Product Manual

Trifecta
X-Series

Designed and Built by:

Chart Inc.

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Part Number 13153225 Rev. F

Contents

Revision Log

Revision Level	Date	Description
C	05/2013	Third release to add 600 LIN model
D	10/2013	Added information on 230 VAC Trifecta
E	08/2017	Reformat to new layout
F	09/2018	New spare parts list, recommended parts list

Preface

General

The Trifecta X-Series is the preferred solution for reliable and continuous laser assist gases for delivery pressures up to 550 psig and flow rates up to 15,000 scfh. Drawing liquid from a standard bulk tank, the Trifecta system boosts the liquid pressure by alternately feeding two liquid cylinders equipped with innovative multi-function pressure building vaporizers. The Trifecta solution has no downtime and minimal losses when compared with other laser assist gas solutions. This convenient solution eliminates high-pressure pumps, compressors, cylinder cradles and surge tanks.

Product Highlights

- System utilizes standard low-pressure bulk tank to lower investment and use existing assets
- No downtime - system maintains pressure and flow when bulk tank is filled and eliminates excessive product losses associated with high-pressure bulk tanks
- Cylinders switch by pressure instead of level to further reduce product loss and protect against pressure decay
- Robust design features streamlined all stainless steel piping with only five control valves and one integrated electronic control system (PLC) for increased durability and reliability
- Computer-controlled design simplifies installation, start-up and continuous operation
- Frame assembly features a protective top cover in a compact footprint with an elevated base for improved ventilation
- Available for oxygen (350 & 500 MAWP), or nitrogen and argon (500 & 600 MAWP) service
- Inconel and copper material used where required on high pressure oxygen unit

Product Manual

The Trifecta X-Series Product Manual is designed to be used in conjunction with all Trifecta models provided by Chart. If there are any questions regarding the operation of this system, contact Chart's Technical Service division at 1-800-400-4683.

This manual contains information regarding the safe operation and handling of liquid nitrogen, argon and oxygen with this system. It should be thoroughly read and understood by anyone that operates the equipment.

The safety requirements for operating the system and handling or transporting extremely cold liquid products are shown in the Safety section. Use this safety section as a "Safety Checklist" each time the equipment is being used.

The Introduction section discusses the general features of the system and describes typical layout and flow capacity.

In the Installation section information is available on the best location of the skid, connecting piping, power supply and commissioning of the system.

For information on settings and operation of the system refer to the Operations section.

The Service, Preventive Maintenance, and Troubleshooting sections of this manual should aid in answering common questions about the system. Part numbers are also available for ease of ordering through www.chartparts.com.

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:

BAR	Pressure (Metric)
CGA	Compressed Gas Association
MAOP	Maximum Allowable Operating Pressure
MAWP	Maximum Allowable Working Pressure
MPT	Male Pipe Thread
NFPA	National Fire Protection Association
PB	Pressure Builder
PLC	Programmable Logic Controller
PN	Part Number
PSI	Pounds per Square Inch
PSIG	Pounds per Square Inch (Gauge)
SCFH	Standard Cubic Feet Hour

Introduction

General

Congratulations, you are now the owner of a Chart Trifecta X-Series high-pressure gas supply system.

Chart works closely with our customers to ensure the total system is designed properly, making the Trifecta system as effective as possible. Built for long-term integrity and industry leading design, these systems give customers the highest performance at the lowest operating cost - all while providing a single point of contact for efficient project management.

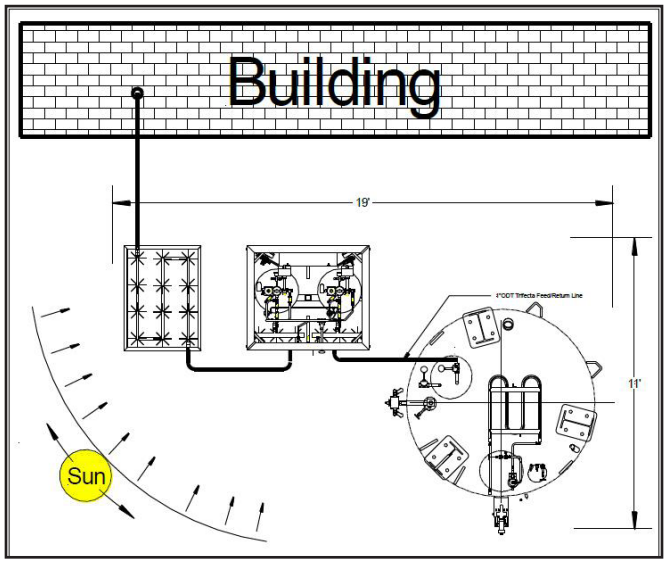
Typical Layout

There are three main components to the "Trifecta" system:

- Low Pressure Bulk Tank
- Vaporizer
- Trifecta X-Series Skid

The Trifecta X-Series has been designed for ease of installation and operation. An ideal install has the Trifecta X-Series skid close to the liquid use valve on the bulk tank, the pressure building side (back) of the skid and the vaporizer facing the sun ("heat of the day").

A typical layout is shown here:



Flow Capacity

The Trifecta X-Series system is designed to supply cryogenic liquid at high flow rates and pressure to a vaporizer, while the reserve tank is being supplied with lower pressure liquid. Its priority is to maintain supply pressure at or above the required pressure setting. The unique design has self-contained diagnostics that alert the operator when the system exceeds the flow rating.

The X-Series can supply liquid nitrogen and liquid argon in maximum average working pressures from 500 to 600 psi. It can supply liquid oxygen in maximum average working pressures from 350 to 500 psi.

Service	MAWP* (psig)	MAOP* (psig)	X5	X10	X15
LIN	500	450	X	X	X
	600	550		X	X
LAR	500	450	X	X	X
	600	550		X	X
LOX	350	300	X	X	X
	500	450			X

*MAWP = Maximum Allowable Working Pressure
MAOP = Maximum Allowable Operating Pressure

The system uses ambient vaporizers to maintain pressure and convert the cryogen into gas; therefore, the performance is dependent on the weather conditions. The best ambient conditions are warm, dry air. The worst is damp air just above the freezing point.

The X-Series was developed and tested by Chart's New Product Development group in the harsh New Prague, Minnesota winter conditions for optimal performance in the field.

For example: the Trifecta X5 is rated to deliver liquid nitrogen at 425 psi @ 5,000 SCFH in ambient conditions similar to Minnesota. If the end user can tolerate lower delivery pressures, the X-Series can deliver even greater flow rates. If the rated flows are not needed, the system can be set to higher pressures. Use the graphics on the following page to find the flow capability for your conditions:

Note: *If the gas use requirements exceed the flow capability of the Trifecta system, the result will be a drop in pressure. Excessive pressure drops can result in pressures and flows at the laser nozzles that result in less than clean cuts (part rework may be required).*

Pressure too low (heavy dross)

Proper pressure and flow

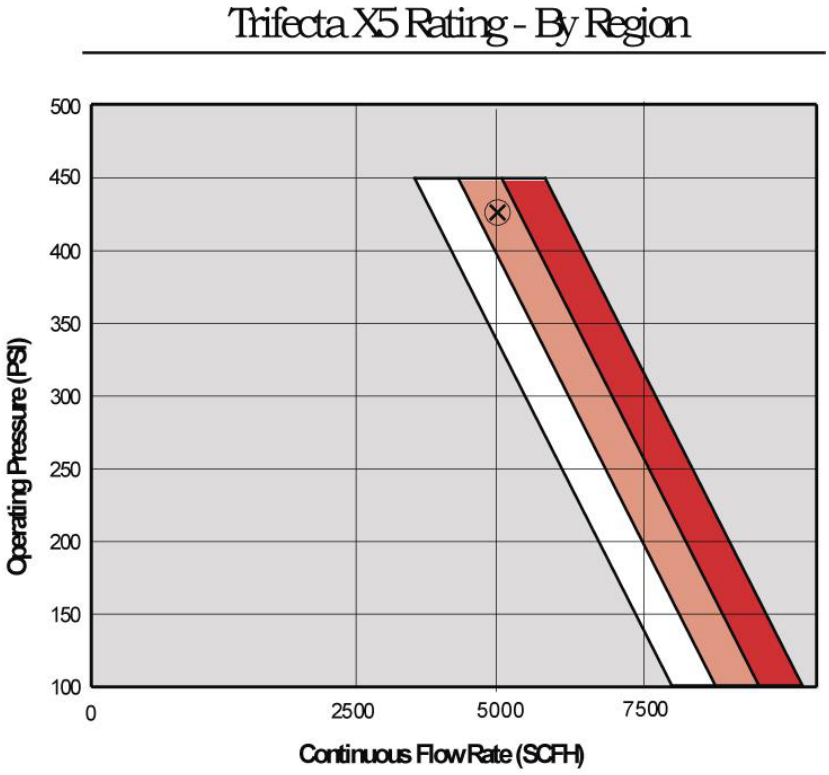
The flow performance depends on the ability of the total system to:

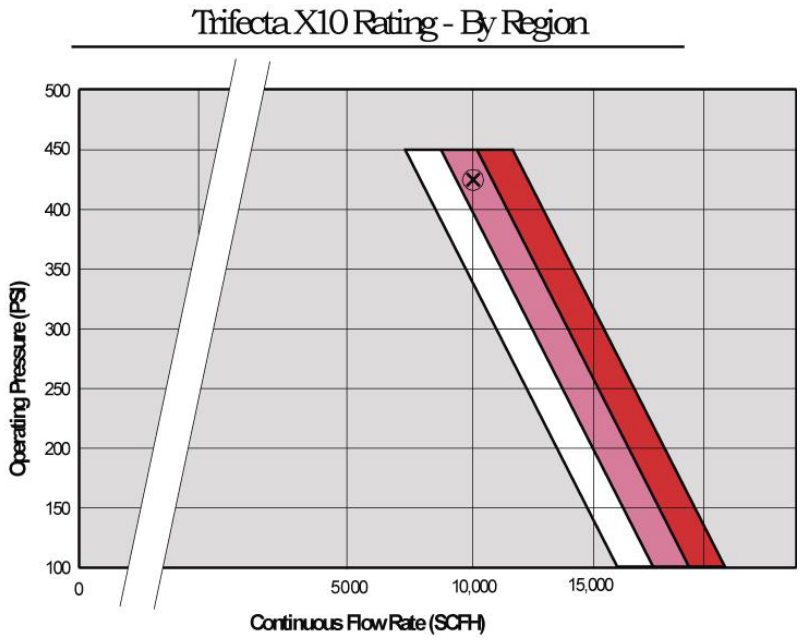
- Build pressure in the transfer tanks using gravity and ambient coils.
  - Proper air flow and sunlight reaching the pressure building coils.
  - Extreme weather conditions may require de-icing of the pressure building system.
- Vaporize liquid into gas to maintain pressure and flow at the use point.
  - The vaporizer must be sized for the geographical location, flow/pressure requirements and duty cycle.
  - Less than optimum sun light and air flows across the coils will reduce the performance.
- Fill times - refilling the reserve tank from the bulk tank prior to the primary tank emptying.
  - The overall flow rate of the system can be limited by the systems ability to refill. Flow out cannot exceed flow in!
  - Special care must be given in selection of the bulk tank that supplies the Trifecta.
  - The tanks heat leak performance is critical in transferring cryogen in the liquid state to the Trifecta.
  - Liquid use lines and valves out of the bulk tank must be sized properly. Small restrictuve liquid lines and valves will increase fill times and increase losses.
  - The pressure building system of the bulk tank needs to be sized to build tank sub-cool. The sub-cool condition (pressure above the liquid saturation pressure) helps keep flow rates up and the cryogen in the liquid state as it travels to the Trifecta.
  - Liquid feed lines from the bulk tank to the Trifecta must be kept as short as possible! There is no limit to the length of pipe that can be used to feed the Trifecta. Any length longer than as short as possible can lead to longer fill times and additional losses. Take great care in laying out your Trifecta system. Insulating the liquid feed line will reduce its effective length resulting in increased fill times and reduced losses.

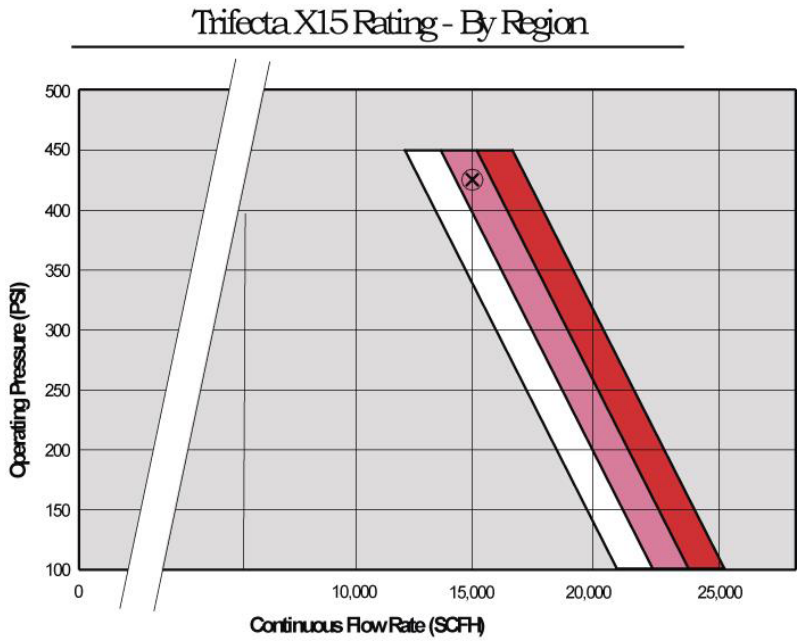
Use the following charts and graphs to estimate the performance of your X-Series Trifecta. Actual performance may vary depending on the installation and equipment used.

1. Identify the color associated with the location of the installation using the following map.
2. Use the rating graph that matches the model, by moving from your desired pressure set point to the right until you reach your regional color.
3. Move down from this point to determine the regional flow rating.

USA Regional Map




Trifecta X10 Rating - By Region
Operating Pressure (PSI)
500
450
400
350
300
250
200
150
100
0
5000
10,000
15,000
Continuous Flow Rate (SCFH)


Trifecta X15 Rating - By Region
Operating Pressure (PSI)
500
450
400
350
300
250
200
150
100
0
10,000
15,000
20,000
25,000
Continuous Flow Rate (SCFH)

Safety

General

All operators should have a full and complete understanding of the content of this manual before operating the equipment described. This manual is intended to describe the operation of the equipment and not intended to supersede any site-specific standards.

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 shut down 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 pressure and liquid levels.

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

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 oxygen enriched atmospheres flammable items burn vigorously and could explode.

Warning! 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.

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.

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! 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. And 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 National Fire Protection Association (NFPA) standards for "Bulk Oxygen Systems at Customer Sites," and with all local safety codes.

The NFPA standard (www.nfpa.org) 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.

Safety Bulletin

Portions of the following information is 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 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 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 an 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.

Chart customer stations are designed with the following safety features:

- A vacuum maintenance system specifically designed to provide long life and all possible safety provisions.
- 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. While Chart equipment is designed and built to the most rigid standards, no piece of mechanical equipment can ever be 100% foolproof.

Installation

Installation Procedure

The installation of the Trifecta X-Series should be done in the following order:

1. Place Trifecta X-Series Skid on concrete pad next to bulk tank.
2. Pipe Trifecta X-Series liquid fill line to bulk tank labeled “From Bulk Tank.”
3. Pipe Trifecta X-Series gas use line to external vaporizer labeled “To Vaporizer.”
4. Connect power supply to dedicated 120V AC, 15 amp circuit (or 230V AC, 50/60 Hz).
5. Commission Trifecta X-Series System.

Placement of Trifecta X-Series Skid

The Trifecta X-Series skid has two 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 as well.

Note: *The Trifecta X-Series assembly weighs almost 1900 lbs. empty (864 kg).*

The Trifecta X-Series skid should be placed on the concrete pad near the bulk storage tank as seen in the Introduction portion of this manual. The portion of the pad that the Trifecta X-Series skid resides must be a minimum of 4” thick and of the same composition as the pad for the adjoining bulk tank. The skid should be placed as close to the bulk tank as possible without interfering with any other equipment or service requirements of the tank. The system requires a transfer of liquid and gas between the bulk storage tank and the Trifecta X-Series skid. This process becomes less efficient with increasing transfer line length.

Note: *Each site may have unique requirements; however, it is recommended to follow the basic layout located in the Introduction section of this manual.*

The skid should also be placed such that there is easy access to all sides of the unit. The skid should be placed where it may receive a maximum amount of sunlight and airflow. One must be able to check the individual cylinder 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.

Note: *It is important that the sun and wind contact both the external vaporizer and pressure build coils inside the skid to insure optimal operation of the unit and prevent unusual buildup of ice.*

Note: *Do not locate the Trifecta or Vaporizer near equipment that produces excessive moisture (i.e. cooling towers, drains, etc.).*

Liquid Line Piping to Bulk Tank

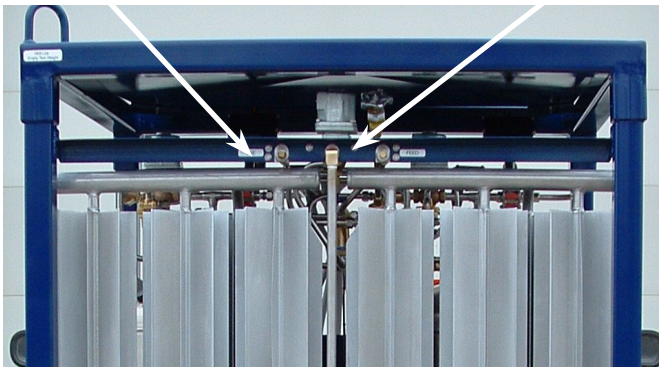
The Trifecta X-Series skid requires a liquid line piped from the bulk storage tank. This line will serve two functions. First, to allow the high pressure gas to return to the liquid side of the bulk tank (reduce losses), second, to allow the transfer of liquid from the bulk tank to the Trifecta.

The recommended line size is no smaller than three-quarters of an inch (3/4” NOM, 19mm).

The backside (PB side) of the X-Series skid has two connection points.

- The connection on the left is the outlet to the vaporizer.
- The connection on the right is the outlet to the liquid feed line from the bulk tank.

To Vaporizer ***Liquid Feed***

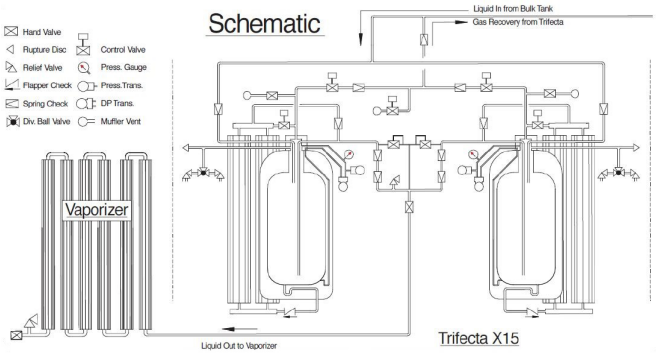


Note: *It is recommended to insulate the liquid feed line to minimize fill times and reduce losses. The fill line (from bulk tank to Trifecta) length should be limited to 15 total feet (5 meters).*

Note: *The isolation valve on the bulk tank liquid line should not be opened until all plumbing connections are complete.*

Piping to Vaporizer

The Trifecta X-Series system does not contain final vaporization. Consequently, a freestanding, external vaporizer must be connected to the "to Vaporizer" line of the Trifecta X-Series. The vaporizer should have a pressure rating of at least 600 psig - or 700 psig for the 600 psig Trifecta.



