi (34 kPa) above saturation pressure.
	Auto subcool valve not opening.	 ***Caution! Do not use fire or flame to thaw valve on an oxygen unit!!!***
	Vessel transmitter fault.	
	Manual valves closed.	Ensure all valves are open.
	Liquid level low.	Check liquid level gauge. Delivery of product should not be attempted at low liquid levels.
	AOV-1 not opening.	
	Loss of 480 volt phase loss.	 ***Caution! Serious damage to pump can occur if pump is run dry!***
	Two-phase flow. This occurs when a combination of liquid and gas flows through the pump.	Increase subcool. If the saturation pressure is high, the vessel may have to be blown down, then subcool added.
Insufficient subcool.	Delivery started without sufficient subcool.	Add subcool while monitoring subcool pressure prior to initial delivery. Required pressure is 5 psi (34 kPaa) above saturation pressure.
Audible change in pump.	Liquid level low.	Check liquid level gauge. Delivery of product should not be attempted at low liquid levels.
	Flow rates through restrictive lines.	 ***Caution! Serious damage to pump can occur if pump is run dry!***
	Pump pressure too high.	Reduce pump pressure.
	Worn bearings in pump.	Remove and replace pump.
Pump not catching prime.	Insufficient subcool. AOV-3 not opening. AOV-2 not closing.	Add subcool by opening pressure building coil. Required pressure is 5 psi (34 kPa) above saturation pressure.
		 ***Caution! Venting during delivery will cause depletion of subcool, and may also cause damage to pump!***
	Liquid level low.	Check liquid level gauge. Delivery of product should not be attempted at low liquid levels.
		 ***Caution! Serious damage to pump can occur if pump is run dry!***
Paper out. (Print / Exit)	Add paper, check cables	Verify that the cables to the printer are plugged in, that the printer is turned on, and that there is paper in the printer.
Lower pump speed, lower pressure or recirc is continuous.	AOV-2 valve not operating properly	Adequate air supply 12 volt supply to solenoid

Symptom	Probable Cause	Remedy
Lower pump speed, lower pressure or recirc is continuous.	AOV-2 valve not operating properly.	Adequate air supply. 12 volt supply to solenoid. Replace actuator/valve.

Error Codes & Warnings

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

Overview of Error Codes

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

Error	Cause	Task
E032	Meter System serial numbers have not been entered yet. Checksum error identified when reading the corresponding settings.	Configure device. See also section 6 “Parameters / Settings” beginning on page 25.27. The calibration seal does not need to be broken.
E033	General setttings of the meter system have not been entered yet. Checksum error identified when reading the corresponding settings.	Configure device. See also section 6 “Parameters / Settings” beginning on page 25.27. The calibration seal does not need to be broken.
E034	The License Key for the selected application has not been entered.	Enter License Key.
E035	Expansion module not connected or defective.	Check connection cable (ribbon cable) and/or replace. Expansion module.
E040	Battery voltage lower than 1.82V (Nominal value is 3.0V)	Replace battery .Check date and time of internal clock and set if necessary.
E041 - E047	Main supply voltage too low.	Address fault in main voltage supply. Replacement of mother board (needs recalibration).
E048	Environmental temperature too low.	Address fault in main voltage supply. Replacement of mother board (needs recalibration).

Overview of Warnings

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

Overview of Operation Error Codes

Symptom	Possible Cause	Remedy
Flowcom® Flow Meter System does not power up.	Fuse blown in 12 volt control circuit. Loss of air.	Replace fuse in fuseblock in truck. Truck air system not working or bad air switch PS331 in Control Panel or Rear Door switch not working.
Metering stopped and flashing red on screen, does not stop dispensing.	Temp probe failure Pump pressure transmitter	Flowcom meter connector 1-4, replace temp probe or bypass in settings with preset density. Flowcom meter connector 9,10, wire cut/ disconnected, transmitter bad.
Message “Discharge Pressure to High”	Pump discharge to high, meter warm, dispense valve not open, valve on tank not open. Receiving tank valve closed, dispensing valve closed.	Cool down tank. Open valve.

Symptom	Possible Cause	Remedy
Flowcom® Flow Meter System cycling screens on startup.	12V supply voltage low.	Check 12V supply.
Dispensing and pump stops.	Stops without errors.	Flowcom meter connector 44.
"Unstable flow rate"	Depletion of sub-cool.	Add sub-cool by opening pressure building coil. 5 - 7 psi (34 - 48 kPa) above saturation pressure is required. ***Caution! Venting during delivery will cause depletion of sub-cool, and may also cause damage to pump!***
	Liquid level low.	Check liquid level gauge. Delivery of product should not be attempted at low liquid levels. ***Caution! Serious damage to pump can occur if pump is run dry!***
	Two-phase flow. This occurs when a combination of liquid and gas flows through the pump.	Increase sub-cool. If the saturation pressure is high, the vessel may have to be blown down, then sub-cool added.
	Loss of air supply valve closes, pump stops.	Check air supply.
	Dispensing valve closes.	Check output connector 36,37 in Flowcom meter or solenoid. Please use the inputs/ outputs function for diagnosis.
	Low Flow <=400 mbar and reduction in flow, or High Flow >400 mbar and reduction in flow, and Flowcom meter shuts off delivery.	Keep constant flow rate, do not change the VFD Hz fast.
	Wiring to transmitter low pressure transmitter.	Please use the inputs/outputs function for diagnosis. Check input connector 5,6.
Message "Insufficient Subcool", psub Vtank - number in red, system shuts down after about 10 sec.	Tank pressure transmitter defective.	Please use the Inputs/Outputs function for diagnosis.
	Broken cable.	Flowcom connector 11,12.
	Force feed valve closed.	Flowcom connector 40, solenoid bad, loss of air.
Message "Flowrate < Q...min" flashing red on screen.	Leak in the DP Transmitter high line or pressure transmitter pump psi = 0, pump shutdown.	Repair leak.
	Low Flow <=400 mbar and transmitter low failure	Flowcom meter connector 5 and 6 disconnected, wire cut/disconnected, transmitter bad.
	High Flow >400 mbar and transmitter high failure.	Flowcom meter connector 7 and 8 disconnected, wire cut/disconnected, transmitter bad.
	Warm hose.	Cool hose.
Message "Flowrate > Q...max" flashing red on screen.	Leak in the DP Transmitter low line, pump shutdown.	Repair leak.
Loss of VFD information on INFO screen.	Connection loss.	Flowcom meter connector 22,23.

Symptom	Possible Cause	Remedy
Low voltage or high voltage error messages on VFD.	Alternator spinning too fast or too slow.	Adjust truck engine speed accordingly.
Over current error message on VFD.	Pump drawing too much current.	Slow pump speed down using speed control.
	Worn bearnings in pump.	Remove and replace pump.
480V loss.	Error code on SVX briefly, Flowcom® Flow Meter System has power.	Check fuses and alternator.
Audible change in pump.	Liquid level low.	Check liquid level gauge. Delivery of product should not be attempted at low liquid levels. ***Caution! Serious damage to pump can occur if pump is run dry!***
	Worn bearings in pump.	Remove and replace pump.
Pump not catching prime.	Insufficient sub-cool.	Add sub-cool by opening pressure building coil. 5 - 7 psi (34 - 48 kPa) above saturation pressure is required. ***Caution! Venting during delivery will cause depletion of sub-cool, and may also cause damage to pump!***
	Liquid level low.	Check liquid level gauge. Delivery of product should not be attempted at low liquid levels. ***Caution! Serious damage to pump can occur if pump is run dry!***
Pump will not start.	Flowcom meter not signaling VFD.	Check connectors 22 thru 44.
	VFD.	Enter VFD settings.
	E-Stop pushed in.	Reset stop button.
	Temperature of pump not cold enough.	Check block valve manual valve or bad temperature probe.
VFD display out.	Loss of connection.	Check 9 pin connector on VFD, damaged cable, display bad.
Pendant start/stop not working.	Bad cable or connection.	Replace pendant cable, Flowcom meter connector 24 - 31.
Printer error	Power loss.	Check power cable, DC convertor bad, and check connector 46,47.
	Data loss.	Broke cable, check connector 17 - 19.
	Flowcom meter not set up.	Complete setup.
	Paper not inserted.	Insert paper.
Dispense valve does not open.	No air supply to the valve.	Verify that there is sufficient air in air tanks. Valve required 100 psi (689 kPa) to operate.
	No 12 volt power to the solenoid.	Verify solenoid is plugged into junction bax, and that wires are not broken.
	Valve is frozen.	Thaw out valve. ***Caution! DO NOT use fire or flame to thaw valve on an oxygen unit!***

Genset Troubleshooting

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



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

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

Manual / Parked Exhaust Filter Cleaning:

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

Preventive Maintenance

General

This section contains maintenance information. Service and/or repairs are not difficult because parts are easily accessible and replaceable. Before performing any of the procedures in this section be sure you are familiar with the location and function of controls and indicators discussed in other sections. It is recommended that the Safety section of this manual be reviewed and understood fully.

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

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

Daily Observation Checks by Operator

Beginning of the Day Checks

1. Observe pressure in tank, pressure should not rise much in tank without the pump operating.



Note: *Submerged pump will build 5-10 psi (34-69 kPa) in recirculation mode and could build more if filling small tanks (69 gal / 260 liters or less).*

2. Ensure safety reliefs are not leaking (frost on safety vent pipes is an indicator of a leak).
3. If equipped with inner vessel pressure regulator, check that they are not frozen and operate properly at desired set point, typically set at 17 psig (117 kPa) or below 25 psig (172 kPa).
4. If ice forms around valves, ensure the valves are fully operational. If not, defrost with water.

During PTO (Power Take Off) Operation

1. Verify engine speed meets desired speed (dash on truck should have desired engine speed to achieve 1800 RPM generator shaft speed).
2. Check that there is no vibration from PTO driveline.



Note: *If there is any vibration, the unit must be reviewed by a mechanic prior to making another delivery. Major damage may occur to equipment. Severe injury or death may occur if PTO shaft becomes unattached.*

During Deliveries

1. Use automatic mode.



Note: *Contact Chart if operator uses manual mode for fills.*

2. Review all plumbing and pressure building coil for any possible leaks.
3. Valves should open and close freely.
4. Air actuated valves should open and close fully.
5. Check for pump noise or lack of building pressure.



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

6. Check that printer is operational (if used).
7. Check that the Flowcom® Flow Meter System has correct units, service, product type and no fault codes (this should not change, but could if service work has been performed).
8. Check that VFD has no fault codes during delivery.

Weekly Preventive Maintenance

Plumbing Inspection

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



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

Power Take Off Inspection

1. Torque all PTO housing bolts (connection from PTO to transmission).



Note: *See original manufacturer for maintenance and torque requirements.*

2. Ensure that transmission has no leaks around PTO housing or shaft.
3. Torque all driveline hardware.
4. Inspect driveline for any wear or breaks.
5. Grease if applicable.
6. Run PTO, ensure a smooth engagement (no grinding/ clunking) and drive shaft has no vibration.

Every Month Preventive Maintenance

Mounting Hardware

1. Bolts/nuts present and torqued.



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

2. Springs not cracked and present forward of rear tandem.
3. Inspect all hardware and replace or tighten as needed.

Every Three Months Preventive Maintenance

Voltage Readings (Must be a well-trained electrician to perform)

1. Take readings at outlet power lugs of generator of WEG.
2. Check all three legs 480 VAC across L1-L2, L1-L3, L2-L3.
3. Check frequency across L1-L2, L1-L3, L2-L3; between 58-62 Hz is acceptable.

Electrical Connection Inspection (12v)

1. Check voltage at the batteries.
2. Check voltage at the relay box.
3. Check voltage at the rear junction box.
4. Check voltage on the junction box, located in the left side of the cabinet.
5. Check electrical connections at the solenoid valves.
6. Check electrical connections at the Flowcom® Flow Meter System and electrical control box.

Electrical Connection Inspection (480v) (Must be a well-trained electrician to perform)

1. Ensure connections are tight to fuse box.
2. Ensure connections are tight in electrical control box.
3. Ensure connections are tight at the junction box located on top of the sump.
4. Inspect for corrosion or broken wires.

Operational Inspection

1. Check that the pump builds pressure when increasing pump speed.
2. Check that the pump is not loud.

Hose Drain Solenoid Operation

1. When dispensing liquid, hose drain line is not frosted up.



Note: *If hose is frosted up, the hose drain valve needs to be checked.*

Temperature Inspection

1. Check connection at junction box located on top of the sump.
2. Make sure the primary relief valve isn't opening before it should (50 MAWP).

Every Six Months Preventive Maintenance

Air Actuated Valve Operation

1. Ensure valves fully open and close.
2. Check wear on couplers.



Note: *If couplers are under frequent use, they should be replaced every year.*

Air Supply

1. Drain air tanks of moisture.



Note: *Especially before winter / freezing months.*

2. Check for air leaks.
3. Perform a DOT test (2 psi / 14 kPa) dropping in less than 2 mintues and 90 - 120 psi (621 - 827 kPa).

Miscellaneous

1. Ensure that printer is operating correctly.
2. Prior to cold weather, test heater system and ensure that it functions properly.

Yearly Preventive Maintenance

1. Check Variable Frequency Drive.
2. Ensure proper service in all programmable settings.
3. Check air supply.
4. Drain the air tank(s) every year before the winter months.
5. Perform a DOT inspection.
6. Test anti-tow system.
7. Inspect pressure building coils and clamps (remove a few clamps and inspect for corrosion or pitting).
8. Get on-site calibration of meter.
9. If hose has been changed, ensure hose volume is the same or updated in Flowcom® Flow Meter System.

