Pro V8 *Liquid Cylinder Manifold*

Product Manual

Patent No. 6,615,861

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Innovation. Experience. Performance.

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Contents

1. WARRANTY AND SERVICE STATEMENTS

Chart warrants all Manifold Systems we manufacture to be free from defects in material and workmanship for **ONE YEAR** from the date of shipment, subject to the exclusions listed below and statements on the following pages.

If a warranty repair is required, the Manifold System will be repaired at the nearest Chart Authorized Service Center.

Exclusions

- We accept no liability for any warranty work performed or costs incurred by the customer, or others, without Chart's express prior written approval.
- Chart's obligations under this warranty are expressly limited to repair or replacement of any part or workmanship that Chart manufactured and found to be defective within **ONE YEAR** after date of shipment.
- Chart is not liable for any other losses, damages, product losses, cost of delays, freight charges, or excess costs for repairs made outside the 48 contiguous United States, including incidental or consequential damages.
- For warranty claims please call Chart's Customer Service at 800-400-4683.

2. SAFETY

2.1 GENERAL

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

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

It is also recommended that when doing maintenance on the system that the manual isolation valves to the storage tanks are closed.

WARNING: Before removing cylinder parts or fittings, completely empty the liquid cylinder of liquid and release the entire vapor pressure in a safe manner. External valves and fittings can become extremely cold and may cause painful burns to personnel unless properly protected. Personnel must wear protective gloves and eye protection whenever removing parts or loosening fittings. Failure to do so may result in personal injury because of the extreme cold and pressure in the cylinder.

2.2 OXYGEN DEFICIENT ATMOSPHERES

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

One aspect of this possible hazard is the response of humans when exposed to an atmosphere containing only 8 to 12% oxygen. In this environment, unconsciousness can be immediate with virtually no warning. When the oxygen content of air is reduced to about 15 to 16%, the flame of ordinary combustible materials, including those commonly used as fuel for heat or light, may be extinguished. Somewhat below this concentration, an individual breathing the air is mentally incapable of diagnosing the situation because the onset of symptoms such as sleepiness, fatigue, lassitude, loss of coordination, errors in judgment and confusion can be masked by a state of “euphoria,” leaving the victim with a false sense of security and well-being.

Human exposure to atmosphere containing 12% or less oxygen leads to rapid unconsciousness. Unconsciousness can occur so rapidly that the user is rendered essentially helpless. This can occur if the condition is reached by an immediate change of environment, or through the gradual depletion of oxygen.

Most individuals working in or around oxygen deficient atmospheres rely on the “buddy system” for protection-obviously, the “buddy” is equally susceptible to asphyxiation if he or she enters the area to assist the unconscious partner unless equipped with a portable air supply. Best protection is obtainable

by equipping all individuals with a portable supply of respirable air. Life lines are acceptable only if the area is essentially free of obstructions and individuals can assist one another without constraint.

If an oxygen deficient atmosphere is suspected or known to exist:

- Use the “buddy system.” Use more than one “buddy” if necessary to move a fellow worker in an emergency.
- Both the worker and “buddy” should be equipped with self-contained or airline breathing equipment.

Additional information on nitrogen and argon and liquid cylinders is available in CGA Pamphlet p-9. Write to the Compressed Gas Association, Inc., New York, NY 10110.

Extracted from Safety Bulletin SB-2 from Compressed Gas Association, Inc., New York, dated March 1966 and from the "Nitrogen Material Safety Data Sheet’" published by Air Products and Chemicals, Inc., Allentown, PA 18105, dated 1 June 1978.

2.3 OXYGEN ENTRICHED ATMOSPHERES

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

It is important to locate an oxygen system in a well-ventilated location since oxygen-rich atmospheres may collect temporarily in confined areas during the functioning of a safety relief device or leakage from the system.

Oxygen system components, including but not limited to, containers, valves, valve seats, lubricants, fittings, gaskets and interconnecting equipment including hoses, shall have adequate compatibility with oxygen under the conditions of temperature and pressure to which the components may be exposed in the containment and use of oxygen. Easily ignitable materials shall be avoided unless they are parts of equipment or systems that are approved, listed, or proved suitable by tests or by past experience.

Compatibility involves both combustibility and ease of ignition. Materials that burn in air may burn violently in pure oxygen at normal pressure and explosively in pressurized oxygen. In addition, many materials that do not burn in air may do so in pure oxygen, particularly when under pressure. Metals for containers and piping must be carefully selected, depending on service conditions. The various steels are acceptable for many applications, but some service conditions may call for other materials (usually copper or its alloys) because of their greater resistance to ignition and lower rate of combustion.

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

CAUTION: Use only replacement equipment, which is compatible with oxygen and has been cleaned for oxygen use. Do not use regulators, fittings, hoses, etc., which have been previously used in a compressed air environment. Similarly, do not use oxygen equipment for compressed air. Failure to comply with these instructions may result in serious damage to the liquid cylinder.

2.4 NITROGEN AND ARGON

Nitrogen and argon (inert gases) are simple asphyxiates. Neither gas will support or sustain life and can produce immediate hazardous conditions through the displacement of oxygen. Under high pressure these gases may produce narcosis even though an adequate oxygen supply sufficient for life is present.