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, set at 550 psig (or 650 psig for the 600 psi high pressure Trifecta Gas Supply System).*

The relief device on the Trifecta X-Series is a fail-safe device and should not be relied upon as the only thermal relief. Operation of the Trifecta X-Series "Gas Use" relief device may vent liquid, creating a noticeable vapor cloud.

The piping and components from the Trifecta X-Series to the vaporizer must be at least 3/4" (19mm) copper or its equivalent and of adequate pressure rating. Small diameter lines will introduce undesirable pressure drops and impact overall system performance. Referring to the attachment piping photo, the left connection should be piped to the vaporizer. The outlet of the vaporizer should be piped to the customer house line with final line regulation as required.

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

Note: *If the house line cannot handle 550 psi, additional safeties and line regulation must be added.*

Warning! Do not set operating pressure higher than the lowest relief device!

Bulk Tank Pressure Transmitter

The system controller required 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 in the upper piping of the Trifecta X-Series and pre-wired into the control box. No additional piping is required by the customer to receive the bulk tank pressure; this will automatically read the current bulk tank pressure unlike previous models.

For the 600 psig Trifecta series, a gas line from the bulk tank needs to be run to the regulator, which supplies pneumatic pressure to the actuators on each ball valve. The regulator regulates the pressure from the bulk tank down to 125 psi. The actuators require a minimum of 80 psig. The maximum pressure for the gas line is 150 psi.

Electrical Power Supply

A dedicated 120 volt AC, 60 Hz, 15 amp circuit (or 230 volt AC, 50/60 Hz, 15 amp version, if ordered) must be provided to power the Trifecta X-Series control system. A voltage converter may be necessary. Back feed of voltage will interfere with component performance.

The Mitsubishi PLC is mounted within a NEMA 4 control box as shown in the following photograph.

It is important that care is taken to install the Trifecta X-Series system on an electrical power circuit that is clean and protected. Circuits 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 X-Series system and a clean, steady circuit must be used to power the Trifecta X-Series system.

Commissioning

The following porcedures require the operation of the solenoid valves.

Note: *On the 600 psig high pressure Trifecta, the solenoid valves are replaced with pneumatic actuated ball valves.*

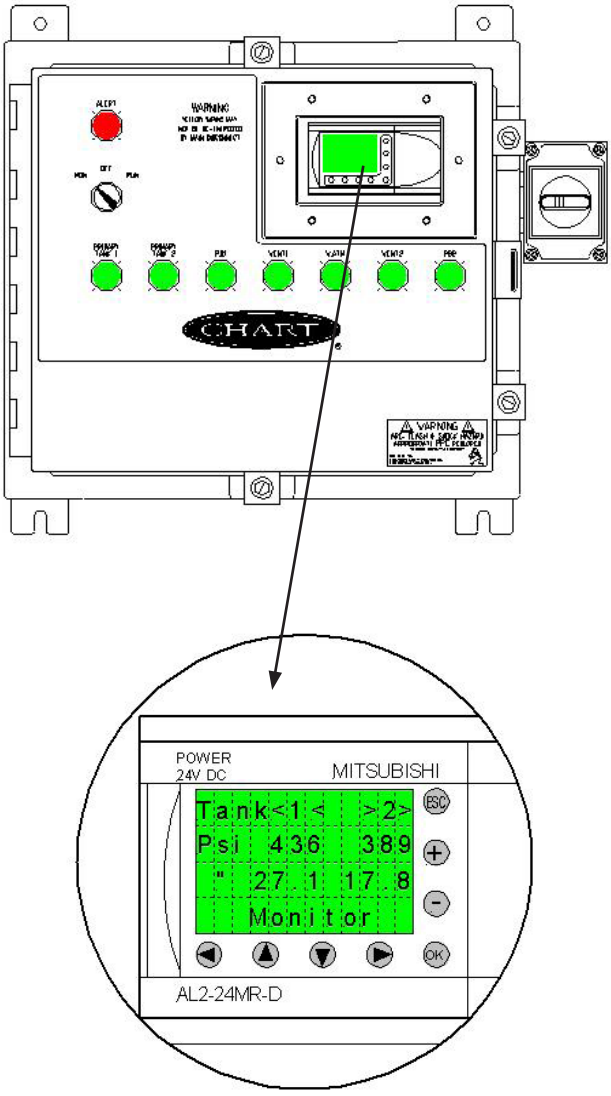
Warning! ***It is important to purge the entire Trifecta X-Series and piping with warm, dry nitrogen before running the system with liquid. Water vapor can cause ice crystals to form that may cause the solenoid valves and other critical components to operate improperly.***

Purge and Pre-Charge of the Trifecta X-Series

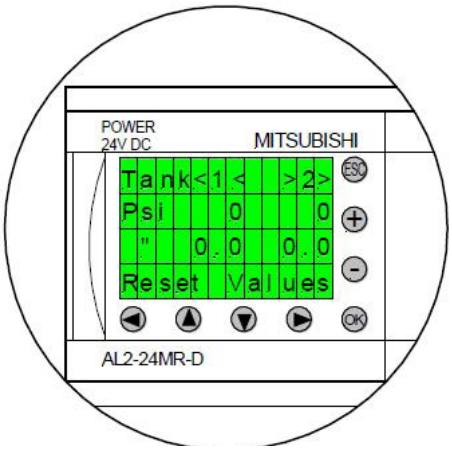
When all connections to the Trifecta X-Series are made, purge the complete system using low-pressure nitrogen.

1. Verify that the controller is in the “OFF” or “Monitor” position and open the liquid feed from the bulk tank until the pressure in the Trifecta X-Series equalizes with the bulk tank. Let all piping warm back to ambient (no frost) and leak check all connections.
2. Slowly open the Trifecta liquid use valve and pressurize the vaporizer and house line to the bulk tank pressure. Perform a leak check on the vaporizer and house line.
3. Once plumbing integrity is confirmed at “Low” pressure (no leaks), close the liquid use valve located on the back of the Trifecta skid, switch the unit from “OFF” or “MONITOR” to the “RUN” position.

Unit in “MON” position



“Monitor” will flash



4. The PLC will ask you to “Reset Values”. There are three parameters that can be set using the buttons found on the PLC. These values are reset to zero at the factory (two weeks of no power can result in parameters reset to zero). To activate the parameters press the left arrow button five times. After activating the parameters set them to the desired set points.

5. With the switch in the “Run” position and the parameters set, the system will begin filling in approximately five minutes. Let the entire unit come up to full working pressure. Allow all piping to warm (no frost) and leak check all components at working pressure.

6. After Trifecta plumbing integrity has been confirmed (no leaks) and at full working pressure, slowly re-open the liquid use valve and pressurize the vaporizer and house line at full pressure.

Caution! Opening the liquid use too fast will result in a “rush” of liquid into the vaporizer. This may cause the line safeties to vent.

7. Perform a leak check on the vaporizer and house line.

Check Trifecta X-Series Cylinder Relief Valves

Check each cylinder’s main relief valves. During operation, the pressure in tank one and/or two will rise to approximately 450 psi (550 psig for the 600 psi Trifecta series). 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 two. Open diverter valve for each cylinder to verify secondary set of safety devices.

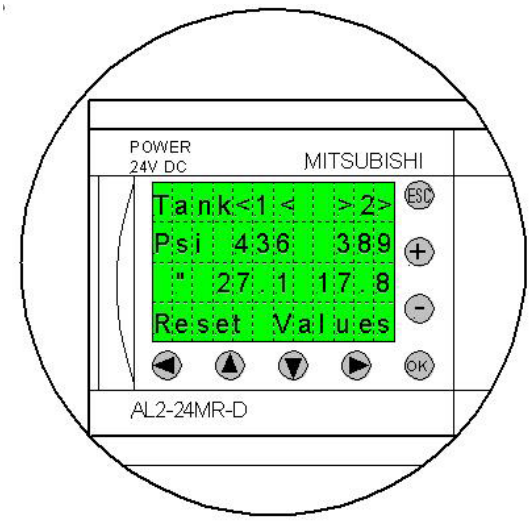
Operation

Parameter Settings

Initial power up from the factory will require some parameters to be set. The display flashes “Reset Values” on the lower line of the main display. No valves will operate while this display is flashing. The Reset Values mode can occur if the power is left off the system for more than two weeks.

Reset Values

To set these parameters without running the system, switch the MON/OFF/RUN switch found on the front of the control panel to the “MON” position. “Monitor” will flash on the lower line of the main display. The valves will not be controlled by the PLC when “Monitor” is in the display.

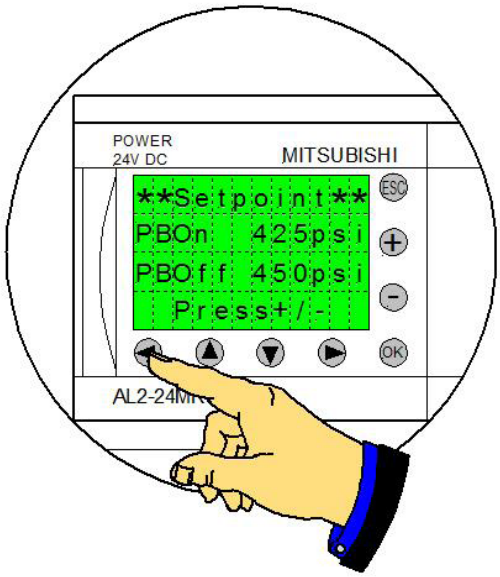


Note: *If power is off for two weeks, the volatile memory will be lost. In this case, parameters MUST be reset before operations continue.*

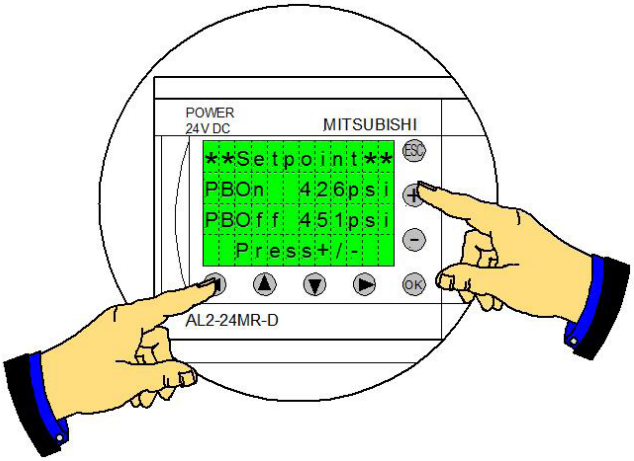
- Reset parameters to default settings by switching to “Monitor” mode and pressing the left arrow five times.
- Reset parameters to site requirements prior to switching to “Run” position.

Setting Pressure Set Points

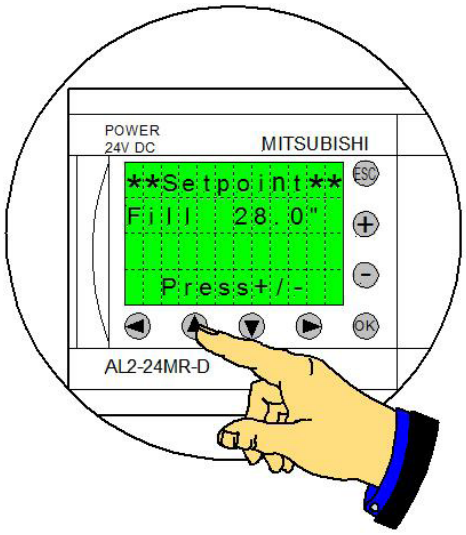
Three settable parameters are accessible from the PLC buttons. These parameters are key to setting all parameters.



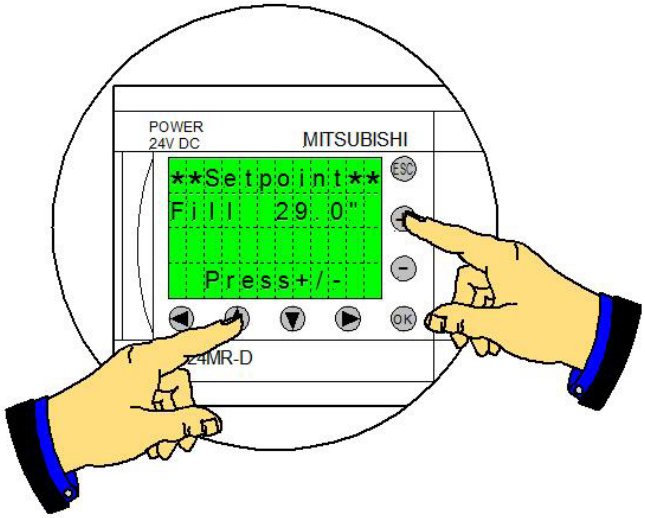
- Pressing the “Left” arrow button accesses the pressure building set points.
- The “PBOff” set point is always 25 psi higher than the “PBOn” set point.
- At the “PBOn” pressure the system turns on the primary tanks PB valve.
- The “PBOff” set point is the pressure that the system turns off the primary PB valve.
- The secondary tanks PB “Hold” pressures are a function of these values.
- Pressing and holding the “Left” arrow and pressing the “+” button or the “-” button will adjust the set points.



Setting Fill Set Point

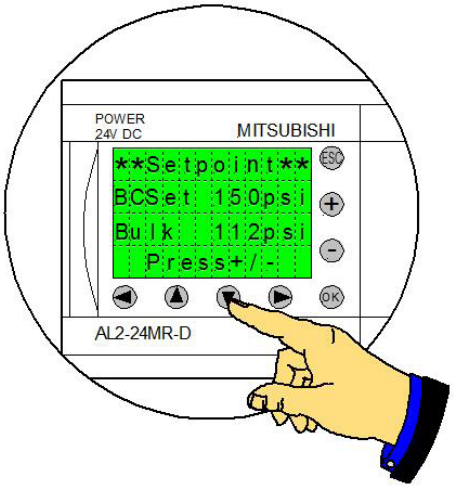


- Pressing the “Up” arrow button accesses the fill set point. The “Fill” set point terminates the filling of the secondary tank when the pressure of the secondary tank is between 80 and 130 psi.
- If the pressure is above 130 psi during the fill, the fill is terminated at the “Fill” set point -1.5”. This allows for the liquid growth due to an increased saturation level.
- If the pressure is below 80 psi the fill is terminated at the “Fill” set point +1.5”. Colder liquid takes up less volume. Adding to the fill set point will assure that the PB time will be consistent.
- Pressing and holding the “Up” arrow and pressing the “+” button or the “-” button will adjust the set point.

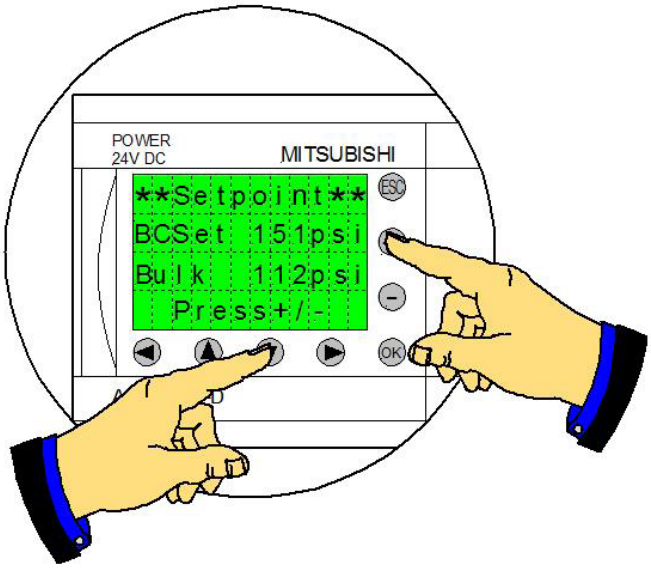


Setting Bulk Tank Critical Pressure

Note: *Since the tanks are warm upon initial installation, they may vent for several minutes before they are cold enough to accumulate liquid.*



- Pressing the “Down” arrow button accesses the Bulk Critical set point. If the storage (bulk) tank is above the “BC” set point during the filling of the secondary tank, the secondary tank will vent to atmosphere to minimize the heat added back to the storage tank.
- If the storage tank pressure is below the “BC” set point the secondary tank will fill in the “Low Loss” fill mode.
- The “Low Loss” fill mode cycles the vent to atmosphere valve to minimize losses. The current “Bulk” pressure is also displayed on this screen.
- Pressing and holding the “Down” arrow and pressing the “+” button or the “-” button will adjust the set point.

