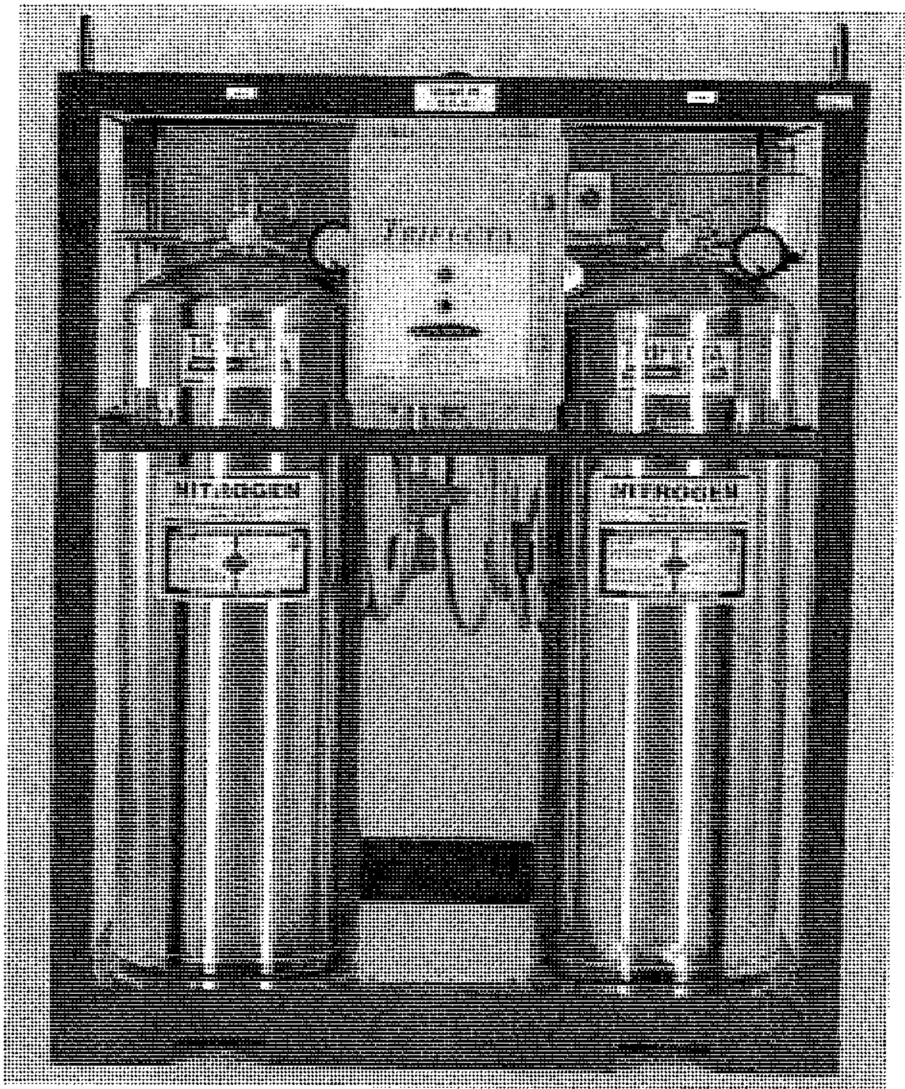
CHART™



TRIFECTA

Laser Solution

Installation Guide and User's Manual

TABLE OF CONTENTS

TABLE OF FIGURES

1. GENERAL

Congratulations, you now own a Chart *Trifecta* high-pressure gas supply system. This system is designed to utilize a standard, low-pressure cryogenic bulk tank to produce the high pressure and flow rate gas that is demanded by today's laser cutting systems. The system is designed to provide a continuous flow of high-pressure gas with no interaction from the user. The user simply maintains liquid in the bulk tank and the *Trifecta* control system manages the rest.

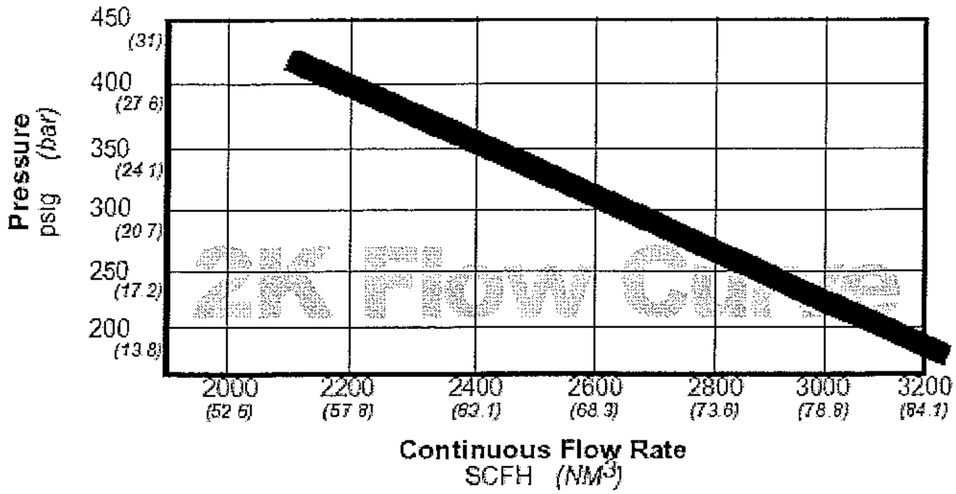
1.1 SYSTEM SPECIFICATIONS

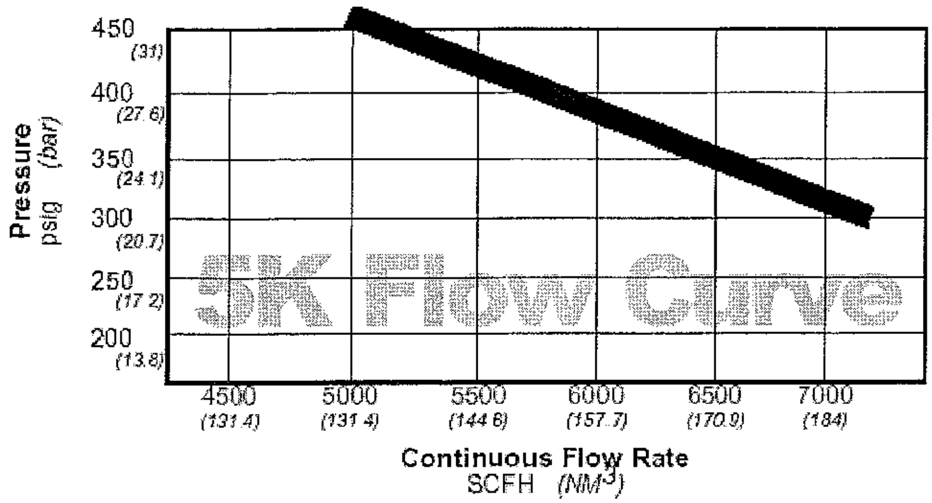
1.1.1 DIMENSIONS

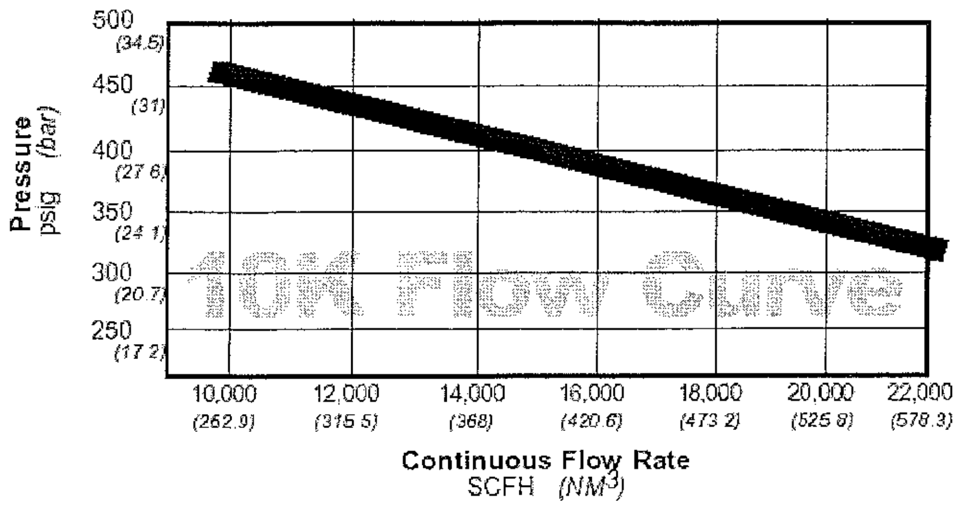
Height:	79 in. (2007 mm)
Length:	65 in. (1651 mm)
Width:	60 in. (1524 mm)
Weight:	2000 lbs. (892 kg)

1.1.2 FLOW CAPABILITY

The Trifecta gas supply system is capable of supplying a continuous nitrogen gas flow rate at higher pressures than standard cryogenic bulk storage tanks. If the customer can tolerate lower delivery pressures, the Trifecta system will deliver greater flow rates. If the customer can tolerate lower flow rates, the Trifecta system will deliver at higher pressures. The following curves are approximations of the pressure that the Trifecta can hold at various flow rates:







Figures 1-3. Trifecta 2K, 5K, and 10K System Flow Curves

2. SAFETY

As with any cryogenic system, it should be observed that any non-insulated piping can get extremely cold and should not be touched by exposed skin. If the system requires maintenance, it should be shutdown and allowed to warm-up.

If maintenance is to be done on the system, such as changing valve seats, it is extremely important that the pressure be relieved from the system through the vent valves. The five transmitters can monitor the system pressures and liquid levels.

When doing maintenance on the system, it is recommended that the manual isolation valve to the bulk tank be closed.

2.1 Safety Summary

Strict compliance with proper safety and handling practices is necessary when using a cryogenic system. We recommend that all our customers re-emphasize safety and safe handling practices to all their employees and customers. While every possible safety feature has been designed into the unit and safe operations are anticipated, it is essential that the user of the cryogenic system carefully read to fully understand all WARNINGS and CAUTION notes listed in this safety summary and enumerated below. Also read the information provided in the Safety Bulletin for Oxygen and Inert Gases following this Safety Summary. Periodic review of the Safety Summary is recommended.

> ☞ **WARNING:**
> **In an oxygen enriched atmosphere, flammable items burn vigorously and could explode.**

Excess accumulation of oxygen creates an oxygen-enriched atmosphere (defined by the Compressed Gas Association as an oxygen concentration above 23%). Certain items considered non-combustible in air may burn rapidly in such an environment. Keep all organic materials and other flammable substances away from possible contact with oxygen; particularly oil, grease, kerosene, cloth, wood, paint, tar, coal, dust, and dirt which may contain oil or grease. Do not permit smoking or open flame in any area where oxygen is stored, handled, or used. Failure to comply with this warning may result in serious personal injury.

> ☞ **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.

> ➔ **CAUTION:**
> **Before removing any parts or loosening fittings, empty the cryogenic container of liquid contents and release any vapor pressure in a safe manner.**

External valves and fittings can become extremely cold and may cause painful burns to personnel unless properly protected. Personnel must wear protective gloves and eye protection whenever removing parts or loosening fittings. Failure to do so may result in personal injury due to the extreme cold and pressure in the tank.

> ☞ **WARNING:**
> **Accidental contact of liquid gases with skin or eyes may cause a freezing injury similar to a burn.**

Handle liquid so that it will not splash or spill. Protect your eyes and cover skin where the possibility of contact with liquid, cold pipes and equipment, or cold gas exists. Safety goggles or a face shield should be worn if liquid ejection or splashing may occur or cold gas may issue forcefully from equipment. Clean, insulated gloves that can be easily removed and long sleeves are recommended for arm protection Cuffless trousers should be worn over the shoes to shed spilled liquid.

> ☞ **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.

> ➔ **CAUTION:**
> **Use only replacement parts that are compatible with liquid oxygen and have been cleaned for oxygen use.**

Do not use regulators, fittings, hoses, etc., which have been previously used in a compressed air environment. Similarly, do not use oxygen equipment for compressed air. Failure to comply with these instructions may result in serious damage to the container.

> **CAUTION:**
> **Before locating oxygen equipment, become familiar with the relevant EU Directives or National Fire Protection Association (NFPA) standard No. 50, "Bulk Oxygen Systems at Customer Sites", and with all local safety codes.**

The NFPA standard covers general principles recommended for installing bulk oxygen systems on industrial and institutional consumer premises.

> **CAUTION:**
> **To prevent possible tip over, do not leave tank standing upright unless it is secured to its foundation (bolted down).**

Transporting and erection of the tank should be performed in accordance with rigging instructions available from CHART. Failure to comply with these instructions may result in serious damage to the container.

2.2 SAFETY BULLETIN

Portions of the following information is extracted from Safety Bulletin SB-2 from the Compressed Gas Association, Inc. (CGA). Additional information on nitrogen and argon and liquid liquid cylinders is available in CGA Pamphlet P-9. Write to the Compressed Gas Association, Inc., 1235 Jefferson Davis Highway, Arlington, VA 22202.

From CGA Safety Bulletin

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

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

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

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

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

2.2.1 Oxygen Deficient Atmospheres

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

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

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

Human exposure to atmosphere containing 12% or less oxygen leads to rapid unconsciousness. Unconsciousness can occur so rapidly that the user is rendered essentially helpless. This can occur if the condition is reached by immediate change 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 an unconscious partner unless equipped with a portable air supply. Best protection is obtainable by equipping all individuals with a portable supply of respirable air. Lifelines are acceptable only if the area is essentially free of obstructions and individuals can assist one another without constraint.

If 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

2.2.2 Oxygen Enriched Atmospheres

An oxygen-enriched atmosphere occurs whenever the normal oxygen content of air is allowed to rise above 23%. While oxygen is non-flammable, ignition of combustible materials can occur more readily in an oxygen-rich atmosphere than in air; and combustion proceeds at a faster rate although no more total 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 proved 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 alloys) because of their greater resistance to ignition and lower rate of combustion.

Similarly, materials that can be ignited in air have lower ignition energies in oxygen. Many such materials may be ignited by friction at a valve seat or stem packing, or by adiabatic compression produced when oxygen at high pressure is rapidly introduced into a system initially at low pressure.

2.2.3 Nitrogen and Argon

Nitrogen and argon (inert gases) are simple asphyxiants. 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 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. Cryogenic burns, which result in blistering or deeper tissue freezing, should be examined promptly by a physician.

CHART customer stations are safely designed with the following features:

1. A vacuum maintenance system specifically designed to provide long life and all possible safety provisions.

2. Safety relief devices to protect the pressure vessel and vacuum casing, sized and selected in accordance with ASME standards to include a dual relief valve and rupture disc system to protect the pressure vessel, and a reverse buckling rupture disc or lift plate to protect the vacuum casing from over-pressure. While CHART equipment is designed and built to the most rigid standards, no piece of mechanical equipment can ever be 100% foolproof.

