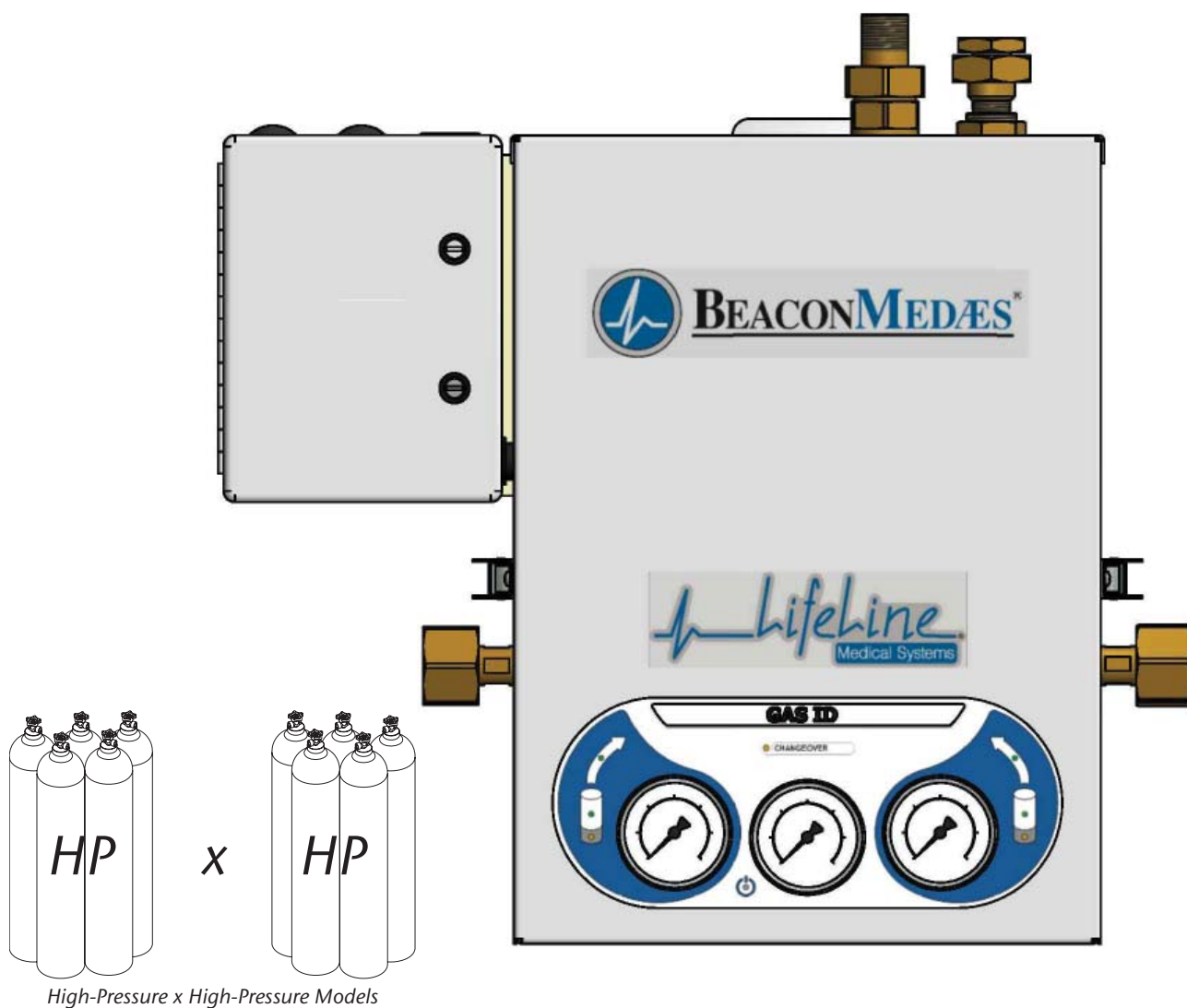


Installation, Operation and Maintenance Instructions



Lifeline Medical Systems High Pressure Fully-Automatic Manifold Basic/TAE NFPA/ISO

Part number 4107 9013 93

Revision 04

14 November 2019

U.S. Design Patent No. D734,854





Installation, Operation and Maintenance Manual

Lifeline Medical Systems

High Pressure Fully-Automatic Manifold

This unit is purchased from: _____

Date purchased: _____

Model number: _____

Serial number: _____

Option(s) included: _____

Any information, service or spare parts requests should include the machine serial number and be directed to:

BeaconMedæs
1059 Paragon Way
Rock Hill, SC 29730

Telephone: (888) 463-3427
Fax: (803) 817-5750

BeaconMedæs reserves the right to make changes and improvements to update products sold previously without notice or obligation.

Part number 4107 9013 93

Revision 04

14 November 2019

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1.0 Introduction

1.1 Audience

This manual provides information related to the installation and operation of the Lifeline High Pressure manifold manufactured by BeaconMedaes. Service information contained in this manual is intended for use by technicians or personnel qualified to repair and service medical equipment.

1.2 Abbreviations

C	Common
CGA	Compressed Gas Association
FNPT	Female National Pipe Thread
MNPT	Male National Pipe Thread
N/C	Normally Closed
N/O	Normally Open
PSIG	Pounds Per Square Inch- Gauge
SCFM	Standard Cubic Feet Per Minute
VAC	Voltage, Alternating Current
VDC	Voltage, Direct Current

1.3 Definition of Statements

Statements in this manual preceded by following words are of special significance.

⚠ WARNING: Means there is a possibility of injury or death to yourself or others.

⚠ CAUTION: Means there is a possibility of damage to unit or other property.

NOTE: Indicates points of particular interest for more efficient and convenient operation.

1.4 Product Description

Lifeline automatic changeover manifold is designed to provide a reliable, uninterrupted supply of gas to a hospital or other medical facility. Manifold utilizes multiple high-pressure cylinders divided into two equal banks.

One bank is designated as “Primary” source of gas while other bank stands in reserve as “Secondary” source.

Lights on front of manifold indicate status of gas supply. When primary bank of cylinders is depleted, manifold will automatically switch to secondary bank of cylinders without interruption of gas flow to facility. Red lamp on depleted bank will illuminate and two normally closed dry contacts will open. One or both sets of contacts may be wired to an external alarm or a building management system.

When replacement cylinders are attached to depleted bank, the red lamp goes out and green lamp illuminates indicating bank has been automatically designated as secondary supply. No other user interaction is required. Both sets of dry contacts close to cancel any external alarm condition.

A power supply converts 100-250 VAC to 24 VDC to power manifold. Two sets of dry normally closed alarm contacts can be accessed inside manifold control panel.

Lifeline manifold is designed in accordance with National Fire Protection Association (NFPA) 99 and International Organization for Standardization (ISO) 7396-1.

1.5 Environmental Considerations

Manifolds are to be installed in accordance with requirements stated by NFPA 99, ISO 7396-1, CGA, and all applicable local codes.

The BeaconMedaes Lifeline manifold has been environmentally tested to MIL STD 810F. The power supply and control board is fully contained inside a NEMA 4 enclosure, allowing for outdoor installations. The manifold can be used in high humidity conditions and was successfully tested at 86°F (30°C) - 140°F (60°C) with 95% relative humidity, per MIL STD 810F.

The power supply and electrical components have a pollution degree 1 classification. The manifold components will be used in a pollution degree 4 environment.

Manifold components are designed to work best over a temperature range of 0° F (-18°C) through 130° F (54°C). Wider temperature variations may cause manifold malfunctions to occur. The manifold is designed to be used below 2,000 meters, for higher elevations contact the factory.

Installing a nitrous oxide or carbon dioxide manifold and high-pressure reserve header assembly in a location that exposes it to ambient temperatures below 32°F (0°C) is not recommended.

1.6 Environmental Declarations

Disposal

General

When developing products and services, BeaconMedæx tries to understand, address, and minimize the negative environmental effects that the products and services may have, when being manufactured, distributed, and used, as well as at their disposal.

NOTE:

This concept can only succeed with your help.

Support us by disposing professionally.

By assuring a correct disposal of the product you help to prevent possible negative consequences for environment and health that can occur with inappropriate waste handling.

Recycling and re-usage of materials helps to preserve natural resources.

Recycling and disposal policies are part of the development of all BeaconMedæx products. BeaconMedæx company standards determine strict requirements.

When selecting materials the substantial recyclability, the disassembly possibilities and the separability of the materials and assemblies are considered as well as the environmental perils and dangers to health during the recycling and disposal of the unavoidable rates of non-recyclable materials.

BeaconMedæx products for the most part consist of metallic materials that can be remelted in steelworks and smelting works and that is therefore almost infinitely recyclable. The plastic use is labeled; sorting and fractioning of the materials for recycling in the future is foreseen.

Disposal of Materials

Dispose contaminated substances and materials separately, according to local applicable environmental legislations.

Dispose all components according to the applicable disposal regulations.

2.0 Installation

2.1 Precautions

WARNING:

- Tampering with gas specific connections shall be prohibited. Do not alter, remove or modify gas specific connections.
- Keep all manifold parts, tools and work surfaces free of oil, grease and dirt. These and other flammable materials may ignite when exposed to high pressure oxygen or nitrous oxide.
- Do not use chemicals, lubricants or sealants unless specified in these instructions.
- Before connecting cylinder to manifold, momentarily open and close cylinder valve to blow out dirt and debris.
- After connecting cylinder to manifold, open cylinder valve s-l-o-w-l-y to allow heat of compression to dissipate.
- Do not use flame or “sniff” tests for leaks.
- Do not apply heat to any part of the manifold system.
- Always secure high-pressure cylinders with racks, straps, or chains. Unrestrained cylinders may fall over and damage or break off cylinder valve.
- Do not repeatedly bend, sharply bend, or twist copper pigtailed as damage to tubing may occur.
- Do not bend flexible pigtailed into a radius smaller than 3”.
- After manifold wall bracket has been mounted, one person alone should not attempt to lift and hang the manifold cabinet.
- Do not put manifold into operation until verified by a qualified person per NFPA 99, ISO 7396-1 or other local standard.

WARNING:

- Do not put manifold into operation until verified by a qualified person per NFPA 99 or ISO 7396-1.

2.2 Manifold System Components

The manifold system may be shipped in more than one carton, depending on the number of cylinder connections. The main carton contains following items:

- Manifold control module
- Wall mounting bracket (attached to manifold control module)
- ¾” source shut-off valve
- Installation, Operation, and Service Manual

Additional cartons contain the appropriate number of header extensions and cylinder pigtail assemblies. Cylinders must be placed in a double row “staggered” configuration. Cylinder inlets closest to the manifold control module are intended for cylinders placed directly beneath the manifold control module. Pigtailed for gases other than O₂, He, CO₂O₂, O₂CO₂, HeO₂, O₂He, ISO N₂O, ISO Inst. Air, and ISO Med. Air are 24” length stainless-steel flexible type.

O₂, He, CO₂O₂, O₂CO₂, HeO₂, O₂He, ISO N₂O, ISO Inst. Air, and ISO Med. Air pigtailed are rigid copper and are pre-bent to the approximate shape for connection to cylinders. The manifold is designed to be mounted directly to a wall, but may be freestanding floor-mounted with addition of a manifold control module floor mount kit and an appropriate number of header floor mount kits (ordered separately).

2.3 Wall Mounting Instructions

1. Remove manifold control module from shipping carton and place face up on cardboard packaging insert.
2. Remove the control module enclosure by releasing the two latches on each side and set the cover aside.
3. Remove the four M8 hex head bolts from the mounting bracket as shown in Figure 1. Lift the manifold away from the mounting bracket and set aside.

4. Mark wall 77-½" from finished floor in location where manifold will be mounted. Convert mark to level horizontal line approximately 8" long.

NOTE:

A bracket mounting height of 77-½" allows for adequate clearance beneath manifold when utilizing standard "H" size cylinders (55" tall overall). Bracket mounting height should be increased proportionally if taller cylinders are to be used. See Figure 2

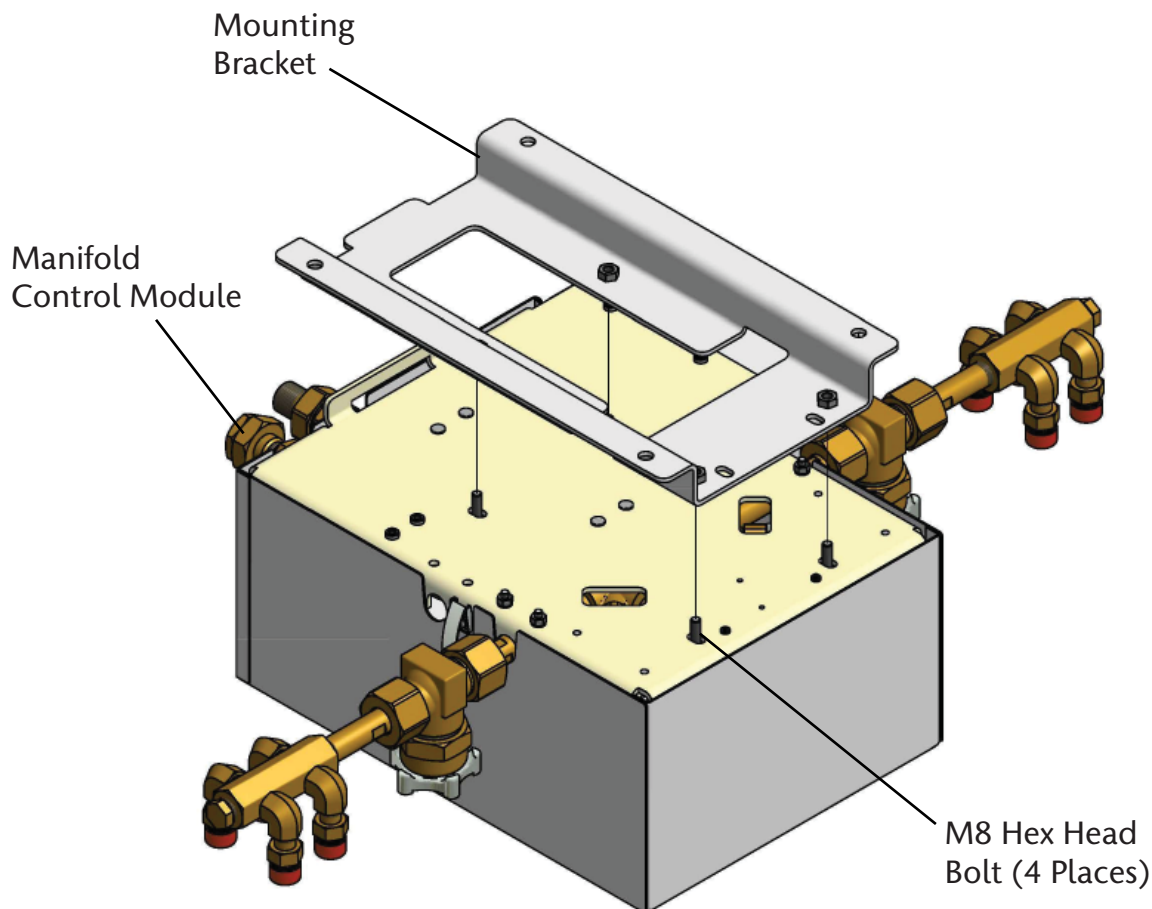


Figure 1

Wall Mounting Instructions (cont.)

5. Place bracket flat against wall as shown in Figure 2 and align top of bracket with level horizontal line. Vertical center line of bracket will be vertical center line of installed manifold. Mounting top of bracket at 77-½" height will net a 65-¾" height from center of header to finished floor.

6. Mark locations of mounting holes. Remove bracket and drill mounting holes. Attach bracket to wall with appropriate anchors (by others). ⅜" diameter anchors are recommended.

⚠ WARNING:

Do not attempt to lift manifold alone. Two people are recommended in order to hang manifold onto wall mounting bracket.

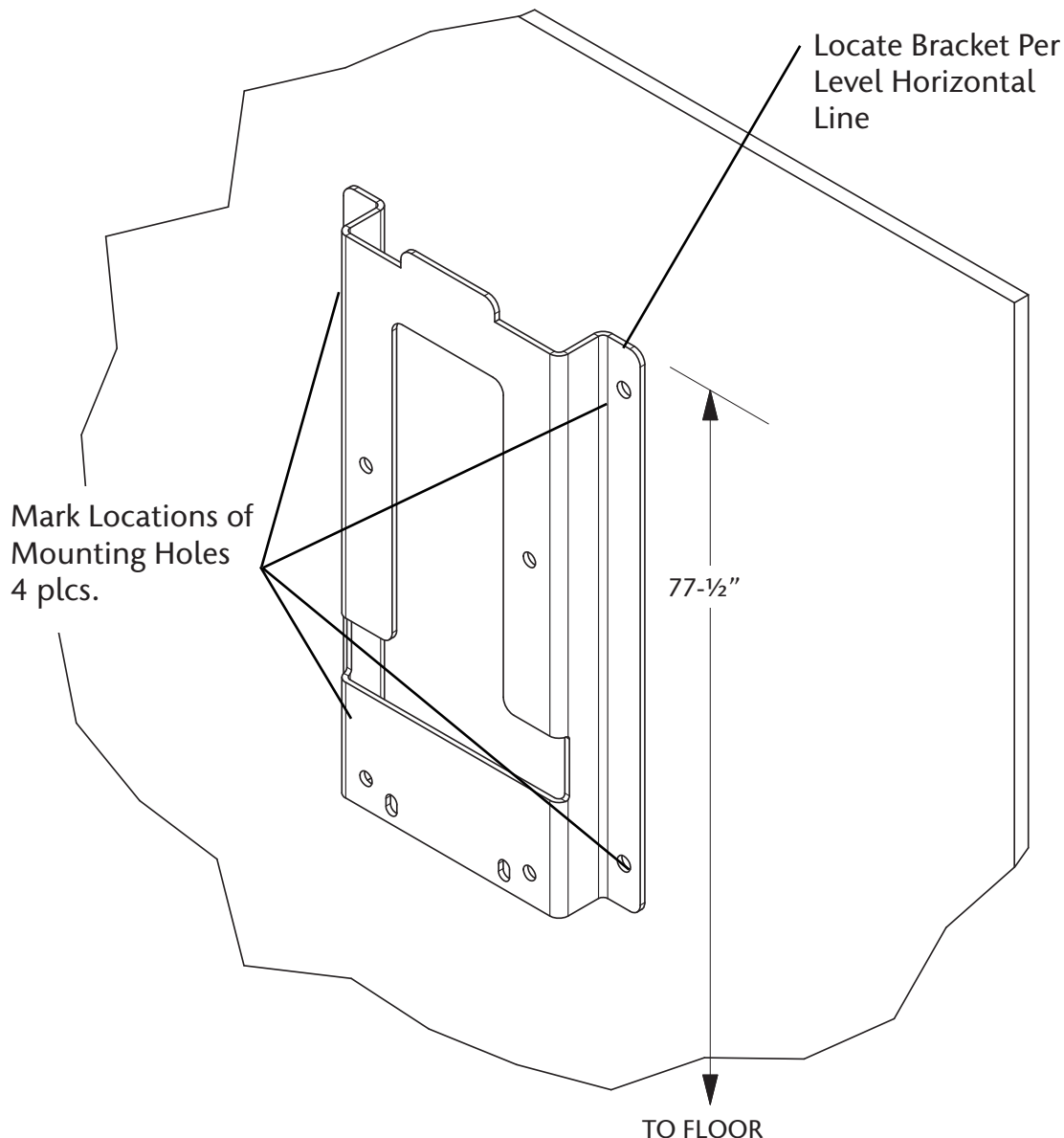


Figure 2

Wall Mounting Instructions (cont.)

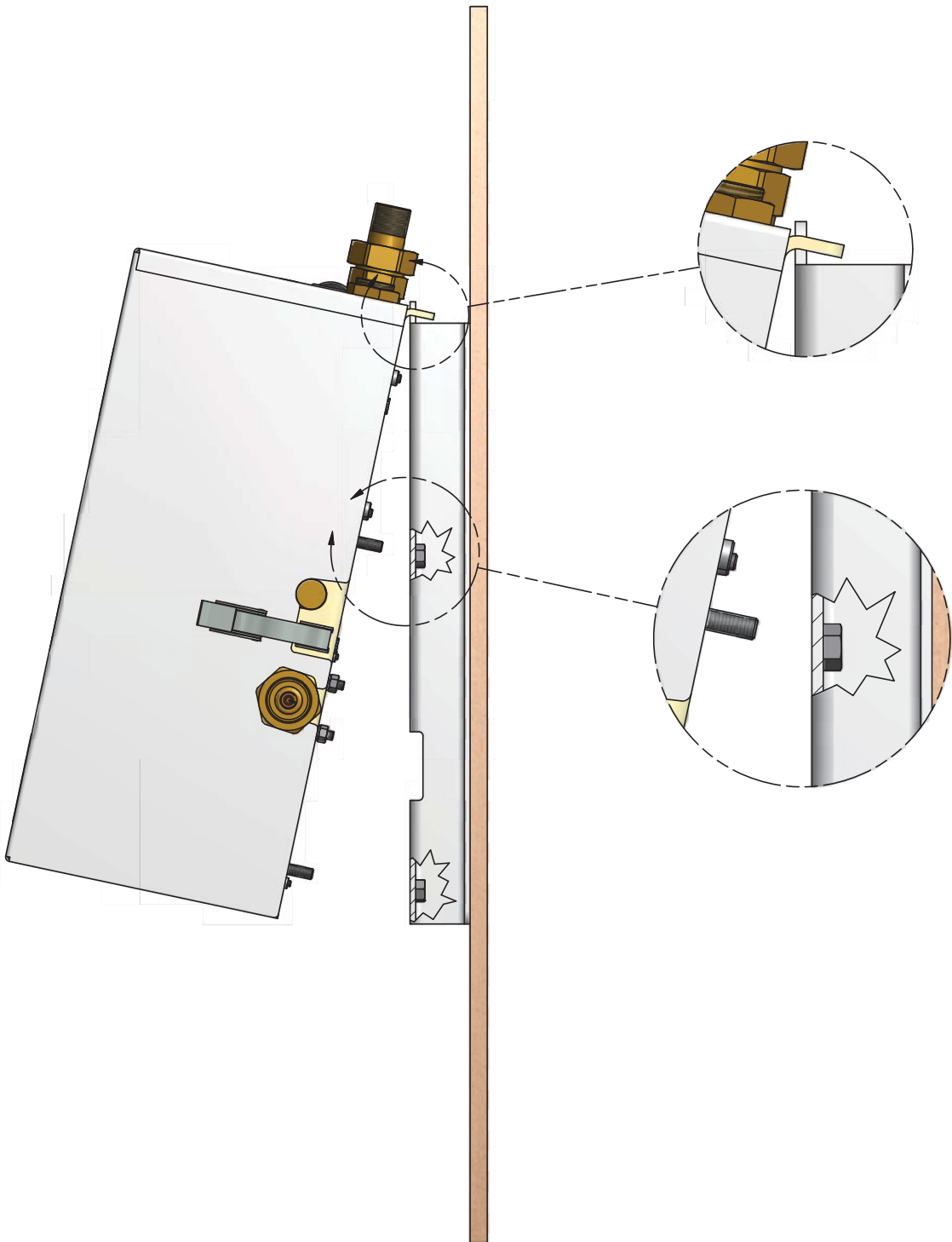


Figure 3

Wall Mounting Instructions (cont.)