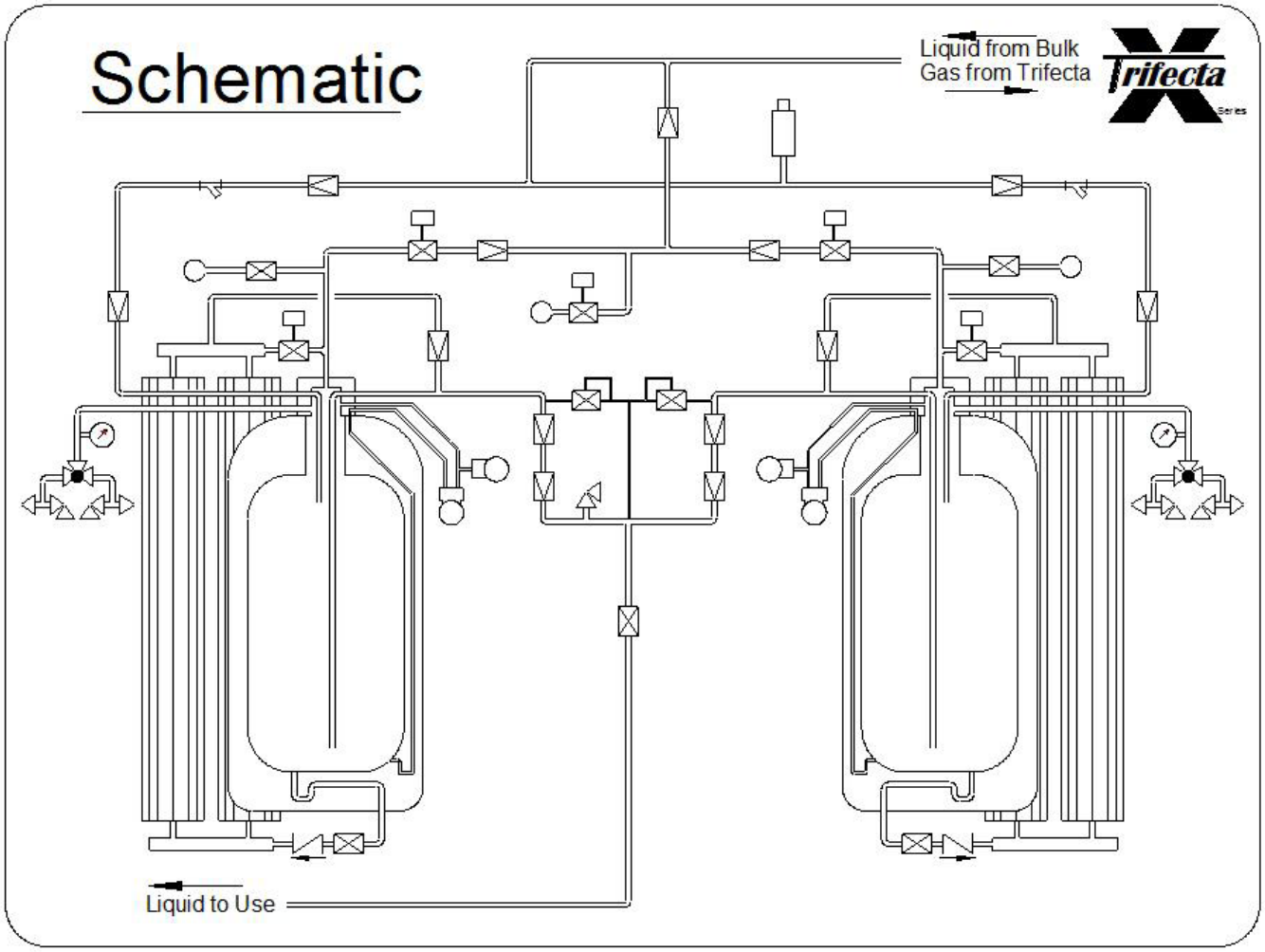


Hard Sets

There are additional settings that cannot be adjusted by the PLC's display. They are stored in the non-volatile memory. They will remain set even after a long power outage.

Operation Details

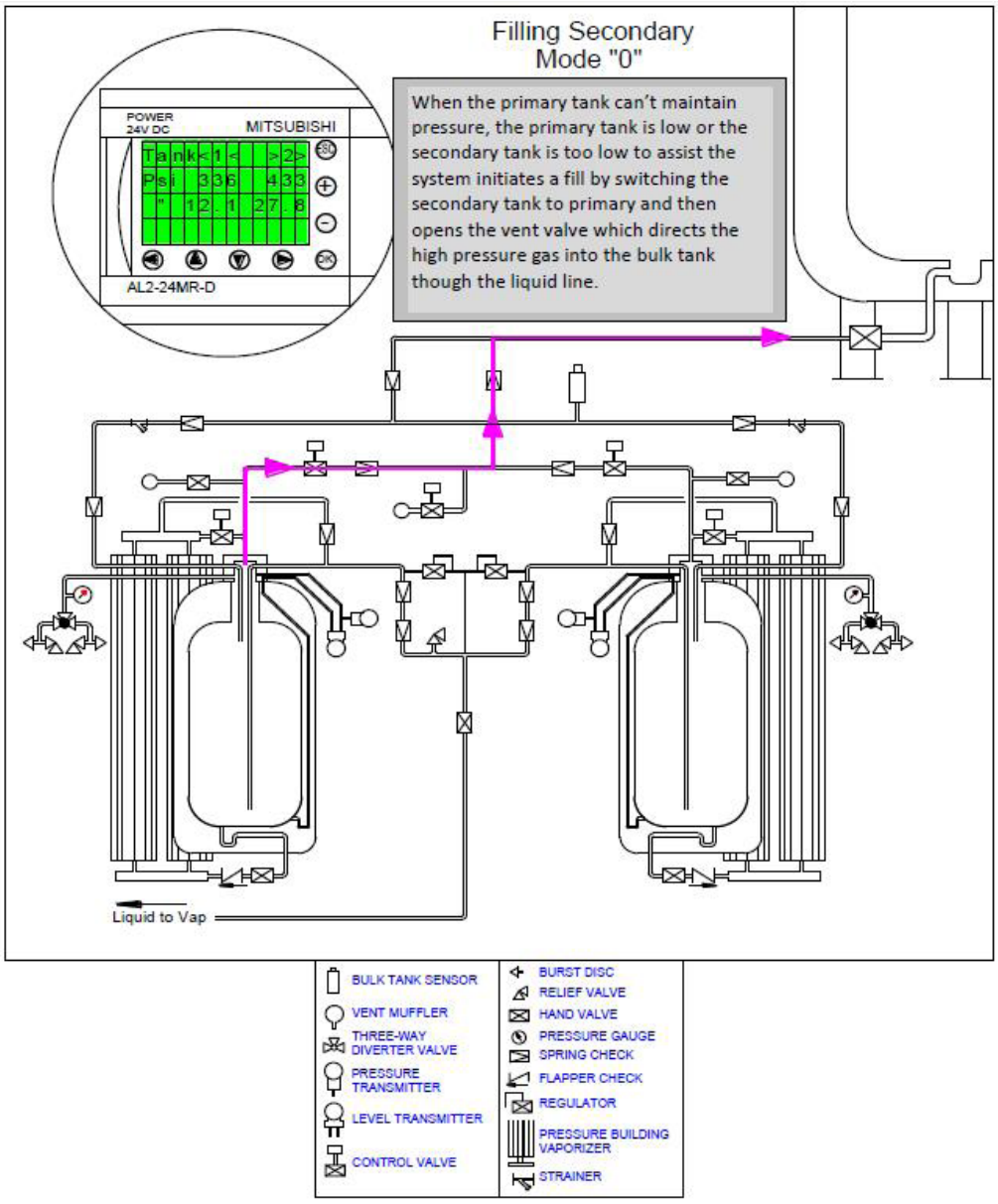
The Trifecta X-Series logic keys on pressure instead of liquid level. The components have been minimized (reduced) yet the design has duplication of key components.



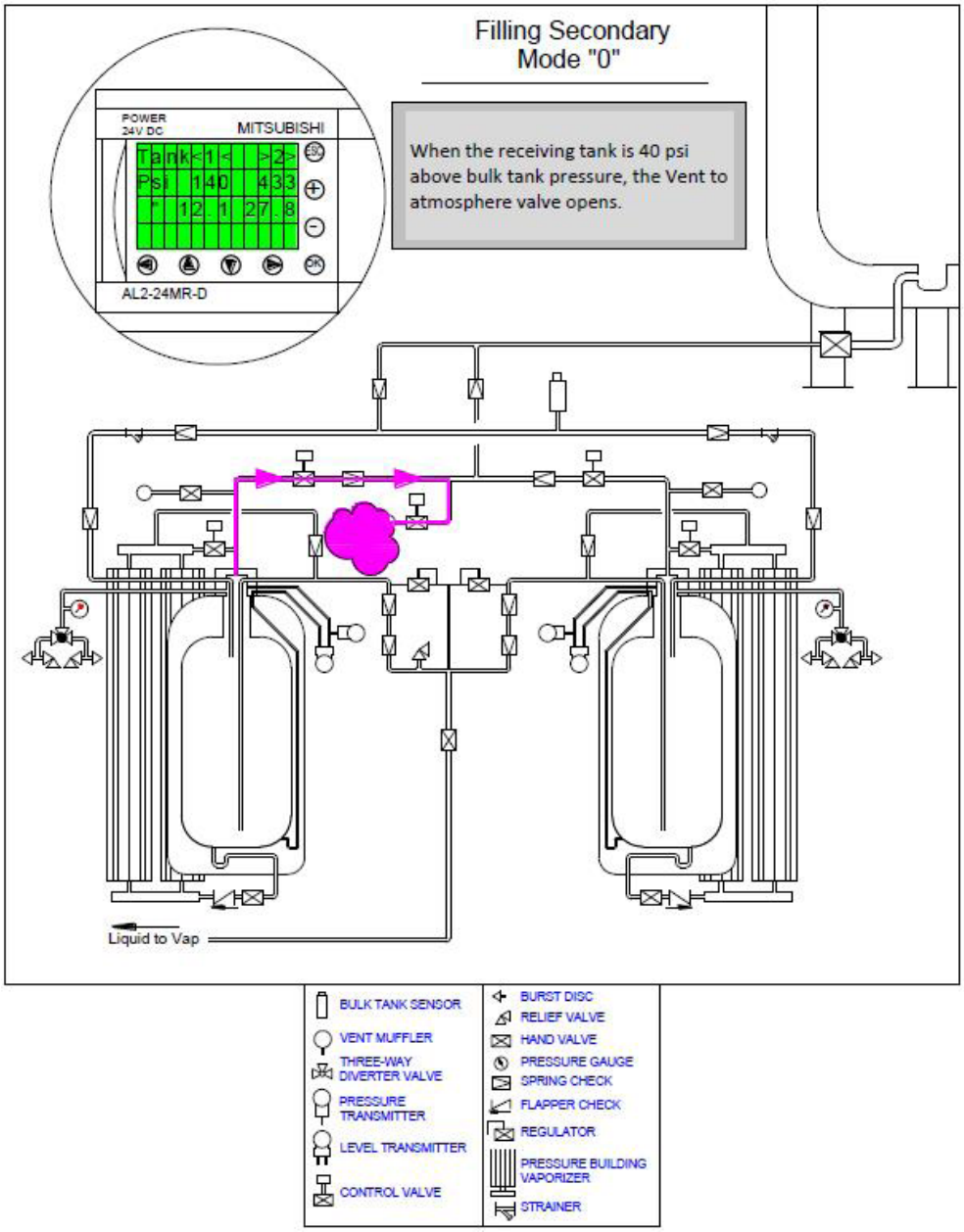
There are four key modes:

- Run/fill (mode 0)
- Initial pressure build (mode 1)
- Run/Ready (mode 2)
- Assist (mode 3)

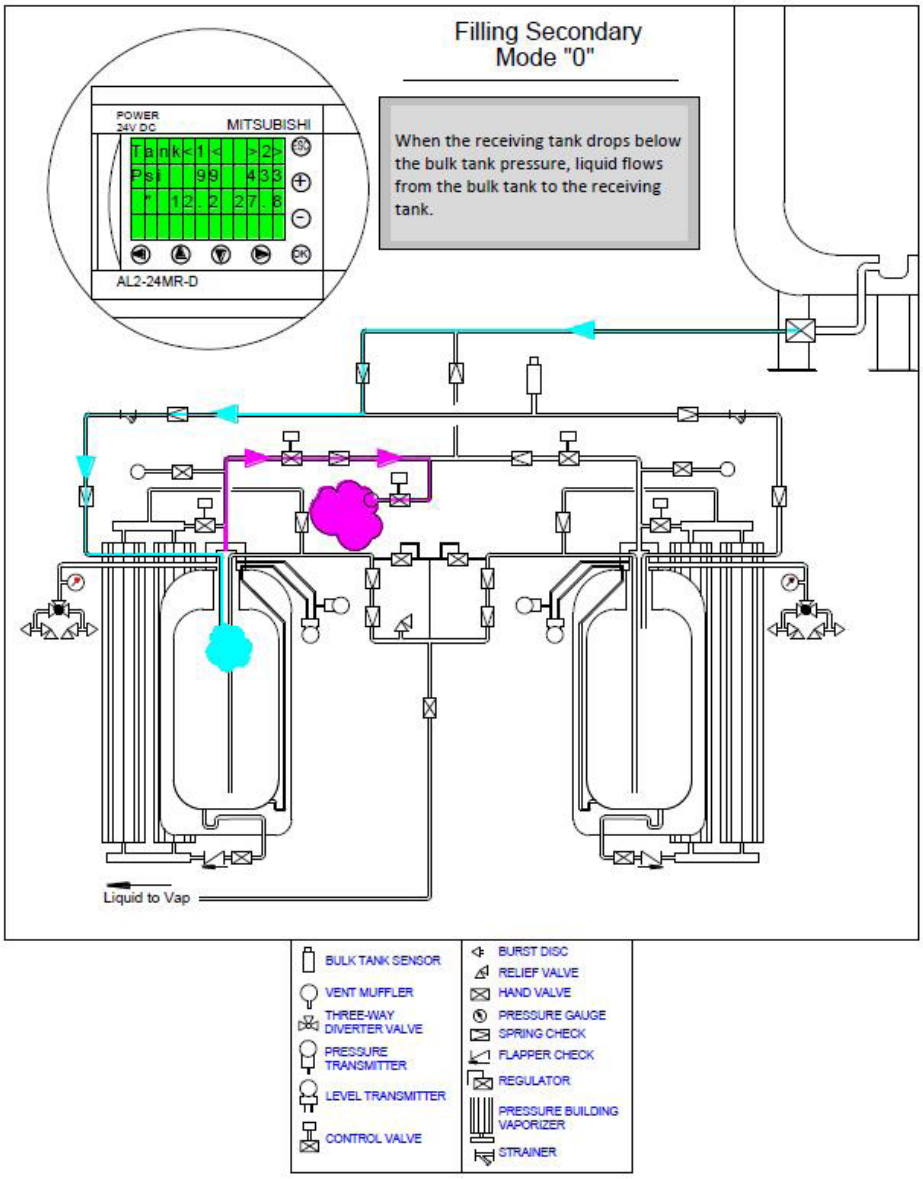
These modes along with the parameter settings determine the operation of the system.



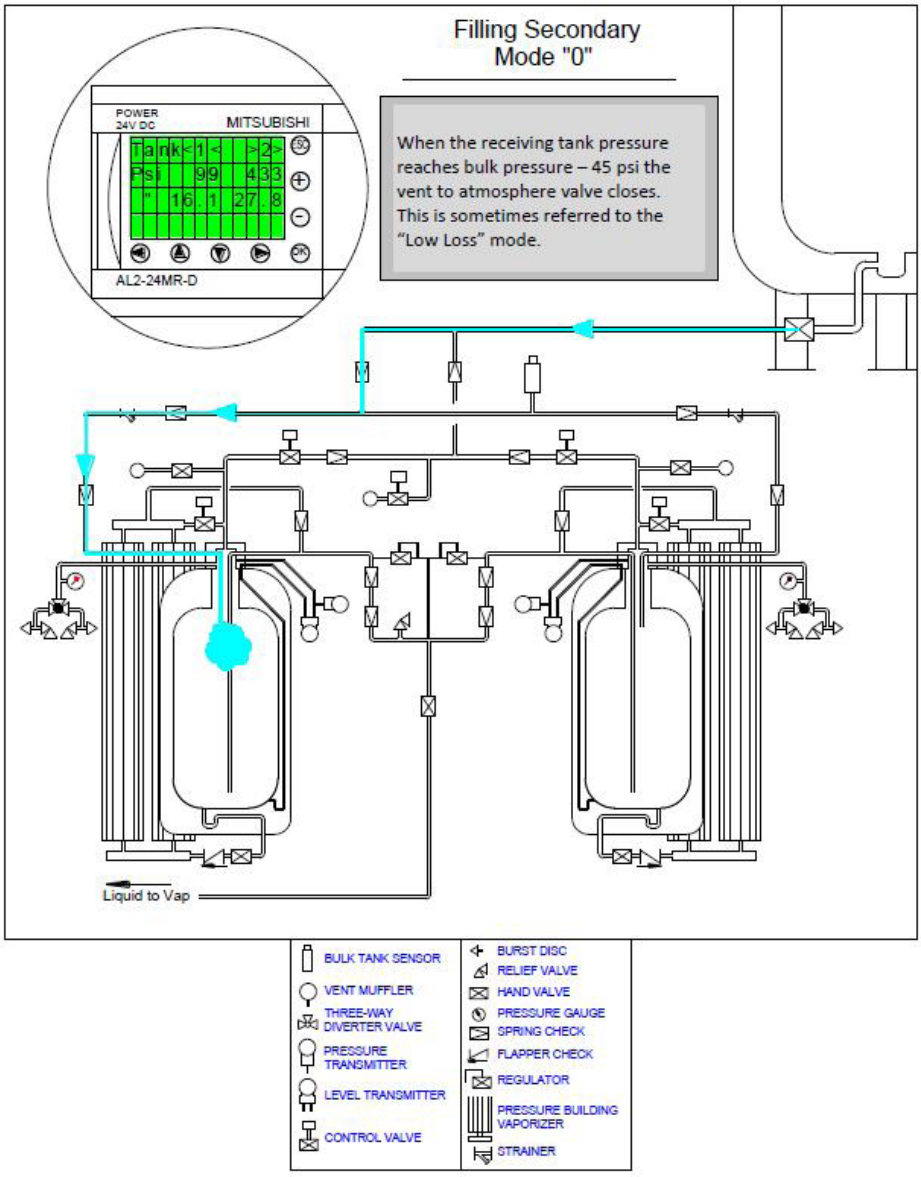
Filling Mode (Vent to Storage)



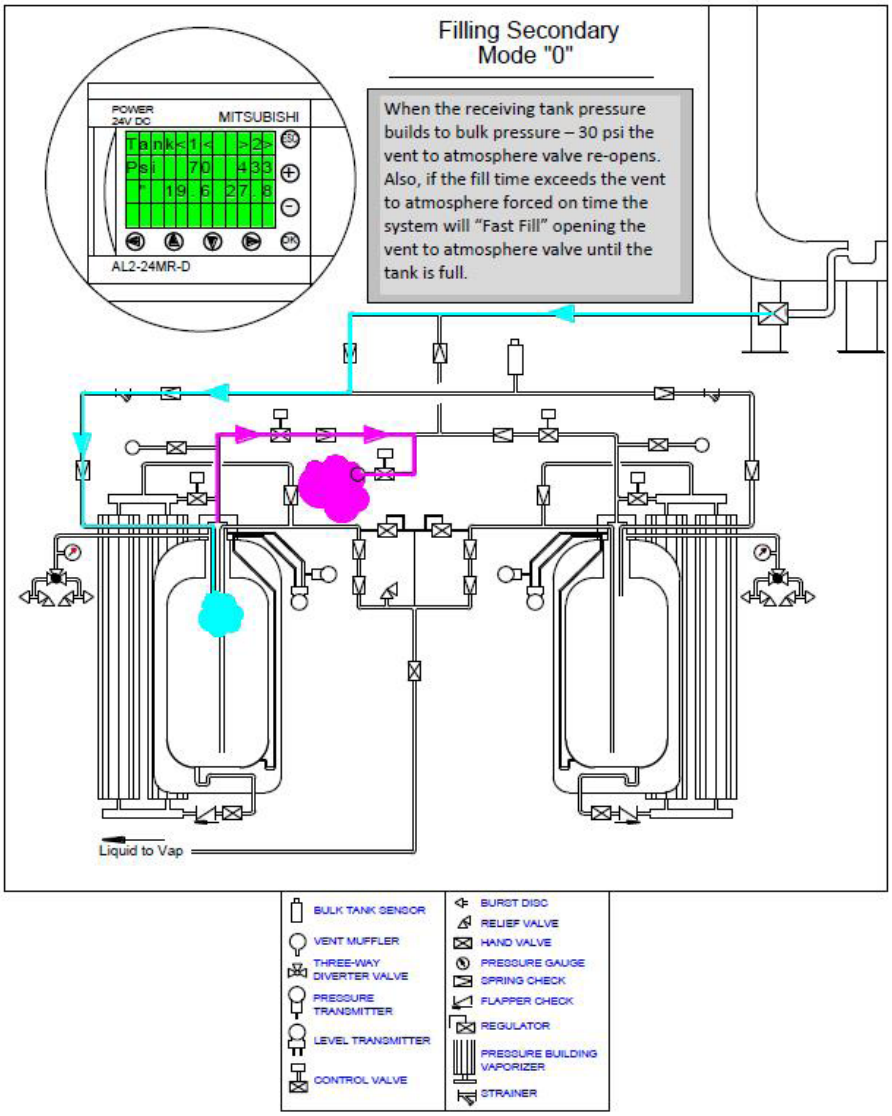
Filling Mode (Vent to Atmosphere)