3. INSTALLATION

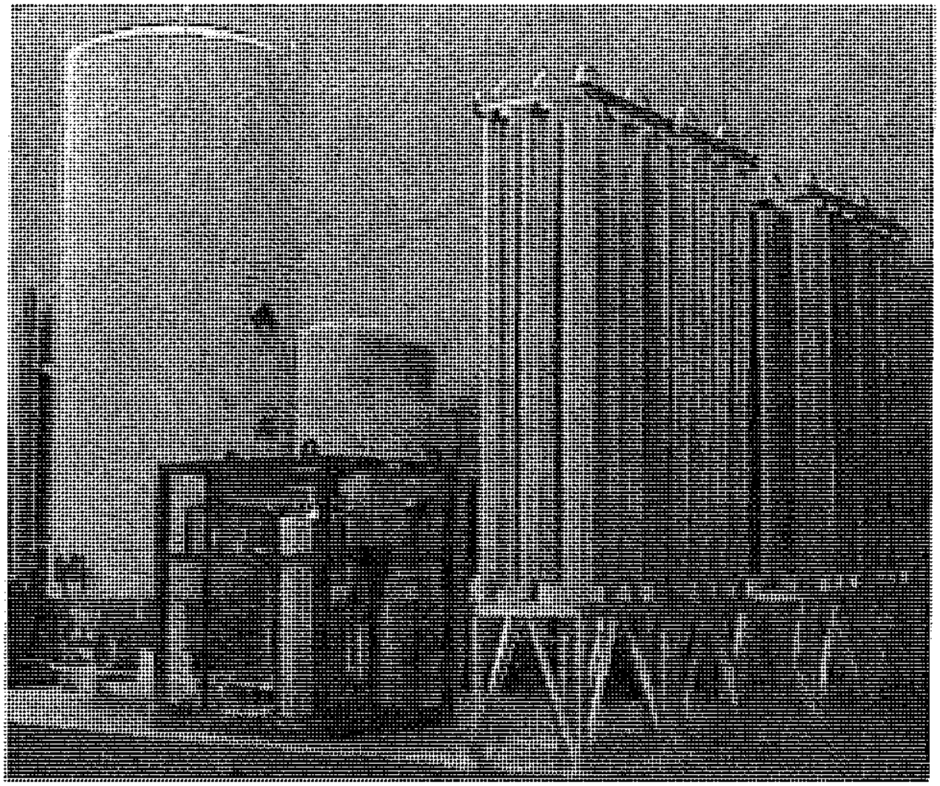


Figure 4. Typical Trifecta Installation

INSTALLATION PROCEDURE

3.1 Place Trifecta Skid on Concrete Pad
3.2 Pipe Trifecta Liquid Fill Line to Bulk Tank
3.3 Pipe Trifecta Gas Use Line to External Vaporizer
3.4 Pipe Pressure Transmitter to Low (Vapor) Phase of Bulk Tank
3.5 Connect Power Supply to dedicated 120VAC, 20 amp circuit
3.6 Commissioning

3.1 PLACEMENT OF TRIFECTA SKID

The *Trifecta* skid has three lifting lugs on the top of the skid. These lifting lugs allow for placement of the skid by overhead crane. If an overhead crane is not available, the skid has fork truck access in the front.

The *Trifecta* skid should be placed on the concrete pad, near the bulk storage tank as seen in Figure 4. The skid should be placed as close to the bulk tank as possible without interfering with any other equipment or requirements of the tank. The system requires a transfer of liquid and gas between the bulk storage tank and the *Trifecta* skid. This process becomes less efficient with increasing transfer line length.

The skid should also be placed such that there is easy access to all sides of the unit. One must be able to check the Laser-Cyl's gauges, the control box, and any of the solenoid valves or transmitters at any time. Consideration should also be given to the external vaporizer placement on the concrete pad. It is important that sun and wind contact both the external vaporizers and the pressure build coils inside the Trifecta frame to insure optimal operation of the unit.

3.2 LIQUID LINE PIPING TO BULK TANK

The Trifecta skid requires liquid line piping to the bulk storage tank. This line will serve two functions. The first function is to allow the transfer of liquid from the bulk tank to the Laser-Cyls in the filling process. The second function is to allow the initial venting of gas from the Laser-Cyl to the bulk tank during the fill process. This gas is vented into the bottom of the bulk tank to minimize pressure rise and must be piped to an auxiliary liquid line. The recommended line size is no smaller than three-quarters of an inch. When looking at the back of the system skid, there are two connection points available for pipe hook-up. The connection point on the left, labeled C-1 on Figure 5, should be piped to the bulk tank.

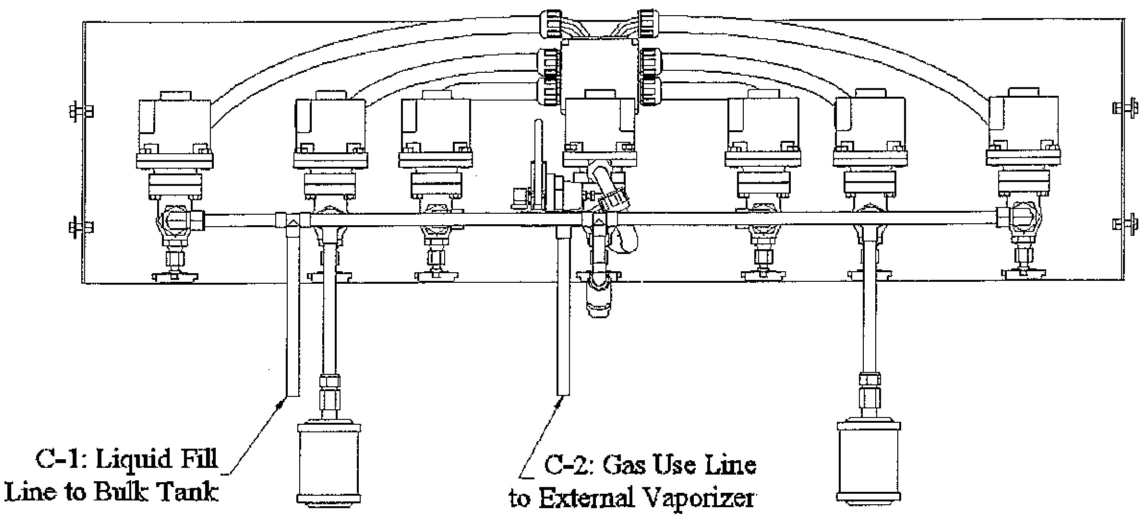


Figure 5. Piping required to skid

The line should be insulated for two reasons. The first reason is that an insulated line will allow more efficient liquid transfers and fills. The second reason is that when the Laser-Cyl vents gas to the bulk tank, it is undesirable for the venting gas to pickup any additional heat on its way to the bulk tank. If the vent gas picks up additional heat, the bulk tank will experience greater pressure rise.

> ➔ **NOTE:**
> The isolation valve on the bulk tank liquid line should not be opened until <u>all</u> piped connections are complete.

3.3 Piping to Vaporizer

The Trifecta system does not contain an internal or external vaporizer. Consequently, a freestanding, external vaporizer must be connected to the Gas Use Line of the Trifecta. The vaporizer should have a pressure rating of at least 550 psig. The piping and components from the Trifecta to the vaporizer must be at least ½ inch diameter. Small diameter lines will introduce undesirable pressure drops and impact overall system performance. Referring to Figure 5, Connection C-2 should be piped to the vaporizer. The outlet of the vaporizer should be piped to the customer house line.

> ➔ **NOTE:**
> It is important to make sure the vaporizer assembly is protected against over-pressurization from trapped liquid. The vaporizer installation must include a thermal relief valve just downstream of the vaporizer, preferably set at 550 psig. The relief device on the *Trifecta* is a fail-safe device and should not be relied upon as the only thermal relief. Operation of the Trifecta Gas Use relief device may vent liquid, creating a noticeable vapor cloud.

> ➔ **NOTE:**
> Installation of an additional drain valve downstream of the vaporizer is highly recommended. This valve aids in the purging of the Trifecta and the external vaporizer. This valve will also serve as an emergency gas feed port.

3.4 Bulk Tank Pressure Transmitter

The system controller requires the pressure input of the bulk tank to perform the filling procedure as efficiently as possible. This is done through a pressure transmitter. The pressure transmitter measures the pressure of the bulk tank and sends an electrical signal back to the controller. The transmitter for the bulk tank is located directly under the control box.

A convenient location to connect the pressure source is the vapor phase line of the bulk tank differential pressure gauge. When piping the pressure source to the transmitter, 1/4" copper tube may be used with appropriate compression fittings.

3.5 Electrical Power Supply

The Mitsubishi PLC is mounted within a NEMA 4 control box that contains an external disconnect switch as illustrated in the photograph below.

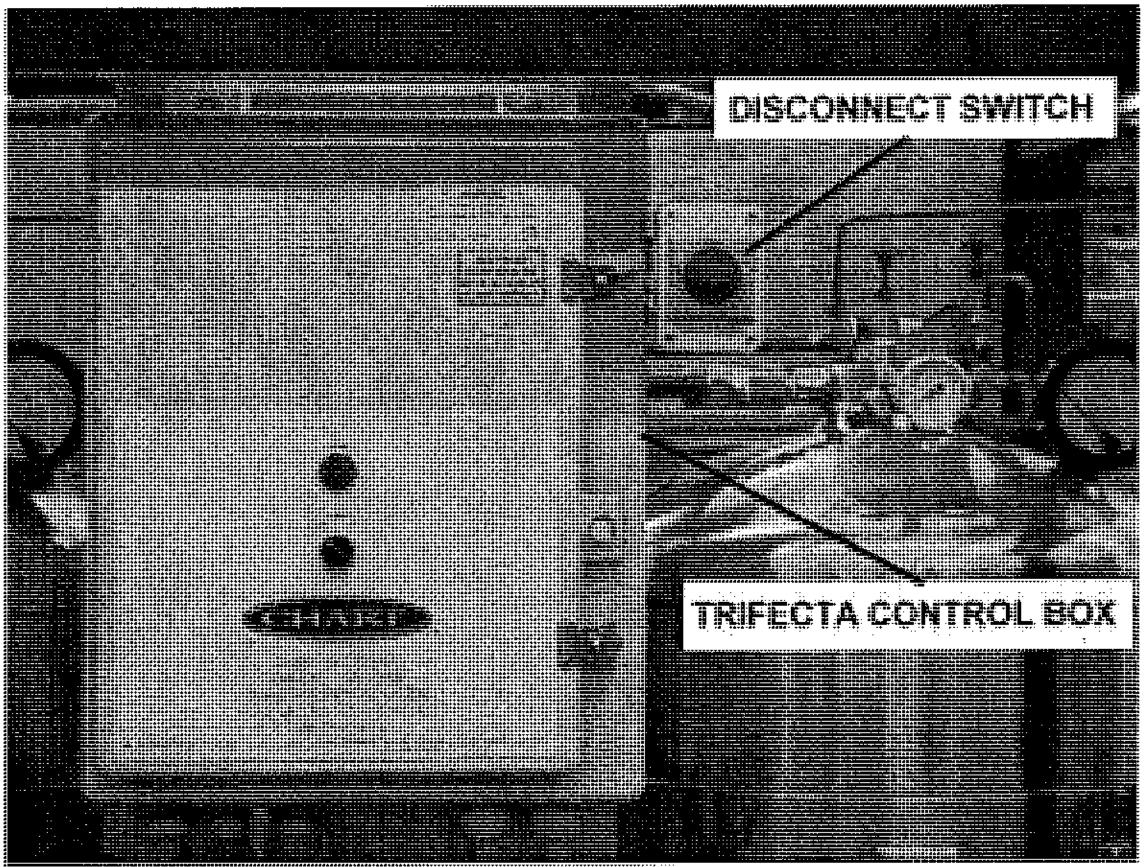


Figure 6. Trifecta Control Box, Disconnect Switch

A dedicated 120 VAC, 20 amp circuit must be provided to power the Trifecta control system. It is important that care is taken to install the Trifecta system on an electrical power circuit that is clean and protected. Circnits that are susceptible to noise and brownouts may cause erratic system behavior. Care should also be taken to avoid installation on a circuit that regularly gets turned on and off to provide power to another piece of equipment (lights, heaters, cooling systems etc.). It should be recognized that a PLC (computer) controls the Trifecta system and a clean, steady circuit must be used to power the Trifecta system.

Field terminals are provided inside the external disconnect switch as shown in the photographs below. The procedure for connecting the input power source is as follows:

1. Loosen the 4 plastic screws that secure the cover on the disconnect switch.
2. Separate the cover of the switch from the base.
3. Provide the input wiring to the disconnect switch box with a conduit or other approved method according to local electrical codes.

4. Securely fasten the ground wire (green) into the grounding lug in the base of the switch box.
5. Securely fasten the hot (black) and neutral (white) wires into the appropriate switch terminals as illustrated in the photograph below.
6. Place the switch cover back on the base and tighten the plastic screws.
7. Make sure the disconnect switch is in the OFF position.
8. Apply power to the input circuit.
9. Turn the disconnect switch to the ON position.
10. The wiring is complete. Follow the commissioning procedure in the Section 3.6.