Every Two Year Preventive Maintenance

1. Replace line relief safety valves (for plumbing circuit protection.)

Vacuum Integrity Check (as required)

Since all transport tanks are vacuum insulated, any deterioration or loss of vacuum will be apparent by cold spots, frost, or condensation on the outside of the tank or evidenced by abnormally rapid pressure build-up. Unless one of these conditions is evidenced, the vacuum level should not be suspect.

In the event one of the above conditions exists, remove the unit from service as soon as possible and contact the factory for advice on vessel vacuum testing.

Recommended Replacement Parts

Tag ID	Part Description	PN	Qty
	Gaskets		
N/A	1.5” Teflon Gasket	6512029	1
N/A	1.5” Copper Gasket	11718915	2
N/A	2.5” Teflon Gasket	10486913	1
N/A	2.5” Copper Gasket	330521	1
	Safeties		
SV-1A	Primary Safety Relief Valve	22256399	1
SV-1B	Secondary Relief Valve	22256400	1
TSV-4	Fill Line Thermal Safety Relief Valve	11761083	1
	Hose Components		
V-41	Wrench Assy. Inert Only LIN/LAR 1/2” Flare	20899903	1
V-41	Wrench Assy. LAR Only 3/4” Flare	20875471	1
V-41	Spin Adaptor 1” Valve	11007881	1
V-41	Spin Adaptor Relief Valve	13618395	1
N/A	Conn BRS 1” Flare Fitting 45D FL	1110302	1
N/A	Conn BRS 1/2” Flare Fitting 45D FL	1110122	2
N/A	Conn BRS 3/4” Flare Fitting 45D FL	12988052	2
N/A	Dust Plug 1” Flare	10677402	1
N/A	Dust Plug 1/2” Flare	21111333	1
N/A	Dust Plug 3/4” Flare	21111335	1
	Electrical		
N/A	Battery 3V, Type 2032, Expected Life 3-5 Years	2032	1
N/A	Printer Ribbon	11693421	1
	For Fleets of Three or More Orca™ MicroBulk Delivery Systems		
N/A	Fuse, 45 Amp	21158605	3
N/A	KA High Flow Dispense 1.5 Flexitallic Gasket CL #300	11934191	1
N/A	Generator - KWG 28KVA (For Standard Submerged & External Pumps Only)	21464028	1
N/A	Generator - KWG 38KVA (For KA & JD Pumps Only)	21464029	1

Preventive Maintenance Log

Date	Preventive Maintenance Performed	Notes

Date	Preventive Maintenance Performed	Notes

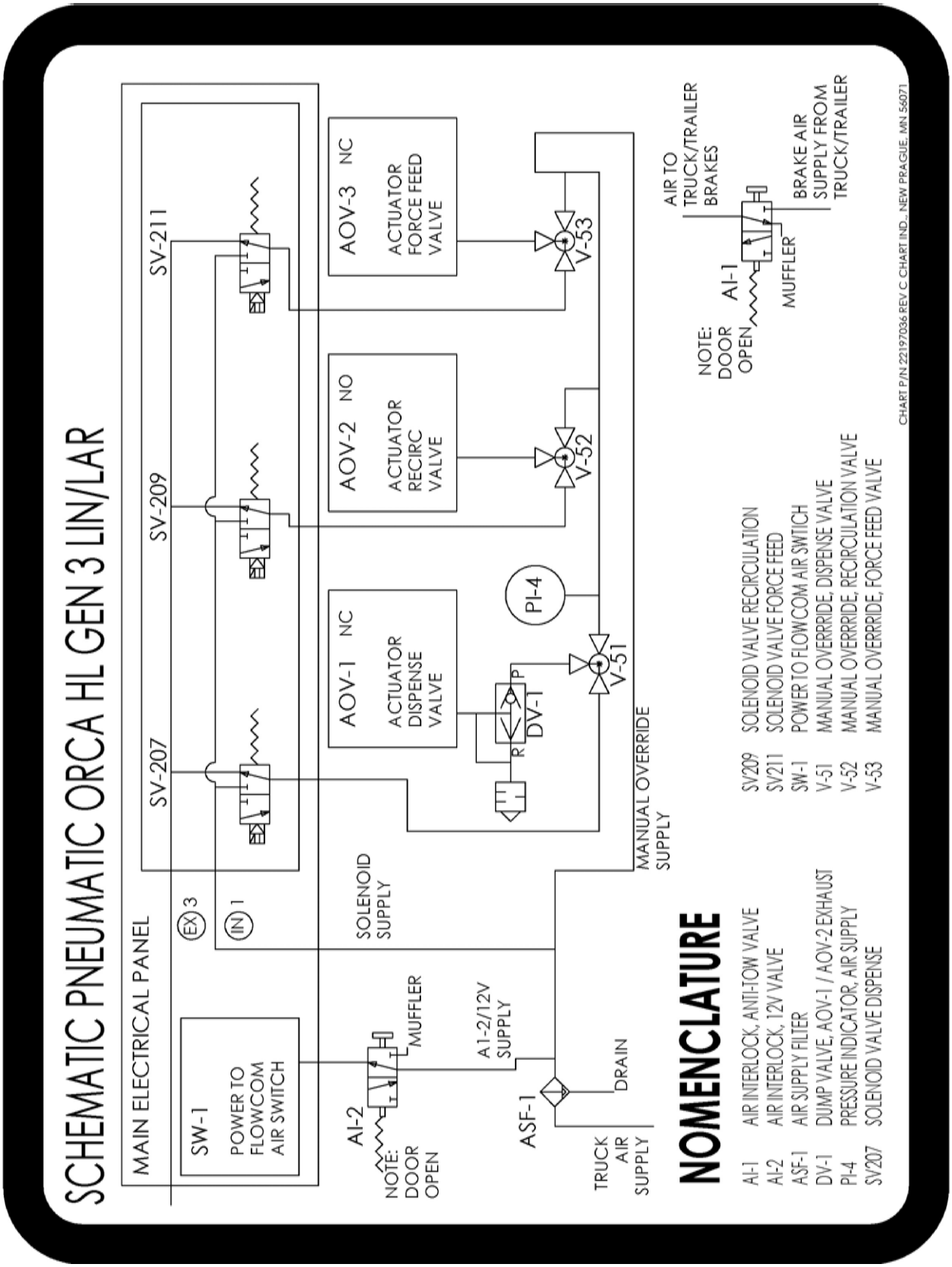
Specifications

Model	HL-2000	HL-2800	HL-3300
Gas Services	LN_2, LAR & LOX	LN_2, LAR & LOX	LN_2, LAR & LOX
Pressure Builder Type	Pump force-feed/ Auto Subcool	Pump force-feed/Auto Subcool	Pump force-feed/ Auto Subcool
Design Code	ASME, MC-338, CGA-341	ASME, MC-338, CGA-341	ASME, MC-338, CGA-341
Specifications			
Gross Capacity (gal/ ltrs)	2144 / 8116	2880 / 10,902	3399 / 12,867
Capacity* **CGA-341 (gal/ltrs)	2037 / 7710	2736 / 10,357	3229 / 12,223
Capacity** **MC-338 (gal/ltrs)	1907 / 7219	2560 / 9691	3023 / 11,443
MAWP (psig/bar)	50 / 3.4	50 / 3.4	50 / 3.4
Overall Length (in/cm)	200 / 508	244 / 620	273 / 693
Overall Height (in/cm)	87 / 221	87 / 221	87 / 221
Overall Width (in/cm)	102 / 259	102 / 259	102 / 259
Tank Diameter (in/cm)	80 / 203	80 / 203	80 / 203
Tare Weight (lbs/kg)	8500 / 3856	9400 / 4264	10,500 / 4763
Performance			
Submerged Pump			
Pump	Sub 60	Sub 100 KA	Sub 100 JD
Min. Dispensing Rate (gpm/lpm)	10 / 38	10 / 38	10/38
Max. Dispensing Rate (gpm/lpm)	60 / 227	100 / 379	100/379
Max. Dispensing Pressure (psig/barg)	275 / 19.0	425 / 29.3	575/39.6
Max. Receiving Tank Pressure (psig/barg)	225 / 15.5	375 / 25.9	500/34.5

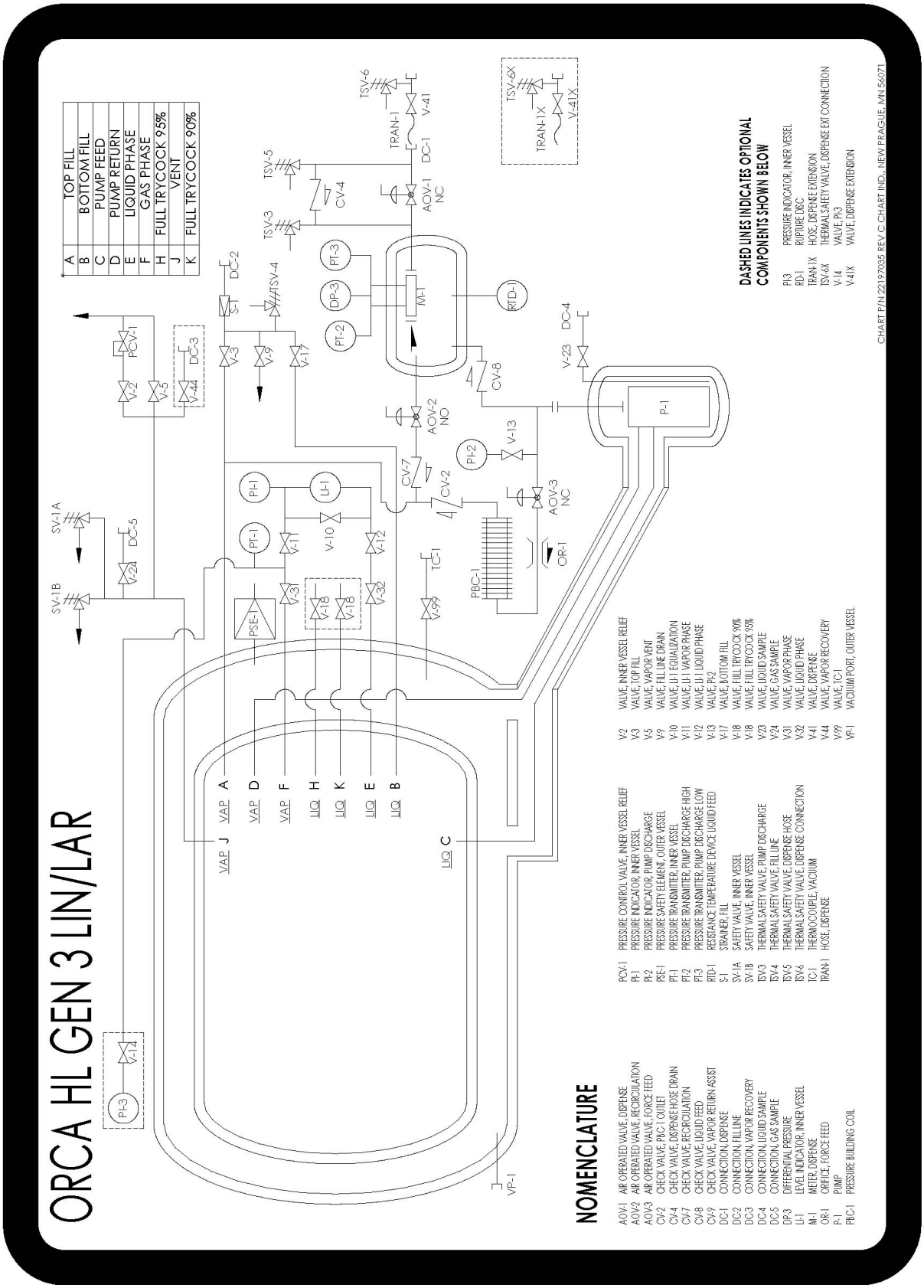
* With road relief valve at 25.3 psig

** Maximum fill levels depend on vehicle specifications

Schematic


SCHEMATIC PNEUMATIC ORCA HL GEN 3 LIN/LAR
MAIN ELECTRICAL PANEL
SW-1
POWER TO FLOWCOM AIR SWITCH
AI-2
NOTE: DOOR OPEN
MUFFLER
A1-2/12V SUPPLY
ASF-1
DRAIN
TRUCK AIR SUPPLY
SOLENOID SUPPLY
SV-207
SV-209
SV-211
EX 3
IN 1
AOV-1 NC
ACTUATOR DISPENSE VALVE
AOV-2 NO
ACTUATOR RECIRC VALVE
AOV-3 NC
ACTUATOR FORCE FEED VALVE
DV-1
PI-4
V-51
V-52
V-53
MANUAL OVERRIDE SUPPLY
AIR TO TRUCK/TRAILER BRAKES
NOTE: DOOR OPEN
AI-1
MUFFLER
BRAKE AIR SUPPLY FROM TRUCK/TRAILER
NOMENCLATURE
AI-1 AIR INTERLOCK, ANTI-TOW VALVE
AI-2 AIR INTERLOCK, 12V VALVE
ASF-1 AIR SUPPLY FILTER
DV-1 DUMP VALVE, AOV-1 / AOV-2 EXHAUST
PI-4 PRESSURE INDICATOR, AIR SUPPLY
SV207 SOLENOID VALVE DISPENSE
SV209 SOLENOID VALVE RECIRCULATION
SV211 SOLENOID VALVE FORCE FEED
SW-1 POWER TO FLOWCOM AIR SWITCH
V-51 MANUAL OVERRIDE, DISPENSE VALVE
V-52 MANUAL OVERRIDE, RECIRCULATION VALVE
V-53 MANUAL OVERRIDE, FORCE FEED VALVE
CHART P/N 22197036 REV C CHART IND., NEW PRAGUE, MN 56071