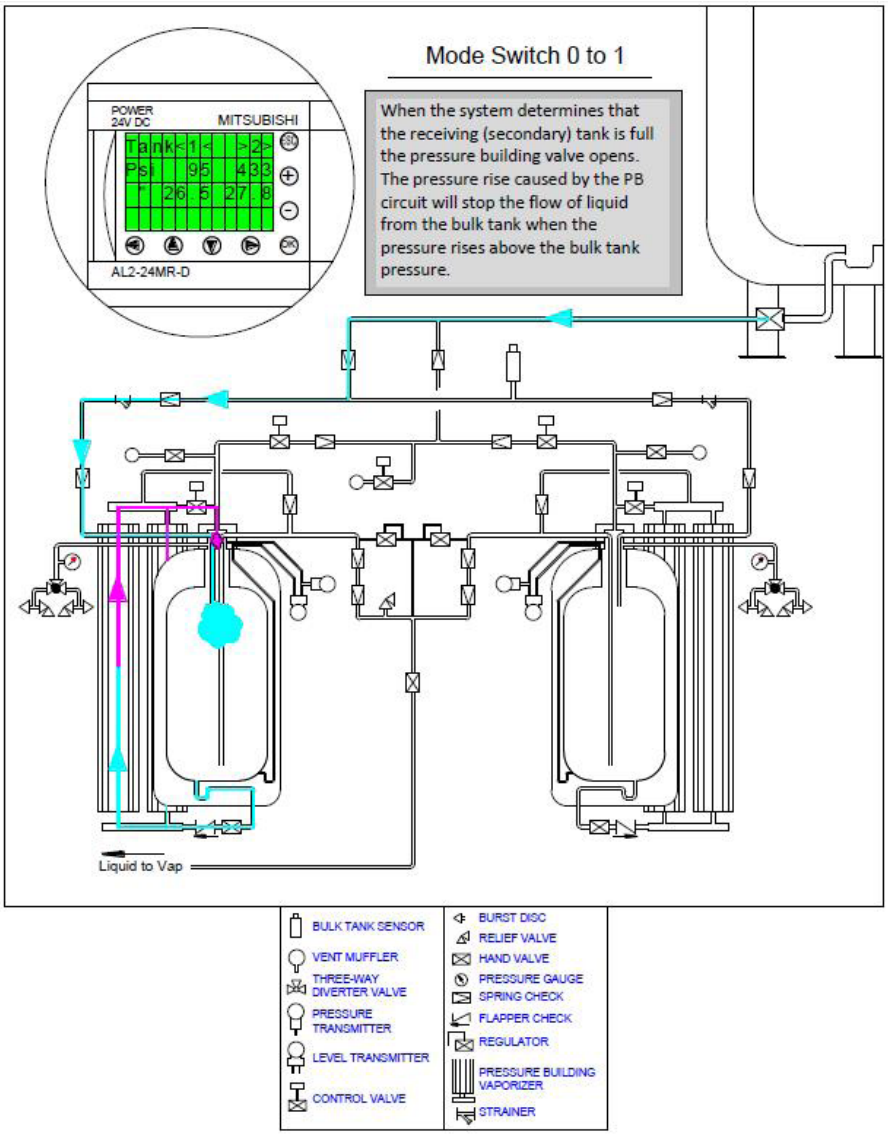
Filling Mode (Liquid Flow)



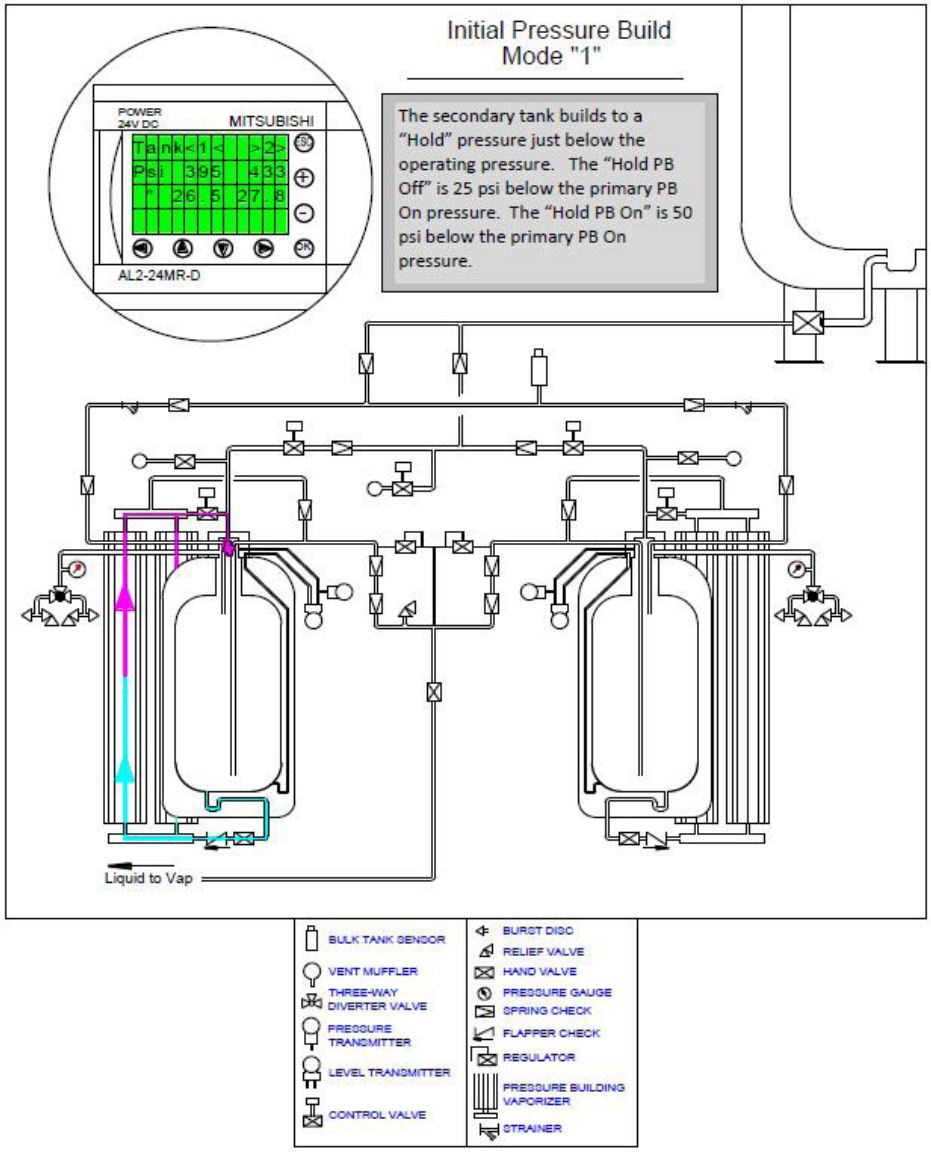
Filling Mode (Low Loss)



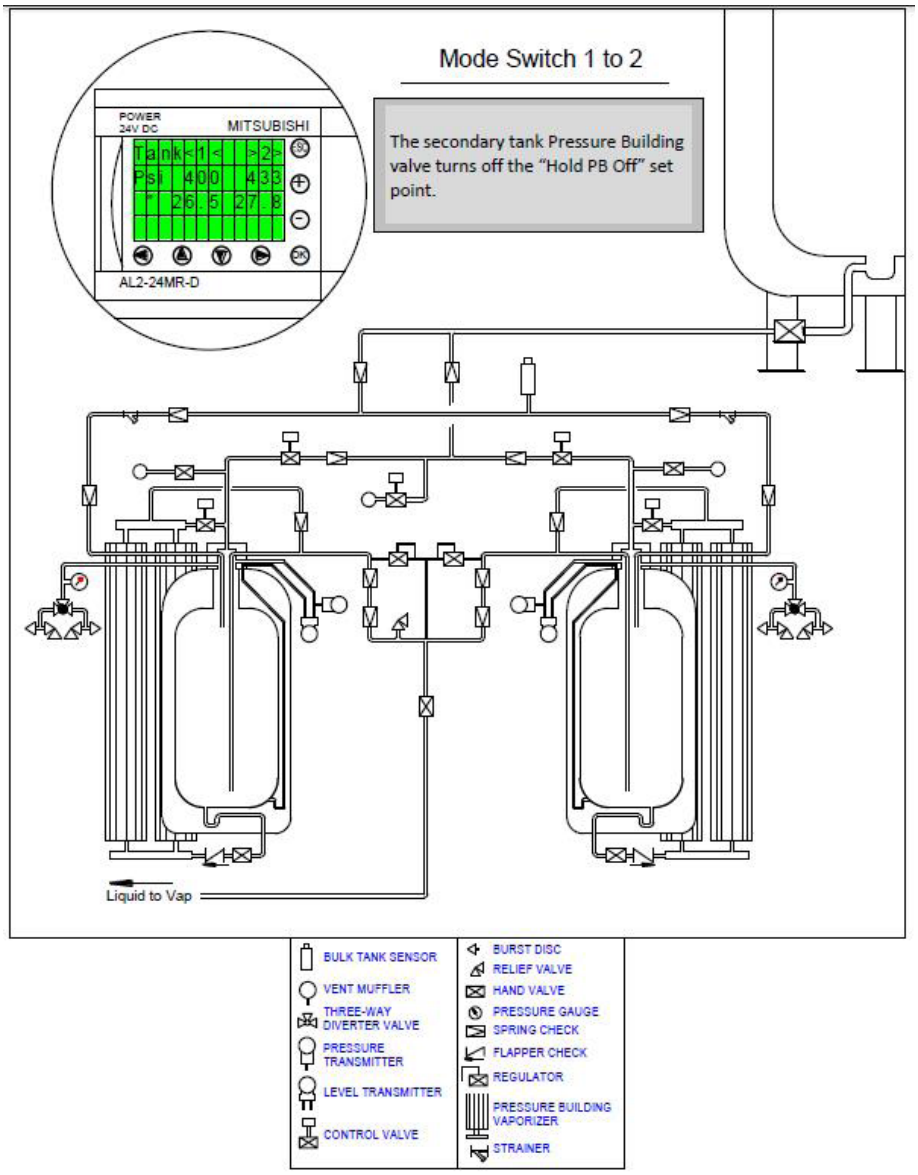
Filling Mode (Low Loss Vent to Atmoshpere)



