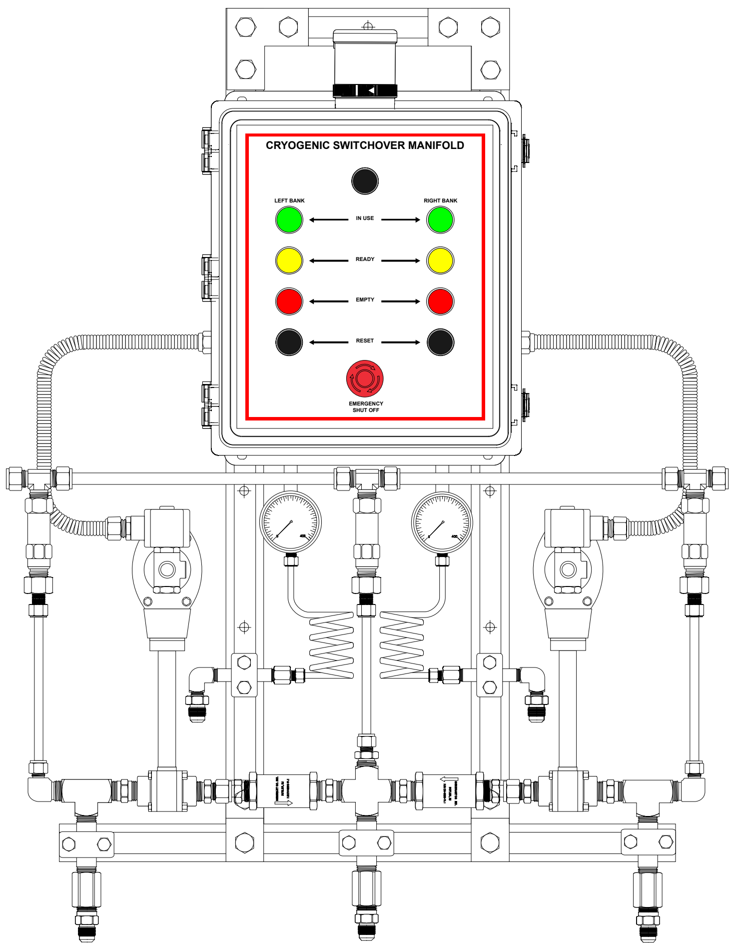
BEACONMEDÆS

Instruction Manual

CFAM-PX Series

THIS BOOKLET CONTAINS PROPRIETARY INFORMATION OF BEACONMEDÆS AND IS PROVIDED TO THE PURCHASER SOLELY FOR USE IN CONJUNCTION WITH FULLY AUTOMATIC SWITCHOVER MANIFOLDS FOR LIQUID CYLINDERS – PRESSURE ACTUATED (LIQUID WITHDRAW / LIQUID DISPENSE).



Important

These instructions are for experienced operators who know the general principles and safety precautions to be observed in handling compressed gases. If you are not certain you fully understand the safety precautions for handling gases, we urge you to obtain and read the Material Safety Data Sheet (MSDS) for each gas being used.

Do not permit untrained persons to install, operate, or maintain these manifolds. Do not attempt to install or operate these manifolds until you have read and fully understand these instructions. If you do not fully understand these instructions, contact BeaconMedæs.

Be sure this information reaches the operator. Your supplier has extra copies.

1 - Safety Precautions

Protect yourself and others. Read and understand the following instructions before attempting to use this equipment. Failure to understand and follow these instructions could result in serious personal injury and/or damage to equipment. Because of the many potential hazards associated with gases, read the Material Safety Data Sheet for each gas you will be using.

- Know and understand the physical and chemical properties of the gas being used.
- Observe general precautions for the use of gases.
- Observe safety precautions for the gas being used.
- Read and follow precautions on cylinder labels.
- Never use these manifolds with gases not compatible with the materials of construction. The use of gases not compatible with the materials of construction may cause damage to equipment or injury to personnel.
- Many gases can cause asphyxiation by displacing oxygen in the atmosphere. Make certain the area where these manifolds are operated is well ventilated. Provide a device to warn personnel of oxygen depletion in the work area.
- Use this equipment only in well ventilated areas. Vent gases to the outside atmosphere, and in an area away from personnel. Be sure that venting and disposal methods are in accordance with Federal, State, Provincial and local requirements. Locate and construct vent lines to prevent condensation or gas accumulation. Be sure the vent outlet cannot be obstructed by rain, snow, ice, insects, birds, etc. Do not inter-connect vent lines; if more than one vent is needed, use separate lines.
- Relief devices should be installed and properly vented in all gas handling systems to protect against equipment failure and over-pressurization.
- Never connect this equipment to a supply source having a pressure greater than the maximum rated pressure. Refer to the Product Specifications for maximum inlet pressures.
- Never permit oil, grease, or other combustible materials to come in contact with cylinders, manifolds, and connections. Oil and grease may react and ignite when in contact with some gases – particularly oxygen and nitrous oxide.
- Cylinder, header, and master valves should always be opened very s-l-o-w-l-y. Heat of recompression may ignite combustible materials.
- Flexible hoses should never be kinked, twisted, or bent into a radius smaller than 3 inches. Mistreatment may cause the flexible hoses to burst.
- Do not apply heat. Some materials may react and ignite while in contact with some gases – particularly oxygen and nitrous oxide.
- Cylinders should always be secured with racks, chains, or straps. Unrestrained cylinders may fall over and damage or break off the cylinder valve which may propel the cylinder with great force.
- Oxygen manifolds and cylinders should be grounded. Static discharges and lightning may ignite materials in an oxygen atmosphere, creating a fire or explosive force.
- Welding should not be performed near nitrous oxide piping. Excessive heat may cause the gas to dissociate, creating an explosive force.
- Do not use leak test solution that contains ammonia. Solutions containing ammonia may cause brass tubing to crack.
- Always use oxygen compatible leak test solution on oxygen or nitrous oxide service equipment.

2 - Safety Precautions - Cryogens

Cryogenic liquids are liquids with a normal boiling point below -238°F (-150°C). The most commonly used industrial or medical gases that are transported, handled, and stored in the liquid state at cryogenic temperatures are oxygen, nitrogen, argon, hydrogen, and helium.

There are a number of general precautions and safety practices which must be observed because of the extremely low temperatures and high rates of conversion into gas of all of the cryogenic liquids. There are also specific precautions which must be followed where a particular liquid may react with contaminants or may present a hazard to life.

The user of any cryogenic liquid covered in this manual should be familiar with both the general and specific precautions outlined. He/She should also be thoroughly familiar with the instructions provided with any equipment to be used with the liquid.

GENERAL SAFETY PRECAUTIONS

Many of the safety precautions observed for gases in the gaseous state also apply to the same gases in the liquid state. However each of the liquids has properties different from those of the others. The potential hazards in handling all cryogenic liquids stem mainly from the following two important properties:

- Cryogenic burns
- Thermal expansion

INTRODUCTION

All cryogenic liquids are extremely cold. Cryogenic liquids and their cold “boil-off” vapor can rapidly freeze human tissue, and cause many common materials such as carbon steel, plastics and rubber to become brittle, or even fracture under stress. Cryogenic liquids in containers and piping at temperatures at or below the boiling point of liquefied air (-318°F[-194°C]) can actually condense the surrounding air to a liquid.

GENERAL SAFETY PRECAUTIONS

All cryogenic liquids produce large volumes of gas when they vaporize. For example, one volume of liquid nitrogen at atmospheric pressure vaporizes to 694 volumes of nitrogen gas at 68°F (20°C). If these liquids are vaporized in a sealed container, they can produce enormous pressures which could rupture the vessel. For this reason pressurized cryogenic containers are usually protected with multiple devices for pressure relief.

Common protective devices are a pressure relief valve for primary protection and a rupture disc for secondary protection. Vaporization of cryogenic liquid, except oxygen, in an enclosed work area can cause asphyxiation, by displacing breathable air. Vaporization of liquid oxygen in an enclosed work area can cause an oxygen-rich atmosphere and could saturate a worker’s clothing which could ignite if an ignition source were present. Although oxygen is not flammable it will vigorously support and/or accelerate the combustion of other materials.

Most cryogenic liquids are odorless, colorless and tasteless when vaporized to the gaseous state. Most of them have no color as a liquid, although liquid oxygen is light blue. However, the extremely cold liquid and vapor have a built-in warning property that appears whenever they are exposed to the atmosphere. The cold “boil-off” gases condense the moisture in the air, creating a highly visible fog. The fog normally extends over a larger area than that of the vaporizing liquid.

HANDLING

Always handle cryogenic liquids carefully. At their extremely low temperatures, they can produce cryogenic burns on the skin and freeze tissues. When spilled on a surface they tend to cover it completely and therefore cool a large area. The vapors from these liquids are also extremely cold and can produce burns. (i.e. freeze tissues). Exposure to these cold gases which is too brief to affect the skin of the face or hands can affect delicate tissues, such as those of the eyes. Stand clear of boiling and splashing always occur when charging a warm container or when inserting objects into the liquid. Always perform these operations slowly to minimize boiling and splashing. Never allow any unprotected part of your body to touch un-insulated pipes or vessels containing cryogenic liquids; the extremely cold material may stick fast and tear the flesh when you attempt to withdraw it. Even nonmetallic materials are dangerous to touch at low temperatures. Use tongs to withdraw objects immersed in a cryogenic liquid. In addition to the hazards of frostbite or flesh sticking to cold materials, objects that are soft and pliable at room temperature, such as rubber or plastics, are easily broken because they become hard and brittle at these extremely low temperatures. Carbon steels become brittle at low temperatures and may easily fracture when stressed.

PROTECTIVE CLOTHING

Safety glasses are recommended during transfer and normal handling of cryogenic liquids. If severe spraying or splashing may occur, a face shield or chemical goggles should be worn for additional protection.

Dry leather gloves should always be worn when handling anything that comes in contact with cold liquids and vapor. Gloves should be loose fitting so that they can be removed quickly if cryogenic liquids are spilled onto them Depending upon the application, special clothing may be advisable. Wear trousers on the outside of boots or work shoes.

SPECIAL INERT GAS PRECAUTIONS

The primary hazards of inert gas systems are ruptures of containers, pipelines or other systems and the potential of an inert gas to asphyxiate. A cryogenic liquid cannot be indefinitely maintained as a liquid, even in well insulated containers. Any liquid or even cold vapor trapped between valves has the potential to cause an excessive pressure build-up to the point of a violent rupture of a container or piping,hence the use of reliable pressure relief devices is mandatory.

Loss of vacuum in vacuum-jacketed tanks containing cryogenic liquids will cause increased evaporation within the system. This may cause the relief devices to function and result in product venting. The vented gases should be routed to a safe outdoor location. If there are no provisions for outdoor venting, the user must assure himself that adequate ventilation is maintained. Liquid helium has the potential of solidifying air which can block safety relief devices and opening, and cause the rupture of the container. The potential for asphyxiation must be recognized when handling inert cryogenic liquids. Because of the high expansion ratios, air can be quickly displaced. Oxygen monitors are recommended whenever you handle cryogenic liquids in closed areas. Refer to the MSDS's on gaseous and liquid argon, gaseous and liquid nitrogen, and gaseous and liquid helium for additional information on properties and safe handling of these inert gases.

SPECIAL OXYGEN PRECAUTIONS

Do not permit smoking or open flames in any area where liquid oxygen is stored or handled. Do not permit liquid oxygen or oxygen-rich air atmospheres to come in contact with organic materials or flammable or combustible substances of any kind. Some of the organic materials that can react violently with oxygen when ignited by a hot spark or even a mechanical shock are oil, grease, asphalt, kerosene, cloth, tar, and dirt that may contain oil or grease. If liquid oxygen spills on asphalt or other surfaces contaminated with combustibles, do not walk on or roll equipment over the area of the spill. Keep sources of ignition away for at least 30 minutes after all frost or fog has disappeared.

Any clothing that has been splashed or soaked with liquid oxygen or exposed to high oxygen concentrations should be removed immediately and aired out for at least an hour. Personnel should stay in a well ventilated area and avoid any source of ignition until their clothing is completely free of excess oxygen. Clothing saturated with oxygen is readily ignitable and will burn vigorously. Refer to the MSDS's on gaseous and liquid oxygen for additional information on its properties and safe handling.

BUILDINGS

Test the atmosphere in confined work areas for oxygen content if a leak or abnormal condition is suspected. 19.5% oxygen concentration in the air is the minimum recommended for working without special breathing equipment. Oxygen concentration in excess of 23.5% in the air can cause clothing and other materials to burn vigorously if accidentally ignited.

3 - About Cryogenic Portable Containers

CRYOGENIC PORTABLE CONTAINERS INTRODUCTION

Cryogenic liquids are stored, shipped, and handled in several types of containers, depending upon the quantity required by the user. The type of containers in use are: dewars, liquid cylinders and liquid tanks. Storage quantities vary from liters to thousands of gallons. Since heat leak is always present, vaporization may be as low as 0.4% and as high as 3% of container content per day, depending upon the design of the container and the volume of the stored product. Containers are designed and manufactured according to applicable codes and specifications for the pressures and temperatures involved.

OPEN FLASK DEWARS

Above is an illustration of a typical, vacuum-jacketed dewar. A dust cap over the outlet of the neck tube prevents atmospheric moisture from plugging the neck tube. This type of container is considered a non pressurized container. The unit of measure for capacity of the container is the liter. Five-to 200-liter containers are available. Product may be removed by pouring into smaller containers. Product should be removed from the 50-liter and larger capacity dewars by means of low pressurization and a transfer tube.

OPEN FLASK DEWARS

The above picture illustrates a typical liquid cylinder. The cylinder is an insulated, vacuum-jacketed container. Safety relief valves and rupture discs protect the cylinders from pressure build-up. Since these cylinders operate at pressures up to 500 psig, their design must comply with Department of Transportation (DOT) specifications. Capacity of the cylinders varies between 100 liters and 450 liters. Product may be with- drawn as a gas by passing liquid through a vaporizing coil or as a liquid under its own vapor pressure. The CFAM series manifolds are designed to withdraw liquid from liquid cylinders and not from dewars.