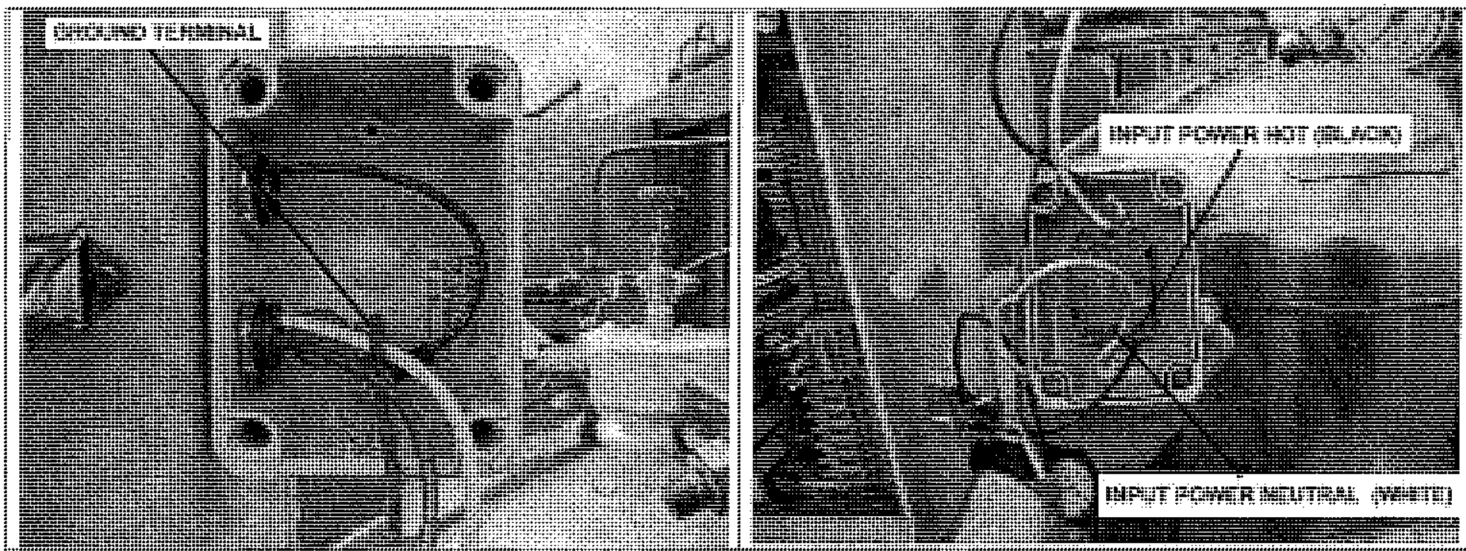


Figure 7. Disconnect Switch Wiring

3.6 Commissioning

The following procedures require the operation of the solenoid valves. Refer to Figure 9 and Table 1 to differentiate the solenoids.

> ☞ **WARNING:**
> It is important to purge the Laser-Cyls and piping with warm, dry nitrogen before running the system with liquid. Water vapor can cause ice crystals to form that may cause the solenoid valves to operate improperly.

3.6.1 Purge and Precharge Trifecta

When all connections to the Trifecta are made, purge the complete system using low-pressure nitrogen.

1. Verify that the controller is in the OFF position and open all solenoid manual by-pass valves (red-hand wheel should be turned into the body of the valve as in Figure 9).

2. Slightly open the auxiliary liquid supply valve at the bulk tank. The liquid will flash (vaporize) as it enters the warm Laser-Cyls and since the vent to atmosphere solenoids are open, purging of the Trifecta will start. It is recommended that the system be purged for 10 minutes. After 10 minutes, close all the red handled bypass valves except the gas use solenoids and the liquid fill solenoid (see figure 9, Table 1). Open the valve downstream of the vaporizer. If the valve was not installed, crack open a fitting downstream of the vaporizer. Purge the vaporizer for 10 minutes, then close this valve or tighten the fitting. Close the red handled bypass valves on the gas use solenoids. Pressure in the Laser-Cyls and vaporizer will equalize with the pressure in the bulk tank. Close the auxiliary liquid valve and the liquid fill solenoid.

3. The entire system has now been purged and pre-charged with pressure. Pre-charging the down stream vaporizer assembly will prevent the sudden rush of liquid into the vaporizer when the Trifecta is initially started. This would cause the 550 psi relief valve downstream of the vaporizer to open.

3.6.2 Leak Check Trifecta

All fittings on the Trifecta should now be leak checked with a bubble solution. Although the system is pressure tested at the factory, it is not uncommon for threaded fittings to vibrate loose during over the road shipment.

1. Perform leak check at the pre-charged pressure on the entire system with special attention to the small instrument connections.

2. Now the system must be leak checked at the Trifecta Operating Pressure.

   a. Manually add 8"-10" H20 of liquid into each Laser-Cyl by opening the liquid fill solenoid and the bulk tank auxiliary liquid valve. Open each Laser-Cyl's vent to atmosphere solenoid to begin filling each Laser-Cyl. Close all solenoids when the differential pressure gauges read 8-10".
   b. Turn in the by-pass valves on solenoids numbered 4 and 8. These are the solenoid valves for the pressure build circuits for each Laser-Cyl. This will manually build pressure in the Laser-Cyls. Since there is a large gas space in each Laser-Cyl, it may take some time to raise the pressure in each vessel. When pressure reaches 425 psi, leak test all fittings again.

3.6.3 CHECK LASER-CYL RELIEF VALVES

Check the Laser-Cyl main relief valves. Turn in by-pass valve on Solenoid Valve 4. Raise the pressure in Tank 1 to 480 psi. The relief valve must not open. If it does, the valve should be replaced as it is opening at a pressure that is too low. Repeat same procedure on Tank 2.

3.6.4 SET CONTROL PANEL HEATER

The Trifecta control panel is equipped with heater system to maintain a minimum temperature during extremely cold conditions. The setting should be set to about 25 °F.

After successful completion of the installation procedures, the Trifecta is now ready for operation. Upon application of power, the unit will begin its continuous, automatic supply. Continue to Operation Section 4 to learn about the automatic operations that will occur upon application of power. This operation section also provides a detailed description of the Trifecta assembly and its normal operations. This knowledge of assembly and operation proves very valuable for customizing the system for the specific application (also see Section 5, PLC Operation - Customizing Operation) or if troubleshooting becomes necessary (also see Section 7, Troubleshooting).

4. OPERATION

Prior to powering the Trifecta, you may wish to familiarize yourself with the basic assembly of the system and details of automatic operation.

4.1 DESCRIPTION OF ASSEMBLY

The following figures provide a guide to numbering and naming conventions used in this manual. Figure 8 below, shows the tank numbering scheme. If the control box is straight ahead, Tank 1 is on the right.

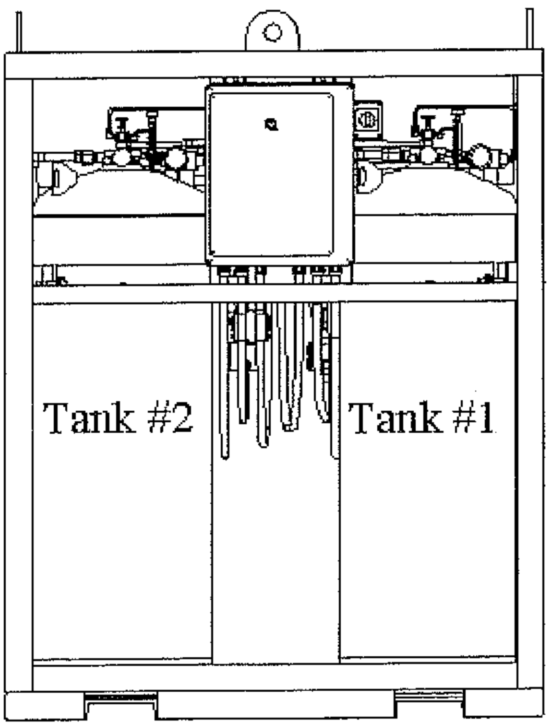


Figure 8. Trifecta Front View

Figure 9 and Table 1 on the following page illustrates the solenoid valve naming conventions and their manual override function.

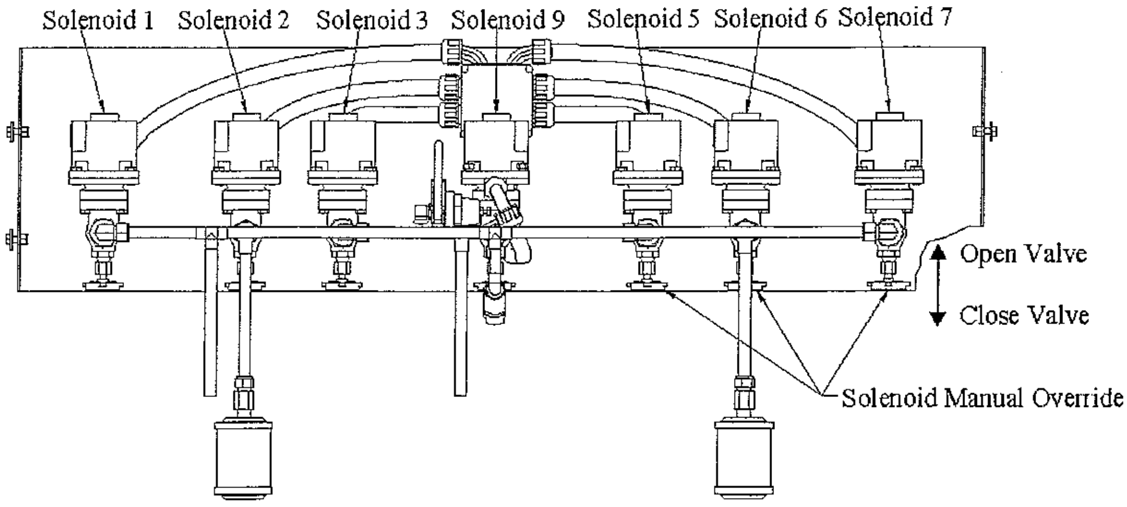


Figure 9. Valve Identification (Trifecta Rear View)

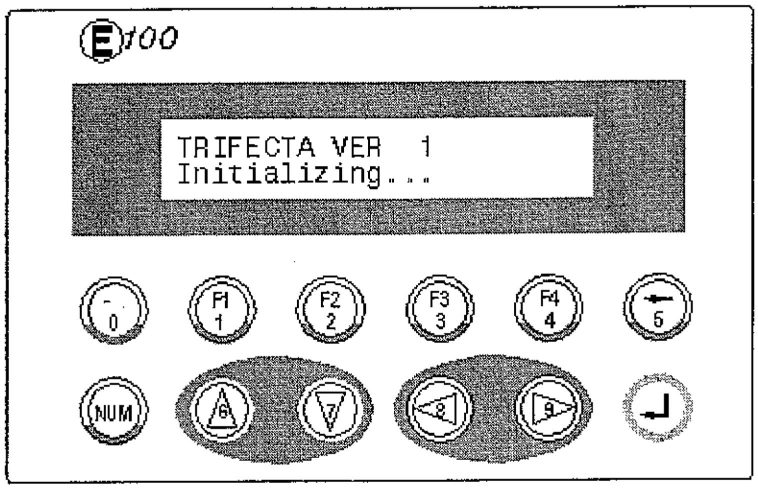
Table 1. Valve Identification

	Solenoid Number	
	Tank 1	Tank 2
Vent to Bulk Tank	#1	#7
Vent to Atmosphere	#2	#6
Gas Use	#3	#5
Pressure Builder	#4	#8
Liquid Fill	#9	

Valves #4 and #8 are the pressure building valves for Tank #1 and Tank #2, respectively. These valves are not on the valve panel, but are mounted on the top of the pressure building vaporizer corresponding to each tank (see Figure 10).

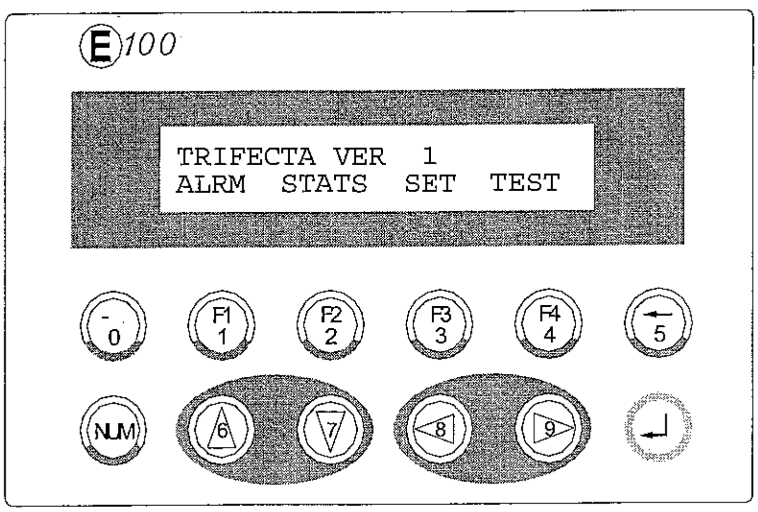
4.2 APPLY POWER AFTER COMPLETION OF INSTALLATION PROCEDURE

When you are ready to begin operation, close all solenoid valve hand wheels (hand wheels turned away from the valve body) and apply power to the control box. The LCD screen on the controller will display the following:



Applying Power

- When 120 VAC power is installed and the switch is placed in the "ON" position, the control system will initialize.



Main Menu

- After initializing, the Controller will display the main menu and begin automatic operation.

After Initialization, the Controller will display the main menu and will open the necessary solenoids to begin the fill cycle once the auxiliary liquid line on the bulk tank is opened.

Open the auxiliary liquid feed line on the bulk tank to begin the fill cycle. The Trifecta is now on automatic mode and will fill both tanks, one at a time and build pressure to the set point.

> ➔ **NOTE:**
> Since the tanks are warm upon initial installation, they may vent for a few minutes before they are cold enough to accumulate liquid.

When the first Laser-Cyltank is full and builds pressure, the Trifecta opens the Laser-Cylgas use line that supplies product to the vaporizer. The Trifecta is now in use. The second Laser-Cylis then filled; it builds pressure and stands by for use.

One normal operation cycle of the Trifecta is complete after each tank is filled, builds pressure and is used.

4.3 DETAILED AUTOMATIC OPERATION

The spreadsheet in the Appendix characterizes the operation of the Trifecta in its entirety. It displays

- tank modes
- the pressure and liquid level parameters of each tank and bulk tank
- and the solenoid positions

corresponding to every event or change during:

4.3.1 initial fill process after installation and commissioning
4.3.2 normal operation cycles
4.3.3 the event of Laser-Cyl overpressure.

These are the only conditions in which the Trifecta controller will energize the solenoids. Descriptions of these 3 processes are also provided in the following sections.

4.3.1 INITIAL FILL PROCESS AFTER INSTALLATION AND COMMISSIONING

- The Trifecta has just been installed, so both tanks need to fill. The controller will automatically begin filling Tank #1. Since the tanks are warm upon initial installation, they vent for a few minutes before they are cooled. Once the tank is cooled, liquid starts to accumulate.
- When Tank #1 is full, it builds pressure to above operating pressure (default 425 psi), and the Tank #1 gas use solenoid opens. Tank #1 is now in use, providing liquid at 425 psi to the external vaporizer.
- Just as Tank #1, Tank #2 will now automatically fill, build pressure, and stand by for usage.

4.3.2 NORMAL OPERATING CYCLE

- Tank #1 in use (gas use valve is open and pressure building valve open on demand to maintain pressure), Tank #2 is on standby, full of product, and pressure building valve opens on demand to maintain pressure at set point.
- Tank #1 liquid level drops to 18% of full volume. After a short time delay, tank #1 switches to the fill mode and tank #2 switches to the gas delivery mode.
- The cycle is repeated thereafter.