Nomenclature



PIPING LEGEND				
TAG DEFINITION		CHART P/N	VENDOR INFORMATION	SIZE
AOV-1	AIR OPERATED VALVE, DISPENSE	21718650	HABONIM NC 15 C47W-666MAAA/BW10-6.0 W/ACT MT36S5-LT	1-1/2" PS
AOV-2	AIR OPERATED VALVE, RECIRCULATION	21718648	HABONIM NO 05 C47W-666MAAA/XBW10-6.0W/ACT MT21S4-LT-FO	1/2" PS
AOV-3	AIR OPERATED VALVE, FORCE FEED	21718649	HABONIM NC 05 C47W-666MAAA/XBW10-6.0W/ACT MT21S4-LT	1/2" PS
CV-2	CHECK VALVE, PBC-1 OUTLET	20896229	GENERANT CV-1000B-T-.15	1" FPT
CV-4	CHECK VALVE, DISPENSE HOSE DRAIN	11051090	GENERANT CV-503B-T-5 O2 CLEAN	1/2" FPT
CV-7	CHECK VALVE, RECIRCULATION	11051090	GENERANT CV-503B-T-5 O2 CLEAN	1/2" FPT
CV-8	CHECK VALVE, LIQUID FEED	15094361	HEROSE 05416.4048.0002	1-1/2" PS
DC-1	CONNECTION, DISPENSE	SO OPTION	PER ORDER	-24 JIC 37° FLARE
DC-2	CONNECTION, FILL LINE	SO OPTION	PER ORDER	CGA
DC-3	CONNECTION, VAPOR RECOVERY	SO OPTION	PER ORDER	CGA
DC-4	CONNECTION, LIQUID SAMPLE	-	CHART STANDARD	1/2" FPT
DC-5	CONNECTION, GAS SAMPLE	-	CHART STANDARD	1/2" FPT
DP-3	DIFFERENTIAL TRANSMITTER	22450495	YOKOGAWA EJX110A-JMS5G-712DN/V1U1/D3/K6/CA + M1100UT	1/4" FPT
LI-1	LEVEL INDICATOR, INNER VESSEL	20890787	WIKA 52707799 0-100"H2O & 0-65 PSI	1/4" FPT
M-1	METER, DISPENSE	FL1174810	FLOW SWM48.3X2.9-18.5-1895-DP18-00	-
OR-1	ORIFICE, FORCE FEED	20898255	MCMASTER #2712T47-2712T659 (∅.125 ORIFICE)	1/2" MPT X 1/2" FPT
P-1	PUMP, SUBMERGED 4 STAGE	13800197	ACD MODEL #54715-3	-
PBC-1	PRESSURE BUILDING COIL	SO OPTION	CHART ORCA FLAT FIN, STAINLESS OR ALUMINUM	-
PI-1	PRESSURE INDICATOR, INNER VESSEL	20890787	WIKA 52707799 0-100"H2O & 0-65 PSI	1/4" FPT
PI-2	PRESSURE INDICATOR, PUMP DISCHARGE	20860869	WIKA 52718748 (212.53) (0-600 PSI)	1/4" MPT
PI-3	PRESSURE INDICATOR, INNER VESSEL	21041492	WIKA 52743715 (212.53) (0-50 PSI)	1/4" MPT
PT-1	PRESSURE TRANSMITTER, INNER VESSEL	21974539	YOKOGAWA EJA530E-JBS4N-012DL/CU1/D3/K6/CA + M1100UT	1/2" FPT
PT-2	PRESSURE TRANSMITTER, PUMP DISCHARGE	22450496	YOKOGAWA EJX530A-JCS4N-012DL/V1U1/D3/K6/CA + M1100UT	1/2" FPT
PT-3	PRESSURE TRANSMITTER, PUMP DISCHARGE LOW	22450496	YOKOGAWA EJX530A-JCS4N-012DL/V1U1/D3/K6/CA + M1100UT	1/2" FPT
RTD-1	RESISTANCE TEMPERATURE DEVICE, LIQUID FEED	FL1145110	FLOW #PT100	-
PCV-1	PRESSURE CONTROL VALVE, INNER VESSEL RELIEF	1720412	AW CASH FRM-2 #10673 B31.3	1/2" FPT
PSE-1	PRESSURE SAFETY ELEMENT, OUTER VESSEL	10899110	CHART STANDARD	-
S-1	STRAINER, FILL	20902507	STRAINER SS FOR 2.00 ASSY 2-1/8"OD X 3-3/4"LG	-
SV-1A	SAFETY RELIEF VALVE, VENT CIRCUIT	22256399	HEROSE #06420.1812.6000 ASME (SET 50 PSI)	1-1/4" MPTX1-1/2" FPT
SV-1B	SAFETY RELIEF VALVE, VENT CIRCUIT	22256400	HEROSE #06420.1812.6000 ASME (SET 55 PSI)	1-1/4" MPTX1-1/2" FPT
TSV-3	THERMAL SAFETY RELIEF VALVE, DISPENSE	22236426	REGO #PRV9434TP600P	1/4" MPT X 3/8"FPT
TSV-4	THERMAL SAFETY RELIEF VALVE, FILL LINE	11761083	REGO #PRV9434TP400P	1/4" MPT X 3/8"FPT
TSV-5	THERMAL SAFETY RELIEF VALVE, DISPENSE HOSE	22236426	REGO #PRV9434TP600P	1/4" MPT X 3/8"FPT
TSV-6	THERMAL SAFETY VALVE, DISPENSE CONNECTION	13618395	NUPRO SS-4CPA2-350-SC-11	1/4" MPT
TSV-6X	THERMAL SAFETY VALVE, DISPENSE EXT CONNECTION	13618395	NUPRO SS-4CPA2-350-SC-11	1/4" MPT
TC-1	THERMOCOUPLE, VACUUM	4210049	HASTINGS 14156715 #DV-6R	1/4" MPT
TRAN-1	HOSE, DISPENSE	SO OPTION	TRANSFER HOSE 1-1/4"ID W/O LINER 1-1/2"MPTX1"MPT	1-1/2" MPTX1" MPT
TRAN-1X	HOSE, DISPENSE EXTENSION	SO OPTION	TRANSFER HOSE 1"ID W/O LINER 1"MPTX1"MPT	1" MPTX1" MPT
V-2	VALVE, INNER VESSEL RELIEF	1718802	REGO BK8404T EXTENDED PACKING	1/2" FPT
V-3	VALVE, TOP FILL	21718647	HABONIM 20 C47W-666MAAA/BW10-6.0 W/LVR	2" PS
V-5	VALVE, VAPOR VENT	13410261	HEROSE 01321.4048.0016	1-1/2" PS
V-9	VALVE, FILL LINE DRAIN	11625639	REGO #BK9454	1/2" FPT
V-10	VALVE, LI-1 EQUALIZATION	20890787	WIKA 52707799 0-100"H2O & 0-65 PSI	1/4" FPT
V-11	VALVE, LI-1 VAPOR PHASE	20890787	WIKA 52707799 0-100"H2O & 0-65 PSI	1/4" FPT
V-12	VALVE, LI-1 LIQUID PHASE	20890787	WIKA 52707799 0-100"H2O & 0-65 PSI	1/4" FPT
V-13	VALVE, PI-2	14817177	REGO CMM250G B31.3	1/4" MPT
V-14	VALVE, PI-3	11701435	WHITEY SS-1VS4-SC-11	1/4" ODT
V-17	VALVE, BOTTOM FILL	21718647	HABONIM 20 C47W-666MAAA/BW10-6.0 W/LVR	2" PS
V-18	VALVE, FULL TRYCOCK 95%	11625639	REGO #BK9454	1/2" FPT
V-23	VALVE, LIQUID SAMPLE	10502848	REGO #T9454 SHORT STEM	1/2" FPT
V-24	VALVE, GAS SAMPLE	10502848	REGO #T9454 SHORT STEM	1/2" FPT
V-31	VALVE, VAPOR PHASE	10907239	REGO CMM250A B31.3	1/4" MPT
V-32	VALVE, LIQUID PHASE	10907239	REGO CMM250A B31.3	1/4" MPT
V-41	VALVE, DISPENSE	11007881	WORCHESTER 1NC4416PM-SE-V32 W/OVAL HANDLE B31.3	1" FPT
V-41X	VALVE, DISPENSE EXTENSION	11007881	WORCHESTER 1NC4416PM-SE-V32 W/OVAL HANDLE B31.3	1" FPT
V-44	VALVE, VAPOR RECOVERY	SO OPTION	PER ORDER	1-1/2" FPT
V-99	VALVE, TC-1	10482381	HOKE 4111L2B4111L2BHPS-18 BRS	1/8" MPT X 1/8" FPT
VP-1	VACUUM PORT, OUTER VESSEL	10826172	CHART STANDARD	3-1/2" DIA

PNEUMATIC PIPING LEGEND				
TAG DEFINITION		CHART P/N	VENDOR INFORMATION	SIZE
AI-1	AIR INTERLOCK, ANTI-TOW	10469961	OPW 0064-300	1/4" FPT
AI-2	AIR INTERLOCK, 12V	10469961	OPW 0064-300	1/4" FPT
ASF-1	FILTER, AIR SUPPLY	21194902	SCFM 211999-0390	1/4" FPT
DV-1	DUMP VALVE, AOV-1 / AOV-2 EXHAUST	21036304	HARTFIEL VSC-544-04	1/4" FPT
PI-4	PRESSURE INDICATOR, AIR SUPPLY	20937291	WIKA 4252951	1/4" MPT
SV207	SOLENOID VALVE, DISPENSE	21198811	MANIFOLD MAC 9-1107471	1/4" FPT
SV209	SOLENOID VALVE, RECIRCULATION			
SV211	SOLENOID VALVE, FORCE FEED			
SW-1	POWER TO FLOWCOM AIR SWITCH			1/4" FPT
V-51	VALVE, AOV-1 OVER RIDE	11809868	APOLLO 70-601-01	1/4" FPT
V-52	VALVE, AOV-2 OVER RIDE	11809868	APOLLO 70-601-01	1/4" FPT
V-53	VALVE, AOV-3 OVER RIDE	11809868	APOLLO 70-601-01	1/4" FPT

Liquid Level Chart 2000 Gallon Inert Service (LN_2/LAR)

Argon - 15 psig						
Level	Volume		Weight		Gas Volume	
In H_2O	Gal	Ltr	Lbs	Kg	SCF	NM^3
0	0	0	0	0	0	0
3	13	49	339	154	3275	86
6	43	163	675	306	6524	171
9	83	314	1128	512	10,908	287
12	132	500	1673	759	16,184	425
15	188	712	2296	1041	22,205	584
18	249	943	2984	1354	28,862	759
21	316	1196	3729	1691	36,068	948
24	387	1465	4524	2052	43,749	1150
27	462	1749	5360	2431	51,841	1363
30	540	2044	6233	2827	60,283	1585
33	621	2351	7137	3237	69,022	1814
36	704	2665	8066	3659	78,006	2051
39	789	2987	9015	4089	87,185	2292
42	875	3312	9979	4526	96,512	2537
45	963	3645	10,954	4969	105,940	2785
48	1050	3975	11,935	5414	115,425	3034
51	1138	4308	12,917	5859	124,921	3284
54	1226	4641	13,895	6303	134,382	3532
57	1313	4970	14,865	6743	143,764	3779
60	1398	5292	15,822	7177	153,021	4022
63	1482	5610	16,762	7603	162,106	4261
66	1564	5920	17,678	8019	170,971	4494
69	1644	6223	18,567	8422	179,564	4720
72	1720	6511	19,422	8810	187,834	4938
75	1793	6787	20,238	9180	195,723	5145
78	1862	7048	21,008	9529	203,169	5341
81	1926	7291	21,725	9854	210,103	5523
81.1 (90%)	1929	7302	21,754	9867	210,383	5530
84	1985	7514	22,381	10,152	216,446	5690
86.9 (95%)	2036	7707	22,953	10,411	221,981	5835
87	2037	7711	22,965	10,417	222,100	5838
90	2082	7881	23,466	10,644	226,941	5965
93	2118	8018	23,863	10,824	230,784	6067
96	2141	8105	24,120	10,941	233,266	6132
99	2143	8112	24,152	10,955	233,578	6140

Nitrogen - 15 psig						
Level	Volume		Weight		Gas Volume	
In H_2O	Gal	Ltr	Lbs	Kg	SCF	NM^3
0	0	0	0	0	0	0
2	14	53	252	114	3473	91
4	51	193	488	221	6742	177
6	101	382	811	368	11,191	294
8	162	613	1199	544	16,555	435
10	231	874	1643	745	22,671	596
12	307	1162	2131	967	29,420	773
14	389	1473	2659	1206	36,703	965
16	476	1802	3219	1460	44,437	1168
18	567	2146	3807	1727	52,547	1381
20	662	2506	4417	2004	60,964	1603
22	760	2877	5044	2288	69,624	1830
24	859	3252	5685	2579	78,465	2063
26	960	3634	6334	2873	87,427	2298
28	1062	4020	6988	3170	96,452	2535
30	1164	4406	7642	3466	105,483	2773
32	1265	4789	8293	3762	114,462	3009
34	1365	5167	8935	4053	123,331	3242
36	1463	5538	9566	4339	132,030	3471
38	1558	5898	10,179	4617	140,499	3693
40	1650	6246	10,771	4886	148,674	3908
42	1738	6579	11,338	5143	156,487	4114
44	1821	6893	11,873	5385	163,864	4307
46	1899	7188	12,369	5610	170,724	4488
46.8 (90%)	1929	7302	12,564	5699	173,419	4559
48	1969	7453	12,822	5816	176,972	4652
50	2031	7688	13,222	5997	182,493	4797
50.2 (95%)	2036	7707	13,254	6012	182,944	4809
52	2083	7885	13,558	6150	187,136	4919
54	2123	8036	13,814	6266	190,665	5012
56	2143	8112	13,944	6325	192,469	5059

Liquid Level Chart 2800 Gallon Inert Service (LN_2/LAR)