7. Hang manifold control module on tab of mounting bracket (Figure 3). Using M8 hex bolt, attach manifold to wall bracket through slots in black plate (4 places).

⚠ CAUTION:

Do not use thread sealant on header or pigtail connections.

8. For all manifolds, additional shipping cartons contain extension headers and header wall brackets. Attach master valve and appropriate header extension to manifold control module. Position cylinder inlet connections of each header extension so they are pointing out (away from the wall) and tighten header extension (Figure 4).

⚠ CAUTION:

Each header segment greater than five inlets must be supported by a header bracket before additional header segments are added.

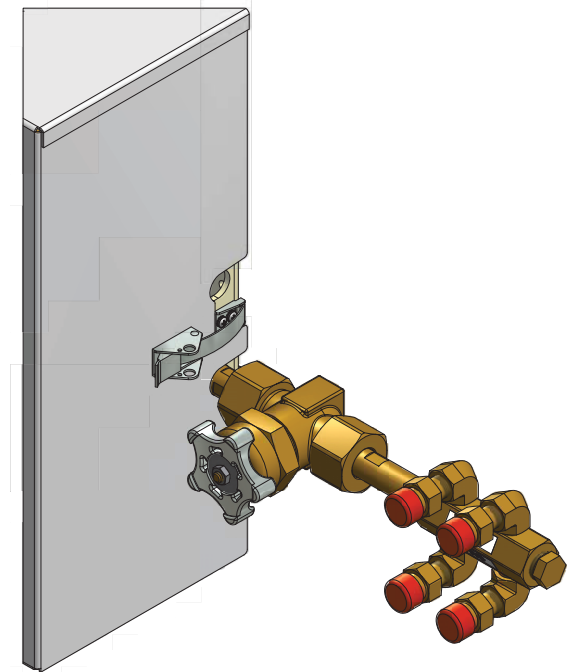


Figure 4

Wall Mounting Instructions (cont.)

9. Each header kit greater than 5 inlets is shipped with an appropriate number of header brackets. Position brackets against wall and on bottom side of header as shown in Figure 5. Attach bracket to wall using appropriate anchors (by others). $\frac{3}{8}$ " diameter anchors are recommended.
10. Assemble u-bolt and bracket hardware as shown. Tighten u-bolt nuts.
11. Additional header extensions may be attached end to end if required.
12. Install large nut and plug on end of last header extension. Tighten large nut.

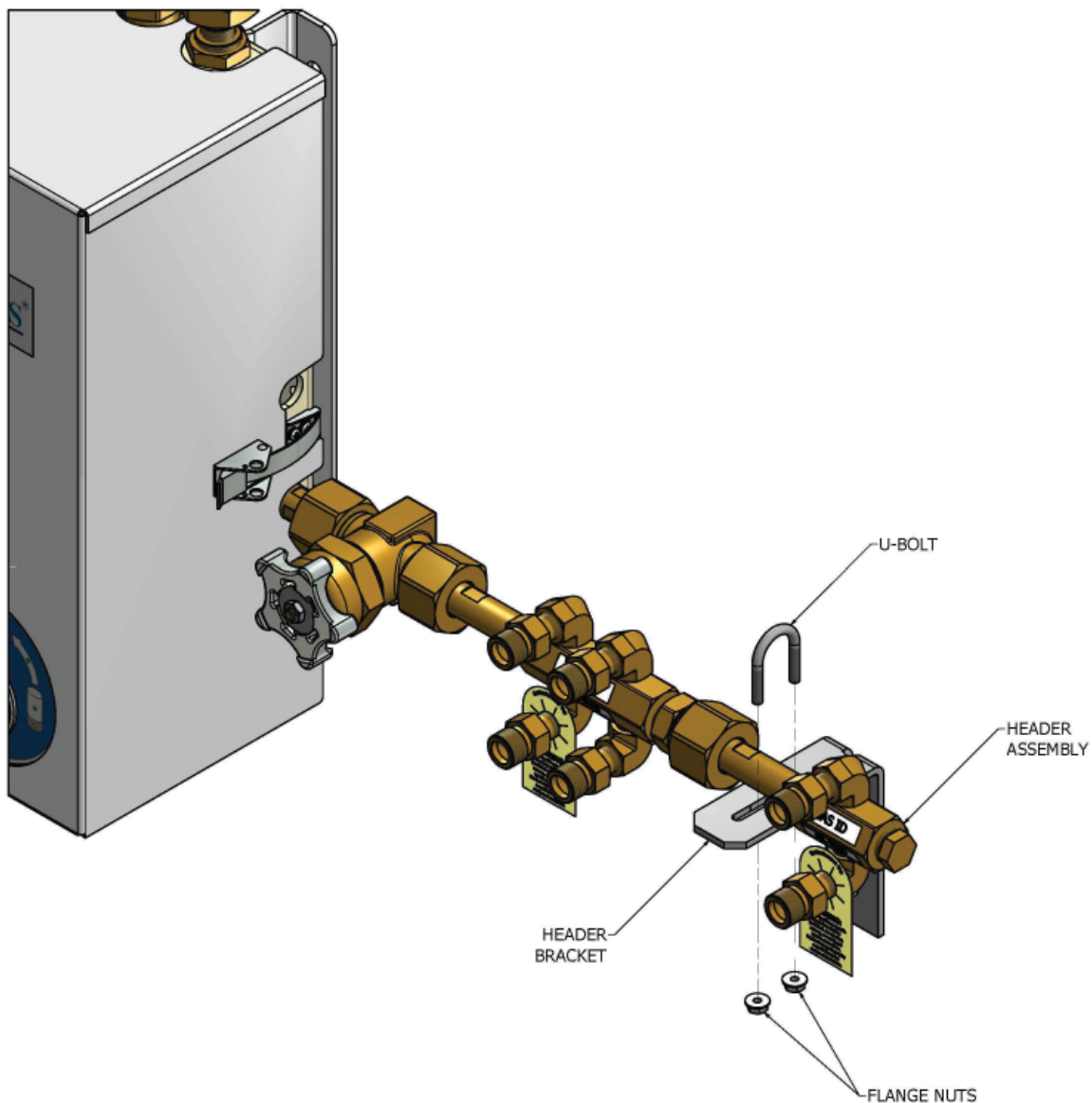


Figure 5

2.4 Floor Mounting Instructions

For floor mounting the manifold control panel and headers, a manifold control panel stand kit and an appropriate number of manifold header stand kits should have been ordered separately. One manifold control panel stand kit contains all items needed to mount the control panel. Depending on the number of header segments, one or more header stand kits are required. A header stand is required for each header segment. Each header stand kit contains two vertical stands and all necessary items to support one header segment on each side of the manifold. Verify contents of stand kits (Figures 6 and 7):

1. Remove manifold control module from shipping carton and place face up on cardboard packaging insert.
2. Remove the control module enclosure by releasing the two latches on each side and set the cover aside.
3. Remove the four M8 hex head bolts from the mounting bracket as shown in Figure 1.
4. Only bracket will be needed at this time. Set manifold control panel aside for installation later.

NOTE: Return control panel to shipping carton if necessary to protect it and keep it clean.

5. Attach post base to one end of each 80-inch channel as shown in Figure 8, Detail A. Use two each $\frac{3}{8}$ " bolts, flat washers and channel nuts per base. Tighten all four bolts.
6. Stand each channel / base side by side. Attach manifold mounting bracket to both bases as shown in Figure 8, Detail C. Use four each $\frac{3}{8}$ " bolts, flat washers and channel nuts per base. Top of bracket should be level and positioned 77- $\frac{1}{2}$ " above floor. Tighten all four bolts.
7. Position entire assembly in desired manifold mounting location. Mark location of eight base mounting holes. Move assembly aside and drill holes. Minimum $\frac{3}{8}$ " diameter mounting bolts are recommended (by others).
8. Reposition assembly over holes and install mounting hardware (by others). Tighten all mounting bolts.
9. Hang manifold control module on tab of mounting bracket (Figure 3). Using M8 hex bolt, attach manifold to wall bracket through slots in black plate (4 places).
10. Additional cartons containing master valves and header assemblies will be shipped loose. Header wall brackets, mounting hardware and plugs will also be shipped loose for manifolds with more than five cylinders per bank. Attach the master valves and appropriate header extensions to the manifold control panel. Position cylinder inlet connections of each header extension so they are pointing out (away from the wall) and tighten header extension (Figure 4). If wall brackets are required install as necessary (Figure 5).
11. Each header extension is shipped with a header bracket. Each header bracket should be attached to a manifold header stand. Assemble each header stand by attaching a post base to one end of 66-inch channel as shown in Figure 8, Detail A. Use two each $\frac{3}{8}$ " bolts, flat washers and channel nuts. Tighten all bolts.
12. Set header stand in a vertical position roughly in alignment with two vertical control panel stands. Position header bracket against channel and on bottom side of header as shown in Figure 5. Attach bracket to channel as shown in Figure 8, Detail B. Use two each $\frac{3}{8}$ " bolts, flat washers and channel nuts. Tighten all bolts.

2.4 Floor Mounting Instructions Cont.

13. Align header stand with two control panel vertical stands, centering the header bracket between two pigtail connections. Mark locations of all four base mounting holes. Move header stand aside and drill holes. Minimum $\frac{3}{8}$ " diameter mounting bolts are recommended (by others).
14. Reposition header stand over holes and install mounting hardware (by others). Tighten all mounting bolts.
15. Assemble u-bolt and bracket hardware as shown in Figure 6. Tighten u-bolt nuts.
16. Additional header extensions may be attached end to end if required.
17. Install large nut and plug on end of last header extension. Tighten large nut.

⚠ CAUTION:

Do not use thread sealant on header or pigtail connections.

STAND KIT, MANIFOLD CONTROL PANEL
P/N 6-135000-KT

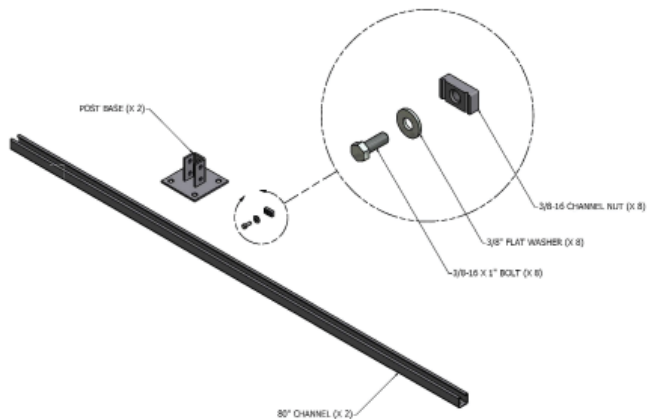


Figure 6

STAND KIT, MANIFOLD HEADER
P/N 6-135001-KT

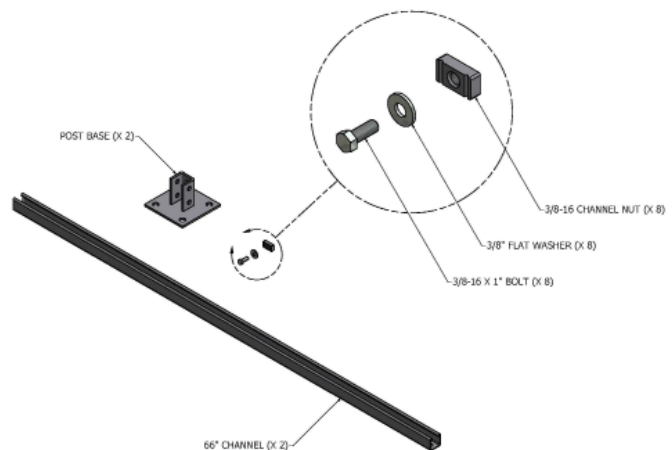


Figure 7

2.4 Floor Mounting Instructions Cont.

⚠ CAUTION:

Each header segment must be supported by a header bracket before additional header segments are added.

MANIFOLD CONTROL AND
HEADER STAND KIT ASSEMBLY

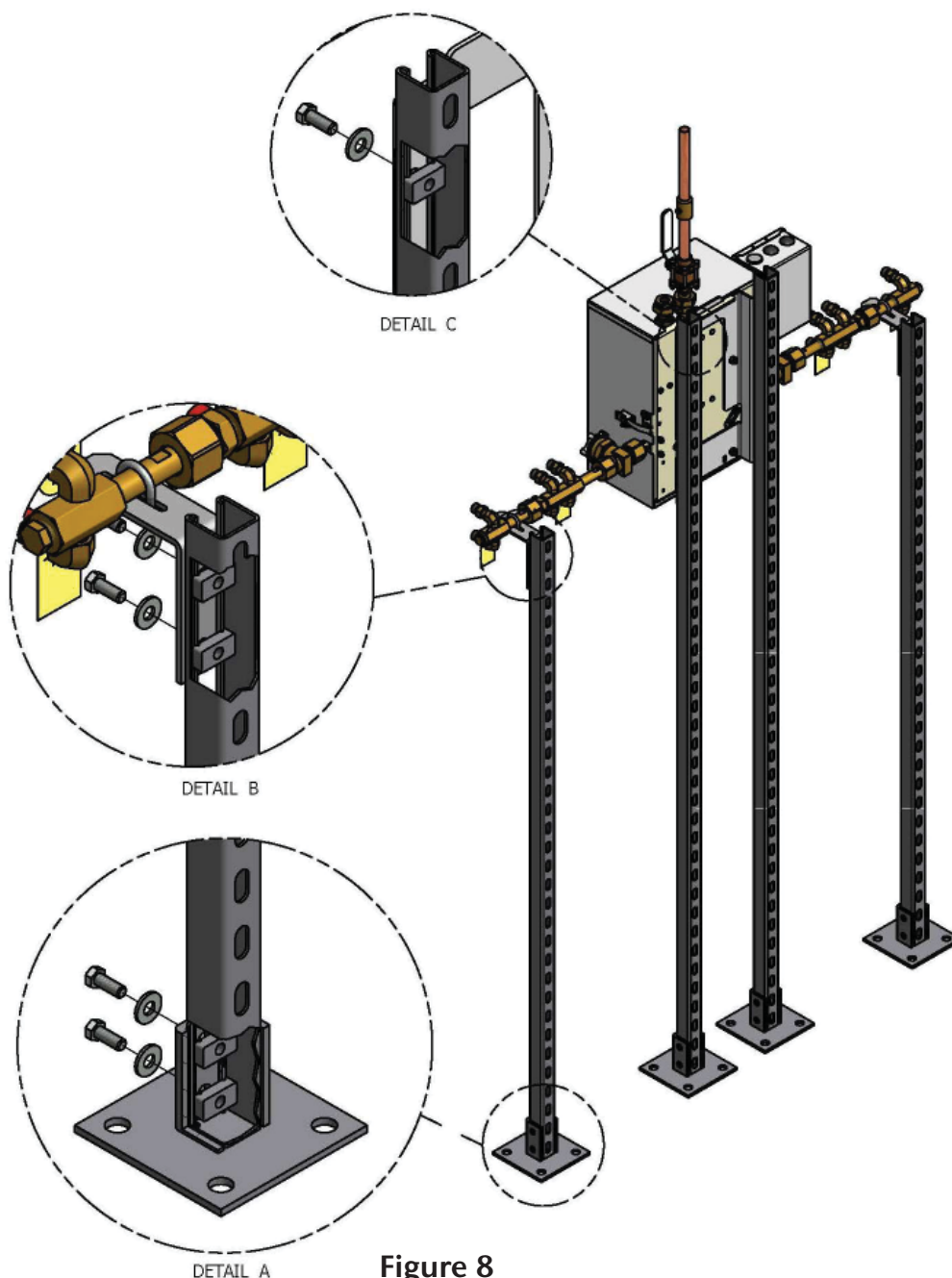


Figure 8

2.5 Power Supply

A power supply assembly is provided with manifold control module. The installer must use 12-14 AWG copper supply wiring when connecting to the manifold. Power supply shall be connected to a building installed circuit breaker. Circuit breaker shall be a maximum 15 amps and marked as disconnecting means for manifold. It is recommended that circuit breaker be in close proximity to manifold and properly selected according to local and national regulations. The manifold has a category II overvoltage rating.

NOTE:

All wiring shall be protected from physical damage by raceways or conduit in accordance with NFPA 70, National Electric Code.

The Power supply box contains a 24 VDC power supply and terminal blocks for AC input power and remote alarm connection.

Holes for ½" conduit are located on top of power supply box for 100 VAC to 250 VAC, 50/60 Hz power and remote alarm wiring. Current draw will be less than 250 milliamperes. Fuse type is 5 x 20 mm, GMD-250mA. Chassis grounding for manifold provided by included wiring to back plate and enclosure door. Only ground wire required is through incoming power terminal.

2.6 Remote Alarm Connection

Two sets of dry, alarm contacts are available inside power supply assembly for connection to a remote alarm or building automation system. Both sets of contacts are independent of each other and will be closed whenever manifold is powered and operating normally (no alarm condition). Each set of contacts will open if an alarm condition occurs (manifold changeover), or if power is removed from manifold. Alarm contacts are rated for 0.4 A @ 24 VDC.

Refer to Figure 6 for power supply connections.

2.7 Main Outlet and Relief Valve Connection

The main outlet and the relief valve outlet are supplied with zero clearance, O-ring sealed unions. The main outlet connection is ¾" MNPT and the relief valve is ½" FNPT. A ¾" source shut-off valve is also supplied with manifold control module. The inlet side of the source shut-off valve is ¾" MNPT for connection directly to the main outlet union. The outlet side of the source shut-off valve is a ¾" nominal copper. A plugged, ⅛ FNPT port is provided on the outlet side of the valve and may be removed to aid in purging.

Power Supply Wiring

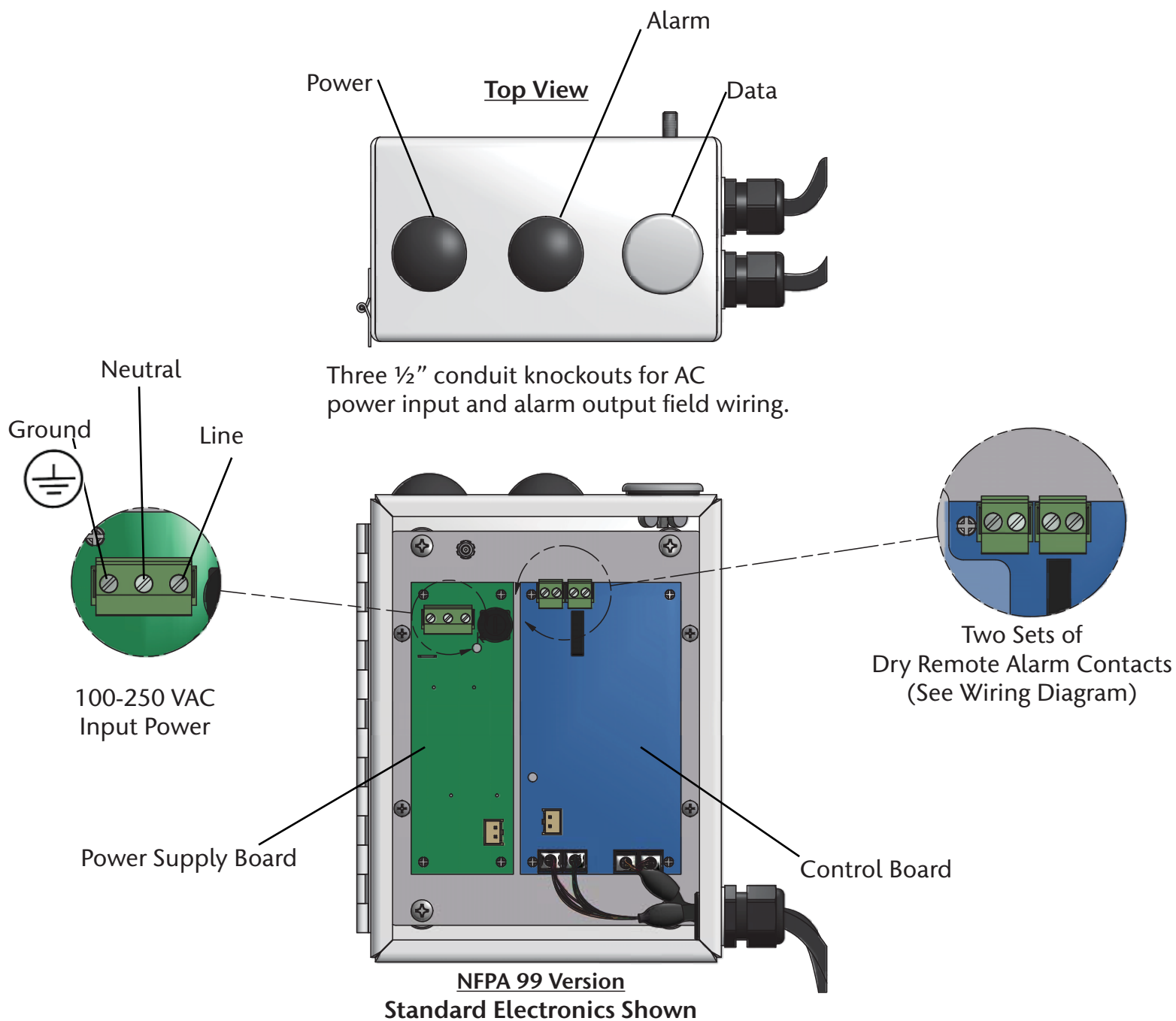


Figure 9

2.8 Pigtail Installation/Cylinder Connection

All manifolds other than O₂, He, CO₂O₂, O₂CO₂, HeO₂, O₂He, ISO N₂O, ISO Inst. Air, and ISO Med. Air utilize 24" length flexible stainless-steel braided pigtails. All cylinders on the right bank of the manifold, even those placed directly beneath should be positioned so that the cylinder outlets face right. All cylinders on the left bank of the manifold, even those placed directly beneath should be positioned so that the cylinder outlets face left. Figure 10 illustrates a typical 4 x 4 manifold system utilizing 24" length flexible pigtails.

O₂, He, CO₂O₂, O₂CO₂, HeO₂, O₂He, ISO N₂O, ISO Inst. Air, and ISO Med. Air manifolds are supplied with pre-formed rigid copper pigtails. All cylinders on the right bank of the manifold, even those placed directly beneath should be positioned so that the cylinder outlets face right. All cylinders on the left bank of the manifold, even those placed directly beneath should be positioned so that the cylinder outlets face left. Figure 11 illustrates a typical 4 x 4 O₂, He, CO₂O₂, O₂CO₂, HeO₂, O₂He, ISO N₂O, ISO Inst. Air, and ISO Med. Air manifold utilizing pre-formed rigid copper pigtails.

