Product Manual

Trifecta

Pro Series

Designed and Built by:

Chart Inc.

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Contents

Revision Log

Revision Level	Date	Description
A	09/17/2019	Manual Creation

Preface

General

The Trifecta Pro 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 utilizes a standard bulk tank, which requires no manufacturing downtime when the tank is refilled. This convenient solution eliminates high-pressure pumps, compressors, cylinder cradles and surge tanks.

Product Highlights

- System utilizes standard medium-pressure bulk tank to lower investment and use existing assets
- No downtime - system maintains pressure and flow when bulk tank is filled and eliminates product losses associated with filling 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 (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 Pro 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 Pro 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 durability 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.

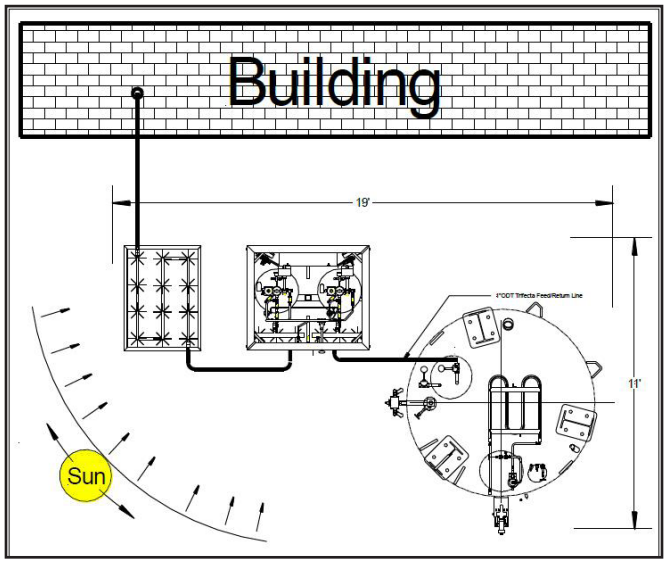
Typical Layout

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

- Medium Pressure Bulk Tank (Minimum 175 psig)
- Vaporizer(s)
- Trifecta Pro Series Skid

The Trifecta Pro Series has been designed for ease of installation and operation. An ideal install has the Trifecta Pro 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 Pro Series system is designed to supply high pressure cryogenic liquid to a vaporizer, while the reserve tank is being filled 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 process exceeds the flow rating of the Trifecta.

The Pro Series can supply liquid nitrogen and liquid argon in maximum allowable working pressures from 500 to 600 psi. It can supply liquid oxygen in maximum allowable working pressures of 500 psi.

Service	MAWP* (psig)	MAOP* (psig)
LIN	500	450
	600	550
LAR	500	450
	600	550
LOX	500	450

*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 Pro 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 X15 is rated to deliver liquid nitrogen at 425 psi @ 15,000 SCFH in ambient conditions similar to Minnesota. If the end user can tolerate lower delivery pressures, the Pro Series can deliver even greater flow rates. If the rated flows are not needed, the system can be set to higher pressures.

Note: *Rated flows on standard Trifectas are not for continuous duties in excess of 8-10 hours per day. Higher duty cycles require auxiliary pressure build capacity and properly sized process vaporizers.*

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, and/or duty cycles, may require de-icing of the pressure building system or the addition of higher capacity vaporizers.
- 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 restrictive 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. Longer liquid fill lines will 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 decreased fill times and reduced losses.

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 Pro Series should be done in the following order:

1. Place Trifecta Pro Series Skid on concrete pad next to bulk tank — concrete pad specifications should be in conformance with local building codes and reviewed by a licensed engineer.
2. Pipe Trifecta Pro Series liquid fill line to bulk tank labeled “From Bulk Tank.”For maximum efficiency, this line should be insulated and no smaller that 3/4”
    a. Use liquid withdrawal line on bulk tank

Note: *Do not use the dip tube line.*

3. Pipe Trifecta Pro Series gas use line to external vaporizer labeled “To Vaporizer.” To minimize ice build-up on pipe, this line should be insulated.
4. Connect power supply to dedicated 120V AC, 15 amp circuit. Connect ethernet cable.
5. Commission Trifecta Pro Series System.

Placement of Trifecta Pro Series Skid

The Trifecta Pro Series skid has four 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 Pro Series assembly weighs almost 1900 lbs. empty (864 kg).*

The Trifecta Pro Series skid should be placed on the concrete pad near the bulk storage tank as seen in the Introduction portion of this manual. 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 Pro 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 Pro 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. By removing the tube connection between A and B — shown in Fig. 1 on next page — the high-pressure vent gas can be separately piped to the gas phase of the bulk tank, or totally vented to atmosphere. Venting the Trifecta to the gas phase is often useful when connecting multiple Trifectas to one bulk tank.

The backside (PB Side) of the Pro Series skid has two/three connection points.

- Connection (A) serves as both the high pressure gas outlet and the liquid inlet when the tubing connection between A and B is in place
- Connection (B) is the high pressure gas outlet when the tubing connector between A and B has been removed.
- Connection (C) is the high pressure liquid outlet to the process vaporizers .

Figure 1

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 Pro Series system does not contain final vaporization. Consequently, one or more freestanding, external vaporizer(s) must be connected to the "to Vaporizer" line of the Trifecta Pro Series. The vaporizer(s) 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 600 psig (or 700 psig for the 600 psi high pressure Trifecta Gas Supply System).*

Note: *The relief device (SRV-3) on the Trifecta Pro Series is a fail-safe device and should not be relied upon as the only thermal relief. Operation of the Trifecta Pro Series "Gas Use" relief device may vent liquid, creating a noticeable vapor cloud.*

The piping and components from the Trifecta Pro 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. The outlet of the vaporizer should be piped to the customer house line with final line regulation as required.

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

Note: *Ensure that the house line is rated for the maximum pressure that can be produced by the Trifecta. Include additional relief valves and line regulation as required.*

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

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 in the upper piping of the Trifecta Pro 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.

Electrical Power Supply

A dedicated 120 volt AC, 60 Hz, 15 amp circuit must be provided to power the Trifecta Pro Series control system. If 120 VAC is not available, an appropriately sized transformer may be necessary.

The Allen Bradley PLC is mounted within a NEMA 4 control box as shown in the following photograph (Fig. 2).

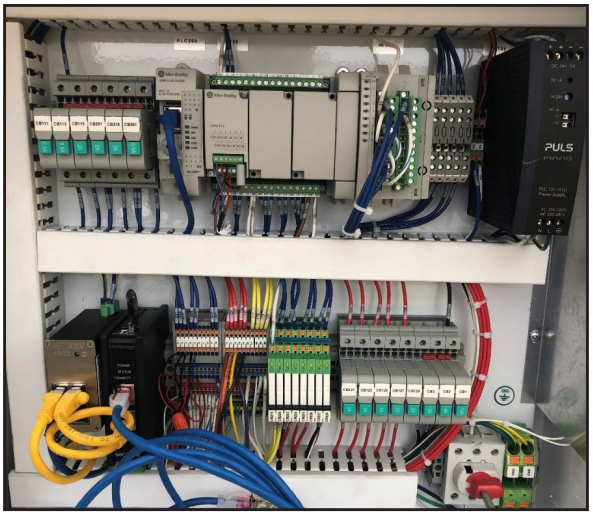


Figure 2 - Allen Bradley Control Panel

It is important that care is taken to install the Trifecta Pro Series system on a dedicated 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 Pro Series system and a clean, steady circuit must be used to power the Trifecta Pro Series system. Connecting the Trifecta to a circuit that is backed up by a generator might also be advantageous.

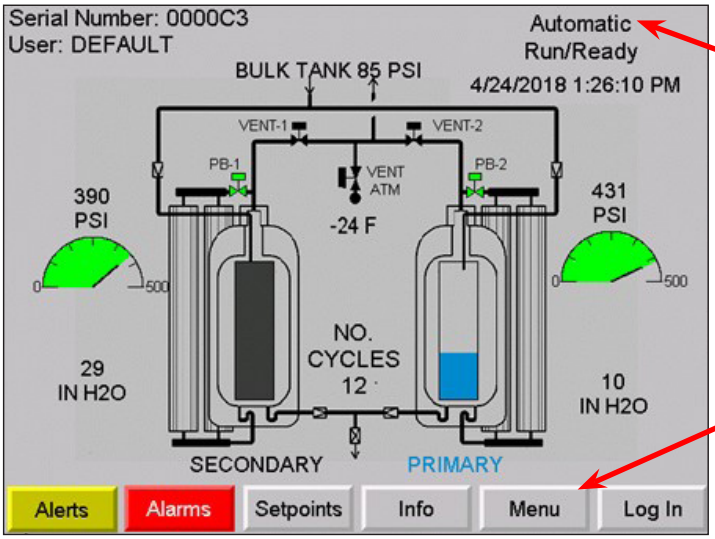
Commissioning

The following procedures should be followed when first commissioning the Trifecta.

Warning! ***It is important to purge the entire Trifecta Pro 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 Pro Series (Ref. to Fig. 4, Pg. 23 for valve tags)

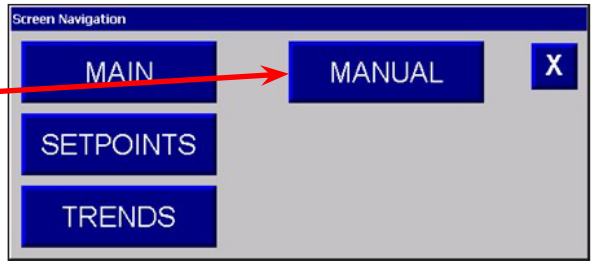
Verify that the controller is in the manual mode (see details below) and all valves are closed.

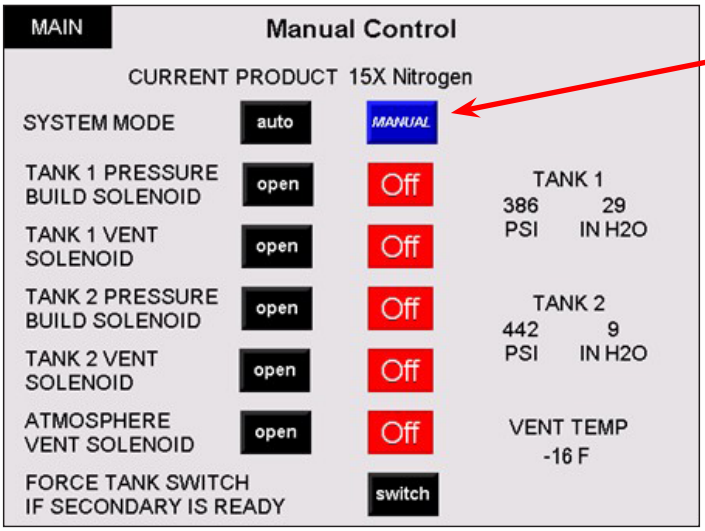


Before beginning purging, in the top right hand of the screen should say "Manual." If it says "Automatic," you will need to change it to manual

First, you will touch the Menu button on the screen. This will bring up a pop up box.

Then touch the "Manual" button on the screen.



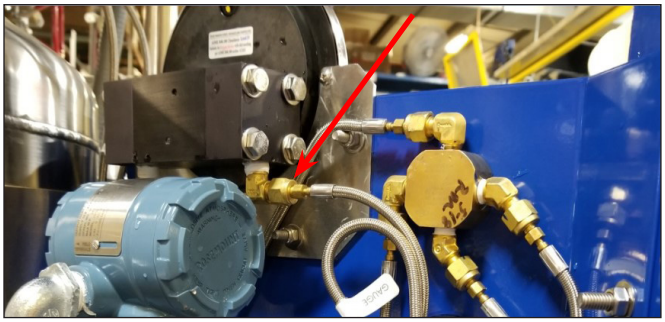


Then press the "Manual" button, which should be blue when it is in manual mode.

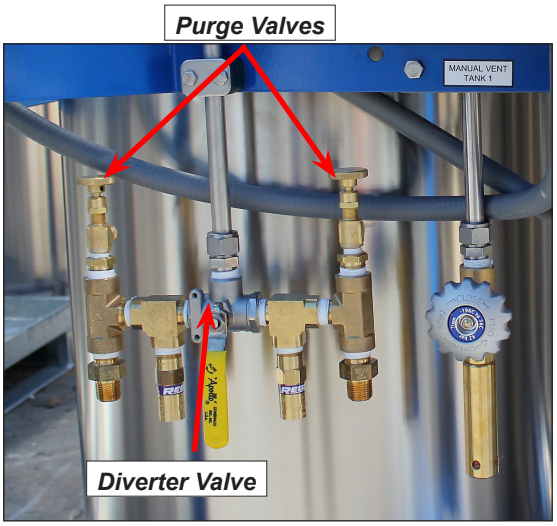
Note: The manual control screen can be used to manually open/close all the solenoid valves. This will be required for initially purging the Trifecta and for troubleshooting.

Purge and Pre-Charge of the Trifecta Pro Series Cont.

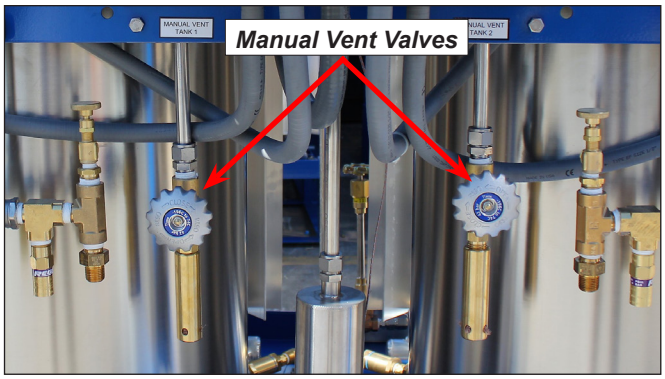
- Crack both of the ¼" Swagelok® nuts on the bottom of the two Wika liquid level gauges (Ll-1) until you can hear nitrogen gas flowing. Purge through both the high and low phase connections on both LL gauges for 10 to 15 seconds.



- Ensure that each ¼" nut is tightened back up after purging.
- Open the purge valves on the safety circuit.



- Cycle the diverter valve (DIV-1) to purge out of both purge valves (V-4). (Do this for tank 1 and tank 2).
- Open both manual vent valves located below the control box (V-1).

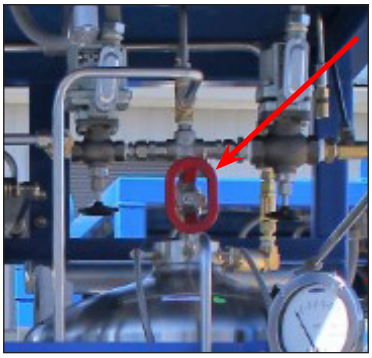


- Purge for one minute.
- Close the manual vents (V-1).
- At any time during the purging process, if the pressure gets down to 20 PSI, stop purging and open the liquid line on the bulk tank to let the Trifecta equalize with the bulk tank again.

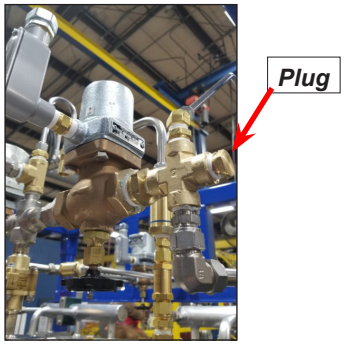
Note: *Remember to shut the liquid line on the bulk tank before resuming purging.*

- Close the PB Isolation valve on the bottom of tank 1 and tank 2 (V-3).

- Close VENT/PB Isolation valve on the top of tank 1 and tank 2 (V-6).

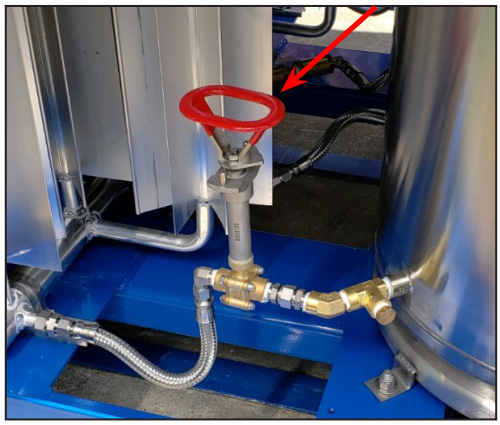


- Remove ½" plug out of the cross on the upstream side of the 1" P.B. Magnatrol solenoid valve (SOL-3) on both tank 1 and tank 2 (See Note 1) .



Purge and Pre-Charge of the Trifecta Pro Series Cont.

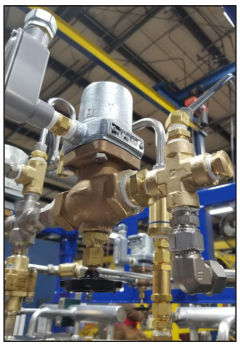
- Open the P.B. Isolation valve on the bottom of tank 1 and tank 2 (V-3)



- Allow purge gas to flow out of each port where the ½" plug was removed for 10 to 15 seconds.
- Close the P.B. Isolation valves on the bottom of tank 1 and tank 2 (V-3).

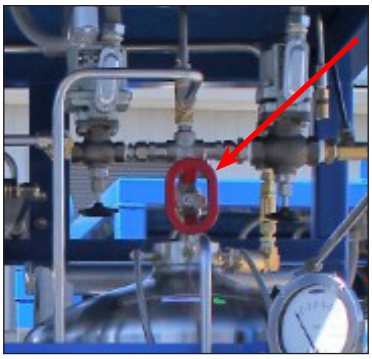
Note 1 *If isolation valves are present in place of the ½" plugs and auxiliary pressure build vaporizers are installed, ensure that you purge through the auxiliary PB vaporizers before filling the trifecta tanks with liquid.*

- Retape the ½" plugs and install them back into each cross from which they were removed.



- Open the P.B. Isolation valve on the bottom of tank 1 and tank 2 (V-3).

- Open VENT/PB Isolation valve on the top of tank 1 and tank 2 (V-6). Leak check the ½" plugs that were removed for purging.



- Turn the switch on the front of the control box to "MON" monitor.
- If "Reset Values" is flashing on the bottom of the screen, press the left arrow five times — this will reset the factory default settings.
- Check your settings (see Operation).
- Slowly open the use valve (V-2).

Purge and Pre-Charge of the Trifecta Pro Series Cont.

- Leak check all pressurized lines.
- If you have a courtesy valve downstream of the process vaporizer, open it in order to purge the vaporizer(s).
- If you do not have a courtesy valve, you can close the use valve and remove a safety downstream of the process vaporizer. Then slowly open the use valve (V-2) and purge through the vaporizer(s).

- While you're purging out the use valve(V-2) open the vent to bulk solenoid valves and the vent to atmosphere solenoid valve on the Manual Control Screen (Fig. 3), in order to purge through the auto vent plumbing circuits.
- Close the use valve (V-2).
- Open the liquid line on the bulk tank and let it equalize with the Trifecta Pro Series.
- Turn the switch on the front of the control box to run.