Argon - 15 psig						
Level	Volume		Weight		Gas Volume	
In H_2O	Gal	Ltr	Lbs	Kg	SCF	NM^3
0	0	0	0	0	0	0
3	18	68	464	210	4484	118
6	59	223	929	421	8986	236
9	115	435	1552	704	15,009	395
12	182	689	2297	1042	22,216	584
15	258	977	3143	1426	30,401	799
18	341	1291	4076	1849	39,416	1036
21	431	1632	5081	2305	49,144	1292
24	527	1995	6151	2790	59,486	1564
27	627	2373	7275	3300	70,358	1849
30	732	2771	8446	3831	81,680	2147
33	840	3180	9656	4380	93,381	2455
36	951	3600	10,898	4943	105,396	2770
39	1065	4031	12,166	5518	117,660	3093
42	1180	4467	13,454	6103	130,113	3420
45	1297	4910	14,755	6693	142,696	3751
48	1414	5353	16,063	7286	155,350	4084
51	1531	5795	17,373	7880	168,018	4417
54	1648	6238	18,678	8472	180,642	4748
57	1764	6677	19,973	9060	193,165	5078
60	1878	7109	21,252	9640	205,529	5403
63	1990	7533	22,507	10,209	217,673	5722
66	2100	7949	23,734	10,766	229,535	6034
69	2207	8354	24,925	11,306	241,051	6336
72	2309	8741	26,072	11,826	252,151	6628
75	2407	9111	27,170	12,324	262,761	6907
78	2500	9464	28,208	12,795	272,800	7171
81	2587	9793	29,177	13,234	282,176	7417
81.3 (90%)	2596	9827	29,274	13,278	283,116	7442
84	2667	10,096	30,067	13,638	290,781	7644
87	2738	10,364	30,863	13,999	298,485	7846
87.1 (95%)	2740	10,372	30,886	14,010	298,709	7852
90	2799	10,595	31,549	14,310	305,116	8020
93	2848	10,781	32,097	14,559	310,417	8160
96	2880	10,902	32,455	14,721	313,876	8251
99	2884	10,917	32,500	14,742	314,316	8262

Nitrogen - 15 psig						
Level	Volume		Weight		Gas Volume	
In H_2O	Gal	Ltr	Lbs	Kg	SCF	NM^3
0	0	0	0	0	0	0
2	20	76	344	156	4744	125
4	71	269	671	304	9267	244
6	140	530	1113	505	15,368	404
8	222	840	1643	745	22,677	596
10	316	1196	2244	1018	30,971	814
12	418	1582	2904	1317	40,087	1054
14	529	2002	3615	1640	49,895	1312
16	646	2445	4368	1981	60,284	1585
18	768	2907	5155	2338	71,155	1870
20	895	3388	5971	2708	82,420	2167
22	1026	3884	6810	3089	93,995	2471
24	1159	4387	7665	3477	105,800	2781
26	1293	4895	8532	3870	117,761	3096
28	1429	5409	9404	4266	129,802	3412
30	1565	5924	10,277	4662	141,850	3729
32	1700	6435	11,145	5055	153,832	4044
34	1833	6939	12,003	5444	165,673	4355
36	1964	7435	12,845	5826	177,299	4661
38	2092	7919	13,666	6199	188,630	4958
40	2215	8385	14,460	6559	199,585	5246
42	2333	8831	15,220	6904	210,075	5522
44	2445	9255	15,939	7230	220,004	5783
46	2549	9649	16,610	7534	229,265	6027
46.9 (90%)	2596	9827	16,908	7669	233,373	6135
48	2645	10,012	17,224	7813	237,730	6249
50	2729	10,330	17,768	8059	245,245	6447
50.3 (95%)	2740	10,372	17,836	8090	246,179	6471
52	2801	10,603	18,229	8269	251,603	6614
54	2856	10,811	18,582	8429	256,476	6742
56	2884	10,917	18,764	8511	258,998	6808

Liquid Level Chart 3300 Gallon Inert Service (LN_2/LAR)

Argon - 15 psig						
Level	Volume		Weight		Gas Volume	
In H_2O	Gal	Ltr	Lbs	Kg	SCF	NM^3
0	0	0	0	0	0	0
3	21	79	550	249	5323	140
6	71	269	1106	502	10,694	281
9	137	519	1846	837	17,855	469
12	216	818	2730	1238	26,400	694
15	306	1158	3731	1692	36,086	949
18	405	1533	4833	2192	46,737	1229
21	511	1934	6019	2730	58,214	1530
24	623	2358	7280	3302	70,403	1851
27	742	2809	8603	3902	83,202	2187
30	865	3274	9980	4527	96,521	2537
33	992	3755	11,403	5172	110,278	2899
36	1123	4251	12,862	5834	124,395	3270
39	1256	4754	14,352	6510	138,799	3649
42	1392	5269	15,864	7196	153,421	4033
45	1528	5784	17,391	7888	168,191	4421
48	1666	6306	18,927	8585	183,043	4812
51	1803	6825	20,464	9282	197,911	5202
54	1940	7344	21,996	9977	212,730	5592
57	2076	7859	23,516	10,667	227,432	5978
60	2211	8370	25,018	11,348	241,951	6360
63	2343	8869	26,493	12,017	256,217	6735
66	2472	9358	27,934	12,671	270,158	7102
69	2597	9831	29,335	13,306	283,701	7458
72	2718	10,289	30,685	13,918	296,764	7801
75	2833	10,724	31,978	14,505	309,262	8129
78	2943	11,140	33,202	15,060	321,099	8441
81	3045	11,527	34,346	15,579	332,168	8732
81.4 (90%)	3058	11,576	34,490	15,644	333,562	8768
84	3139	11,882	35,398	16,056	342,343	8999
87	3224	12,204	36,342	16,484	351,469	9239
87.2 (95%)	3228	12,219	36,389	16,506	351,924	9251
90	3297	12,481	37,156	16,854	359,342	9446
93	3355	12,700	37,809	17,150	365,654	9612
96	3393	12,844	38,236	17,344	369,790	9720
99	3398	12,863	38,291	17,369	370,320	9734

Nitrogen - 15 psig						
Level	Volume		Weight		Gas Volume	
In H_2O	Gal	Ltr	Lbs	Kg	SCF	NM^3
0	0	0	0	0	0	0
2	24	91	408	185	5626	148
4	85	322	798	362	11,018	290
6	167	632	1323	600	18,265	480
8	264	999	1951	885	26,923	708
10	375	1420	2661	12074	36,727	965
12	496	1878	3440	1560	47,486	1248
14	626	2370	4278	1940	59,045	1552
16	764	2892	5164	2342	71,276	1874
18	908	3437	6090	2762	84,062	2210
20	1057	4001	7050	3198	97,302	2558
22	1210	4580	8035	3645	110,899	2915
24	1366	5171	9039	4100	124,762	3280
26	1524	5769	10,056	4561	138,802	3649
28	1684	6375	11,080	5026	152,934	4020
30	1843	6977	12,105	5491	167,075	4392
32	2001	7575	13,124	5953	181,140	4762
34	2158	8169	14,131	6410	195,044	5127
36	2312	8752	15,120	6858	208,599	5486
38	2462	9320	16,085	7296	222,016	5836
40	2607	9869	17,018	7719	234,899	6175
42	2746	10,395	17,913	8125	247,246	6499
44	2878	10,894	18,761	8510	258,945	6807
46	3001	11,360	19,552	8869	269,871	7094
47.0 (90%)	3058	11,576	19,921	9036	274,955	7228
48	3114	11,788	20,277	9197	279,874	7357
50	3214	12,166	20,922	9490	288,773	7591
50.3 (95%)	3228	12,219	21,013	9531	290,036	7624
52	3299	12,488	21,468	9738	296,320	7789
54	3364	12,734	21,889	9929	302,125	7942
56	3398	12,863	22,108	10,028	305,145	8021

Storage Systems Division
Chart Industries, Inc.

407 Seventh Street NW
New Prague, MN 56017-1000, USA

ORCA 30HP GEN 2
CONTROL PANEL DRAWINGS

DWG#	DESCRIPTION	SHEETS
20903203	PANEL LAYOUT DRAWINGS	1 & 2
	ELECTRICAL DIAGRAMS	3 & 4
	PNEUMATIC DIAGRAM	5
	SNAP TERMINAL WIRING INSTRUCTIONS	6
	BILL OF MATERIAL	7

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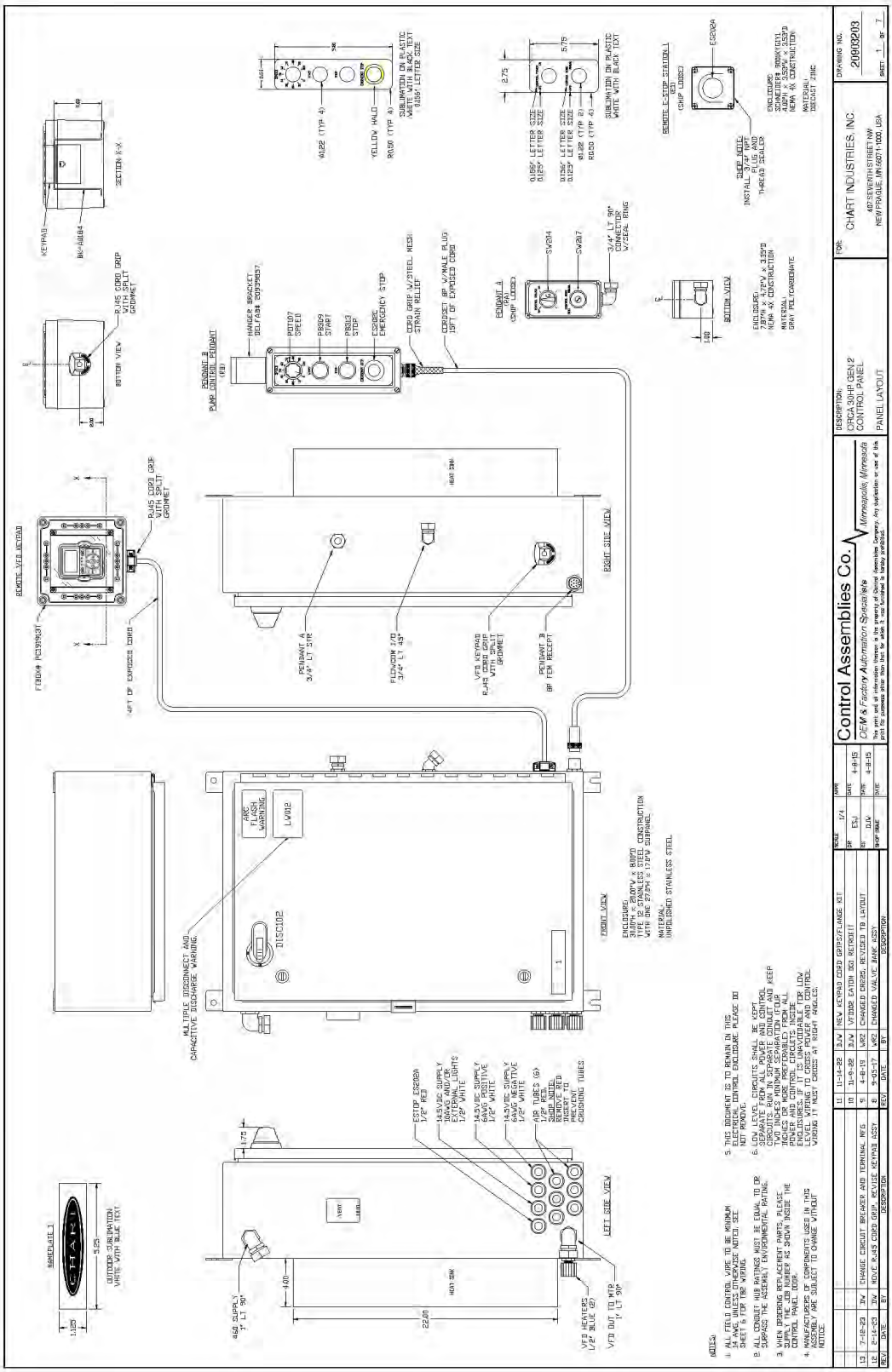
Fax : (763) 557-9646
www.controlassemblies.com