4 - Abbreviations

C	Common	**OSHA**	Occupational Safety & Health Administration
CGA	Compressed Gas Association	**PSIG**	Pounds per Square Inch Gauge
FT-LBS	Foot-Pounds	**SCFH**	Standard Cubic Feet per Hour
IN-LBS	Inch-Pounds	**VAC**	Voltage, Alternating Current
N/C	Normally Closed	**VDC**	Voltage, Direct Current
N/O	Normally Open	**PCB**	Printed Circuit Board
NPT	National Pipe Taper		

5 - Disclaimer

BeaconMedæs shall not be liable for errors contained herein or incidental or consequential damages in connection with providing this manual or the use of material in this manual.

6 - Manufacturer Statement

The information contained in this instruction booklet has been compiled by BeaconMedæs, from what it believes are authoritative sources, and is offered solely as a convenience to its customers. While BeaconMedæs believes that this information is accurate and factual as of the date printed, the information, including design specifications, is subject to change without prior notice.

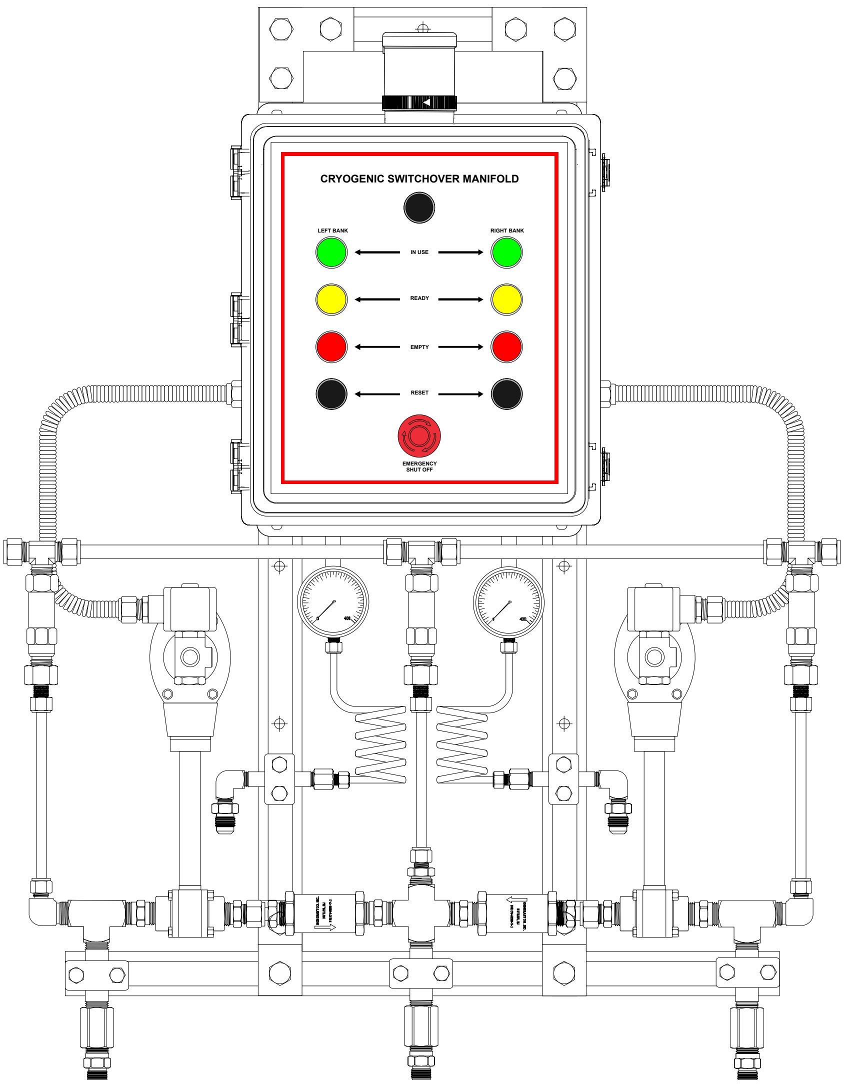
7 - Introduction

BeaconMedæs manifold systems are cleaned, tested and prepared for the indicated gas service and are built following National Fire Protection Association and Compressed Gas Association guidelines. The manifold consists of a manifold box, a control module and two supply bank headers, to provide an uninterrupted supply of gas for the specific gas application. This system is designed and built with features providing automatic switchover from the depleted “Service” supply bank to the “Reserve” supply bank. Pressure switches, alarm signal connections and lights show system status and alert the need to replace depleted cylinders.

8 - Components

Verify that all components below have been received. If any of these items are missing or damaged, please notify your supplier immediately.

QTY=1
CRYOGENIC
MANIFOLD



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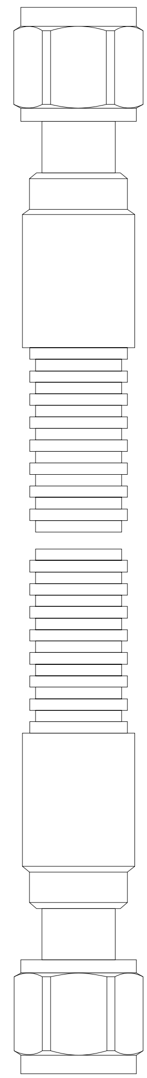
CRYOGENIC
HOSE



9 - Description

The BeaconMedæs CFAM Series Fully Automatic Switchover Manifolds assures a continuous supply of liquid cryogens or liquid carbon dioxide. It is set to transfer automatically from a depleted “In Service” supply bank to a “Stand-By” supply bank based on the pressure of cryogenic liquid (or carbon dioxide) in the cylinder.

Visual Indicators - There are seven (7) lights (LED’s) indicating the status of each bank.

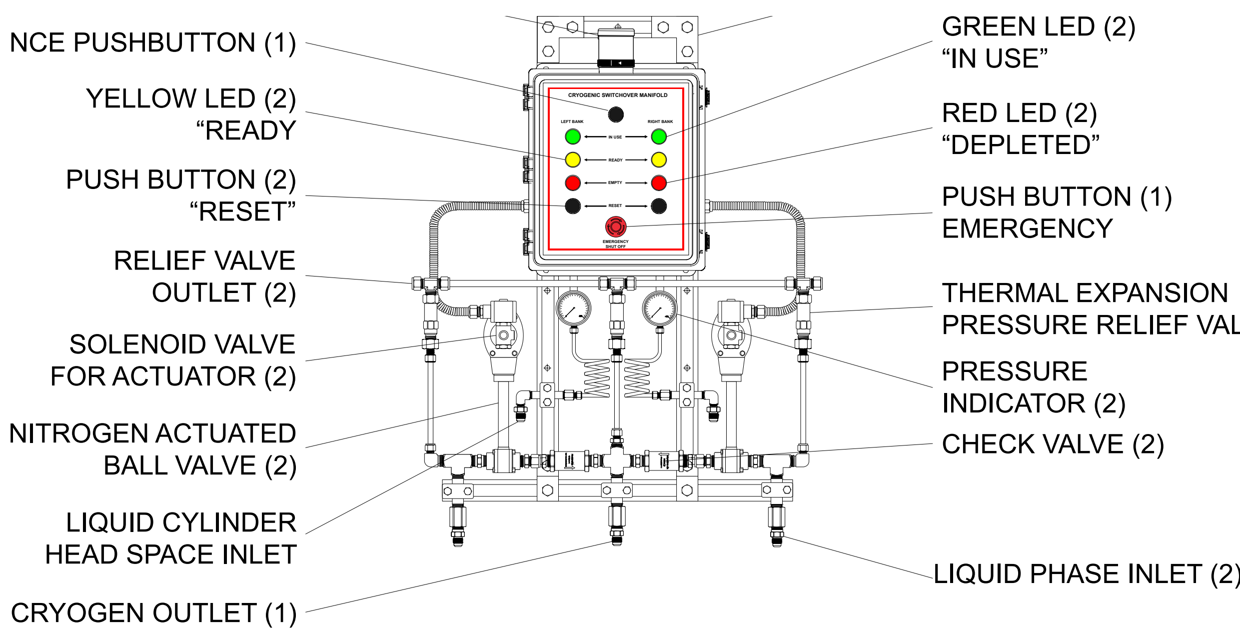
Green Light	Indicates which bank is “In Service”	One per bank
Yellow Light:	Indicates the bank is in “Stand-By” mode (Ready)	One per bank
Red Light:	Indicates a “Depleted” bank	One per bank
Clear Light:	Indicates the manifold is energized	One for the entire manifold

Audible Signal - The buzzer is actuated each time a bank is depleted. The silence pushbutton kills the buzzer without extinguishing its corresponding red light.

Pressure Switches - Each bank pressure is monitored by a pressure switch. The pressure switch is factory preset but can be easily changed in the field. Once the pressure drops lower than the pressure switch setting, the manifold controller switches from the “IN USE” depleted cylinder bank to the “READY” stand-by bank automatically.

Reset Push Buttons - The reset pushbutton needs to be pushed when an empty cylinder has been replaced by a full cylinder. There is one (1) Reset Pushbutton per bank.

Ice and Water Management - There will be some “water management” required with this equipment. Because air is always humid and the wetted components are extremely cold, the water vapor will freeze up on the wetted parts and ice will accumulate. When the equipment will not be in service, the ice will melt and water will drip down. The amount of water will vary upon the relative humidity of the air and the usage of the cryogenic manifold.



10 - Ordering Information

CFAM-PX – [ ] – [ ] – [ ] – [ ] – [ ] – [ ]

Fluid	Inscribe
Liquid Argon	CGA 295
Liquid Carbon Dioxide	CGA 320
Liquid Nitrogen	CGA 295
Liquid Oxygen	CGA 440

No. of Cylinders	Inscribe
Inscribe the no. of liquid cyl. per side (must be pair)	

Hoses	Inscribe
Stainless Steel	SSH
Stainless Steel with Guard	SSHG
Vacuum Jacketed	VJH

Liquid Cylinder Used	Inscribe
22 PSIG	22
235 PSIG	235
350 PSIG	350
500 PSIG	500

Installation Hardware	Inscribe
Wall mount bracket	WM
Floor Stand	FS

Options	Inscribe
Outside Installation	3R
Ultra High Purity Cleaning	UHP

11 - General Instructions

Manifolds should be installed in accordance with guidelines stated by the National Fire Protection Association, the Compressed Gas Association, OSHA, and all applicable local codes. Carbon dioxide and nitrous oxide manifolds must not be placed in a location where the temperature will exceed 120°F (49°C) or fall below 32°F (0°C). The manifolds for all other gases should not be placed in a location where the temperature will exceed 120°F (49°C) or fall below 32°F (0°C). A manifold placed in an open location should be protected against weather conditions. During winter, protect the manifold from ice and snow. In summer, shade the manifold and cylinders from continuous exposure to direct rays of the sun. The manifold should be located in a clean, well ventilated area which is free of oil and combustible materials.

Leave all protective covers in place until their removal is required for installation. This precaution will keep moisture and debris from the piping interior, avoiding operational problems.

If the manifold happens to be installed indoors, all safety relief valves should be piped/vented to a safe location.