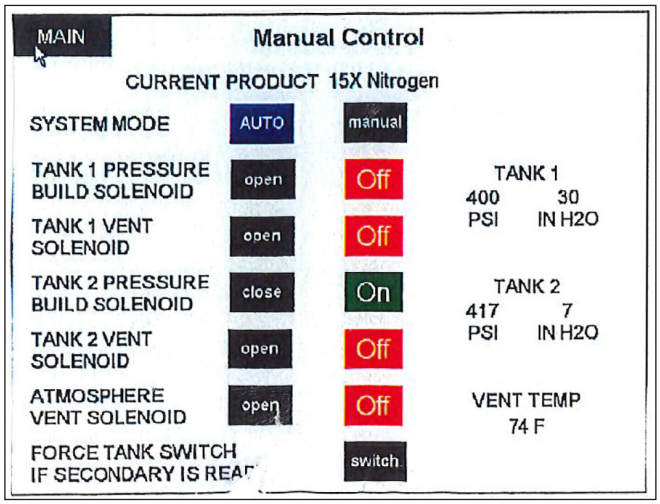


Figure 3 - Manual Control Screen

- From the Manual Control Screen, put the unit into Auto by pressing the Auto Button (See Fig. 3). Both tanks should now begin to fill and pressurize.
- Once both tanks are filled and pressured up, allow all lines to thaw.
- Leak check entire system at operating pressure.
- Slowly open the use valve (V-2) to pressure up the process vaporizer and house lines.

- Leak check the house lines at operating pressure.

Check Trifecta Pro 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

The Trifecta Pro Series operation is based on pressure first and liquid level second. This logic assures that the system pressure is maintained. Pressure is the primary concern.

Hard Sets (Complete Parameter List)

The following tables are intended to give detailed information on the internal parameters. Most of these settings are hardcoded into the program and password protected. They cannot be changed by the operator.

500.0	MAWP
29.0	Secondary Fill Level Setpoint
15.00	Primary too low to assist multiplier in %
75.00	Secondary too low to assist multiplier %
25.0	Primary PB OFF Value Added from Primary PB ON
425.0	Primary PB ON (Available If PB ON Upper Limit >200)
450.0	PB ON Upper Limit
25.0	Secondary PB OFF Value Subtracted from Primary PB ON
50.0	Secondary PB ON Value Subtracted from Primary PB ON
10.0	Fast Drop SP Added to Primary PB ON
150.0	Bulk Tank Critical Setpoint
40.0	Below Critical Vent TO ATM (Bulk PSI + 40.0)
45.0	Low Loss setpoint Vent Off: Sec Press < (Bulk PSI - 45.0)
30.0	Low Loss setpoint Vent On: Sec Press > (Bulk PSI - 30.0)
1.5	Secondary Fill Level Subtract SP when Press is >
130.0	Sec Tank Press < that Fill Level reduced
80.0	Sec Tank Press > that Fill Level increased
1.5	Secondary Fill Level Added SP when Press is <
10	Secondary Assist to Primary When < PB ON and Alarm (sec)
120	Pri & Sec Pressure < Primary PB ON Alarm Delay Time (sec)
360	Secondary Filling Too Long Alarm Setpoint (sec)
495.0	Tank 1 Pressure relief setpoint
495.0	Tank 2 Pressure relief setpoint
-5.0	Pressure Transmitters Too Low Fault setpoint
515.0	Pressure Transmitters Too High Fault setpoint
-1.0	Level Transmitters Too Low Fault setpoint
55.0	Level Transmitters Too High Fault setpoint
3	Liquid Sensed at Vent via Temperature Time Delay (sec)
120	Vent Temperature Disarm Time on Pressure Relief (sec)
10	Fast Drop Check Time (sec)
300	Slow Fill Time Resulting in Vent Open (sec)
128	Discharge Rate Check Time Setpoint (sec)
25.0	Primary Level To Start Check of Discharge Rate
21.0	Primary Level to Stop Discharge Rate Check
-300.0	Vent Temperature Alarm Setpoint

500 PSI MAWP N2

600.0	MAWP
29.0	Secondary Fill Level Setpoint
25.00	Primary too low to assist multiplier in %
85.00	Secondary too low to assist multiplier %
25.0	Primary PB OFF Value Added from Primary PB ON
525.0	Primary PB ON (Available If PB ON Upper Limit >200)
550.0	PB ON Upper Limit
25.0	Secondary PB OFF Value Subtracted from Primary PB ON
50.0	Secondary PB ON Value Subtracted from Primary PB ON
10.0	Fast Drop SP Added to Primary PB ON
150.0	Bulk Tank Critical Setpoint
590.0	Tank 1 Pressure relief setpoint
590.0	Tank 2 Pressure relief setpoint
-5.0	Pressure Transmitters Too Low Fault setpoint
515.0	Pressure Transmitters Too High Fault setpoint
-1.0	Level Transmitters Too Low Fault setpoint
55.0	Level Transmitters Too High Fault setpoint
3	Liquid Sensed at Vent via Temperature Time Delay (sec)
120	Vent Temperature Disarm Time on Pressure Relief (sec)
10	Fast Drop Check Time (sec)
300	Slow Fill Time Resulting in Vent Open (sec)
40.0	Below Critical Vent TO ATM (Bulk PSI + 40.0)
45.0	Low Loss setpoint Vent Off: Sec Press < (Bulk PSI - 45.0)
30.0	Low Loss setpoint Vent On: Sec Press > (Bulk PSI - 30.0)
1.5	Secondary Fill Level Subtract SP when Press is >
130.0	Sec Tank Press < that Fill Level reduced
80.0	Sec Tank Press > that Fill Level increased
1.5	Secondary Fill Level Added SP when Press is <
10	Secondary Assist to Primary When < PB ON and Alarm (sec)
120	Pri & Sec Pressure < Primary PB ON Alarm Delay Time (sec)
360	Secondary Filling Too Long Alarm Setpoint (sec)
128	Discharge Rate Check Time Setpoint (sec)
25.0	Primary Level To Start Check of Discharge Rate
21.0	Primary Level to Stop Discharge Rate Check
-280.0	Vent Temperature Alarm Setpoint

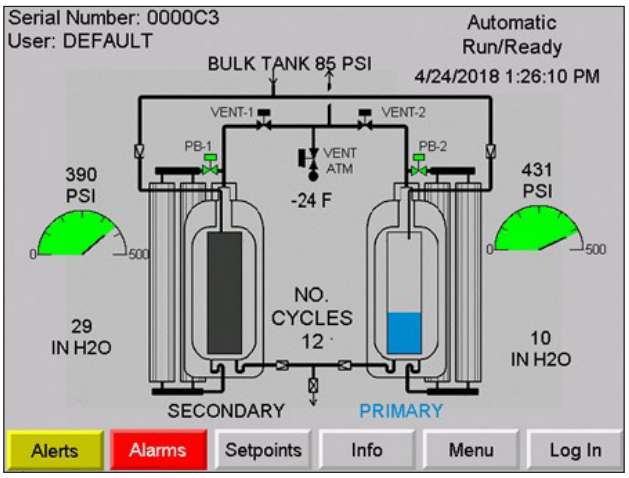
600 PSI MAWP N2

Below are the different set points for different services. These settings will be the default settings.

Fill Level	*Nitrogen*	*Oxygen*	*Argon*
Adjustable	*29”*	*36”*	*46”*
Temperature	***Nitrogen***	***Oxygen***	***Argon***
Hard Set	*-300*	*-280*	*-280*

HMI Screens

MAIN Screen



Serial Number field — Displays Serial Number of Unit when logged in as user other than defualt

User field — Shows current logged in user

Auto/Manual field — Displays if the Trifecta is in Auto or Manual mode

Status field — Displays the status of the Trifecta when in **Auto**

- **Run/Fill** — Secondary tank is filling
- **Run/PB Hold** — Secondary tank is building pressure
- **Run/Ready** — Secondary tank is ready to be used
- **Run/Assist** — Secondary tank is being called for assist

Date & Time field — Displays current date and time

Bulk Tank field — Displays the pressure of the liquid coming from the bulk tank

Pressure gauges — Shows pressure of tanks 1 and 2

Level gauges — Displays the level of tanks 1 and 2. Primary tank's level is shown in blue

Vent Temperature field — Displays the temperature at Trifecta's vent to atmosphere

Valve indicators — Displays the status of Trifecta's five valves. Green indicates the valve is open

Cycle Count field — Displays the number of cycles the Trifecta has had. Users may tap on the Cycle Count to open RESET COUNTS popup

Primary/Secondary fields — Displays which tank is presently the Primary tank and which is the Secondary.

Alerts/Alarms button — Displays ALERTS and ALARMS screens, respectively

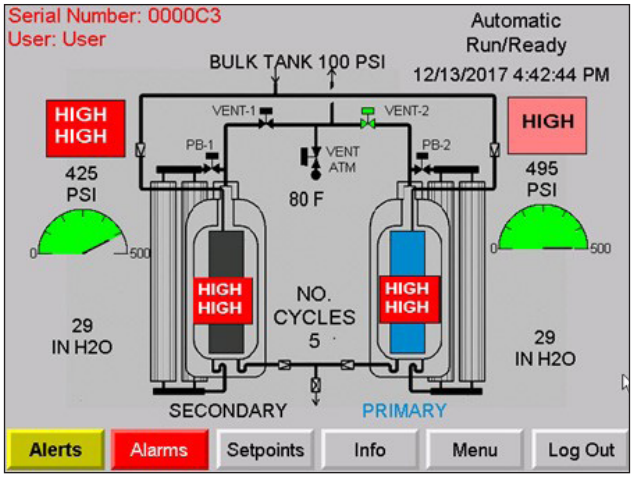
Setpoints — Brings user to Setpoints popup

Info button — Displays the INFO popup

Menu — Displays the SCREEN NAVIGATION popup

Login/Logout — Displays the Login popup is logged in as defult. Logs out the current user if logged in as user other than default.

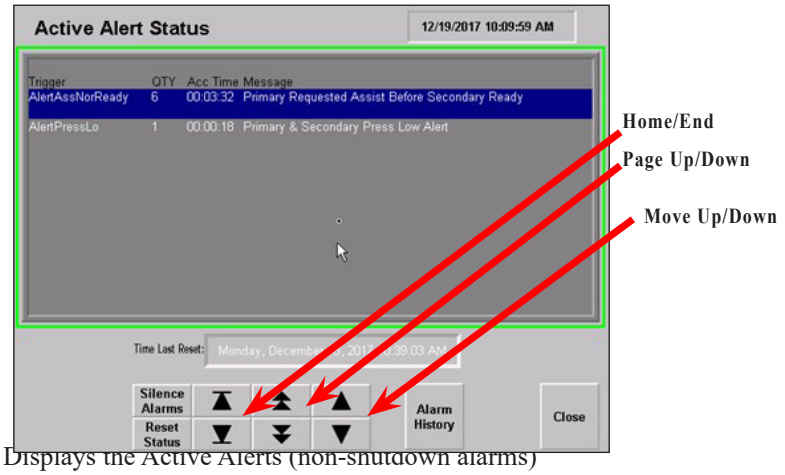
HIGH/HIGH HIGH ALARM Screen



High/High High Pressure popups — Display that a High (tank overpressure) or High High (Pressure transmitter fault) has occurred

High High Level popups — displays that a High High Level (Level transmitter fault) has occurred

ALERT Screen



Displays the Active Alerts (non-shutdown alarms)

ALERT Screen Cont.

Date & Time field — Displays current date and time

Alert Table

- Trigger Column – Displays label of Alert
- Qty – Displays number of times Alert has been triggered since Time Last Reset
- Acc Time – Displays Accumulated time of Alert since Time Last Reset
- Message – Description of Alert

Note: *Selected Alert is shown with a blue background and white text*

Time Last Reset — Date and Time of last Reset Status

Silence Alarms button — Stops strobe light on control panel from flashing if currently flashing. Will also silence any alarms running to the customer facility from customer alarm relay

Reset Status — Resets Quantity count and Accumulation Time of each Alert and Alarm trigger

Home — Jumps to first Active Alert

End — Jumps to last Active Alert

Page Up — Moves up 1 page of Active Alerts

Page Down — Moves down 1 page of Active Alerts

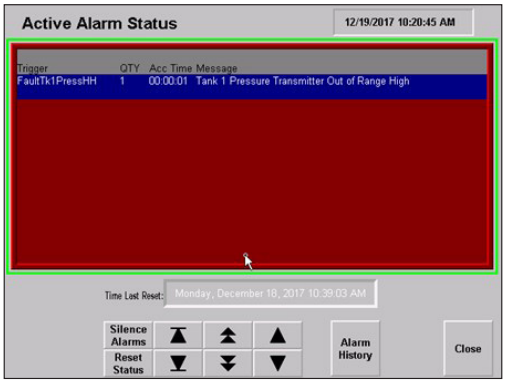
Move Up — Scrolls up Active Alerts

Move Down — Scrolls down Active Alerts

Alarm History — Opens the ALARM & ALERT HISTORY Screen

Close — Returns to MAIN Screen

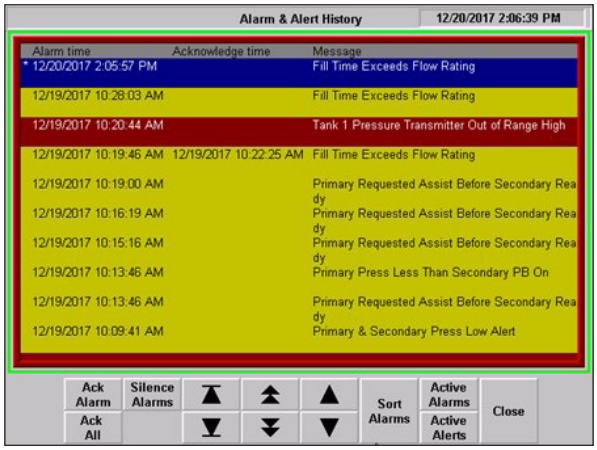
ALARM Screen



Displays the Active Alarms (Shutdown Alarms)

ALARM & ALERT HISTORY Screen

Displays the history of Alarms and Alerts



Note: *Alerts are shown with a yellow background and black text. Alarms are shown with a red background and white text. Selected Alarm/Alert is shown with a blue background and white text.*

Ack Alarm button — Acknowledges selected Alarm/Alert

Ack All — Acknowledges all Alarms and Alerts

Clear All — Clears all Alarms and Alerts from History

Sort Alarms — Sorts the history by time or by trigger

Active Alerts — Displays the ACTIVE ALERTS screen

Active Alarms — Displays the ACTIVE ALARMS screen

RESET COUNTS Popup

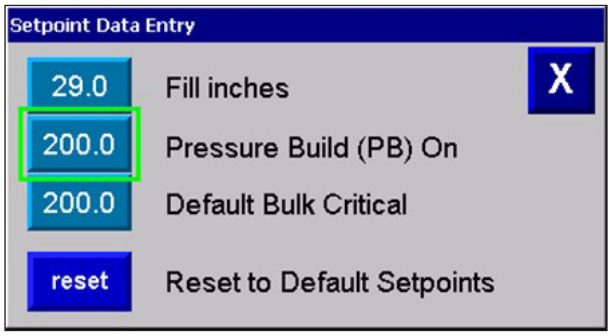
Current Cycle Time field — Amount of time for the current cycle

Prev. Cycle Time — Amount of time for previous cycle

Cycle Count — Number of cycles Trifecta has had since last reset

Reset — Resets cycle count to 0. A non-resettable counter can be found on a password protected screen.

SETPOINT DATA ENTRY Popup



Fill Inches field — The level to fill tanks to

Pressure Build (PB) On — The pressure at which to begin Pressure Build on Primary Tank

Default Bulk Critical — Displays Bulk Tank Pressure at which Trifecta will only vent to atmosphere

Reset — Resets setpoints to default settings

INFO Popup

PLC Rev field — Revision of PLC Program running on unit

HMI Rev — Revision of HMI Program running on Trifecta

Trifecta Service # — Chart Customer Service phone number

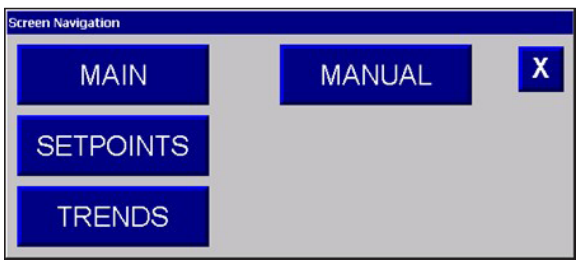
Serial Number — Serial number of the Trifecta

Current PLC Program — Current recipe running on the Trifecta PLC

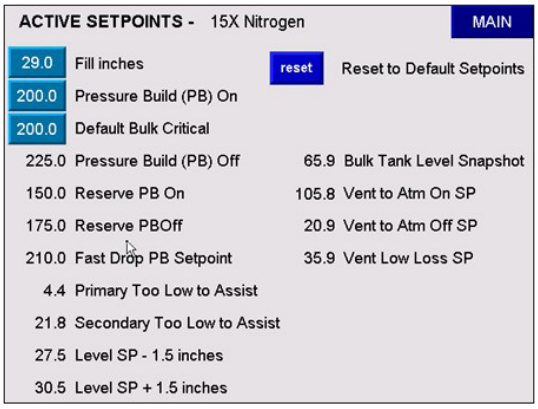
User — User currently logged into unit

Enclosure Temp — Temperature inside of the Control Panel

SCREEN MENU NAVIGATION Popup



ACTIVE SETPOINT Screen



Pressure Build (PB) Off field — The pressure at which Pressure Build will stop

Reserve PB On — The pressure at which to begin PB on Secondary Tank if not assisting

Reserve PB Off — The pressure at which PB of Secondary Tank will stop

Fast Drop PB Setpoint — The pressure at which to begin Pressure Build if Pressure is dropping fast

Primary Too Low to get an assist — The level at which the primary tank will automatically switch to the secondary tank (low level value is programmed into the hard sets of the PLC)

Secondary Too Low to Assist — The level at which the Secondary Tank is too low to assist the primary tank (75% of the current liquid level setpoint) and a primary tank switch will occur.

Level SP -1.5 — The adjusted fill level if pressure in Secondary Tank is greater than 130 psi at the end of the fill cycle

Level SP +1.5 — The adjusted fill level in pressure in Secondary Tank is less than 80 psi at the end of the fill cycle

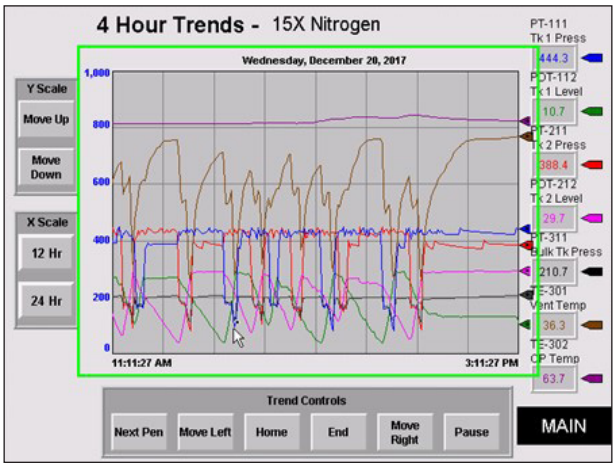
Bulk Tank Level Snapshot — The point at which the PLC takes a snapshot of the bulk tank pressure to determine when to turn on and off the vent to atmosphere during the filling process.