1. Remove plastic shipping caps from manifold header pigtail connections.
2. Connect one end of pigtail assembly to header connection. Coiled end of rigid copper pigtails attaches to header connection.
3. Position gas cylinders as shown in Figures 10 and 11. Secure each cylinder to wall or floor stand with chains or straps.
4. Connect pigtails to each cylinder. Rigid copper pigtails used on O₂, He, CO₂O₂, O₂CO₂, HeO₂, O₂He, ISO N₂O, ISO Inst. Air, and ISO Med. Air manifolds are pre-formed to approximate required shape. Lower end of rigid copper pigtails must be bent 90° toward cylinder outlets.

5. Tighten all pigtail connections firmly. Do not over-tighten.

WARNING:

All pigtail assemblies are shipped in sealed bags and are cleaned as if for oxygen use. Manifold header connections are clean and capped. Do not unpackage or remove any cap until ready to install. During installation use care to maintain cleanliness.

WARNING:

- Do not repeatedly bend, sharply bend, or twist copper pigtails as damage to tubing may occur.
- Do not bend flexible pigtails into a radius smaller than 3".
- Always secure cylinders with racks, straps, or chains. Unrestrained cylinders may fall over and damage or break off cylinder valve.

CAUTION:

Do not use thread sealant on header or pigtail connections.

CAUTION:

Prior to connecting pigtail to cylinder, slightly open and close each cylinder valve to blow out dirt and debris.

NOTE:

Both ends of flexible pigtails are the same. Either end may be connected to manifold header. Rigid copper pigtails are preformed and must be connected as shown in Figure 11. Tighten all pigtail connections firmly. Do not over tighten.

Pigtail Installation/Cylinder Connection (cont.)

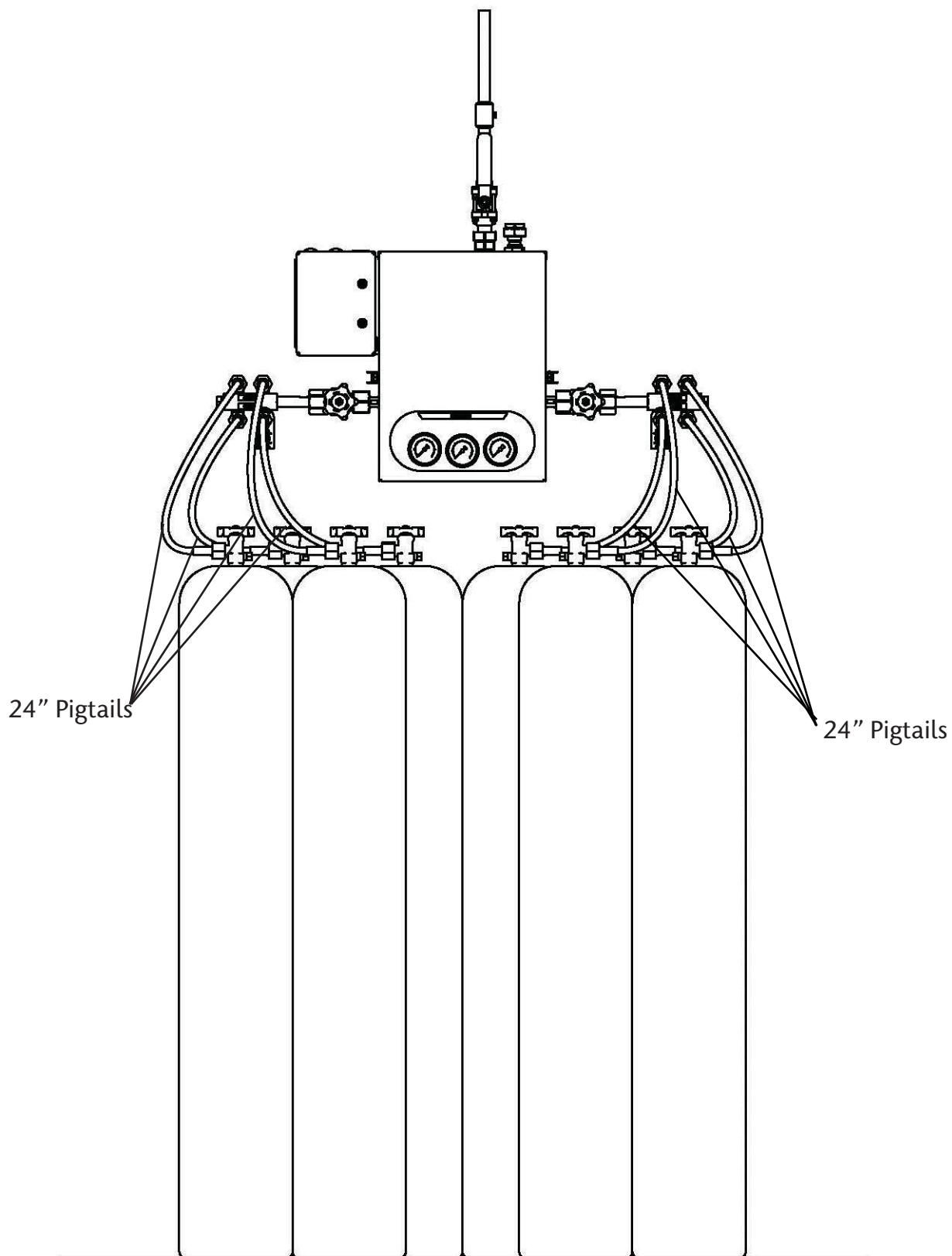


Figure 10

Pigtail Installation/Cylinder Connection (cont.)

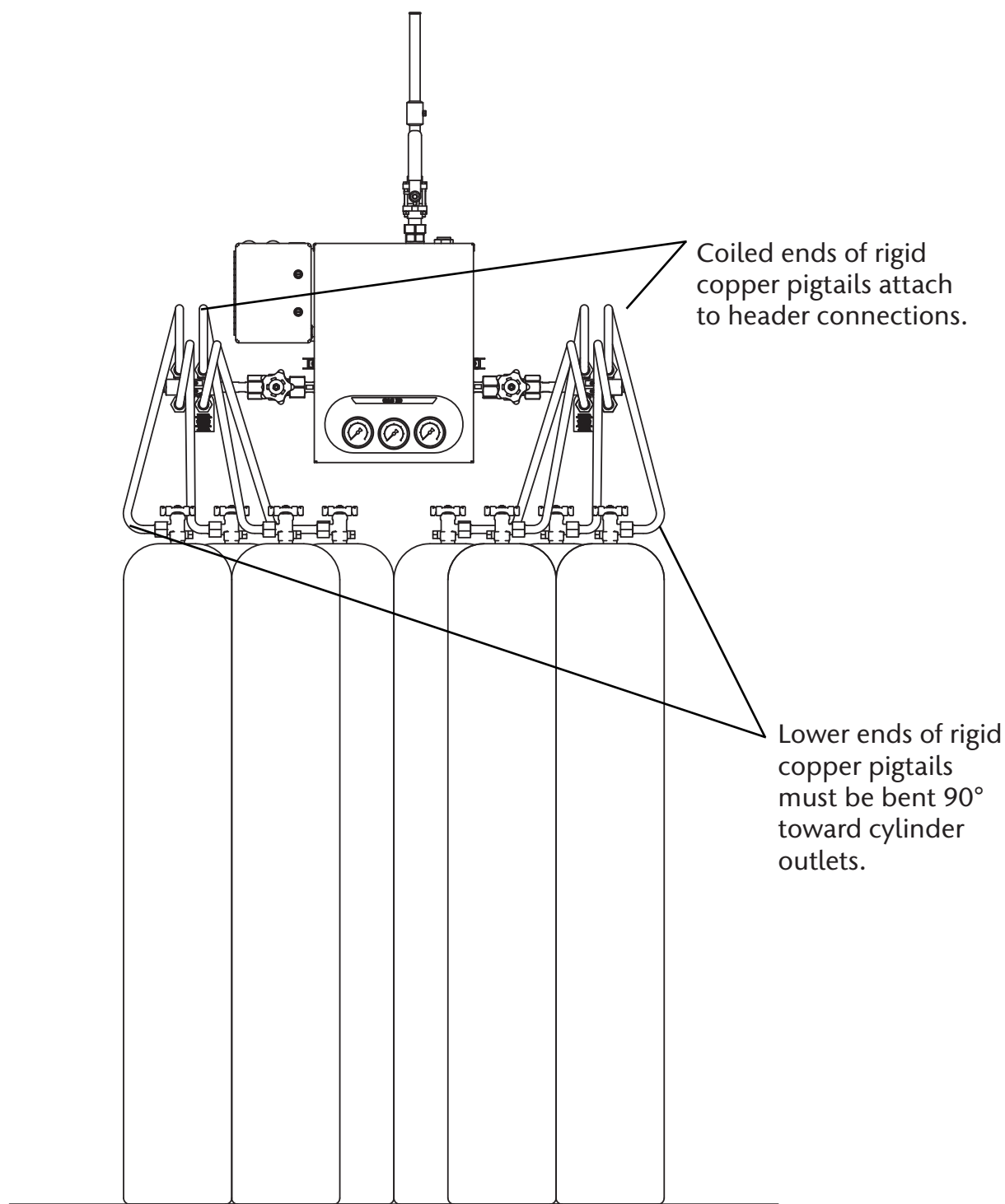


Figure 11

2.9 Initial Power-Up and Operational Testing

1. Release two latches on sides of manifold control module cover (one on each side). Remove cover.
2. Verify the following: (Refer to Figure 12 for component location and Figure 13 & 14 for Light Location).
 - Both master valves are turned fully counterclockwise (open)
 - All isolation valves to be open.
 - Both red “Empty” indicators on front of manifold are illuminated.
 - If connected to a master alarm panel, “CHANGEOVER” alarm is activated.
3. Close $\frac{3}{4}$ ” source shut-off valve.
4. Slowly open one cylinder on right side of manifold.
5. Verify the following:
 - Right bank red “Empty” light goes out.
 - Right bank green “In Use” & “READY” lights illuminate.
 - Right bank cylinder contents gauge reads cylinder pressure.
6. Slowly open one cylinder on left side of manifold.
7. Verify the following:
 - Left bank red “Empty” light goes out.
 - Left bank green “Ready” light illuminates.
 - Left bank cylinder contents gauge reads cylinder pressure.
 - If connected to a master alarm panel, “CHANGEOVER” alarm is not activated.
8. Close right bank cylinder. Slightly open vent valve (Figure 12). Verify the following:
 - Right bank cylinder contents gauge drops slowly.
 - As right cylinder contents gauge is nearly depleted, manifold changes over to left bank.
- After change-over, right bank green “In Use” & “READY” lights goes out and red “Empty” light illuminate.
- After change-over, left bank green “In Use” light illuminates.
9. Close vent valve.
10. Verify “Line Pressure” gauge reading is acceptable.
11. Slowly open one cylinder on right side of manifold.
12. Verify the following:
 - Right bank red “Empty” light goes out.
 - Right bank green “Ready” light illuminates.
 - Right bank cylinder contents gauge reads cylinder pressure.
13. Close left bank cylinder. Slightly open vent valve. Verify the following:
 - Left bank cylinder contents gauge drops slowly.
 - As left cylinder contents gauge is nearly depleted, manifold changes over to right bank.
 - After change-over, left bank green “In Use” & “READY” lights go out and red “Empty” light illuminates.
 - After change-over, right bank green “In Use” light illuminates.
14. Close vent valve.
15. Slowly open one cylinder on left side of manifold.
16. Verify the following:
 - Left bank red “Empty” light goes out.
 - Left bank green “Ready” light illuminates.
 - Left bank cylinder contents gauge reads cylinder pressure.
17. Close left and right side cylinders.
18. Record pressure readings of left and right bank cylinder contents gauges.
19. Wait 15 minutes.

2.9 Initial Power-Up and Operational Testing (Cont.)

20. Compare current readings of left and right bank cylinder contents gauges to those recorded in step 18. If there is a noticeable pressure change on either gauge, perform leak testing described in the next section.
21. Reinstall manifold control panel cover.
22. Slowly open all cylinders on both banks of manifold.
23. Open $\frac{3}{4}$ " source shut-off valve.

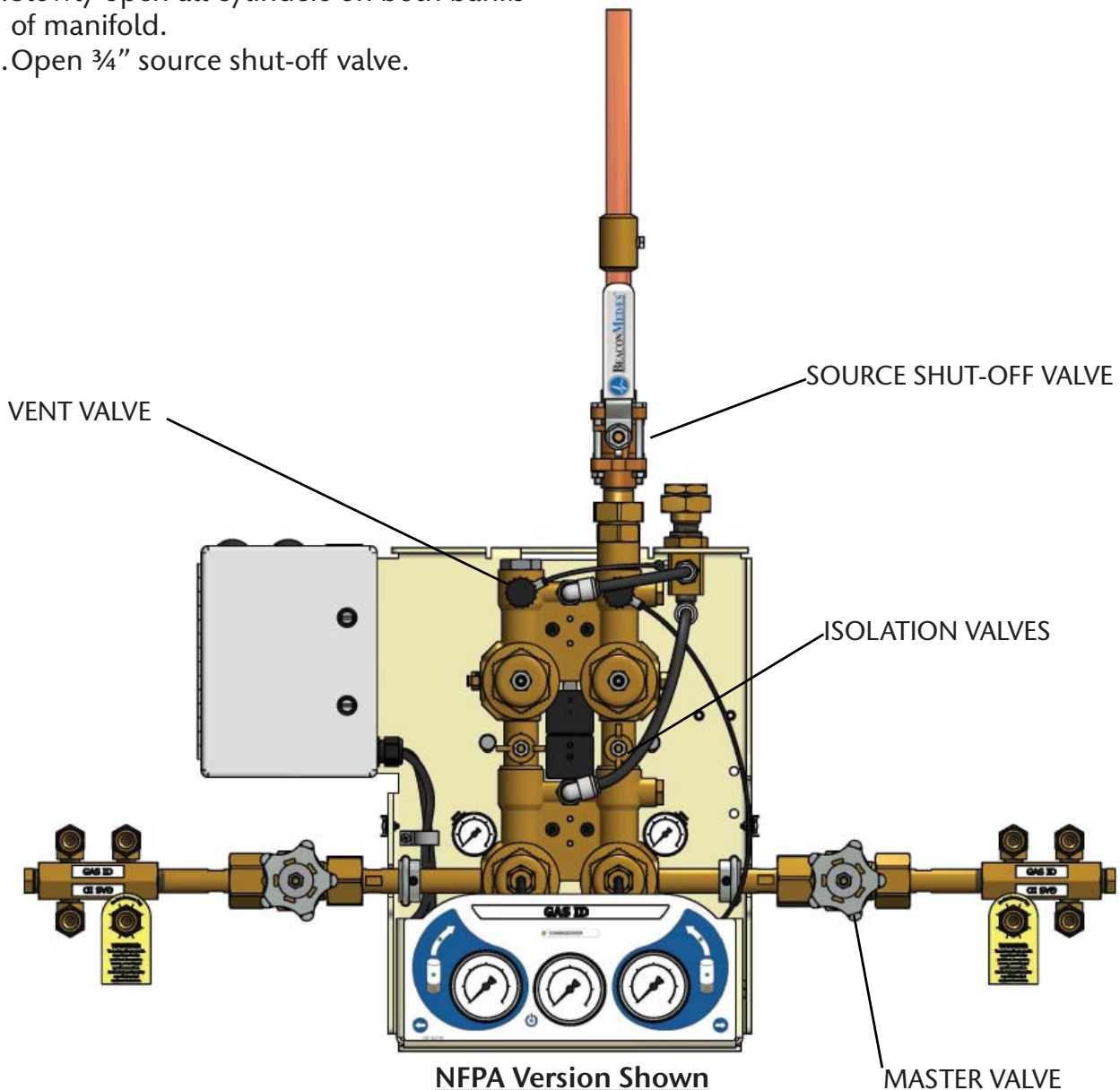


Figure 12

2.9 Initial Power-Up and Operational Testing (Cont.)

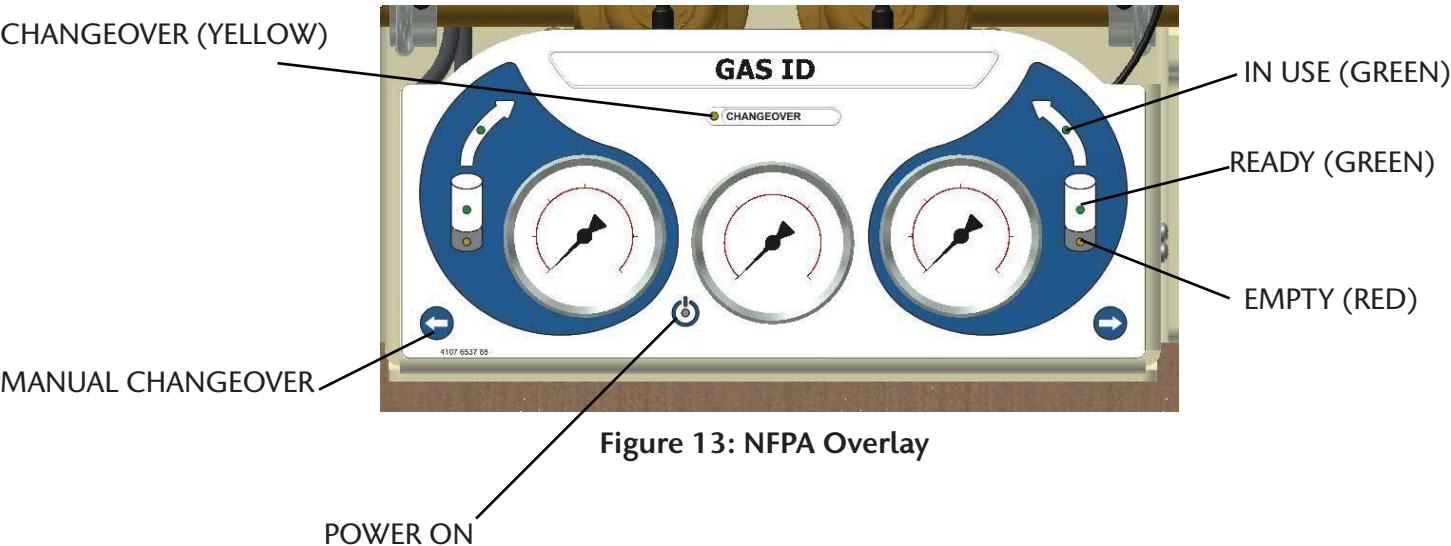


Figure 13: NFPA Overlay

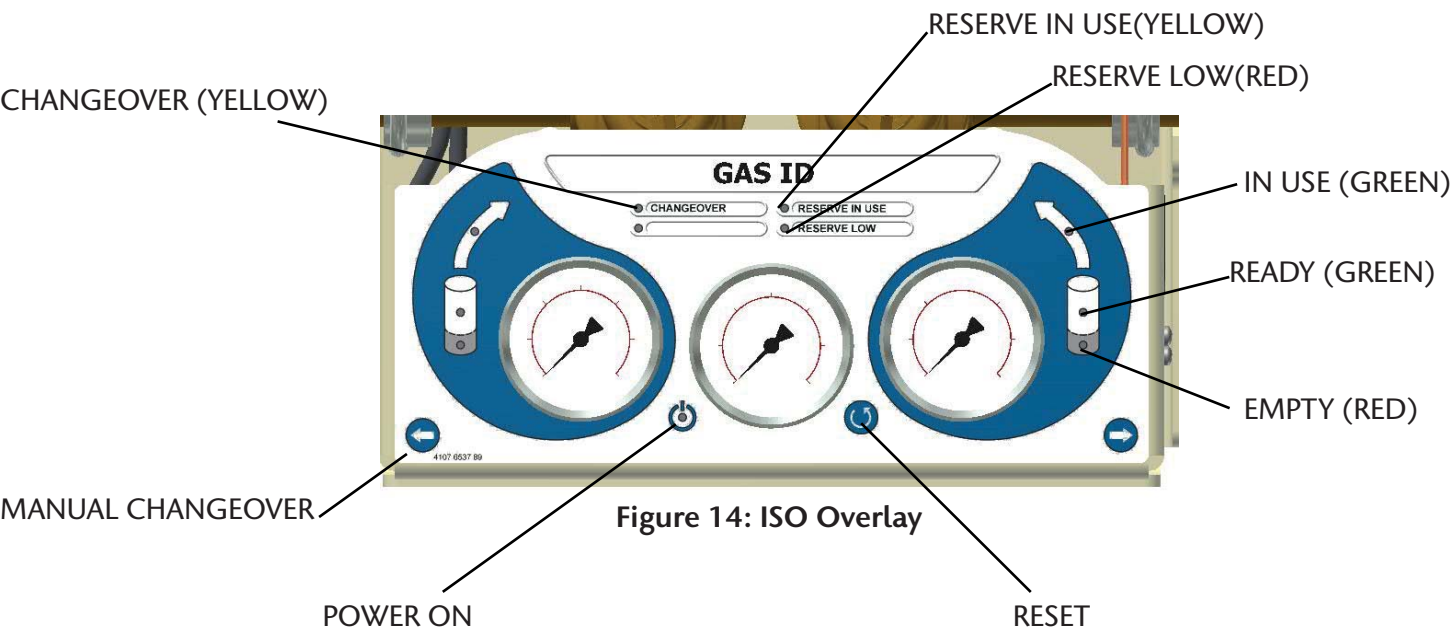


Figure 14: ISO Overlay

2.10 Leak Testing

The following leak testing is recommended if a leak is observed during the previous Initial Power-Up and Operational Testing procedure. If a noticeable drop in either pressure gauge reading was not detected, this leak testing is not required.

1. Release two latches on sides of manifold control panel cover (one on each side).
2. Close $\frac{3}{4}$ " source shut-off valve.
3. Verify isolation valves on outlets of line regulators are open.
4. Slowly open one cylinder on left and right bank of manifold.
5. Close two internal isolation valves on inlets of line regulators. (Refer to Figure 15 & 16 for component location).
6. Close left and right side cylinders.
7. Record pressure readings of left and right bank cylinder contents gauges and line pressure gauge.
8. Wait 15 minutes.
9. Compare current readings of all three gauges to those recorded in step 7.
10. A loss of pressure on line pressure gauge indicates a leak downstream of line regulator inlet isolation valves. A loss of pressure on left or right cylinder contents gauges indicate a leak in components upstream of line regulator inlet isolation valves.
11. Locate leak by applying a small amount of an oxygen compatible leak detector while manifold is under pressure. Formation of bubbles indicates a leak. Since manifold is factory leak tested, suspect those items first that were added during installation process. For example, main outlet union fitting for leaks downstream of line regulator isolation valves and header connection points for leaks upstream of line regulator isolation valves.