Control Assemblies Co.
OEM & Factory Automation Specialists
Minneapolis, Minnesota
DESCRIPTION:
ORCA 30HP GEN 2
CONTROL PANEL
PANEL LAYOUT
FOR:
CHART INDUSTRIES, INC
407 SEVENTH STREET NW
NEW PRAGUE, MN 56071-1000, USA
DRAWING NO.
2003203
SHEET 1 OF 7
CHART
OUTDOOR SUBMATION WHITE WITH BLACK TEXT
KEYPAD
BAY-A0884
PLUG CORD GRIP WITH SPLIT GROMMET
BOTTOM VIEW
SECTION X-X
YELLOW HALO
SUBLIMATION ON PLASTIC WHITE WITH BLACK TEXT
PENDANT A PUMP CONTROL PENDANT (FEB)
HANGER BRACKET BOLF484 20939857
POT107 SPEED
PB209 START
PB210 STOP
ES2020 EMERGENCY STOP
CORD GRIP W/STEEL MESH STRAIN RELIEF
CONDUIT BP W/MALE PLUG LEFT OF EXPOSED CORD
PENDANT A (SA) (CHIP LOCED)
SV204
CV207
3/4" LT 90° CONNECTOR W/SEAL RING
REMOTE E-STOP STATION L (CHIP LOCED)
ES2020
SUBLIMATION ON PLASTIC WHITE WITH BLACK TEXT
SUMP NOTE: INSTALL 3/4" NPT THREAD PLUG AND THREAD SEALER
ENCLOSURE DIMENSIONS 20.00"W x 32.50"H x 13.50"D NEMA 4X CONSTRUCTION
MATERIAL: DIECAST ZINC
ENCLOSURE 20.00"W x 32.50"H x 13.50"D NEMA 4X CONSTRUCTION
MATERIAL: GRAY POLYCARBONATE
REMOTE VFD MOUNT
FEB(V)# MC939937
RJ45 CORD GRIP WITH SPLIT GROMMET
4FT OF EXPOSED CORD
PENDANT A 3/4" LT 90°
FLEXCONN 1/2 3/4" LT 45°
VFD KEYPAD RJ45 CORD GRIP WITH SPLIT GROMMET
PENDANT B 90° ITEM RECEPT
RIGHT SIDE VIEW
MULTIPLE DISCONNECT AND CAPACITIVE DISCHARGE WARNING.
ARC FLASH WARNING
LV102
DISC102
FRONT VIEW
ENCLOSURE 20.00"W x 60.00"H x 8.00"D TYPE 12 STAINLESS STEEL CONSTRUCTION WITH ONE 27.94"H x 17.19"W SUBPANEL
MATERIAL: UNPOLISHED STAINLESS STEEL
ESTOP ES2020 1/2" RED
14.5VDC SUPPLY 6AWG AND/OR EQUIVALENT WIRE LIGHTS 1/2" WHITE
14.5VDC SUPPLY 6AWG POSITIVE 1/2" WHITE
14.5VDC SUPPLY 14AWG NEGATIVE 1/2" WHITE
AIR TUBES (6) 1/2" RED REMOVABLE PLUGS INSERT TO PREVENT CRUSHING TUBES
LEFT SIDE VIEW
VENT
LOAD
HOA SW
460 SUPPLY 1" LT 90°
VFD HEATERS (1/2" BLUE QT)
VFD OUT TO MTR 1" LT 90°
NOTES:
1. ALL FIELD CONTROL WIRE TO BE MINIMUM 14 AWG, UNLESS OTHERWISE NOTED. SEE SHEET 6 FOR TBP WIRING.
2. ALL CONDUIT HUB RATINGS MUST BE EQUAL TO OR SUPPASS THE ASSEMBLY ENVIRONMENTAL RATING.
3. WHEN ORDERING REPLACEMENT PARTS, PLEASE SUPPLY THE SERIAL NUMBER AS SHOWN INSIDE THE CONTROL PANEL DOOR.
4. MANUFACTURERS OF COMPONENTS USED IN THIS ASSEMBLY ARE SUBJECT TO CHANGE WITHOUT NOTICE.
5. THIS DOCUMENT IS TO REMAIN IN THIS ELECTRICAL CONTROL ENCLOSURE. PLEASE DO NOT REMOVE.
6. LOW LEVEL CIRCUITS SHALL BE CLASS 2 OR CLASS 3 POWER AND CONTROL CIRCUITS. RUN IN SEPARATE CONDUIT AND KEEP 3" MIN. CLEARANCE FROM LINE VOLTAGE WIRING.
7. ALL CUTOUTS ARE PREFORMED FROM KLP. PLEASE USE CARE WHEN CUTTING TO AVOID DAMAGE TO THE POWER AND CONTROL CIRCUITS INSIDE.
8. PROVIDE 3" MIN. CLEARANCE FOR LOW LEVEL WIRING TO CROSS POWER AND CONTROL WIRING IT MUST CROSS AT RIGHT ANGLES.
REV# DATE BY DESCRIPTION
13 7-18-20 JW CHANGE CIRCUIT BREAKER AND TERMINAL #15
12 6-14-19 JW MOVE RJ45 CORD GRIP, REVISE KEYPAD 1057
11 11-14-22 JW HEV KEYPAD CORD GRIPS/FLANGE KIT
10 11-6-20 JW VFD/HE EATON 360 RETROFIT
9 4-18-19 WR2 CHANGED CROSS, REVISED TB LAYOUT
8 4-23-17 WR2 CHANGED VALVE BANK ASSY
SCALE 1/4
DR ESJ DATE 4-8-15
BY DLW DATE 4-8-15
SHOP ISSUE DATE
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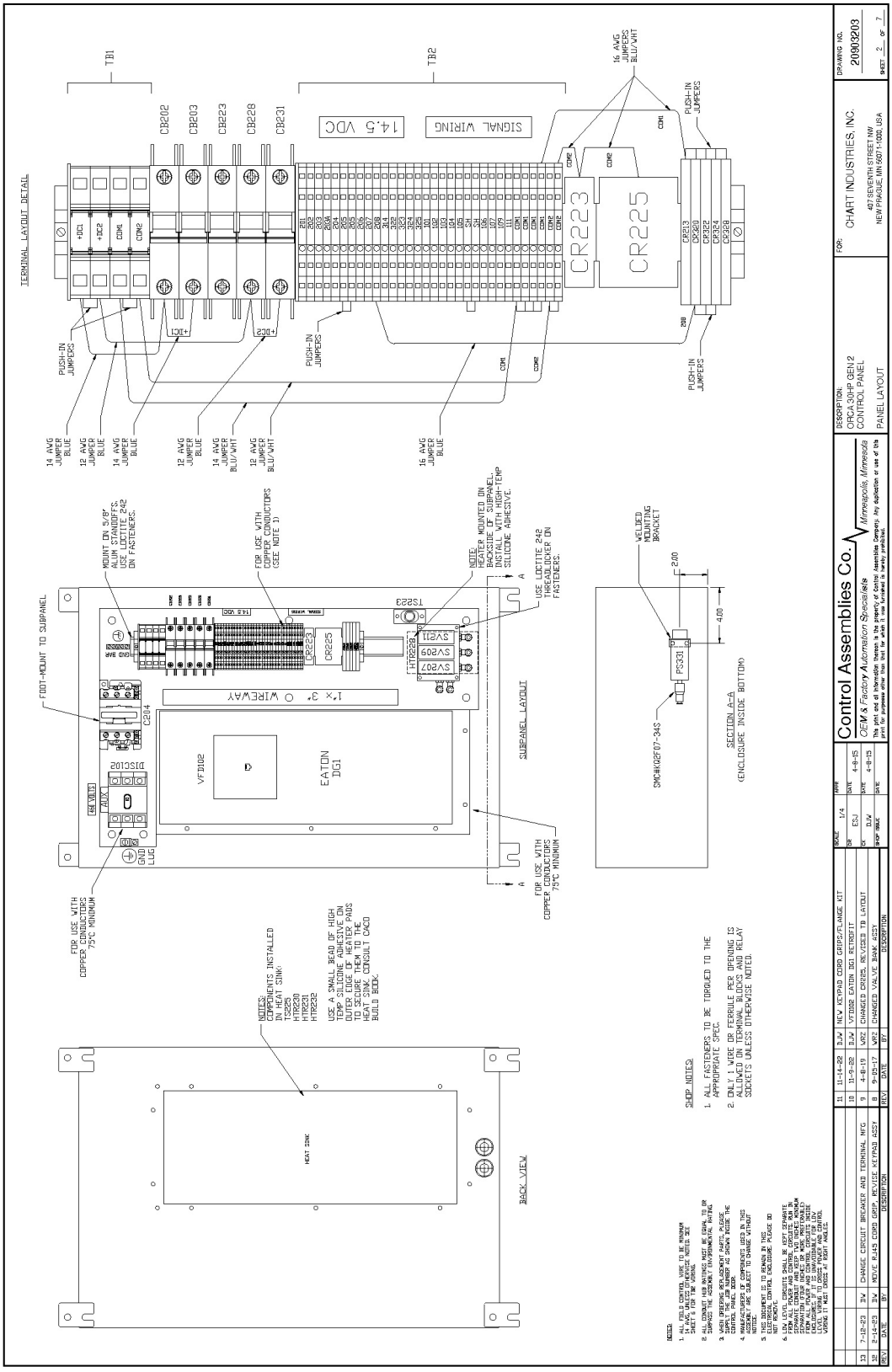
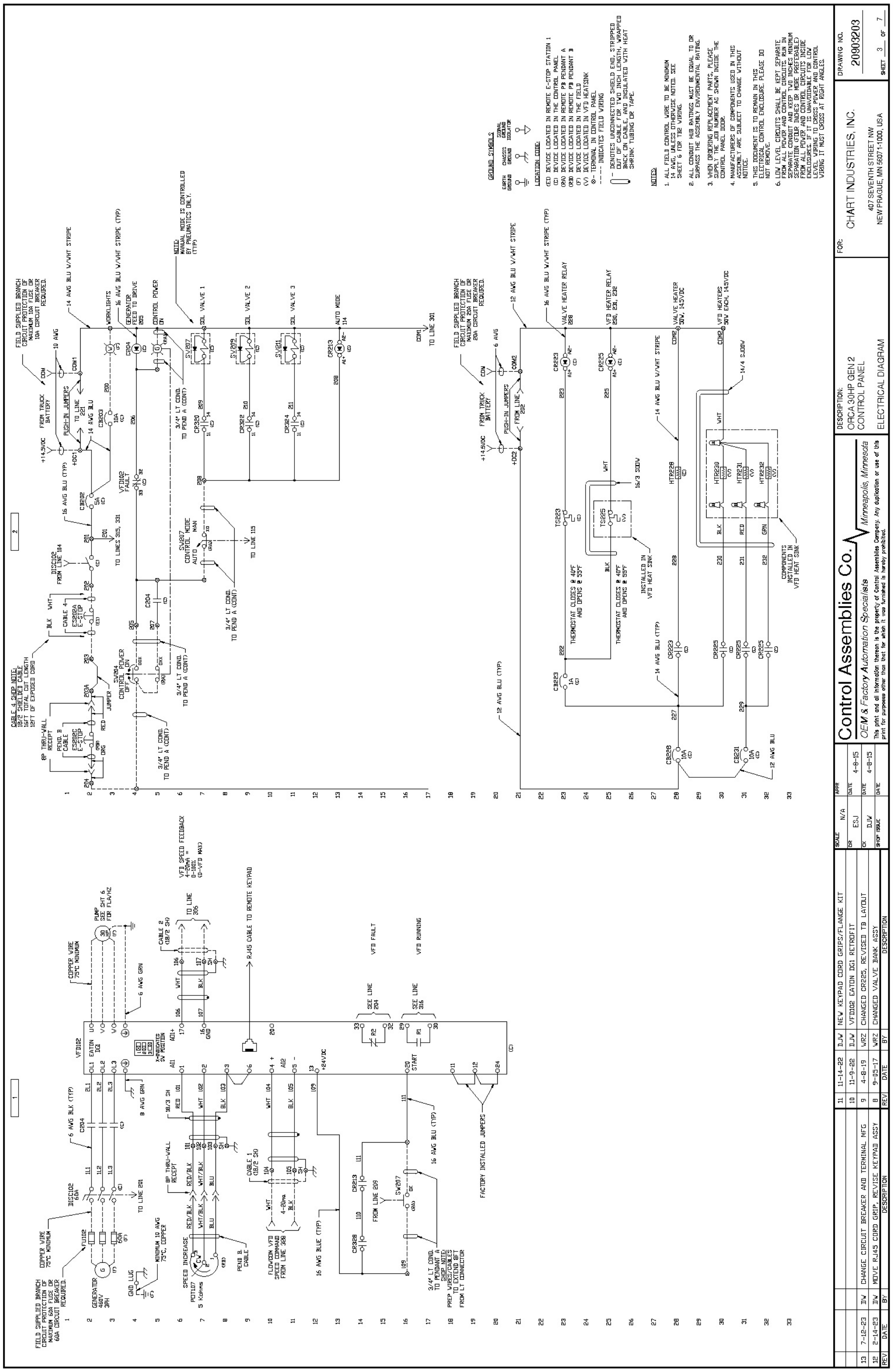