Fill Mode

The following is a typical fill cycle, where the Laser-Cyl automatically fills and re-pressurizes, ready to be switched into the gas delivery mode:

- Upon reaching 18% of full volume, the gas use valve closes and a vent valve opens to reduce the pressure in the Laser-Cyl to approximately 40 psig less than the pressure in the bulk tank. Depending upon the setting of the "Bulk Tank Critical", the Laser-Cyl may vent directly into the bulk tank, or to the atmosphere. If the pressure in the bulk tank is below the bulk tank critical parameter (default 125 psi), pressure in Laser-Cyl will be vented back to the bulk tank until the pressure in the Laser-Cyl is 20 psi above the bulk tank pressure. Then the pressure in the Laser-Cyl will be reduced to 40 psi below the bulk tank by venting the gas to the atmosphere.
- When the pressure drops to 40 psi less than the bulk tank pressure, the liquid fill process begins. The Laser-Cyl is top filled and maintains a low pressure to complete the fill.
- When the liquid level reaches 32" H2O (28" for 5K and 10K)[1], the pressure building solenoid opens to build pressure to the set point. The pressure in the Laser-Cyl increases above the bulk tank pressure and terminates the transfer of liquid (the check valves prevent back flow into the bulk tank).

Typical Trifecta Fill Cycle Time

Operation	Time
Vent to Bulk Tank	1 min
Vent to Atmosphere	1 min
Liquid Filling	5 min
Repressurization	3 min
Totals	**10 min**

[1] These are the liquid fill levels for Nitrogen. For argon the levels are 55" H_20 for the 2K and 48" H_20 for 5K and 10K. For oxygen, the fill levels are 45" H_20 for the 2K and 39" H_20 for the 5K and 10K.

> ➔ **NOTE:**
> The times listed above are typical but not exact. Times will vary and are effected by distance of Trifecta from the bulk tank, condition of the liquid in the bulk tank, bulk tank pressure, and ambient conditions.

4.3.3 LASER-CYL OVERPRESSURE

- If the Trifecta is left unused for some time but still contains liquid, the tank may build to overpressure due to normal evaporation of the liquid.
- To conserve product, if the bulk tank pressure is not above the "bulk tank critical" pressure, the tanks will vent through the liquid auxiliary line into the bulk tank.
- If the bulk tank pressure is above the "bulk tank critical", the Trifecta will simply vent that Laser-Cyl to atmosphere.
- This is more an exercise of conservation than a safety mechanism. In the event that power is lost and overpressure is reached, the Trifecta tanks already have redundant pressure relief devices (relief valve and burst disc) on the plumbing stack.

4.4 SHUT DOWN

If the system is shut off, upon turning the power back on, the controller will go through the initialization routine and begin controlling. Nothing is lost when the controller is turned off. The system does not have to be turned off in periods of no use (over-night, weekend's etc.). Turning the system off will de-energize the solenoids and will cause the main relief valves to control the pressure in the Laser-Cyl.

4.5 MANUAL MODE

If power is lost to the system, all of the solenoid valves will close. To run the system, manually operate the solenoid valves by turning the valve handle on the bottom of the valve to provide flow as required. The manual by-pass feature on the solenoid valve operates such that turning the valve handle in (closer to the valve body) will open the valve. Turning the valve handle out (away from the valve body) will close the valve. This can be seen in Figure 9 and it is also labeled on the valve handle.

The operator will have to pick a tank to use, open its gas use solenoid, and throttle the pressure building solenoid to maintain the desired operating pressure. It is important to note that when the system is running in manual mode, the pressure-building valve on the Laser-Cyl will need to be opened <u>and monitored</u>. If the loss of power continues and a tank needs to be filled, the operator will need to close the previous tank's gas use and pressure-building valves, and open the other tank's gas use and pressure building valves. To fill the tank, the operator needs to open the liquid fill Solenoid Valve #9, and control the vent of the Laser-Cyl to remain below the pressure of the bulk tank by operating the vent to atmosphere valve. When the pressure is lower than the bulk tank, liquid will flow into the tank through the check valve. The Laser-Cyls should be filled to 27 inches of water as shown on the liquid level gauges

> ➔ **NOTE:**
> It is important that if the system is run in manual mode, the pressure-building valve not be opened and left unattended. The pressure building circuit does not have any regulators or control devices. If the valve is left open, rapid, uncontrolled pressure rise may occur. Since there is no power, the PLC controller will not be available to control the pressure. The Laser-Cyl relief valve and rupture disk will potentially open to relieve the pressure. The system should only be operated this way for brief periods of time until power can be restored. While operating this in this mode, someone should closely monitor the pressure of the tank and close the pressure building valve if the pressure rises more than desired.

5. MITSUBISHI PLC OPERATION

A Programmable Logic Controller (PLC) that has a keypad interface that controls the Trifecta system. There are a variety of parameters pertaining to the Trifecta operation which can be monitored and/or altered with the push of a button on the Mitsubishi controller. The following operations are at your fingertips:

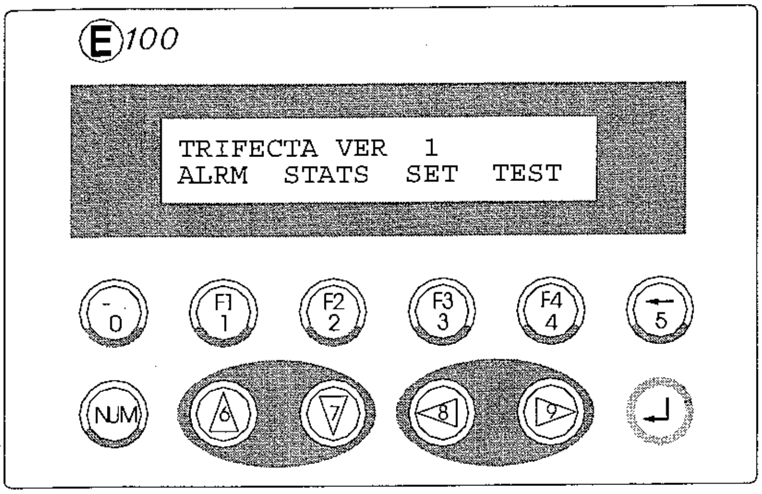
5.2 Status Screen – Displays each Laser-Cyl's Mode of Operation
5.3 Set Parameters Screen – Customize Operation Parameters including:
- Operating Pressure
- Bulk Tank Critical Pressure
- Laser-Cyl Overpressure
- Trifecta Model
- Laser-Cyl Size
- Product Selection

5.4 Test Menu – Activate Particular Solenoids or Alarm Light
5.5 View Parameters – View Parameters including
- Bulk Tank Pressure
- Tank 1 Pressure
- Tank 2 Pressure
- Tank 1 Liquid Level
- Tank 2 Liquid Level

Sections 5.1 through 5.5 explain navigation through the screens to perform the above functions.

5.1 MAIN MENU

Pressing F1 from the status screen and from most other screens and menus can access the main menu.

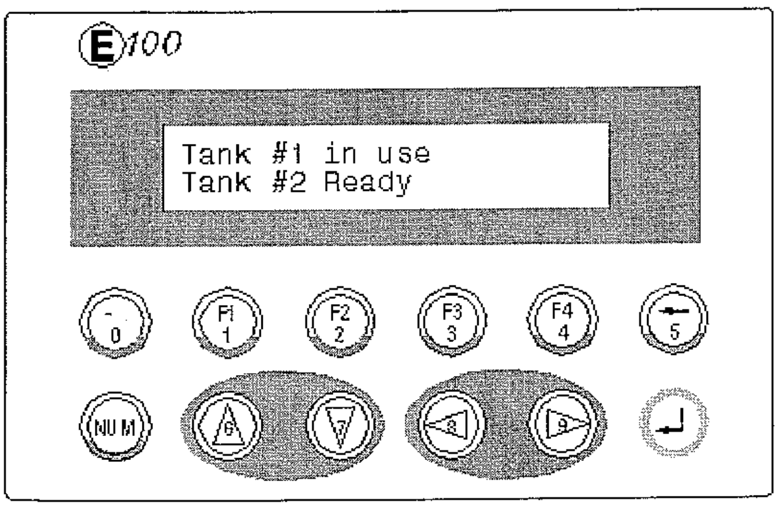


Main Menu

- The main menu allows the user to access one of the following sub-menus:
    - Press **F2** to access the Status Screen
    - Press **F3** to access the Set Parameter Screens
    - Press **F4** to access the Test Menu

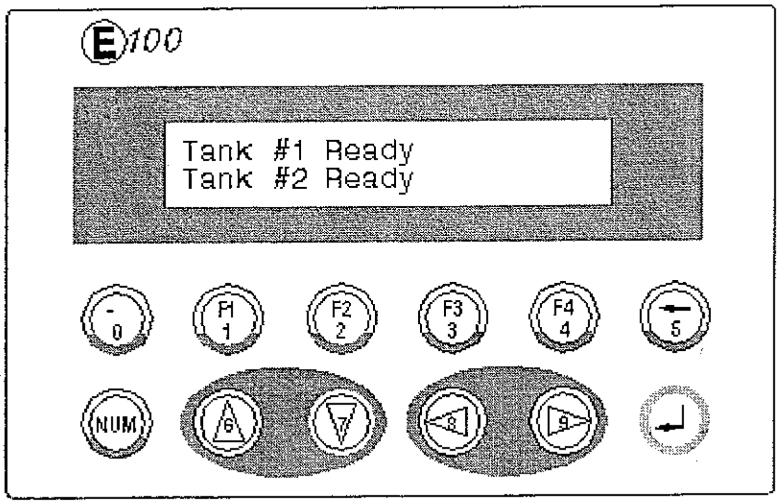
5.2 STATUS SCREEN

The status screen indicates the mode of each tank (i.e. "Filling Tank #1" or "Tank #1 Ready"). This screen is active during normal operations.



Status Screen

- The status screen indicates the condition of each tank (i.e. "Filling Tank #1" or "Tank #1 Ready").



Accessing Main Menu from Status Screen

- To access the main menu from the status screen, simply press the **F1** key.

5.3 SET PARAMETER SCREENS

The set parameter screens allow modification of the basic operating parameters such as operating pressure, bulk tank critical pressure and over pressure. The set parameter screens are accessed through the main menu.

> → **NOTE:**
> When entering the Set Parameters Menu, the system will shut down and all valves will close. This should only be done in a time of service such that the end use is not immediately dependent on gas flow. Product will start being delivered upon exiting the Set-up Menu.

5.3.1 About PLC Controller Parameters

The software in the controller allows you to set up certain parameters to accommodate your particular application. In most cases, the default values will be satisfactory. The controller allows you to configure the following parameters:

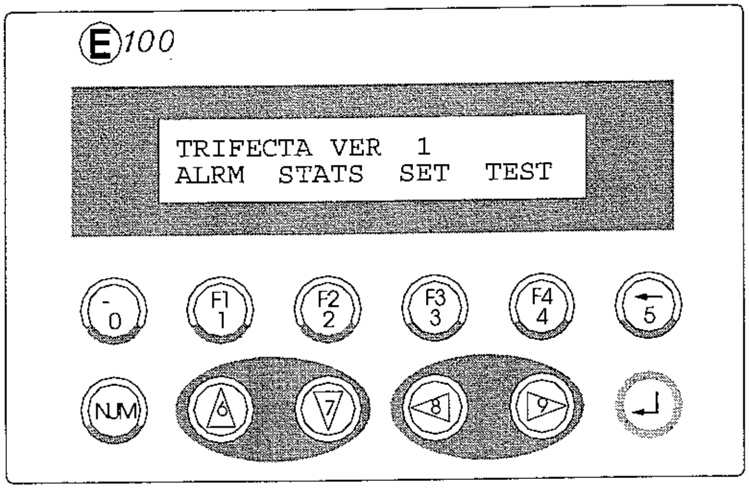
- **Operating Pressure** - This pressure is the low pressure that will cause the pressure builder to start. The pressure builder will come on when the Laser-Cyl reaches this pressure and build pressure up to 20 psig above the operating pressure.
- **Bulk Tank Critical** - At the start of the filling process, the Laser-Cyl will vent its gas into the bulk tank to conserve product if the pressure in the bulk tank is *less* than this value. If the pressure in the bulk tank is greater than this value, it will vent to atmosphere. This also applies to the over pressure condition.
- **Over Pressure** - This is intended for safety purposes and to reduce the risk of relief valves opening. If the pressure in the Laser-Cyl is *above* this value, it will vent product either to the bulk tank or to the atmosphere (according to Bulk Tank Critical).

These values have pre-programmed minimums and maximums. Table 2 shows the respective minimum, maximum and default value for each of the variables.

Table 2. Configurable Values

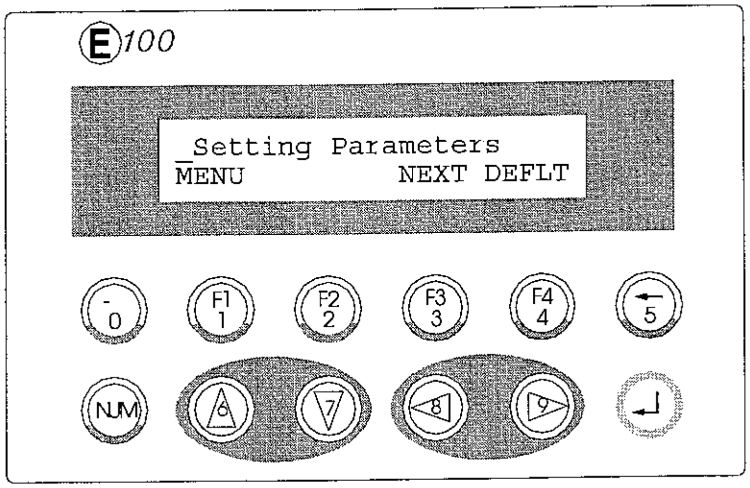
VARIABLE	DEFAULT VALUE	MINIMUM	MAXIMUM
Operating Pressure	425 psig	20 psig	475 psig
Bulk Tank Critical	150 psig	35 psig	245 psig
Over Pressure	480 psig	Operating Pressure + 22 psig	499 psig

5.3.2 CHANGING PLC CONTROLLER PARAMETERS



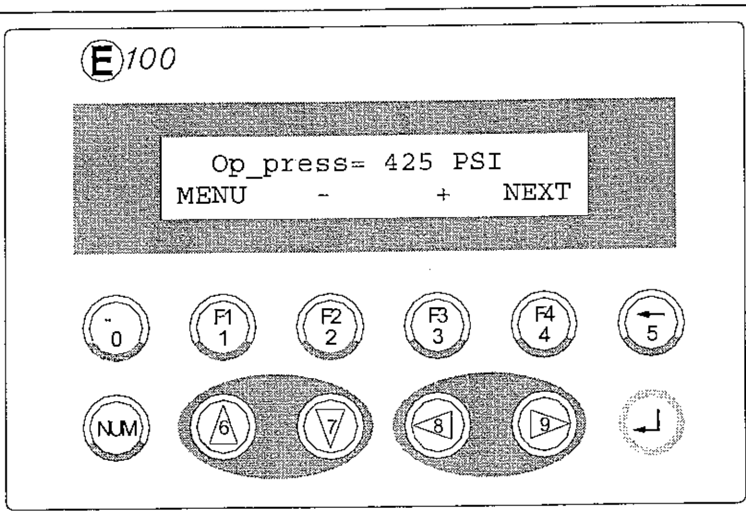
Set Parameter Screens

- Press **F3** to enter the **set parameter** screens.