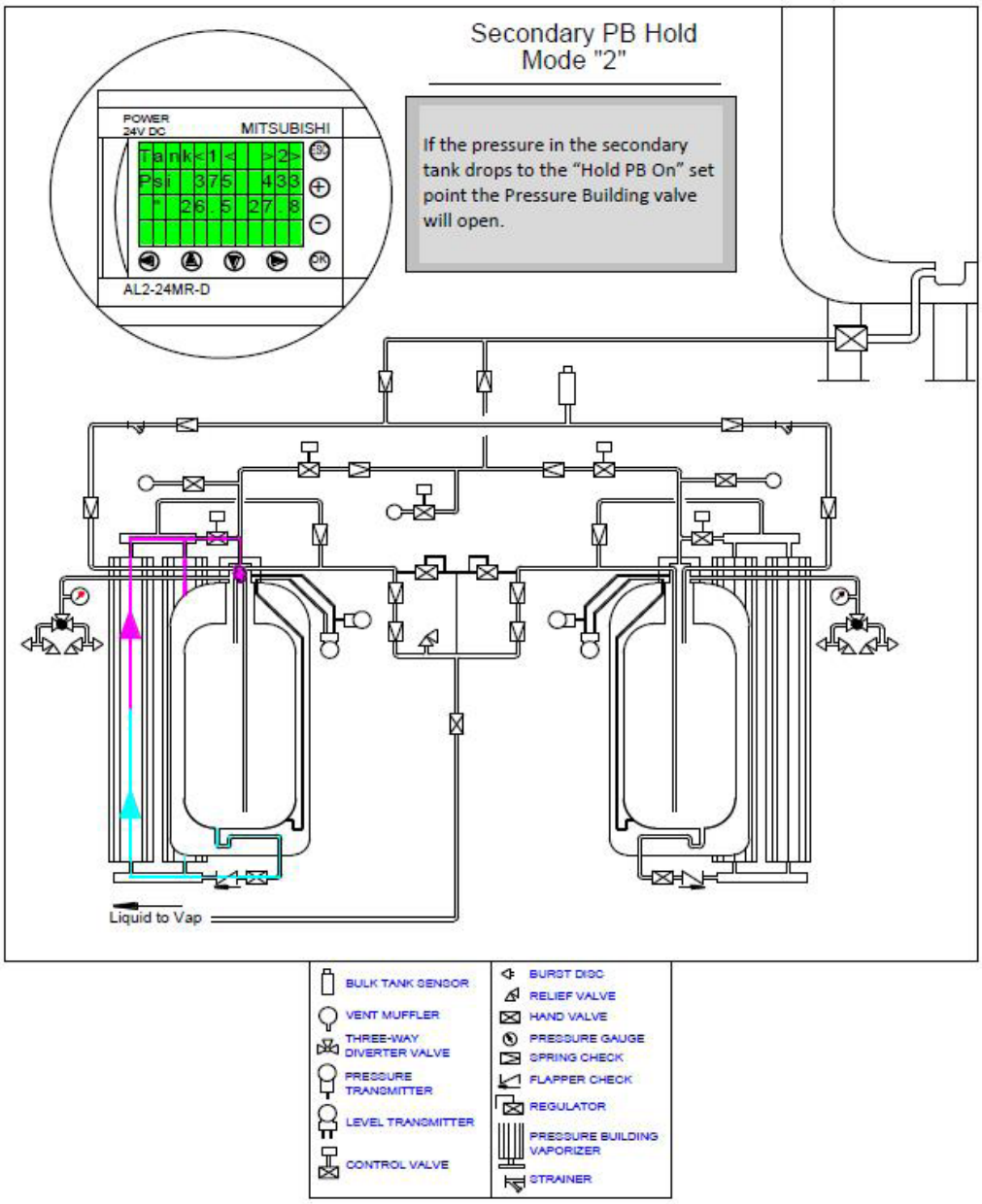
Filling Mode Termination



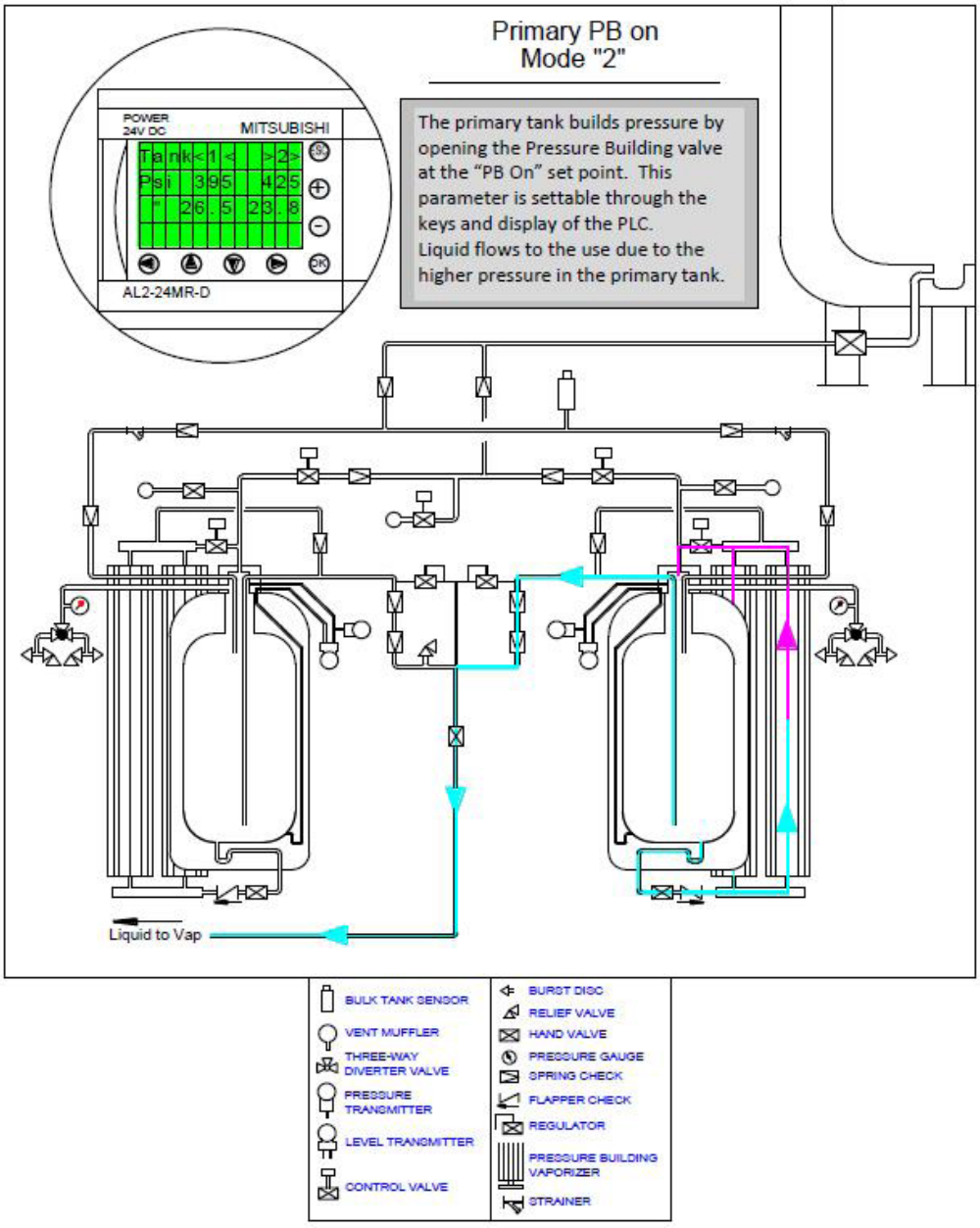
Initial Pressure Build after Filling



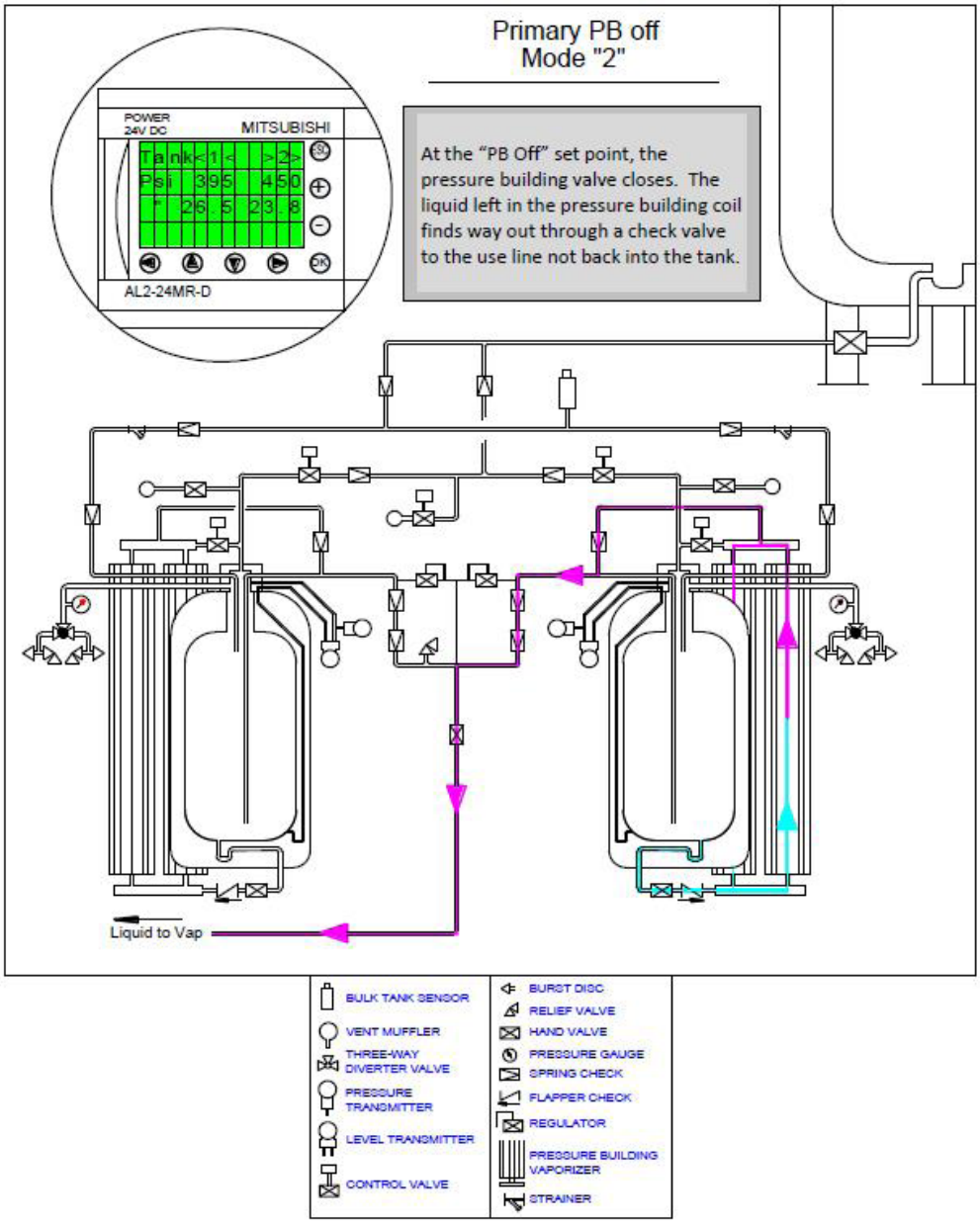
Secondary Ready to Assist



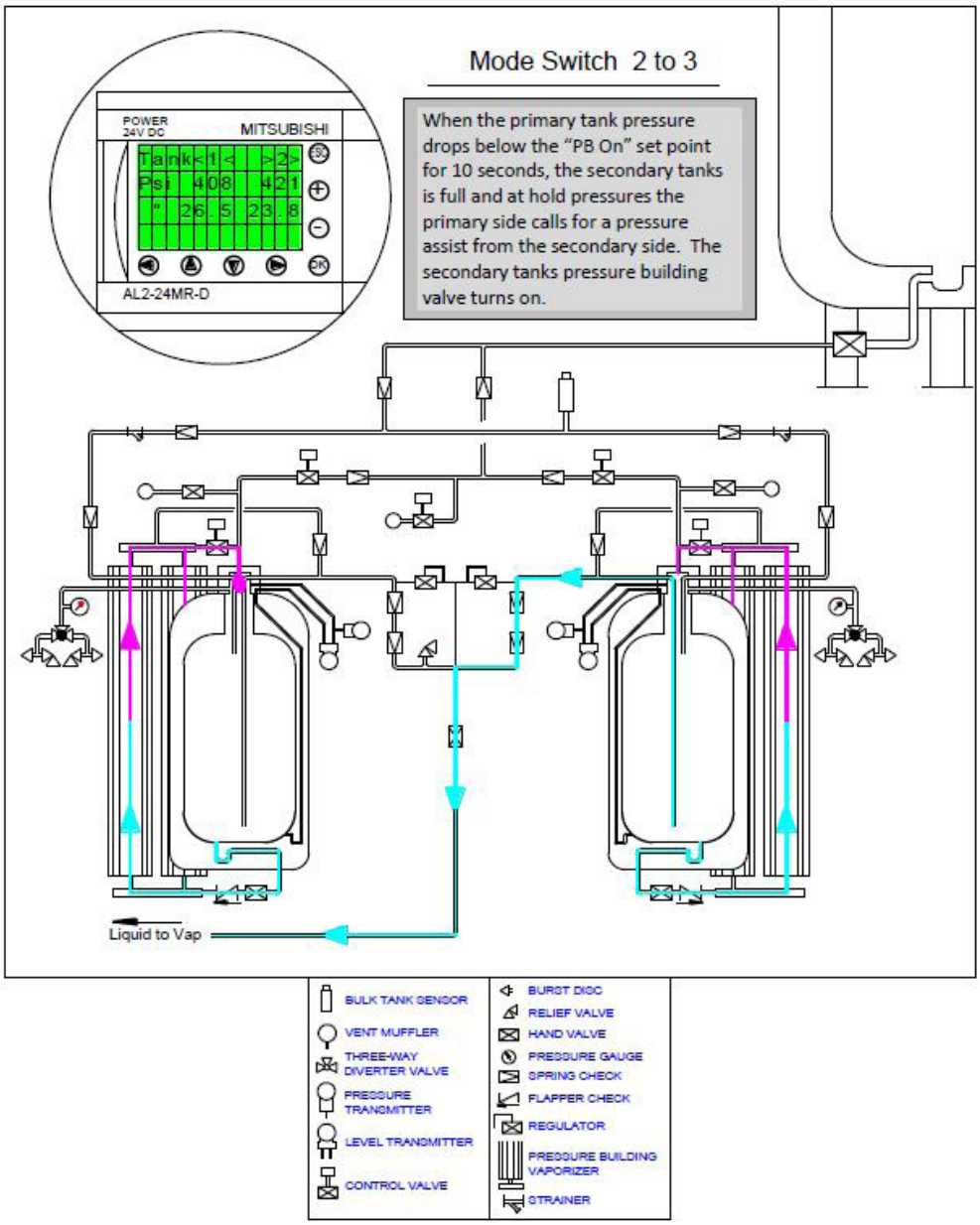
Secondary Maintains "Hold" Pressure



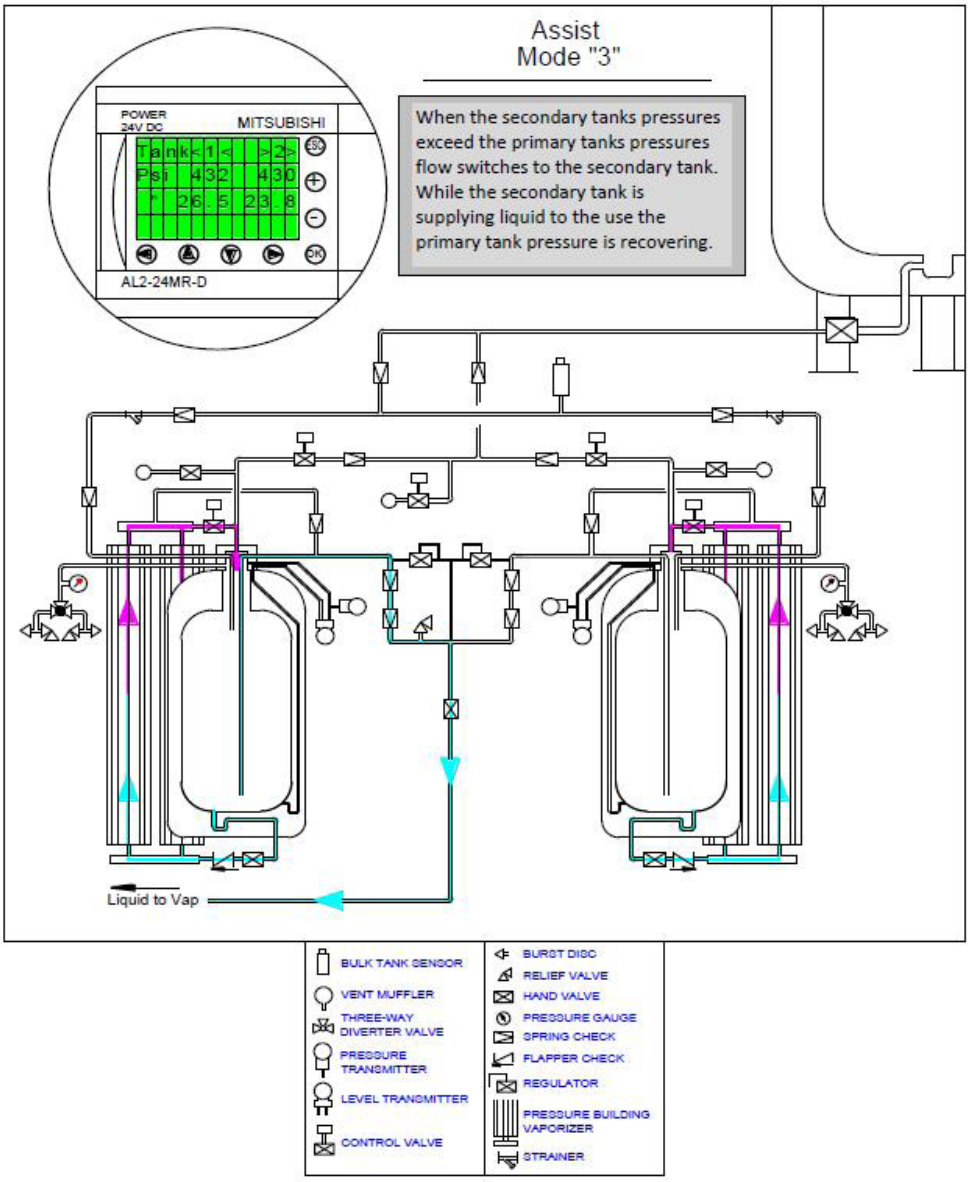
Primary Pressure Build



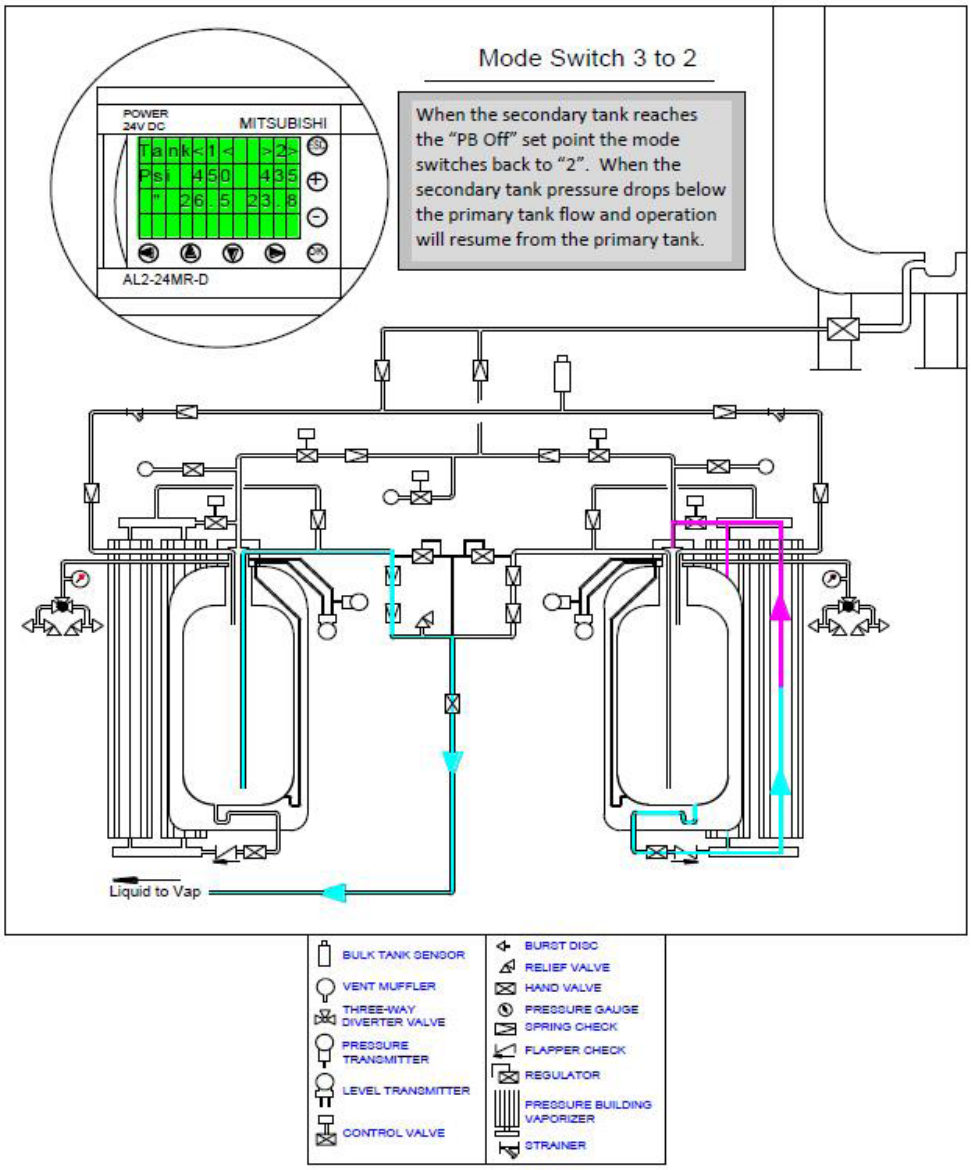
Primary PB Off



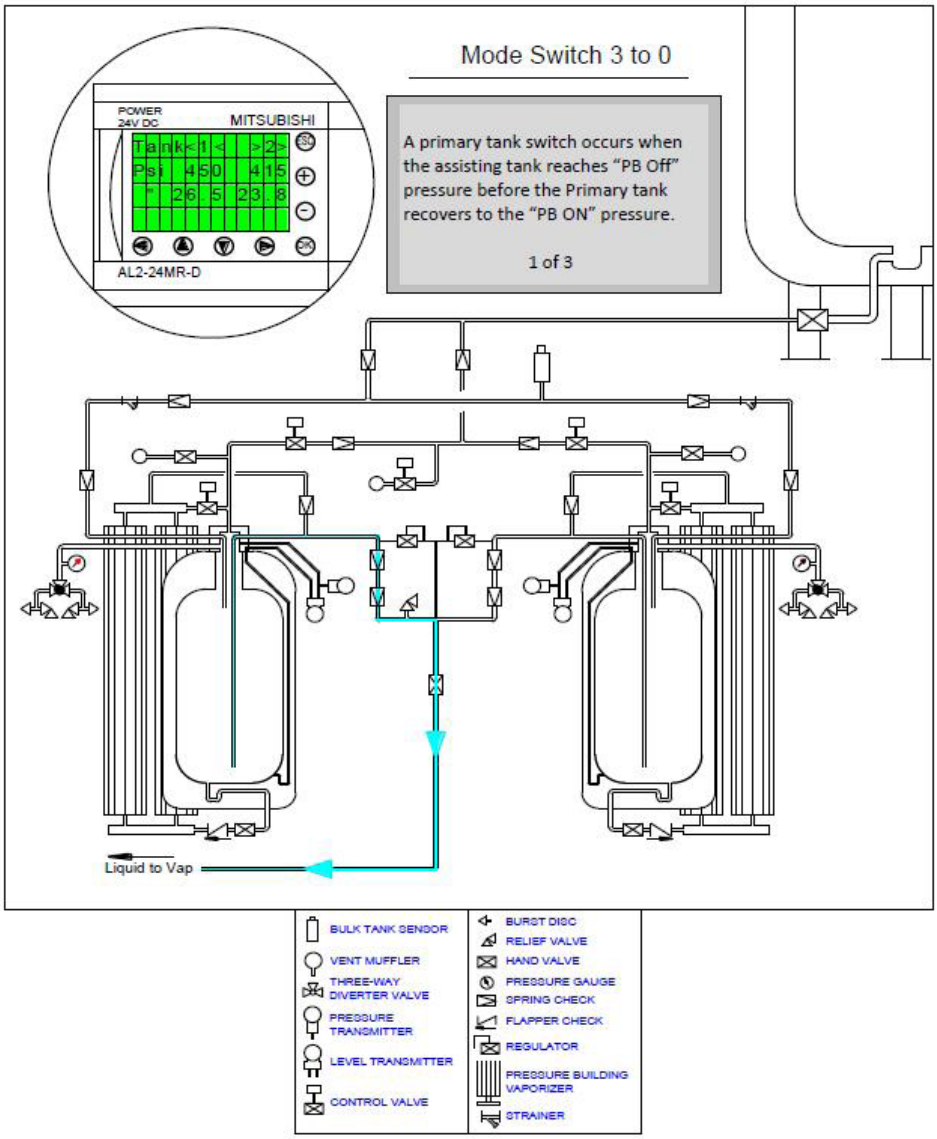
Call for Assist



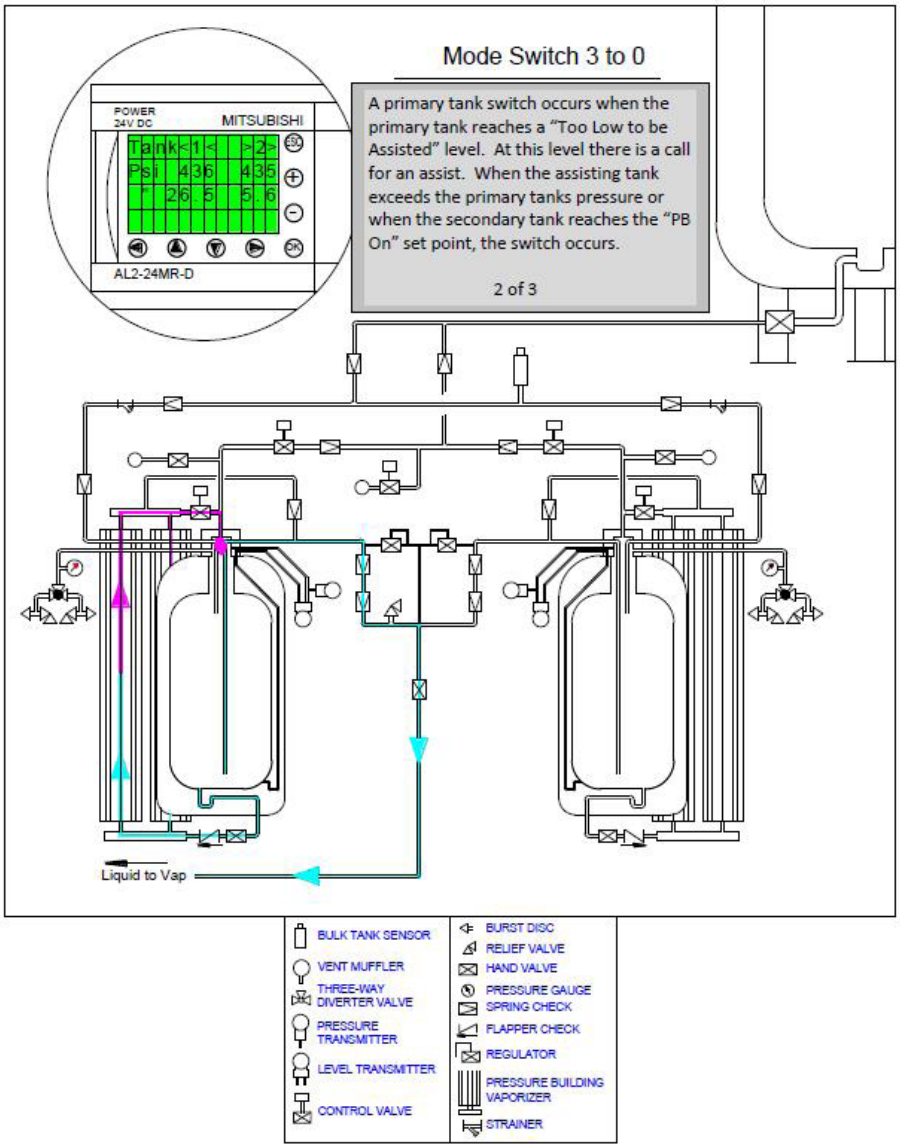
Secondary Assist of Primary



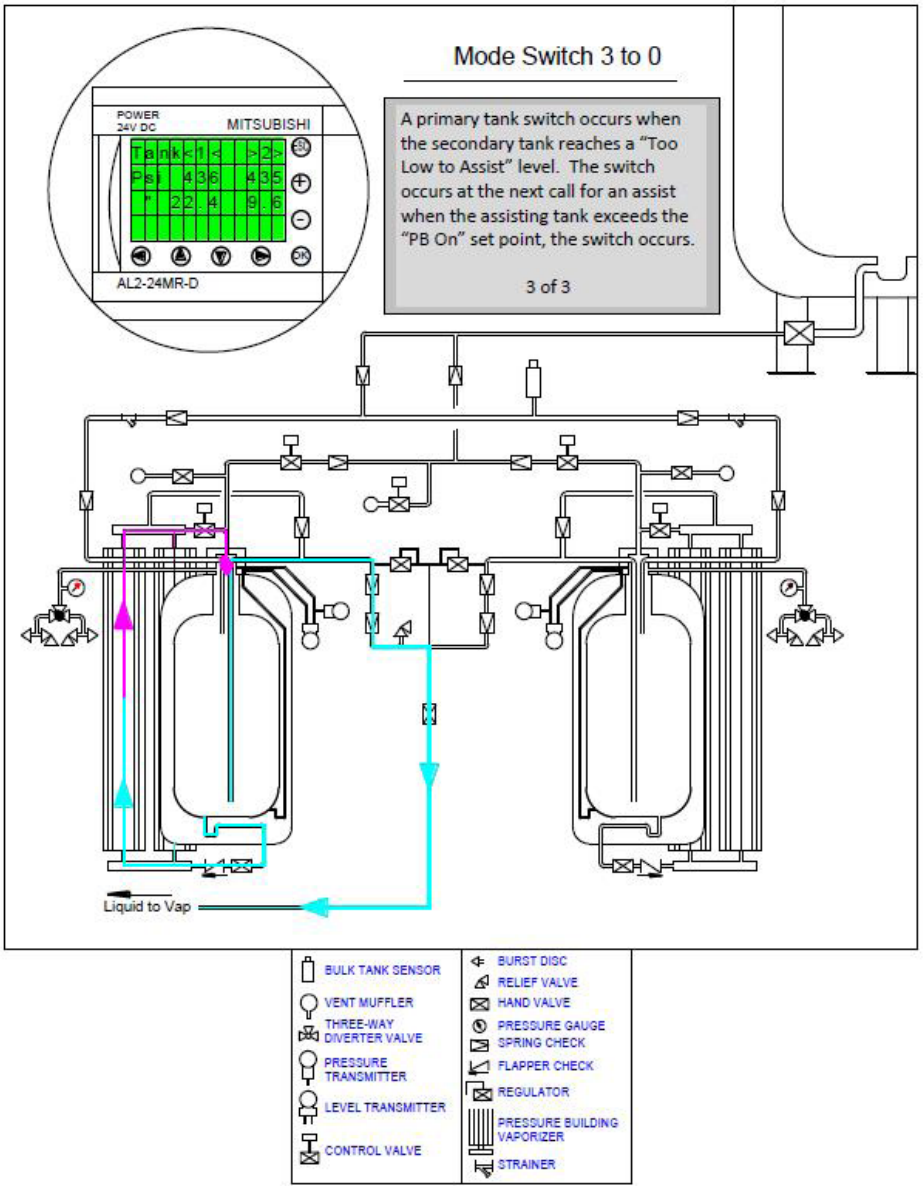
Assist Complete Primary Recovery



Primary Unable to Recover (Switch Primary Side)



Primary "Too Low to be Assisted" (Switch Primary Side)



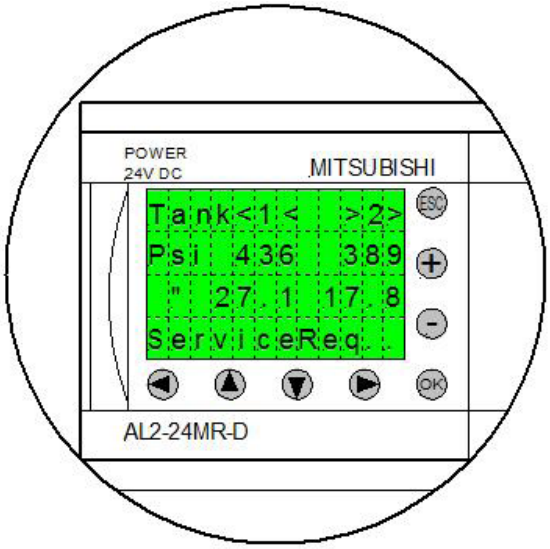
Secondary Tank "Too Low to Assist" (Switch Primary Side)

Service

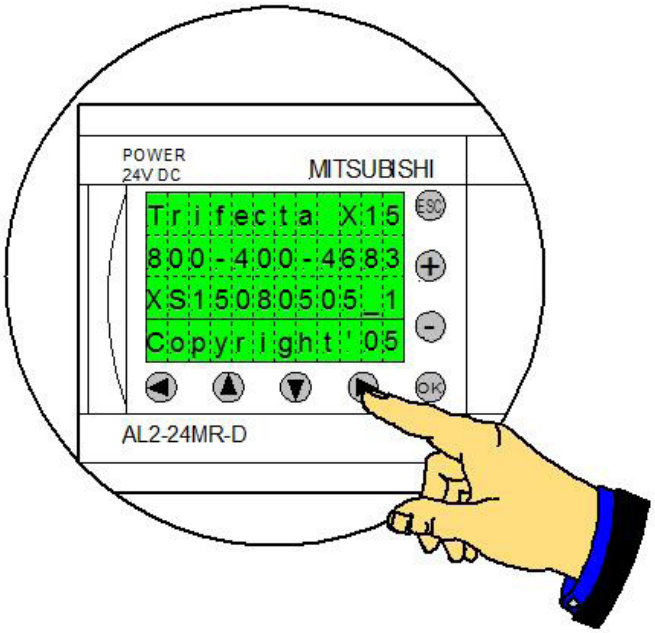
Service Menus

The Trifecta X-Series PLC has built into the program service information and error codes.

If the PLC determines that there is a service issue "ServiceReq.." will be displayed.



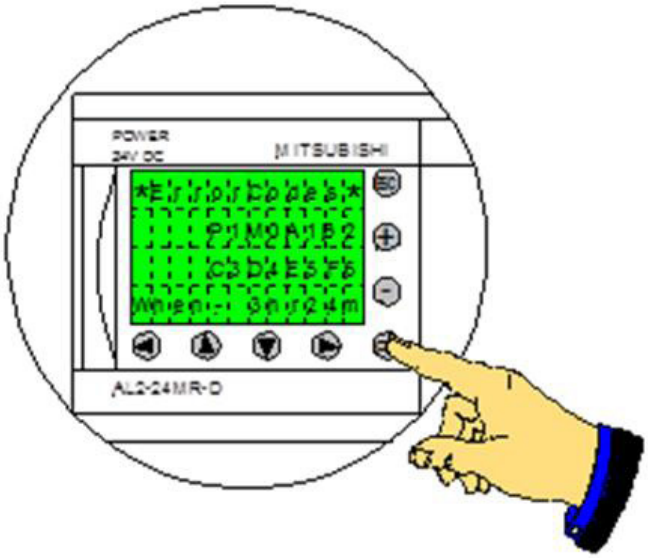
Press the right arrow on the PLC controller to acces the service phone number (1-800-400-4683).



Before calling for assistance note the current program revision (example: XS15080505_5). The revision number will help in troubleshooting.

Error Codes

The PLC reviews timers, flows, values and counters to assure they are within reason. If the PLC determines that they are not within reason an error code will be displayed.



Access the error codes by pressing and holding the "OK" button. Along with the error codes the current primary tank (example P1 - side 1 is primary) is indicated.

Also, the current mode is displayed (example M0 - Secondary filling).

The following is the summary of the error codes:

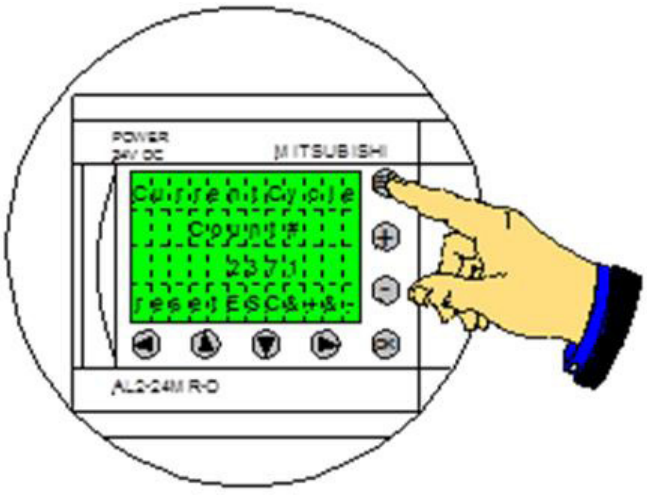
Code	Description	Action
P1	Primary Side 1	None
P2	Primary Side 2	None
M0	Filling Secondary	None
M1	Secondary PB after Fill	None
M2	Secondary Ready	None
M3	Secondary Assist of Primary	None
A0	OK!	None
A1	Fill time exceeds flow rating	Improve fill times by: Increasing sub-cool reduce bulk critical pressure reduce restrictions on liquid line.
B0	OK!	None
B2	The primary tank called for an assist before the secondary tank was ready to assist	Check fill levels. Check for leaks in the PB circuits. Check PB valve operation.
C0	OK!	None

Code	Description	Action
C3	The temperature switch has detected liquid at the vent muffler.	Reduce fill levels. Check DP Transmitter. Check thermocouple connection. Check termperature switch function.
D0	OK!	None
D4	Overpressure has occurred. Tank or Tanks have vent back to storage.	Check fill levels. Check PB valve function. Check DP transmitter accuracy.
E0	OK!	None
E5	System has exceeded the flow rating.	Check for house line leaks. Check for system leaks. Need additional or next size Trifecta X-Series.
F0	OK!	None
F6	One of the systems transmitters has gone out of range	Check electrical connects. Replace faulty transmitter.

The alert light will flash when the system has seen a low pressure event. A low pressure event is when both primary and secondary tanks are below the PB On set point for 90 seconds. During the alert status the system will continue to attempt to recover. In the service menu activated by pressing the “OK” button a timer is displayed showing the running time from the alert event (example: 3 hours and 24 minutes since the low pressure event that activated the alert light). At the moment of the alert the error codes are frozen to assist in trouble shooting (alert codes during a non-alert events are reset at every fill). Reset the frozen codes by pressing the “OK” button and the “-” button simultaneously.