12. Eliminate leaks by tightening or replacing connections or tubing. Retest and verify all leaks have been eliminated.
13. Open line regulator isolation valves.
14. Reinstall manifold control panel cover.
15. Slowly open all cylinders on both banks of manifold.
16. Open $\frac{3}{4}$ " source shut-off valve.

CAUTION:

Avoid getting leak detector solution onto electrical components. Wipe off excess leak detector solution after testing.

3.0 Operation

3.1 Precautions

⚠ WARNING:

- Tampering with gas specific connections shall be prohibited. Do not alter, remove or modify gas specific connections.
- Before connecting cylinder to manifold, momentarily open and close cylinder valve to blow out dirt and debris.
- After connecting cylinder to manifold, open cylinder valve s-l-o-w-l-y to allow heat of compression to dissipate.
- Always secure high-pressure cylinders with racks, straps, or chains. Unrestrained cylinders may fall over and damage or break off cylinder valve.
- Do not repeatedly bend, sharply bend, or twist copper pigtails as damage to tubing may occur.
- Do not bend flexible pigtails into a radius smaller than 3".
- Service to be performed by qualified medical equipment technician.

NOTE:

In order to ensure proper manifold changeover operation, do not set delivery (line) pressure less than 40 PSI.

3.2 Manifold Specifications

All Lifeline Manifold systems are designed in accordance with the current revision of NFPA 99 and ISO 7396-1.

There are three categories of Lifeline manifolds depending upon the delivery pressure. The following gas types are available for each delivery pressure:

55 PSI Delivery Pressure

- Oxygen
- Nitrous Oxide
- Medical Air
- Carbon Dioxide
- Helium
- Carbon Dioxide/Oxygen, CO₂ over 7%
- Oxygen/Carbon Dioxide, CO₂ not over 7%
- Helium/Oxygen, Helium over 80%
- Oxygen/Helium, Helium not over 80%
- Argon

100 PSI Delivery Pressure

- Oxygen
- Medical Air
- Carbon Dioxide

180 PSI Delivery Pressure

- Nitrogen
- Instrument Air

Refer to Table 1 for the manifold's specifications.

Parameter (psi)	Delivery (Line) Pressure - (see NOTE above)		
	55 PSI	100 PSI	180 PSI
Intermediate Pressure - Ready Bank	70 PSI	210 PSI	210 PSI
Dome Bias Pressure	55 PSI **	40 PSI	40 PSI
Intermediate Pressure - In Use Bank	125 ± 10 PSI *	250 ± 10 PSI	250 ± 10 PSI
Intermediate Relief Valve	350 PSI	350 PSI	350 PSI
Line Regulator Relief Valve	75 PSI	150 PSI	250 PSI
Changeover Pressure Switch (on pressure drop)	150 ± 5 PSI	300 ± 10 PSI	300 ± 10 PSI
Maximum Inlet Pressure	3000 PSI	3000 PSI	3000 PSI
Reserve In Use activation (ISO) If supplied****	150 ± 5 PSI ***	300 ± 10 PSI	300 ± 10 PSI
Reserve Low (ISO) If supplied	1500 ± 25 PSI ***	1500 ± 25 PSI	1500 ± 25 PSI

* The intermediate pressure value of the "In Use" bank is dependent upon the dome bias pressure. Variations from the 55 PSI delivery pressure will affect the intermediate pressure reading.

** Same as delivery pressure.

***For N₂O/CO₂ Reserve In Use = 210 ± 5 PSI, Reserve Low = 400 ± 25 PSI

**** This activation point happens when both changeover pressure switches open

Table 1

3.3 Manifold Components

Refer to Figures 13, 14, 15 & 16.

Master Valve Multi-turn high pressure valves allow flow from cylinders to be shut off. Master valves use metallic seating surfaces. Both master valves should always be turned to fully open, maximum counterclockwise position.

Bank Regulator A dome loaded, single-stage, piston diaphragm type regulator. Used to reduce incoming cylinder contents pressure to a lower intermediate pressure. Bank regulator (one for each bank of cylinders) has an internal adjusting spring used to set a “base” pressure of approximately 70 PSI (210 PSI on nitrogen manifolds). “Dome” (i.e. bonnet or bell) of regulator is a pressure tight chamber. When pressure is applied to dome, amount of force applied is added to force of adjusting spring. For example, when 55 PSI of pressure is applied to dome, 70 PSI base pressure setting is raised to approximately 125 PSI.

Changeover Pressure Switch An adjustable, single pole, normally open pressure switch. A pressure switch is connected to high pressure port of each bank regulator in order to monitor pressure in each bank of cylinders. When adequate cylinder pressure is applied, switch contacts are held closed. When cylinder pressure drops to switch setting of 150 PSI (300 PSI for nitrogen manifolds), switch contacts will open.

Pressure Transducer (TAE Version Only) A 4-20mA Pressure Transducers are used on the TAE version of the Manifold to monitor pressures in place of the switches used on the standard manifold. A Pressure Transducer is connected to the high pressure port of each bank regulator to monitor pressures in each bank of cylinders. Bank Pressure Transducers have a pressure range of 0-3000 psi. Another Pressure Transducer is connected downstream of the Line Regulators to monitor delivery pressure. Delivery Pressure Transducer

has a range of 0-300 psi. Transducers are NOT adjustable.

Check Valve Soft-seal check valves (not shown) are provided downstream of each bank regulator to allow service of upstream components while the other side of the manifold is in use.

Intermediate Relief Valve The intermediate relief valve protects the components between the bank regulators and the line regulators in the event of an overpressure condition caused by bank regulator failure. The outlet of the relief valve is piped to a common relief valve port on top of the manifold.

Line Regulator Isolation Valve Quarter-turn ball valves are provided upstream. These valves allow for removal and servicing of one line regulator while the other is in use. Both isolation valves are normally in the open position.

Line Regulator A single-stage, piston diaphragm type regulator used to reduce manifold's intermediate pressure to normal hospital line pressure. Two line regulators are provided per NFPA 99 requirements to allow for isolation and service of one while other is in use.

Line Relief Valve A relief valve to prevent overpressurization of the hospital piping system by failure of a line regulator. Outlet of relief valve is piped to a common relief valve port on top of manifold.

Dome Regulator A single-stage, diaphragm type, relieving regulator used to limit amount of pressure provided to domes of bank regulator. Used on manifolds greater than 55 psi delivery pressure.

Solenoid Valve A 24 VDC, solenoid assembly used to direct dome bias pressure to one of the bank regulators. As dome bias pressure is directed to one of the bank regulators, the dome of the other bank regulator is vented through the solenoid valve.

Source Shutoff Valve, ¼ turn valve used to isolate manifold from hospital piping for repair.

Control Board is installed in NEMA 4 enclosure pre-mounted to the back bracket. The electronic circuit board that controls manifold changeover. The control board monitors the pressure switches / transducers and controls the solenoid valve in order to initiate manifold changeover. The control board illuminates the appropriate front panel indicators and also provides dry contacts for activation of the external master alarms.

NOTE:

NFPA Basic Version Shown

Some components not shown for clarity.

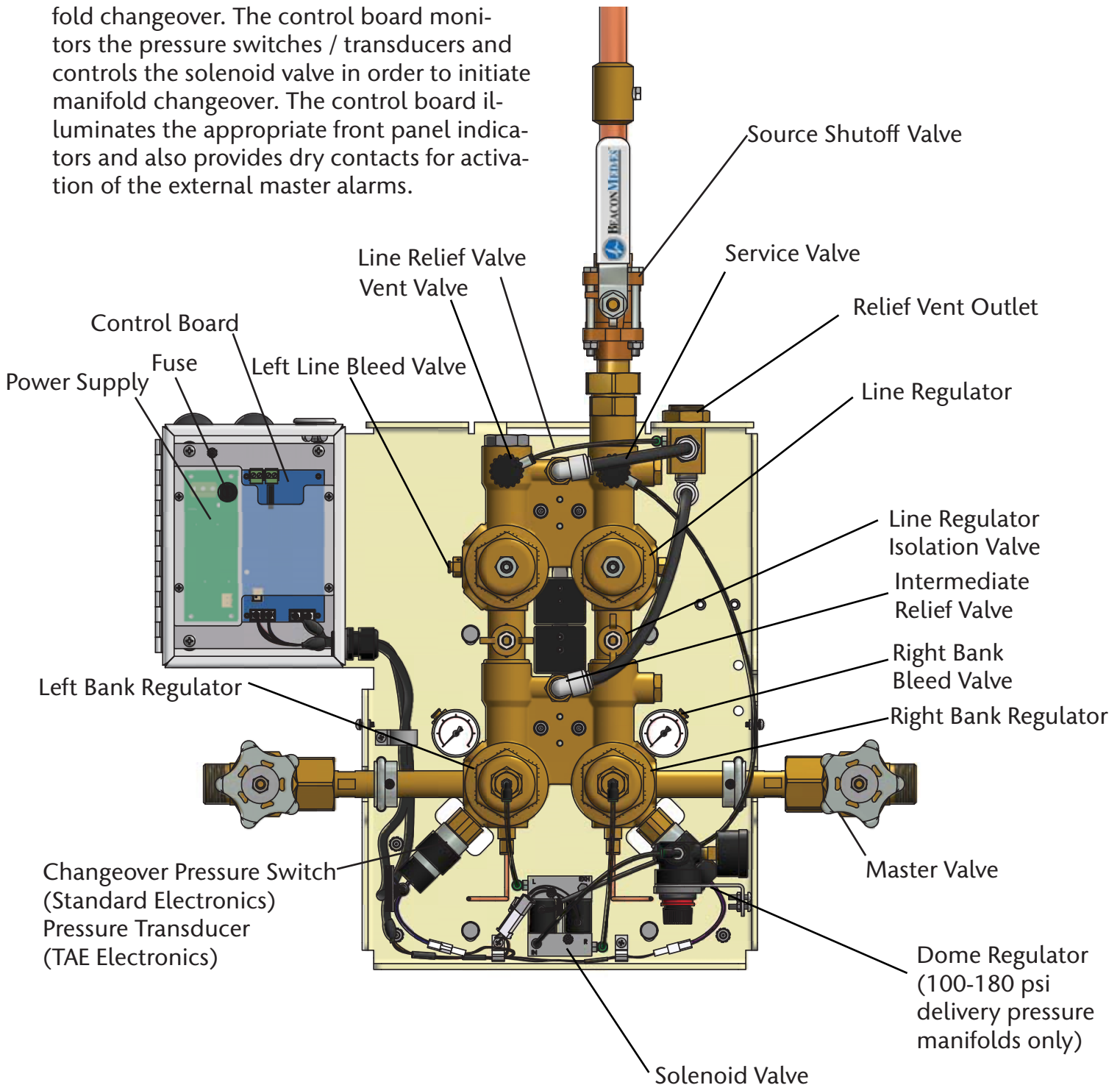


Figure 15 (NFPA version shown)

Manifold Components (Cont.)

NOTE:

ISO 7396-1 Basic Version Shown

Some components not shown for clarity.

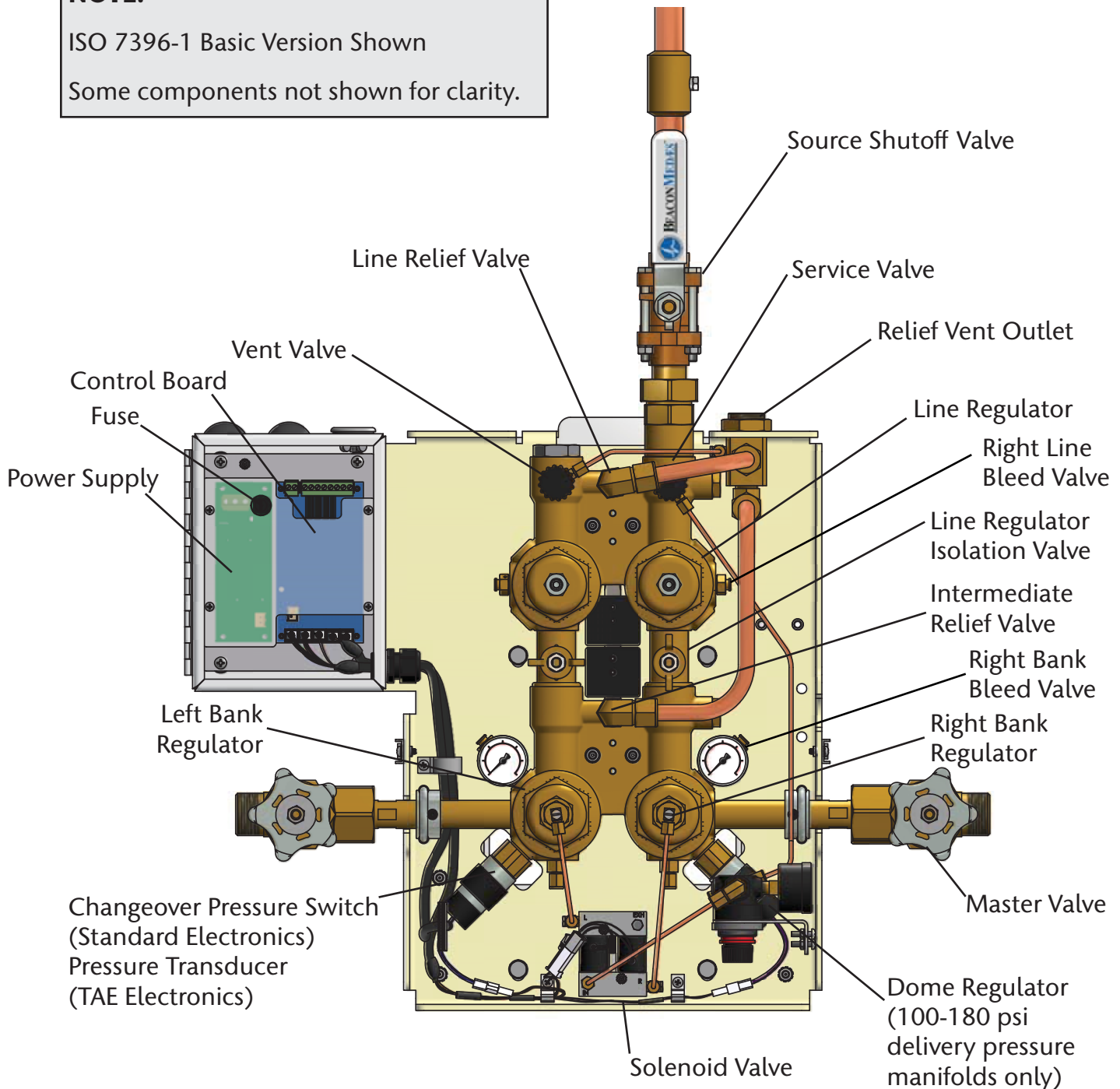
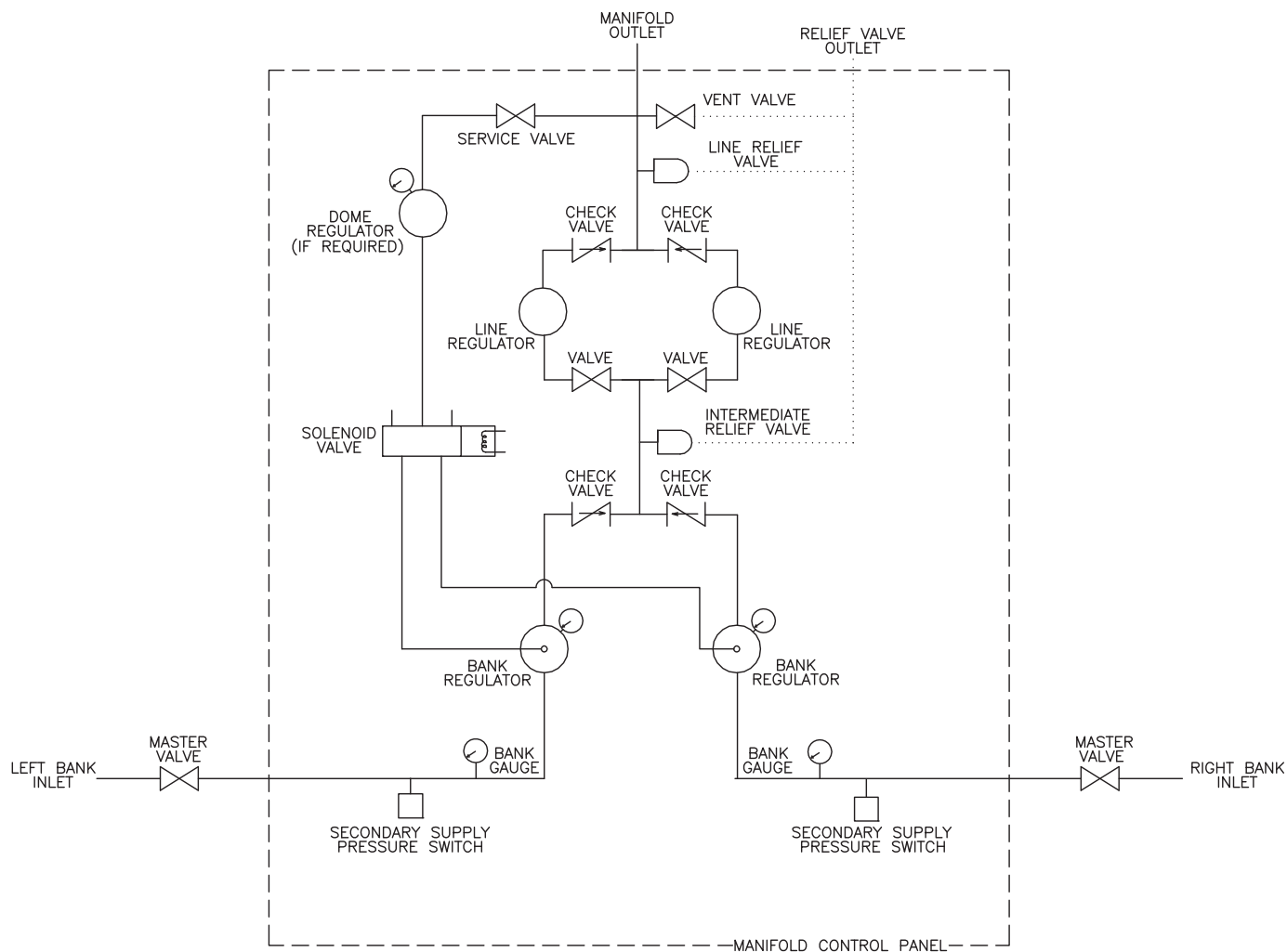


Figure 16 (ISO 7396-1 version shown)

Manifold Components (Cont.)




 HIGH PRESSURE BY HIGH PRESSURE NFPA/ISO
 TYPICAL FLOW DIAGRAM
 SCALE: NOT TO SCALE

Figure 17

Power Supply The power supply is 100-250 VAC to 24 VDC. The 24 VDC is connected to the manifold control board via a two conductor cable and connector. An in-line .25 amp slow-blow fuse is provided in 120 VAC power line. Terminal blocks on power supply allow for connection of AC input power.

3.4 Gas Flow Through the Manifold

Refer to Figure 17.

High pressure gas is provided to left and right manifold bank inlets via cylinders, pigtails, and header assemblies. Flow of high pressure gas through left and right side of manifold is exactly the same, each passing through a master valve and then directly to a bank regulator. Cylinder pressure is also applied to a normally open pressure switch (closes when pressure is applied) and a front panel high pressure gauge.

Bank regulators reduce incoming cylinder pressures to an intermediate pressure. Bank regulators are referred to as a “dome loaded” type of regulator. These regulators have an internal adjusting spring manually set at a specific pressure similar to other diaphragm type pressure regulators. In addition to internal adjusting spring, bias pressure may be applied to dome of regulator (adjusting spring side of diaphragm) thus boosting pressure above what is manually set by adjusting spring. This output pressure boost will be approximately equal to amount of bias pressure.

For example, if a bank regulator is manually adjusted to 70 PSI via internal adjusting spring, and a dome bias pressure of 55 PSI is applied, output pressure will increase to approximately 125 PSI (70 + 55). When bias pressure is removed, output pressure setting will return to 70 PSI.

Outputs of both left and right bank regulators pass through check valves and connect together upstream of a dual line regulator assembly. An intermediate relief valve protects components between bank and line regulators in the event of a bank regulator seat failure.

Dual line regulator assembly consists of two line regulators plumbed in parallel with upstream ¼-turn ball valves. Output of both line regulators tee together and exit at manifold's main outlet. A line relief valve and line pressure gauge are connected to manifold's main outlet.

Outlet pressure is routed to a dome regulator reducing pressure to 40 PSI at solenoid valve. Solenoid valve switches 40 PSI (dome bias pressure) to one of the bank regulators. When one bank regulator is supplied bias pressure, the other bank regulator's dome is vented to atmosphere. An electronic circuit board controls solenoid valve based upon input from right and left pressure switches. Solenoid valve directs bias pressure to bank designated as primary.

Manifolds designed for 55 PSI nominal output pressure do not incorporate a dome regulator. Full line pressure (55 PSI) is routed directly to solenoid valve and is used as dome bias pressure.

3.5 Manifold Changeover

After electrical power has been applied to manifold, side pressurized first is designated primary or "In Use" bank. In order to simplify the following explanation, we will arbitrarily select right side of manifold as primary bank. Green "In Use" and "READY" lights on right side is illuminated. Green "Ready" light is illuminated on left (secondary) bank.

Solenoid valve directs dome bias pressure to bank regulator on right side. If we use a 55 PSI oxygen manifold as an example, output of right bank pressure regulator is approximately 125 PSI (70 PSI base pressure + 55 PSI bias pressure). Output of left bank regulator is 70 PSI (base pressure only, no bias pressure). Since bank regulator on right side has highest pressure, all flow is supplied by right bank of cylinders.

As cylinder pressure on right side depletes, pressure falls to pressure switch setting (150 PSI). Right side pressure switch opens signaling circuit board to switch solenoid valve. Solenoid valve vents dome bias pressure from right bank regulator and directs bias pressure to left bank regulator. Green "IN USE" and "READY" lights on right side go out and red "Empty" light illuminates. Green "IN USE" light on left side illuminates. Circuit board alarm contacts open in order to activate master alarm panel changeover alarm. All flow is supplied by left bank of cylinders.

When cylinders on right side are replaced and pressure is restored, right pressure switch closes and signals circuit board. Circuit board will in turn, cancel remote switchover alarm, turn off right side red "EMPTY" light and illuminate right side green "Ready" light.

Since left bank regulator has dome bias pressure applied, its output pressure is boosted to approximately 125 PSI. Right bank regulator has no dome bias pressure and its output pressure is controlled only by base pressure (70 PSI). All flow is supplied by left bank of cylinders until pressure in left bank drops to left pressure switch setting (150 PSI). Left pressure switch then opens, causing changeover to right side in same fashion as previously described.