Nitrogen and argon vapors in air dilute the concentration of oxygen necessary to support or sustain life. Inhalation of high concentrations of these gases can cause anoxia, resulting in dizziness, nausea, vomiting, or unconsciousness and possibly death. Individuals should be prohibited from entering areas where the oxygen content is below 19% unless equipped with a self-contained breathing apparatus. Unconsciousness and death may occur with virtually no warning if the oxygen concentration is below approximately 8%. Contact with cold nitrogen or argon gas or liquid can cause cryogenic (extreme low temperature) burns and freeze body tissue.

Persons suffering from lack of oxygen should be immediately moved to areas with normal atmospheres. SELF-CONTAINED BREATHING APPARATUS MAY BE REQUIRED TO PREVENT ASPHYXIATION OF RESCUE WORKERS. Assisted respiration and supplemental oxygen should be given if the victim is not breathing. If cryogenic liquid or cold boil-off gas contacts worker's skin or eyes, the affected tissue should be flooded or soaked with tepid water (105-115°F or 41-46°C). DO NOT USE HOT WATER. Cryogenic burns that result in blistering or deeper tissue freezing should be examined promptly by a physician.

2.5 CARBON DIOXIDE

Carbon dioxide is a compound formed by the combination of carbon and oxygen atoms in a 1:2 ratio expressed by the chemical symbol CO_2. The weight percentages of carbon and oxygen are 27.3% and 72.7% respectively. Carbon dioxide is a gas at normal atmospheric temperature and pressure.

CO_2 is heavier than air and can collect in low areas such as basements, stairwells, and confined spaces. Avoid entry into areas where CO_2 leaks or high concentrations of CO_2 are suspected. Enter those areas with caution only after they have been thoroughly ventilated.

Depending on the temperature and pressure to which it is subjected, carbon dioxide may exist in the form of a solid, a liquid, or a gas. At a temperature of -69.90°F (56.60°C) and a pressure of 60.43 psig (417 kPa) carbon dioxide can exist simultaneously in all three phases. This condition is known as the triple point. The phase diagram for carbon dioxide is shown in Figure 1: Carbon Dioxide Phase Chart .

At temperatures above 87.90°F (31.10°C), carbon dioxide can exist only as a gas, regardless of the pressure. This is known as its critical temperature. As shown in Figure 1, liquefied carbon dioxide can only exist in a sealed container between the triple point and critical point temperatures under pressure. There is a definite pressure-temperature relationship of the liquid and gas in equilibrium.

CO_2 gas is a colorless, odorless, tasteless gas that displaces oxygen and does not support life. It is about 1.5 times denser than air. The gas is difficult to detect without assistance of special equipment. Avoid breathing or contacting CO_2 in gas, liquid or solid form.

EXPOSURE TO CONCENTRATIONS OF MORE THAN 3% IN AIR CAN CAUSE UNCONSCIOUSNESS, SERIOUS INJURY, OR DEATH. Even low concentrations of CO_2 can cause:

- Dizziness, headaches, nausea, or disorientation
- Increased respiration or heart rate
- Shortness of breath or rapid asphyxiation

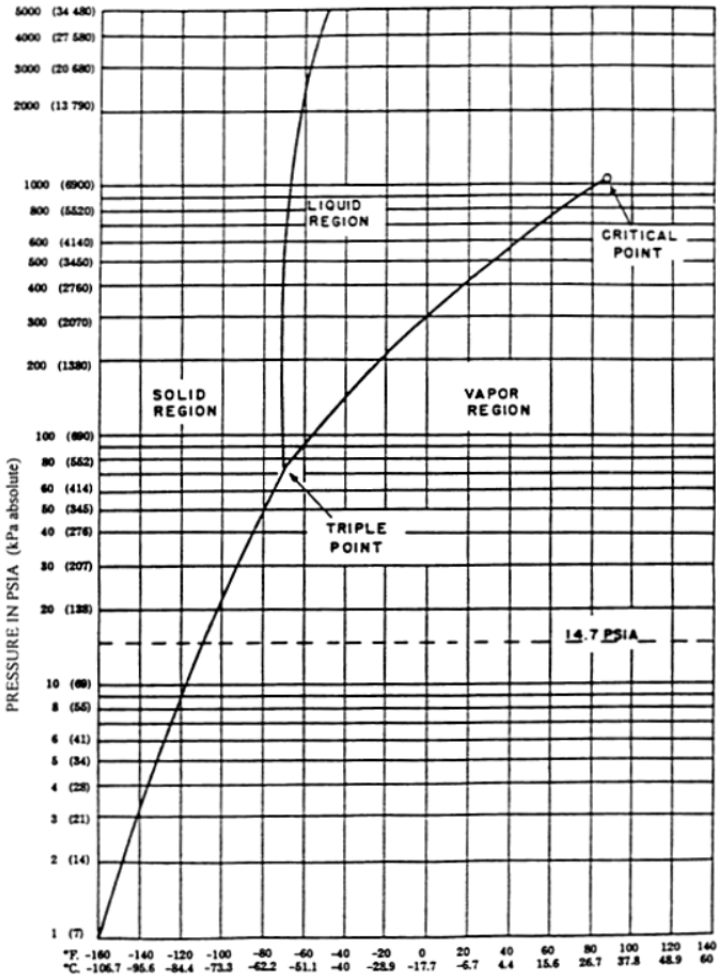


Figure 1: Carbon Dioxide Phase Chart

3. GENERAL DESCRIPTION

3.1 RECEIVING CHECK POINTS

1. Check braces, skids, wooden chocks, and other shipping supports. Damage or deformation would indicate the possibility of mishandling during shipment.
2. Examine welded or brazed joints on plumbing for cracks or deformation, especially near valves and fittings.
3. Check welds on manifolds for cracks or breaks.
4. Check relief valves for dirt or damage.