TERMINAL LAYOUT DETAIL
TB1
TB2
CB202
CB203
CB223
CB228
CB231
14.5 VDC
SIGNAL WIRING
CR223
CR225
16 AWG JUMPERS BLU/WHT
PUSH-IN JUMPERS
14 AWG JUMPER BLUE
12 AWG JUMPER BLUE
14 AWG JUMPER BLU/WHT
12 AWG JUMPER BLU/WHT
16 AWG JUMPER BLUE
FOOT-MOUNT TO SUBPANEL
MOUNT ON 5/8" ALUM STANDOFFS. USE LOCTITE 242 ON FASTENERS.
FOR USE WITH COPPER CONDUCTORS (SEE NOTE 1)
NOTE: HEATER MOUNTED ON BACKSIDE OF SUBPANEL. INSTALL WITH HIGH-TEMP SILICONE ADHESIVE.
USE LOCTITE 242 THREADLOCKER ON FASTENERS.
TS223
HTR228
SV211
SV209
SV207
1"x 3" WIREWAY
C204
DISC102
VFD102
EATON DG1
SUBPANEL LAYOUT
FOR USE WITH COPPER CONDUCTORS 75°C MINIMUM
WELDED MOUNTING BRACKET
PS331
SMC#KR2F07-34S
SECTION A-A (ENCLOSURE INSIDE BOTTOM)
NOTES: COMPONENTS INSTALLED IN HEAT SINK: TS225 HTR230 HTR231 HTR232
USE A SMALL BEAD OF HIGH TEMP SILICONE ADHESIVE ON OUTER EDGE OF HEATER PADS TO SECURE THEM TO THE HEAT SINK. CONSULT CACO BUILD BOOK.
HEAT SINK
BACK VIEW
SHOP NOTES:
1. ALL FASTENERS TO BE TORQUED TO THE APPROPRIATE SPEC.
2. ONLY 1 WIRE OR FERRULE PER OPENING IS ALLOWED ON TERMINAL BLOCKS AND RELAY SOCKETS UNLESS OTHERWISE NOTED.
NOTES:
1. ALL FIELD CONTROL WIRE TO BE MINIMUM 14 AWG, UNLESS OTHERWISE NOTED. SEE SHEET 6 FOR TRIP WORK.
2. ALL CONDUIT HAS RATINGS MUST BE EQUAL TO OR SUPPLY THE ASSEMBLY. ENVIRONMENTAL RATING SHOWN IS THE ASSEMBLY.
3. WHEN ORDERING REPLACEMENT PARTS, PLEASE CONTACT THE CHART SUPPLY SHOWN IN THE CONTROL PANEL BOOK.
4. MANUFACTURER'S COMPONENTS USED IN THIS ASSEMBLY ARE SUBJECT TO CHANGE WITHOUT NOTICE.
5. THIS DOCUMENT IS TO REMAIN IN THIS ELECTRICAL CONTROL ENCLOSURE. PLEASE DO NOT REMOVE.
6. LOW LEVEL CIRCUITS SHALL BE KEPT SEPARATE FROM ALL FUSES AND CONTROL CIRCUITS. ONLY SEPARATE CONDUIT AND KEEP TWO INCHES MINIMUM SEPARATION FOR ONCE OR MORE PREFERABLE. THIS PANEL ALSO CONTAINS CIRCUITS WHICH ARE INTERCONNECTED. ONLY THE INSTALLATION OF THE CONTROL CIRCUITS IS IT IS CONVENIENT FOR LOW LEVEL WIRING TO CROSS THEM AND CONTROL WIRING IT MUST CROSS AT RIGHT ANGLES.
Control Assemblies Co.
OEM & Factory Automation Specialists
Minneapolis, Minnesota
This print and all information thereon is the property of Control Assemblies Company. Any duplication or use of this print for purposes other than that for which it was furnished is hereby prohibited.
DESCRIPTION: ORCA 30HP GEN 2 CONTROL PANEL
PANEL LAYOUT
FOR: CHART INDUSTRIES, INC.
407 SEVENTH STREET NW
NEW PRAGUE, MN 56071-1000, USA
DRAWING NO. 20903203
SHEET 2 OF 7
SCALE 1/4
DR ESJ DATE 4-8-15
CK DJW DATE 4-8-15
SHOP ISSUE DATE
REV DATE BY DESCRIPTION
11 11-14-22 DJW NEW KEYPAD CORD GRIPS/FLANGE KIT
10 11-9-22 DJW VFD102 EATON DG1 RETROFIT
9 4-8-19 WRZ CHANGED CR225, REVISED TB LAYOUT
8 9-05-17 WRZ CHANGED VALVE BANK ASSY
13 7-12-23 DJW CHANGE CIRCUIT BREAKER AND TERMINAL MFG
12 2-14-23 DJW MOVE RJ45 CORD GRIP, REVISE KEYPAD ASSY


GROUND SYMBOLS
EARTH GROUND
CHASSIS GROUND
SIGNAL GROUND ISOLATOR
LOCATION CODE:
(ED) DEVICE LOCATED IN REMOTE E-STOP STATION 1
(C) DEVICE LOCATED IN THE CONTROL PANEL
(RA) DEVICE LOCATED IN REMOTE PB PENDANT A
(RB) DEVICE LOCATED IN REMOTE PB PENDANT B
(F) DEVICE LOCATED IN THE FIELD
(V) DEVICE LOCATED IN VFD HEATSINK
⊗- TERMINAL IN CONTROL PANEL
---- INDICATES FIELD WIRING
- DENOTES UNCONNECTED SHIELD END, STRIPPED OUT OF CABLE FOR TWO INCH LENGTH, WRAPPED BACK ON CABLE, AND INSULATED WITH HEAT SHRINK TUBING OR TAPE.
NOTES:
1. ALL FIELD CONTROL WIRE TO BE MINIMUM 14 AWG, UNLESS OTHERWISE NOTED. SEE SHEET 6 FOR TB2 WIRING.
2. ALL CONDUIT HUB RATINGS MUST BE EQUAL TO OR SURPASS THE ASSEMBLY ENVIRONMENTAL RATING.
3. WHEN ORDERING REPLACEMENT PARTS, PLEASE SUPPLY THE JOB NUMBER AS SHOWN INSIDE THE CONTROL PANEL DOOR.
4. MANUFACTURERS OF COMPONENTS USED IN THIS ASSEMBLY ARE SUBJECT TO CHANGE WITHOUT NOTICE.
5. THIS DOCUMENT IS TO REMAIN IN THIS ELECTRICAL CONTROL ENCLOSURE. PLEASE DO NOT REMOVE.
6. LOW LEVEL CIRCUITS SHALL BE KEPT SEPARATE FROM ALL POWER AND CONTROL CIRCUITS. RUN IN SEPARATE CONDUIT AND KEEP TWO INCHES MINIMUM SEPARATION (FOUR INCHES OR MORE PREFERABLE) FROM ALL POWER AND CONTROL CIRCUITS INSIDE ENCLOSURES. IF IT IS UNAVOIDABLE FOR LOW LEVEL WIRING TO CROSS POWER AND CONTROL WIRING IT MUST CROSS AT RIGHT ANGLES.
FIELD SUPPLIED BRANCH CIRCUIT PROTECTION OF MAXIMUM 60A FUSE OR 60A CIRCUIT BREAKER REQUIRED.
GENERATOR 460V 3PH
FU102 60A (F)
DISC102 60A
VFD102 EATON DG1
PUMP SEE SHT 6 FOR FLA/HZ
COPPER WIRE 75°C MINIMUM
6 AWG BLK (TYP)
6 AWG GRN
8 AWG GRN
GND LUG
MINIMUM 10 AWG 75°C, COPPER
SPEED INCREASE POT107 5 Kohms
PEND B. CABLE
8P THRU-WALL RECEPT
18/3 SH
CABLE 1 (18/2 SH)
CABLE 2 (18/2 SH)
FLOWCOM VFD SPEED COMMAND FROM LINE 328
VFD SPEED FEEDBACK 4-20mA = 0-100% (0-VFD MAX)
RJ45 CABLE TO REMOTE KEYPAD
X-INDICATES SW POSITION
VFD FAULT
VFD RUNNING
SEE LINE 204
SEE LINE 316
16 AWG BLUE (TYP)
16 AWG BLU (TYP)
FACTORY INSTALLED JUMPERS
3/4" LT COND. TO PENDANT A
SHOP NOTE: PREP WIRES/CABLES TO EXTEND 8FT FROM LT CONNECTOR
CABLE 4 SHOP NOTE: 18/2 SHIELDED CABLE 16FT TOTAL CUT LENGTH 12FT OF EXPOSED CORD
ES202A E-STOP
ES202C E-STOP
SW204 CONTROL POWER
SW207 CONTROL MODE AUTO MAN
FIELD SUPPLIED BRANCH CIRCUIT PROTECTION OF MAXIMUM 10A FUSE OR 10A CIRCUIT BREAKER REQUIRED.
FROM TRUCK BATTERY
+14.5VDC
PUSH-IN JUMPERS
14 AWG BLU W/WHT STRIPE
16 AWG BLU W/WHT STRIPE (TYP)
WORKLIGHTS
GENERATOR FEED TO DRIVE 205
CONTROL POWER ON
SOL VALVE 1
SOL VALVE 2
SOL VALVE 3
AUTO MODE 114
NOTE: MANUAL MODE IS CONTROLLED BY PNEUMATICS ONLY. (TYP)
TO LINE 301
FIELD SUPPLIED BRANCH CIRCUIT PROTECTION OF MAXIMUM 20A FUSE OR 20A CIRCUIT BREAKER REQUIRED.
12 AWG BLU W/WHT STRIPE
VALVE HEATER RELAY 228
VFD HEATER RELAY 230, 231, 232
VALVE HEATER 50W, 14.5VDC
VFD HEATERS 50W EACH, 14.5VDC
THERMOSTAT CLOSES @ 40°F AND OPENS @ 55°F
INSTALLED IN VFD HEAT SINK
COMPONENTS INSTALLED IN VFD HEAT SINK
14/4 SJOOW
16/3 SOOW
12 AWG BLU (TYP)
14 AWG BLU (TYP)
12 AWG BLU
11 | 11-14-22 | DJW | NEW KEYPAD CORD GRIPS/FLANGE KIT
10 | 11-9-22 | DJW | VFD102 EATON DG1 RETROFIT
9 | 4-8-19 | WRZ | CHANGED CR225, REVISED TB LAYOUT
8 | 9-05-17 | WRZ | CHANGED VALVE BANK ASSY
13 | 7-12-23 | DW | CHANGE CIRCUIT BREAKER AND TERMINAL MFG
12 | 2-14-23 | DW | MOVE RJ45 CORD GRIP, REVISE KEYPAD ASSY
REV DATE BY DESCRIPTION
SCALE N/A
DR ESJ DATE 4-8-15
CK DJW DATE 4-8-15
SHOP ISSUE
Control Assemblies Co. Minneapolis, Minnesota
OEM & Factory Automation Specialists
This print and all information thereon is the property of Control Assemblies Company. Any duplication or use of this print for purposes other than that for which it was furnished is hereby prohibited.
DESCRIPTION: ORCA 30HP GEN 2 CONTROL PANEL ELECTRICAL DIAGRAM
FOR: CHART INDUSTRIES, INC. 407 SEVENTH STREET NW NEW PRAGUE, MN 56071-1000, USA
DRAWING NO. 20903203
SHEET 3 OF 7

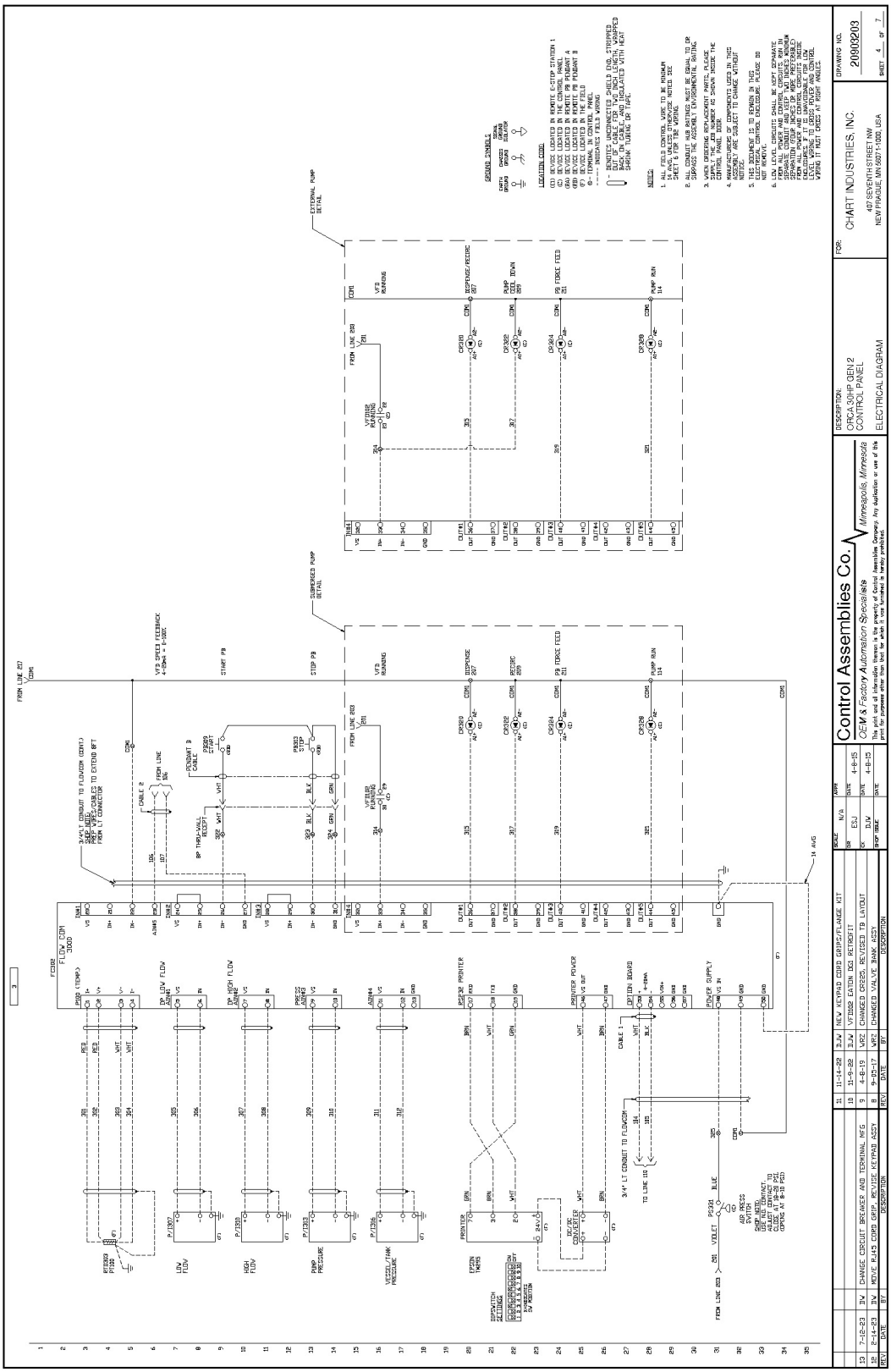
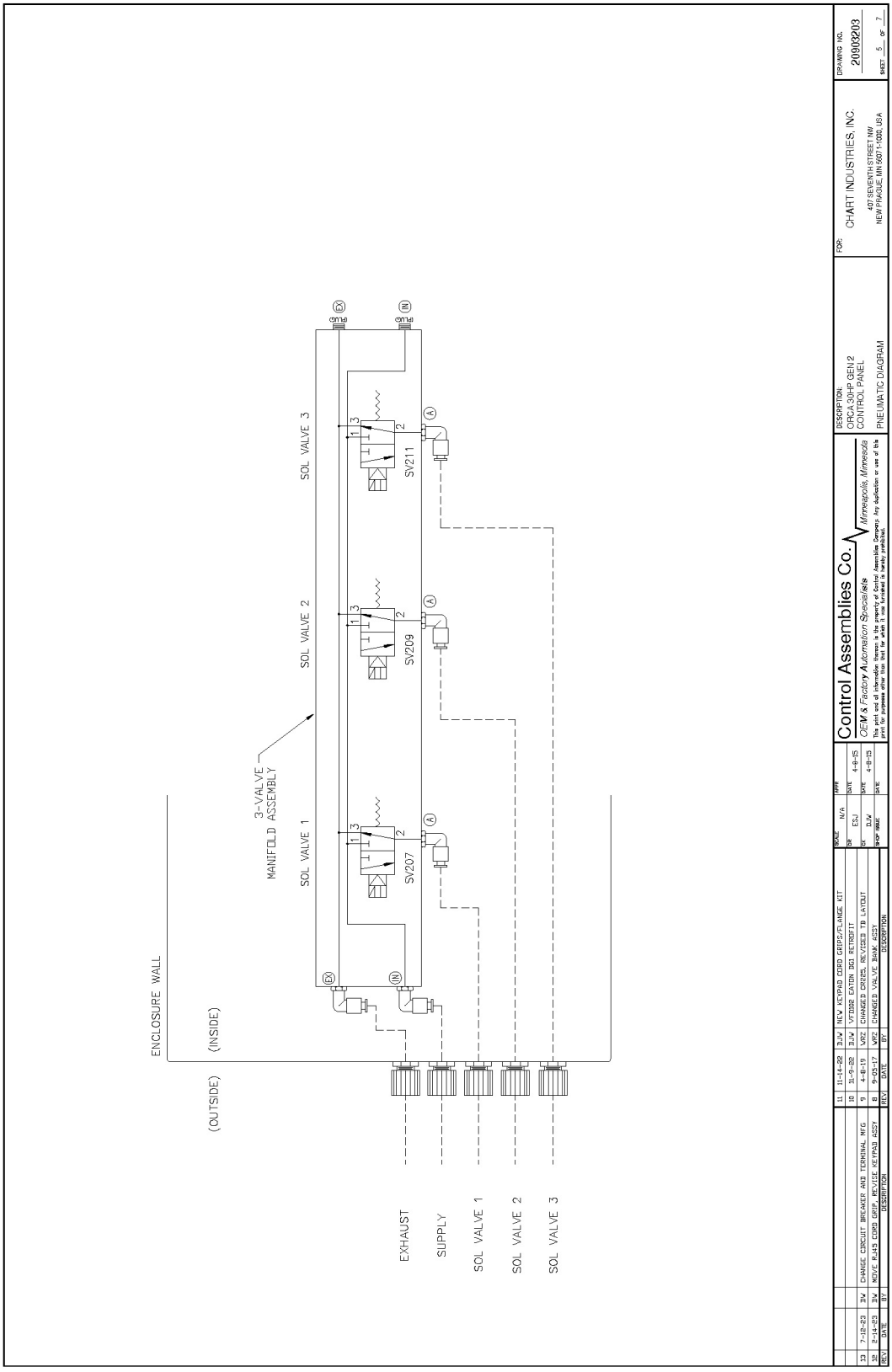