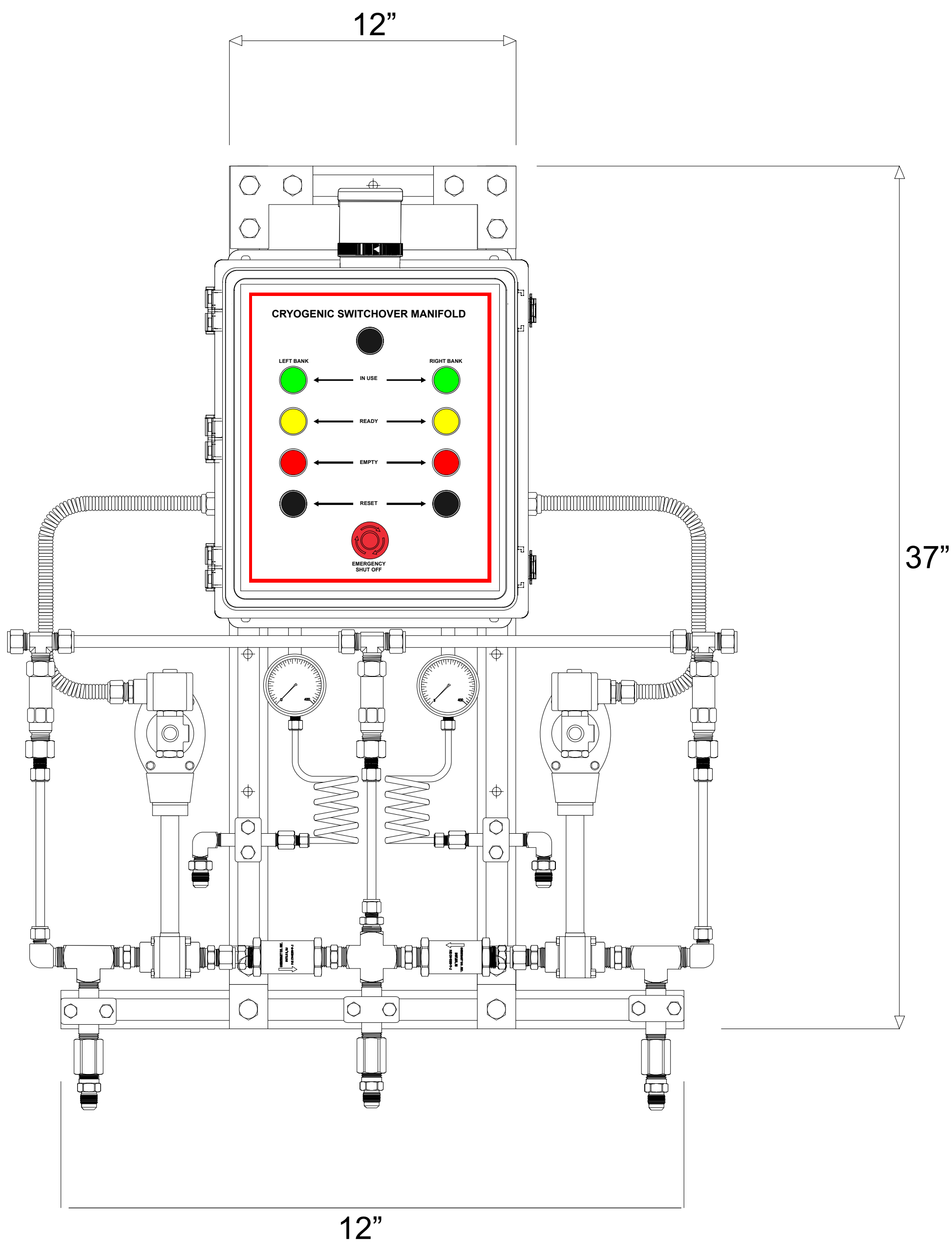
12 - Specifications

Fluids	Liquid Nitrogen, Liquid Argon, Liquid Oxygen, Liquid Carbon Dioxide, Liquid Nitrous Oxide
Maximum Inlet Pressure	350 PSIG (Standard) – 600 PSIG (Special Order)
Operating Temperature	-300ºF to 120ºF
Pressure Gauge Size	2-1/2” Dial
Inlet Connection	Liquid Nitrogen: CGA 295 ½” Flare 45º Male Liquid Argon: CGA 295 ½” Flare 45º Male Liquid Oxygen: CGA 440 ⅝” Flare 45º Male
Outlet Connection	Liquid Nitrogen: CGA 295 ½” Flare 45º Male Liquid Argon: CGA 295 ½” Flare 45º Male Liquid Oxygen: CGA 440 ⅝” Flare 45º Male
Pressure Relief Valve Outlet Connection	½” Compression (Stainless Steel)
Audible and Visual Alarm	Standard
Header	1/2” Nominal Pipe Size
Power Requirement	Manifold Controller: 24 VAC, 6 Amp.
Alarm Signal	Dry Contact Normally Open, 30 Amp, MTBA: 5 million operations
Power Transformer	Primary: 110 VAC – Secondary: 24 VAC – Single Phase – 6 Amp.

13 - Standard Factory Pressure Settings

Inlet Pressure Gauge	0-400 PSIG (Standard) / 0-600 PSIG (Special Order)
Switchover Pressure	Field Adjustable from 10-150 PSIG (Factory Setting is Written on the Name Tag)
Alarm Set Point (Both Banks)	Same as Switchover Pressure
Pressure Relief Valve	400 PSI (Standard) / 600 PSI (Special Order)

14 - Dimensions



15 - Standard Specifications

Name Tag

Each piece of equipment bears a name tag which provides important information about:

- Gas service
- Alarm set points
- Pressure settings
- Year of manufacture
- Project number

16 - Oxygen Service Equipment

All oxygen and nitrous oxide service equipment made by BeaconMedæs is cleaned as per the requirements of CGA G-4.1-1996.

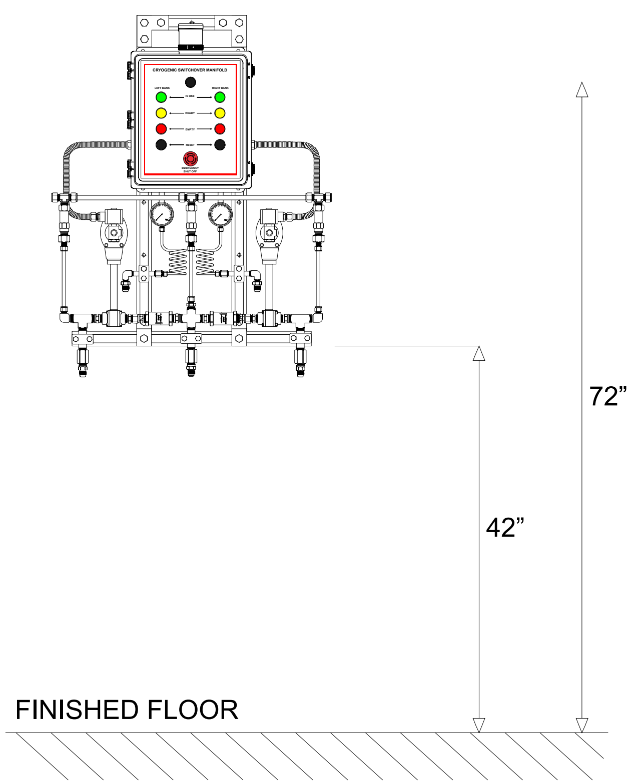
CAUTION

Remove all protective caps prior to assembly.

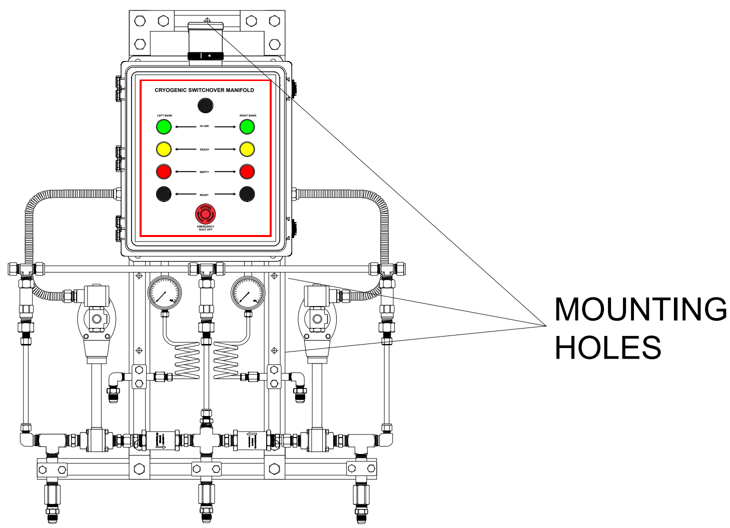
The protective cap may ignite due to heat of recompression in an oxygen system.

17 - Mechanical Installation

1. **Recommended Height** – The manifold box height should be such to have the silence push button at 72” from the finished floor (see figure below).

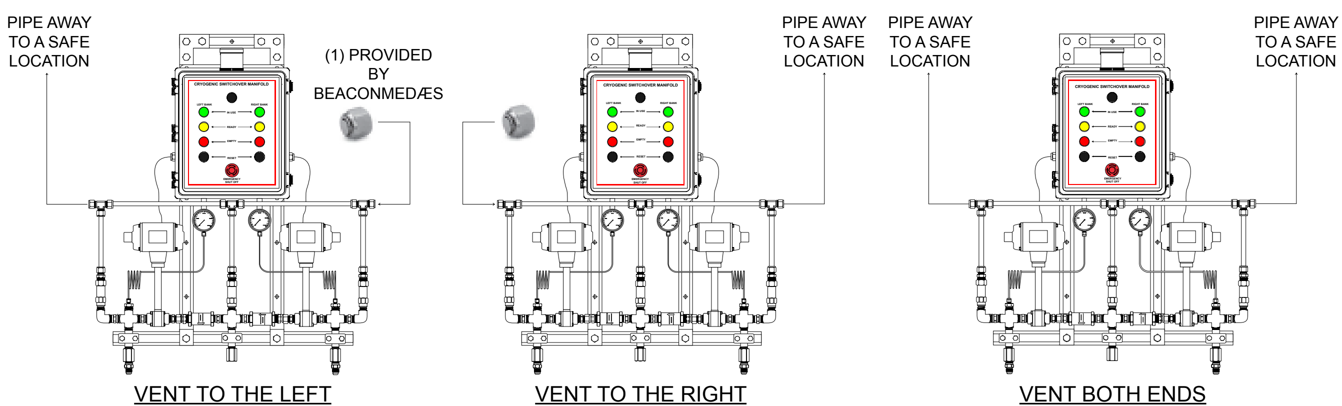


2. **Installing the manifold box** – The manifold box must be secured to a solid wall. The installer is responsible to select the proper hardware for this installation. Please note that the manifold box weighs about 60 lbs without the hoses (proper backing might be required). We do not recommend installing this manifold to walls constructed from drywall as cryogenic manifolds generate a fair amount of moisture that can damage that kind of building material. The materials supporting the manifold must be water resistant. Several holes have been made at the factory into the aluminum mounting frame for ease of installation (drill some more holes wherever it is convenient for you). Attach the manifold directly to the wall. Do not take apart any components that are attached to the mounting frame.



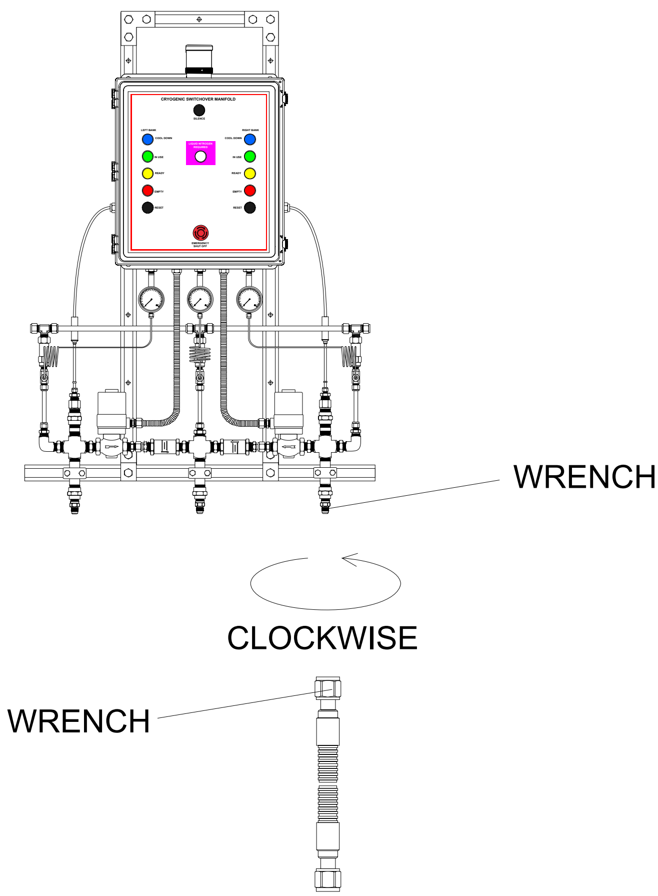
3. **Pressure Relief Valves**– There are three (3) thermal expansion pressure relief valves (aka PRV's) on the manifold. The three (3) pressure relief valves are manifolded together. The PRV's must be piped to a safe location. There are two (2) outlets to the PRV manifold. Each outlet connection is ½" compression in stainless steel. You can connect either outlet or both as shown below. The piping dedicated to the PRV must follow the following specification:

   a. The vent pipeline must not create flow restriction or back pressure
   b. Do not install any valves downstream of the PRV outlet.
   c. Make sure the pipeline outlet will not collect water or cannot be obstructed by insects, debris or ice.
   d. The vent pipeline discharge must be located so that people and buildings in the surrounding area will not be affected in any way.

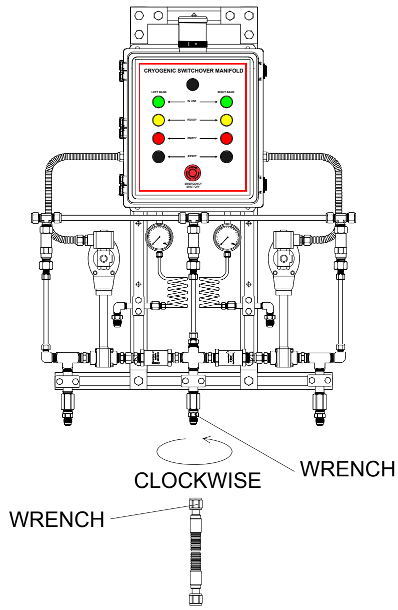


Typical Relief Valve Connections (Model Shown: CFAM-PX)

4. **Cryogenic Liquid Inlet Hoses**– Your manifold comes standard with four hoses: two (2) hoses. The hoses have to be connected in the field. Unless otherwise specified, the hoses have the same inlet and outlet connection and there is no check valve (so either end can be connected to the manifold inlet). There are two (2) inlets to the manifold: left bank and right bank. The connection located in the middle of the manifold at the bottom is the outlet. The manifold inlet is flared male and the hose ends are both flared female swivel. The thread type is specific for the fluid service as specified in Section 10 of this manual. To connect the hoses to the manifold inlets, simply screw the swivel part of the hoses into the male fixed inlets of the manifold. Then, using two (2) wrenches firmly tighten the connection (see schematic below for details). THESE TWO HOSES WILL BE CONNECTED TO THE LIQUID USE VALVES OF THEIR RESPECTIVE LIQUID CYLINDERS.



5. **Cryogenic Liquid Outlet Connection** – The cryogenic liquid outlet is located in the middle piping pointing down between the two inlets. The outlet connection is the same CGA fitting as the inlets which is either CGA 295, CGA 320 or CGA 440. These CGA adaptors allow for cryogenic hose installation. This fitting can be removed in the field to become ½” F.NPT for hard piping.



HOSE INSTALLATION

Hose Installation - The picture above shows the installation of a cryogenic hose as an outlet conduit. To connect the hose to the manifold outlet, simply screw the swivel part of the hose into the male fixed outlet of the manifold. Then, with two (2) wrenches, firmly tighten the connection (see schematic above for details).