3.2 PHYSICAL DESCRIPTION

The Pro V8 system is primarily built to be a mobile system. All connections and components are mounted on a chassis which has been sized to fit through a 34" doorway. Caster wheels are used for mobility, as well as fork slots and lift eyes.

The chassis is connected to as many as 8 liquid cylinders and manifolded together into two sides.

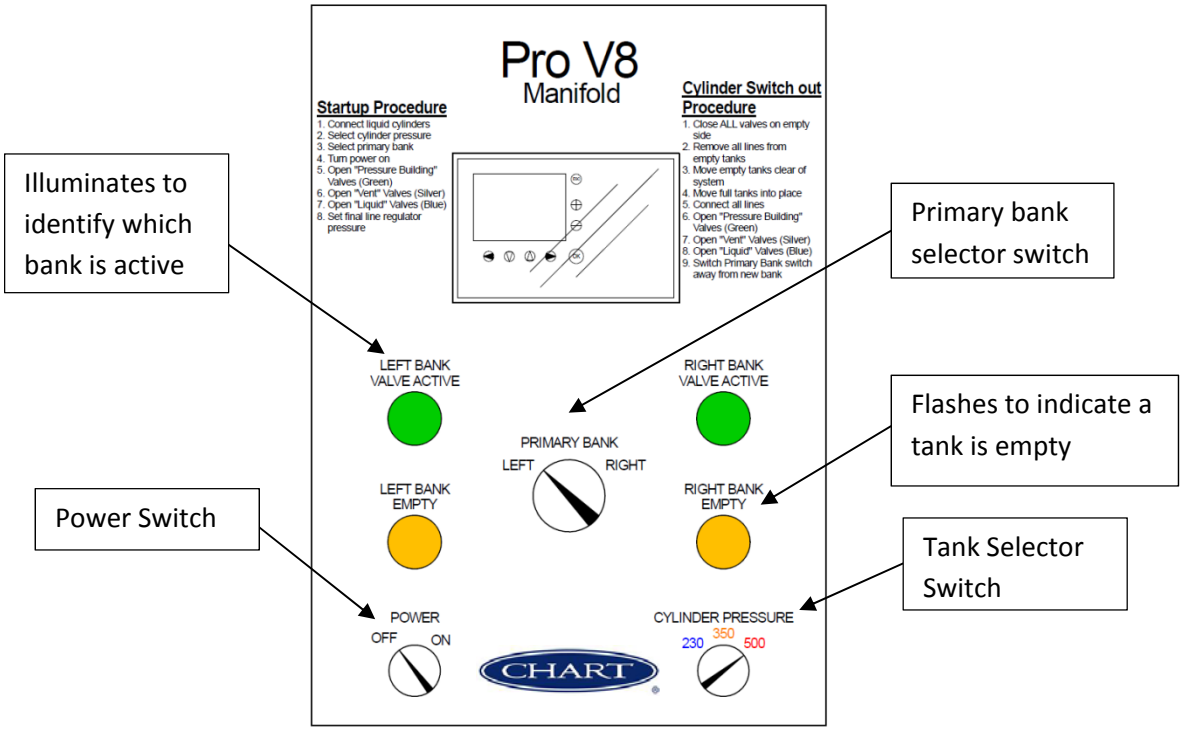


Figure 2 Control Box

3.3 SUMMARY OF OPERATION

The Pro V8 is designed as a system to manifold together up to eight liquid cylinders for continuous gas flow to an end use. Liquid leaves the cylinders and travels through the manifold and the control valves into a vaporizer. The vaporizer converts the liquid into a gas and warms it to room temperature. Finally, the gas flows through a pressure regulator before exiting the system through the selected output valve.

The system accepts 230 (MP), 350 (HP), and 500 (Laser) cylinders with a selectable setting. Four tanks are plumbed to each side of the manifold with flex hoses. The controller then switches back and forth between the two banks to maximize the gas output from all the cylinders. A light on the control panel indicates which bank is currently active. When one cylinder bank is empty a light on the control panel illuminates to let the operator know it is time to switch the tanks.

3.4 OPERATOR QUALIFICATIONS

Chart systems are designed for safe and simple operation. The operator is expected to be knowledgeable of the nature of the gases with which they are working, as well as all applicable safety requirements. This manual contains several chapters dealing with operating instructions, handling instructions, and maintenance procedures.

To fully understand these procedures, we recommend the operator first become familiar with controls and indicators (see section 6, OPERATION on page 15).