Vent to ATM on SP (initial depressurization) — The pressure at which a Secondary Tank will begin Vent to Atmosphere if it drops below

Vent to ATM Off SP (while filling) — The pressure at which a Secondary Tank will stop Venting to Atmosphere if it drops below

Vent Low Loss SP (while filling) — The pressure at which a Secondary Tank will resume Venting to Atmosphere if it rises above

TREND Screen



Tk1 Press field — Pressure of Tank 1 in psig

Tk1 Level — Level of Tank 1 in H_2O

Tk2 Press — Pressure of Tank 2 in psig

Tk2 Level — Level of Tank 2 in H_2O

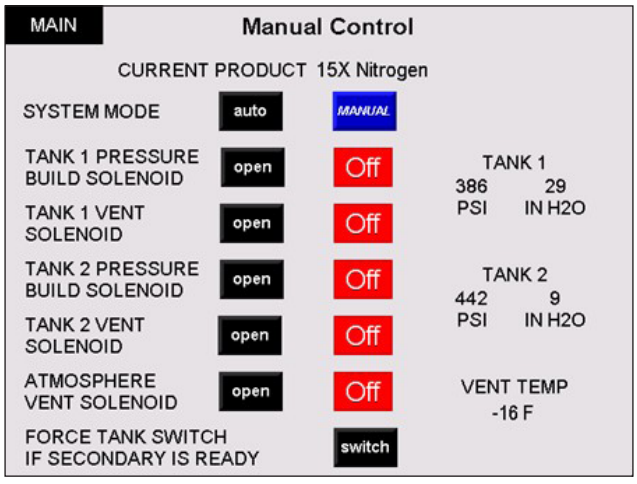
Bulk Tk Press — Pressure of the Bulk Tank in psig

Vent Temp — Temperature at the vent in °F

CP Temp — Temperature in the Control Panel in °F

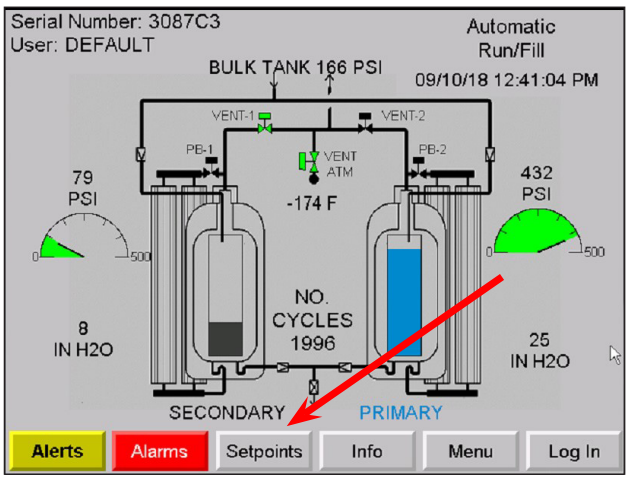
Next Pen — Toggles Active Pen

MANUAL CONTROL Screen



When system is in "manual," the operator can manually open each solenoid valve by touching the "open" buttons. This screen can also be used to force a tank switch. See Service Section for details.

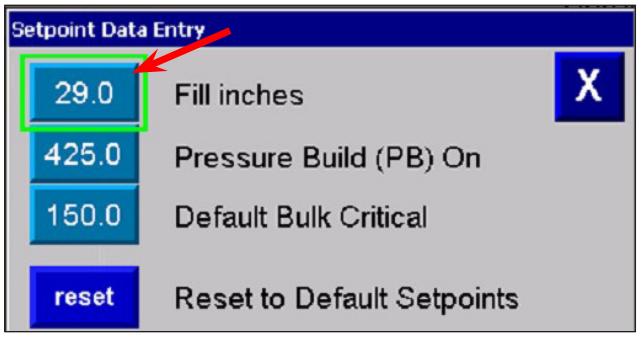
Parameter Settings



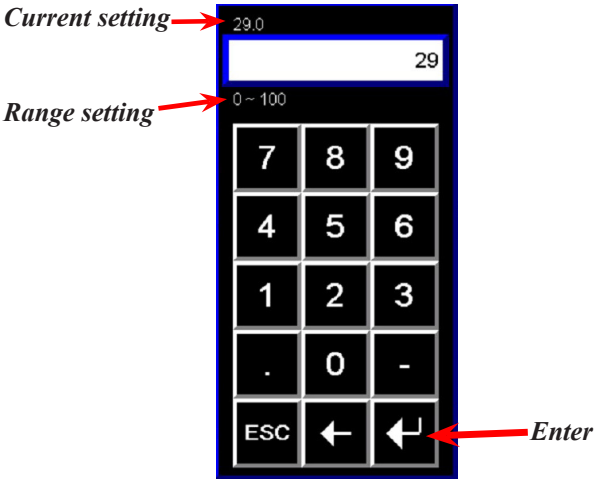
Three settable parameters are accessible from the HMI "Setpoints" button. These parameters are key to setting all parameters. To get the adjustable setpoints, the "Setpoints" button will bring up the "Setpoint Data Entry" popup menu. Here you can adjust the Fill inches, Pressure Build On and the Bulk Critical.

FILL SETPOINT

Pressing of "Fill inches" button will bring up another popup window.

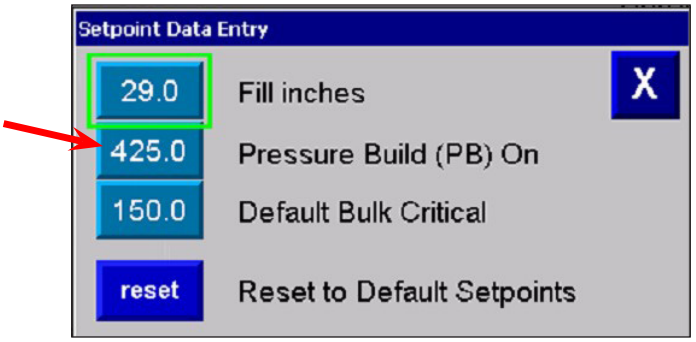


Here you can enter a new value and press enter to save it.

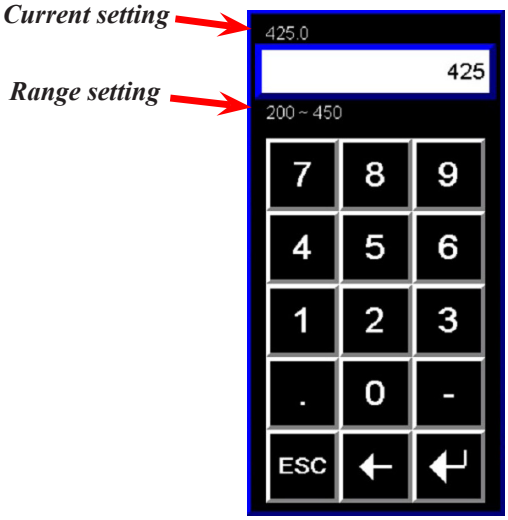


Pressure Build Setpoint

Pressing of the "Pressure Build" button will bring up another popup window.



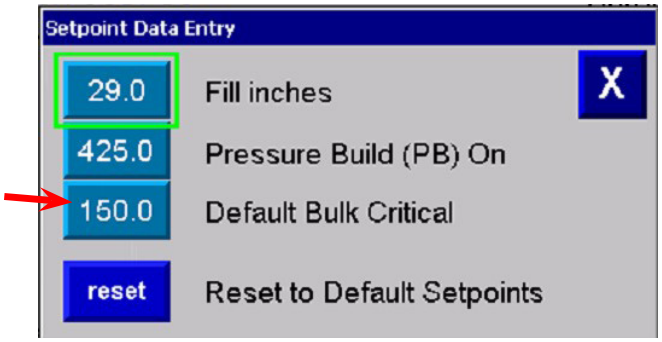
Here you can enter a new value and press enter to save it.



Note: *"PB OFF" setpoint will be automatically set to 25 psig above the "PB ON" setpoint.*

Bulk Critical Setpoint

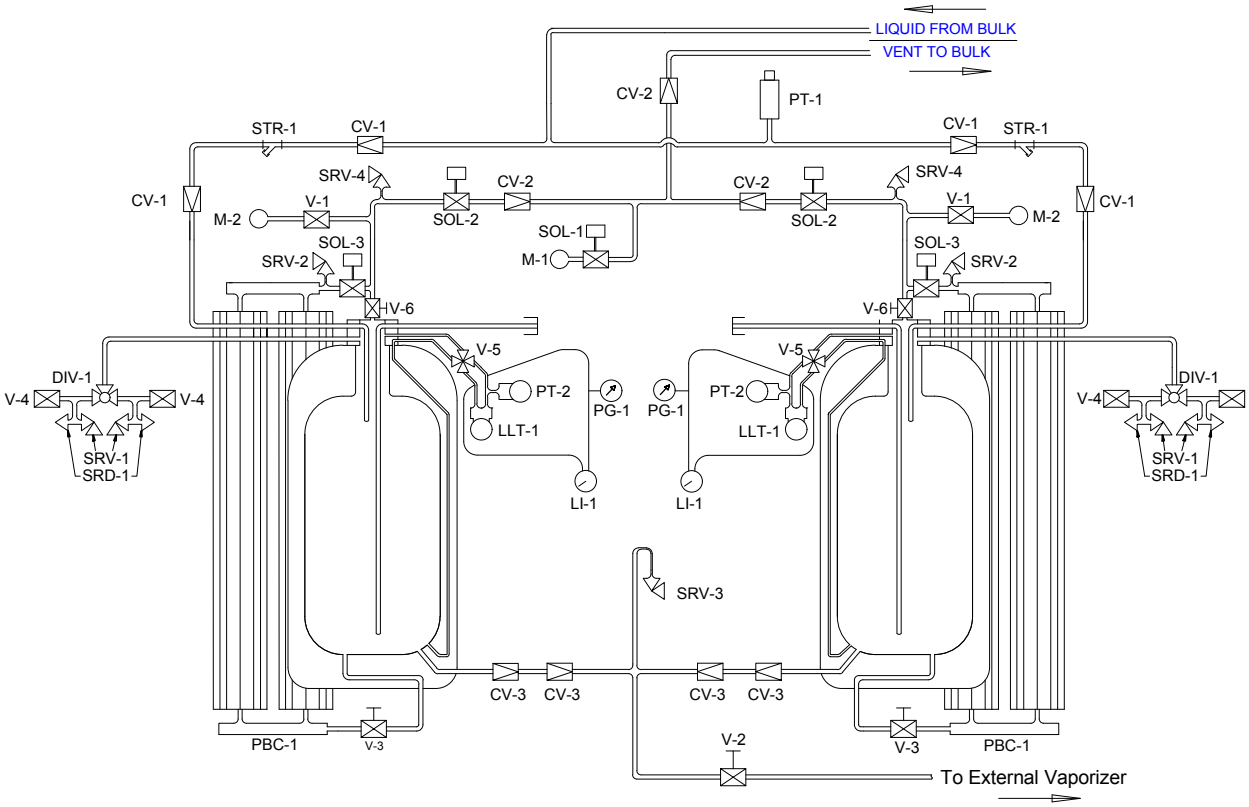
Pressing of the "Bulk Critical" button will bring up another popup window.



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

Operation Details

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



NOMENCLATURE					
CV-1	FILL CHECK VALVE	PG-1	TANK PRESSURE GAUGE	SRV-2	P.B. SAFETY RELIEF VALVE
CV-2	VENT CHECK VALVE	PT-1	BULK PRESSURE TRANSMITTER	SRV-3	LINE RELIEF VALVE
CV-3	LIQUID USE CHECK VALVE	PT-2	PRESSURE TRANSMITTER TRIFECTA	SRV-4	VENT RELIEF VALVE
DIV-1	TANK SAFETY DIVERTER VALVE	STR-1	LIQUID USE STRAINER	V-1	MANUAL VENT VALVE
LI-1	LIQUID LEVEL GAUGE	SOL-1	VENT TO ATMOSPHERE SOLENOID VALVE	V-2	LIQUID USE VALVE
LLT-1	LIQUID LEVEL TRANSMITTER	SOL-2	VENT TO BULK SOLENOID VALVE	V-3	P.B. ISOLATION VALVE
M-1	VENT TO ATMOSPHERE MUFFLER	SOL-3	PRESSURE BUILD SOLENOID VALVE	V-4	MANUAL RELIEF VALVE
M-2	MANUAL VENT MUFFLER	SRD-1	TANK SAFETY RUPTURE DISC	V-5	TRANSMITTER ISOLATION VALVE
PBC-1	PRESSURE BUILD COIL	SRV-1	TANK SAFETY RELIEF VALVE	V-6	VENT / P.B. ISOLATION VALVE

Figure 4 - Schematic

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.

Mode "0"

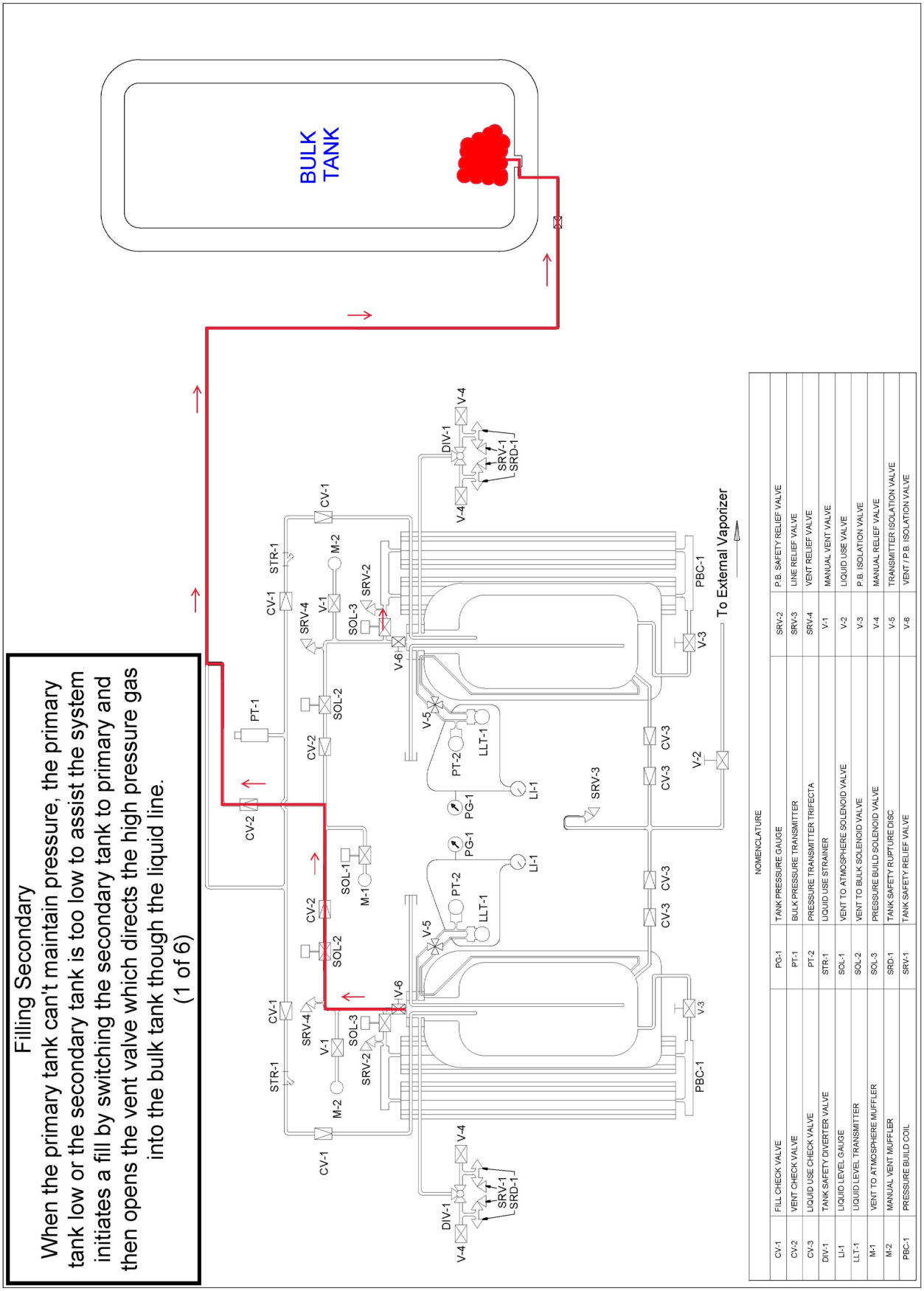


Figure 1 - Filling Mode (Vent to Storage)

Mode "0"

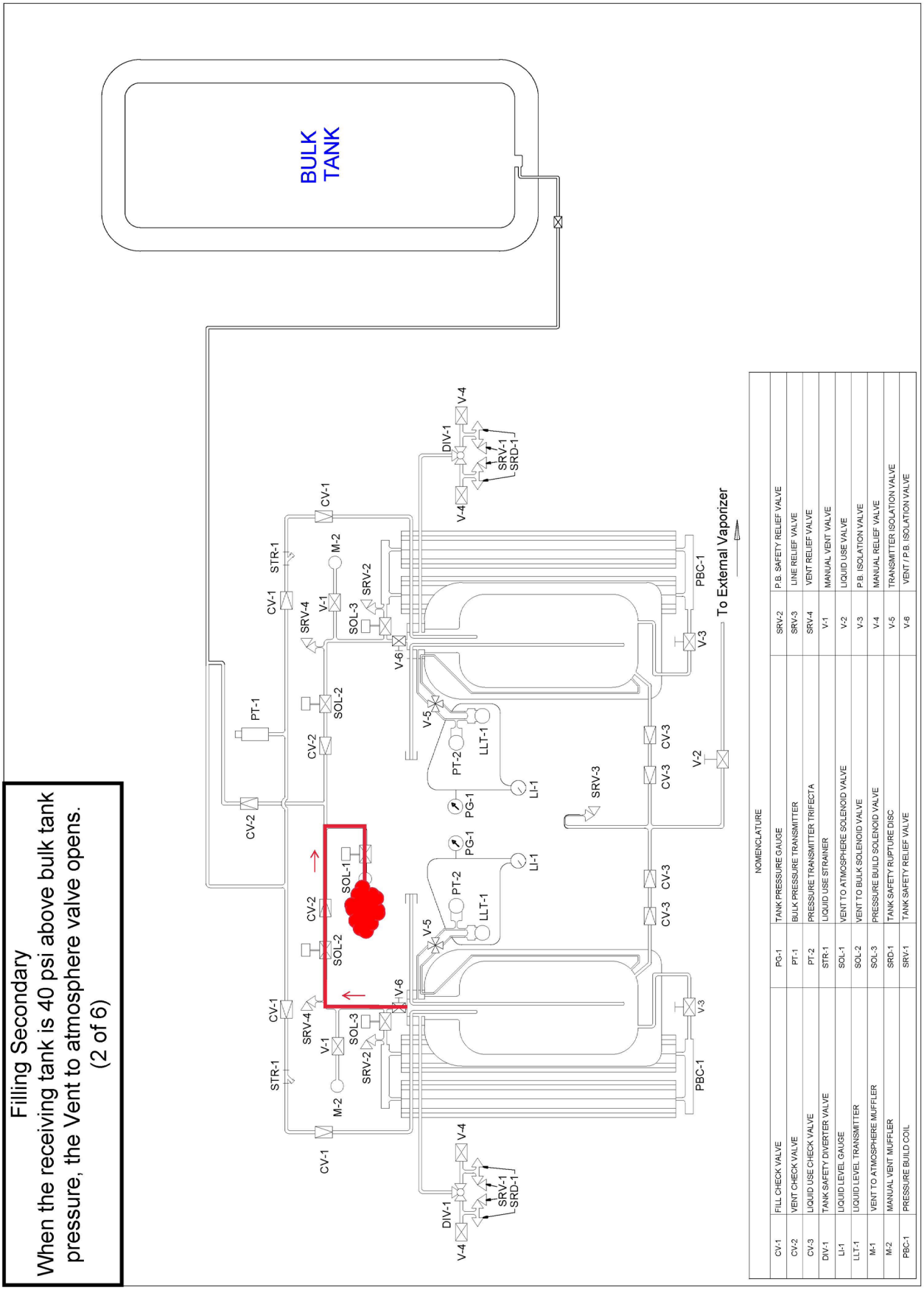


Figure 2 - Filling Mode (Vent to Atmosphere)

Mode "0"