CHART INDUSTRIES, INC.
407 SEVENTH STREET NW
NEW PRAGUE, MINNESOTA 56071 USA
DRAWING NO. 20903203
SHEET 4 OF 7
DESCRIPTION: ORCA 30HP GEN 2 CONTROL PANEL
ELECTRICAL DIAGRAM
Control Assemblies Co.
Minneapolis, Minnesota
OEM & Factory Automation Specialists
This print and all information thereon is the property of Control Assemblies Company. Any duplication or use of this print for purposes other than that for which it was furnished is hereby prohibited.
REV DATE BY DESCRIPTION
13 7-12-23 JW CHANGE CIRCUIT BREAKER AND TERMINAL MFG
12 2-14-23 JW MOVE RJ45 CORD GRIP, REVISE KEYPAD ASSY
11 11-14-22 JLW NEW KEYPAD CORD GRIPS/FLANGE KIT
10 11-9-22 JLW VFD018 EATON DG1 RETROFIT
9 4-8-19 VPZ CHANGED DR285, REVISED TB LAYOUT
8 9-20-17 VPZ CHANGED VALVE BANK ASSY
SCALE N/A APPR
SB ESJ DATE 4-8-15
DK DJV DATE 4-8-15
STOP GRAF DATE
FROM LINE 217
COM
FLOW COM 3000
FLOW (TEMP)
LOW FLOW ALARM
HIGH FLOW ALARM
PRESS ALARM
ALARM
EPSON PRINTER
PRINTER POWER
EDITION BOARD
POWER SUPPLY
VFD SPEED FEEDBACK 4-20mA = 0-100%
START PB
STOP PB
VFD RUNNING
SUBMERGED PUMP DETAIL
EXTERNAL PUMP DETAIL
PUMP RUN 114
PB FORCE FEED 211
PUMP STOP 209
VFD RUNNING 203
VFD FAULT 208
VFD REFERENCE 207
PUMP RUN 209
3/4" LT CONDUIT TO FLOWCOM (CONT) PROP VFD CABLES TO EXTEND BFT FROM LT CONNECTION
PENDANT B CABLE
CABLE 2
FROM LINE 105
BP THRU-WALL RECEPT
TO LINE 105
TO LINE 110
3/4" LT CONDUIT TO FLOWCOM
CABLE 1
DC/DC CONVERTER
AIR PRESS SWITCH
VESSEL/TANK PRESSURE
PUMP PRESSURE
BP285 START
BP283 STOP
VFD018 ROMOTE KEYPAD
DP280 DP282 DP284 DP288
DP280 DP282 DP284 DP288
GROUND SYMBOLS
EARTH GROUND
CHASSIS GROUND
SIGNAL GROUND
LOCATION CODE:
(C) DEVICE LOCATED IN REMOTE E-STOP STATION 1
(D) DEVICE LOCATED IN REMOTE PB PENDANT A
(DA) DEVICE LOCATED IN REMOTE PB PENDANT A
(DB) DEVICE LOCATED IN REMOTE PB PENDANT B
(E) DEVICE LOCATED IN E-STOP BOX
(P) - TERMINAL IN CONTROL PANEL
----- INDICATES FIELD WIRING
NOTES:
1. ALL FIELD CONTROL WIRE TO BE MINIMUM 14 AWG UNLESS OTHERWISE NOTED. SEE SPECIFICATION MANUAL.
2. ALL CONDUIT RUN RATINGS MUST BE EQUAL TO OR SUPASS THE ASSEMBLY ENVIRONMENTAL RATING.
3. WHEN ORDERING REPLACEMENT PARTS, PLEASE REFERENCE THE PART NUMBER AS SHOWN ON THIS CONTROL PANEL DOOR.
4. MANUFACTURER OF COMPONENTS USED IN THIS CONTROL PANEL ASSEMBLY MAY CHANGE WITHOUT NOTICE.
5. THIS DIAGRAM IS TO BE USED IN THIS PROGRAMMING MANUAL PLEASE DO NOT MODIFY.
6. ALL LOW VOLTAGE CIRCUITS SHALL BE KEPT SEPARATE FROM ALL POWER AND CONTROL CIRCUITS. RUN IN SEPARATE CONDUIT AND/OR CABLE TRAY. ALL LOW VOLTAGE LEVEL WIRING TO LOCAL POWER AND CONTROL PANEL MUST BE RUN IN SEPARATE CONDUIT FROM ALL POWER AND CONTROL WIRING.


ENCLOSURE WALL
(OUTSIDE)
(INSIDE)
3-VALVE MANIFOLD ASSEMBLY
SOL VALVE 1
SOL VALVE 2
SOL VALVE 3
SV207
SV209
SV211
EXHAUST
SUPPLY
SOL VALVE 1
SOL VALVE 2
SOL VALVE 3
Control Assemblies Co.
Minneapolis, Minnesota
OEM & Factory Automation Specialists
DESCRIPTION: ORCA 30HP GEN 2 CONTROL PANEL
PNEUMATIC DIAGRAM
FOR: CHART INDUSTRIES, INC.
407 SEVENTH STREET NW
NEW PRAGUE, MN 56071-1600, USA
DRAWING NO. 20900203
SHEET 5 OF 7

TB2 WIRING INSTRUCTIONS

SIMPLE

Klippon® Connect with SNAP IN technology: For simple and intuitive operation

The new connection is as simple in principle as it is to use: The terminal blocks are delivered with pre-loaded spring. Stripped wires could be easily and safely inserted into the clamping point without further preparation. The conductor is contacted in the clamping point with a clear „Click". And it's just as fast the other way round. By pressing the pusher, the conductor can be quickly and easily released at any time and the clamping point pre-loaded again.



Step 1
The terminal blocks are delivered with pre-loaded spring. The status of the pre-loaded terminal block is signaled by the height position of the pusher.



Step 2
Stripped wires could be easily and safely inserted into the clamping point without further preparation.
For cable shields and 20-22AWG wire, twist strands before inserting.



Step 3
The conductor is contacted in the clamping point with a clear „Click". The triggered clamping point is additionally signaled visually by an increased pusher.



Step 4
By pressing the pusher, the conductor can be quickly and easily released at any time and the clamping point pre-loaded again.

REV	DATE	BY	DESCRIPTION
13	7-12-23	DW	CHANGE CIRCUIT BREAKER AND TERMINAL MFG
12	2-14-23	DW	MOVE RJ45 CORD GRIP, REVISE KEYPAD ASSY

REV	DATE	BY	DESCRIPTION
11	11-14-22	DJW	NEW KEYPAD CORD GRIPS/FLANGE KIT
10	11-9-22	DJW	VFD10R EATON DG1 RETROFIT
9	4-8-19	WRZ	CHANGED CR225, REVISED TB LAYOUT
8	9-05-17	WRZ	CHANGED VALVE BANK ASSY

		APPR
SCALE	N/A	
DR	ESJ	DATE 4-8-15
CK	DJW	DATE 4-8-15
SHOP ISSUE		DATE

Control Assemblies Co.
OEM & Factory Automation Specialists — *Minneapolis, Minnesota*