4. SYSTEM SPECIFICATIONS

Capacity		1		2		3		3+Pusher	
		Cylinders per side							
MP (230)									
Liquid (Gross)	liters	209		418		627		732	
Liquid (Net)	liters	196		392		588		686	
Gas (N_2)	ft^3 / Nm^3	4,375	115	8,750	230	13,125	345	15,313	403
Gas (O_2)	ft^3 / Nm^3	5,435	143	10,870	286	16,305	429	19,023	501
Gas (Ar)	ft^3 / Nm^3	5,290	139	10,580	278	15,870	417	18,515	487
HP (350)									
Liquid (Gross)	liters	209		418		627		732	
Liquid (Net)	liters	196		392		588		686	
Gas (N_2)	ft^3 / Nm^3	4,072	108	8,144	216	12,216	324	14,252	378
Gas (O_2)	ft^3 / Nm^3	5,048	133	10,096	266	15,144	399	17,668	466
Gas (Ar)	ft^3 / Nm^3	4,932	130	9,864	260	14,796	390	17,262	455
Gas (CO_2)	ft^3 / Nm^3	4,011	105	8,022	210	12,033	315	14,039	368
Laser (500)									
Liquid (Gross)	liters	209		418		627		732	
Liquid (Net)	liters	196		392		588		686	
Gas (N_2)	ft^3 / Nm^3	3,521	93	7,042	186	10,563	279	12,324	326
Gas (O_2)	ft^3 / Nm^3	4,674	123	9,348	246	14,022	369	16,359	431
Gas (Ar)	ft^3 / Nm^3	4,552	120	9,104	240	13,656	360	15,932	420
Gas (CO_2)	ft^3 / Nm^3	3,537	93	7,074	186	10,611	279	12,380	326

Performance		1		2		3		3+Pusher	
		Cylinders per side							
MP (230)									
Gas Flow (N_2, O_2, Ar)	SCFH / Nm^3/hr	400	10.5	700	17.9	1000	26.8	2500	66.2
HP (350)									
Gas Flow (N_2, O_2, Ar)	SCFH / Nm^3/hr	400	10.5	700	17.9	1000	26.8	2500	66.2
Gas Flow (CO_2)	SCFH / Nm^3/hr	110	2.9	200	6	300	8.9	730	22.1
Laser (500)									
Gas Flow (N_2, O_2, Ar)	SCFH / Nm^3/hr	350	9.2	600	15.6	900	23.5	2200	58.0
Gas Flow (CO_2)	SCFH / Nm^3/hr	110	2.9	200	6	300	8.9	730	22.1

Vaporizer Performance

Flowrate (SCFH)	Hours of Continuous Operation
0-1700	24/7
1800	10
1900	7
2000	5
2100	2.5
2200	2
2300	1.5
2400	1.25
2500	1

* Actual Test Data
Ambient Temp 60 °F
65% relative humidity
In sunlight
No wind
Min outlet temp 0 °F
3 tanks + 1 pusher
LN2 Saturated at 450 psig
Recovery time 15 min
For CO_2 service, reduce performance by a factor of 3

Key Pressure Setting Requirements

Setting	Laser-Cyl	Dura-Cyl HP	Dura-Cyl MP
Tank Relief Valve	500	350	230
Pro V8 Economizer	480	330	150
Tank Economizer	475	325	140
Tank PB setting	450	300	125
Pro V8 Switch point (max)*	425	275	110
Final Line Reg (max)*	410	260	95

* Operator adjustable

All values in psig

5. INSTALLATION

5.1 SITE CONSIDERATIONS AND PREPARATIONS

Install the system on flat level ground with enough area around the system to safely connect and disconnect the tanks. Ample room should be given to exchange the empty liquid cylinders. Be sure there is proper ventilation and adequate safety precautions are taken (section 2, SAFETY on page 5).

5.2 SYSTEM HANDLING INSTRUCTIONS

Securely fasten all flexible hoses before transporting the Pro V8 system (see Figure 3).

Figure 3: Hoses secured to the frame before transport

Tie down straps should be used accordingly to ensure the payload does not move during transport.

The system is designed to slide easily into the back of a pickup truck. Figure 4 below shows the system mounted in a pickup truck.

Figure 4: Prototype Pro V8 System loaded in a pickup truck

6. OPERATION

6.1 BASIC OPERATION

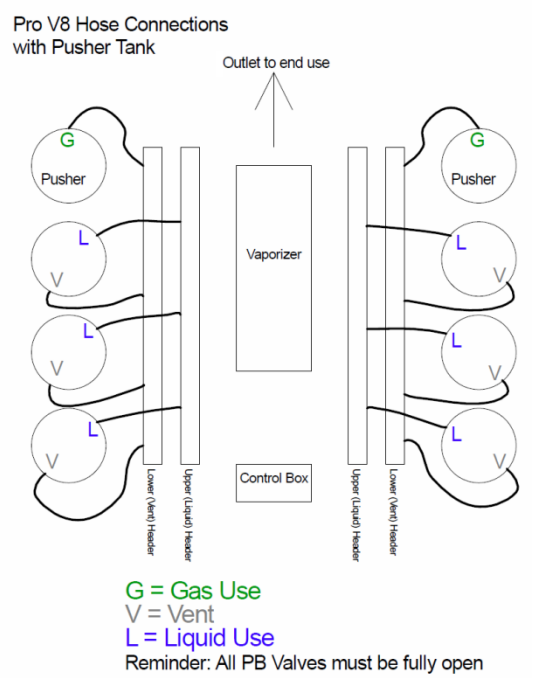
The system uses check valves on the upper (liquid) header to prevent back flowing to a liquid cylinder that may be at a lower pressure. Orifices are used on the lower (vent) header to prevent the sudden collapse of pressure when a cylinder on one side of the manifold runs empty and vapor rushes into the empty cylinder and out the liquid header. This combination of check valves and orifices allow liquid cylinders to perform far better than simply connecting them together.