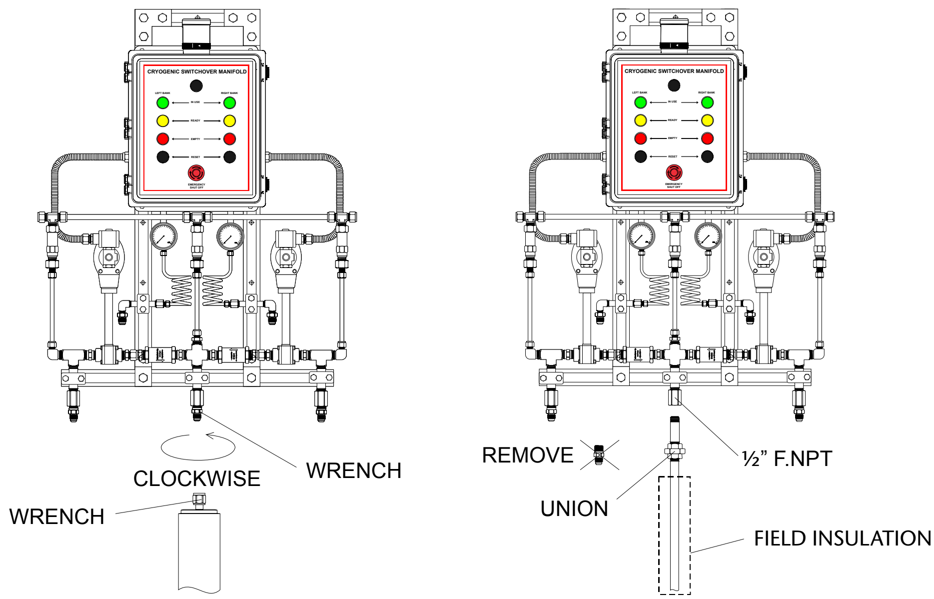
ABOUT CRYOGENIC HOSES

There are two types of cryogenic hoses: vacuum insulated and standard liquid transfer hoses (not vacuum insulated).

Vacuum Jacketed Hoses - The vacuum insulated hose is the by far the best hose to prevent heat loss and avoid ice accumulation. It consists of a corrugated metal hose surrounded by another flexible metal jacket. The space between the metal jacket and the corrugated metal hose is called the annular space. A vacuum has been pulled in the annular space which greatly minimizes the heat transfer between the cryogen in the hose and the outer ambient air.

Liquid Transfer Hoses - The non-vacuum-insulated hose is a corrugated metal hose surrounded by a braid of stainless steel. Most hoses come with a metal shroud called “armor-guard”. The ends are normally flare swivel nuts that are related to the gas service. That type of hose is designed to transfer cryogens. But, because this hose is not insulated, there will be heat transfer between the hose and the ambient air resulting in ice build-up along the hose. This ice build-up is normal and cannot be prevented.

Cryogenic Liquid Outlet Connection – Similar to hoses, rigid piping can be vacuum insulated or not vacuum insulated. Whether you install one style versus the other, it is important to have a union of some sort (either flare, compression or other style) between the manifold and the greater portion of the rigid pipe. The installer must be thoroughly trained in the installation of cryogenic piping not only for proper installation technique but also for proper material selection. This manual is not about cryogenic piping installation. This manual is about the installation and operation of the CFAM-PX fully automatic switchover manifold. The illustration below shows the minimum requirements to properly install a rigid pipe to the manifold outlet.



VJ PIPING INSTALLATION **HARD PIPING INSTALLATION**

Vacuum Jacketed (VJ) Piping Installation - The left side of the picture above shows the installation of a VJ pipe as an outlet conduit. To connect the VJ pipe to the manifold outlet, simply screw the swivel part of the hoses into male fixed inlets of the manifold. Then, with two (2) wrenches, firmly tighten the connection (see schematic above for details).

Hard Piping Installation - The left side of the picture above shows the installation of a hard pipe as an outlet conduit. As mentioned previously, it is imperative to install a union capable of supporting both pressure and temperature of the cryogen. Furthermore, the installer is responsible to insure the cleanliness and the compatibility of the materials used for the cryogenic distribution piping. We strongly recommend insulating the piping to prevent ice build up. Field insulation is serious business and should be made only by qualified professionals.

Recommendations and Technical Tips

The following recommendations apply for piping and any other parts connected to this manifold or piping system:

- Ice build-up could be very significant. It will add weight to the piping and proper support must be considered. Ice build-up can also damage the piping itself and adjacent structures such as walls, water pipes and electrical conduits. Finally, ice will melt when the piping is not in use. Water management must be considered.
- The selection of the insulating materials is important. The insulation must be capable of withstand cryogenic temperatures without cracking or breaking. The insulation must be water-tight so that moisture cannot find its way between the pipe and the insulation.
- The insulation itself must be protected from falling objects and mechanical impacts. Finally, and it is particularly important for oxygen service piping, the insulation material must be compatible with cryogen in service in case of a leak. For example, a foam insulated piping made out of urethane foam can burst into flames if it is saturated with liquid oxygen. The fire or explosion resulting from this could be deadly and/or cause serious damages to buildings and adjacent structures.
- By definition, cryogens are extremely cold and it will have a great impact on the expansion and retraction of the conduit itself. The piping material must be capable to mechanically resist to this movement. The pipe supports and clamps must allow the conduit to move.
- The selection of all materials in contact with the cryogen is of paramount importance. Carbon steel must be avoided at all cost anywhere in the system. Soft tubing even if it is in Teflon must not be used as a conduit. Rubber materials and rubber-like materials such as Viton, neoprene, Buna-N and EPDM must be avoided. For valve seals and seats, Teflon or reinforced Teflon (PCTFE) are the best materials. Finally, any valves, hoses or any other components must be rated and identified for cryogenic applications.
- DO NOT TRAP CRYOGENIC LIQUID IN A PIPE UNLESS PROTECTED BY A SAFETY RELIEF VALVE.

6. Nitrogen Supply to the Actuators – There are two (2) pressure actuated ball valves mounted to this manifold. The actuators require nitrogen to open and close. The nitrogen flow is controlled by two (2) three-way / two-position solenoid valves (one solenoid valve per actuator).

a. **<u>Supply Pressure</u>** - The actuators require a minimum pressure to operate. For this manifold, the pressure must be kept around 100 PSIG. The maximum pressure shall not exceed 125 PSI and shall not fall under 80 PSIG. Because the actuator models may vary upon the manifold model, please look at the name tag of the actuator. The nitrogen supply pressure must be midway between the minimum and maximum pressure inscribed on the actuator name tag. In all cases, the actuators must be protected by a safety relief valve to make sure the pressure will not exceed the maximum working pressure of the actuator.

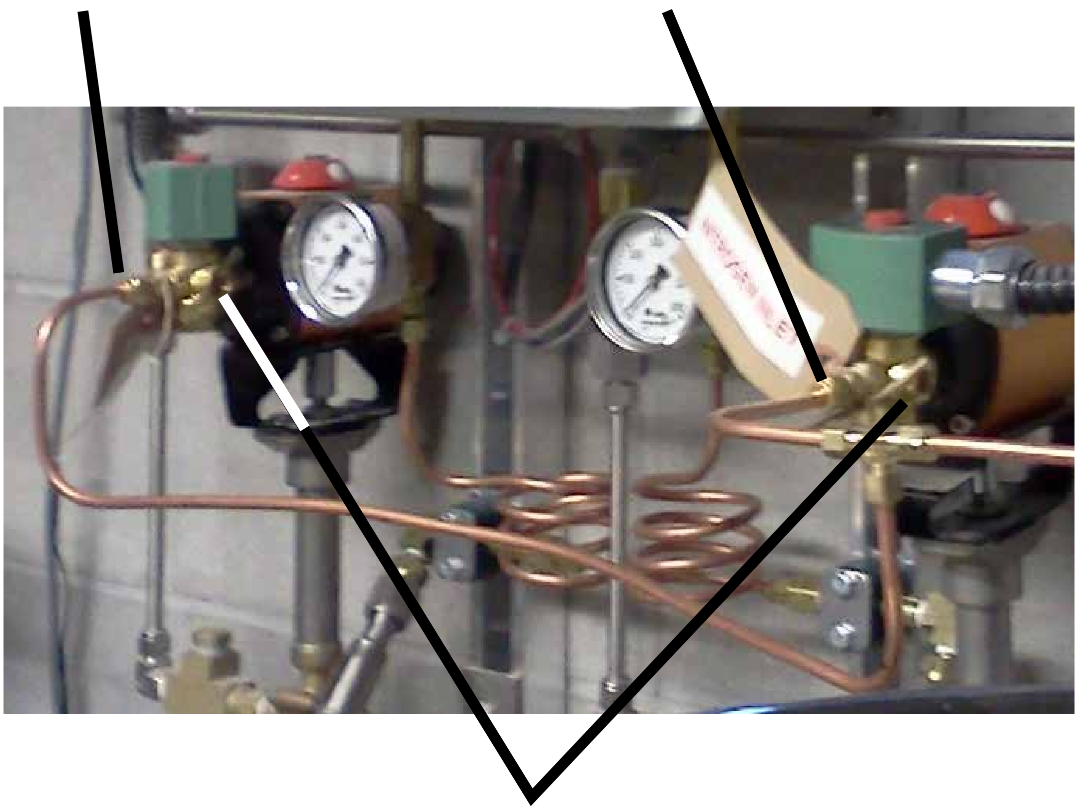
b. **<u>Inlet Connection</u>** – The inlet connection of each solenoid valve is ¼” compression (brass). This fitting (called a male connector) can be removed to expose the ¼” F.NPT inlet of the solenoid valve.

c. **<u>Connecting the Solenoid Valves Together</u>** – The solenoid valves can be connected together to a single source of nitrogen. The solenoid valves can also be supplied by independent sources of nitrogen. In any cases, the installer is responsible to perform the field installation and supply proper hardware.

d. **<u>Solenoid Valve Exhausts</u>** – Each solenoid valve has an exhaust port (1/4” F.NPT). This port is used to empty the actuator. This port must remain open to atmosphere (no plugs, no restrictions of any kind). There is not enough nitrogen in the actuator to change the level of oxygen in a room (even if the room is small).

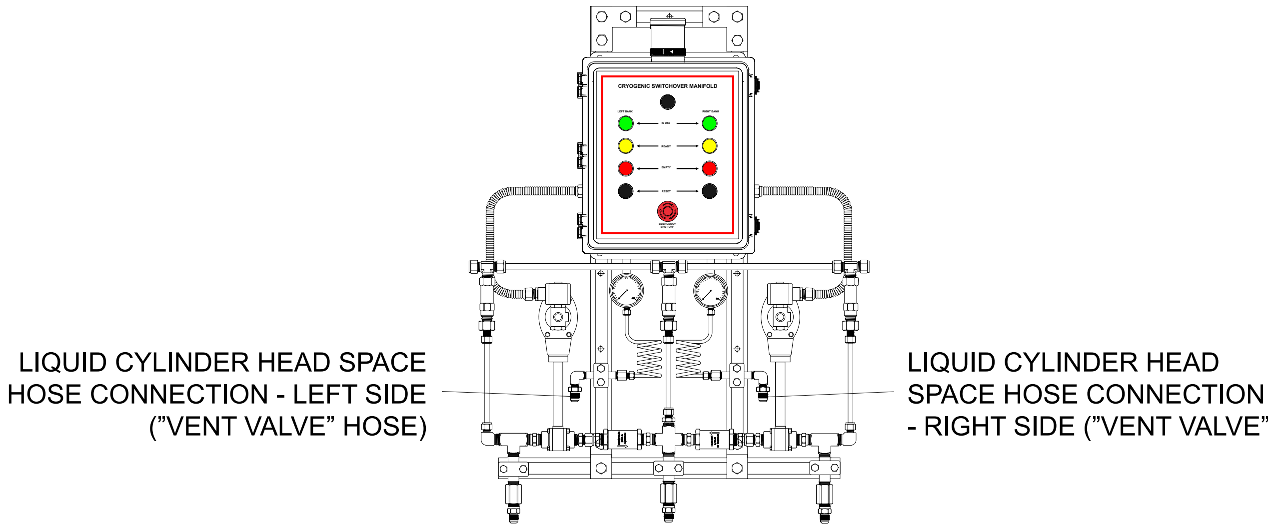
NITROGEN INLET
LEFT SOLENOID VALVE

NITROGEN INLET
RIGHT SOLENOID VALVE



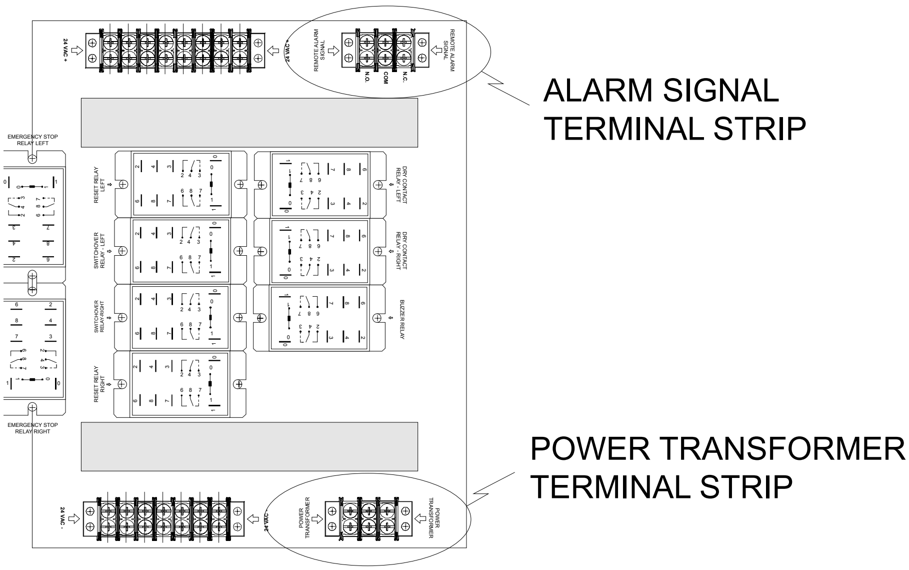
EXHAUSTS
DO NOT OBSTRUCT OR PLUG

7. **Liquid Cylinder Head space Hoses (Labeled “VENT VALVE”)** – The switchover process of this manifold is triggered by the pressure of each liquid cylinder. You have to use the two (2) hoses labeled “VENT VALVE” for this section of the manual.