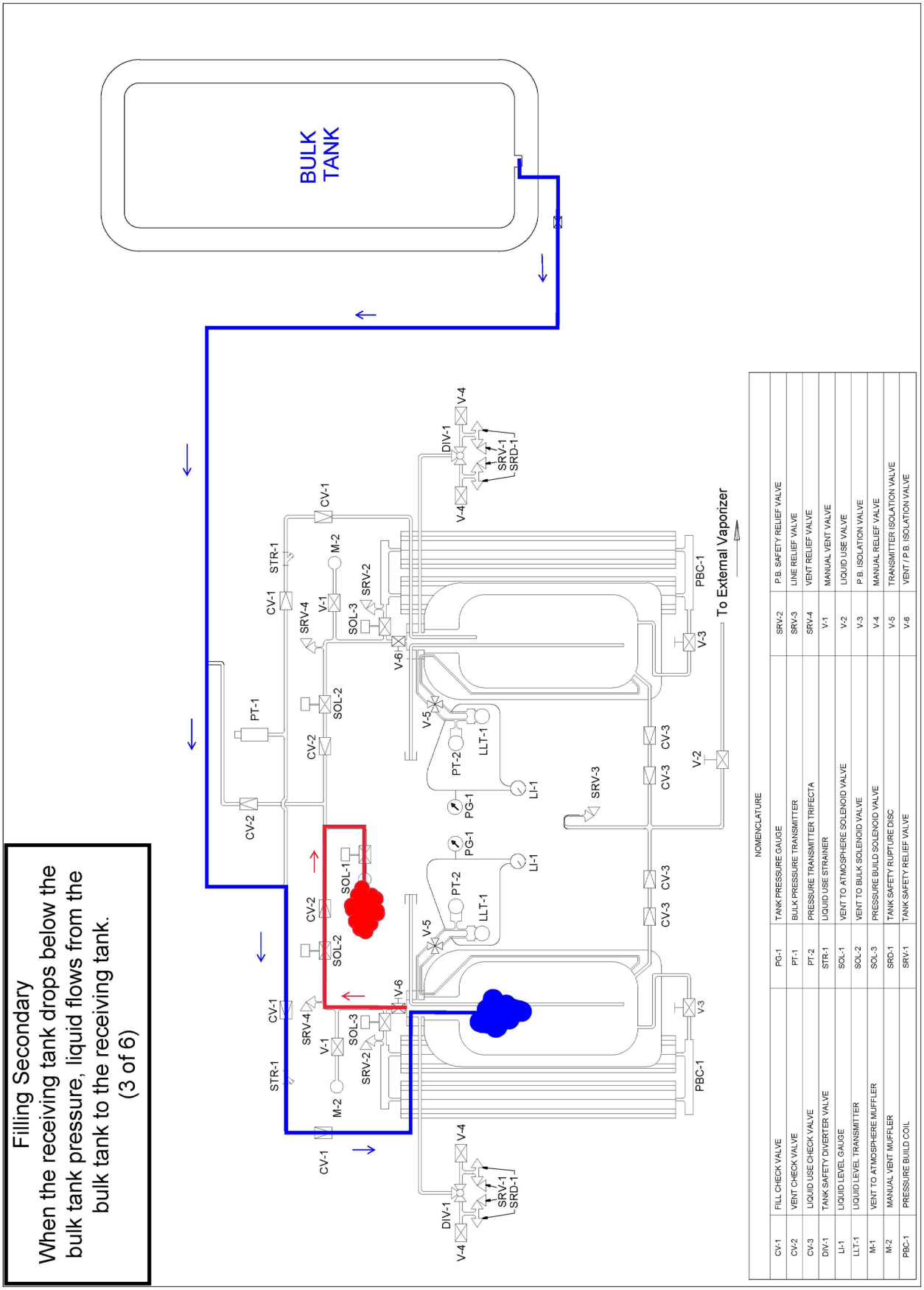


Figure 3 - Filling Mode (Liquid Flow)

Mode "0"

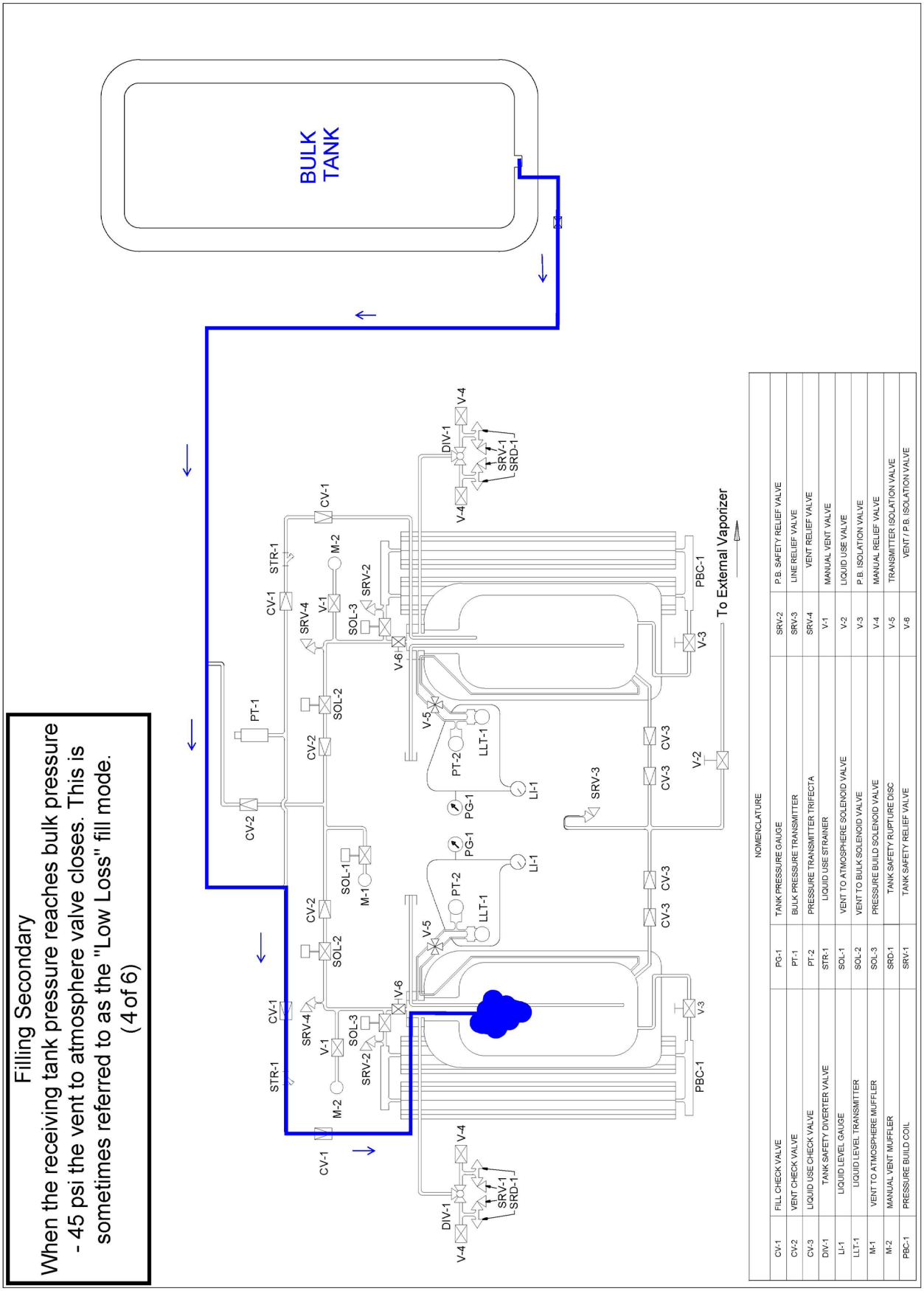


Figure 4 - Filling Mode (Low Loss)

Mode “0”

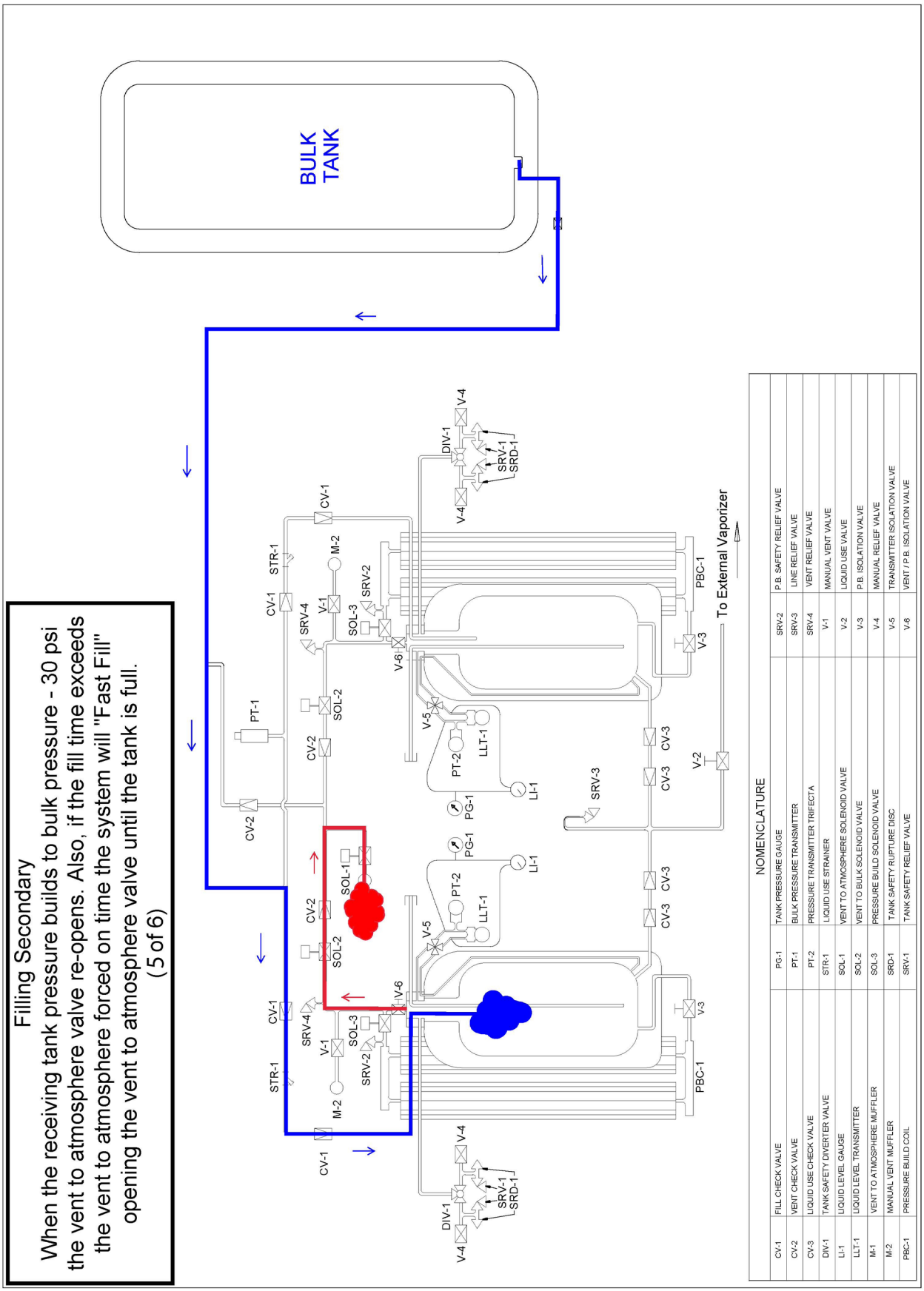


Figure 5 - Filling Mode (Low Loss Vent to Atmosphere)

Mode Switch "0" to "1"

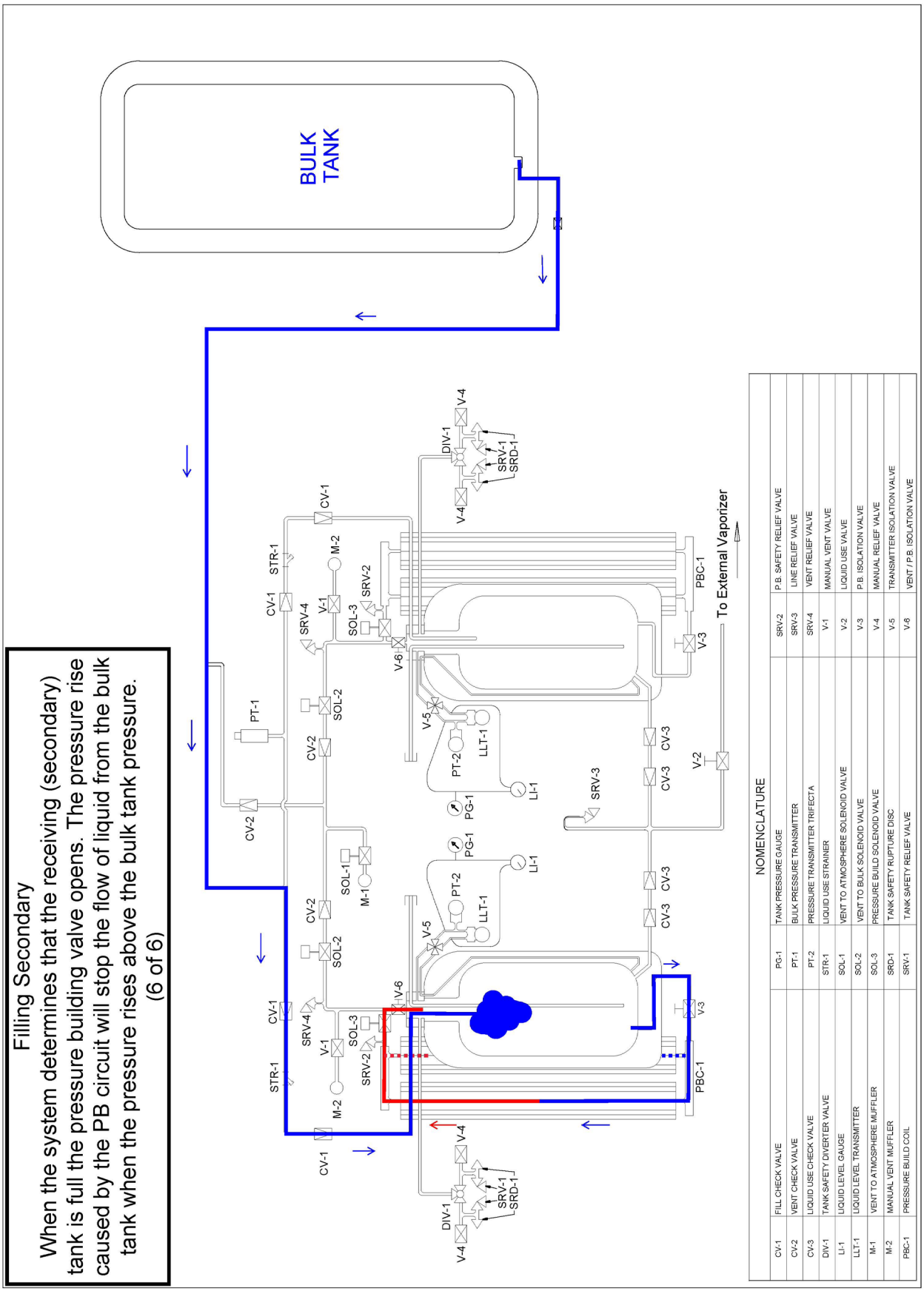


Figure 6 - Fill Mode Termination

Mode “1”/Mode Switch “1” to “2”

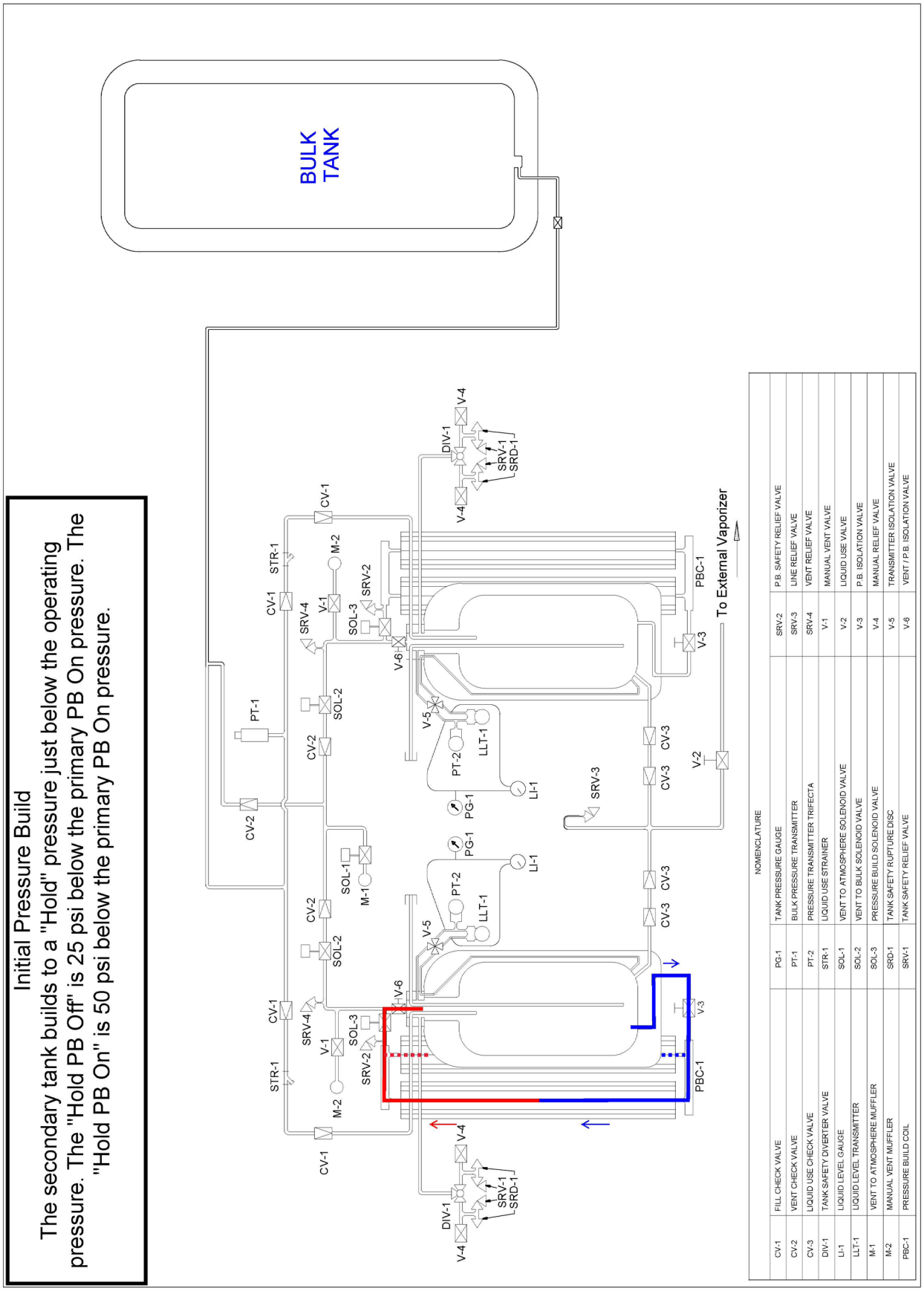


Figure 7 - Initial Pressure Build after Filling/Secondary Ready to Assist

Mode Switch "1" to "2"