In the event of a power failure, unpowered solenoid valve will direct dome bias pressure to left bank regulator. A changeover alarm will be activated on master alarm panels. All flow will be supplied by left bank of cylinders until depleted. Right bank of cylinders will then automatically begin to supply flow.

Manual Changeover

The Manual Changeover Buttons allow the user to manually change banks for servicing and/or inspection. Press the left arrow to change the Left Bank to Primary/In Use. Press the right arrow to change the Right Bank to Primary/In Use.

4.0 Testing and Adjustments

4.1 Performance Verification

Use following test steps to verify manifold's functional performance.

1. Remove manifold cover.
2. Before beginning test, verify following:
 - Both left and right side master valves are turned to full counterclockwise open position.
 - Cylinders are attached to both sides of manifold and left and right bank pressure gauges indicate at least 1800 PSI (at least 600 PSI for Nitrous Oxide or Carbon Dioxide).
 - Power is applied to manifold.

⚠ WARNING:

If necessary, most service, adjustment, and testing can be performed while manifold is in service. However, this should only be done by qualified technicians experienced in servicing medical equipment. Servicing and testing manifold while not in use, with $\frac{3}{4}$ " source shutoff valve closed, is preferred. Following test procedure assumes manifold is not in service.

3. If manifold is not in use, close $\frac{3}{4}$ " source shutoff valve.
4. Verify right-side line regulator isolation valve is open and left-side line regulator isolation valve is closed.
5. As a starting point for this procedure, set manifold so right bank is in use. If right bank green light is illuminated, proceed to next step. If left bank green light is illuminated, manually switch manifold to right side by pressing right arrow button on overlay (See Figure 13 or Figure 14).
6. Verify only right bank green "IN USE," right bank green "READY" and left bank green "READY" lights are illuminated.

7. If manifold is connected to a master alarm panel, verify manifold changeover alarm is not activated.
8. If manifold is equipped with a dome regulator, verify dome regulator's gauge reads 40-45 PSI. If manifold does not have a dome regulator, proceed to next step.

NOTE:

The dome regulator's red locking ring must be pulled out away from the regulator body before adjustment knob can be turned. After adjustment, push locking ring inward to lock knob. Since dome regulator is self-relieving, it is recommended that dome regulator always be increased to the desired pressure. For example, if dome regulator pressure is too high, first lower pressure to approximately 30 PSI. Then raise pressure to between 40-45 PSI.

9. Slightly open vent valve to create a small flow of gas through manifold.
10. Verify pressure gauge reading (intermediate pressure - in use bank) on right-side bank regulator is as indicated in Table 1. If pressure is not correct, refer to Bank Regulator Pressure Adjustment procedure.
11. Verify front panel line pressure gauge reading is as indicated in Table 1 (delivery pressure). If pressure is not correct, refer to Line Regulator Pressure Adjustment procedure. Note reading for later use.

NOTE:

Line pressure values listed in Table 1 are nominal factory settings. Actual customer settings may vary.

12. Close vent valve. Watch pressure gauge readings of right side bank regulator and front panel line pressure gauge for at least five minutes. Readings may be slightly higher without vent flow. Verify readings do not continue to increase.
13. Close all cylinders on right side of manifold. Open vent valve slightly so front panel right bank high pressure gauge drops slowly. Verify manifold switches to left bank when right bank high pressure gauge drops to value indicated in Table 1. If pressure value is not correct, right pressure switch needs adjustment. Refer to Pressure Switch Adjustment procedure.
14. Close vent valve. Verify only left bank green "IN USE" and "READY" and right bank red "EMPTY" lights illuminate.
15. If manifold is connected to a master alarm panel, verify manifold changeover alarm is activated.
16. Slowly open one cylinder on right side. Verify right bank red "EMPTY" light goes out and right bank green "READY" light illuminates.
17. Close right-side line regulator isolation valve and open left-side line regulator isolation valve.
18. Slightly open vent valve to create a small flow of gas through manifold.
19. Verify pressure gauge reading (intermediate pressure - in use bank) on left-side bank regulator is as indicated in Table 1. If pressure is not correct, refer to Bank Regulator Pressure Adjustment procedure.
20. Verify front panel line pressure gauge reading is same as in step 11. If pressure is not correct, refer to Line Regulator Pressure Adjustment procedure.
21. Close vent valve. Watch pressure gauge readings of left side bank regulator and front panel line pressure gauge for at least five minutes. Readings may be slightly higher without vent flow. Verify readings do not continue to increase.
22. Close all cylinders on left side of manifold. Open vent valve slightly so front panel left bank high pressure gauge drops slowly. Verify manifold switches to right bank when left bank high pressure gauge drops to value indicated in Table 1. If pressure value is not correct, left pressure switch needs adjustment. Refer to Pressure Switch Adjustment procedure.
23. Close vent valve. Verify only right bank green "IN USE" and "READY" and left bank red "EMPTY" lights illuminate.
24. Slowly open one cylinder on left side. Verify left bank red "EMPTY" light goes out and left bank green "READY" light illuminates.
25. Open right side line regulator isolation valves.
26. Close left and right side cylinders.
27. Record pressure readings of left and right bank cylinder contents gauges.
28. Verify after 15 minutes, pressure gauge readings have not changed.
29. Slowly open all cylinders on both banks of manifold.
30. Using changeover buttons on overlay, switch manifold to bank of cylinders with least pressure.
31. Reinstall manifold control panel cover.
32. Open $\frac{3}{4}$ " source shut-off valve.

4.2 Bank Regulator Pressure Adjustment

The following procedure describes process of setting bank regulator's "base" pressure. This procedure should only need to be performed if bank regulator pressures were not within acceptable limits during performance verification procedure or after servicing regulator.

Base pressure setting is a mechanical adjustment controlled by regulator's internal adjusting spring and is regulator's output pressure without any dome bias. Recommended settings are listed in Table 1 under heading of "Intermediate Pressure - Ready Bank". After base pressure has been set, pressure will be increased by amount of dome bias pressure applied. Refer to Figures 13, 14, 15 & 16 for location of components called out in this procedure.

1. Remove front cover to expose changeover buttons located on the overlay.
2. Close service valve.
3. Using manual changeover buttons on overlay, cycle manifold from bank to bank to vent residual dome bias pressure.
4. Shut off all cylinders on the bank opposite of the regulator to be adjusted.
5. Slightly open vent valve (less than 1/4 turn) to create a small flow of gas through manifold.

NOTE:

By closing service valve, manifold's outlet pressure gauge is also isolated. Cycling manifold to vent residual dome bias pressure will also vent pressure shown on manifold's outlet pressure gauge. Actual outlet pressure supplied by manifold is not affected by following procedure.

6. Using a 1" wrench, loosen Bank Regulator Locknut.
7. Using $\frac{3}{4}$ " wrench, set bank regulator to the value specified in Table 1 (Intermediate Pressure - Ready Bank).
8. Tighten the Bank Regulator Locknut.
9. Close vent valve.
10. If other bank regulator also needs to be adjusted, repeat steps 4 through 9.
11. Slowly open all cylinders on both manifold banks.
12. Open service valve and reset dome regulator to 40 PSI (if app).
13. Verify manifold operation.
14. Install and secure front cover using the two latch hinges.

NOTE:

Dome regulator's red locking ring must be pulled out away from regulator body before adjustment knob can be turned. After adjustment, push locking ring inward to lock knob. Since dome regulator is self-relieving, it is recommended dome regulator always be increased to desired pressure. For example, if dome regulator pressure is too high, first lower pressure to approximately 30 PSI. Then raise pressure to between 40-45 PSI.

4.3 Line Regulator Pressure Adjustment

Following procedure describes process of setting line regulator pressure. This procedure should only need to be performed if line regulator pressures were not within acceptable limits during Performance Verification procedure or after installation of a new line pressure regulator.

When shipped from factory, inlet and outlet isolation valves to both line regulators are in open position. Refer to Figure 15 & 16 for location of components called out in this procedure.

NOTE:

If inlet and outlet isolation valves for both line regulators are open, manifold's outlet pressure gauge will indicate pressure of line regulator with highest setting. Verify setting of each regulator individually as described in following procedure.

1. Remove the front cover.
2. Open the right-side Line Regulator Isolation Valve and close the left-side Line Regulator Valve.
3. Slightly open vent valve (less than 1/4 turn) to create a small flow of gas through manifold.
4. Using a 16mm wrench, loosen the right Line Regulator Locknut.
5. Using 5mm Hex Key wrench, turn the Right Line Regulator Adjusting Screw to achieve an appropriate output pressure gauge reading. Note reading for later use. Refer to Table 1 (delivery pressure) for factory settings.
6. Tighten the Right Line Regulator Lock Nut.
7. Open left-side Line Regulator Isolation Valve and close the right-side Line Regulator Isolation Valve.

8. Using a 16mm wrench, loosen Line Regulator Locknut.
9. Using 5mm Allen wrench, turn left-side Line Regulator Adjusting Screw to achieve the same outlet pressure gauge reading as noted in step 4.
10. Tighten the left Line Regulator Lock Nut.
11. Close Vent Valve.
12. Open right-side Line Regulator Isolation Valve.
13. Verify manifold operation.
14. Install and secure front cover using the two latch hinges.

4.4 Changeover Pressure Switch Adjustment

Following procedure describes process of setting pressure switches. This procedure should only need to be performed if manifold changeover pressures were not within acceptable limits during Performance Verification procedure. Recommended settings are listed in Table 1.

Pressure switch is a normally open type that closes when pressure in excess of switch setting is applied. When cylinder pressure is applied to both banks of manifold, both pressure switches are closed. When cylinder pressure of "IN USE" bank drops to switch setting, manifold will switch to opposite cylinder bank. Switches should always be adjusted as pressure decreases. If pressure switch can not be set, switch must be replaced. Pressure switches are not repairable. Refer to Figure 15 & 16 for location of components called out in this procedure.

1. Verify at least one cylinder is open on each bank of manifold.
2. Using the manual changeover buttons on the overlay, switch manifold to bank whose pressure switch is to be adjusted. For example, if pressure switch on right side is to be adjusted, press right arrow button on the overlay so green "IN USE" light on right bank is illuminated.

3. Close cylinders on “IN USE” bank.
4. Slightly open vent valve to create a small flow of gas through manifold. Front panel cylinder contents gauge for “IN USE” bank should begin to drop. Adjust vent valve so gauge drops very slowly.
5. Note gauge reading when manifold changeover takes place. Recommended settings are listed in Table 1.
6. Close vent valve.
7. If switch adjustment is necessary, slide collar of switch toward wires to access internal adjustment barrel. Insert tip of small screwdriver or Allen wrench into adjustment barrel and rotate barrel (Figure 18).
8. Slowly open one cylinder on bank of manifold just tested.
9. Using manual changeover buttons on overlay, switch manifold back to bank just tested.
10. Repeat steps 3 through 9 until pressure switch(es) have been set within acceptable limits.
11. Slide pressure switch collar back to original position.
12. Slowly open all cylinders on both banks of the manifold.

NOTE:

When viewing switch from wire end, rotating barrel clockwise will raise switch setting. Counterclockwise rotation will lower switch setting. Make small adjustments and retest as described in section 4.4.

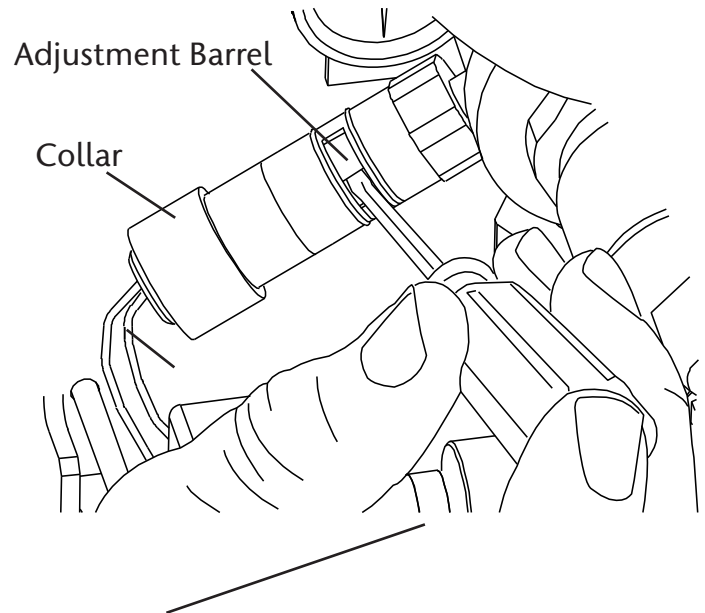


Figure 18

5.0 Service Procedures

5.1 Precautions

WARNING:

- Tampering with gas-specific connections shall be prohibited. Do not alter, remove or modify gas specific connections.
- Keep all manifold parts, tools, and work surfaces free of oil, grease, and dirt. These and other flammable materials may ignite when exposed to high pressure oxygen or nitrous oxide.
- Use only proper repair tools and parts. Use only approved repair parts provided by BeaconMedaes.
- Do not use chemicals, lubricants or sealants unless specified in these instructions.
- Before connecting cylinder to manifold, momentarily open and close cylinder valve to blow out dirt and debris.
- After connecting cylinder to manifold, open cylinder s-l-o-w-l-y to allow heat of compression to dissipate.
- Do not use flame or “sniff” test for leaks.
- Do not apply heat to any part of manifold system.
- Always secure cylinders with racks, straps, or chains. Unrestrained cylinders may fall over and damage or break off cylinder valve.
- Do not repeatedly bend, sharply bend, or twist copper pigtails as damage to tubing may occur.
- Do not bend flexible pigtails into a radius smaller than 3”.

5.2 Routine Maintenance

Daily:

- Visually inspect manifold for normal operation. Record front panel indicator status (e.g. left bank “IN USE,” right bank “READY”).
- Record left and right bank pressure gauge readings.
- Record line pressure gauge reading.

At Cylinder Replacement:

- Visually inspect each pigtail for cleanliness, and damage. Do not use and immediately replace dirty or damaged pigtails.
- Check for leaks at cylinder to pigtail connection using oxygen compatible leak detector solution.

Annually:

- Verify manifold operation using Performance Verification procedure.

Every 3-5 Years:

- Replace pigtails.

5.3 Techniques for Leak-Tight Connections

Lifeline manifold utilizes three different types of connection between internal components.

- Parker brand “A-Lok” fittings.
- Parker brand “Prestolock” fittings.
- O-ring face seal fittings.

Parker brand “A-Lok” fittings are a type of compression fitting. Mark nut and fitting prior to disassembly. Before retightening, make sure assembly has been inserted into fitting until ferrule seats in fitting. Retighten nut by hand. Torque nut with wrench until marks line up, which indicates that fitting has been tightened to its original position. A noticeable increase in mechanical resistance will be felt indicating ferrule is being resprung into sealing position. Then, tighten nut $\frac{1}{2}$ of a turn ($\frac{1}{2}$ of a wrench flat) past original position. If tightening a fitting for first time, make sure tube has been inserted completely into fitting and tighten nut by hand. Wrench tighten nut an additional 1- $\frac{1}{4}$ turns.

Parker brand “Prestolock” fittings are used throughout manifold to attach each end of black nylon tubes (NFPA 99 version only). To release tube from fitting, press fitting’s release button against body while pulling tube out. If you experience difficulty, open a Crescent wrench so that it just slides over outside of nylon tube. Push side of Crescent wrench against fitting’s release button while pulling out on tube. Verify end of tube is cut square and free of burrs and debris. Insert tube into fitting until it bottoms. Pull on tubing to verify it is properly retained in fitting.

O-ring face seal fittings are used on main outlet and relief valve vent outlet unions and four line regulator isolation valve unions. Leaks at these connections can be caused by damaged O-rings or scratches / nicks in brass fittings where O-rings contact. Replace either O-ring or fitting as necessary to correct leak. Lubrication of O-ring is not required.

5.4 Changeover Pressure Switch/ Transducer Replacement

See Figures 15 & 16

Following procedure describes process of replacing pressure switch/transducer. If necessary, pressure switch replacement can be performed while manifold is in service. However, this should only be done by qualified technicians experienced in servicing medical equipment.

1. Close all cylinders on side of manifold where pressure switch will be replaced.
2. Vent pressure from bank that was shut off in step 1 by pushing bleed valve located near the bank pressure gauge.
3. Disconnect pressure switch/transducer wires at white connector.
4. Verify all pressure has been vented. Remove old pressure switch/transducer from bank regulator body.
5. Install new pressure switch/transducer
6. Tighten switch/transducer snug fit. Do not overtighten.
7. Route switch wires and reconnect switch to the white electrical connector. Secure wires with cable ties.
8. S-l-o-w-l-y open each cylinder on side of manifold where pressure switch was replaced.
9. Verify new switch/transducer is set correctly by performing appropriate steps of Performance Verification procedure.

CAUTION:

Bank regulator high pressure ports incorporate filter material in each port.

Take care not to dislodge filter when removing and reinstalling pressure switch.

5.5 Bank Regulator Maintenance

See Figures 15,16 & 19.

IMPORTANT: Vent all inlet pressure and outlet pressure to 0 psig prior to servicing the regulator. Make sure assembly is performed in a clean environment free of any oils and grease (hydrocarbons). Use care as not to damage the regulator's sealing surfaces. Scratches or other damage to certain surfaces may render regulator non-repairable.

Following procedure describes process to service bank regulator. If necessary, bank regulator service can be performed while manifold is in service. However, this should only be done by qualified technicians experienced in servicing medical equipment. Internal repair of bank regulator is not recommended.

1. Close all cylinders on side of manifold where bank regulator will be repaired.
2. Vent pressure from bank that was shut off in step 1 by pressing the bleed valve.
3. Disconnect tubing from bank regulator by depressing ring on fitting.
4. Using a 1" Wrench, loosen Bank Regulator Locknut.
5. Using a ¾" Wrench, turn the Bank Regulator Adjustment Screw counter-clockwise to release all spring tension. Remove Adjustment Screw/Locknut and set aside in clean area.
6. Using a 2" Socket, remove the Spring Chamber.
7. Using a Screwdriver, insert into top of Spring Chamber past Adjustment Screw threads and push on the Spring Button to push out Piston Diaphragm, Spring and Spring Button. Set components aside in a clean area.
8. Remove Pusher Post Button and set aside.
9. Using a Plastic Pick, remove the Regulator/Body O-ring. Discard O-ring.
10. Using a 7/8" Socket, remove the Seat Ring by turning counter-clockwise.
11. Discard Seat Ring w/O-ring.
12. Remove Piston Sub-Assembly and discard.
13. Verify the Piston Spring remains in place within regulator body.
14. Insert new Piston Sub-Assembly.
15. Insert new Seat Ring and remove spring pressure from seat ring during installation by pressing on piston sub-assembly while screwing in the seat ring.
16. Assemble Pusher Post Button.
17. Insert new Regulator/Body O-ring. Use care to place uniformly in groove.
18. Using Plastic pick, remove old O-ring from Piston Diaphragm and install new one included in kit.
19. Stack Piston Diaphragm, Spring and then the Spring Button together.
20. Place Spring Chamber on top of these components to capture them. The O-ring on the Piston Diaphragm should hold all the components in the Spring Chamber.
21. Assemble Spring Chamber to the Regulator Body. Tighten to 50 ft-lbs.
22. Using a Plastic Pick, remove the Adjustment Screw O-ring. Discard O-ring.
23. Assemble new Adjustment Screw O-ring.
24. Put Locknut on Adjustment Screw and assemble to Spring Chamber.
25. Turn Adjustment Screw until desired set pressure is reached.
26. Tighten Locknut.
27. Verify manifold operation.

NOTE:

Refer to Techniques For Leak-Tight Fittings for recommendations concerning removal and reassembly of fittings.

NOTE:

Check valves downstream of bank regulators will prevent back flow. Check valves are intended to prevent gross leaks during service and may not be bubble tight.

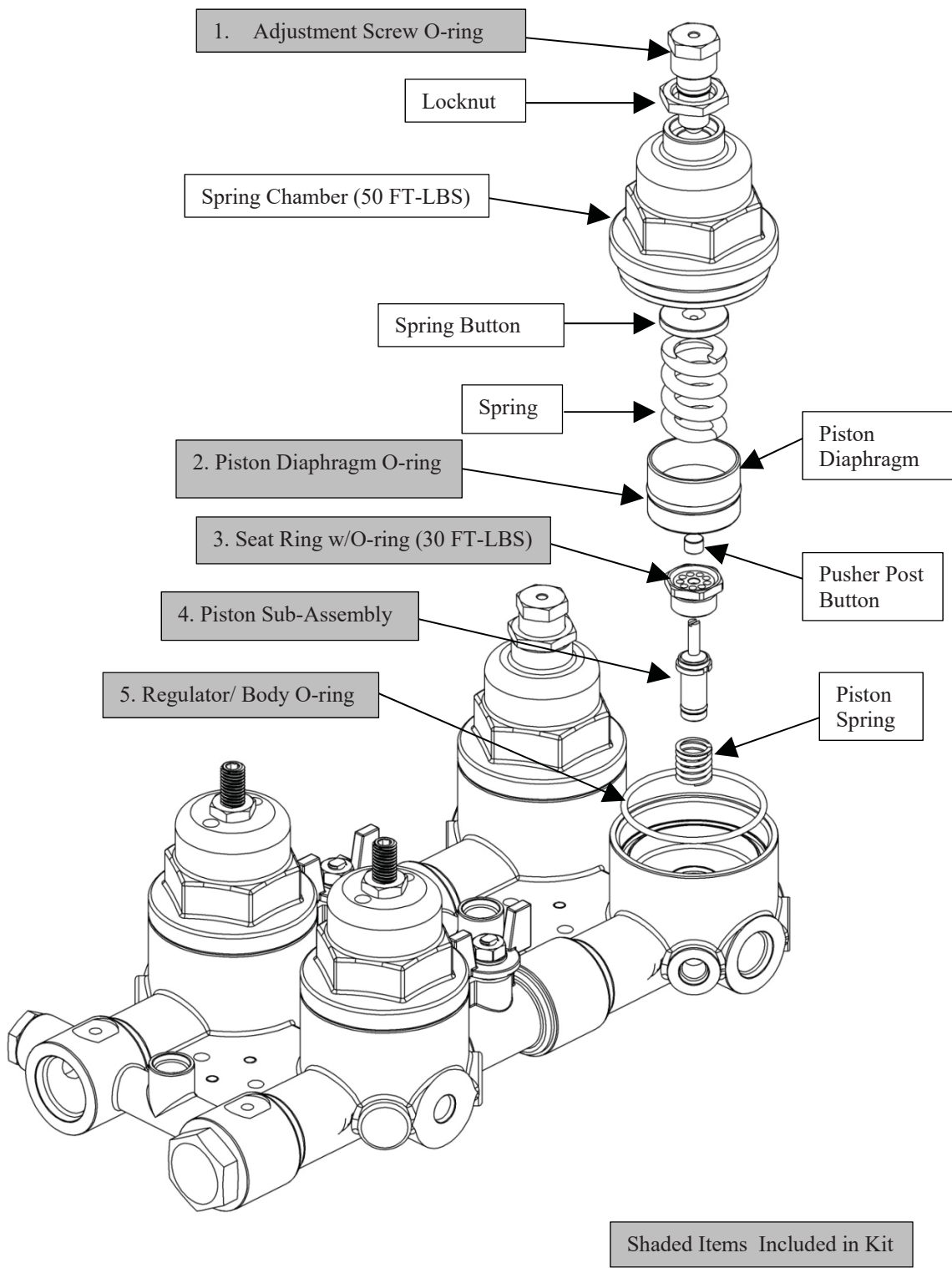


Figure 19: NFPA/ISO version HP x HP Manifold Shown.