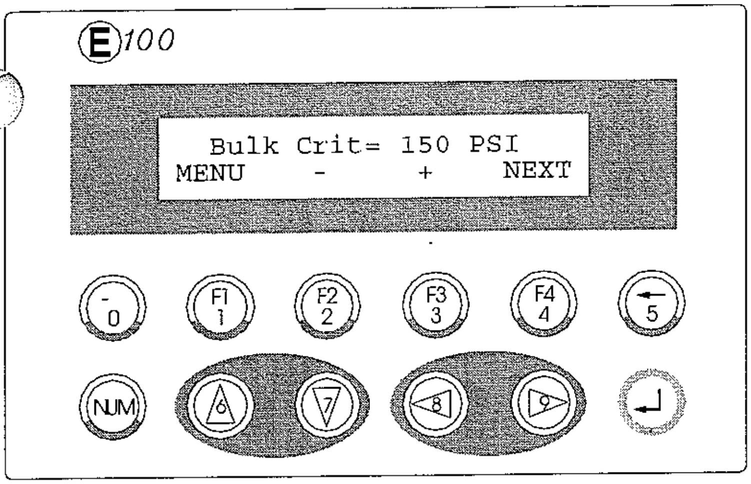
Set Parameter Screens

- When the "Setting Parameters" screen is displayed, press **F3** to continue or **F1** to return to the **main menu**.



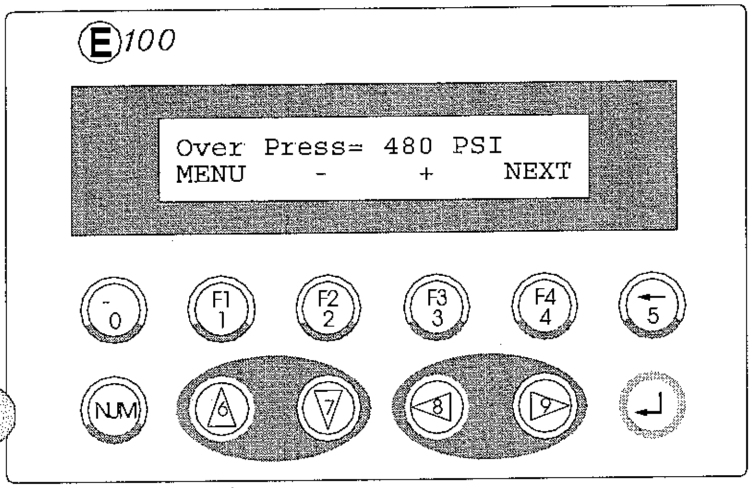
Operating Pressure

- The Trifecta operating pressure can be increased (by pressing **F3**) or decreased (by pressing **F2**) in increments of 1 psi.
- Press **F4** to continue or **F1** to return to the **main menu**



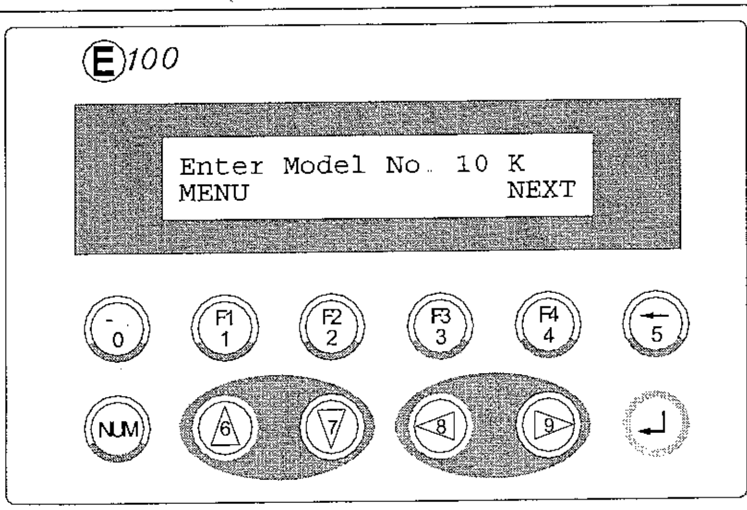
Bulk Tank Critical Pressure

- The Trifecta bulk tank critical pressure can be increased (by pressing **F3**) or decreased (by pressing **F2**) in increments of 5 psi.
- Press **F4** to continue or **F1** to return to the **main menu**



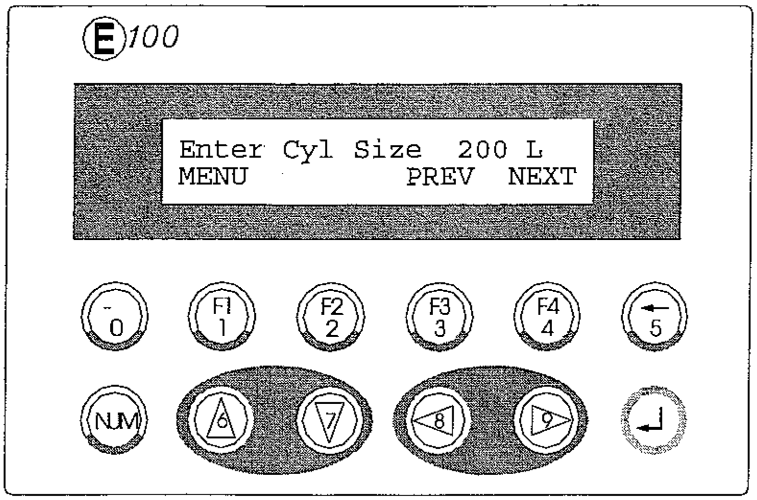
Over Pressure

- The Trifecta over pressure can be increased (by pressing **F3**) or decreased (by pressing **F2**) in increments of 1 psi.
- Press **F4** to continue or **F1** to return to the **main menu**.



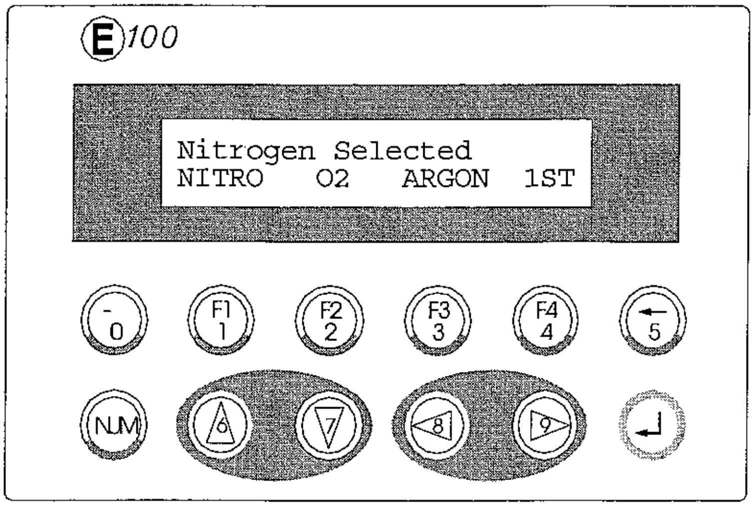
Model or Flow Rating

- To change the Trifecta model, press and hold the NUM key and simultaneously press either "2" for 2K or "1" and "0" for 10K. Release the NUM key and press the enter key (bottom right).
- Note: For 5K model, use 10K.
- This parameter only affects the Laser-Cyl filling. If 2K is selected, the Laser-Cyls will fill to 32" H_2O and if 10K is selected, the Laser-Cyls will fill to 28" H_2O.
- Press **F4** to continue or **F1** to return to the **main menu.**



Laser-Cyl Size

- The Laser-Cyl size parameter may be changed in the same manner as the model number.
- Note: All new Trifecta systems use 200 L Laser-Cyls and this parameter will be factory set.
- Press **F4** to continue or **F1** to return to the **main menu**.



Product Selection

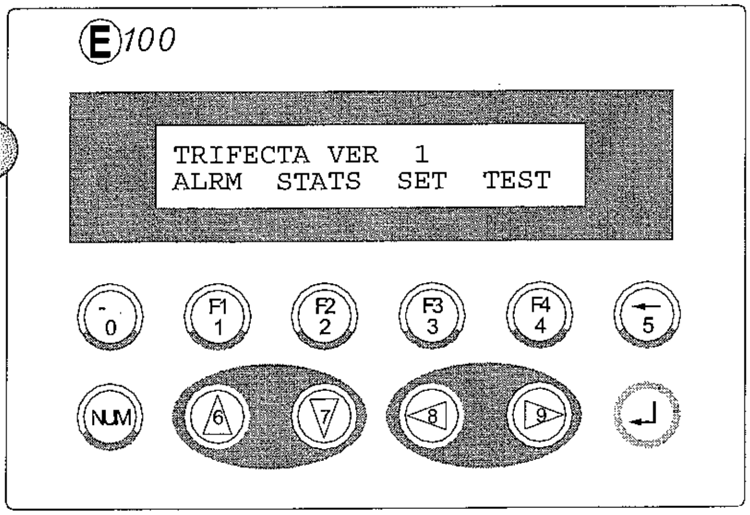
- Select the product by pressing **F1** for Nitrogen, **F2** for Oxygen or **F3** for Argon.
- The product that is currently selected will be displayed on the top line.
- Press **F4** to return to the **main menu**.
- From the **main menu**, press **F2** to return to the **status** screen.

If the system is turned off, all of the parameters are stored in memory. When the system is turned back on, the controller will resume operation based on the most current values. The values will not need to be re-configured each time it is turned on.

5.4 TEST MENU

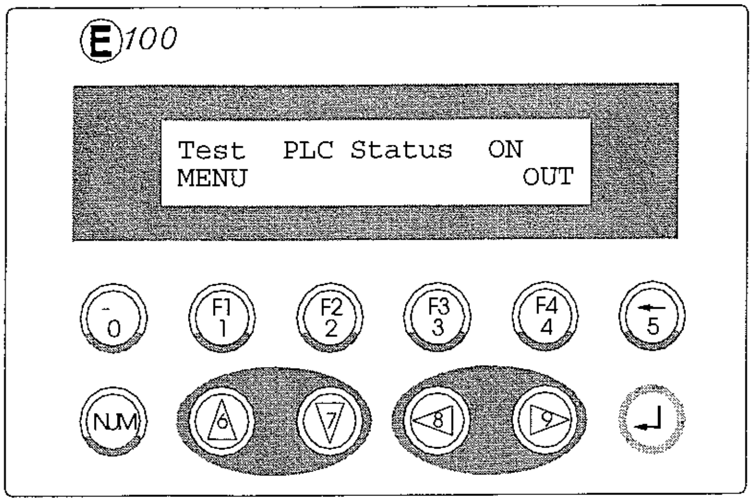
The **test menu** allows the user to energize the solenoid valves individually for troubleshooting or manual startup operations. The **test menu** is accessed through the **main menu**.

> ➔ **NOTE:**
> When entering the Test Menu, the system will shut down and all valves will close. This should only be done in a time of service such that the end use is not immediately dependent on gas flow. Product will start being delivered upon exiting the Test Menu.



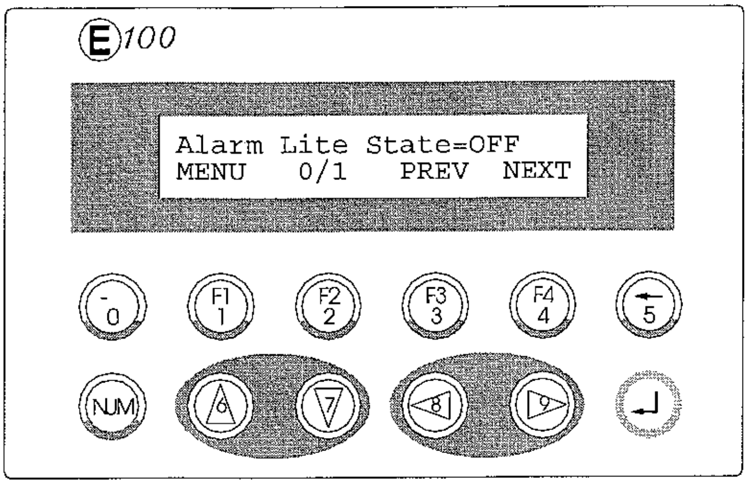
Test Menu

- The test menu can be accessed by pressing **F4** from the **main menu**.
- The **main menu** can be accessed by pressing **F1** while on the **status** screen.



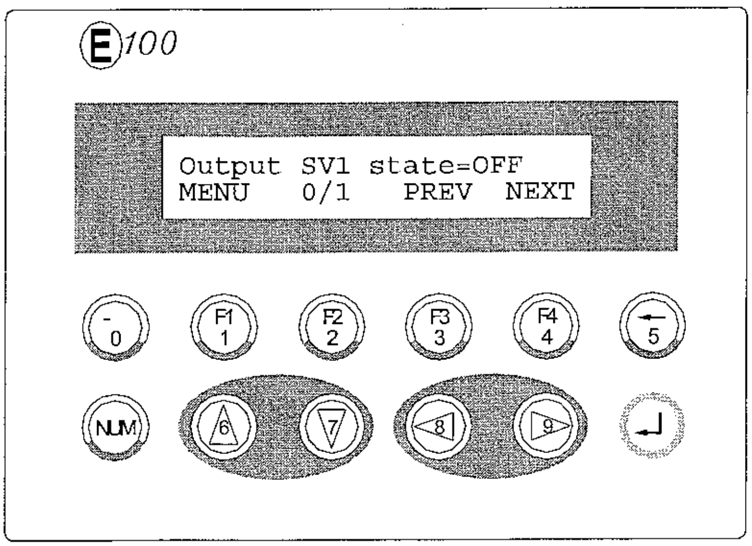
Test Menu – PLC Status

- This screen indicates the PLC operational status.
- Press **F4** to continue or press **F1** to return to the **main menu**.



Test Menu – Alarm Light State

- This screen allows on/off testing of an optional alarm light.
- Press and hold **F2** to energize optional alarm light. Note: alarm light is not supplied as standard equipment.
- Press **F4** to continue, press **F3** to go back or press **F1** to return to the **main menu**.