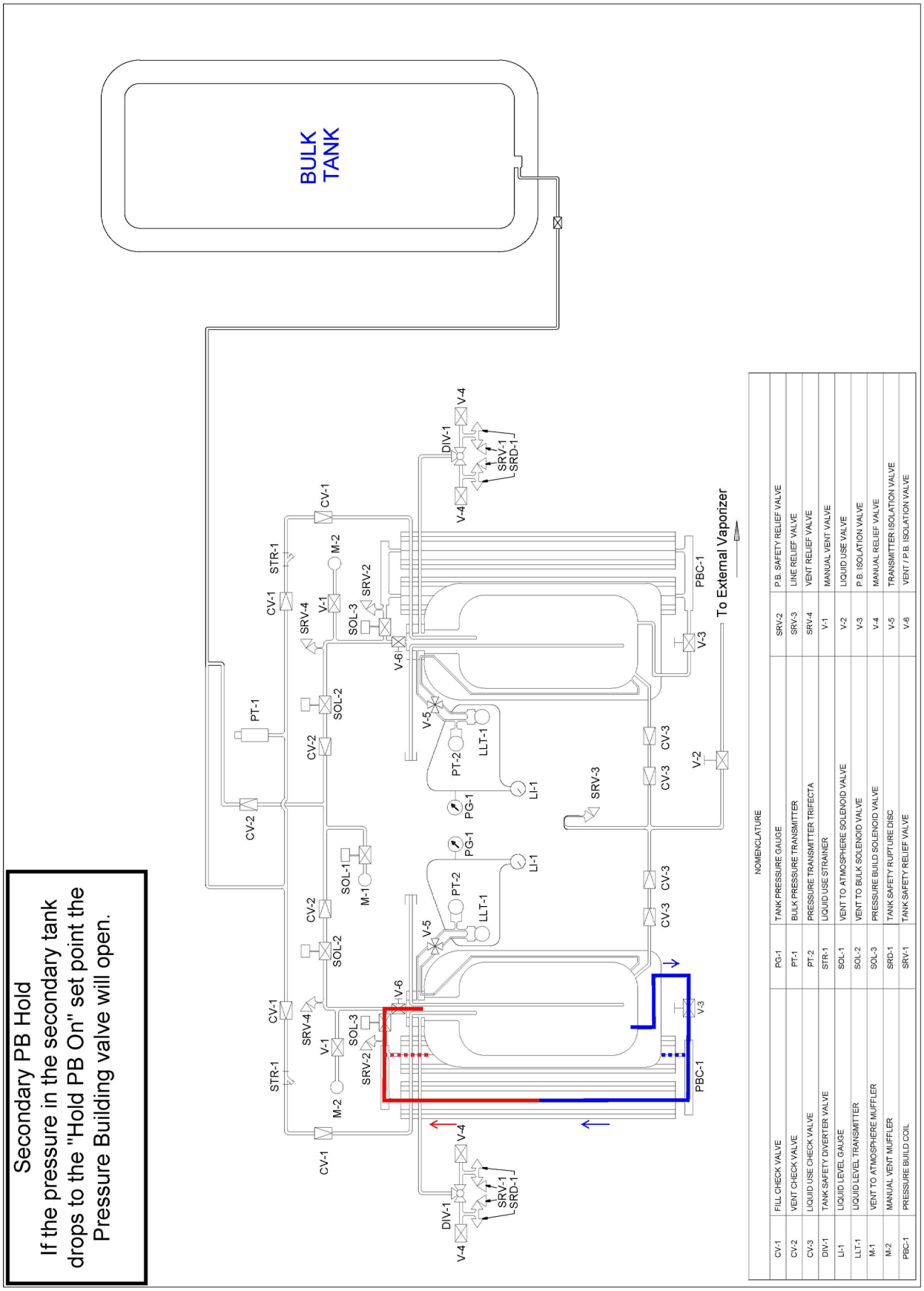


Figure 8 - Secondary Maintains "Hold" Pressure

Mode “2”

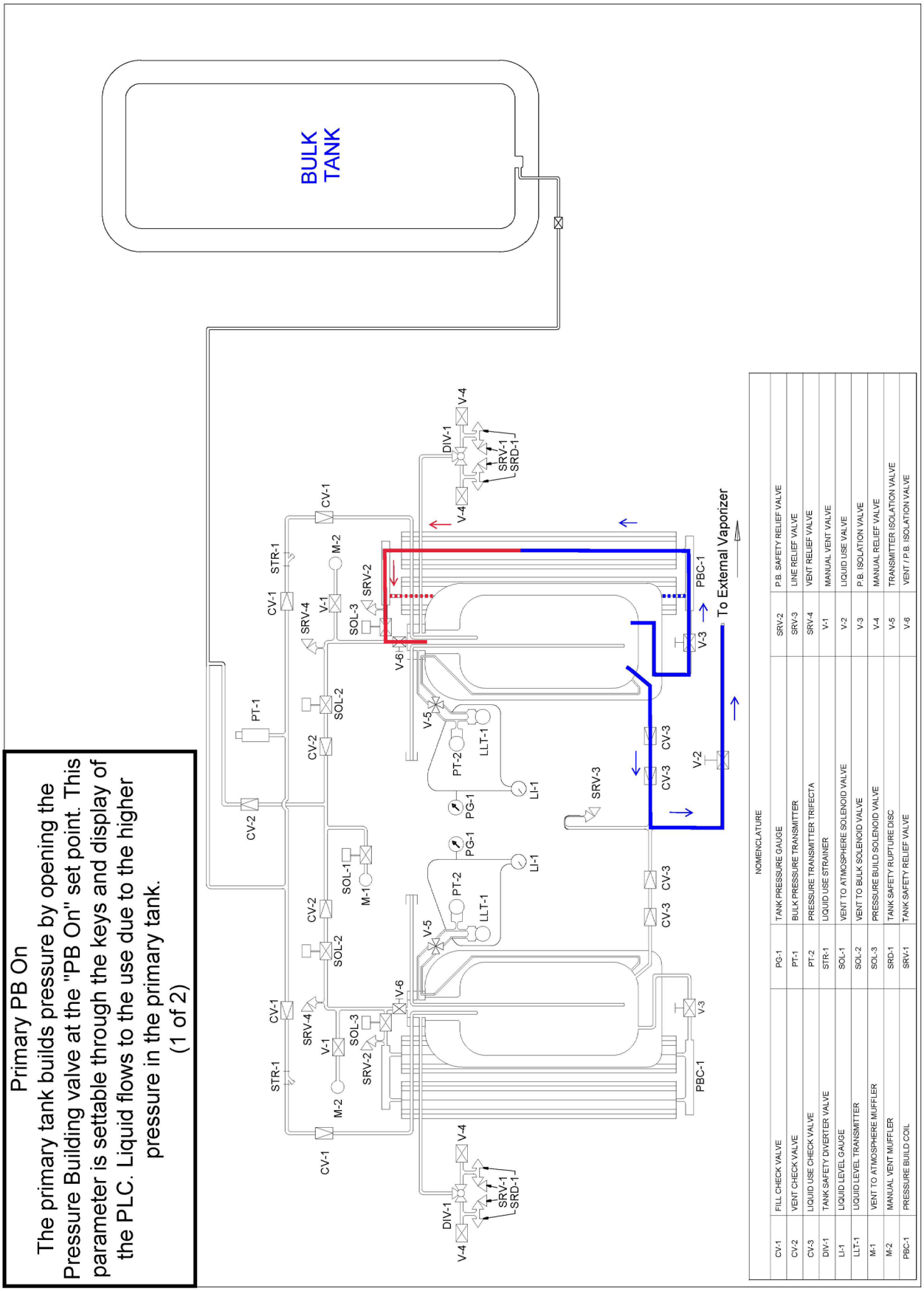


Figure 9 - Primary Pressure Build

Mode "2"

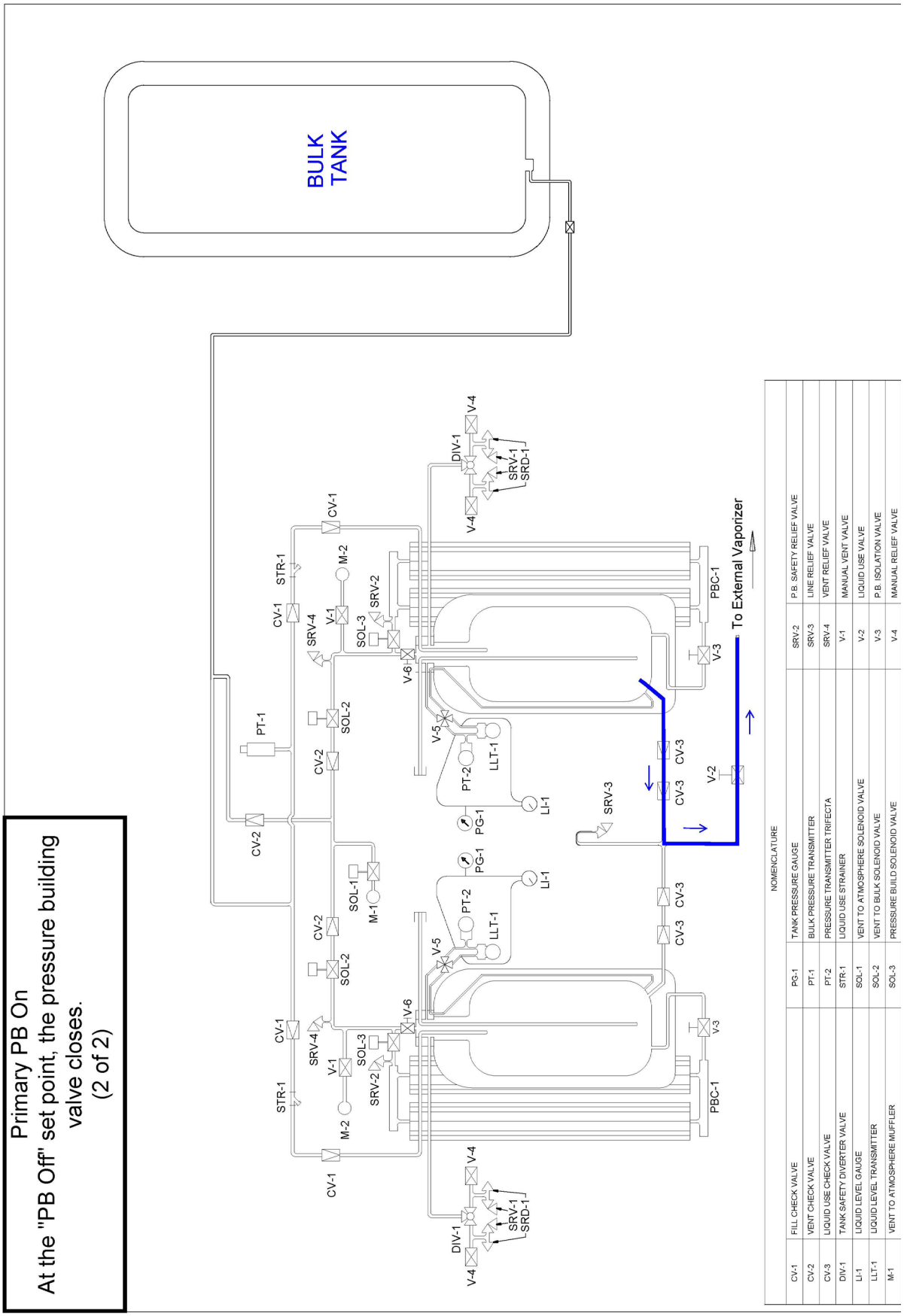


Figure 10 - Primary PB Off

Mode Switch “2” to “3”

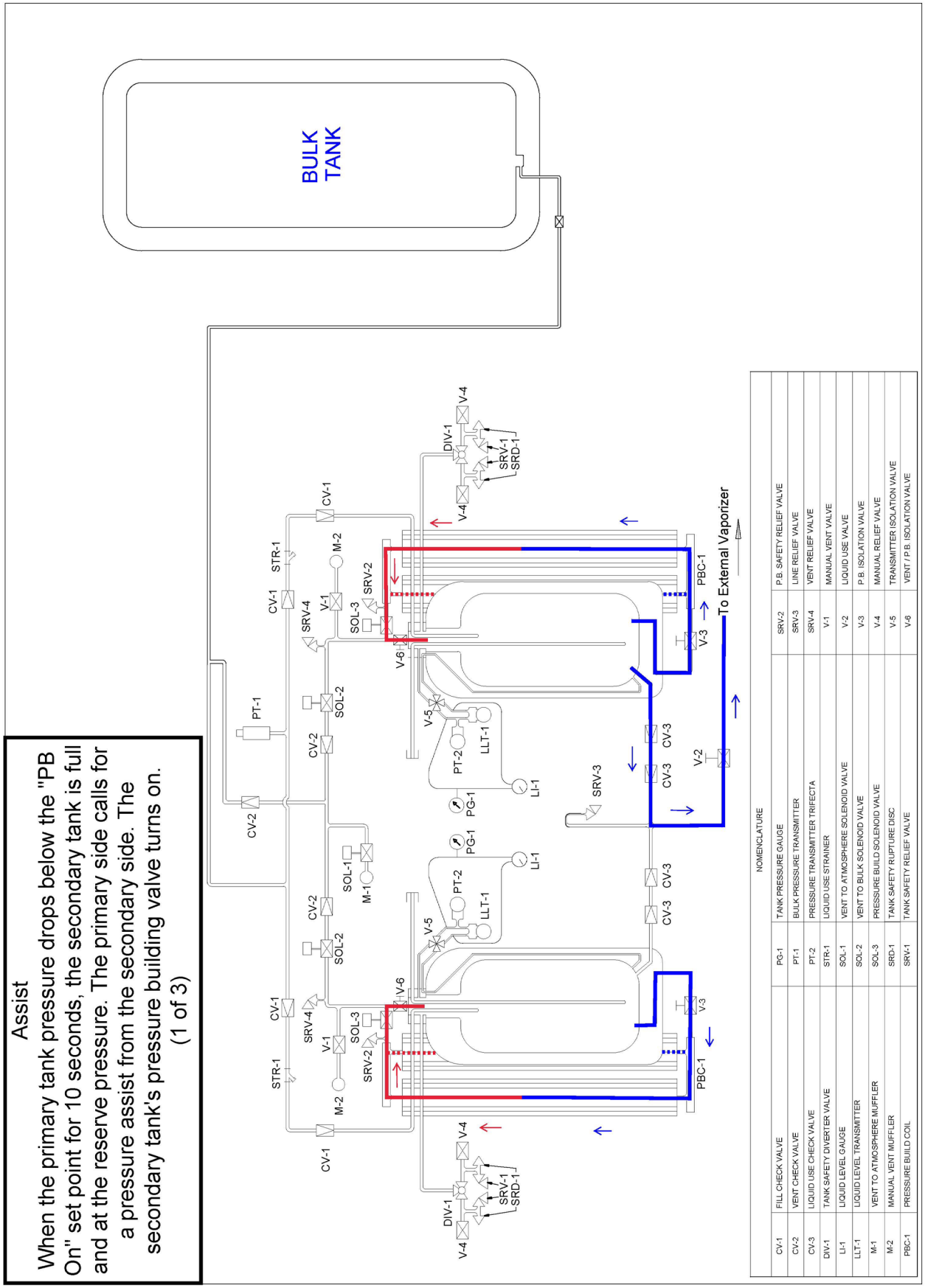


Figure 11 - Call for Assist

Assist Mode "3"