5.6 Line Regulator Maintenance

See Figure 20.

IMPORTANT: Vent all inlet pressure and outlet pressure to 0 psig prior to servicing the regulator. Make sure assembly is performed in a clean environment free of any oils and grease (hydrocarbons). Use care as not to damage the regulator's sealing surfaces. Scratches or other damage to certain surfaces may render regulator non-repairable.

1. Close line regulator isolation valve upstream of the regulator being repaired.
2. Vent all inlet and outlet pressure of line-regulator to 0 psi by pressing the bleed valve. (Figure 15 & 16)
3. Using a 16mm Wrench, loosen Line Regulator Locknut.
4. Using a 5mm Hex Key Wrench, turn Line Regulator Adjustment Screw counterclockwise to release all spring tension. Remove Adjustment Screw/Locknut and set aside in clean area.
5. Using a 2" Socket, remove Spring Chamber.
6. Using a Screwdriver, insert into top of Spring Chamber past Adjustment Screw threads and push on Spring Button to push out Piston Diaphragm, Spring and Spring Buttons. Set components aside in a clean area.
7. Remove Pusher Post Button and set aside.
8. Using a Plastic Pick, remove Regulator/Body O-ring. Discard O-ring.
9. Using the $\frac{7}{8}$ " Socket, remove Seat Ring by turning counter-clockwise.
10. Discard Seat Ring w/O-ring.
11. Remove Piston Sub-Assembly and discard.
12. Verify Seat Spring and O-ring remains in place within regulator's body.
13. Insert new Piston Sub-Assembly.
14. Insert new Seat Ring and remove spring pressure from seat ring during installation by pressing on piston sub-assembly while screwing in the seat ring.
15. Assemble Pusher Post Button.
16. Insert new Regulator/Body O-ring. Use care to place uniformly in groove.
17. Using Plastic Pick, remove old O-ring from Piston Diaphragm and install new one included in kit.
18. Stack Piston Diaphragm, Spring and Spring Buttons together.
19. Place Spring Chamber on top of these components to capture them. The O-ring on Piston Diaphragm should hold all components in Spring Chamber.
20. Assemble Spring Chamber to the Manifold Body. Tighten to 50 ft-lbs.
21. Put Locknut on Adjusting Screw and assemble to Spring Chamber.
22. Turn Adjustment Screw until desired set pressure is reached.
23. Tighten Locknut.
24. Verify manifold operation.

NOTE:

Refer to Techniques For Leak-Tight Fittings for recommendations concerning removal and reassembly of fittings.

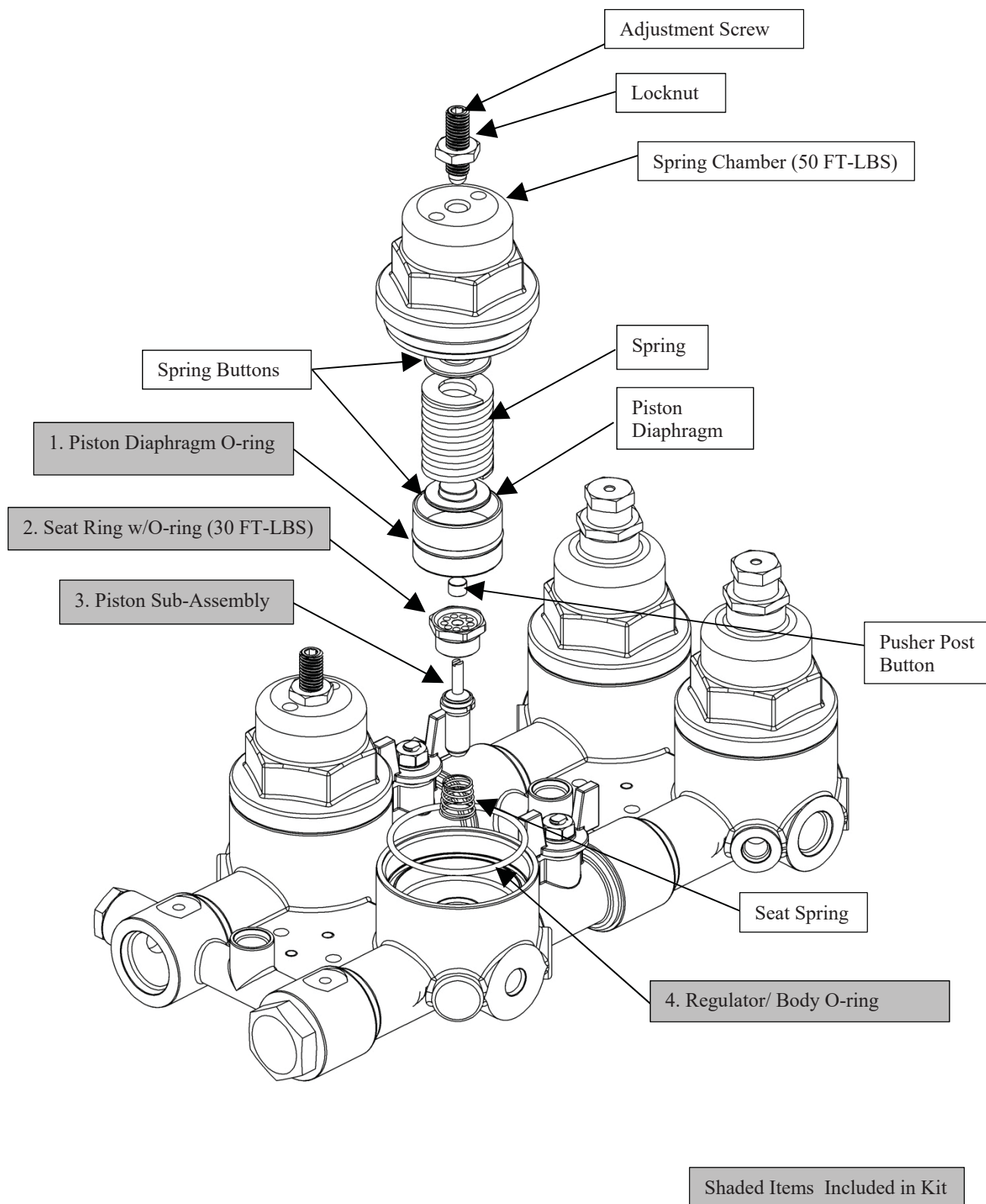


Figure 20: NFPA/ISO version HPxHP Manifold Shown.

5.7 Check Valve/Ball Valve Replacement

See Figures 21 and 22.

IMPORTANT: Check Valve replacement will require a COMPLETE MANIFOLD SHUTDOWN.

IMPORTANT: Vent all inlet pressure and outlet pressure to 0 psig prior to servicing. Make sure assembly is performed in a clean environment free of any oils and grease (hydrocarbons).

Bank Regulator Check Valve/Ball Valve Replacement (NFPA 99 Version)

1. Remove regulator assembly from system.
2. Remove (2) Socket Head Cap Screws connecting Bracing Bar to Line Regulator section.
3. Carefully pull out (2) Ball Valves with Line Regulator section as shown in Figure 18.
4. Using Retaining Ring pliers, remove Retaining Ring holding in Check Valve.
5. Using Needle Nose pliers grasp the Guide of Check Valve and pull Check Valve out of the manifold Body. See Figure 21 and 22.
6. Insert new Check Valve supplied.
7. Using Needle Nose pliers, push on Check Valve Body. You will feel the O-ring on Check Valve engage the Body.
8. Insert Retaining Ring into Body to secure the Check Valve. A new Retaining Ring is included in the kit should you lose one.

CAUTION:

Make sure Retaining Ring is fully engaged in the groove.

9. Re-assemble Line Regulator, Ball Valves and Bank Regulator. Use care to engage pin on small end of ball valve into slot on line regulator body. Firmly press together Bank and Line sections together and tighten the (2) Socket Head Cap Screws hand tight.
10. Tighten Socket Head Cap screws to 150 in-lbs.
11. Reassemble regulator assembly into manifold.
12. Verify manifold operation.

Line Regulator Check Valve Replacement (NFPA 99/ISO 7396-1 Verison Only)

1. If replacing left side check valve, remove SAE-12 Plug to gain access to the Check Valve. If replacing the right side check-valve, remove Outlet Adapter.
2. Using Retaining Ring pliers, remove Retaining Ring holding in Check Valve.
3. Using Needle Nose pliers grasp the Guide of Check Valve and pull Check Valve out of the manifold Body. See Figure 21 and 22.
4. Insert new Check Valve supplied.
5. Using Needle Nose pliers, push on Check Valve Body. You will feel the O-ring on Check Valve engage the Body.
6. Insert Retaining Ring into Body to secure the Check Valve. A new Retaining Ring is included in the kit should you lose one.
7. Reassemble item(s) from step 1 above.
8. Verify manifold operation.

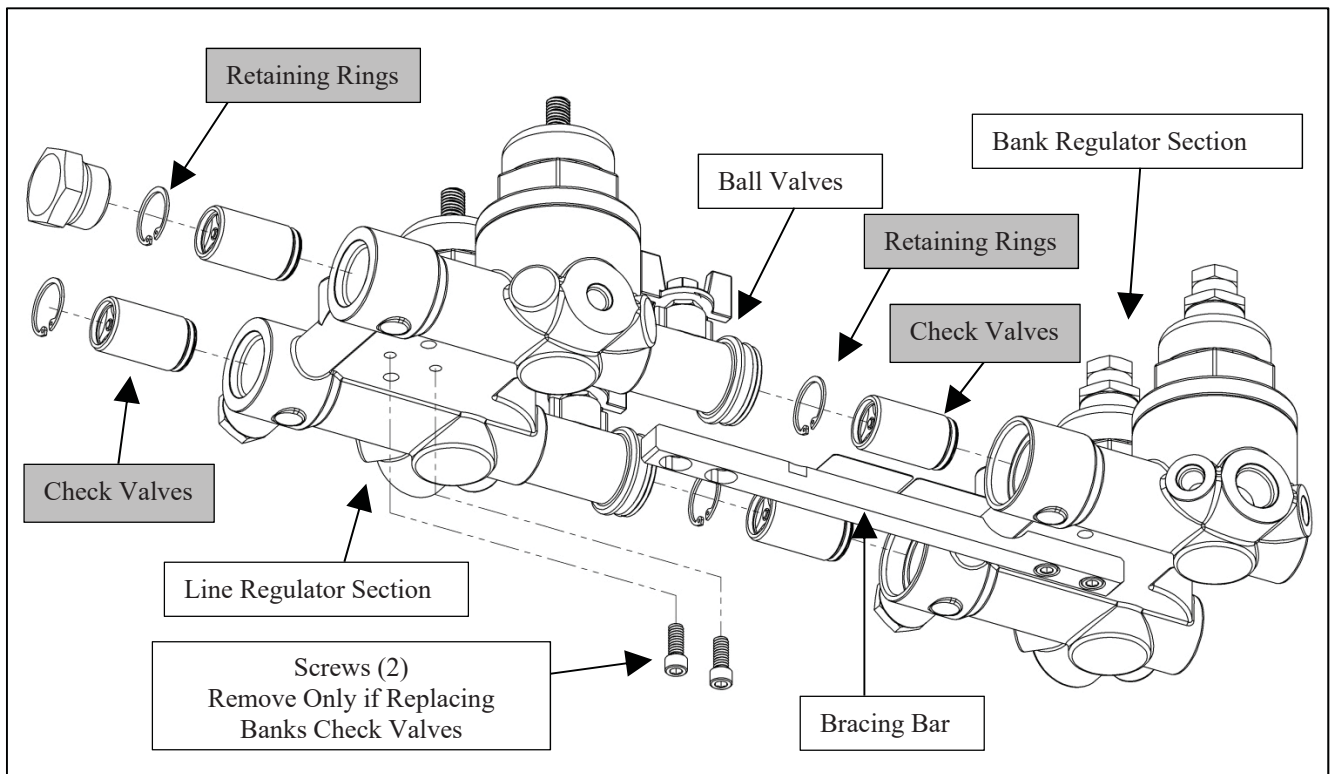


Figure 21: Check Valve Removal. NFPA/ISO Version Shown.

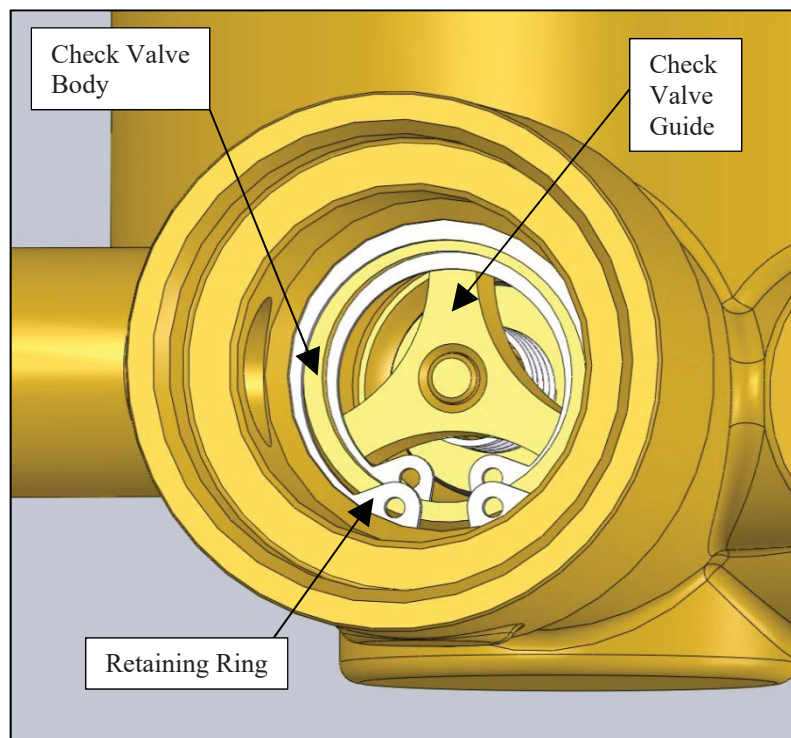


Figure 22: Check Valve Installation Close-up.

5.8 Control Board Replacement

See Figure 9 and 24.

Following procedure describes process of replacing manifold's electronic control circuit board. If necessary, control board replacement can be performed while manifold is in service. However, this should only be done by qualified technicians experienced in servicing medical equipment. Repair of the control board is not recommended.

1. Disconnect power from the manifold.
2. Remove 4 screws from plastic plate covering boards.
3. Disconnect pluggable terminal blocks, control connections and power supply cable on the control board, disconnect the Ethernet cable if equipped (TAE models only).
4. Remove control board by pulling the circuit board off the mounting stand-offs.
5. Check removeable jumpers JP1-6 on new circuit board to match orientation of old circuit board.
6. Install new control board on to mounting stand offs.
7. Connect each wire to appropriate terminal.
8. Replace plastic plate to cover boards with 4 screws.
9. Restore Power. Verify correct operation of new control board by performing Performance Verification.

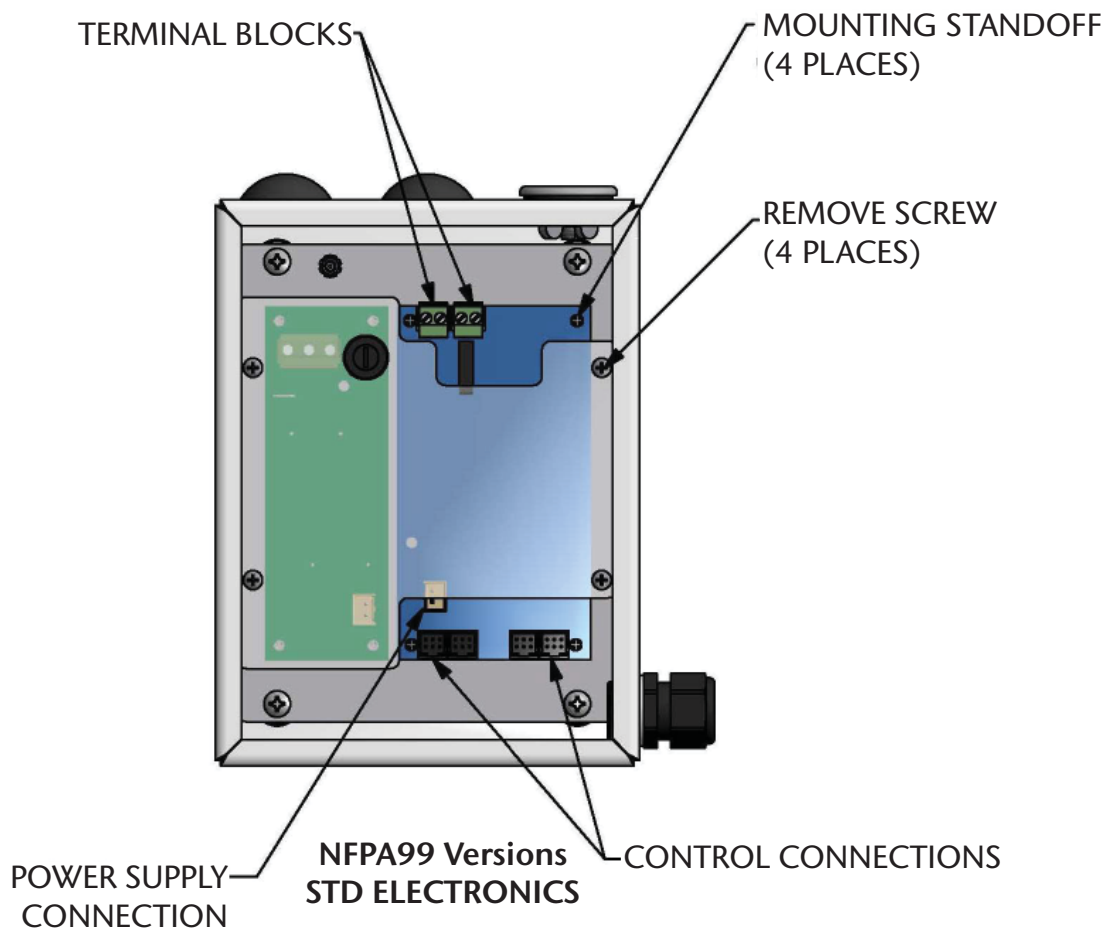


Figure 24: Control Board Replacement.