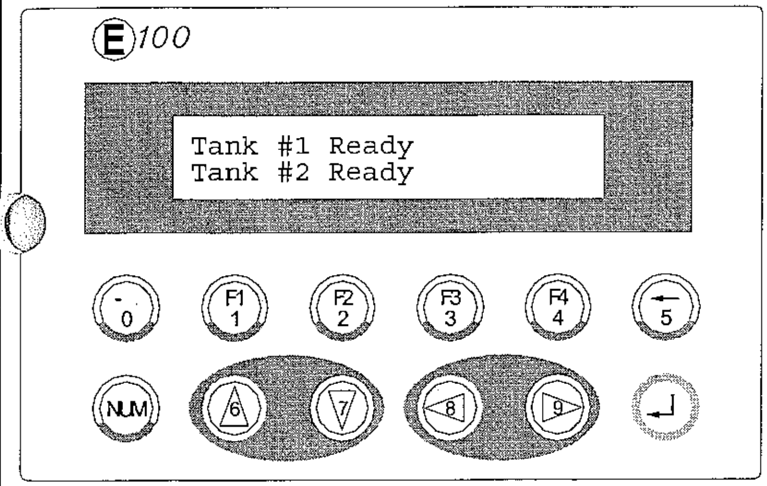
Test Menu – Solenoid Valves

- These screens allow on/off testing of the solenoid valves.
- Press and hold **F2** to energize solenoid valve #1. When F2 is released, the solenoid will be de-energized.
- Press **F4** to continue, press **F3** to go back or press **F1** to return to the **main menu**.
- All 9 solenoid valves can be accessed and tested in this menu by repeatedly pressing **F4**.

5.5 View Parameter Screens

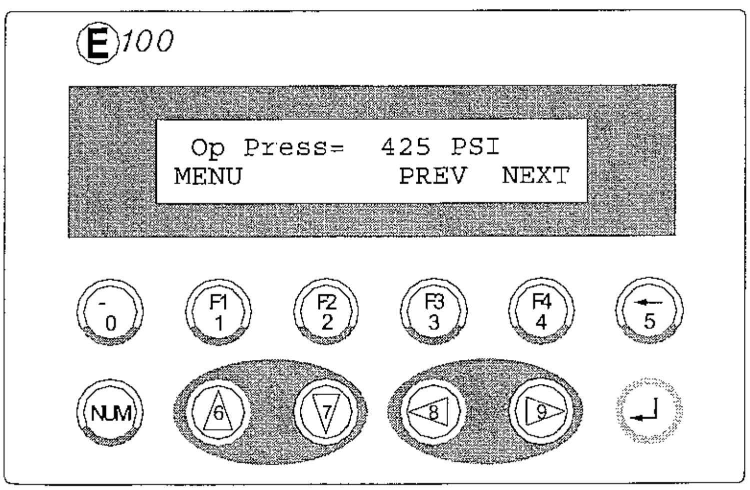
The **view parameter** screens display the operating parameters such as operating pressure, tank liquid levels and tank pressures. The **view parameter** screens are accessed by pressing **F4** from the **status** screen.

> ➔ **NOTE:**
> When the **view parameter** screens are accessed, the Trifecta system remains operational.



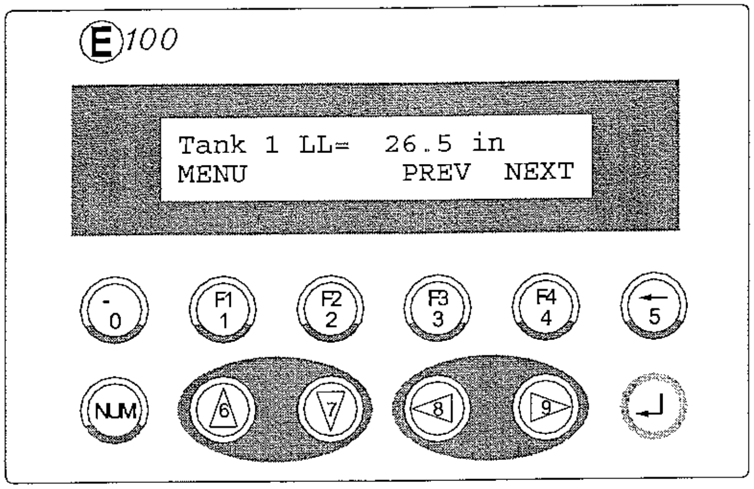
Accessing Parameter Screens from Status Screen

- To access the **parameter** screens from the status screen, simply press the **F4** key.



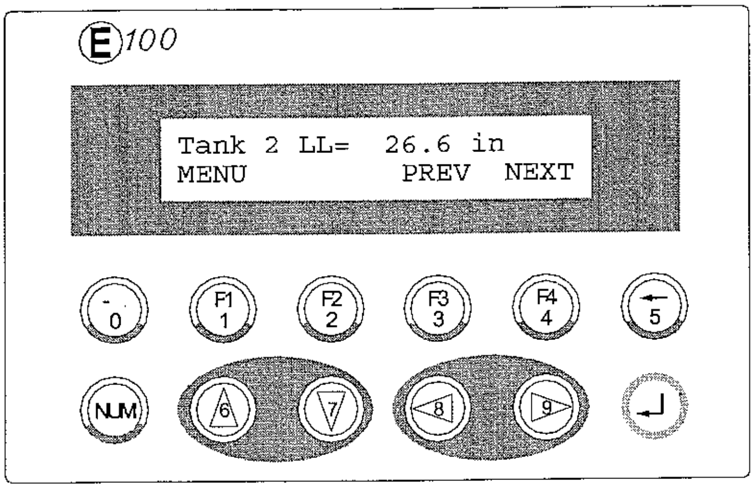
Parameter Screen – Operating Pressure

- The operating pressure **parameter** screen displays the current operating pressure setting.
- This is a read-only screen. Changes can be made from the **set parameter** screens (see procedure above).
- Press **F4** to continue, press **F1** to access the **main menu**, or press **F3** to return to the **status** screen.



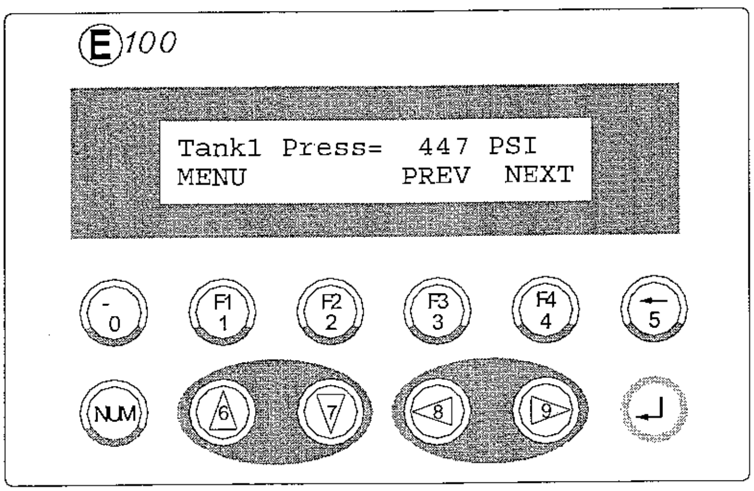
Parameter Screen – Tank 1 Liquid Level

- The Tank 1 LL **parameter** screen displays the current liquid level in Tank 1 (inches H2O).
- This parameter is read-only and is not changeable.
- Press **F4** to continue, press **F1** to access the **main menu**, or press **F3** to go back.



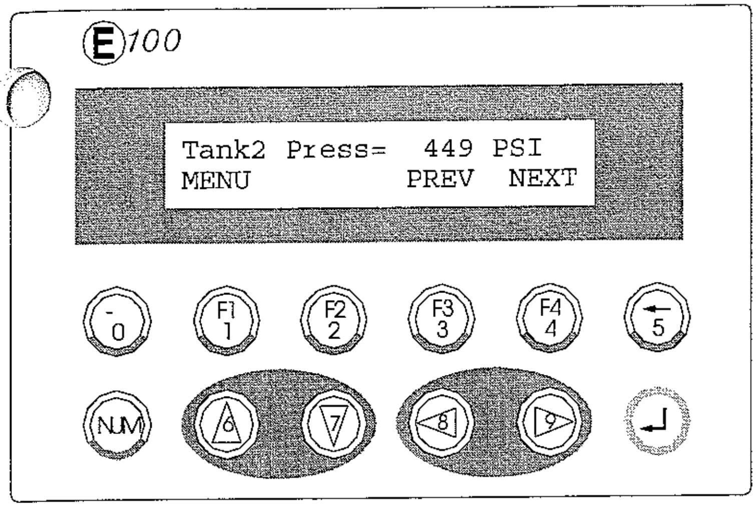
Parameter Screen – Tank 2 Liquid Level

- The Tank 2 LL **parameter** screen displays the current liquid level in Tank 2 (inches H2O).
- This parameter is read-only and is not changeable.
- Press **F4** to continue, press **F1** to access the **main menu**, or press **F3** to go back.



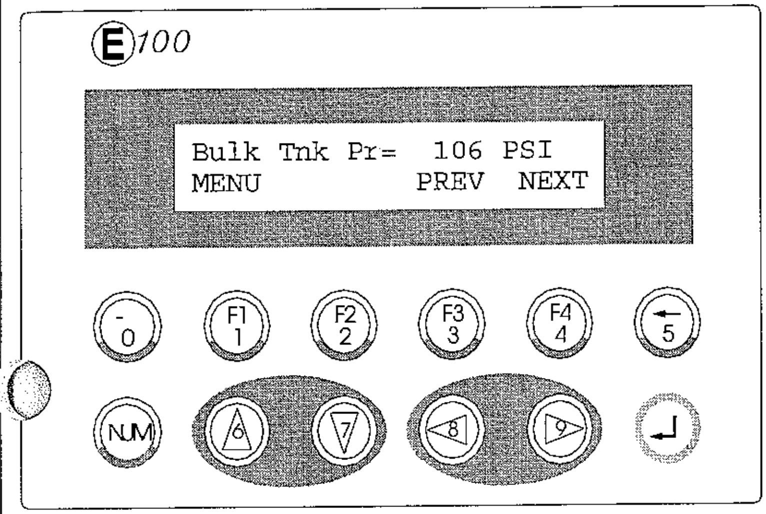
Parameter Screen – Tank 1 Pressure

- The Tank 1 Pressure **parameter** screen displays the current pressure in Tank 1 (psi).
- This parameter is read-only and is not changeable.
- Press **F4** to continue, press **F1** to access the **main menu**, or press **F3** to go back.



Parameter Screen – Tank 2 Pressure

- The Tank 2 Pressure **parameter** screen displays the current pressure in Tank 2 (psi).
- This parameter is read-only and is not changeable.
- Press **F4** to continue, press **F1** to access the **main menu**, or press **F3** to go back.



Parameter Screen – Bulk Tank Pressure

- The Bulk Tank Pressure **parameter** screen displays the current pressure in the bulk tank (psi).
- This parameter is read-only and is not changeable.
- Press **F4** to continue, press **F1** to access the **main menu**, or press **F3** to go back.
- All the other parameters can be viewed by repeatedly pressing **F4** (i.e. Bulk Tank Critical, Laser-Cyl Size, Model Number, etc)

6. PREVENTATIVE MAINTENANCE

6.1 Preventative Maintenance Procedure

Over time, the wear items on the Trifecta (as in any mechanical system) will fail. For this reason, a regular maintenance procedure is recommended to prevent any unexpected downtime when such a part requires replacement.

The most common field failures are due to:

- Malfunctioning Solenoids and Check Valves (leaks) caused by
  - Build up of impurities of liquid fed to the system from the bulk tank
  - Introduction of moisture to system without proper purge process
  - Normal wear and tear of solenoids' pistons and seats due to cycling
- Leaking Fittings
- Malfunctioning Laser-Cyl Reliefs
  - Relief Valve opening at lower pressure than set point
  - Burst Disc rupture (fatigue failure)

With a regular maintenance procedure, these possible failures and corresponding down times can be prevented. To ensure uninterrupted operation, it is recommended that the following maintenance procedures be followed.

Every Year:

- Verify two normal operation cycles per Section 7.2
- Inspect integrity of all wire connections in control box
- Verify accuracy of analog gauges against pressure transmitters per Section 7.5
- Leak check entire Trifecta System per Section 7.4

Every Three Years:

- Replace all check valves (6)
- Replace pistons on all solenoid valves (9) per section 9.1
- Replace relief valves and burst discs on tanks 1 and 2

6.2 RECOMMENDED SPARE PARTS

In the event that repair is necessary, Chart Industries recommends the following spare parts should be kept on hand:

Table 3 - Recommended Spare Parts List

PART Description	CHART. Part Number	Quantity
Terminals	11794491	1
Fuses	11794504	1
Line Relief Valve	11022934	1
Solenoid Valve Piston Assembly for 10925509	10963062	1
Solenoid Valve Piston Assembly for 11033191	11034020	1
Laser-Cyl Relief Valve	11485293	1
Laser-Cyl Rupture Disc	11055525	1
Pressure Transmitter	11043743	1
Differential Pressure Transmitter	11043751	1

7. TROUBLESHOOTING GUIDE

If the regular maintenance procedure above is followed, troubleshooting should not be necessary. If problems do occur, the following is a step-by-step troubleshooting guide. If you are not familiar with normal Trifecta operation, please read Section 4 before continuing.

While Troubleshooting the Trifecta, there are five things that should be monitored or checked for inconsistency to aid in diagnosis.

- **7.1 Confirm** all **valves** on the Bulk Tank and Trifecta are in their normal operating position
- **7.2** Compare actual energizing of solenoids to **normal activation of solenoids** outlined in the normal operation spreadsheet of the Appendix.
- **7.3** Check for **frost formation** on lines which should not have recently been active
- **7.4 Leak check** all plumbing components
- **7.5 Check for discrepancies** between analog gauges and controller parameters

The above steps, described in greater detail below, will lead you to the root of the malfunction.

7.1 Confirm Valve Positions

Confirm that all the following valves are in the correct position.

Bulk Tank Auxiliary Liquid Valve	Open
Bulk Tank Pressure Building Valve	Open
Needle valves on plumbing stack of Trifecta tanks	Open
All 9 Solenoid Valves on Trifecta	Closed (manually closed per Figure 9)

7.2 Normal Activation of Solenoids

Compare the Energizing (opening) of solenoids to the normal solenoid operation spreadsheet shown in the Appendix. This will tell you what solenoids should be firing during any given operation, and what the operational parameters (pressures, liquid levels) should be to make that solenoid open.

If a solenoid is not firing when it should, continue to Solenoid/Relay Section 8.2. If the solenoid is firing when it should not, continue to the solenoid section.