Figure 5: Orifice on lower (vent) header and check valve on upper (liquid) header

In order to achieve high flow performance, the Pro V8 Liquid Cylinder Manifold is equipped with an onboard vaporizer. The vaporizer is slightly oversized to ensure peak flow demands do not result in cold gas or liquid exiting the vaporizer. The outlet of the vaporizer includes a valve manifold to which various connections can be attached for ease of use.

6.2 LIQUID CYLINDER INSTALLATION

To accommodate fast, simple installation of liquid cylinders, the Pro V8 Liquid Cylinder Manifold includes flexible stainless steel transfer hose options for all Chart cylinder models. There are two connections for each liquid cylinder to be connected to the manifold. The first is the connection of the liquid cylinder's liquid line to the upper (liquid) header. The second is the connection of the liquid cylinder's vent line to the lower (vent) header. If a pusher tank is needed (usually for flow rates above 1,000 SCFH) the gas use line is connected to the lower (vent) header.



6.3 LEAK CHECK

At the initial installation of the Pro V8 Liquid Cylinder Manifold, the system should be checked for leaks that may have developed due to road vibration during shipping or transport. With the liquid cylinders installed, and the manual override valves on the solenoid valves in the closed position (hand wheel backed away from the solenoid body), slowly open the vent valves on the liquid cylinders and check for leaks at the connections on the lower (vent) header. Next, slowly open the liquid valves and check for leaks at the connections on the upper (liquid) header. Check for leaks at all connections.

6.4 PRE-CHARGE THE VAPORIZER

To avoid erratic pressure swings at startup, the downstream line, including the ambient vaporizer, can be pre-charged with gas if equipped with optional manual override solenoid valves. This can be accomplished by slowly opening the manual override hand wheel on one of the solenoid valves until the pressure equalizes. If the system is not equipped with manual override solenoid valves, the vaporizer cannot be pre-charged.

6.5 POWER UP

With the previous tasks complete, the system is now ready to be powered up.

1. Plug in the power connection to any 15 amp 110 VAC electrical outlet.
2. Use the selector switch to choose the desired primary bank and tank type.
3. Turn on the power switch.

The appropriate solenoid valve will be energized (opened) and a green indicator light will indicate the bank that is in operation.

6.6 SET MINIMUM PRESSURE

To set the minimum pressure for the Pro V8, the operator must first open the electronic control box.

1. Use the OK button to cycle through the set points until the desired tank type is displayed.

2. Use the + & - buttons to raise or lower the set point. Set point changes take effect immediately.

3. To reset the Pro V8 to the factory set point, simply press the ESC button when the desired set point is displayed.

The factory set points for minimum pressure of each tank type are displayed below.

Tank	Factory Set Point
MP	100 psig
HP	275 psig
Laser	400 psig

6.7 OPERATION DETAILS

6.7.1 SYSTEM STARTUP PROCEDURE

The following steps should be taken to connect tanks to the manifold and begin flowing gas to the usage point.

1. Ensure the manifold system is on level ground with enough room to exchange tanks all the way around.
2. Connect the Liquid use lines from each tank's Liquid valve to the upper (liquid) manifolds.

3. Connect the Vent line from each tank's Vent valve to the lower (vent) manifolds.
4. Connect the Gas Use line from the pusher tank's Gas Use valve to the lower (vent) manifolds.
5. Plug the system in.
6. Select the tank type BEFORE turning the power on.