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DESCRIPTION:
ORCA 30HP GEN 2
CONTROL PANEL
TB2 WIRING INSTRUCTIONS

FOR:
CHART INDUSTRIES, INC.
407 SEVENTH STREET NW
NEW PRAGUE, MN 56071-1000, USA

DRAWING NO.
20903203
SHEET 6 OF 7

BILL OF MATERIALS

Tag	Description	Manfacturer	Manufacturer PN	Qty/ Tag	UM
C204	CONTACTOR 3P 12VDC 1 NO AUX W/DIODE SQUD#LC1D65AJD	SQUARE D	LC1D65AJD	1.00	EA
CB202	CIRCUIT BREAKER 1P, 5A, 277VAC 48VDC UL489, ALLBRA#1489-M1C050	ALLEN BRADLEY	1489-M1C050	1.00	EA
CB203, CB228, CB231	CIRCUIT BREAKER, 1P 10A, 277VAC, 48VDC, UL489, ALLBRA#1489-M1C100	ALLEN BRADLEY	1489-M1C100	1.00	EA
CB223	CIRCUIT BREAKER, 1-POLE, 1-AMP, UL 489, ALLBRA#1489-M1C010	ALLEN BRADLEY	1489-M1C010	1.00	EA
CR213, CR320, CR322, CR324, CR328	TERMINAL RELAY 12VDC, FINREL#34.51.7.012.0010	FINDER RELAYS	34.51.7.012.0010	1.00	EA
CR213, CR320, CR322, CR324, CR328	TERMINAL RELAY SOCKET TENSION CLAMP, W/DIODE, FINREL#93.51.7.024	FINDER RELAYS	93.51.7.024	1.00	EA
CR223	RELAY MIDGET BLADE TYPE SPDT 10AMP W/LIGHT AND DIODE 12VDC IDEC#RH1B-ULD-DC12V	IDEC	RH1B-ULD-DC12V	1.00	EA
CR223	SOCKET 1POLE 5 BLADE 10A 250V IDEC#SH1B-05	IDEC	SH1B-05	1.00	EA
CR223, CR225	HOLD-DOWN SPRINGS IDEC#SFA-101	IDEC	SFA-101	2.00	EA
CR225	RELAY MIDGET BLADE TYPE 4PDT 10AMP W/LIGHT AND DIODE 12VDC IDEC#RH4B-ULD-DC12V	IDEC	RH4B-ULD-DC12V	1.00	EA
CR225	RELAY SOCKET, 4-POLE, 14 BLADE, 10A, 300V, WIRE RANGE: UP TO (2) 12AWG, IDEC#SH4B-05	IDEC	SH4B-05	1.00	EA
DISC102	DISCONNECT NON-FUSED 60A 6MM, 3-POLE UL98, ABBCON#OT60F3	ABB CONTROLS	OT60F3	1.00	EA
DISC102	DISC PISTOL HANDLE BLK 6MM NEMA 4/4X ABBCON#OHB65L6	ABB CONTROLS	OHB65L6	1.00	EA
DISC102	DISC SHAFT 7.4-9.1IN DEPTH, (8.26IN)(0.24X0.24) ABBCON#OXP6X210	ABB CONTROLS	OXP6X210	1.00	EA
DISC102	DISC AUX CONTACTS 1NO 10A, 600V FOR SWITCHES OT16-45, MOUNTS ON RIGHT SIDE OF SWITCH, ABBCON#OA1G10	ABB CONTROLS	OA1G10	1.00	EA
ES202A	ESTOP BOX ASSEMBLY ALUM 30MM NEMA 4 SQUD#9001KYG1Y1	SQUARE D	9001KYG1Y1	1.00	EA
ES202C	E-STOP PUSH BUTTON TURN-TO-RELEASE TRIGGER ACTION SQUD#9001SKR16	SQUARE D	9001KR16	1.00	EA
ES202C	CONTACT BLOCK 1 N.C. 30MM SQUD#9001KA3	SQUARE D	9001KA3	1.00	EA
HTR228, HTR230, HTR231, HTR232	HEATER 50W 12VDC FLEXIBLE 3"X5" W/12" LEADS TEMPCO#SHS80869	TEMPCO ELECTRIC HEATER CORP.	SHS80869	1.00	EA
PB309	PB MOMENTARY 30MM GREEN FLUSH 1NO 1NC SQUD#9001SKR1GH13	SQUARE D	9001SKR1GH13	1.00	EA
PB313	PB MOMENTARY 30MM RED EXTENDED 1NO 1NC SQUD#9001SKR3RH13	SQUARE D	9001SKR3RH13	1.00	EA
PENDANT-A	ENCLOSURE PC W/ 2 PB HOLES 30MM, HOFEN&#C2PBPCD	HOFFMAN ENGINEERING	C2PBPCD	1.00	EA
PENDANT-B	ENCLOSURE POLYCARBONATE 4-PB 30MM STAHLIN#CF4PB	ROBROY STAHLIN	CF4PB	1.00	EA
PENDANT-B	CORD GRIP W/STEEL MESH STRAIN RELIEF 0.250-0.375" HUBBELL#07401006	HUBBELL	07401006	1.00	EA
PENDANT-B	GASKET SEALING 1/2" CONDUIT CROHN#SG1	CROUSE HINES	SG1	1.00	EA
PENDANT-B	CORDSET 8-PIN MALE 20FT YELLOW MENCOM#MIN-8MPX-20	MENCOM CORP	MIN-8MPX-20	1.00	EA
PENDANT-B	RECEPT 8P FEM ROUND THRU-WALL W/3FT LEADS MENCOM#MIN-8FR2-3-18	MENCOM CORP	MIN-8FR2-3-18	1.00	EA
POT107	NEMA 4X POT OPERATOR 5K OHM #POT05K	C3CONTROLS	POTO	1.00	EA
POT107	TERMINAL BLOCK KIT#TBK	CONTROL CONCEPTS	TBK	1.00	EA
PS331	AIR PRESSURE SWITCH 10-150PSI MCMAST#3427K4	MCMASTER CARR	3427K4	1.00	EA
PS331	FITTING 1/4 TUBE X 1/8 NPT FEMALE SMC#KQ2F07-34A	SMC CORPORATION OF AMERICA	KQ2F07-34A	1.00	EA
PS331	LOCKNUT 1/2IN CONDUIT BRIDGE#101-S	BRIDGE ELECTRONICS	101-S	2.00	EA
SV207, SV209, SV211	VALVE MANIFOLD ASSY COMPLETE WITH 3 VALVES AND FITTINGS INSTALLED MAC#9-1107471	MAC	9-1107471	1.00	EA
SW204	SEL SW 3POS 30MM SPRING RET TO CTR ILLUM ALLBRA#800H-90JRX91KB7	ALLEN BRADLEY	800H-90JRX91KB7	1.00	EA
SW204	SEL SW KNOB GREEN ILLUM ALLBRA#800H-N154G	ALLEN BRADLEY	800H-N154G	1.00	EA
SW204	LED MODULE 12-130VAC/DC ALLBRA#800TC-N374	ALLEN BRADLEY	800TC-N374	1.00	EA
SW204	LED LAMP GREEN UNIV ALLBRA#800T-N376G	ALLEN BRADLEY	800T-N376G	1.00	EA
SW204	CONTACT BLOCK 1NLCB 1NC ALLBRA#800T-XA7	ALLEN BRADLEY	800T-XA7	1.00	EA
SW207	CONTACT BLOCK 1 N.O. 1 N.C. 30MM SQUD#9001KA1	SQUARE D	9001KA1	1.00	EA
SW207	KEYED SELECTOR SWITCH 30MM 2-POS. MAINTAIN KEY OUT LEFT SQUD#9001KS11K1	SQUARE D	9001KS11K1	1.00	EA
TS223, TS225	THERMOSTAT REMOTE 40/55F FIXED 12IN LEADS WATLOW#ST-207E-0011B	WATLOW	ST-207E-0011B	1.00	EA

Tag	Description	Manfacturer	Manufacturer PN	Qty/ Tag	UM
VFD102	EPDM NEOPRENE SBR STRIP, FLAME-RESISTANT, 1/2 IN X 50 FT NOMINAL SIZE (LXW), 1/16 IN THICK, BLACK GRAING#6YHD2	GRAINGER	6YHD2	5.00	FT
VFD102	VFD 46A MAX 480V 30 HP CT/VT GENERAL PURPOSE EATON#DG1-34046FB-C21C	EATON	DG1-34046FB-C21C	1.00	EA
VFD-KEYPAD	ENCLOSURE 7X7X5 PC W/CLEAR COVER FIBOX#PC191913T	FIBOX	PC191913T	1.00	EA
VFD-KEYPAD	PATCH CABLE 600V CAT5E ROBOTIC OUTDOOR UL PVC TEAL RJ45 TO RJ45 3 METER, ALLBRA#1585J-M8TBJM-3	ALLEN BRADLEY	1585J-M8TBJM-3	1.00	EA
VFD-KEYPAD	CORD GRIP SPLIT UL TYPE 4/4X/VT-ER25 MAX CABLE DIA 15MM, ICO#45450	ICOTEK	45450	2.00	EA
VFD-KEYPAD	SPLIT GLAND GROMMET GRAY 5-6MM CABLE ICO#41205	ICOTEK	41205	2.00	EA
	CUSTOM ENCLOSURE KIT 30X20X8 NEMA12 SS FOR 30HP DELFAB#CHTKIT30	DELTA FABRICATING	CHTKIT30	1.00	EA
	SEALING RING 1IN THOBET#5264	THOMAS & BETTS	5264	2.00	EA
	SPACER #10 X 5/8IN ALUMINUM ROUND GRAING#6MYY2	GRAINGER	6MYY2	4.00	EA
		UNICORP	S-1367-M04-F16I		
	GROUND BAR 4 POLE 4-14AWG SQUD#PK4GTA	SQUARE D	PK4GTA	1.00	EA
	GROUND LUG 3/16IN STUD 6-14GA ILSCO#SLU-35	ILSCO CORP	SLU-35	1.00	EA
	PLUG, CLOSE-UP 3/4" ZINC REDDOT#PLG-2RD	RED DOT	PLG-2RD	1.00	EA
	BREATHER VENT NEMA 4X ROBROY#BV4XKT	ROBROY STAHLIN	BV4XKT	1.00	EA
	CORD CONN 1/2IN NYLON 0.187-0.250 RED INSERT UL TYPE 4 HUBBEL#SHC1021CR KILLARK#ZS103CR	KILLARK/HUBBELL	ZS103CR	7.00	EA
	1/2IN CONDUIT LOCKNUT NYLON, UL TYPE 4, KILLARK#LN-1CR	KILLARK/HUBBELL	LN-1CR	13.00	EA
	3/4IN LIQUIDTIGHT STRT FITTING THOBET#5333	THOMAS & BETTS	5333	1.00	EA
	LT CONNECTOR 3/4" 45DEG THOBET#5343	THOMAS & BETTS	5343	1.00	EA
	NYLON CORD GRIP STR 1/2IN NPT, .375-.500 NYLON, UL LISTED, BLUE INSERT, HUBBEL#SHC1023CR KILLARK#ZS108CR	KILLARK/HUBBELL	ZS108CR	2.00	EA
	CONNECTOR 90 DEGREE 1IN THOBET#5354	THOMAS & BETTS	5354	2.00	EA
	CORD CONN 1/2 NYLON 0.250-0.375 WHITE INSERT HUBBEL#SHC1022CR KILLARK#ZS105CR	KILLARK/HUBBELL	ZS105CR	3.00	EA
	SEALING RING 3/4IN THOBET#5263	THOMAS & BETTS	5263	3.00	EA
	CONNECTOR 3/4 LT 90 DEGREE, INSULATED THROAT, THOBET#5353	THOMAS & BETTS	5353	1.00	EA
	DIN RAIL TS 35 TS 35 X 7.5 WITH SLOT STEEL GALVANIC ZINC PLATED AND PASSIVATE WEIDMU#0514500000	WEIDMULLER	514500000	0.25	PC
	TERMINAL TENSION CLAMP ZDU16 WEIDMU#1745230000	WEIDMULLER	1745230000	4.00	EA
	END PLATE ZAP/TW ZDU16 WEIDMU#1745150000	WEIDMULLER	1745150000	1.00	EA
	BAND END STOP GREY DIN 3 ENTREL#209635116	ENTRELEC	209635116	2.00	EA
	JUMPER 10-POLE BJDL 5.10 ENTREL#029111026	ENTRELEC	029111026	1.60	EA
	TERMINAL BLOCK SNAP IN, 4 ENTRIES, 15A, 20-14AWG, S4C 2.5, BEIGE, WEIDMU#2674550000	WEIDMULLER	2674550000	32.00	EA
	END SECTION FOR 4-ENTRY SNAP IN TERMINALS, SEP 4C 2.5 BEIGE WEIDMU#2751100000	WEIDMULLER	2751100000	1.00	EA
	JUMPER BAR, ZGV 2.5N/2, ORANGE, WEIDMU#1527540000	WEIDMULLER	1527540000	3.00	EA
	END BRACKET SNAP TERMINAL WEIDMU#2661280000	WEIDMULLER	2661280000	2.00	EA
	JUMPER 20-POLE BLUE FINREL#093.20 FINREL#093.20	FINDER RELAYS	093.20	0.50	EA
	SOOW CORD 16-3C 600V 90C 4A-1603			4.00	FT
	SJOW CORD 14-4C 300V 90C 4B-1404			4.00	FT
	18 GA 2 COND SHIELDED 300V BELDEN#8760	BELDEN WIRE AND CABLE	8760	36.00	FT
	18AWG 3COND SHIELDED CABLE ANIWIR#AL-1803C-2-1S-09	ANIXTER WIRE & CABLE GROUP	AL-1803C-2-1S-09	15.00	FT
	COVER 1IN WHITE 6FT LONG PANDUI#C1WH6	PANDUIT	C1WH6	0.25	PC
	DUCT 1IN X 3IN WHITE 6FT LONG PANDUI#G1X3WH6	PANDUIT	G1X3WH6	0.25	PC

REV	DATE	BY	DESCRIPTION
13	7-12-23	BW	CHANGE CIRCUIT BREAKER AND TERMINAL MFG
12	2-14-23	BW	MOVE RJ45 CORD GRIP, REVISE KEYPAD ASSY
11	11-14-22	DJW	NEW KEYPAD CORD GRIPS/FLANGE KIT
10	11-9-22	DJW	VFD102 EATON DG1 RETROFIT
9	4-8-19	WRZ	CHANGED CR225, REVISED TB LAYOUT
8	9-05-17	WRZ	CHANGED VALVE BANK ASSY

REV	DATE	BY	DESCRIPTION

SCALE: N/A — APPR
DR: ESJ — DATE: 4-8-15
CK: DJW — DATE: 4-8-15
SHOP ISSUE — DATE

Control Assemblies Co. — Minneapolis, Minnesota
OEM & Factory Automation Specialists

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DESCRIPTION: ORCA 30HP GEN 2 CONTROL PANEL
BILL OF MATERIAL

FOR: CHART INDUSTRIES, INC.
407 SEVENTH STREET NW
NEW PRAGUE, MN 56071-1000, USA

DRAWING NO. 20903203
SHEET 7 OF 7

Warranty Statement

Chart Standard Warranty

Chart Purchased Parts

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

Major Components

Component	Time Frame*
Resistance Temperature Device (RTD)	1 Year
Differential Pressure Transmitter (DP Transmitter)	1 Year
Spin-on Connections	6 Months
Meter Section	1 Year
Meter Element	Life of Orca System
Differential Pressure Gauge 0-100" H_2O	1 Year
AOV-1 Dispense Valve	1 Year
AOV-2 Recirculation Valve	1 Year
AOV-3 PB Force Feed Valve	1 Year
Orca HL Series Delivery Hose	1 Year
Flowcom Flow Processor	1 Year
Printer	6 Months
Generator	Mfg Warranty
Pump Submerged Pump LIN/LAR Service	1 Year
Variable Frequency Drive (VFD)	18 Months
Control Panel (480 VAC)	6 Months
Check Valves	1 Year
Safety Relief Valves, Vent	1 Year

*From shipment of Orca HL Series unit.

Workmanship and Vacuum

Chart Inc. warrants all Orca HL Series units 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. 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 HL Series unit will be repaired at the nearest Chart Authorized Service Provider, by the Purchaser, or Chart Inc personnel in the field, or at Chart Inc. at the discretion of Chart Inc. and in accordance with the attached Warranty Claims Procedure.

Exclusions

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

Claim Procedure

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

   Chart Inc.
   Attn: Customer Service
   407 Seventh Street NW
   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 Inc. within 14 days of the claim. Customer Service will issue an 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 Inc. for payment of credit.

2. All Warranty Claims submitted to Chart Inc. for credit must be submitted within 21 days of the date of purchaser receiving their vendors invoice for services rendered. This Credit Request must include the RMA number that was provided by Chart Inc. 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 Inc.

4. Vacuum pumping of any units, requires prior authorization from Chart Inc. and all procedures must be adhered to or the warranty will be void.

5. On Chart Inc. purchased parts, Chart Inc. 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 Inc. will replace parts at no charge excluding labor and other items listed in the exclusion section. Chart Inc. 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 Inc. and determined to be within the warranty period.

6. Authorization must be obtained from Chart Inc. prior to shipment of any units to our location or any other repair facility for warranty work.