Cycle Counter

Pressing the “ESC” button activates the Cycle Count display.



This counter tracks the number of times the system has switch primary tanks since being reset. When the counter reaches 20,000 cycles, the Alert light will flash and “ServiceReq..” will be displayed. The counter is used to proactively service the systems valves. To reset the counter: press “ESC”, “+” and “-” buttons simultaneously.

If the system is shut off, upon turning the power back on, the controller will go through the initialization routine and begin controlling. The current program is not affected 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 Trifecta X-Series’ cylinders.

Button Press Summary

- Press 5 times to "Reset Values" factory settings
- Set Point PB On and PB Off
- Set Point Fill Level in Inches
- Set Point Bulk Critical and Display Bulk psi
- Trifecta Version/800#/Copyright
- Error Codes
- Service Screen/Cycle count
- Increase PB set points
- Decrease PB set points
- Increase fill set point
- Decrease fill set point
- Increase bulk critical set point
- Decrease bulk critical set point
- Manual Primary Switch
- Reset parameter counter (shipment)
- Manual PB#1 valve on(manual only)
- Manual Vent#1&VentAtm valve on(manual only)
- Manual Vent#2&VentAtm valve on(manual only)
- Manual PB#2 valve on(manual only)
- Reset Cycle Count
- Reset Alerts

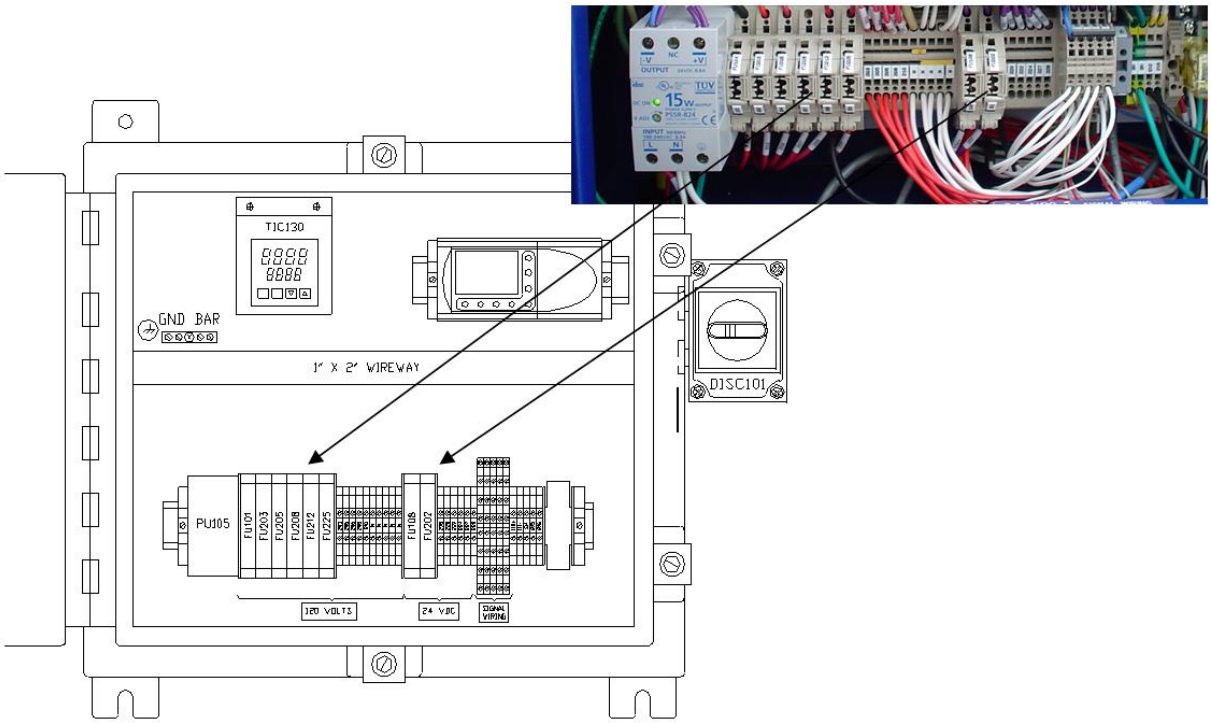
Manually Operating the Valves

With the system in the “Monitor” mode, valves and valve sets can be operated by pressing the “ESC” button and the arrow buttons (see Button Press Summary for details).

The solenoids have a manual over-ride hand wheel.

- Turning the red wheel in (clockwise) over-rides the solenoid locking the valve open.
- Turning the red wheel out (counter-clockwise) allows the solenoid to open and close the valve electrically.

Fuses



Fuse #	Voltage	Fuse Type (Amps)	Device(s) Protected	Chart Part Number
FU101	110AC	MDA-10 (10)	Main (Panel)	11832443
FU203	110AC	MDL-2 (2)	PB Valve/Light Side 1	11832398
FU205	110AC	MDL-2 (2)	PB Valve/Light Side 2	11832398
FU208	110AC	MDL-2 (2)	Vent Valves/Lights Side 1 & 2	11832398
FU212	110AC	MDL-4 (4)	Vent Atm. Valve/Light @ Muffler	12942935
FU225	110AC	MDL-2 (2)	Box Heater	11832378
FU108	24VDC	AGC - 2/10 (2)	Transmitter Power	12942978
FU202	24VDC	MDL - 1 (1)	PLC Power	12942943

Power down the panel before changing fuses.

Before replacing a fuse and powering back up it is best to have an understanding why the fuse failed.

Repairs

Note: *Any time plumbing is removed from the Trifecta X-Series system, take care not to allow any moisture to enter the system. This moisture can freeze and cause check valves and control valves to stick. Critical lines can freeze causing incorrect level and pressure readings.*

Check Valve Leaking

If you find that there is a leaking check valve, the Trifecta X-Series will have to be emptied and depressurized. The check valve should then be replaced. Replacement parts can be found in the Preventive Maintenance section on this manual and ordered on www.chartparts.com.