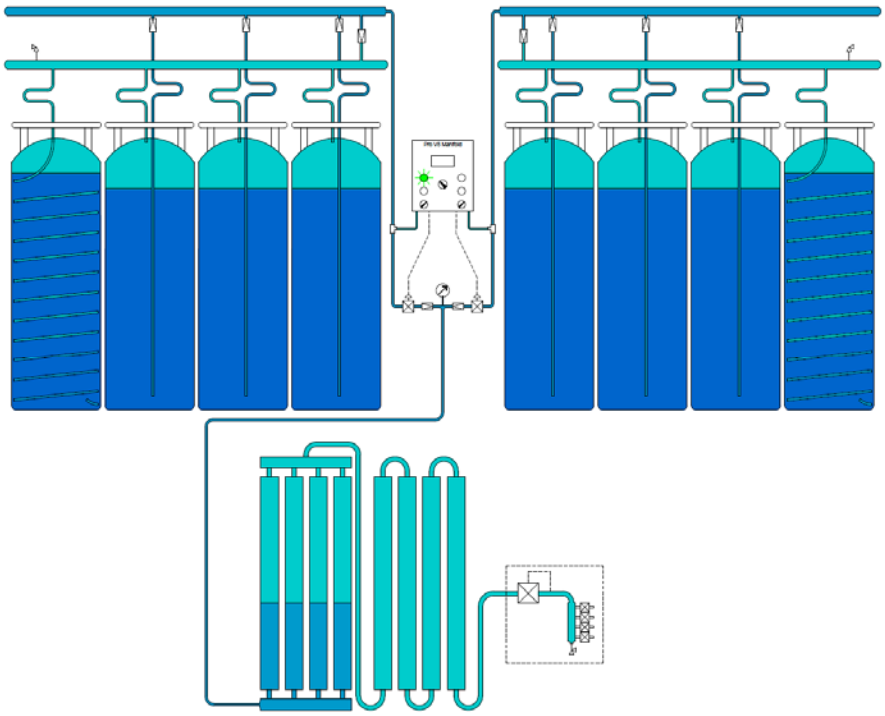
   (Note: To ensure safe operation the tank type must be set before power is turned on. Tank type cannot be changed while power is on.)
7. Using the switch on the control panel, turn on power to the system.
8. Using the switch on the control panel, select the desired primary bank.
9. Slowly open all Vent, Liquid, and Pressure Building valves for the connected tanks.
10. On the pusher tank, slowly open the Gas Use and Pressure Building valves.
11. Check the screen in the control box to see the pressures of each bank.
12. Adjust the final line pressure regulator to the desired output pressure.
13. The system should now be able to run for at least 5-6 hours. The operator should check back periodically to ensure the system is operating properly.

6.7.2 PRIMARY BANK DRAW

Liquid is delivered to the vaporizer from the liquid cylinder through the liquid cylinder dip tube, the upper (liquid) header check valve, the control panel solenoid valve, and a final check valve before entering the main feed line to the vaporizer (see Figure 6).

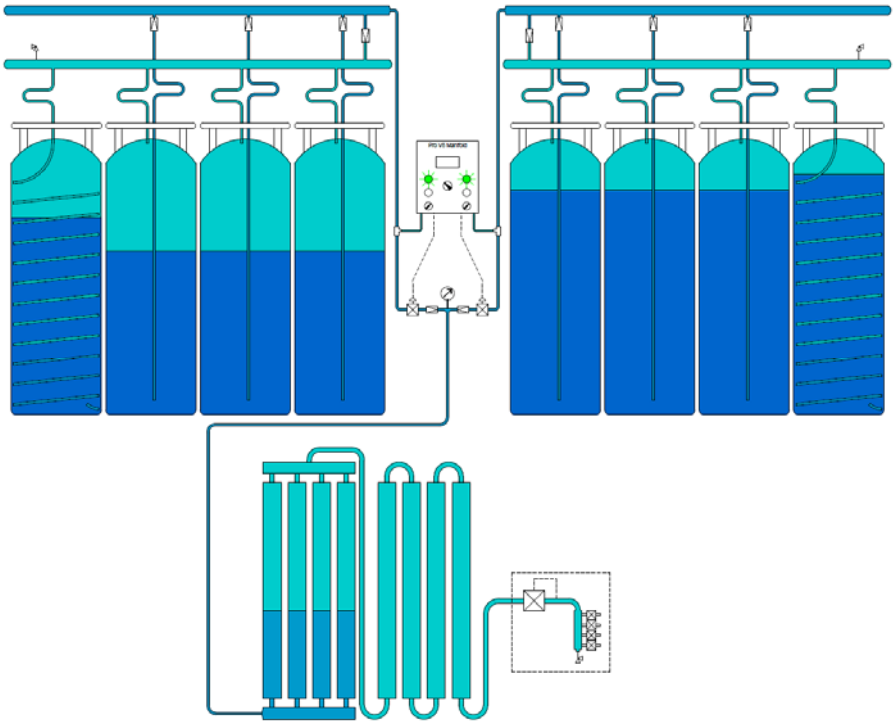
Figure 6: Solenoids, check valves, and main feed line to vaporizer

In this example, the “OPERATION” switch is positioned to the left. This means that the left bank is the primary bank. The electronic control box LEFT BANK (green) light should be illuminated during this stage. The system will draw on the primary bank until its pressure falls below the set point.