5.9 Wiring Diagram
NFPA (Standard Electronics)

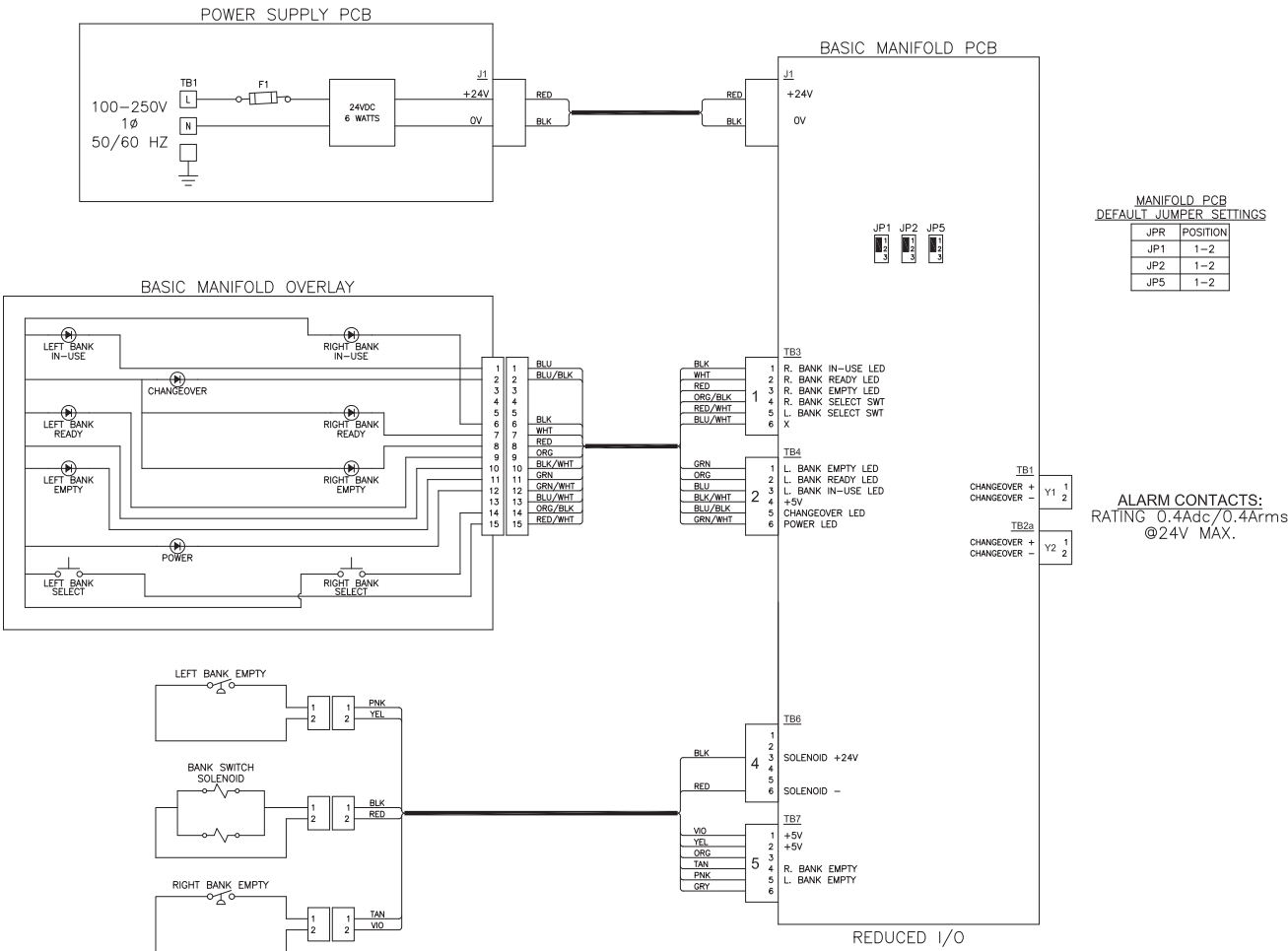


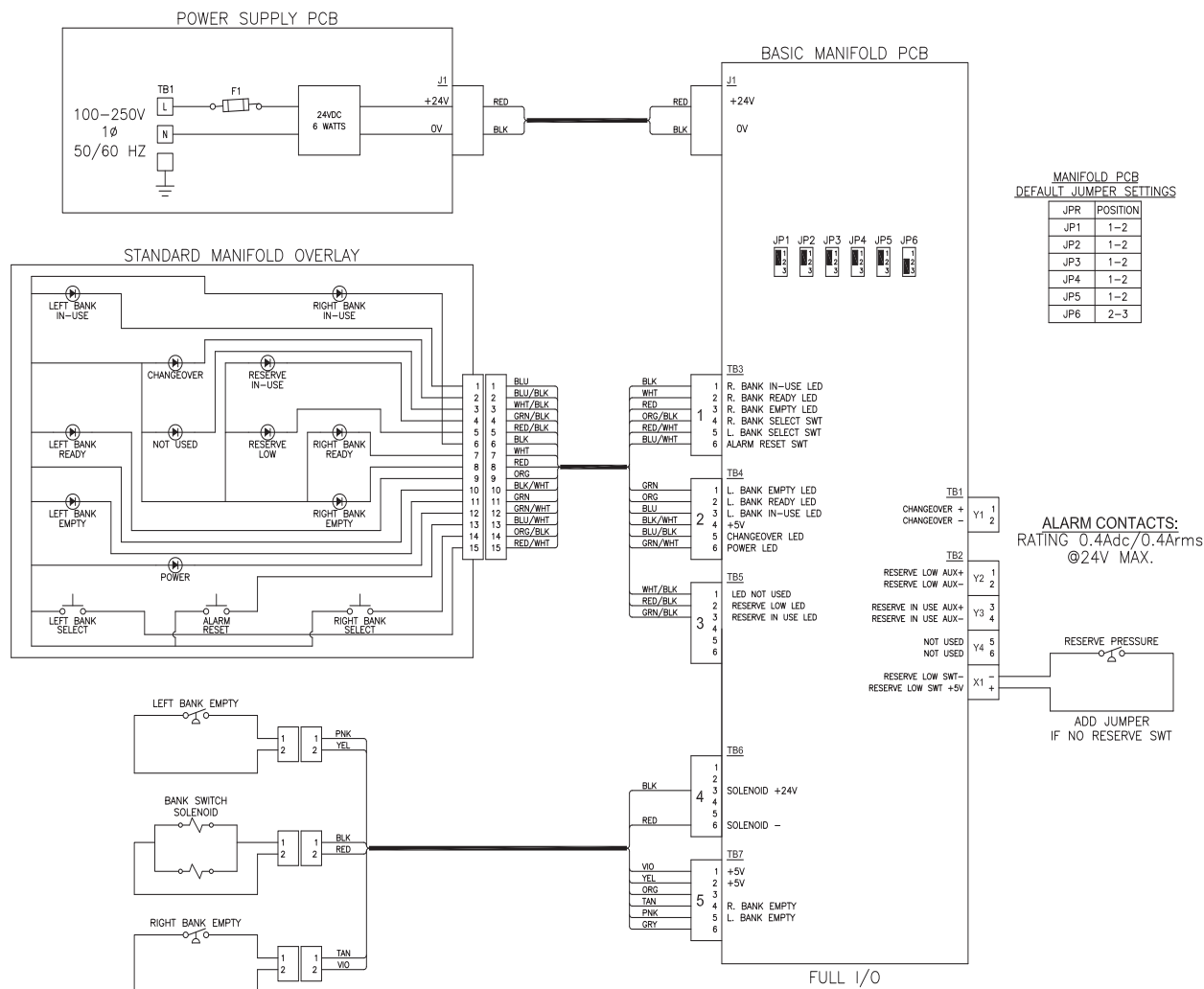
Figure 25

NFPA (TAE Electronics)

Figure 26

5.9 Wiring Diagram

ISO (Standard Electronics)



5.9 Wiring Diagram
ISO (TAE Electronics)

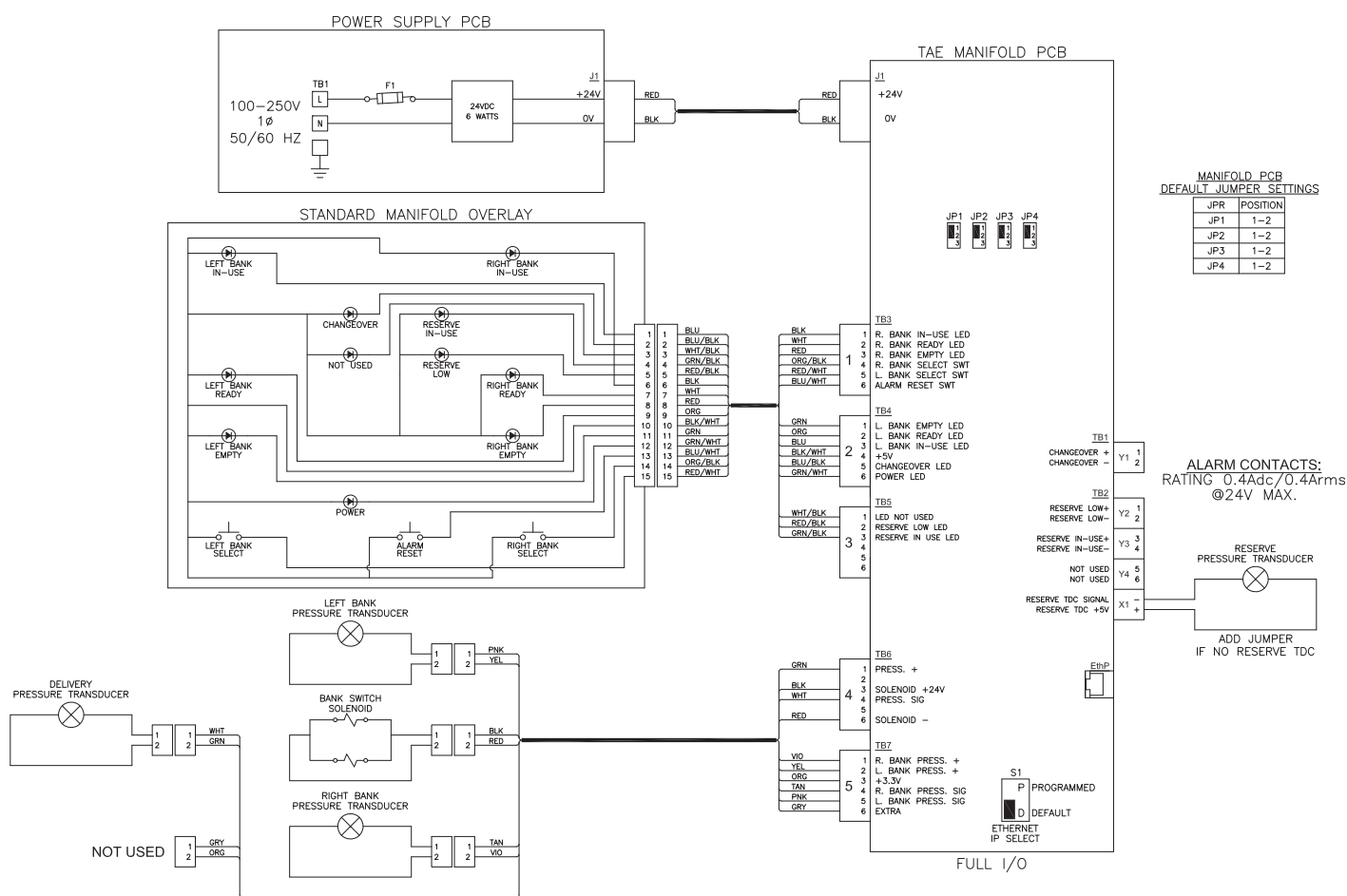


Figure 28

6.0 TotalAlert Embedded (TAE)

6.1 Remote Monitoring

CAUTION: The information systems personnel should be notified before changing any of the network settings. Changing the settings could keep the equipment from working properly.

Set Up: Equipment Required

- PC with an Ethernet connection
- PC with a web browser, such as Microsoft Internet Explorer
- Cat5 or better Ethernet cable

6.2 Set Up: Physical Connection

WARNING:

ONLY CONNECT THE CUSTOMER NETWORK TO THE CUSTOMER ETHERNET CONNECTION AS SHOWN IN FIGURE 29.

NOTE:

Factory Default IP Address:

169.254.100.100

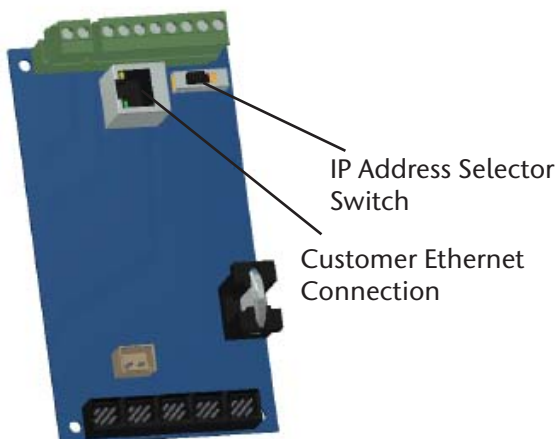


Figure 29: Connecting the cable

1. Place the IP Address Selector Switch in the Left-hand position.
2. Using a Cat5 Ethernet cable, connect the manifold to an Ethernet switch or hub. Connect the cable to the Customer's Ethernet Connection on the control board.
3. Verify the green LINK LED on the control board illuminates.

6.3 Set Up: Network Configuration

1. IP Address can only be configured using the Static Method: Upon power up of the system, the device will immediately begin using the fixed IP configuration.
2. The IP Address Selector Switch allows the user to choose between Factory Default IP address and a User Defined IP Address.
3. The IP Address Selector Switch left-hand position is for the factory default IP Address, which is 169.254.100.100. This cannot be changed.
4. The Selector Switch right-hand position is for the user defined IP Address. User defined IP Address must be set up using the TAE webpage.
5. The middle position of the switch is not used.

6.4 Set Up: Connecting to the Embedded Website of the manifold.

1. Ensure that the IP Address Selector Switch is in the left hand position.
2. Start a web browser, such as Microsoft Internet Explorer.
3. Enter the default IP address into the browser's address bar:
http://169.254.100.100

6.5 Log in to Setup Pages

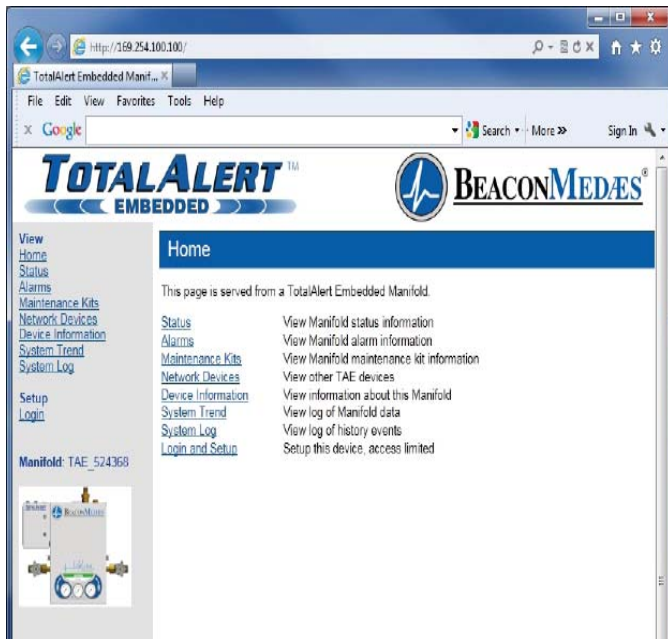


Figure 30: Manifold Home Page

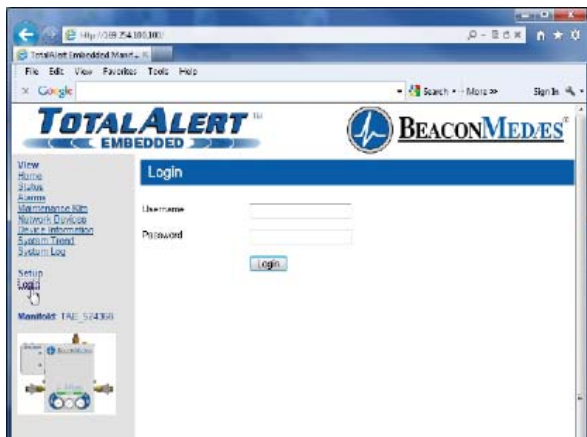


Figure 31: Login for Setup Pages

1. Once connected to the TotalAlert Embedded control system, your browser will display the typical home page (Figure 30).
2. Click "Login" on the menu bar in the left pane. The web browser will request a username and password (Figure 31).
3. The factory defaults are:
Username: new
Password: new
4. The left sidebar will now contain the setup links (Figure 32).

6.6 Device Setup

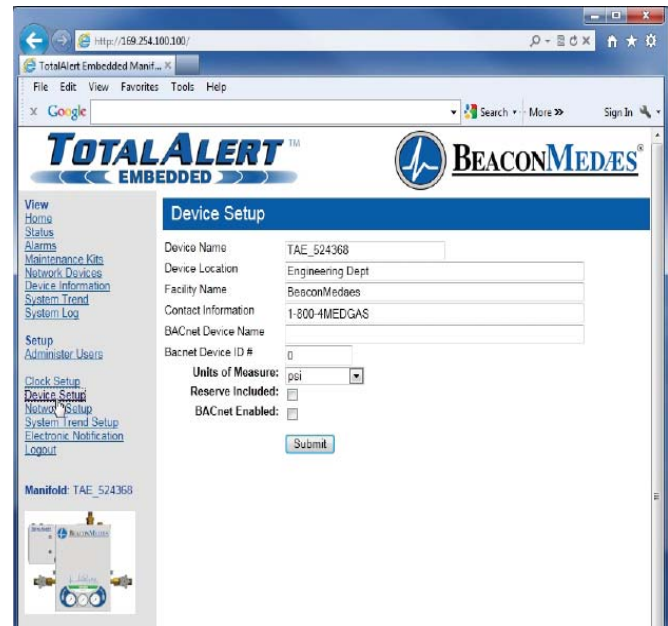


Figure 32: Device Setup

This Device Setup page (Figure 32) is used to configure the manifold name, location, facility name, and contact information.

1. Click Device Setup to access the Device Setup page.
2. Enter the new device name.
3. Enter the location
4. Enter the facility description.
5. Enter the contact information.
6. Click the Submit button.

6.7 Network Setup

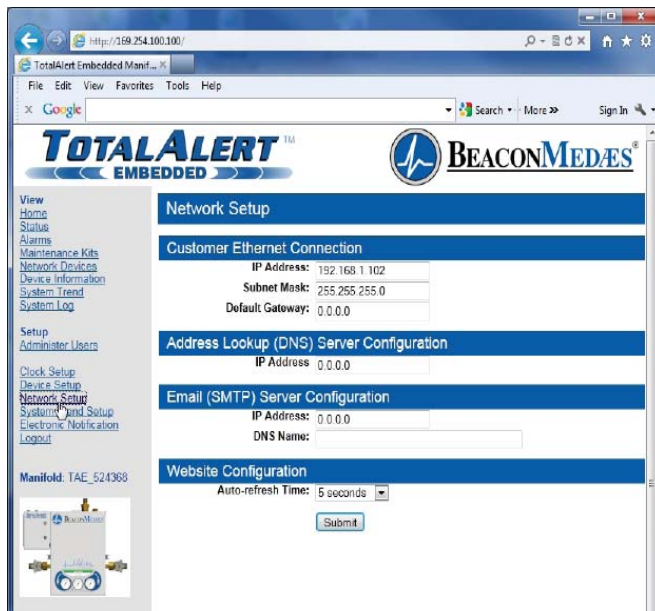


Figure 33: Network Setup

This Network Setup page (Figure 33) is used to configure the facility network information, e-mail server configuration, and webpage auto refresh rate.

NOTE: Obtain the IP Address and DNS Name from the facility's Information Systems department.

To Configure the Customer Ethernet Connection:

1. Click Network Setup to access the Network Setup page.
2. Enter the desired IP Address and Subnet Mask.
3. Click Submit.
4. This User Defined IP Address will only work if the IP selector switch is in the Right Hand Position.

To Configure Email Server:

1. Click Network Setup to access the Network Setup page.
2. If DNS name (Address Lookup) is to be used, enter the IP Address for the DNS Server configuration.
3. Enter the IP Address for the email SMTP server or the Server Name (if Address Lookup is used).

4. Click Submit.

To set the desired Website refresh rate:

1. Select the desired refresh rate.
2. Click Submit.

6.8 System Trend Setup

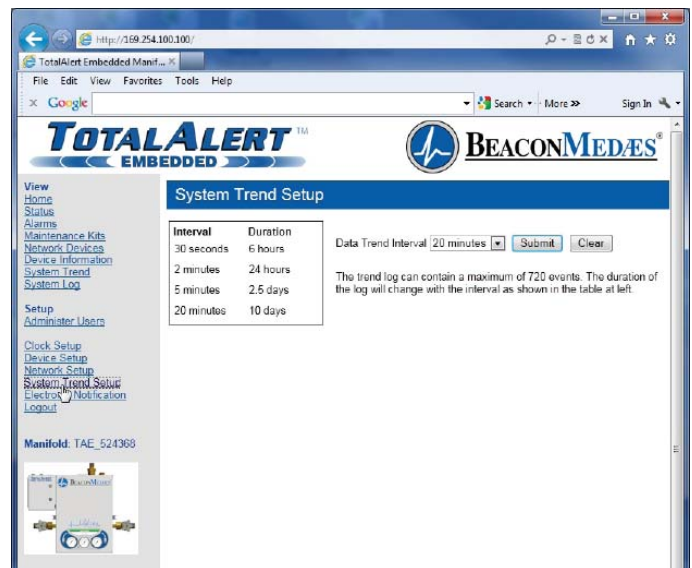


Figure 34: System Trend Setup

This System Trend Setup page (Figure 34) is used to configure the trend log for the website and to allow the data to be cleared. The System Trend screen contains a maximum of 720 events for each of the items recorded, so the actual duration of the trend log changes with the time interval selected. The durations available to select are 6 hours, 24 hours, 2.5 days, and 10 days.

1. Click System Trend Setup to access the System Trend Setup page.
2. Select a time interval from the pull-down list of options.
3. Click the Submit button.
4. To clear the System Trend Data, click the CLEAR button.

CAUTION:

Pressing the CLEAR button will permanently delete all Trend Data!

6.9 Electronic Notification Setup

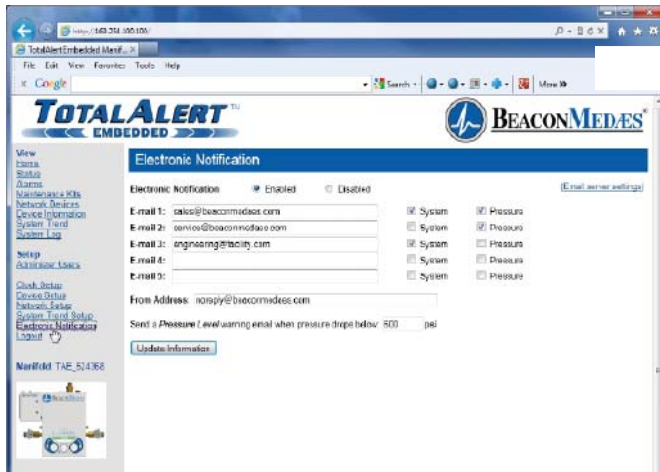


Figure 35: Electronic Notification Setup

This Electronic Notification Setup page (Figure 35) is used to configure the Electronic Notification feature of the TotalAlert Embedded control system. By setting up the Electronic Notification, key personnel can receive notifications of all alarm/shutdown alerts and pressure level alerts. The device acts as an SMTP client. An SMTP server is required for electronic notification to function.

1. Click Electronic Notification Setup to access the Electronic Notification Setup page.
2. Select Enable to enable the e-mail notification tool.
3. Enter up to five email addresses.
4. For each address, select "System" for that person to receive all alarm/shutdown alerts. Select "Pressure" for that person to receive all pressure low alerts. An individual may receive both types of alerts.
5. Enter an email address in the "From" box as this will be the sender of the notifications.
6. Enter the bank pressure level that will be used for sending low bank pressure alerts.
7. Click the Submit button.

6.10 Navigating the Website

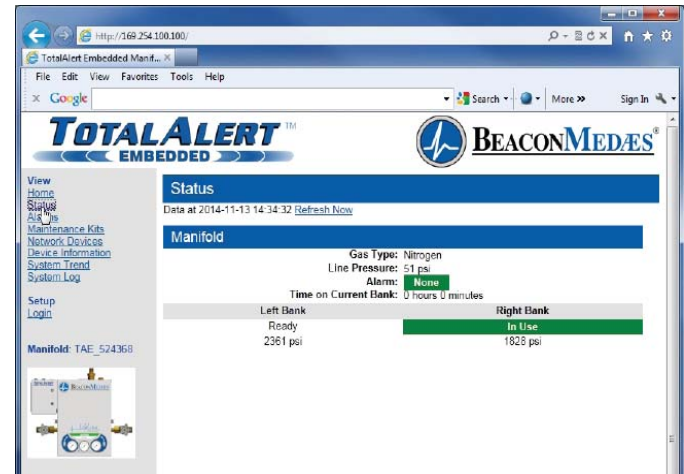


Figure 36: Status Page

The TotalAlert Embedded website allows the user to easily view the status of all activity pertaining to the manifold system. By clicking the menu items to the left of the screen, a user can view pages displaying accurate and timely information about the system.

These pages include:

Status: The Status page (Figure 36) displays all current pressure conditions including the left and right bank pressure of the manifold as well as any alarm conditions.

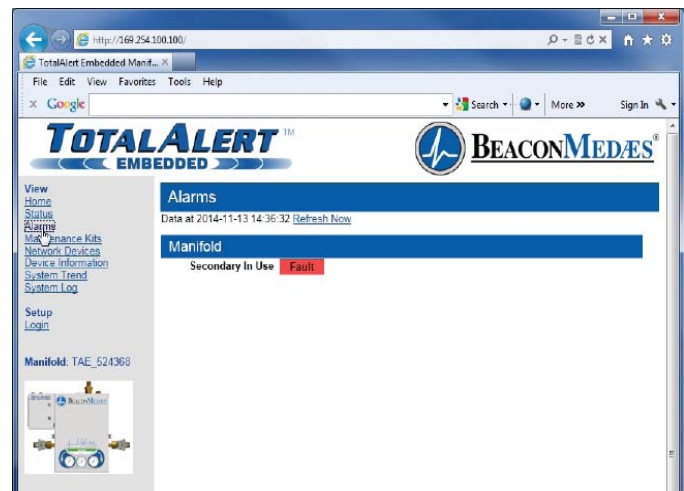


Figure 37: Alarms Page

Alarms: The Alarms page (Figure 37) displays all alarm conditions such as Changeover, Reserve Low, Reserve in Use, and Secondary Low(as provided).