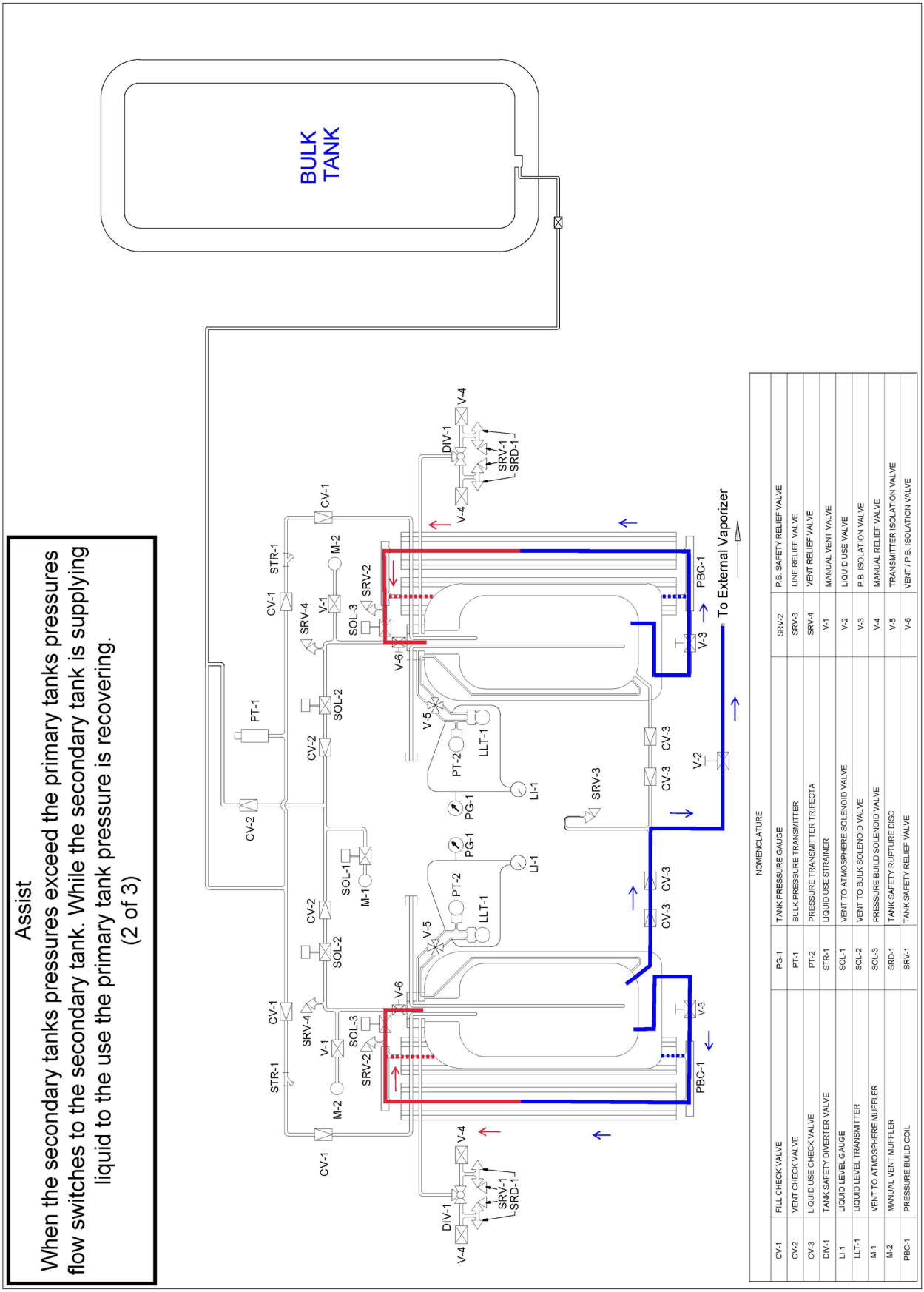


Figure 12 - Secondary Assist of Primary

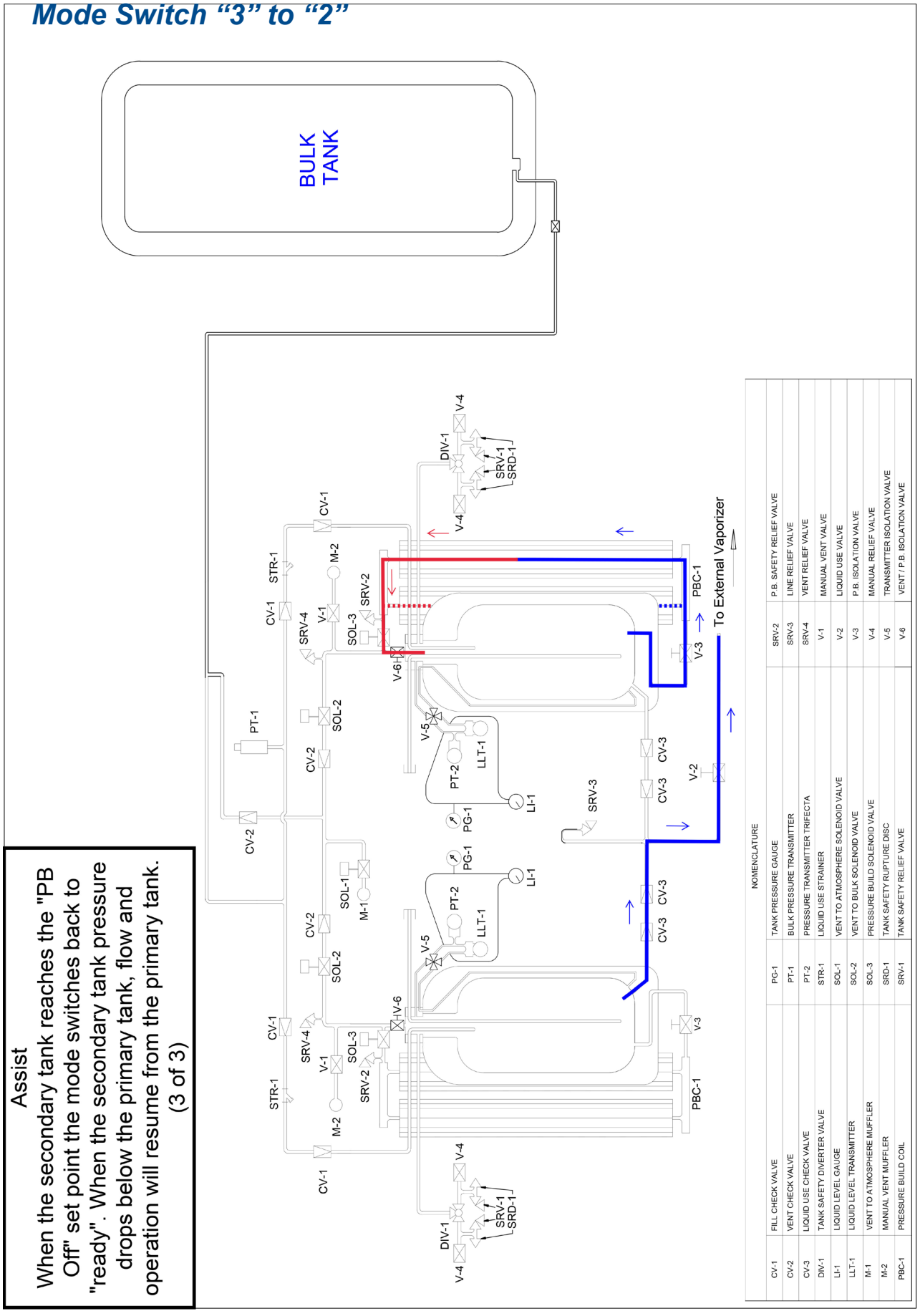


Figure 13 - Assist Complete - Primary Restored

Mode Switch “3” to “0”

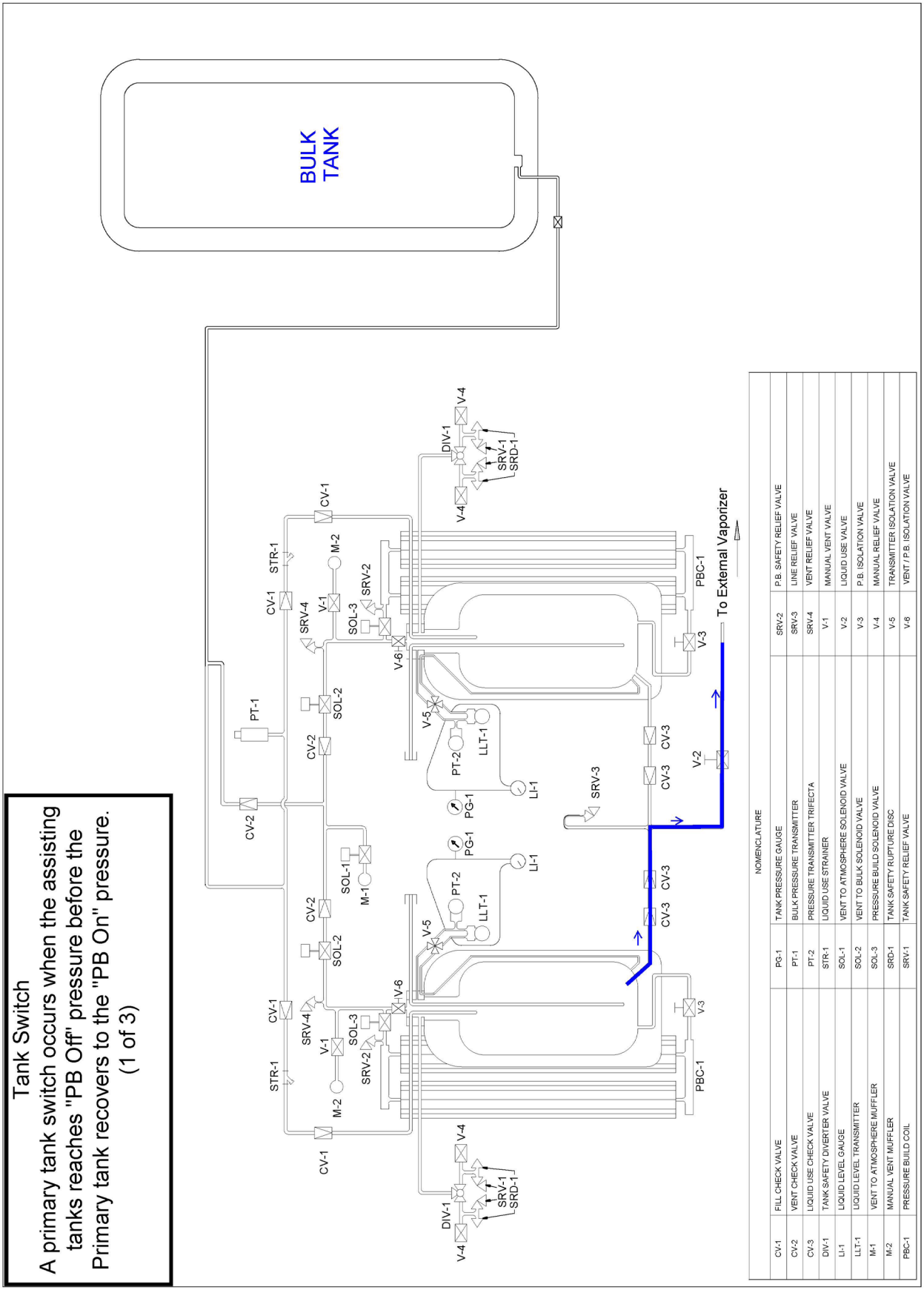


Figure 14 - Primary Unable to Recover (Switch Primary Side)

Mode Switch “3” to “0”

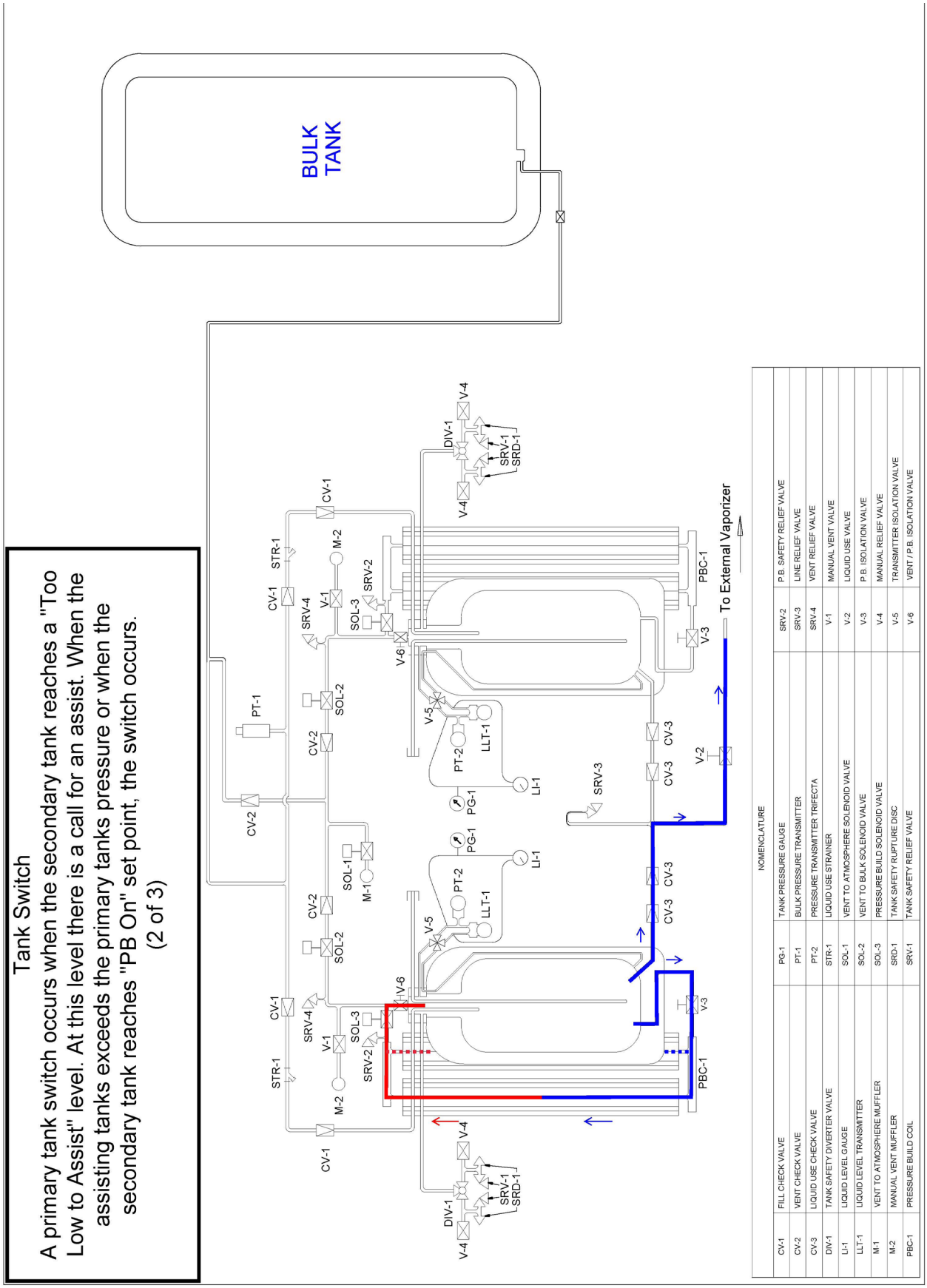


Figure 15 - Primary too low to be assisted (Switch Primary Side)

Mode Switch “3” to “0”

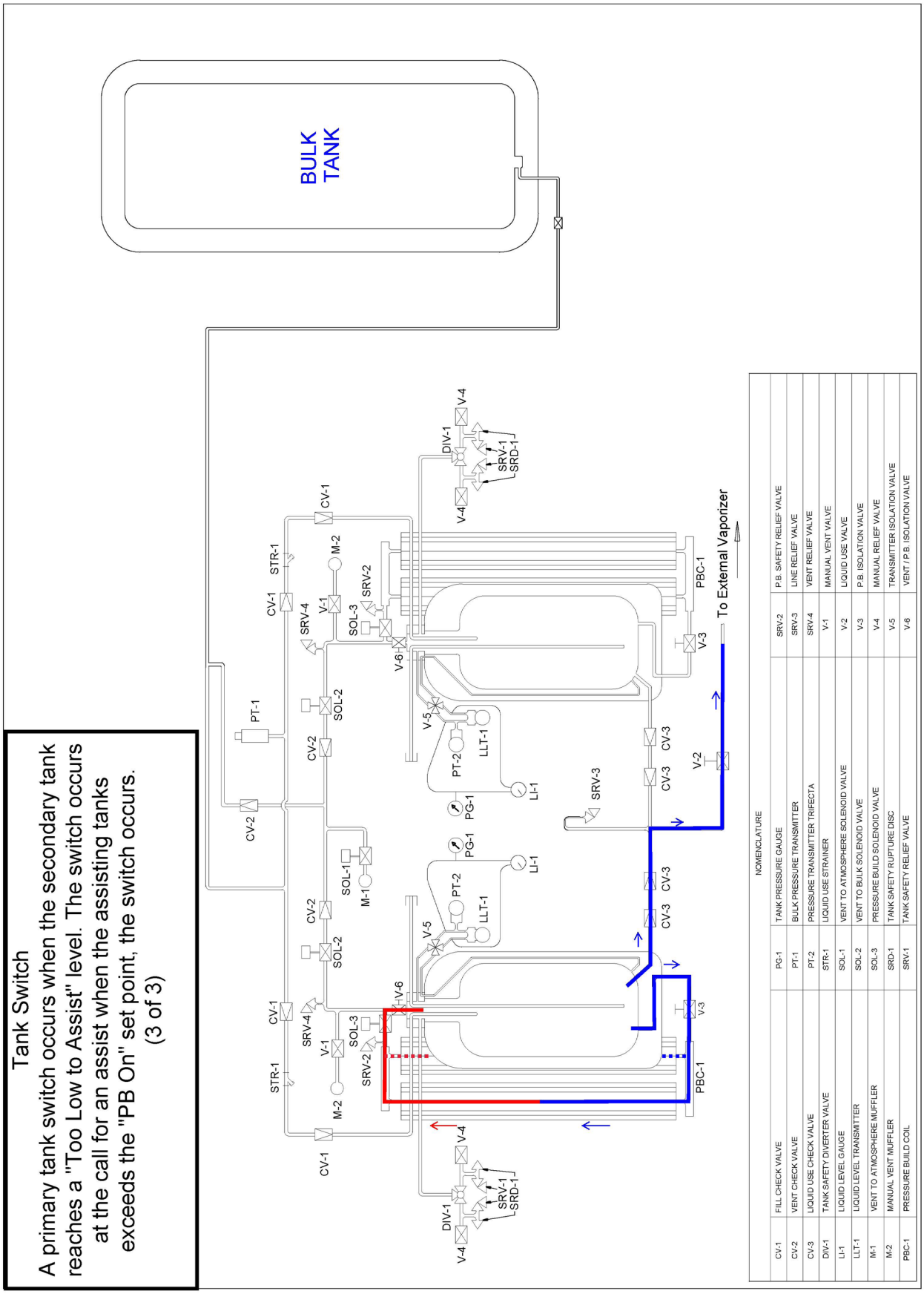


Figure 16 - Secondary Tank too low to Assist (Switch Primary Side)

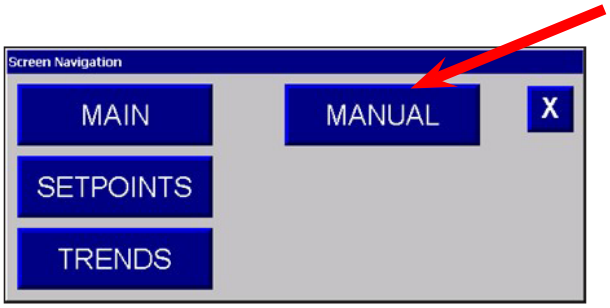
Service

Alerts & Alarms

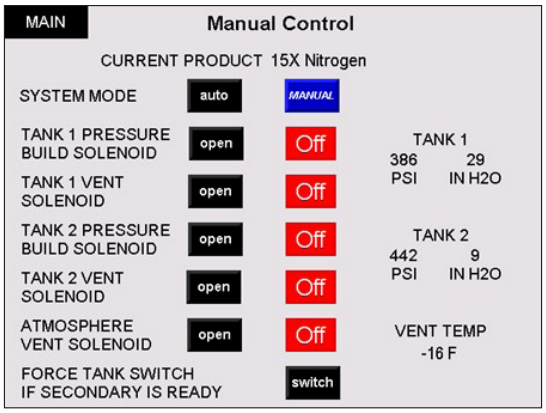
Code	Description	Action
ALERTS	Vent Temperature Alarm	Tank Overfill, liquid detected at vent outlet
ALERTS	Tank 1 Pressure High	Overpressure Condition
ALERTS	Tank 2 Pressure High	Overpressure Condition
ALERTS	Primary Tank Flow High	Instantaneous flowrates exceeding rating of unit
ALERTS	Fill Time Exceeds Flow Rating	Fill time is too slow to keep up with max flows
ALERTS	Primary Requested Assist Before Secondary Ready	Pressure in primary dropped below “PB ON” for 10 sec. Secondary not ready to assist.
ALERTS	Cycles Exceed Service Setting	Service Required (20,000 cycles)
ALERTS	Primary Press Less Than Secondary PB ON	When in Modes 0 or 2, Primary tank has fallen below secondary’s PB on Setpoint.
ALERTS	Primary & Secondary Press Low Alert	Both Primary & Secondary have been pressure building for 10 Min. (in Auto)
ALERTS	Primary Pressure Less Than PB ON 10 seconds	Primary Pressure has dropped below PB ON for 10 sec. (Disabled)
ALARMS	Tank 1 Pressure Transmitter Out of Range High	Transmitter error
ALARMS	Tank 1 Pressure Transmitter Out of Range Low	Transmitter error
ALARMS	Tank 2 Pressure Transmitter Out of Range High	Transmitter error
ALARMS	Tank 2 Pressure Transmitter Out of Range Low	Transmitter error
ALARMS	Bulk Tank Pressure Transmitter Out of Range High	Transmitter error
ALARMS	Bulk Tank Pressure Transmitter Out of Range Low	Transmitter error
ALARMS	Tank 1 Level Sensor Out of Range High	Transmitter error
ALARMS	Tank 1 Level Sensor Out of Range Low	Transmitter error
ALARMS	Tank 2 Level Sensor Out of Range High	Transmitter error
ALARMS	Tank 2 Level Sensor Out of Range Low	Transmitter error

Manually Operating the Valves

From the Main Screen, you need to press “Menu” on the screen, this will bring up a pop-up box.



Here, press the “MANUAL” button, which will bring up the Manual Control screen.



Press the “manual” button. When the Trifecta is in manual control, “Manual” will be highlighted in blue. You can press the open button and the red”OFF” will turn to a green “ON” and the valve will open and stay open until you press the “CLOSE” button. You can view the tank pressure and liquid level on the right side. If you are operating it manually, you will be able to see what is going on.