6.7.3 ECONOMIZING

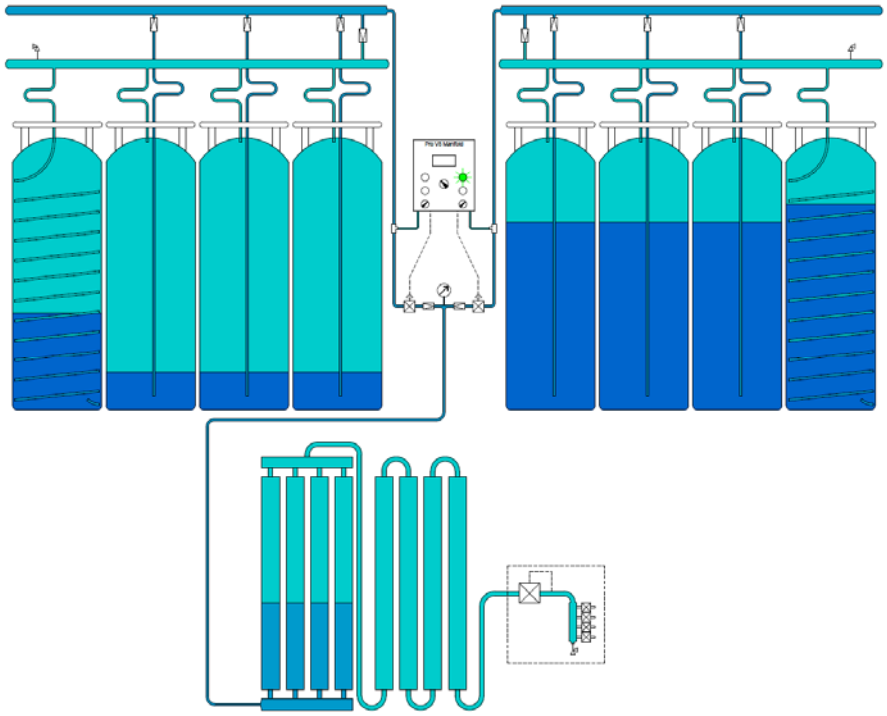
If the pressure in the secondary bank rises above an economizing set point, the secondary supply solenoid valve will open. At this point, both green lights will be on. This minimizes product loss due to inactivity of the secondary supply.



6.7.4 PRIMARY BANK PRESSURE DROP

When the pressure in the primary bank drops below the set point, the controller automatically switches to the secondary bank. At this point, the RIGHT BANK light is illuminated and the LEFT BANK light will turn off.

"SEC" on the controller screen will blink when the system switches to the secondary bank.



The controller continues to monitor the primary bank's pressure. When the primary bank's pressure recovers, the system switches back to the primary bank and uses the remaining liquid. The LEFT BANK light will be illuminated and the RIGHT BANK light will turn off.

Depending on the pressure and flow requirements this step may occur several times.

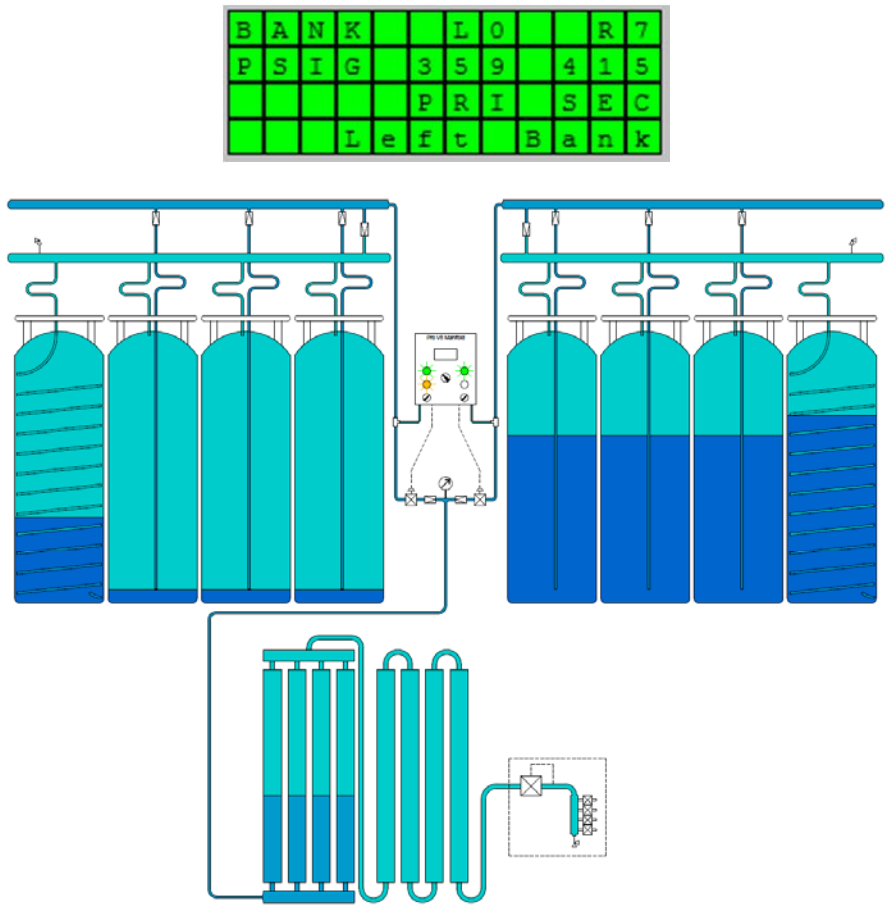
6.7.5 SWITCH BACK TO PRIMARY BANK

If the pressure in the primary bank recovers within 11 minutes, the system will switch back to draw from the primary bank. The reason the system waits 11 minutes is to give the primary bank enough time to build pressure so that it does not instantly crash again. This process will repeat up to 7 times if necessary. A counter on the top of the control panel display measures the number of switches.

After the seventh switch, the primary bank will be considered empty and the amber light will start to blink.

6.7.6 CYLINDER EXCHANGE REQUIRED

When the primary bank is empty, the amber status light will blink. The system will draw from the secondary bank. The cylinders in the primary bank must be exchanged. “Left Bank Empty” will scroll across the bottom of the control panel screen and “SEC” will blink.