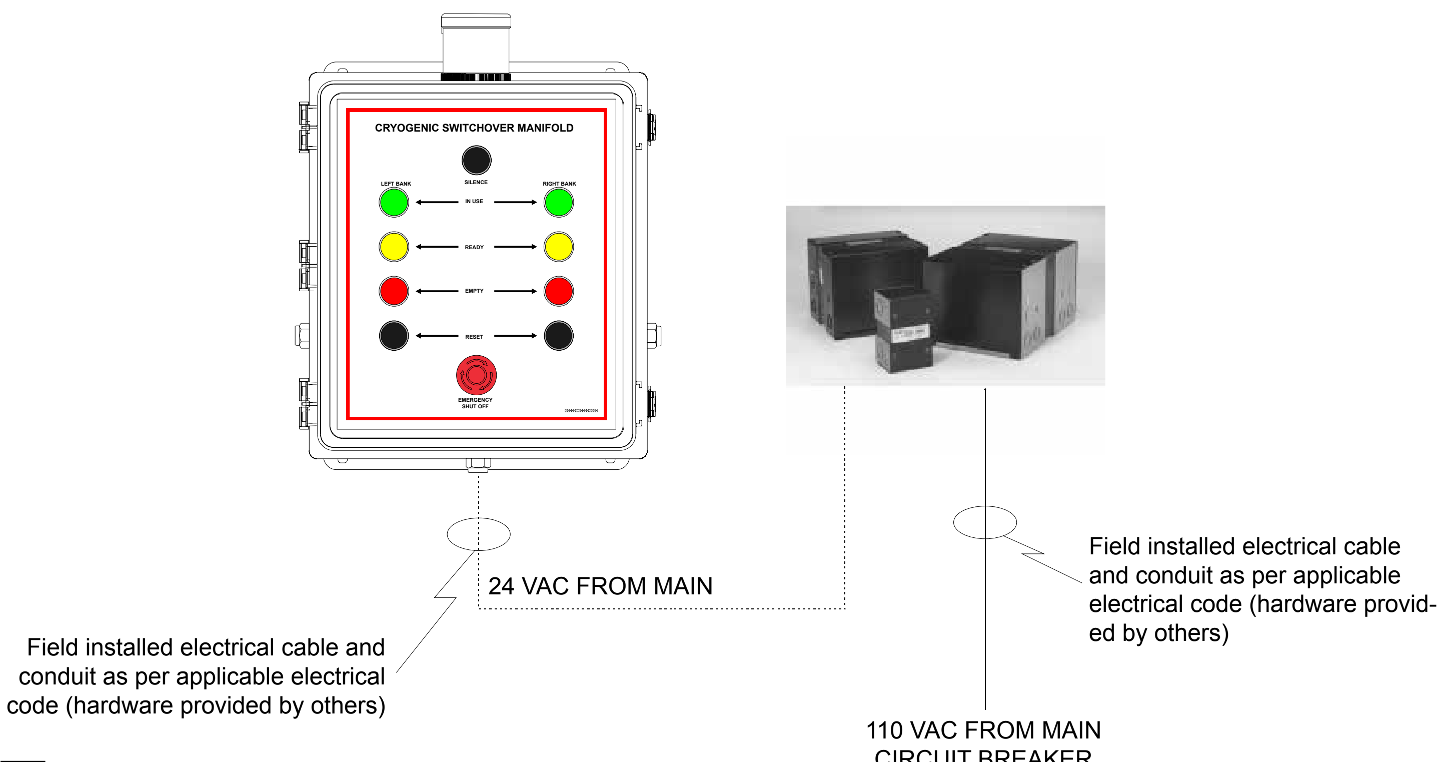
The picture below shows the installation of the “vent valve” hoses to their respective side. To connect the hose to the head space fitting, simply screw the swivel part of the hoses into male fixed inlets of the manifold. Then, with two (2) wrenches, firmly tighten the connection (see schematic above for details).

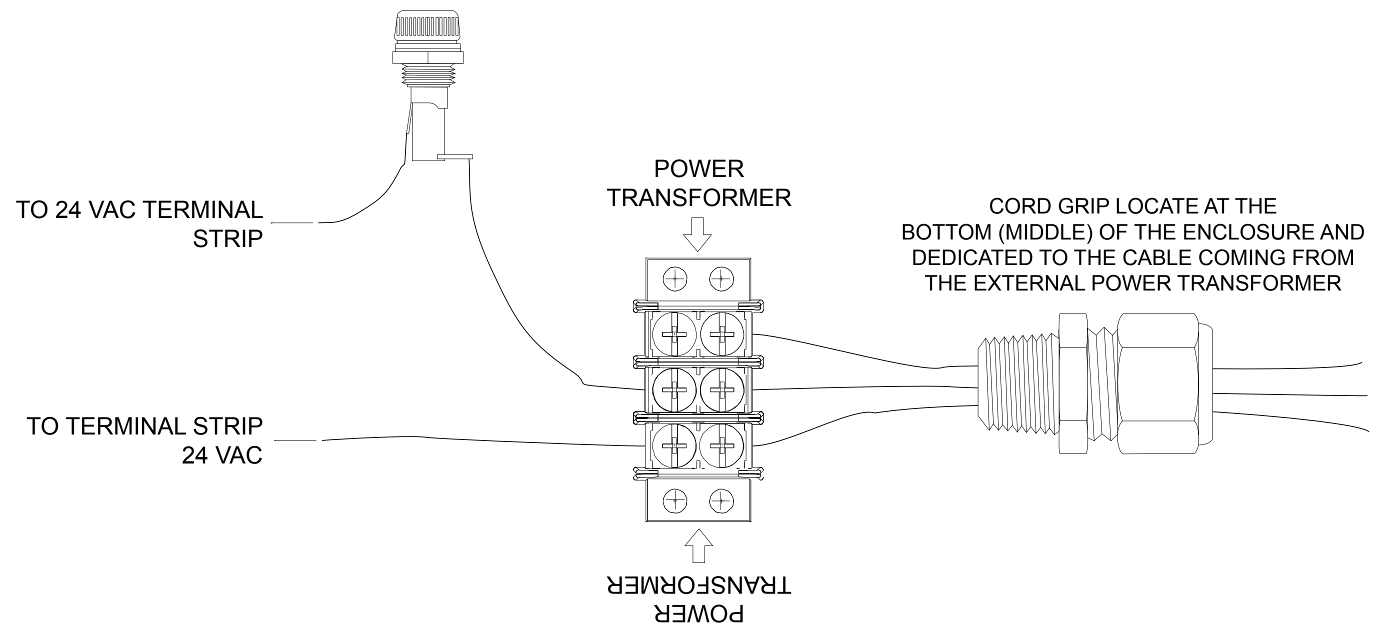
18 - Electrical Installation

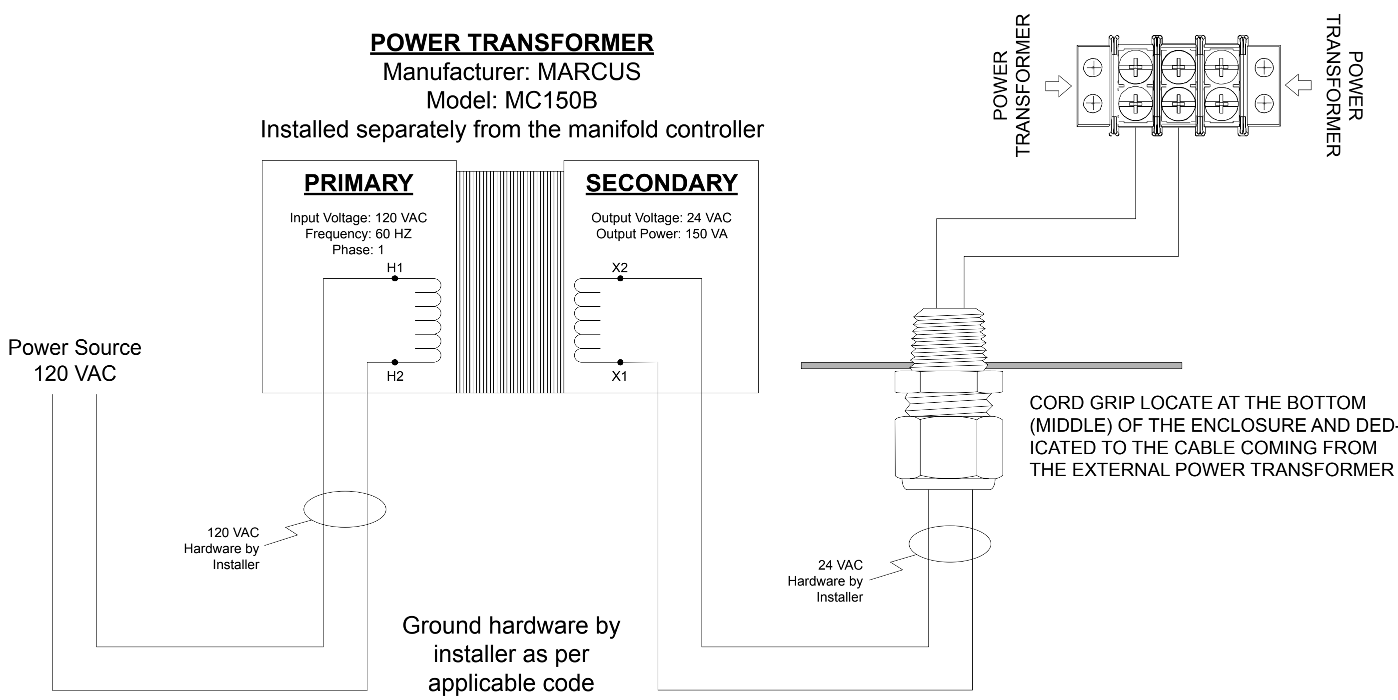


There are two (2) possible electrical connections that can be performed in the field: power supply and the remote alarm signal.

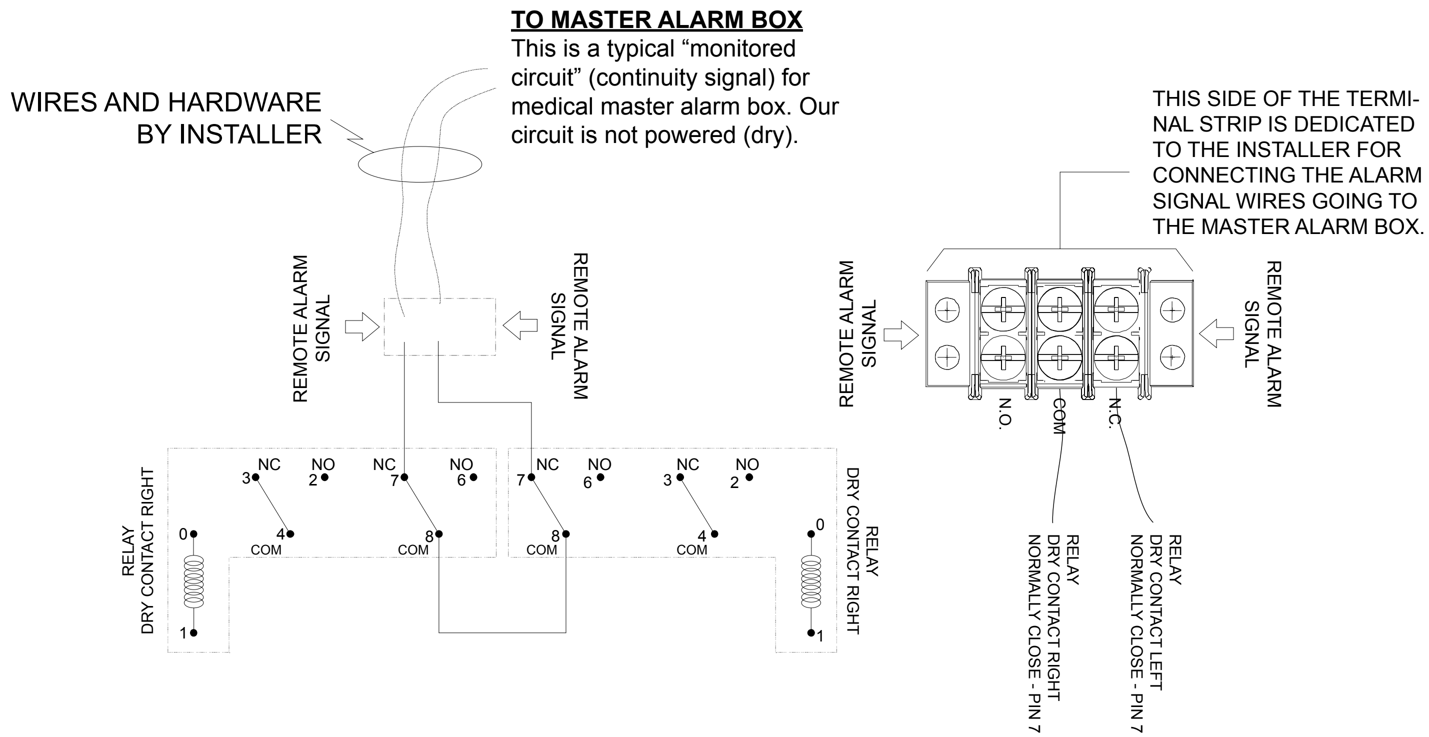
<u>Connecting the 24 VAC Power Supply</u>: The control module requires 24 VAC to operate. The power consumption is maximum 6 Amp. at 24 VAC. The power transformer is supplied with your manifold but it is separate from the manifold itself. It has to be field installed. This power transformer must be installed inside a building (NEMA 1 rated). The terminals where the 24 VAC wires go are shown on the diagram in the next page. The hardware required - wires, conduits and related accessories - to connect the power transformer to the control module are to be supplied by others.