Solenoids

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

- PLC is not sending signal to energize the solenoid
- Contaminants on solenoid seat
- Moisture in solenoid
- Solenoid failure

The most common symptoms of these failures and their remedies are described in the following sections:

Non-Energizing Solenoid

The PLC sends a signal to the solenoid to energize the coil during a particular operation of the Trifecta X-Series. When this signal is sent from the PLC, an LED on the front panel lights up. If the LED lights up but the solenoid is not energized and does not open, check for loose wiring and voltage at the valve with a multi-meter. If there is power at the valve and the valve does not open, the coil will need to be replaced. Contact www.chartparts.com for replacement parts.

Contaminants on Solenoid Seat

If the solenoid appears to be leaking, there are lost likely contaminants on the seat of the piston. The seat or piston may also be damaged. In this case, remove the piston and replace. Also verify that the strainer is in place and replace if it has been six months prior to last replacement.

Moisture in Solenoid

Solenoid should be allowed to thaw. Once thawed, moisture may be removed from solenoid upon next use via the flow of new gas.

Solenoid Failure

If none of the above improves the situation, there has been a catastophic failure within the solenoid coil. The entire solenoid must be replaced.

Leaking Components

If the leak cannot be fixed via tightening or re-plumbing a component, a new component will have to be fitted. Refer to the Preventive Maintenance section of this manual to locate the description and part number of this component.

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

Pressure and Liquid Level Transmitters

1. Leak check all fittings associated with the transmitter to verify the circuit has zero leaks. The sensor error check function is designed to find problems such as a wire coming disconnected, or a short in the transmitter. “F6” will display in the error code section of the PLC if a pressure or liquid level transmitter is out of range. See the Service section of this manual for Error Codes.
2. Confirm that all wiring connection terminals are tight.
3. If all connections are made and the error condition does not go away, check the transmitter output.
4. Recalibrate or replace the transmitter as necessary.
5. Also verify display versus the analog gauges for pressure readout.

Ball Valve Repair (Trifecta X-Series - X15 only)

The Trifecta X-Series X-15 uses cryogenically rated ball valves in the pressure building circuit. Chart recommends that these ball valves be serviced via the replacement of the seal kits at least every two years (approximately 150,000 cycles.

Preventive Maintenance

Procedure

Over time components of the Trifecta X-Series (as in any mechanical system) can degrade and/or fail if not properly maintained. For this reason, a regular maintenance procedure is recommended to prevent any unexpected downtime.

The most common field failures are due to:

- Clogged fill line strainer or strainer having been completely removed by service technician permitting entry of debris to system.
- Malfunctioning solenoids and check valves (leaks) caused by:
  - Buildup of impurities of liquid fed to the system from the bulk tank
  - Introduction of moisture to the bulk system without proper purge process
  - Normal wear and tear of solenoids' pistons and seats due to cycling
  - Debris entering Trifecta X-Series from bulk station due to removed strainer
- Leaking fittings
  - All connections are leak checked from the factory and should be re-checked periodically
  - All replaced fittings in the field must be checked to ensure proper operation
- Malfunctioning cylinder 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 six months:
  - Replace strainer on liquid feel line

Note: *DO NOT operate system without a fill line strainer in place.*

- Every year:
  - Verify two normal operation cycles
  - Inspect integrity of all wire connections in control box. Tighten all loose connectors.
  - Verify accuracy of analog gauges against pressure transmitters
  - Leak check entire Trifecta X-Series system
- Every three years or at cycle count limit:
  - Replace all check valves
  - Replace pistons on all solenoid valves and rebuild cryogenic ball valves
  - Replace relief valves and burst discs on tanks 1 and 2

Note: *Reset cycle counter after servicing valves*

Recommended Spare Parts

In the event that repair is necessary, Chart provides the following spare parts at www.chartparts.com.

Control Box		
Item Description 1	**Item Description 2**	**Chart PN**
Fuse FU101 MDA-10 (10 amp Main Panel)	FUSE MDL-1 1/2 AMP SLOW 250V	4614489
Fuse FU-108 AGC-2/10 (2/10th amp Transmitter power)	FUSE BUSSMANN #AGC-2/10-R	12942978
Fuse FU202 MDL-1 (1 amp PLC Power)	FUSE BUSSMANN #MDL-1	12942943
Fuse FU203 MDL-2 (2 amp PB Valve/Light Side 1)	FUSE BUSSMAN #MDL-2-R	11832398
Fuse FU212 MDL-4 (4 amp Vent Atm. Valve/Light)	FUSE BUSSMANN #MDL-4-R	12942935
Switch MON/OFF/RUN	KIT SWITCH TRIFECTA	20686433
Light Bulb-LED	BULB LED GE GREEN	12942919
Temperature Controller-Red Lion	TEMP CONTROLLER RED LION	12942901
Thermocouple Type T Probe	THERMOCOUPLE TYPE T 60” LEADS	14271813
PLC(UNPROGRAMMED-REQUIRES EEPROM/SERVICE SPECIFIC)	PLC MITSUBISHI CONTROLLER	1877019
PLC (programmed LIN service X-5 500 psi ONLY) Software Version 11	PLC PROGRAMMED X5 TRIFECTA	13481991
PLC (programmed LIN service X-10 500 psi ONLY) Software Version 11	PLC PROGRAMMED X10 TRIFECTA	13482002
PLC (programmed LIN service X-15 500 psi ONLY) Software Version 11	PLC PROGRAMMED X15 TRIFECTA	13482011
EEPROM Chips		
Item Description 1	**Item Description 2**	**Chart PN**
EEPROM (UNPROGRAMMED-REQUIRES EEPROM/SERVICE SPECIFIC)	IC EPROM FOR MITSUBISHI	13090017
EEPROM (X-5 500 psi LIN ONLY)	EEPROM TRIFECTA 5X N2 500 PSI	21240340
EEPROM (X-5 500 psi LAR ONLY)	EEPROM TRIFECTA 5X AR 500 PSI	21240346
EEPROM (X-5 350 psi LOX ONLY)	EEPROM TRIFECTA 5X O2 350 PSI	21240347
EEPROM (X-10 500 psi LIN ONLY)	EEPROM TRIFECTA 10X N2 500 PSI	21240344
EEPROM (X-10 500 psi LAR ONLY)	EEPROM TRIFECTA 10X AR 500 PSI	21240348
EEPROM (X-10 500 psi LOX ONLY)	EEPROM TRIFECTA 10X O2 350 PSI	21240354
EEPROM (X-15 500 psi LIN ONLY)	EEPROM TRIFECTA 15X N2 500 PSI	21240345
EEPROM (X-15 500 psi LOX ONLY)	EEPROM TRIFECTA 15X O2 500 PSI	21240350
EEPROM (X-15 350 psi LOX ONLY)	EEPROM TRIFECTA 15X O2 350 PSI	21240352
EEPROM (X-10 600 psi LIN ONLY)	EEPROM TRIFECTA 10X N2 600 PSI	21240356
EEPROM (X-15 600 psi LIN ONLY)	EEPROM TRIFECTA 15X N2 600 PSI	21240355

Recommended Spare Parts Cont.

Safety Tree		
Item Description 1	***Item Description 2***	***Chart PN***
Safety Relief Valve-Cylinder (BRS ½"MPT 500 psi)	RV BRS 1/2MPT 500PSI W/O DRAIN	20894583
Safety Relief Valve-Cylinder (BRS ½"MPT 600 psi)*	RV BRS 1/2MPT 600PSI	20547372
Rupture Disc-Cylinder (RPD assy. Inline 1/2"MPT 700 psi)	RPD ASSY INLINE 1/2MPT 700PSI	11526622
Rupture Disc-Cylinder (RPD Inline 1/2"MPT 800 psi)*	RPD ASSY INLINE 1/2MPT 800PSI	20547371
Pressure Gauge (0-600 psi)	PG 2"DIAL 0/600PSI/BAR/KPA	14932546
Pressure Gauge (0-800 psi)	PG 2"DIAL 0-800 PSI/BAR	14954366
VALVE BALL DIV SS 1/2NPT	VALVE BALL DIV SS 1/2NPT	11773885
Regulators/Check Valves/Globe Valves		
Item Description 1	***Item Description 2***	***Chart PN***
Economizer Regulator (525 psi)	REGULATOR .250NPT @ 525PSI	13774101
Economizer Regulator (625 psi)*	REGULATOR .250NPT @ 625PSI	20553102
Strainer-Inlet	STRAINER .500ODT BRS BODY	13660471
Strainer-Inlet Replacement Element	STRAINER ELEMENT KIT SWGLK 440	13729343
Check Valve Generant (1 psi) ½"FPT x ½"FPT	VALVE CHECK BRS 1/2FPTX1/2FPT	13620233
Check Valve Generant (5 psi crack) ½"FPT x ½"FPT	VALVE CHECK BRS 1/2FPTX1/2FPT	11051090
PB Inlet Check Valve (1/2"FPT - bottom of tank)	VALVE CHECK BRS 1/2FPT	11208931
pb inlet/maunal muffler valve	VALVE BRS SH 1/2FPTX1/2FPT	11555482
use (Valve Glove BRS ½")	VALVE GLOBE BRS 1/2NPT SCRD	10616790
Safety Relief Valve-Piping (BRS ¼"MPT 575 psi)	RV BRS 1/4MPT 575PSI	13849812
RV BRS 1/4MPT 675PSI *	RV BRS 1/4MPT 675PSI	20548031
MUFFLER ASSY SS 5/8" 45D FL	MUFFLER ASSY SS 5/8" 45D FL	13060248
MUFFLER 1/2"MPT WITAN 600 PSIG	MUFFLER 1/2"MPT WITAN 600 PSIG	11731685
MUFFLER OXY TRIFECTA X-SERIES	MUFFLER OXY TRIFECTA X-SERIES	13744164
Solenoid Valves		
Item Description 1	***Item Description 2***	***Chart PN***
Vent Solenoid Valve (120VAC-½")	VALVE SOLENOID 1/2FPT 120VAC	10925509
Vent Valve Solenoid Coil (120VAC-½")	COIL SOLENOID 120V 60HZ	10963071
Vent Valve Gasket (1/2")	GASKET SOLENOID MAGNATROL	10963100
Vent Valve Piston Assembly (120VAC-½")	PISTON ASSY SOLENOID MAGNATROL	10963062
MANUAL OVER-RIDE ASSY (1/2")	MANUAL OVER-RIDE ASSY	11554877
PB Solenoid Valve (120VAC – ¾")	VALVE SOLENOID 3/4FPT 120VAC	11033191
PB Solenoid Valve Coil (120VAC – ¾")	COIL SOLENOID MAGNATROL 120V	11034011
PB Solenoid Valve Gasket (¾")	GASKET SOLENOID MAGNATROL	10963100
PB Solenoid Valve Piston Assy. (120VAC – ¾")	PISTON ASSY SOLENOID MAGNATROL	11034020
PB Solenoid Valve (120VAC – 1")	VALVE SOLENOID 1FPT 120VAC	14413113
PB Solenoid Valve Coil (120VAC – 1")	COIL SOLENOID MAGNATROL 120V	11034011
PB Solenoid Valve Gasket (1")	GASKET SOLENOID 1" TEFLON	20571792
PB Solenoid Valve Piston Assy. (120VAC – 1")	PISTON ASSY 1" SOLENOID	20571789
PB Manual Override Valve Assy. (1")	MANUAL OVER-RIDE ASSY 1"	20571793

Recommended Spare Parts Cont.

600 PSI Valve and Actuator		
Item Description 1	**Item Description 2**	**Chart PN**
PB Ball Valve Assy. (Habonim Valve 1/2”MPT w/Max Air Actuator)	VALVE BALL SS 1/2FPT W/AOV HAB	20866318
ACTUATOR MAX-AIR FOR EMC VALVE	ACTUATOR MAX-AIR FOR EMC VALVE	13931752
VALVE BALL SS 1/2"NPT W/6"EXT	VALVE BALL SS 1/2"NPT W/6"EXT	21070662
KIT REPAIR HABONIM 1/2" BALL	KIT REPAIR HABONIM 1/2" BALL	21077704
KIT REPAIR ACTUATOR SEALS MAX AIR# UT21S70 SILICONE	KIT REPAIR ACTUATOR SEALS	13926988
KIT REPAIR ACTUATOR SEALS MAX AIR# MT21SSR5 SILICONE		
VALVE SOLENOID AL 1/4NPT 120V	VALVE SOLENOID AL 1/4NPT 120V	14296295
Replace PB 1/2” Actuating to 1” Solenoid Valves		
Item Description 1	**Item Description 2**	**Chart PN**
PB Valve Kit	KIT TRIFECTA 15X PB RETURN VLV	14413092
Air Actuator - Safeties and Regulators (600 psig Trifecta)		
Item Description 1	**Item Description 2**	**Chart PN**
PB Ball Valve Actuator Safety Relief Valve (BRS ¼” 125psi)	RV BRS 1/4MPT 125PSI	1810652
PB Ball Valve Actuator Regulator (90 psi)	REGULATOR .250NPT @ 90PSI A-32	10852311
PB Ball Valve Actuator Safety Relief Valve (BRS ¼” 150 psi)	RV BRS 1/4MPT 150PSI ASME	11915581
Regulator-PB/Vent Actuating Valve (125 psi)	REGULATOR .500NPT @ 125PSI	11779806
TRANSMITTERS		
Item Description 1	**Item Description 2**	**Chart PN**
DIFF PRESS CALBRATED 0-40"RSMT	DIFF PRESS CALBRATED 0-40"RSMT	13963691
TRANSMITTER PRESS 0-500PSIG	TRANSMITTER PRESS 0-500PSIG	12894574
TRANSMITTER PRESS 0-600PSIG*	TRANSMITTER PRESS 0-600PSIG	20547373
Pressure Transducer (Bulk Tank Pressure - WIKA 0-500 psi)	PRESSURE TRANS 0-500 PSI C-10	14877751
Change from Honeywell to Rosemount DP		
Item Description 1	**Item Description 2**	**Chart PN**
KIT TRIFECTA DIFF TRANSMITTER	KIT TRIFECTA DIFF TRANSMITTER	21176647

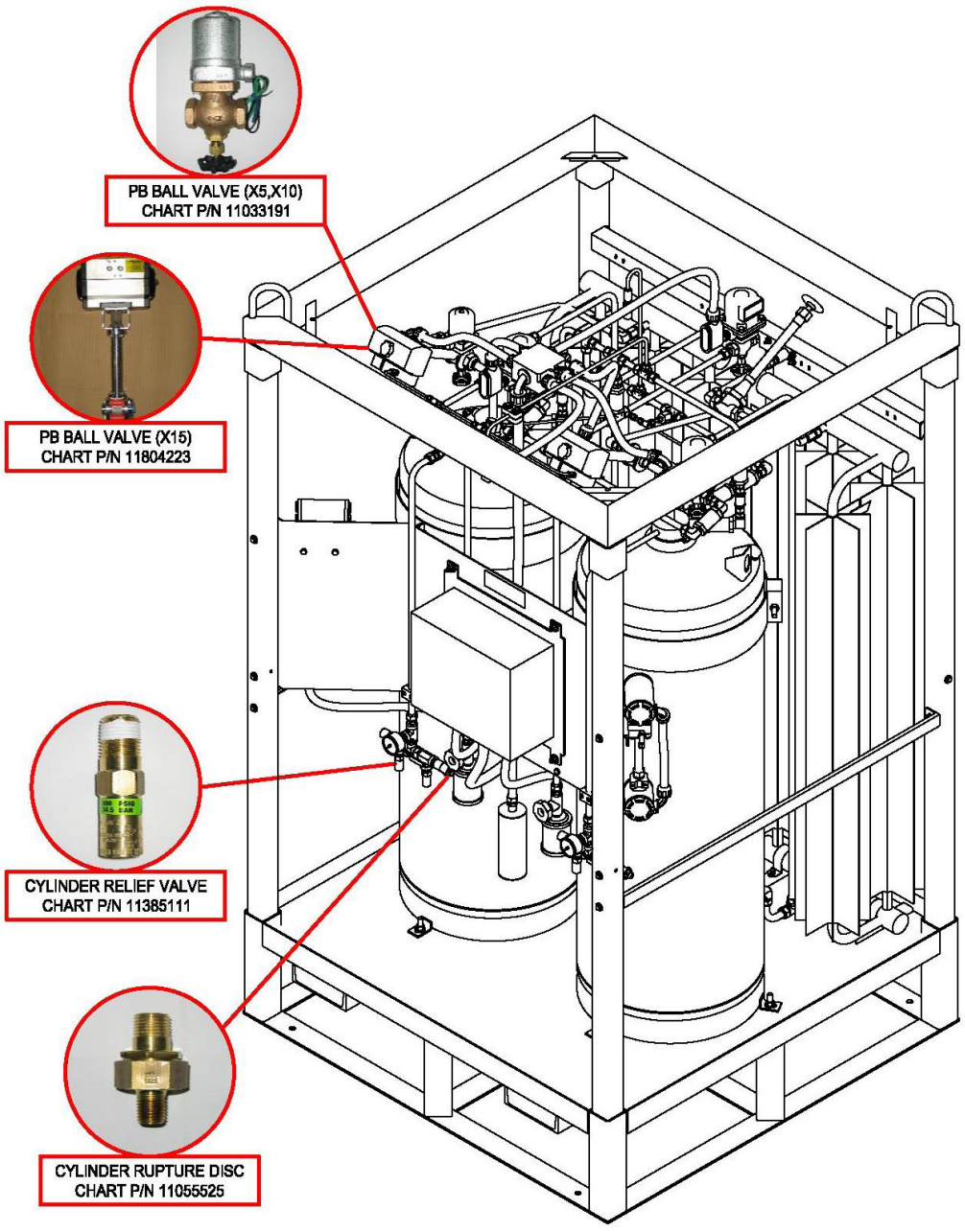
Spare Parts Kits

X-10 500PSI (PN 21323717)		
Item Description	**Chart PN**	**QTY**
REGULATOR .250NPT @525PSI	13774101	1
VALVE SOLENOID 1/2FPT 120VAC	10925509	1
GASKET SOLENOID MAGNATROL	10963100	2
PISTON ASSY SOLENOID MAGNATROL	10963062	1
FUSE BUSSMANN #AGC-2/10-R	12942978	1
FUSE BUSSMANN #MDL-2-R	11832398	2
FUSE BUSSMANN #MDL-4-R	12942935	1
RV BRS 1/2MPT 500PSI	11385111	2
VALVE CHECK BRS 1/2FPTX1/2FPT	13620233	2
VALVE CHECK BRS 1/2FPTX1/2FPT	11051090	1
PLC PROGRAMMED X10 TRIFECTA	13482002	1
VALVE SOLENOID 3/4FPT 120VAC	11033191	1
PISTON ASSY SOLENOID MAGNATROL	11034020	1
KIT TRIFECTA DIFF TRANSMITTER	21176647	1
TRANSMITTER PRESS 0-500PSIG	12894574	1