The solenoids have a manual override hand wheel:

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

Control Box

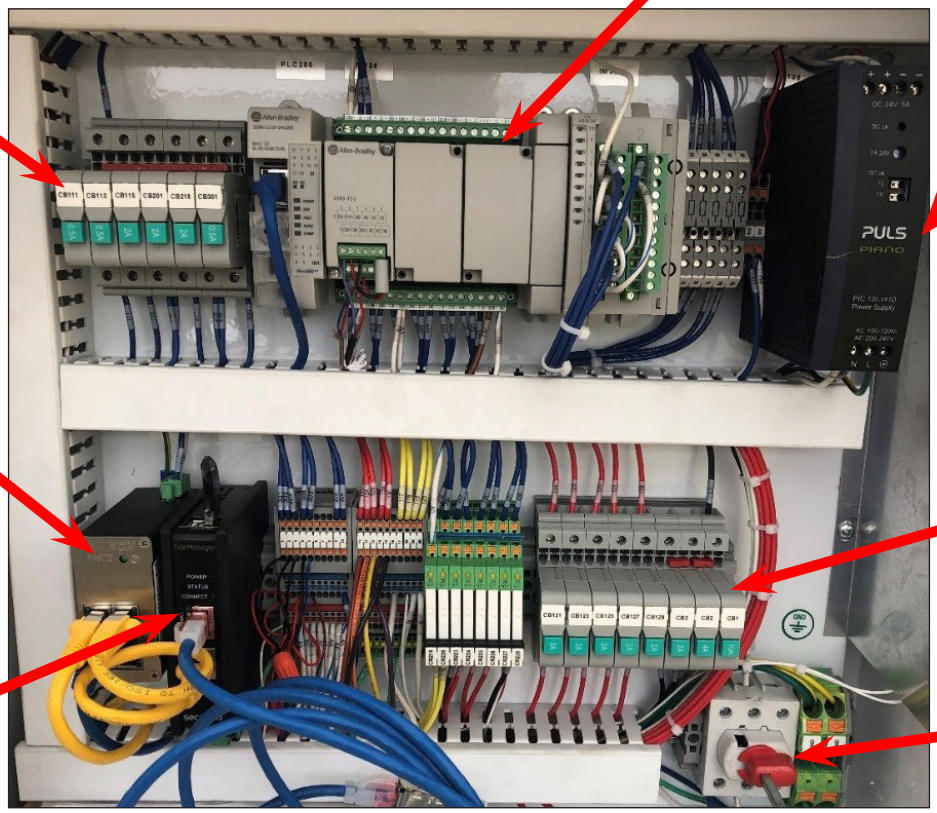


Figure - 5 Primary Components Inside Allen Bradley Control Box

Circuit Breakers (See Fig. 6 & 7)

Circuit Breaker No.	Description	Amps
CB111 (24 VDC)	Ethernet Switch	.5A
CB113 (24 VDC)	Remote Monitor Controller	.5A
CB115 (24 VDC)	HMI Interface	2A
CB201 (24 VDC)	Allen Bradley PLC	2A
CB218 (24 VDC)	Customer Alarm	2A
CB301 (24 VDC)	Transmitters	.5A
CB121 (120 VAC)	Tank #1 Pressure Build	2A
CB123 (120 VAC)	Tank #2 Pressure Build	2A
CB 125 (120 VAC)	Tank #1 Vent	2A
CB127 (120 VAC)	Tank #2 Vent	2A
CB129 (120 VAC)	Vent to Atmosphere	2A
CB3 (120 VAC)	Power Supply CB	2A
CB2 (120 VAC)	Enclosure Heater CB	4A
CB1 (120 VAC)	Main CB for all solenoids	10A

Fig. 6 - 120 VAC

Fig. 7 - 24 VDC

Circuit Breaker Detail

Note: *Reset tripped circuit breaker by pushing in on square green button. Before resetting, it is best to have an understanding of why the circuit breaker tripped.*

Repairs

Note: *Any time plumbing is removed from the Trifecta Pro 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 Pro 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 Pro Series. When this signal is sent from the PLC, The solenoid valve shown on the HMI Screen turns green. If the solenoid turns green 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. If there is not power at the valve, trace wiring back to find out where disconnect is occurring. Contact www.chartparts.com for replacement parts.

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. 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

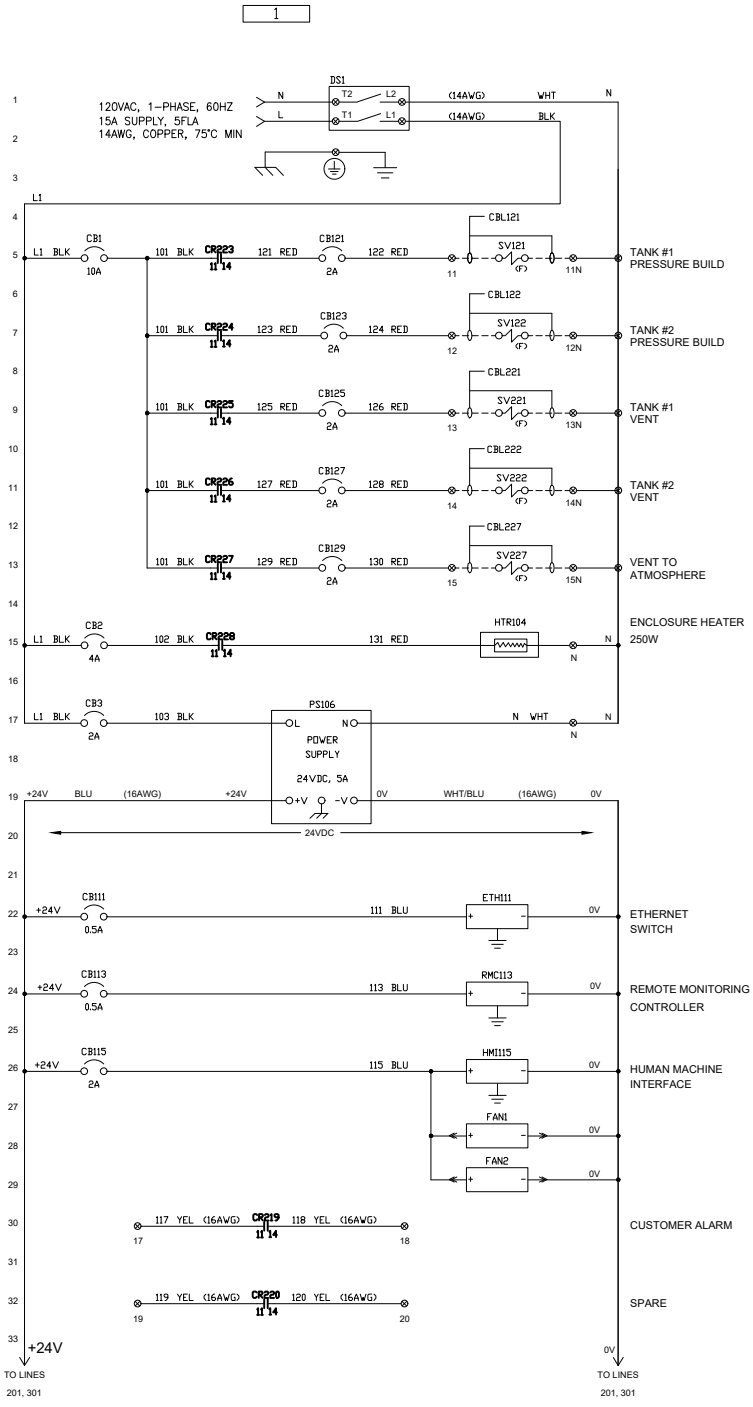
1. Leak check all fittings associated with the transmitter to verify the circuit has zero leaks. The sensor error check function is designed to find problems such as a wire coming disconnected, or a short in the transmitter. See the Service section of this manual for Alerts and Alarms.
2. Confirm that all wiring connection terminals are tight.
3. If all connections are made and the Alarm condition does not go away, check the transmitter output.
4. Recalibrate or replace the transmitter as necessary.
5. Also verify display readouts versus the analog gauges for both pressure and differential pressure.

Ball Valve Maintenance and Repair

Chart recommends that these ball valves have their stem seals checked and tightened at least every six months. Ball seals and actuator seals should also be checked and replaced at least once per year.

Extended stem and short stem Worcester cryogenically-rated ball valves are used for isolation valves. These valves, for the most part, stay in the open position. Chart recommends these ball valves have their stem seals checked and tightened at least every six months. Ball seals should also be checked at least once per year and replaced as required.

Electrical Schematic

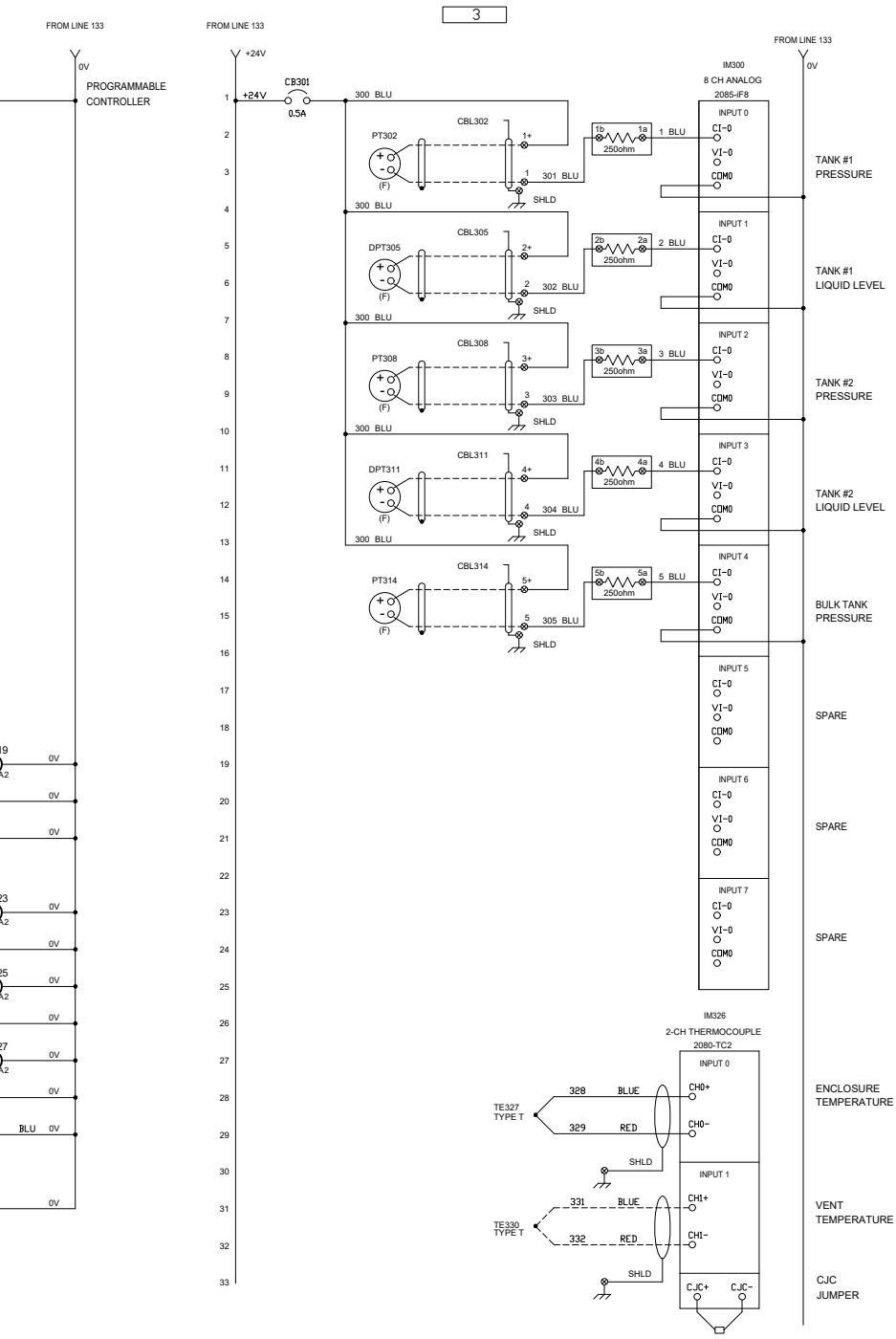


NOTES: UNLESS OTHERWISE SPECIFIED
(1) BLACK, WHITE AND GREEN WIRES #16AWG, UL AWM 1007
(2) BLUE AND WHITE/BLUE WIRES #18AWG, UL AWM 1007
(3) ALL WIRE ENDS MARKED WITH WIRE NUMBER
(4) ALL WIRE ENDS TERMINATED WITH FERRULE OR TINNED LEADS

REV	APPV	ECR	R

DESIGNATES A NOTE REFERENCE (X.X) D

DRAWING NO. B-36000.002



APP'VD	DATE	ORIGINAL ECR / ER
DRAWN BY P.RYBAK	12.18.2017	CHART — CHART INDUSTRIES, INC. FREMONT, CA 94538
CHECKED BY		
PROJ.ENGR.		TITLE: SCHEMATIC

PROJECT: TRIFECTA PRO CONTROLLER

DRAWING NO. B-36000.002 REV: D

SCALE: none DO NOT SCALE DRAWING SHEET: 1 of 1

REVISION DESCRIPTION	BY	DATE

DING THE PRINCIPLES THE EXCLUSIVE ENTIAL INFORMATION. MITTED TO YOU WITH PRODUCED, COPIED, THE INFORMATION TO ICE OF THIS DRAWING O THE ABOVE.

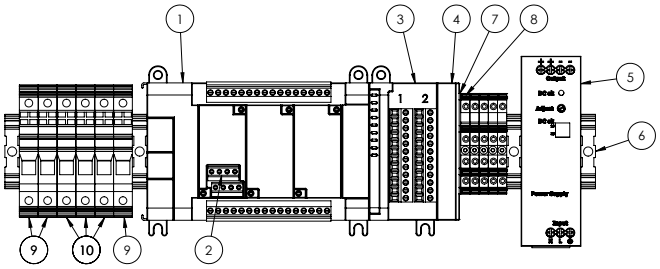
ESIGNATES INSPECTION DIM.

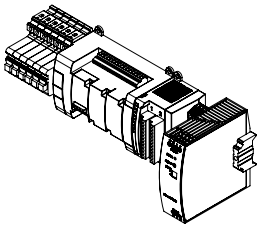
MAT'L

FINISH P/N

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES.
TOLERANCES:
FRACTIONS ± 1/16"
ANGLES ± 1°
1 PLACE DECIMAL ± .030
2 PLACE DECIMAL ± .015
3 PLACE DECIMAL ± .005

Rail Assemblies

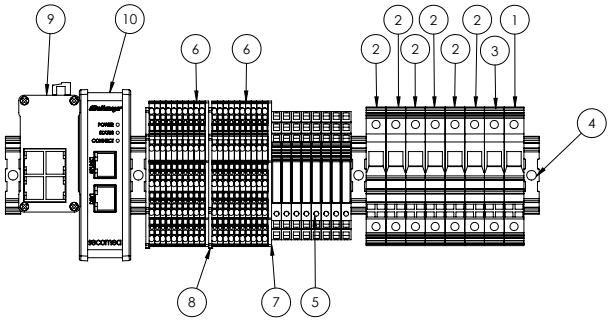


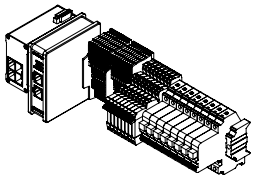


ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	351004.1201.0001	PLC CONTROLLER	1
2	351004.1202.0003	PLC TC MODULE	1
3	351004.1202.0002	PLC MODULE	1
4	351004.1202.0001	PLC TERMINATOR	1
5	351008.1101.0120	POWER SUPPLY	1
6	351007.1702.0001	DIN-RAIL ANCHOR	4
7	351007.2102.0001	TERMINAL BLOCK END PLATE	1
8	351007.2101.0001	RESISTOR BLOCK	5
9	351009.1101.0050	CIRCUIT BREAKER 0.5A	3
10	351009.1101.0200	CIRCUIT BREAKER 2A	3

RAIL ASSEMBLY 1

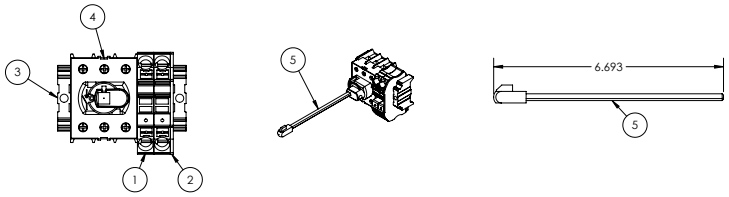
RAIL ASSEMBLY 2





ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	351007.1101.1000	CIRCUIT BREAKER 10A	1
2	351009.1101.0200	CIRCUIT BREAKER 2A	6
3	351009.1101.0400	CIRCUIT BREAKER 4A	1
4	351007.1702.0001	DIN-RAIL ANCHOR	4
5	351010.1101.001	RELAY MODULE	8
6	351007.1201.0001	TERMINAL BLOCK	20
7	351007.1200.0001	TERMINAL BLOCK END PLATE	2
8	351007.1701.0001	TERMINAL BLOCK PARTITION	2
9	351004.2101.0001	ETHERNET SWITCH	1
10	351004.3101.0001	GATEWAY MANAGER	1

RAIL ASSEMBLY 3



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	351007.1101.0006	GROUND BLOCK	2
2	351007.1100.001	TERMINAL BLOCK END PLATE	1
3	351007.1702.0001	DIN-RAIL ANCHOR	2
4	351009.2101.0016	DISCONNECT SWITCH	1
5	36000.001.XX	INTERLOCK SHAFT	1

Preventive Maintenance

Procedure

Over time components of the Trifecta Pro 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 Pro 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:
  - Clean/replace strainer on liquid feed 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 and DP transmitters.
  - Leak check entire Trifecta Pro Series system.
  - Inspect flex hoses for leaks and defects
- Every three years or at cycle count limit: (10,000 cycles per tank)
  - Replace all check valves
  - Replace pistons and coils on all solenoid valves and rebuild cryogenic ball valves
  - Replace relief valves and burst discs on tanks 1 and 2
- Every five years or at cycle count limit (20,000 cycles per tank)
  - Replace flex hoses on bottom withdrawal lines

Note: *Reset cycle counter after servicing valves.*

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.