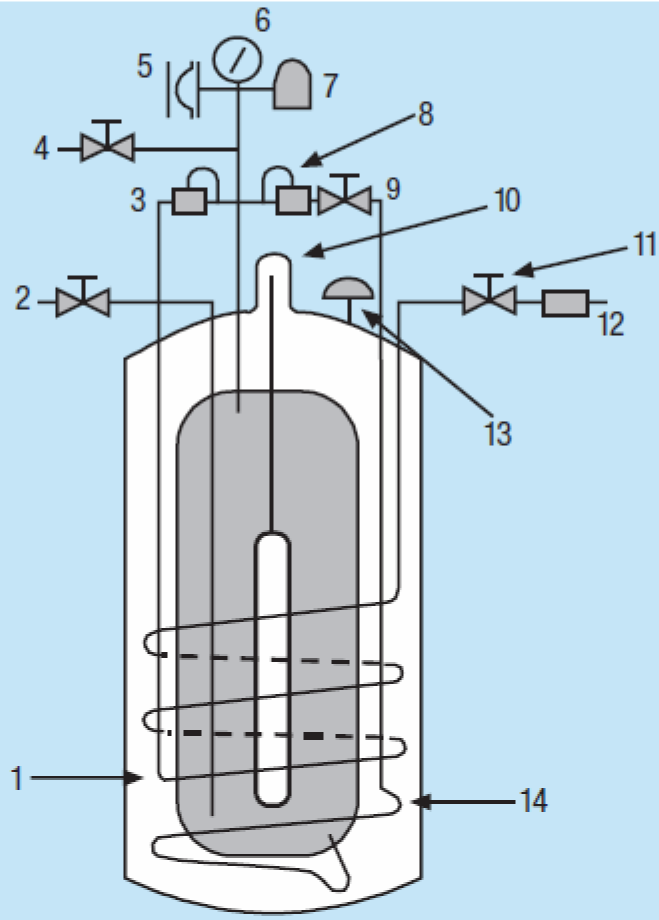
Remote Alarm Connection: The remote alarm signal (to a master alarm box for example) is a dry contact. The CFAM-PX manifold has one (1) N.O., one (1) N.C. and one (1) COM contacts. The SPDT relay will change position when either bank is empty (i.e. when a switchover has occurred). The terminals where the remote alarm connection has to be made are indicated below. The wire size has to be determined by the installer.

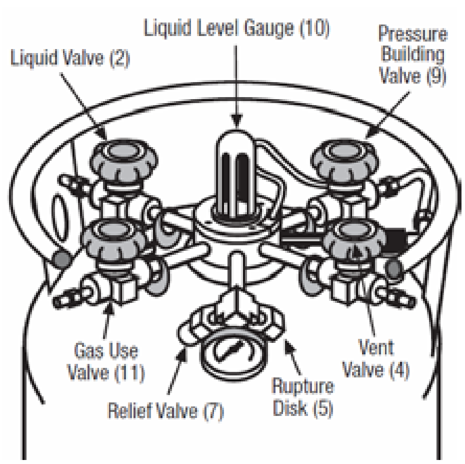

TO MASTER ALARM BOX
This is a typical "monitored circuit" (continuity signal) for medical master alarm box. Our circuit is not powered (dry).
WIRES AND HARDWARE BY INSTALLER
THIS SIDE OF THE TERMINAL STRIP IS DEDICATED TO THE INSTALLER FOR CONNECTING THE ALARM SIGNAL WIRES GOING TO THE MASTER ALARM BOX.
REMOTE ALARM SIGNAL
REMOTE ALARM SIGNAL
REMOTE ALARM SIGNAL
REMOTE ALARM SIGNAL
N.O.
COM
N.C.
RELAY DRY CONTACT RIGHT
RELAY DRY CONTACT RIGHT
RELAY DRY CONTACT RIGHT NORMALLY CLOSE - PIN 7
RELAY DRY CONTACT LEFT NORMALLY CLOSE - PIN 7
NC
NO
COM

19 - How a Liquid Cylinder Works

This part of the manual is dedicated to explain how a liquid cylinder works in conjunction with the CFAM-PX fully automatic cryogenic switchover manifold. Should you require more details and explanations about cryogenic liquid cylinders, please consult your gas supplier.

1. Gas withdrawal vaporizer
2. Liquid withdrawal valve
3. Economizer regulator
4. Vent valve
5. Inner tank rupture disk
6. Pressure gauge
7. Safety relief valve
8. Pressure building regulator
9. Pressure building valve
10. Liquid level gauge
11. Gas withdrawal valve and integral check valve
12. Check valve in house line
13. Outer tank rupture disk
14. Pressure building vaporizer





Liquid Withdrawal Valve (2) - Liquid product is withdrawn from the container through the connection controlled by this valve. It has a CGA connection specified for the appropriate cryogenic liquid. The cryogenic liquid feeding the CFAM-PX cryogenic switchover manifold is coming from this valve via a liquid transfer hose (labeled “LIQUID VALVE” hose). It is important to understand that both the Liquid Valve and the Vent Valve have the same CGA connection.

Vent Valve (4) - This valve controls a line into the vapor space of the container. It is primarily used in the fill process to vent the vapor space while filling and can be used to vent unwanted pressure during storage and use. When used with the CFAM-PX cryogenic manifold, the vent valve is used to monitor the liquid cylinder pressure by connecting a hose (labeled “Vent Valve” hose) from the vent valve directly its related pressure gauge and pressure switch.

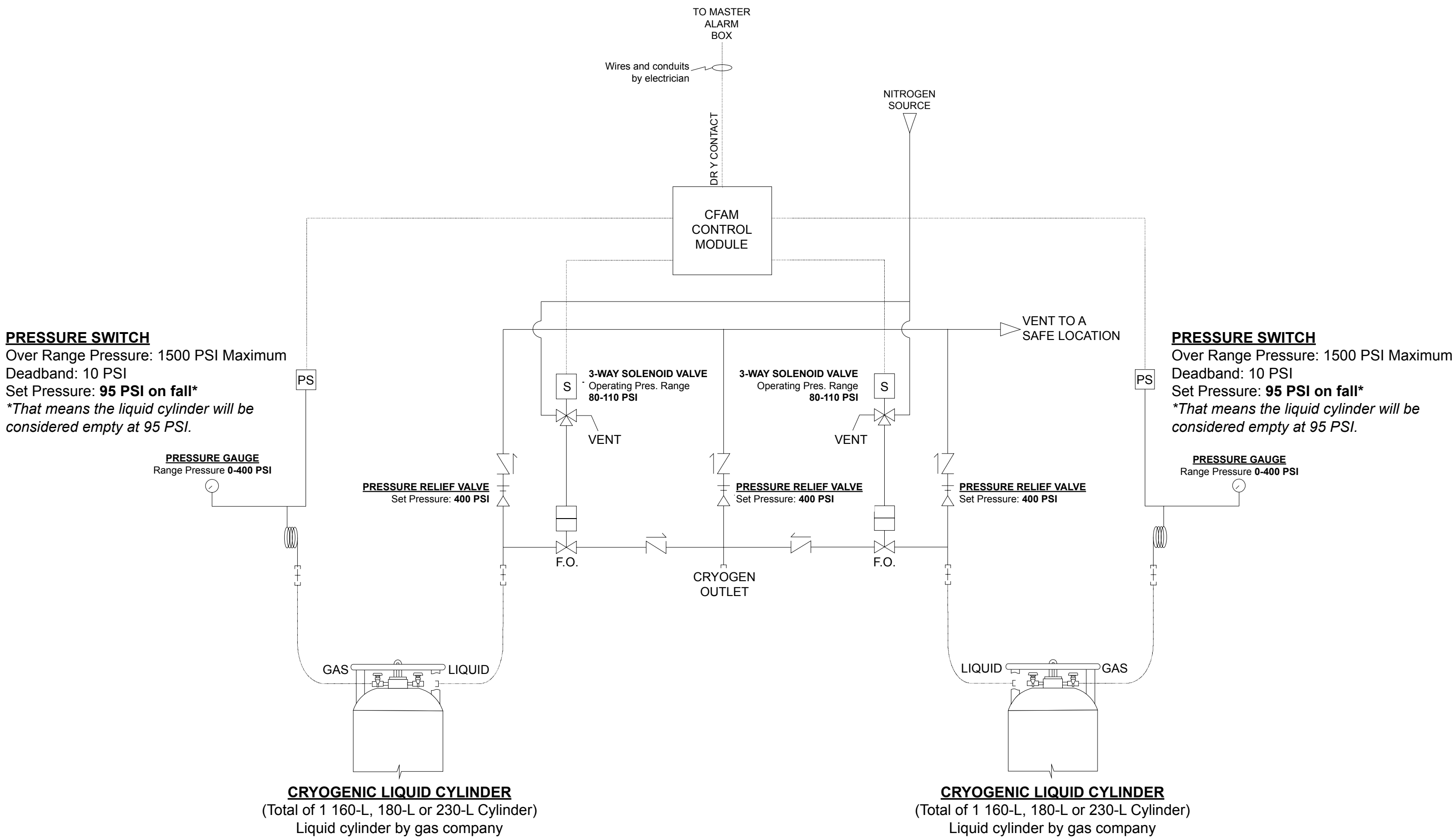
Relief Devices (5) and (7) - To protect the container from over-pressurization, it is equipped with two relief devices. The first is a reseating spring-loaded relief valve that, depending on the setting, will relieve pressure at 22 psig, 230 psig, or 350 psig. The second is a burst disk rated to protect the inner vessel. Never plug, restrict, or remove any relief device. Never attempt to cap or seal a venting relief device in anyway. Notify your supplier about any container that continuously vents through any of the relief devices.

Pressure Build / Economizer Valve (9) - When the head pressure is near the relief setting, an economizer circuit preferentially directs gas from the vapor space to the gas use valve when it is open. This minimizes the loss of gas to over-pressurization and venting. Excess pressure in the vapor space of the container is relieved to the gas use valve outlet while preserving normal operating pressure. The economizer requires no operator attention and will function automatically. Reversely, the pressure building circuit is used to create sufficient operating pressure. It is controlled by a regulator that opens to allow liquid to flow from the bottom of the container, through a vaporizer, where it becomes a gas. The gas then collects in the vapor space at the top of the container. The vaporization of the liquid into gas increases the pressure in the container. In most liquid cylinders, the pressure building circuit and the economizer is open or closed by a common and single valve.

Gas Use Valve (11) – This valve allows gaseous product withdrawal through the internal vaporizer and/or the economizer. It has the recommended Compressed Gas Association (CGA) connection that matches the gas service for which the container is configured. In some applications, BeaconMedæs recommends to connect a secondary gas supply source (aka “Pusher”) that will be used to maintain the liquid cylinder gas pressure to an acceptable level in the eventuality the internal pressure build device cannot cope with the flow of cryogen coming out of the liquid cylinder. The external pusher would then be connected to the “Gas Use Valve”. In that case, a specially designed hose (completely different from the “Liquid Valve” hose and “Vent Valve” hose) is provided.

Liquid Level Gauge (10) - This is a float-type liquid level gauge. This is used to indicate the approximate amount of container contents. This indicator is often defective as it is a fairly sensitive device. Therefore, it is not always a good indication of how much liquid is left in the cylinder.

20 - Theory of Operation



GENERAL INFORMATION

This section concentrates on the basic theory of the components of this fully automatic switchover manifold.

IMPORTANT COMPONENTS

The manifold control unit includes the following components and features:

Status Devices and Push buttons:

- Green LED	"In Service"	(one per bank)
- Yellow LED	"Ready for Use"	(one per bank)
- Red LED	"Bank Depleted"	(one per bank)
- Clear LED	"On/Off"	(one for the entire manifold)
- Buzzer	"Empty Cylinder"	(one for the entire manifold)
- Silence Push button		(one for the entire manifold)
- Reset Push button	"Reset"	(one per bank)
- Emergency Push button		(one for the entire manifold)

Wetted Parts:

- Analog Cylinder Pressure Gauge	(one per bank)
- Thermal Expansion Pressure Relief Valve	(one per bank and one for the outlet)
- Fail open cryogenic ball valve	(one per bank)
- Pressure Switch	(one per bank)
- Liquid Valve Hose	(one per bank)
- Vent Valve Hose	(one per bank)

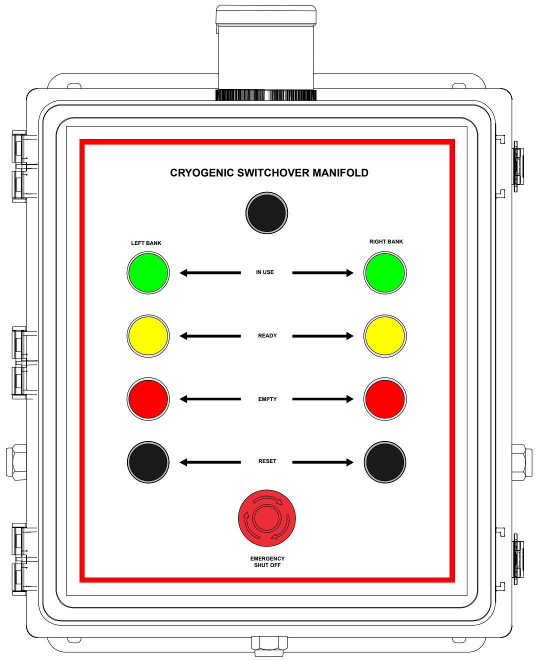
MANIFOLD OPERATION

The automatic switchover manifold consists of a manifold box, a control module and two supply banks: one service and one reserve supply, to provide an uninterrupted supply of cryogenic liquid.

After initial power-up and with both banks empty, the red lights will be illuminated. The bank that is pressurized first will be considered the “in service” bank. The cylinder bank that supplies the piping system is known as the “Service” supply (as indicated by the green “In Use“ light), while the cylinder bank on stand-by is referred to as the “Secondary” supply (as indicated by the yellow “Ready” light). On the service bank, the cryogenic liquid flows into the “Liquid Valve” hose before entering into the nitrogen actuated ball valve. The cryogen then goes across the check valve before leaving the manifold through the cryogenic outlet. The liquid cylinder pressure is sensed by a pressure switch located inside the manifold control box. The operator can see the liquid cylinder pressure via a pressure gauge located right under the manifold control box. The pressure switch and the pressure gauge read the pressure directly from the gas head space of the liquid cylinder via a second hose directly connected to the “Vent Valve” of the liquid cylinder.