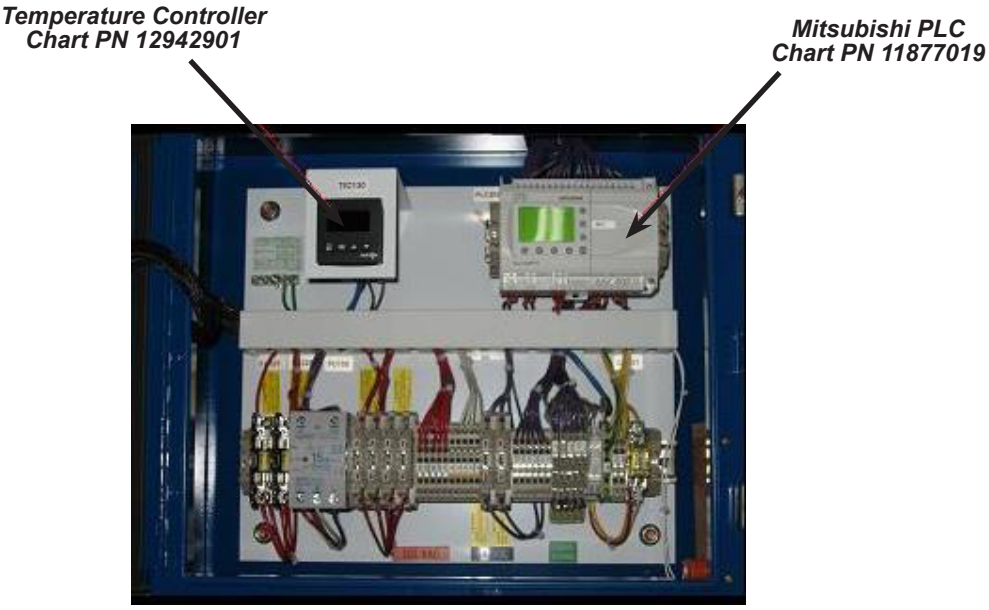
X-15 500PSI (PN 21323718)		
Item Description	**Chart PN**	**QTY**
REGULATOR .250NPT @525PSI	13774101	1
VALVE SOLENOID 1/2FPT 120VAC	10925509	1
GASKET SOLENOID MAGNATROL	10963100	2
PISTON ASSY SOLENOID MAGNATROL	10963062	1
FUSE BUSSMANN #AGC-2/10-R	12942978	1
FUSE BUSSMANN #MDL-2-R	11832398	2
FUSE BUSSMANN #MDL-4-R	12942935	1
RV BRS 1/2MPT 500PSI	11385111	2
VALVE CHECK BRS 1/2FPTX1/2FPT	13620233	2
VALVE CHECK BRS 1/2FPTX1/2FPT	11051090	1
PLC PROGRAMMED X15 TRIFECA	13482011	1
VALVE SOLENOID 1FPT 120VAC	14413113	1
PISTON ASSY 1” SOLENOID	20571789	1
GASKET SOLENOID 1”TEFLON	20571792	1
KIT TRIFECTA DIFF TRANSMITTER	21176647	1
TRANSMITTER PRESS 0-500PSIG	12894574	1

X-10 600PSI (PN 21323719)		
Item Description	**Chart PN**	**QTY**
REGULATOR .250NPT @625PSI	20553102	1
FUSE BUSSMANN #AGC-2/10-R	12942978	1
FUSE BUSSMANN #MDL-2-R	11832398	2
FUSE BUSSMANN #MDL-4-R	12942935	1
RV BRS 1/2MPT 600PSI	20547372	2
VALVE CHECK BRS 1/2FPTX1/2FPT	13620233	2
VALVE CHECK BRS 1/2FPTX1/2FPT	11051090	1
PLC PROGRAMMED X10 500PSI	21323461	1
VALVE BALL SS 1/2FPT W/AOV HAB	20866318	1
ACTUATOR MAX-AIR FOR EMC VALVE	13931752	1
VALVE SOLENOID AL 1/4NPT 120V	14296295	1
KIT TRIFECTA DIFF TRANSMITTER	21176647	1
TRANSMITTER PRESS 0-600PSIG	20547373	1

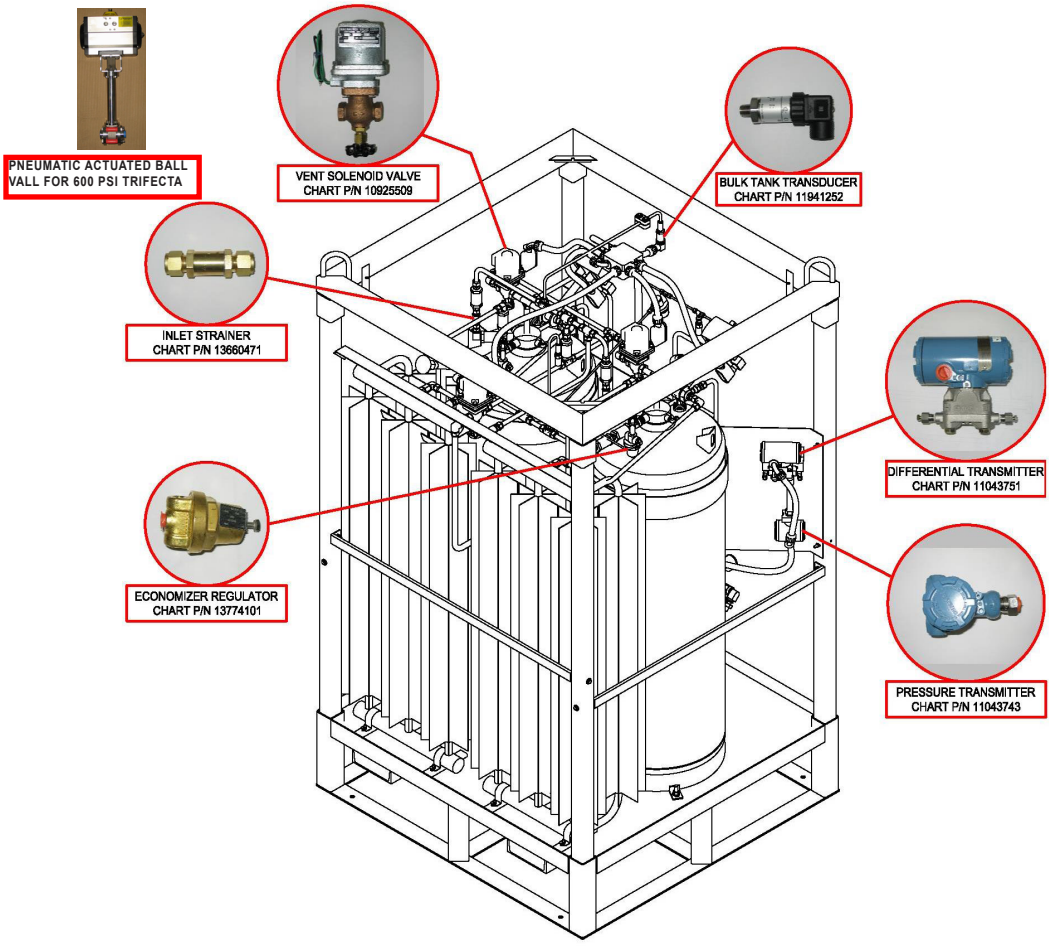
X-15 600PSI (PN 21323720)		
Item Description	**Chart PN**	**QTY**
REGULATOR .250NPT @625PSI	20553102	1
FUSE BUSSMANN #AGC-2/10-R	12942978	1
FUSE BUSSMANN #MDL-2-R	11832398	2
FUSE BUSSMANN #MDL-4-R	12942935	1
RV BRS 1/2MPT 600PSI	20547372	2
VALVE CHECK BRS 1/2FPTX1/2FPT	13620233	2
VALVE CHECK BRS 1/2FPTX1/2FPT	11051090	1
PLC PROGRAMMED X15 600PSI	21323462	1
VALVE BALL SS 1/2FPT W/AOV HAB	20866318	1
ACTUATOR MAX-AIR FOR EMC VALVE	13931752	1
VALVE SOLENOID AL 1/4NPT 120V	14296295	1
KIT TRIFECTA DIFF TRANSMITTER	21176647	1
TRANSMITTER PRESS 0-600PSIG	20547373	1



Front Isometric view of Trifecta



Inside picture of Control Box



Rear Isometric view of Trifecta

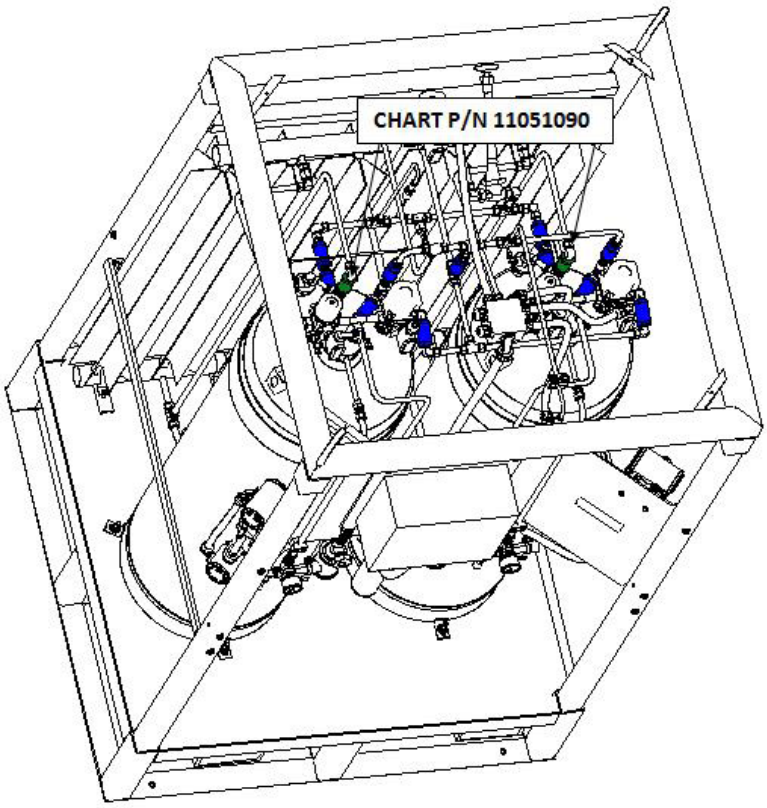


CHART P/N 13620233
GENERANT P/N CV-513-B-T-1

CHART P/N 11051090
GENERANT P/N CV-503B-T-5

Whenever solenoid piston assemblies are serviced, or valve is taken apart for cleaning, the bolts must be accurately torqued to 10 to 12 foot-pounds of torque in a normal cross pattern upon re-assembly. If they are over torqued, the body will become distorted, and “pinch” the piston, causing the valve to stick open or closed. It is also recommended that every time the valve is disassembled, that the gasket be replaced, as the gasket takes a permanent set each time the bolts are tightened and will not re-seal a second time.

When the pneumatically actuated ball valves that are on the 600 psig Trifecta units get rebuilt, torque specs on these bolts are specified to be 9.38 foot pounds. Special care should also be taken to insure that the relief port in the ball is oriented so it vents on the upstream side of the valve. Failure to properly orient the vent port in the ball will cause the valve to leak by.

Troubleshooting

If the regular maintenance procedure 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 X-Series operation, please read the Operation section of this manual before continuing.

While troubleshooting the Trifecta X-Series, there are five things that should be monitored or checked for inconsistency to aid in diagnosis:

1. Confirm all valves on the bulk tank and Trifecta X-Series are in their normal operating position.
2. Confirm solenoids (and/or pneumatic actuated ball valves) energize correctly by manually "firing" them per the instructions in the Operations section of the manual.
3. Check for frost formation on lines which should not have recently been active.
4. Leak check all plumbing components.
5. Check for discrepancies between analog gauges and controller parameters.

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

Confirm Valve Positions

- Confirm that the following manual override on all valves are in the correct position:
  - Bulk Tank Auxiliary Liquid Valve Open
  - Bulk Tank Pressure Building Valve Open
- All five solenoid (5k, 10k, 15k) valves on Trifecta X-Series
- Manual override hand wheel in the "Out" position

Normal Activation of Solenoids

Dial main switch on front of the control panel to "Monitor." Open control panel door giving you access to the PLC controller. Per the Operations section of this manual, press the corresponding buttons on the controller to "fire" each cluster of solenoids. Make sure all valves energize accordingly.

Frost Formation

Frost forms on all lines that have cold vapor or liquid flowing 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 are leaking or inoperable, can often be detected.

Likewise, 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.

Leak Check

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

- A leak at any point in the Trifecta X-Series system will result in loss of product.
- A leak in the plumbing within the plumbing stack or pressure transducers and transmitters can cause incorrect values to be translated by the PLC. These transducers provide the input to the Trifecta X-Series controller, which tell it when to open and close solenoids. Incorrect values will cause the Trifecta unit to operate in a random fashion and could cause supply issues downstream.

Data from Main Screen and Analog Pressure Gauges

Record Trifecta X-Series and bulk tank parameters as described in the Parameter Settings section of this manual. Compare these values to those on the analog gauges of the tanks and the bulk tank. (an example form is on the next page.)

Bulk Tank

Pressure (Analog Gauge)	_____	PSIG
Pressure (from PLC Display)	_____	PSIG

Tank 1

Pressure (Analog Gauge)	_____	PSIG
Pressure (from PLC Display)	_____	PSIG
Liquid Level (from PLC Display)	_____	"H_20

Tank 2

Pressure (Analog Gauge)	_____	PSIG
Pressure (from PLC Display)	_____	PSIG
Liquid Level (from PLC Display)	_____	"H_20

PLC Information

Press left arrow/record PB Set Point	_____	PSIG
Press up arrow/record Fill Set Point	_____	"H_20
Press down arrow/record bulk critical	_____	PSIG
Press "ESC"/record cycle count	_____	#cycles

Press"OK"/record Error Codes and elapsed time since event:

P _____ M _____ A _____ B _____

C _____ D _____ E _____ F _____

When _____ hr _____ minute

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 result is an inaccurate analog gauge. Replace this gauge first.

Appendix 1

LOX Thread Sealant Spec Sheet

TECHNICAL DATA SHEET: LOX-8®

FLUORAMICS
formula LOX 8® SEALANTS
chem LOX 8® GREASES

LOX-8®
Thread Sealant & Grease

DESCRIPTION

LOX-8 Paste and **LOX-8 Grease**, PCTFE/PTFE pastes and greases, are used where oxygen or harsh chemicals such as chlorine or powerful oxidizers are present. Providing superior performance as a lubricant and sealant, LOX-8 is stable from -400° F to +550° F. LOX-8 is certified for use in gaseous and liquid oxygen.

Use LOX-8 Grease and LOX-8 Paste in environments where extended service life is important: medical, nuclear and other high-tech fields including chemical processing, industrial gases and other aggressive applications. Approved for use in food processing facilities. Fire resistant. MIL-PRF-27617G.
NSN 8030-00-829-3982.

TYPICAL APPLICATIONS

Paste applications include:
- off-shore rigging
- oxygen and chlorine systems
- cryogenics
- waste-water processing
- welding gases
- stainless steel anti-galling

Grease applications include:
- greasing oxygen service bearings, valves, O-rings, pumps and regulators
- fire-resistant grease

TYPICAL PROPERTIES

LOX-8 is specifically formulated for wet and dry conditions. It is non-migrating, remaining where it is applied. LOX-8 is ideal where repetitive assembly and disassembly are required. It is non-flammable, non-toxic, non-hardening, and is anti-galling with stainless steel.

Available sizes for both LOX-8 Grease and LOX-8 Paste:
- 25 gram jar
- 100 gram jar
- 1 lb. jar
- 100 gram plunger*

* Applicator gun to fit plunger is also available.

APPLICATION DETAILS

LOX-8 is the only thread sealant that does it all.
Apply liberally to a clean, dry surface. Fit and torque the matching piece.

STORAGE/SHIPPING/ HANDLING

No special handling required.

HEALTH & SAFETY

LOX-8 is a very safe solvent-free product. Wash hands after use. Keep product out of eyes.

Thread Sealants | Tufoil® Technology | Hinder*RUST* | Oxygen-Safe Greases & Pastes

Fluoramics, Inc.
Winona, MN • Made in the U.S.A.

fluoramics.com
1-800-922-0075
1-507-205-9216
Fax: 507-474-4585

LOX Thread Sealant Cont.

LOX-8 PASTE and GREASE ARE . . .

- Certified by NASA (ASTM G72-82) (ASTM G86)
- Certified by BAM
- Oxygen-compatible
- Anti-galling
- Anti-seizing
- Non-migrating
- Chemically Inert
- Waterproof
- Non-flammable
- Easy to apply
- Silicone free
- Hydrocarbon free
- Non-toxic
- Odorless

LOX-8®
Thread Sealant & Grease

LOX-8 is compatible with many aggressive chemicals, including...

Acetylene
Aluminum chloride
Ammonia
Ammonium hydroxide
Ammonium nitrate
Ammonium perchlorate
Anhydrous ammonia
Antimony trichloride
Argon
Bicarbonate Acid
Boron trichloride
Boron trifluoride
Bromine
Bromine trifluoride (gaseous)
Calcium hypochlorite
Carbon dioxide
Chlorine
Chlorine trifluoride (gaseous)
Chlorosilanes
Chlorosulfonic acid
Chromic acid
Chromyl nitrate
Ethylene oxide
Fuming nitric oxide
Helium
Hydrogen
Hydrogen bromide
Helium
Hydrochloric acid
Hydrogen fluoride
Hydrogen peroxide (all concentrations)
Hydrogen sulfide
Hydroiodic acid
Hypochlorite solutions
Iodine
Kerosene
Muriatic acid
Natural Gas
Nitric acid
Nitrogen
Nitrogen oxides (all)
Nitrogen trifluoride
Oleum
Oxygen (liquid & gaseous)
Phosphoric acid
Potassium perchlorate
Potassium persulfate
Propane
Propylene oxide
Silane
Silicone tetrachloride
Sodium
Sodium hydroxide (all concentrations)
Sodium peroxide
Sulfur trioxide
Sulfuric acid
Sulfur dioxide
Thionyl chloride
Titanium tetrachloride
Uranium hexafluoride
Water

The chemistries found in LOX-8 are compatible with the following elastomers and plastics:

Cured epoxies
EPDM
Ethylene propylene rubber
Fluoro-silicones
Neoprene
Polycarbonates
Polyamides
Polyvinyl alcohol
Rigid PVC
Rigid CPVC
Teflon type plastics
Urethanes
Viton type plastics

Thread Sealants Tufoil® Technology HinderRUST Oxygen-Safe Greases & Pastes

Fluoramics, Inc.
Winona, MN • Made in the U.S.A.

fluoramics.com
1-800-922-0075
1-507-205-9216
Fax: 507-474-4585