7.3 Frost Formation

Frost forms on all lines that have cold vapor or liquid flow through them. The frost will begin to thaw when product is no longer flowing through the lines. The frost will be evident for any significant amount of flow through the lines. Simply by looking at the frost formation, a check valve and/or solenoid, which is leaking or stuck open, can often be detected.

By the same token, lack of frost on a line will indicate that product is not flowing through the line and that a solenoid is stuck shut or for some reason not firing properly.

If a solenoid is not firing when it should, continue to the Solenoid/Relay section 8.2. Also, if the solenoid is firing when it should not, continue to the Solenoid Section 8.2. If a check valve is leaking through the seat, continue to Check Valve Section 8.1.

7.4 Leak Check

Leak check all plumbing components, with special attention to plumbing stack on tank and connections to pressure transmitters.

- A leak at any point in the Trifecta system will result in loss of product.

- A leak in the plumbing on the plumbing stack or pressure transducers can cause the pressure and differential pressure transducers to read incorrectly. These transducers provide the input to the Trifecta controller, which tell it when to open and close solenoids.

Refer to Leak Section 8.3 to remedy.

7.5 PRESSURE GAUGE DISCREPANCIES

Record tank and bulk tank parameters as described in the View Parameters Section 5.5. Compare these values to those on the analog gauges of the tanks and the bulk tank.

Bulk Tank		
Liquid Level (Analog Gauge)	___________	" H2O
Pressure (Analog Gauge)	___________	PSIG.
Pressure (from LED Display)	___________	PSIG.
Tank 1		
Pressure (Analog Gauge)	___________	PSIG.
Pressure (from LED Display)	___________	PSIG.
Liquid Level (Analog Gauge)	___________	" H2O
Liquid Level (from LED Display)	___________	" H2O
Tank 2		
Pressure (Analog Gauge)	___________	PSIG.
Pressure (from LED Display)	___________	PSIG.
Liquid Level (Analog Gauge)	___________	" H2O
Liquid Level (from LED Display)	___________	" H2O

Note that the transmitter and gauge readings may not match exactly.

A discrepancy can be caused by either the analog gauge or by the transmitter. In most cases, the cause is the analog gauge. Replace this first. If the cause is the transmitter, continue to the Pressure Transmitter Section 8.4.

8. REPAIRS

> ➔ **NOTE:**
> Any time plumbing is removed from the Trifecta system, take care not to allow any moisture enter the system. This moisture will freeze at the Trifecta's internal temperatures and can cause check valves and solenoid valves to stick.

8.1 CHECK VALVE LEAKING

If you find that there is a leaking check valve, the Trifecta will have to be emptied and depressurized. The check valve should then be replaced. Replacement parts can be located through Replacement Parts Section 9.

8.2 SOLENOIDS/RELAYS

If the solenoid appears to be malfunctioning, it could be for a few reasons:

8.2.1 RELAY IS NOT ENERGIZING SOLENOID
8.2.2 CONTAMINANTS ON SOLENOID SEAT
8.2.3 MOISTURE IN SOLENOID
8.2.4 SOLENOID FAILURE

Below, the most commons symptoms of these failures and their remedies are described.

8.2.1 RELAY IS NOT ENERGIZING SOLENOID

The relay gets a signal from the controller telling it to energize it's solenoid. When this happens, an LED on the relay itself lights up. If the LED lights up, but the solenoid is not energized and does not open, the relay is bad. Continue to Section 9, Replacement Parts, to obtain a new relay.

8.2.2 CONTAMINANTS ON SOLENOID SEAT

If the solenoid appears to be leaking, there are most likely contaminants on the seat of the piston. The seat or piston may also be damaged. In this case, remove the piston and replace as in Replacement Parts Section 9.1.

8.2.3 MOISTURE IN SOLENOID

Solenoid should be allowed to thaw. Once thawed, moisture will be removed from solenoid upon next use.

8.2.4 Solenoid Failure

If none of the above improves the situation, there has been a catastrophic failure within the solenoid coil. The entire solenoid must be replaced as in Replacement Parts Section 9.1.

8.3 Leaking Components

If the leak can not be fixed by tightening or replumbing a component, a new component will have to be ordered. Refer to the Repair section to locate the description and part number of this component

> ➔ **NOTE:**
> All replacement fittings should be cleaned for oxygen service. Refer to replacement parts section for Chart part numbers for all plumbing components.

8.4 Pressure Transmitter

The sensor error check function is designed to find problems such as a wire coming disconnected, or a short in the transmitter. This feature will not determine if the transmitter reading is off by any amount. If a Sensor Connection Error occurs, check the wire junctions at the transmitter end and inside the control box. Confirm that all connections are made. If all connections are made and the error condition does not go away, check the transmitter output as shown in the Section 5.5. Recalibrate or replace the transmitter as necessary.

9. REPLACEMENT PARTS

If replacement parts are ever required, the following section will locate the part number to order from Chart customer service 1 (800) 400-4683.

9.1 SOLENOID VALVES

The solenoid valves that are used in this system have very long life and valve failure or replacement is unlikely. In the event that a valve needs to be repaired, the following table gives the part number of the valve. It is generally not necessary to remove the valve body, but only replace the top works of the valve.

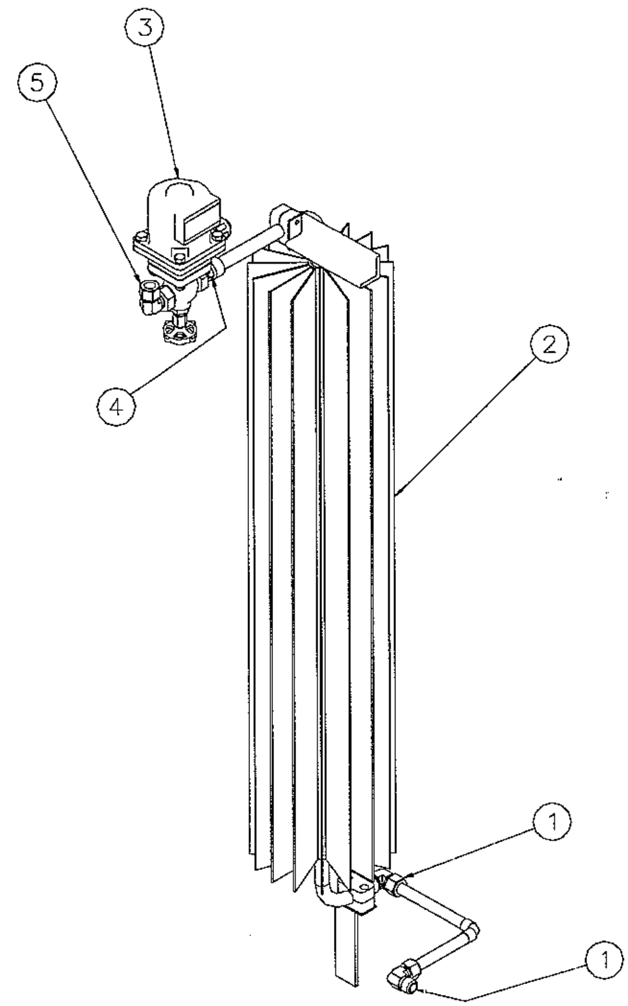
If the whole valve is not required, there are repair kits available for various parts of the valve. The following table lists the available repair kits for these valves:

Table 1 - Solenoid Valve Repair Kits

Repair Kit	Chart Part Number (for valve # 10925509)	Chart Part Number (for valve # 11033191)
Solenoid Coil (120 Vac)	10963071	11034011
Piston Assembly	10963062	11034020
Gasket	10963100	10963100

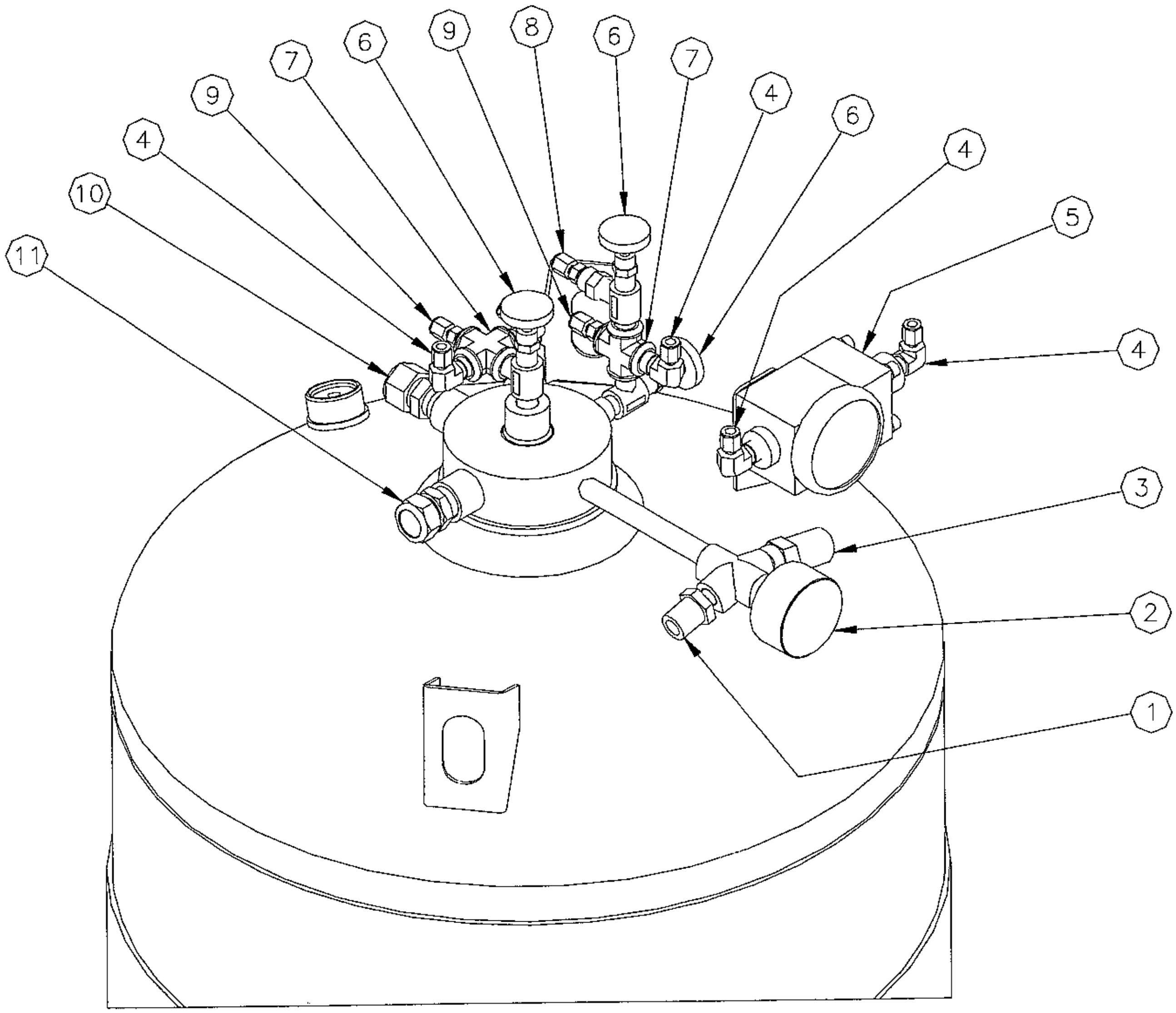
Whenever piston assemblies are changed, or valve is taken apart for cleaning, the bolts must be torqued to 10 to 12 foot-pounds torque, in a normal cross pattern upon re-assembly. If they are over torqued, the body will be distorted, and hang open the piston, causing the valve to stick open. It is also recommended that every time the valve is opened, that the gasket be replaced, as the gasket takes a permanent set each time the bolts are torqued.

9.2 ASSEMBLY DIAGRAMS FOR REPLACEMENT PART LOCATION



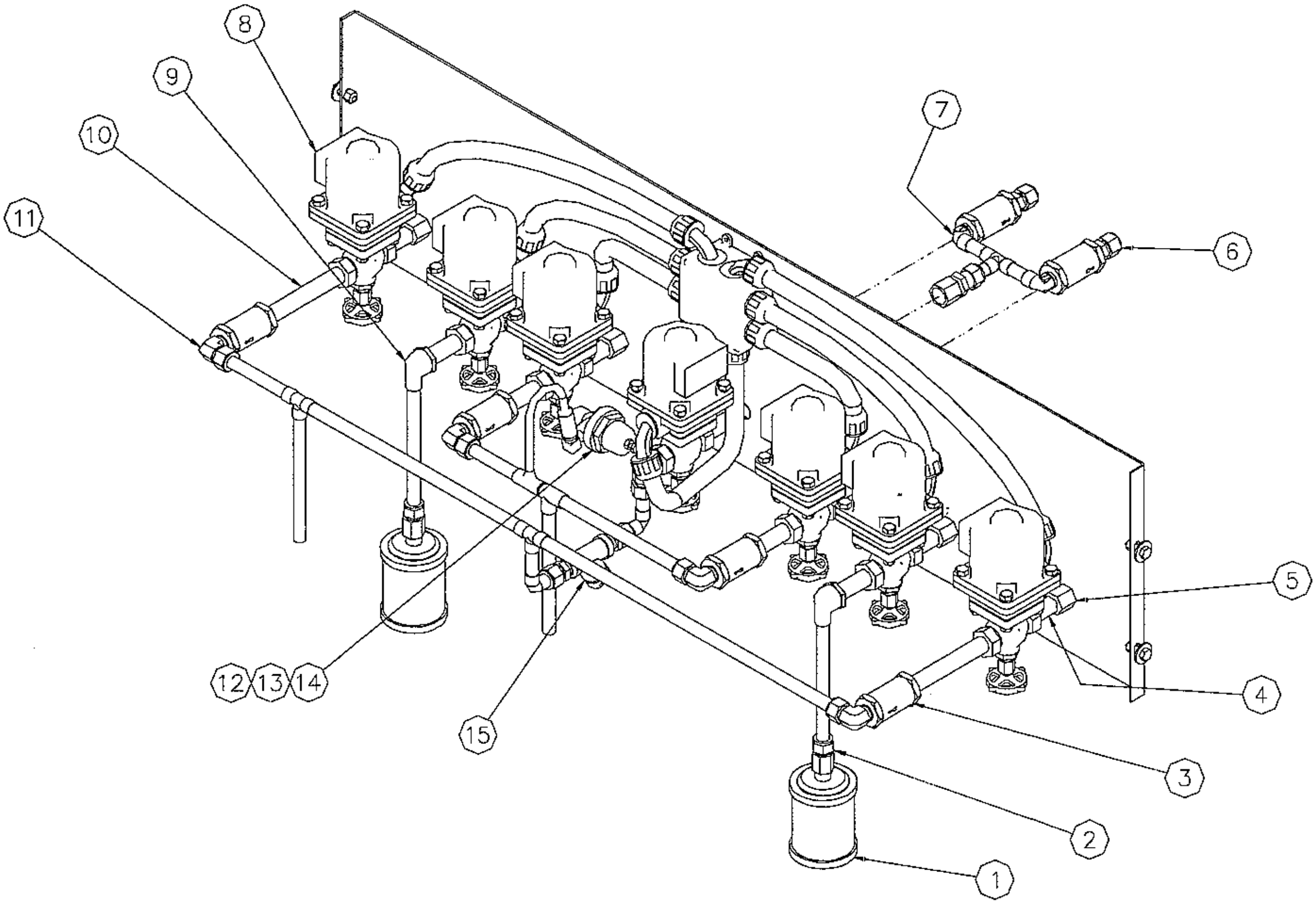
#	MODEL	PART NUMBER	QTY	DESCRIPTION
1	2K	11078196	2	ELBOW BRS 90D-5/8ODT*1/2MPT
	5K, 10K	11078196	2	ELBOW BRS 90D-5/8ODT*1/2MPT
2	2K	11731175	1	VAPORIZER ASSY 2K
	5K	11731183	1	VAPORIZER ASSY 5K
	10K	11731191	1	VAPORIZER ASSY 10K
3	2K	10925509	1	VALVE SOLENOID-1/2FPT-500PSI
	5K, 10K	11033191	1	VALVE SOLENOID-3/4FPT-500PSI
4	2K	1310102	1	NIPPLE HEX BRS-1/2NPT
	5K, 10K	1311891	1	NIPPLE HEX BRS-3/4NPT
5	2K	11078196	1	ELBOW BRS 90D-5/8ODT*1/2MPT
	5K, 10K	11078217	1	ELBOW BRS 90D-7/8ODT*3/4MPT