The cryogen on the secondary bank flows into the “Liquid Valve” hose and stops at the nitrogen actuated ball valve. The pressure of the secondary bank is sensed by a second set of pressure switch and pressure gauge which are connected directly to the liquid cylinder head space via a second “Vent Valve” hose. Since this is the secondary bank, the valve is closed, preventing the secondary bank from flowing. Switchover from the “Service” to “Secondary” side is accomplished when the service pressure drops below a predetermined point (this switchover pressure is determined by the pressure switch setting). The control module then signals the secondary bank solenoid to open, allowing it to start flowing cryogen without any interruption in the pipeline supply. There are three definite indicators as to which bank should be replenished; (1) the red “Bank Depleted” light, (2) the cylinder bank pressure readout (gauge) and (3) both the green light and the yellow light of the depleted side are extinguished.

Each time a fresh liquid cylinder has been installed and properly connected, the operator is required to push the reset pushbutton signifying the manifold controller that a fresh liquid cylinder has been put into service and it is ready for use.



DESCRIPTION OF VISUAL AND AUDIBLE SIGNALS AND PURPOSE OF PUSH BUTTONS

BUZZER	• The buzzer is actuated when a liquid cylinder becomes empty (i.e. when a red light is lit). • If a red light is already lit while the second red light comes on, the buzzer WILL NOT come on again. • The buzzer can be silenced by pushing the silence push button.
SILENCE PUSH BUTTON	• The silence push button kills the buzzer when pressed. • The red lights do not extinguish when the push button is pushed.
RED LIGHT (EMPTY)	• A red light indicates a low pressure that can be caused by one of the following conditions: - a depleted liquid cylinder - a closed pressure building valve (the liquid cylinder may or may not be empty) - a closed vent valve (the liquid cylinder may or may not be empty) - the liquid withdrawal was such that the pressure of the liquid cylinder dropped below the pressure switch set point.
YELLOW LIGHT (READY)	• A yellow light indicates that the liquid cylinder pressure is adequate but the liquid cylinder on that manifold side is not in service. • Both yellow lights (one per bank) cannot be lit at the same time.
GREEN LIGHT (EMPTY)	• A green light indicates that the liquid cylinder pressure is adequate and its respective valve is open (cryogenic liquid is feeding from that bank). • Both green lights (one per bank) cannot be lit at the same time. • Furthermore, a green light and a yellow light cannot be lit at the same time on the same bank side.
RESET PUSH BUTTON	• The purpose of the reset pushbutton is to indicate to the manifold controller that a fresh liquid cylinder has been installed and it is ready to be put into service. • If the reset push button is not pushed even if all hoses are connected, valves are open and the pressure is satisfactory, the manifold will not use this new liquid cylinder. In that situation, all lights of that manifold side will be extinguished signifying to the operator that the reset push button has to be pushed.
EMERGENCY STOP	• The emergency stop is directly connected to the solenoid valves that operate the nitrogen actuated ball valves. • When pushed, both actuators will be filled and both nitrogen actuated ball valves will close which will automatically stop the supply of cryogenic liquid to the pipeline. • Consequently, the emergency stop, when pushed, will energize (light) both red lights. • The emergency stop pushbutton DOES NOT cancel any yellow or green lights. • To cancel the emergency stop button, simply pull and turn the emergency push button. The flow of cryogenic liquid will come from the bank having a green light lit (if any).

21 - Putting a Liquid Cylinder into Service

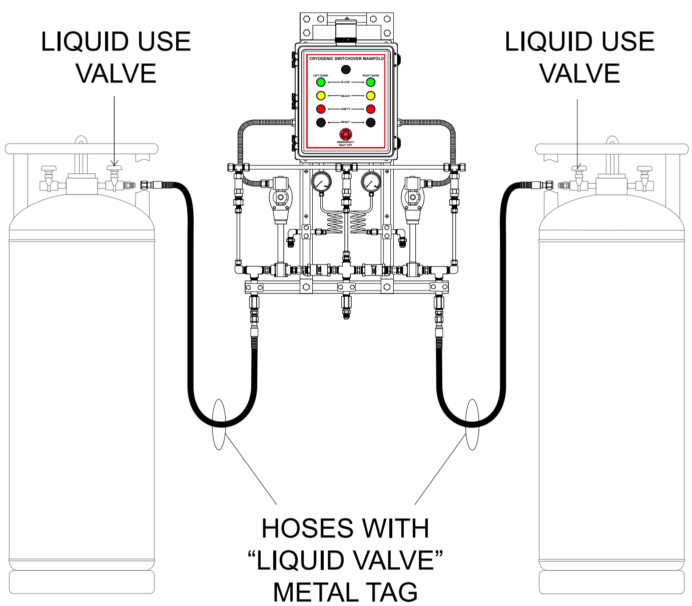
Four hoses are normally provided with the CFAM-PX manifolds: two (2) hoses labeled “Liquid Valve” (one per liquid cylinder) and two (2) hoses labeled “Vent Valve” (one per liquid cylinder). This section of the manual is to provide you with the proper instructions not only on how and where to connect the hoses to the liquid cylinders but also to give you important instruction on how to put a liquid cylinder into service. This section of the instruction manual assumes that the manifold has been properly installed.

CONNECTING THE “LIQUID VALVE” HOSE

The first hose to connect to the liquid cylinder is the “Liquid Valve” hose. The “Liquid Valve” hose bares a metal tag attached to its extremity. This hose has a stainless steel flare fitting female end, a stainless steel armor guard and is approximately 60”-72” long. This hose is similar to the “Vent Valve” hose. There are two things that differentiate the two hoses: the tag and where it is connected to the manifold. The “Liquid Valve” hose is connected to the inlets of the manifold located (see schematic below).

Procedure

1. Make sure that all valves on the liquid cylinder are closed (off)
2. Using gloves if the hose is cold tighten by hand the swivel flare female end of the “Liquid Valve” hose to the fixed male flare end of the “LIQUID USE” valve of the liquid cylinder.
3. Using two (2) wrenches tighten that same connection.

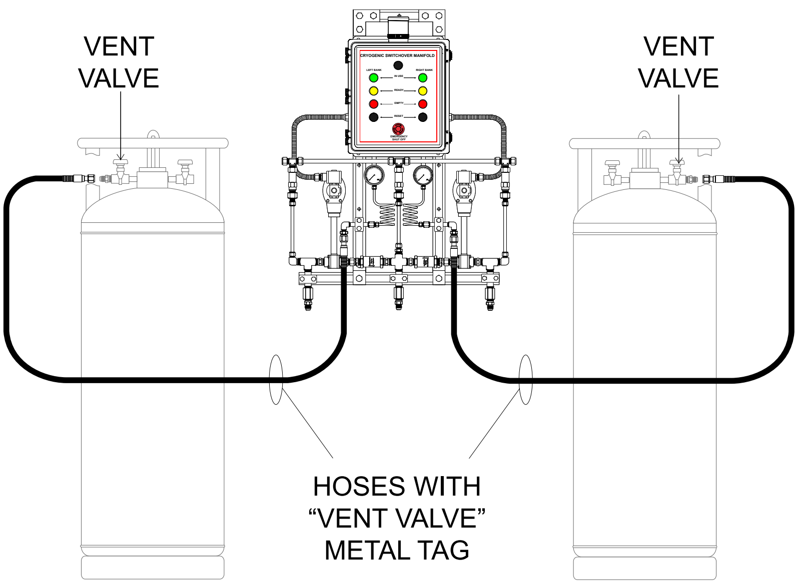


CONNECTING THE “VENT VALVE” HOSE

The second hose to connect to the liquid cylinder is the “Vent Valve” hose. The “Vent Valve” hose bares a metal tag attached to its extremity. This hose has a stainless steel flare fitting female end, a stainless steel armor guard and is approximately 60”-72” long. This hose is similar to the “Liquid Valve” hose. There are two things that differentiate the two hoses: the tag and where it is connected to the manifold. The “Vent Valve” hose is connected to the pressure gauges of the manifold located (see schematic below).

Procedure

4. Make sure that all valves on the liquid cylinder are closed (off)
5. Using gloves if the hose is cold tighten by hand the swivel flare female end of the “Liquid Valve” hose to the fixed male flare end of the “VENT” valve of the liquid cylinder.
6. Using two (2) wrenches tighten that same connection.



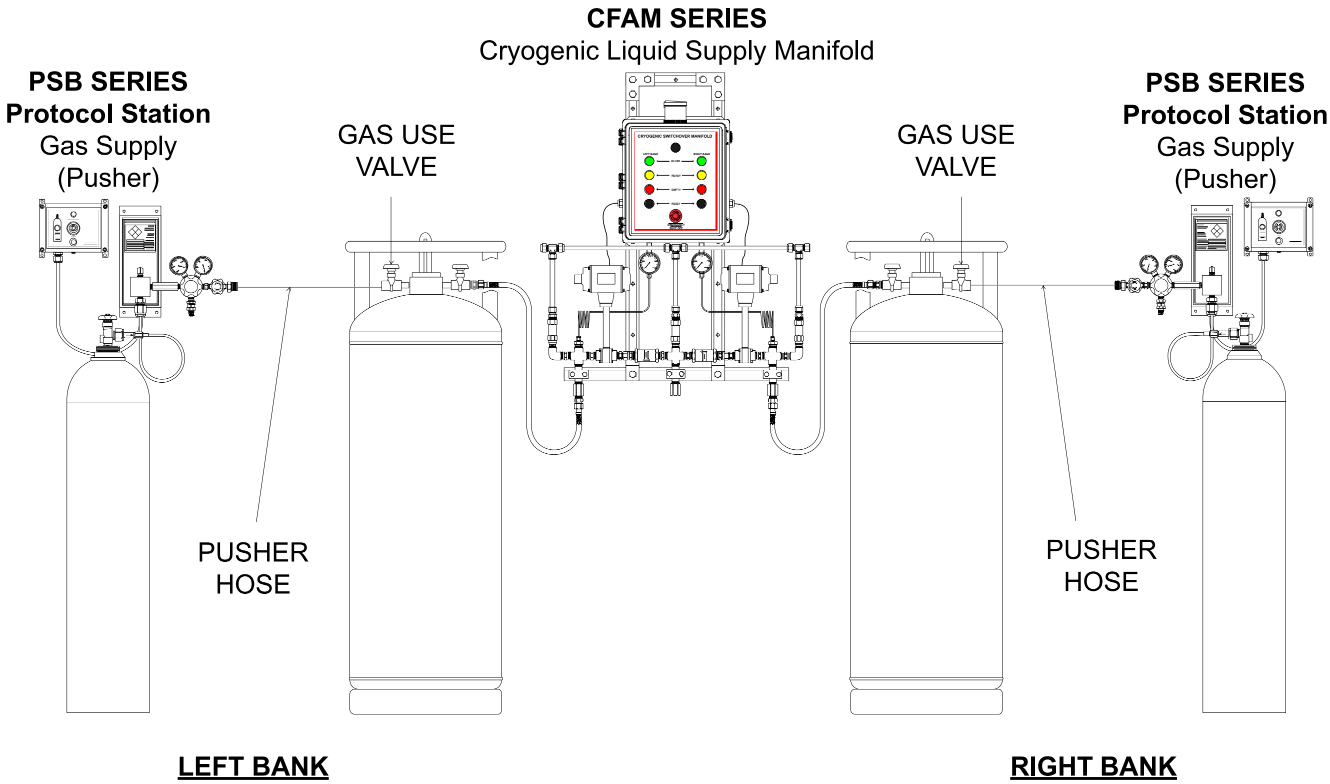
WHERE APPLICABLE - CONNECTING THE "PUSHER" HOSE

For some applications, a "pusher" hose must be connected to the liquid cylinder. As shown on the schematic below, the pusher is an external source of gas that maintains a minimum amount of pressure inside the liquid cylinder in the event that the pressure building circuit of the liquid cylinder can't keep up with the flow.

In that case, the third hose to connect to the liquid cylinder is the "Pusher" hose. The "Pusher" hose bares no tag. This hose is normally a medical type hose made for the specific service gas. It is also approximately 60"-72" long. The end connection of the hose (the one connecting to the liquid cylinder) is always of a different CGA of the liquid valve or vent valve and cross connection is therefore impossible. The "Pusher" hose is always connected to the "Gas Use" valve of the liquid cylinder. The "Pusher" hose is not connected to the cryogenic CFAM-PX manifold but rather is connected to another pressure reducing device such as a regulator or a protocol station.

Procedure

7. Make sure that all valves on the liquid cylinder are closed (off)
8. Using gloves if the hose is cold tighten by hand the CGA nut (swivel) of the "Pusher" hose to the fixed CGA end of the "GAS USE" valve of the liquid cylinder.
9. Using two (2) wrenches tighten that same connection.



OPENING VALVES AND RESETTING THE MANIFOLD

At this moment, all hoses are properly connected to the liquid cylinder. It is now time to put that liquid cylinder into service.

Procedure
(ALWAYS USE GLOVES – PREFERABLY CRYOGENIC GLOVES – WHEN TOUCHING COLD VALVES AND HOSES)

10. Open (turn on) the pressure building valve (9).
11. Open (turn on) the gas use valve (11). Check for leaks with Snoop (soapy solution) and check for bubbles. Depressurize and re-tighten. Check for leaks again.
12. Open (turn on) the vent valve (4). Check for leaks with Snoop (soapy solution) and check for bubbles. Depressurize and retighten. Check for leaks again. At this point, if the pressure of the liquid cylinder is above the empty set pressure of the pressure switch, there will be no light lit on the manifold controller (for the bank side you want to put into service). If the red light is still on, that means the pressure is not high enough inside the liquid cylinder. Give it a couple of minutes to allow the pressure building circuit to build the pressure). When the red light extinguishes, go to step 13.
13. Open (turn on) the liquid use valve (2). Check for leaks with Snoop (soapy solution) and check for bubbles. Depressurize and re-tighten. Check for leaks again. If the hose or the liquid cylinder is too cold, it is possible that the Snoop will freeze and bubbles will not appear. It that case, pay attention to hissing around the connection as it may indicate a leak. If it is the case, close the valve, depressurize and remake the connection.
14. Push the reset push button on the manifold controller for the bank side you want to put into service.
15. The system is now ready for use.