6.10 Navigating the Website (Cont.)

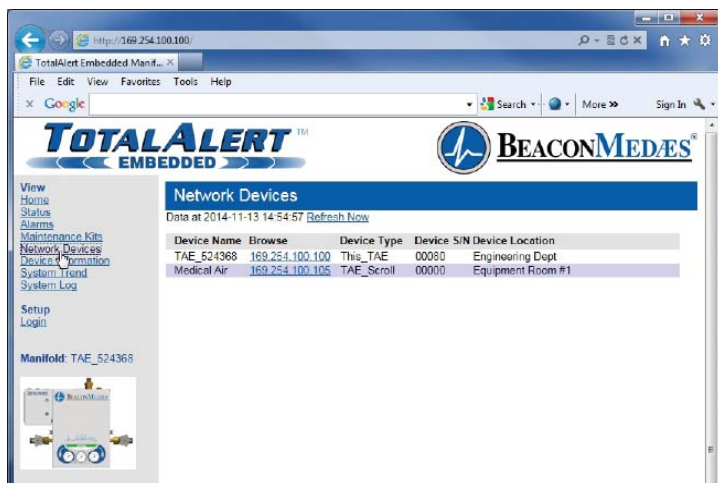


Figure 38: Network Devices

Network Devices: The Network Devices page (Figure 38) displays all TotalAlert and TotalAlert Embedded devices on the facility's network. The page displays the device name, IP address, device type, device serial number, and device location. By clicking the IP address of a device, the user moves to the website of that device.

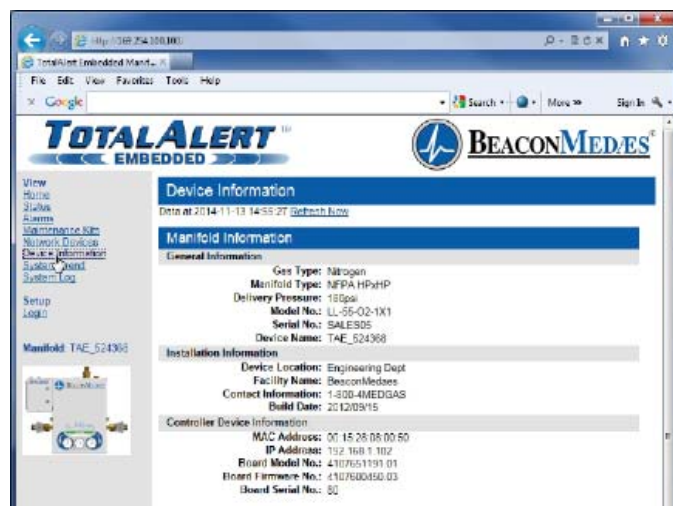


Figure 39: Device Information

Device Information: The Device Information Page (Figure 39) displays information specific to the TotalAlert Embedded device. The information shows all manifold general information, installation information, and controller device information. This information includes setup model number, serial number and much more.

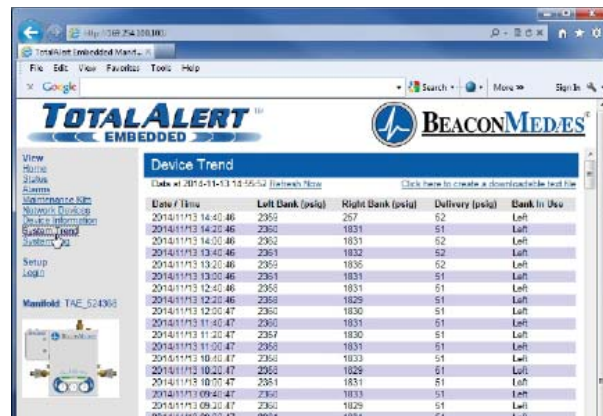


Figure 40: System Trend Page

The System Trend Page (Figure 40) displays multiple items on the system, measured at specified time intervals. These items may include Left Bank Pressure, Right Bank Pressure, Delivery Pressure and Bank in Use. The time intervals may be every 30 seconds, 2 minutes, 5 minutes, or 20 minutes (see section 6.8 - System Trend Setup). The System Trend page includes the option to create a downloadable spreadsheet file of the events. To clear the System Trend data, go to the System Trend Setup page on the website.

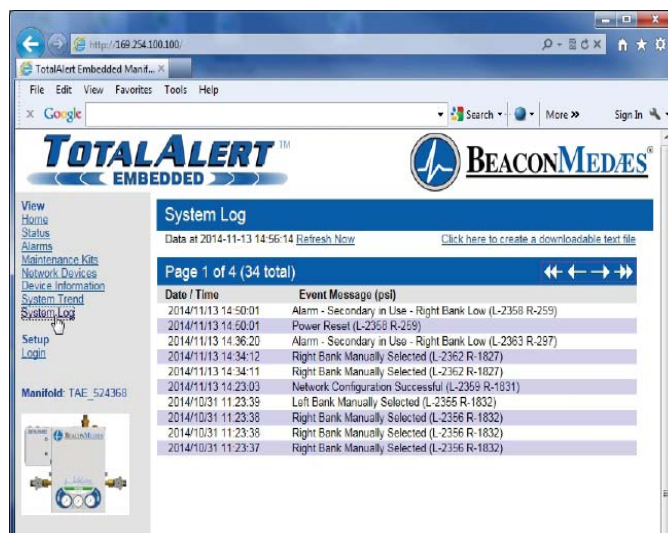


Figure 41: System Log

System Log: The System Log page (Figure 41) displays all manifold events including automatic and manual changeovers, as well as alarm resets. This screen also records bank pressure readings at the time of the events. The System Log page includes the option to create a downloadable text file of the log.

7.0 Optional Reserve Header (ISO Versions)

7.1 Reserve Header Installation

For ISO units requiring a reserve header, the following steps must be followed to ensure proper operation of the manifold.

1. Open the control box cover and remove the electrical jumper located on terminal block X1. See Figure 42.
2. Install the reserve header check valve kit into the right port of the manifold regulator assembly by removing the plug shown in Figure 43.
3. Install the supplied adapter fitting, check valve and zero clearance union into the open port.

NOTE:

Verify the arrow on the check valve is pointing in the direction of gas flow from the reserve header to the regulator assembly.

4. Once the check valve assembly is installed onto the manifold, the reserve header can now be mounted and wired into the manifold.

Electrical Jumper
Location

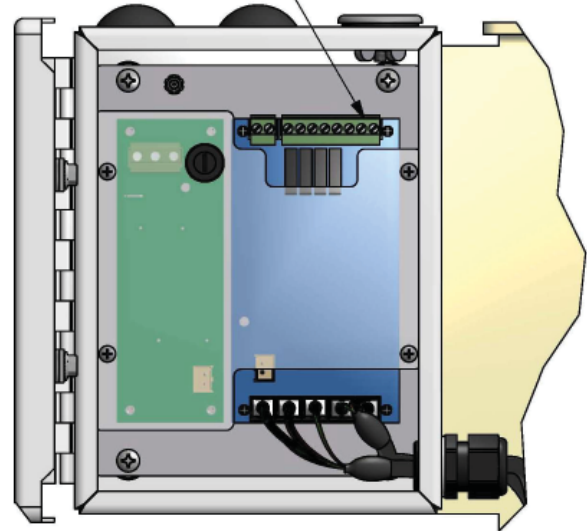


Figure 42: Jumper on Electrical Box

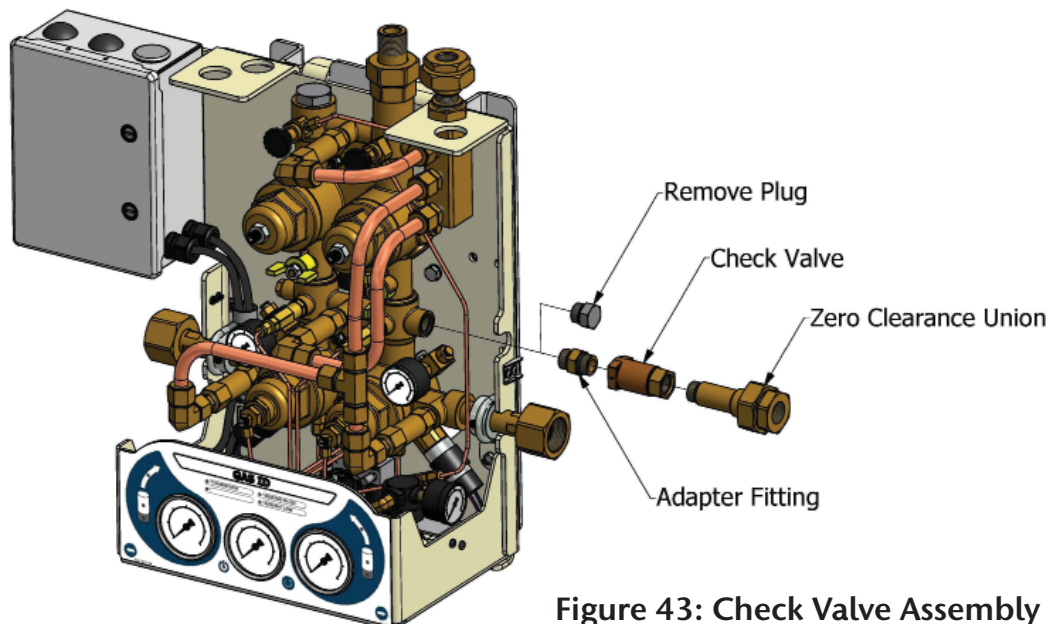


Figure 43: Check Valve Assembly

7.2 Wall Mounting HP Reserve Header

High pressure reserve header components may be shipped in several cartons. One carton will contain the control section assembly consisting of regulator assembly, and reserve low pressure switch as shown in Figure 44. Additional shipping cartons contain header extensions, cylinder pigtails, header wall brackets, master valve, and plug and nut. Depending on the number of cylinders, header extensions are configured with two or three cylinder inlets. Large reserve headers may also include combinations and multiples of each type of header extension.

1. Attach master valve to the regulator assembly. Attach appropriate header extension to regulator assembly. Position cylinder inlet connections of each header extension so they are pointing out. Additional header extensions may be attached end to end if required. Install large nut and plug on end of last header extension (Figure 46).
2. Mark wall 65- $\frac{3}{4}$ " from finished floor in location where high-pressure reserve header will be mounted. Convert mark to level horizontal line approximately as long as assembled high-pressure reserve header.
3. Depending upon number of header extensions, two or more header brackets will be provided. Header brackets should be positioned along length of high-pressure reserve header assembly and should contact header directly between cylinder connections. A header bracket will typically be provided for each header extension. Measure centerline distance between header brackets and transfer those measurements to horizontal line described in step 2 as shown in Figure 45.
4. Position header bracket against wall and align top of bracket with horizontal line. Center brackets with centerline marks from step 3. Attach brackets to wall using appropriate anchors (by others). $\frac{3}{8}$ " diameter anchors are recommended.
5. Set complete reserve header on top of wall brackets and assemble u-bolt and bracket hardware as shown. Tighten u-bolt nuts.
6. One more wall bracket should be installed to support left side of reserve header assembly as shown in Figure 46.
7. Tighten all header extension unions and plugs. Ensure all cylinder connections point away from wall.
8. The reserve pressure switch (Transducer for TAE models) should be routed in conduit back to the manifold control box and wired into terminal block X1.

Wall Mounting HP Reserve Header (cont.)

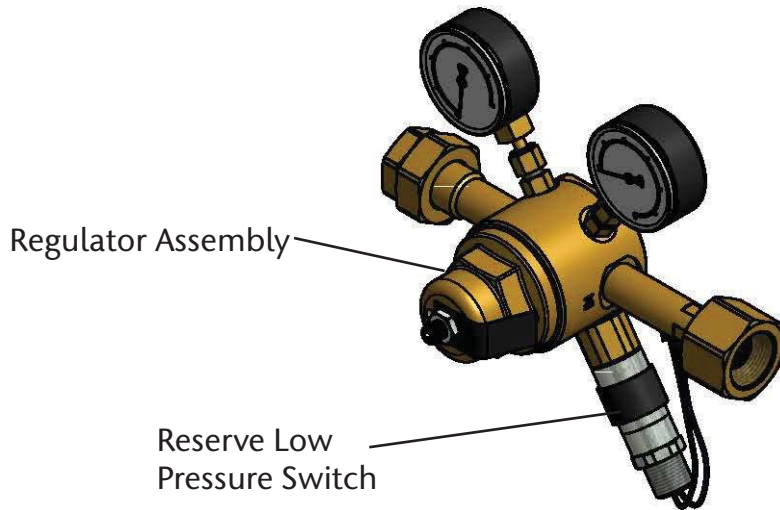
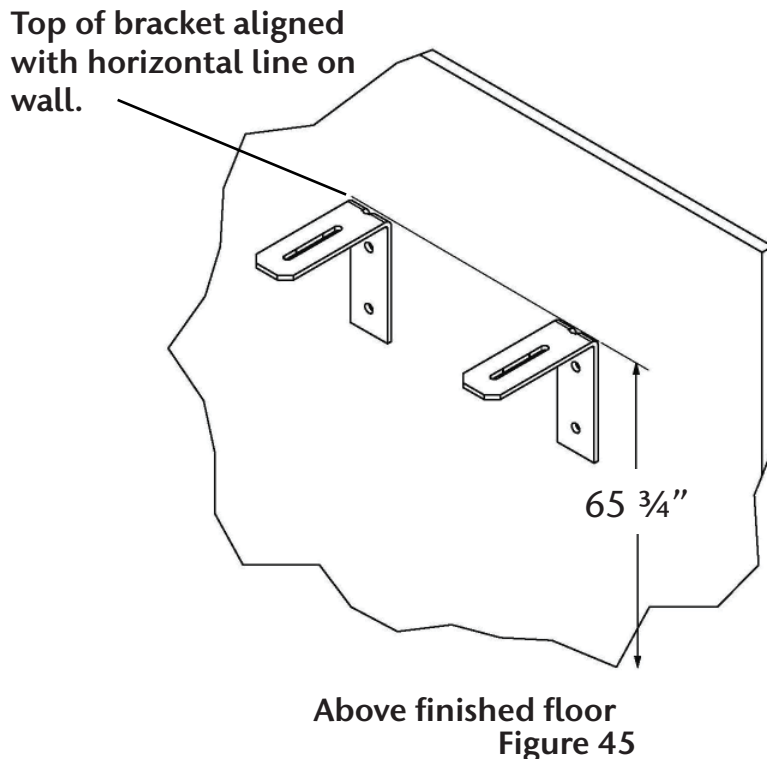


Figure 44

NOTE:

Configuration and number of header extensions will vary depending upon size of high-pressure reserve header assembly (5-cylinder model shown).



NOTE:

Distance between wall brackets to be determined by installer. Depending upon reserve header configuration, multiple brackets may be required. A bracket is provided for each header segment and should contact header between cylinder connections as shown in Figure 46.

Wall Mounting HP Reserve Header (cont.)

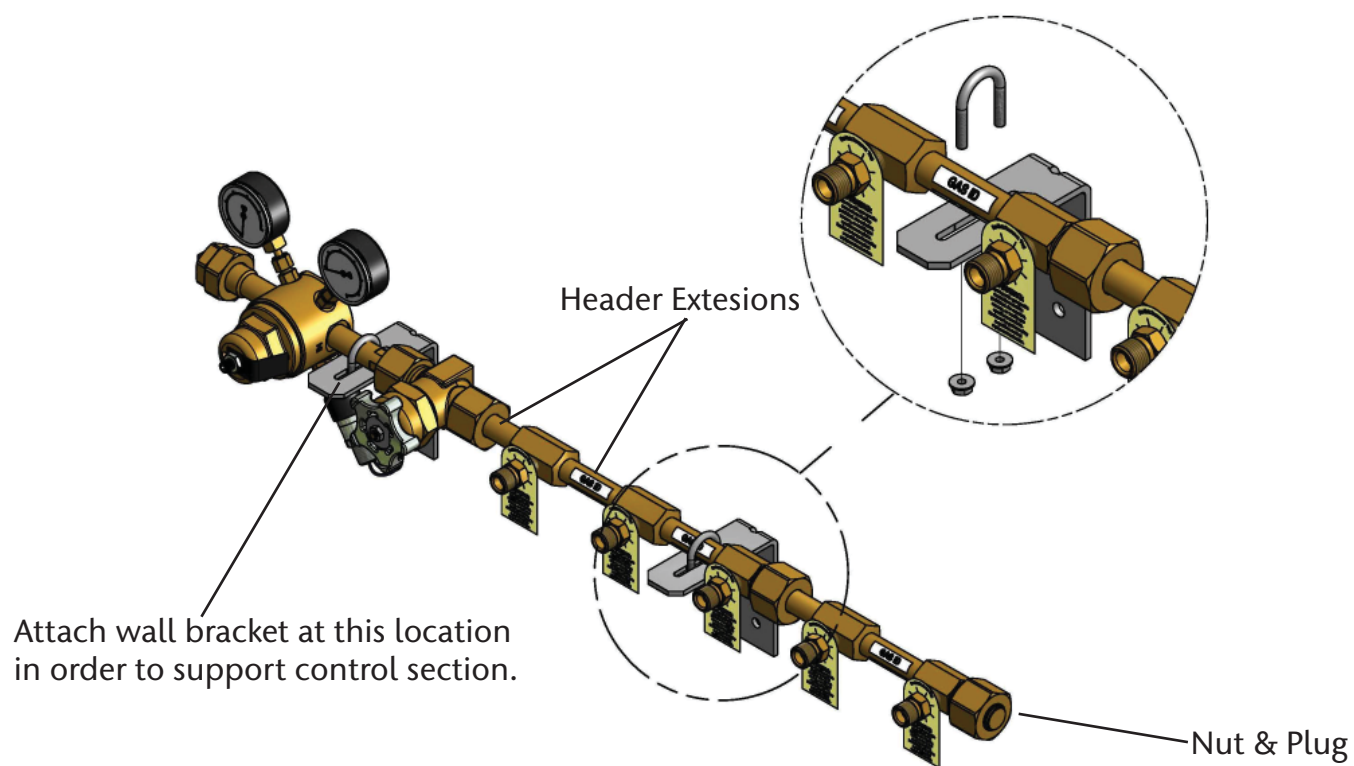


Figure 46

7.3 Initial Power Up and Operational Testing

See Figures 12, 13, 14, and 15.

1. Release two latches on sides of manifold control module cover (one on each side). Remove cover.
2. Verify the following: (Refer to Figure 12 for component location and Figure 13 for Light location).
 - Both manifold master valves are turned fully counterclockwise (open).
 - All isolation valves to be open. (handles vertical)
 - Reserve header master valve is turned fully counterclockwise (open).
 - Both red "EMPTY" lights on front of manifold and yellow "RESERVE IN USE" and red "RESERVE LOW" are illuminated (See Figure 14).
 - If connected to a master alarm panel, "CHANGEOVER", "RESERVE IN USE", and "RESERVE LOW" alarms are activated.
3. Close $\frac{3}{4}$ " source shut-off valve.
4. Slowly open one cylinder on high-pressure reserve header assembly.
5. Verify the following:
 - "RESERVE LOW" light turns off.
 - If connected to a master alarm panel, "RESERVE LOW" alarm cancels.
 - Contents gauge on reserve header regulator reads cylinder pressure (approx. 2200 PSI for O₂, N₂, and AR. / approx. 1000 PSI for N₂O and CO₂).
6. Slowly open one high pressure cylinder on right side of manifold.
7. Verify following:
 - Manifold right bank red "EMPTY" light turns off.
 - Manifold right bank green "READY" and "IN USE" light illuminates.
 - Manifold right bank contents gauge reads high pressure cylinder pressure.
 - Manifold yellow "RESERVE IN USE" light turns off.
 - If connected to a master alarm panel, "RESERVE IN USE" alarm cancels.
8. Slowly open one high pressure cylinder on left side of manifold.
9. Verify following:
 - Manifold left bank red "EMPTY" light turns off.
 - Manifold left bank green "READY" light illuminates.
 - Manifold left bank contents gauge reads high pressure cylinder pressure.
 - If connected to a master alarm panel, "CHANGEOVER" alarm cancels.
10. Close manifold right high pressure cylinder. Slightly open vent valve (Figure 15). Verify following:
 - Right bank contents gauge drops slowly.
 - As right contents gauge is nearly depleted, manifold changes over to left bank.
 - After changeover, right bank green "READY" and "IN USE" light turns off and red "EMPTY" light illuminates.
 - After changeover, left bank green "IN USE" light illuminates, yellow "CHANGEOVER" light illuminates and changeover alarm sounds.
11. Close vent valve.
12. Verify "Line Pressure" gauge reading is acceptable.
13. Slowly open one high pressure cylinder on right side of manifold.
14. Verify following:
 - Right bank red "EMPTY" light turns off.
 - Right bank green "READY" light illuminates and "Yellow" "CHANGEOVER" light turns off.
 - Right bank contents gauge reads high pressure cylinder pressure.
15. Close left high pressure cylinder. Slightly open vent valve. Verify following:
 - Left bank contents gauge drops slowly.
 - As left contents gauge is nearly depleted, manifold changes over to right bank.
 - After changeover, left bank green "IN USE" light turns off and red "EMPTY" light illuminates.

- After changeover, right bank green “IN USE” light illuminates and yellow “CHANGEOVER” light illuminates.
16. Close vent valve.
 17. Close right high pressure cylinder. Slightly open vent valve. Verify following:
 - Right bank contents gauge drops slowly. As right cylinder contents gauge is nearly depleted, right bank green “IN USE” light goes out and red “EMPTY” light illuminates.
 - Shortly after illumination of right bank red “EMPTY” light, “RESERVE IN USE” light illuminates. If connected to a master alarm panel, “RESERVE IN USE” alarm is activated.
 18. Close vent valve.
 19. Close cylinder on high pressure reserve header. Slightly open vent valve. Verify following:
 - Reserve header cylinder contents gauge drops slowly.
 - As reserve header cylinder contents gauge drops to approximately 1500 PSI (400 PSI for N₂O and CO₂ systems), red “RESERVE LOW” light illuminates.
 - If connected to a master alarm panel, “RESERVE LOW” alarm is activated.
 20. Close vent valve.
 21. Slowly open one high pressure cylinder on reserve header.
 22. Slowly open one high pressure cylinder on each side of manifold.
 23. Record pressure readings of manifold’s left and right contents gauges.
 24. Record pressure reading of reserve header contents gauge.
 25. Close left and right high pressure cylinders and high pressure reserve header cylinder.
 26. Wait 15 minutes.
 27. Compare current reading of left and right bank cylinder contents gauges to those recorded in step 23. If there is a noticeable pressure change on either gauge, perform leak testing described in section 2.10.
 28. Reinstall manifold control panel cover.
 29. Slowly open all cylinders on both banks of manifold and reserve header.
 30. Open ¾” source shut-off valve.



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