Figure 10. Pressure Building Assembly



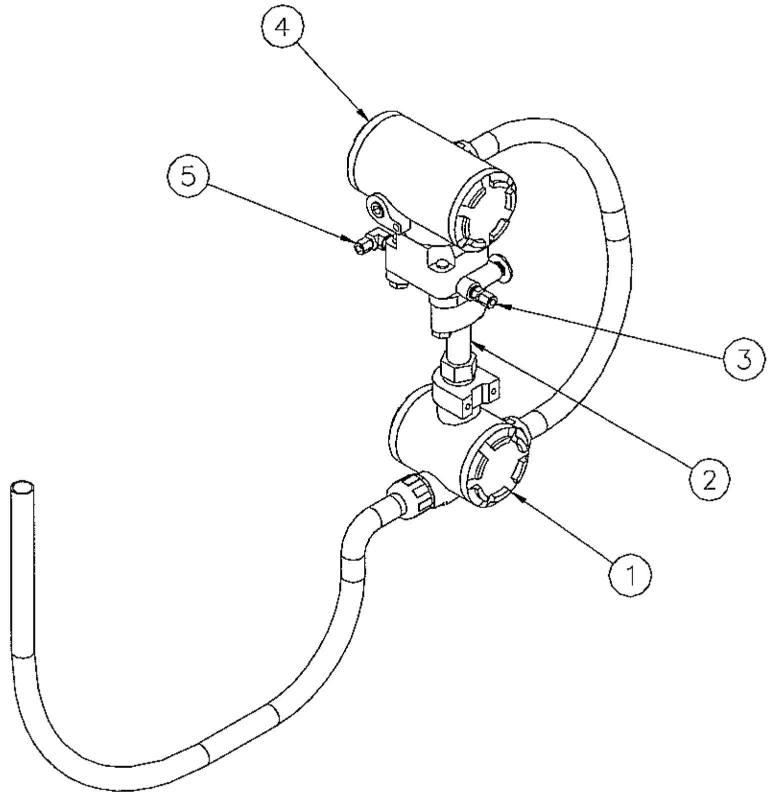
#	PART NUMBER	QTY	DESCRIPTION
1	11055525	1	RUPUTURE DISC ASSY-1/4MPT*3/8MPT
2	2010064	1	PRESSURE GAUGE 0-600 PSI
3	11485293	1	RELIEF VALVE 500 PSI-1/4MPT
4	11555431	5	ELBOW BRS 90D-1/4ODT*1/4MPT
5	11527828	1	DIFFERENTIAL PRESSURE GAUGE-0-60"H20
6	10907239	3	NEEDLE VALVE-1/4 MPT
7	1212922	2	CROSS BRS-1/4MPT
8	11555458	1	CONN BRS-1/4ODT*1/4FPT
9	11555440	2	CONN BRS-1/4ODT*1/4MPT
10	11078161	2	CONN BRS-5/8ODT*1/2MPT
11	11789449	1	CONN BRS-7/8ODT*1/2MPT

Figure 11. Tank Plumbing Assembly



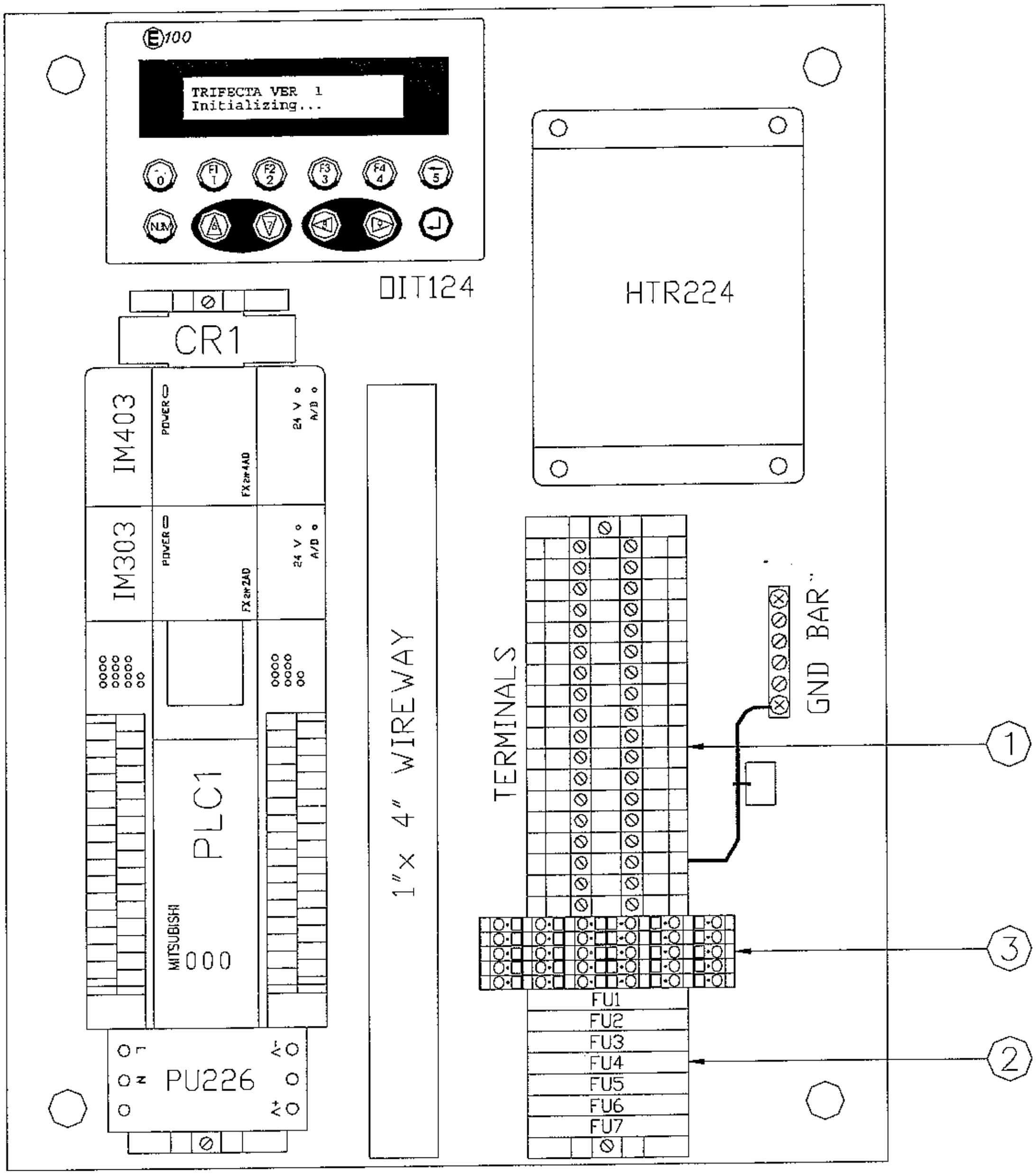
#	PART NUMBER	QTY	DESCRIPTION	#	PART NUMBER	QTY	DESCRIPTION
1	11731685	2	MUFFLER-500 PSI-1/2MPT	9	1611152	2	ELBOW BRS 90D-1/2C*1/2FPT
2	11078153	2	CONN BRS-5/8ODT*1/2FPT	10	1312061	2	NIPPLE SS-1/2NPT*6
3	11051090	6	CHECK VALVE-1/2FPT*1/2FPT	11	11078196	5	ELBOW BRS 90D-5/8ODT*1/2MPT
4	1312502	9	NIPPLE BRS-1/2NPT*3	12	11022934	1	REGULATOR-575PSI-1/4NPT
5	10886394	7	CONN BRS BULKHEAD-5/8ODT*1/2FPT	13	1310092	1	NIPPLE HEX BRS-1/4NPT
6	11078161	4	CONN BRS-5/8ODT*1/2MPT	14	1210462	2	ELBQW STREET BRS 90D-1/4MPT
7	1611122	2	ELBOW BRS 90D-1/2C*1/2MPT	15	11379600	1	STRAINER-1/2FPT
8	10925509	7	SOLENOID VALVE-500 PSI-1/2FPT	16			

Figure 12. Valve Panel Assembly



#	PART NUMBER	QTY	DESCRIPTION
1	11043743	1	PRESSURE TRANSMITTER–500PSIG
2	1312061	1	NIPPLE SS–1/2NPT*6
3	11555440	1	CONN BRS–1/4ODT*1/4MPT
4	11043751	1	DIFFERENTIAL PRESSURE TRANSMITTER
5	11555431	1	ELBOW BRS 90D–1/4ODT*1/4MPT

Figure 13. Transmitter Subassembly



#	PART NUMBER	QTY	DESCRIPTION
1	11794491	1	TERMINAL QUICK CONNECT
2	11794504	7	TENSION CLAMP FUSE-1/4*1-1/4
3	11794512	5	TENSION CLAMP TRIPLE LEVEL

Figure 14. Terminal, Fuse Location Diagram

10. ADDITIONAL TECHNICAL ASSISTANCE

In the event problems occur that are not explained in this manual, technical assistance is available by calling 1-800-400-4683.

11. WARRANTY

Vacuum integrity as measured by conformance to Chart NER (Normal Evaporation Rate) specifications is warranted for 3 years from the date of invoice.

Piping components are warranted for a period of 90 days from the date of invoice. Authorization to replace piping components can be given by the product manager, regional sales person or customer service representative.

All replacements under warranty with a component price less than $75.00 will be replaced at no charge. The return material authorization (RMA) process must be initiated prior to replacements being sent out. All components exceeding $75.00 that are replaced under warranty will be invoiced to the customer. Upon return of the components the customer will be issued a credit based on our component evaluation

Chart Storage Systems Division will not be liable for component replacement labor exceeding 2 hours for actual replacement and 2 hours travel time (4 hours @ 65.00/hour), product losses, or any other costs not related to replacement of components covered by warranty.

APPENDIX

Trifecta Automatic Operation

							Solenoids								
							Tank 1				Tank 2				Liquid Fill
							Vent to Bulk	Vent to Atm.	Gas Use	Pressure Building	Vent to Bulk	Vent to Atm.	Gas Use	Pressure Building	
Tank 1 Mode	Tank 2 Mode	Bulk Tank Pressure	Tank 1 Liquid Level	Tank 1 Pressure	Tank 2 Liquid Level	Tank 2 Pressure	Solenoid #1	Solenoid #2	Solenoid #3	Solenoid #4	Solenoid #7	Solenoid #6	Solenoid #5	Solenoid #8	Solenoid #9
		psi	" H20	psi	" H20	psi									
1. After installation and commisioning:															
Apply Power		130	0	130	0	130									
Filling	Need to Fill	130	filling	maintains ~90 psi*	0	130		intermittent							open
In Use (full, pressure building)	Filling	130	28" or 32"	increasing	filling	maintains ~90 psi*			open	open		intermittent			open
In Use	Filling	130	decreasing	425 < pressure < 450	filling	maintains ~90 psi*			open	intermittent		intermittent			open
In Use	Stand By (full, pressure building)	130	decreasing	425 < pressure < 450	28" or 32"	Building			open	intermittent				open	
After this first Cylcle, operation continues as shown below ...															
2. Typical Usage Cycle:															
In Use	Stand By	130	decreasing	425 < pressure < 450	28" or 32"	425 < pressure < 450			open	intermittent				intermittent	
Filling (Vent to Bulk)	In Use	130	5.8"	decreasing to 150	decreasing	"	open						open	intermittent	open
Filling (Vent to Atmosphere)	In Use	130	filling	maintains ~90 psi*	"	-		intermittent					open	intermittent	open
Stand By (full, pressure building)	In Use	130	28" or 32"	increasing	-	"				open			open	intermittent	
Stand By	In Use	130	"	425 < pressure < 450	"	"				intermittent			open	intermittent	
In Use	Filling (Vent to Bulk)	130	decreasing	"	5.8"	decreasing to 150			open	intermittent	open				open
In Use	Filling (Vent to Atmosphere)	130	"	"	filling	maintains ~90 psi*			open	intermittent		intermittent			open
In Use	Stand By (full, pressure building)	130	"	"	28" or 32"	increasing			open	intermittent				open	

This Typical Usage Cylce then continues to repeat itself until the power is shut off.

3. Other Trifecta Operations

Tank 1 above "Over Pressure"	Bulk Tank Pressure below "Bulk Tank Critical"	Vents Tank 1 to 20 psi below overpressure
Tank 1 above "Over Pressure"	Bulk Tank Pressure above "Bulk Tank Critical"	Vents Tank 1 to 20 psi below overpressure
Tank 2 above "Over Pressure"	Bulk Tank Pressure below "Bulk Tank Critical"	Vents Tank 2 to 20 psi below overpressure
Tank 2 above "Over Pressure"	Bulk Tank Pressure above "Bulk Tank Critical"	Vents Tank 2 to 20 psi below overpressure

Chart Industries Inc.
P/N 11811589 3/03