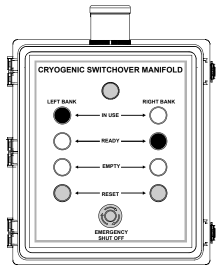
LIQUID CYLINDER CHANGEOUT

At this point in time, we consider that a red light is lit on the manifold and the liquid cylinder has to be replaced. Hereunder are the steps to follow (always use cryogenic gloves when handling cold equipment and valves – a face shield is required to disconnect the liquid hose – Step 23):

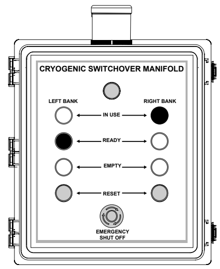
16. Close (turn off) the pressure building valve (9).
17. Close (turn off) the gas use valve (11).
18. Close (turn off) the vent valve (4)
19. Close (turn off) the liquid use valve (2).
20. If you are using a pusher, close (turn off) the supply valve of the source equipment for that pusher gas.
21. Using two (2) wrenches slowly disconnect the pusher hose from the gas use valve. Pressure will release from the connection you are breaking. Place the hose in a safe location.
22. Using two (2) wrenches slowly disconnect the “Vent Valve” hose from the vent valve. Pressure will release from the connection you are breaking. Place the hose in a safe location.
23. Using two (2) wrenches slowly disconnect the “Liquid Valve” hose from the liquid valve. Pressure will release from the connection you are breaking. In the unlikely event there is still some cryogenic liquid left in the hose, let the hose rest in place until the pressure is down to zero before disconnecting the hose from the liquid valve. Place the hose in a safe location.
24. Remove the empty cylinder.
25. Put a fresh liquid cylinder in place and start from Step 1.

22 - Message Center

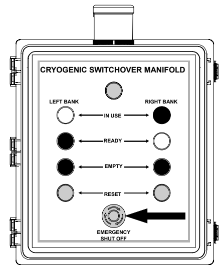
This section of the manual shows you all possible “light configurations” you can see with the CFAM-PX manifold. Please understand that the buzzer, when energized, can be killed by the silence pushbutton without extinguishing any red light.



LEFT BANK IN USE
RIGHT BANK READY

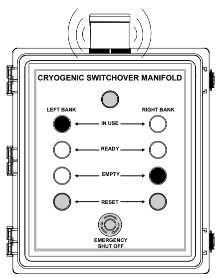


LEFT BANK READY
RIGHT BANK IN USE

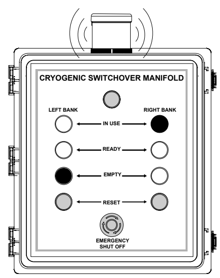


WHEN THE TWO RED LIGHTS ARE LIT ALONG WITH ANY OTHER LIGHTS LIT.

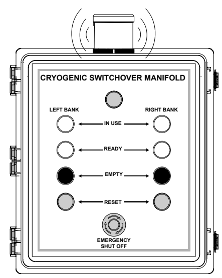
THIS MEANS THE EMERGENCY STOP PUSHBUTTON HAS BEEN ACTUATED



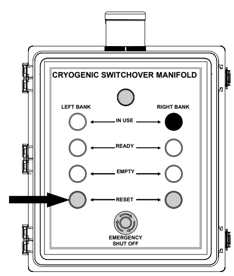
LEFT BANK IN USE
RIGHT BANK EMPTY
BUZZER ENERGIZED



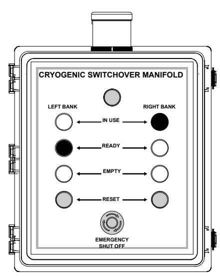
LEFT BANK EMPTY
RIGHT BANK IN USE
BUZZER ENERGIZED



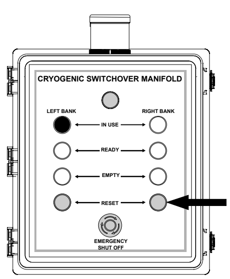
LEFT BANK EMPTY
RIGHT BANK EMPTY
BUZZER ENERGIZED



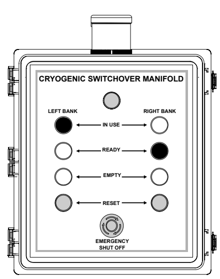
LEFT BANK PRESSURE IS OK
RIGHT BANK IN USE
PUSH RESET BUTTON LEFT BANK
TO PUT INTO SERVICE



LEFT BANK READY
RIGHT BANK IN USE
AFTER RESET BUTTON LEFT BANK
HAS BEEN PUSHED



LEFT BANK IN USE
RIGHT BANK PRESSURE IS OK
PUSH RESET BUTTON RIGHT BANK
TO PUT INTO SERVICE



LEFT BANK READY
RIGHT BANK IN USE
AFTER RESET BUTTON LEFT BANK
HAS BEEN PUSHED

23 - Is it Normal?

By definition, cryogens are extremely cold. Because of that, some facts have to be brought to the attention of the end user about what will happen when the cryogenic manifold is in service.

The Liquid Cylinder is “Singing” – When the “Liquid Use” valve is open and the pressure is building up in the system, you will hear some kind of high pitch sound coming from the liquid cylinder. It is normal as this sound will diminish and/or stop once the pressure is equalized and the cryogenic liquid is flowing in the pipeline.

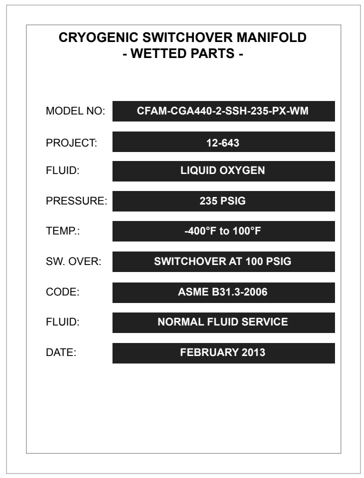
Fume, Frost and Ice – As the temperature starts to drop inside the pipeline, the non insulated components in contact with the cryogen gradually transfer that cold temperature to the ambient air. The air contains moisture (water vapor) to various levels. The water vapor starts to condense in the air at first (creating a floating fume) and then creates frost on the wetted components. If the exposure to the cryogen is long enough, ice will start to build up on the parts in contact with the cryogen. The parts in contact with the cryogens are the liquid cylinder valves, the cryogenic liquid transfer hoses and the cryogenic manifold valves and piping.

Water – When there is no demand for cryogens in the pipeline. There is no cryogen flowing and therefore, the components with ice buildups on them will thaw. Provisions for floor drains and/or gutters must be considered.

The Pressure of the Liquid Cylinder Goes Up and Down – It is normal for the pressure to go up and down inside a liquid cylinder. As you draw liquid from the liquid cylinder, the gas head space gets bigger. It may take a couple of minutes for the pressure building circuit to increase the pressure inside the cylinder. Reversely, when there is no demand for cryogenic liquid and the liquid cylinder sits idle for too long, the pressure inside the liquid cylinder will start to climb. The pressure relief valve will open if the pressure climbs to high (this is also normal and usual).

24 - Adjusting the Pressure Switches

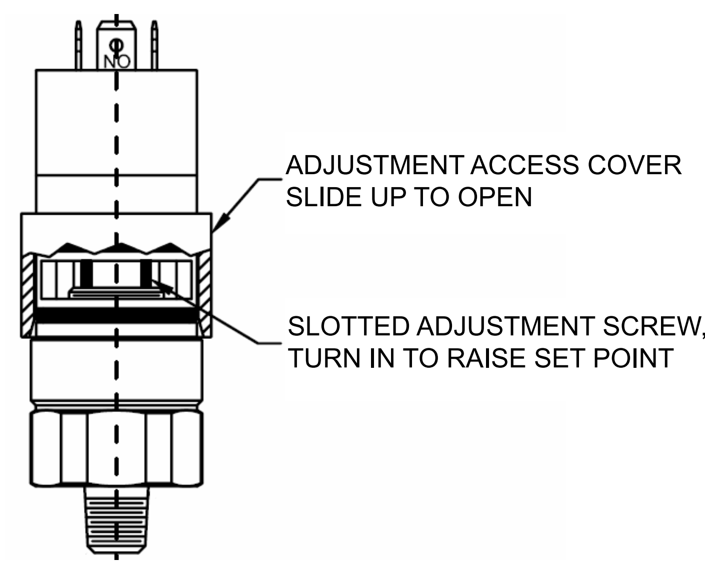
The pressure at which the CFAM-PX cryogenic manifold will switch from one bank to the other is determined by the pressure setting of the two pressure switches located inside the manifold controller. The pressure switches have been set at the factory. The set pressure is inscribed on the name tag located on the right side of the enclosure.



Tools Needed: Flat Blade Screwdriver and a Voltmeter (Optional)

Procedure

1. Make sure you have pressure to the pressure switch. You will have to get the pressure to go up and down.
2. Make sure the manifold is powered.
3. Slide cover to toward electrical terminations while twisting it to overcome friction.
4. **For setting on rise** - Insert screwdriver into adjustment slot and turn clockwise until switch actuates. In order to determined if the switch actuates or not, the red light will come off. You will have to push on the reset pushbutton. The other way to determine if the switch actuates or not is to use a voltmeter and measure voltage (the switch is energized 24 VAC).
5. **For setting on fall** - Apply pressure equal to normal system operating pressure. Reduce pressure to set point value. Turn adjustment counter clockwise until switch actuates.
6. After completing adjustments, slide cover closed over the adjustment compartment. Recheck set point.



25 - Shutdown

WARNING

Cryogenic fluids and gases must be discharged a safe location. Be sure to use a venting procedure that is environmentally acceptable and complies with Federal, State, Provincial and local requirements.

1. Close all liquid cylinder valves.
2. Vent the system pressure to 0 psig.
3. Close all system valves.
4. Disconnect all hoses from both liquid cylinders.

26 - Repairs

If the manifold or any part of the switchover leaks or malfunctions, take it out of service immediately. Repairs should be made only by BeaconMedæs with the special tools, test equipment and trained personnel required to make a safe repair. Tampering with the switchover manifold voids the warranty. Please contact BeaconMedæs to arrange for any necessary repairs.

Repairs to switchover manifolds done after the initial warranty period has expired are chargeable to the customer. Upon receipt at the factory, the switchover manifolds will be inspected and you will be contacted with a repair cost estimate. No item will be repaired until approval is received. There will be an evaluation charge assessed for equipment not repaired. All repairs should be arranged through your BeaconMedæs supplier.

NOTE: All equipment being returned must be purged of all hazardous materials using a clean, dry inert gas (e.g. Dry Nitrogen) prior to return.

27 - Warning

Our equipment is primarily intended for use in compressed gas systems. BeaconMedæs products are designed for use by persons technically trained in the proper use and safe handling of gas delivery systems. Due to the high pressure and hazardous gases employed in these processes, misapplication could result in injury or death. BEACONMEDÆS expressly warns against the sale to, or use of our products by, anyone other than professionally trained personnel. Do not use this equipment where pressures and temperatures can exceed those listed under the « Specifications » section.

Through misuse, age, or malfunction, components used with inert, combustible, corrosive, toxic, or oxidizing gases can fail in various modes. The system designer is warned to consider the failure modes of all component parts used with the above mentioned gases and to provide adequate safeguards to prevent personal injury or damage to equipment in the event of such failure modes. Adequate safeguards can be, but are not limited to:

- Pressure relief devices adequately piped to a safe location;
- Gas detection devices connected to a proper warning audible and visual alarm;
- Automatic shutoff valves and/or manual shutoff valves with an emergency stop push button;
- Self-contained breathing apparatus;
- Pipeline purge system with inert gas;
- Fire extinguishers and/or automatic sprinklers.

System designers must provide a warning to end users in the systems instructional manual if protection against a failure mode cannot be adequately provided for.

It should be recognized that warnings are valid for any equipment, regardless of manufacturer, and are not restricted to equipment manufactured by BeaconMedæs. BeaconMedæs' reputation for equipment quality performance is well established. We feel we have the additional obligation to provide information or warnings to customers to assist them in applying our equipment in a reasonable and safe manner.

28 - Design Changes

In line with our commitment to continuous improvement, BeaconMedæs reserves the right to make design modifications or discontinue manufacture of any equipment without prior notice.

LIMITED WARRANTY

WARRANTY: The Seller expressly warrants that the products manufactured by it will be free from defects in material, workmanship and title at the date of shipment. This warranty is exclusive and is IN LIEU OF ALL IMPLIED OR STATUTORY WARRANTIES (INCLUDING WITHOUT LIMITATION, WARRANTIES AS TO MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, OR ARISING FROM COURSE OF DEALING OF USAGE OR TRADE) or any other express or implied warranties or representations. All claims under this warranty must be made in writing and delivered to the seller prior to the expiration of 1 year from the date of shipment from the factory, or be barred. Upon receipt of a timely claim, the seller shall inspect the item or items claimed to be defective, and seller shall, at its option, modify, repair, or replace free of charge, any item or items which the seller determines to have been defective at the time of shipment from the factory, excluding normal wear and tear. Inspection must be performed at the seller's plant and in such event, freight for returning items to the plant shall be paid by Buyer. Seller shall have no responsibility if such item has been improperly stored, installed, operated, maintained, modified and/or repaired by an organization other than the seller. Adjustment for products not manufactured by Seller shall be made to the extent of any warranty of the manufacturer or supplier thereof. The foregoing shall be the Seller's sole and exclusive liability and buyer's sole and exclusive remedy for any breach of warranty or for any other claim based on any defect in, or non-performance of, the products whether based on breach of contract or in tort, including negligence or strict liability.

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