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**
HMI, PANELVIEW 7 PLUS GRAPHIC TERMINAL	ALLEN-BRADLEY	351004.1101.0001
PLC, MICRO-850 SERIES, CONTROLLER, 14 INPUTS, 10 SOURCE OUTPUTS	ALLEN-BRADLEY	351004.1201.0001
PLC, MICRO 850 SERIES, I/O TERMINATOR MODULE	ALLEN-BRADLEY	351004.1202.0001
PLC, MICRO 850 SERIES, ANALOG INPUT MODULE, 8-CHANNEL	ALLEN-BRADLEY	351004.1202.0002
PLC, MICRO 800 SERIES THERMOCOUPLE MODULE, 2-CHANNEL	ALLEN-BRADLEY	351004.1202.0003
GATEWAY, REMOTE ACCESS SITE MANAGER	SECOMEA	351004.3101.0001
ETHERNET SWITCH, UNMANAGED, 4-PORT	N-TRON	351004.2101.0001
POWER SUPPLY, 24V/5A OUT, 120W	PULS	351008.1101.0120
HEATER, 5”X10” 120VAC 250W, W/ THERMOSTAT AND MOUNTING PLATE	WATLOW	350800.1101.0250
THERMOCOUPLE, BOLT-ON ASSEMBLY, TYPE-T, 36IN WIRES, #10 BOLT HOLE	OMEGA	350800.2101.1036
CIRCUIT BREAKER, UT 6-TMC M SERIES, 1-POLE, 0.5A (UL1077)	PHOENIX CONTACT	351009.1101.0050
CIRCUIT BREAKER, UT 6-TMC M SERIES, 1-POLE, 2A (UL1077)	PHOENIX CONTACT	351009.1101.0200
CIRCUIT BREAKER, UT 6-TMC M SERIES, 1-POLE, 4A (UL1077)	PHOENIX CONTACT	351009.1101.0400
CIRCUIT BREAKER, UT 6-TMC M SERIES, 1-POLE, 10A (UL1077)	PHOENIX CONTACT	351009.1101.1000
OPERATOR, HW SERIES, SELECTOR SWITCH, 2-POSITION, NON ILLUMINATED	IDEC	351006.2101.0001
INDICATOR, TL50BL SERIES, TOWER LIGHT, R/Y/G, 12-30V AC/DC, 2M CABLE	BANNER	351006.1101.0001
RESISTOR, 250ohm	ABB	351007.2101.0001
THERMOCOUPLE TYPE T PROBE	THERMOCOUPLE TYPE T 60” LEADS	14271813

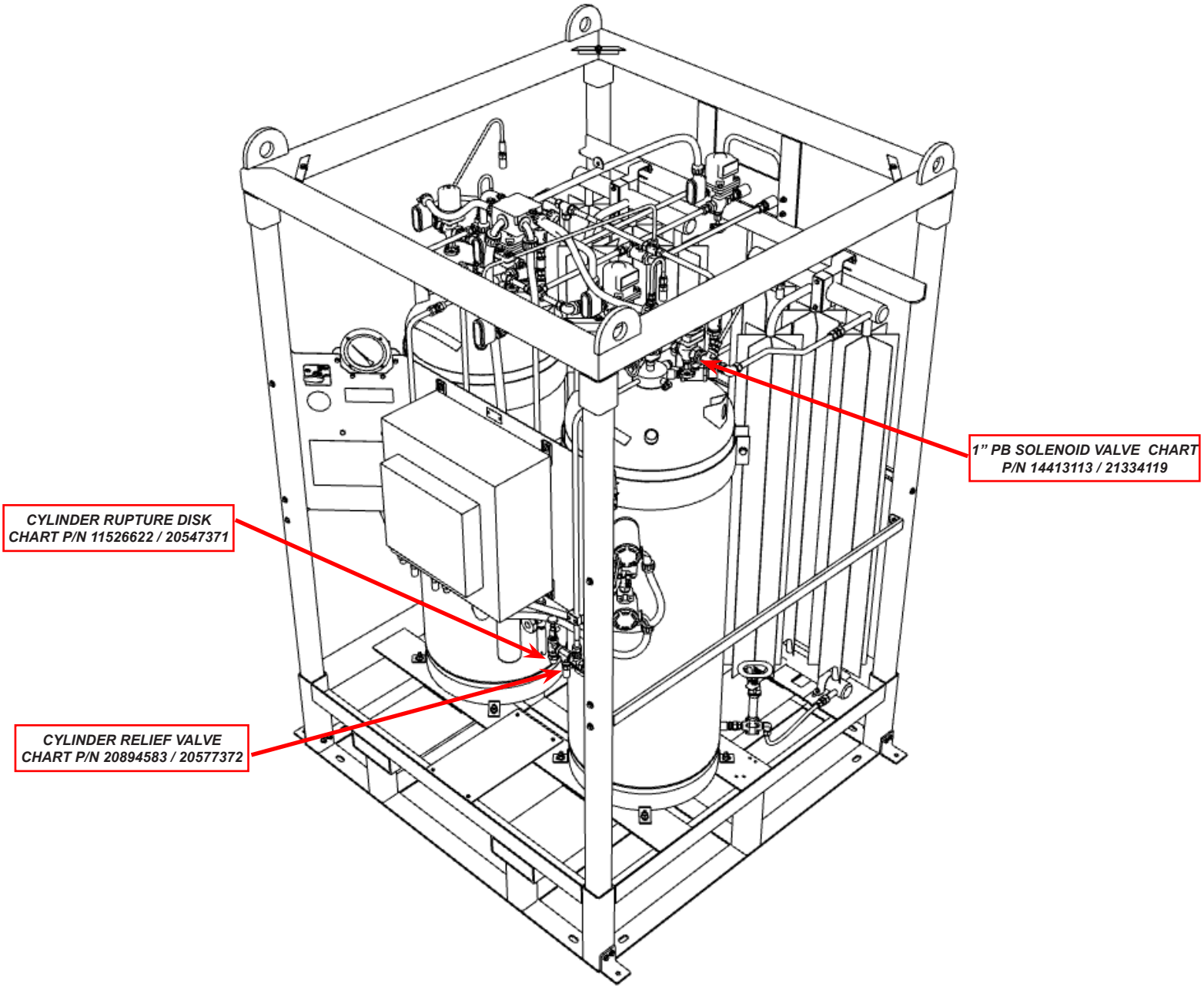
Safety Tree		
Item Description 1	**Item Description 2**	**Chart PN**
SAFETY RELIEF VALVE-CYLINDER (BRS ½”MPT 500 PSI)	RV BRS 1/2MPT 500PSI W/O DRAIN	20894583
SAFETY RELIEF VALVE-CYLINDER (BRS ½”MPT 600 PSI)*	RV BRS 1/2MPT 600PSI	20547372
RUPTURE DISC-CYLINDER (RPD ASSY. INLINE 1/2”MPT 700 PSI)	RPD ASSY 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/Ball Valves		
Item Description 1	**Item Description 2**	**Chart PN**
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
USE (VALVE GLOVE BRS ½”) - REGO BB9404T	VALVE GLOBE BRS 1/2NPT SCRD	20915798
RV BRS 1/4MPT GENERENT CRV-250B-K-720	RV BRS 1/4MPT 720 PSI	21191971
MUFFLER ASSY SS 5/8" 45D FL	MUFFLER ASSY SS 5/8" 45D FL	13060248
MUFFLER OXY 7/8” - 14 UNF	MUFFLER	9710399
MUFFLER OXY TRIFECTA XPRO SERIES	MUFFLER OXY TRIFECTA XPro Series	13744164
4-WAY INSTRUMENT ISOLATION VALVE	1/8 FPT SWAGELOK	20683719
PB RETURN/VENT ISOLATION VALVE	1/2 FPT WORCESTER SHORT STEM	13088865
BOTTOM WITHDRAWAL ISOLATION VALVE	1/2 FPT WORCESTER EXT STEM	20897965
RV BRS 1/4MPT 660 PSI GENERANT	CRV-250B-K-660	12898487

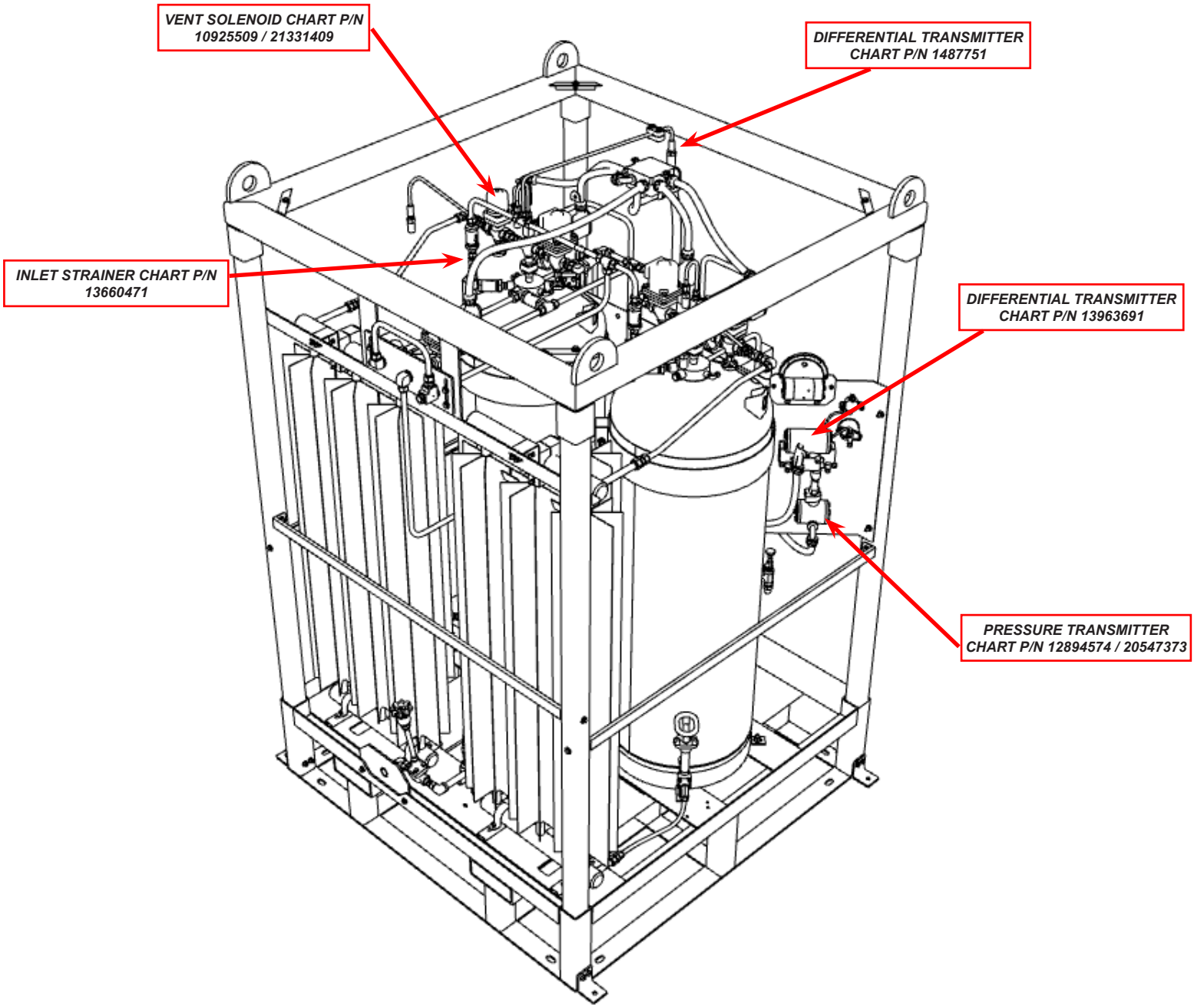
Solenoid Valves		
Item Description 1	***Item Description 2***	***Chart PN***
VENT SOLENOID VALVE (120VAC-½”)	VALVE SOLENOID 1/2FPT 120VAC	10925509
VENT VALVE SOLENOID COIL (120VAC-½”)	COIL SOLENOID 120V 60HZ	10963071
VENT VALVE GASKET (1/2”)	GASKET SOLENOID MAGNATROL	10963100
VENT VALVE PISTON ASSEMBLY (120VAC-½”)	PISTON ASSY SOLENOID MAGNATROL	10963062
MANUAL OVER-RIDE ASSY (1/2")	MANUAL OVER-RIDE ASSY	11554877
PB SOLENOID VALVE (120VAC – 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

TRANSMITTERS		
Item Description 1	***Item Description 2***	***Chart PN***
DIFF PRESS CALIBRATED 0-100” RSMT	DIFF PRESS TRANS	14319186
TRANSMITTER PRESS 0-500PSIG	TRANSMITTER PRESS 0-500PSIG	12894574
TRANSMITTER PRESS 0-600PSIG	TRANSMITTER PRESS 0-600PSIG	20547373
PRESSURE TRANSDUCER (0-500 PSI S20 4-20mA)		21100754

Solenoid Valves (600 PSI Trifecta)		
VALVE SOLENOID 1/2 FPT 120 VAC SS	VENT SOLENOID	21331409
GASKET SOLENOID MAGNATROL	VENT SOLENOID	10963100
MANUAL OVERRIDE ASSEMBLY	VENT SOLENOID	21360543
PISTON ASSEMBLY 1/2”	VENT SOLENOID	21360544
COIL SOLENOID 120VAC 60HZ	VENT SOLENOID	10963071
VALVE SOLENOID 1”FPT 120VAC SS	PB SOLENOID	21334119
GASKET SOLENOID MAGNATROL	PB SOLENOID	20571792
MANUAL OVERRIDE ASSEMBLY	PB SOLENOID	21360540
PISTON ASSEMBLY 1”	PB SOLENOID	21360542
COIL SOLENOID 120 VAC 60HZ	PB SOLENOID	21360541



Front Isometric View of Trifecta 500/600 psig



Rear Iso view of nitrogen Trifecta (500/600 psig)

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 Pro Series operation, please read the Operation section of this manual before continuing.

While troubleshooting the Trifecta Pro 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 Pro Series are in their normal operating position.
2. Confirm solenoids 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 (15k) valves on Trifecta Pro Series – manual override hand wheel in the "Out" position (fully counterclockwise).

Normal Activation of Solenoids

Open HMI cover giving you access to the PLC screen. Per the Operations section of this manual, switch the controller to "Manual" and open each solenoid. 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 Pro 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 Pro 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 Pro 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
Liquid Level (from Analog Gauge)	_____	“H_2O

Tank 2

Pressure (Analog Gauge)	_____	PSIG
Pressure (from PLC Display)	_____	PSIG
Liquid Level (from PLC Display)	_____	“H_20
Liquid Level (from Analog Gauge)	_____	“H_2O

PLC Information

Press “Setpoints on main screen/record PB Set Point	_____	PSIG
Press Fill Set Point	_____	“H_20
Press bulk critical	_____	PSIG
Cycle Count	_____	#cycles

Press Alarms, Alerts and Record and Active ALARMS/ALERTS to include times/record Error Codes and elapsed time since event.

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

Introduction

The Trifecta Pro control system allows for multiple units to communicate if connected via common Ethernet network. When connected, one Trifecta is configured as the Master Trifecta, while up to four other units are configured as Slave Trifectas. The Trifecta units will cycle between Active and Standby in order to share the workload. When needed, the Master Trifecta can call upon the Standby units for assistance.

The Master will control which Trifectas are at the Active and which are at Standby. The pressures which Active and Standby units run at are controlled by the Master Trifecta. Standby units will run at a preset pressure below the PB On setpoint of the Master Trifecta. The Master will rotate which Trifectas are Active and which are Standby based on an adjustable amount of time.

The Master Trifecta will make any Standby Trifectas Active if any of the Active units request assistance or loses communications with a Slave Trifecta. If any Slave units lose communication with the Master, it will run as a standalone Trifecta, using its own pressure on setpoint.

If an Active unit requests assistance, all Standbys will remain active for a minimum of 30 minutes. The Previous Cycle Timer must be greater than the preset amount of time based on flow capacity of the Trifectas in order to release the Standby units back to Standby.

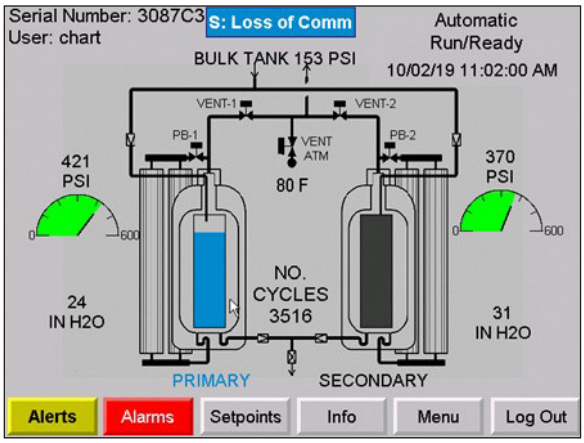
HMI Screens

The following screenshots describe changes to existing screens and screens which were added for when running in parallel with other Trifectas.

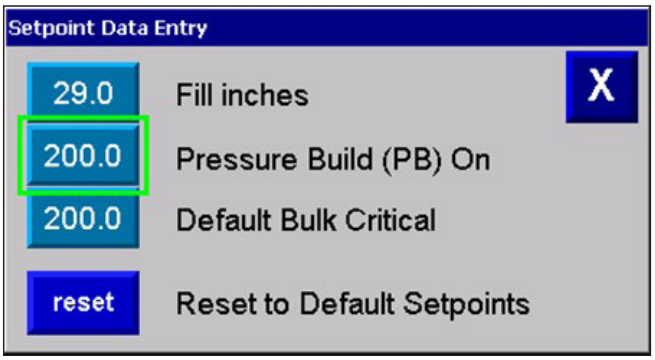
MAIN Screen - Master/Slave

M/S Mode field — Displays if the unit is a Master or Slave. It also indicates if the unit is Active, Standby or has lost communications

- **S: Active** — Slave Trifecta with PB on set to the Active Pressure
- **S: Standby** — Slave Trifecta with PB on set to the Standby Pressure
- **S: Loss of Comm** — Slave Trifecta which has lost communications with the Master. Will run using PB On Setpoint set locally until communications are restored.
- **M: Active** — Master Trifecta with PB on set to the Active Pressure
- **M: Standby** — Master Trifecta with PB on set to the Standby Pressure
- **M: Loss of Comm** — Master Trifecta has lost communications with the one or more Slave units. Will run using Active PB On until communication is restored



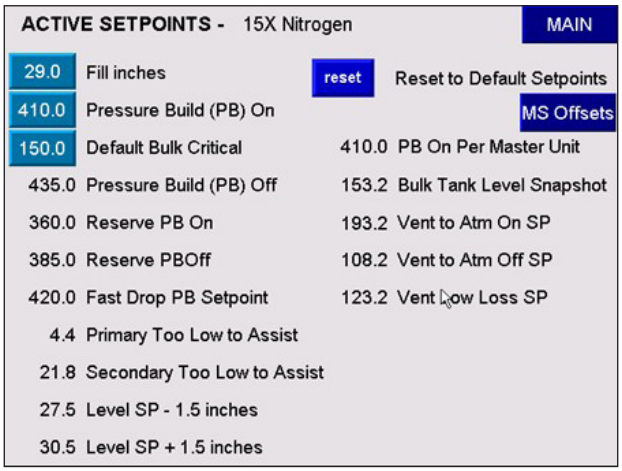
SETPOINT DATA ENTRY Popup - Master/Slave



Pressure Build (PB) On field

- **Master —** Displays the PB On setpoint to be used by all Active Trifectas
- **Slave —** Displays the PB On setpoint to be used upon loss of communications with the Master Trifecta

ACTIVE SETPOINT Screen - Master/Slave



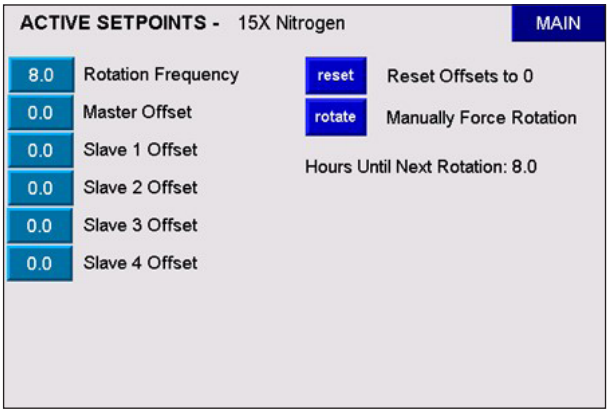
Pressure Build (PB) On field

- **Master** — Displays the PB On setpoint to be used by all Active units
- **Standby** — Displays the PB On setpoint to be used upon loss of communications with the Master Trifecta

PB On Per Master Unit field — Displays the PB On pressure currently being used by the Trifecta

MS Offsets button (Master Trifecta Only) — Opens an additional setpoint screen for the Master Trifecta

ACTIVE SETPOINT MS Offsets Screen (Master Only)



Rotation Frequency field — Displays the number of hours between rotation of Active units

Offset fields — Allows the user to fine tune the balancing of the units, if necessary. When an offset is applied, the Master unit will instruct the respective Trifecta to run at the desired PB On plus the offset (+/- 10).

Note: *The offset is meant to overcome difference in pressure drop. If the cycles for all the units are within an acceptable percentage (5-10%), it is recommended to leave the Offsets at 0 to minimize complexity.*

PB On per Master Unit field — Displays the PB On pressure currently being used by the Trifecta.

MS Offsets button (Master Trifecta Only) — Opens an additional setpoint screen for the Master Trifecta

Reset Offsets to 0 button — Resets setpoints to default settings

Rotate button — Manually forces a rotation of which Trifectas are Active (Hours until next rotation will reset)

Hours Until Next Rotation field — Displays number of hours until the next rotation of Active Units.