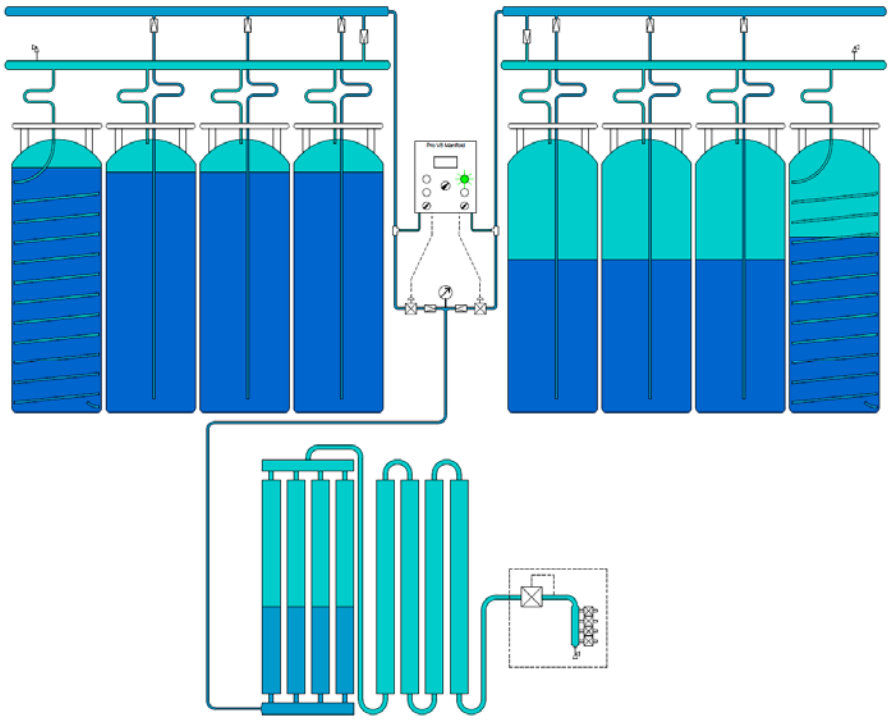


6.7.7 CYLINDER EXCHANGE PROCEDURE

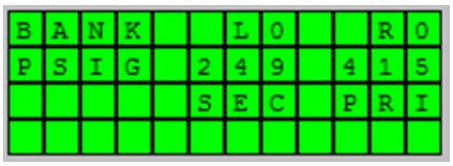
The following steps should be taken to properly exchange the empty cylinders with full ones.

1. Switch primary bank selector to opposite bank.
2. Close all valves on the cylinders to be changed out.
3. Close all isolation valves on the lower (gas) header.
4. Use two wrenches to remove the lines connected from the header to the liquid cylinders.
5. Slowly loosen the connections to assure the check valves seat properly.
6. Continue to remove the connections to the liquid cylinders.
7. Replace the empty cylinders with full cylinders.

8. Reconnect the vent and liquid lines, making sure the vent is connected to the lower (vent) header and the liquid is connected to the upper (liquid) header.
9. Connect the pusher tank's gas use line to the lower (vent) header.



Once the cylinder exchange procedure has been completed the operation starts over from section 6.7.2 PRIMARY BANK DRAW with the primary and secondary sides swapped.



6.7.8 MITSUBISHI BUTTON CONTROLS OVERVIEW

The following list covers the operation of the buttons on the Mitsubishi controller.

◀ NA

▶ NA

△ Close the Left Bank manually

▽ Close the Right Bank manually

◀▶ Open Both Banks manually (press both buttons together)

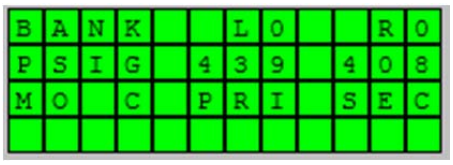
OK Cycles through the different set points

ESC Resets the visible set point to the factory setting and clears any errors which cover the entire screen

When ◀▶ are pressed to open both banks manually, the controller enters Manual Operation Mode, indicated by a “MO” displayed on the screen. The following screen indicates that both solenoids are manually open.

Both banks will remain open unless closed manually by pushing the △ or ▽ buttons. When the left bank is closed, a “C” will be displayed in the space directly to the right of the “MO”.

When the right bank is closed, a “C” will be displayed in the space to the right of the left bank’s “C”.



The solenoids can both be closed at the same time. The screen will display “CC” to indicate that both are closed.

To turn off Manual Operation Mode, press ◀▶ again and the “MO” will disappear. If either of the banks is still manually closed, △ or ▽must be pressed again until the “C”s disappear from the controller screen.

The banks can also be closed manually during normal operation. To do this, press △ or ▽to close the left or right bank, respectively.

Note that the banks can only be opened manually during Manual Operation Mode.

7. GENERAL

7.1 COMPATIBILITY AND CLEANING

It is essential to always keep the system clean and free of grease and oil. This is particularly important for units used in nitrogen and argon service since the temperature of liquid nitrogen or argon is below the liquefaction temperature of air, thus making it possible to condense liquid oxygen from air on the piping and vaporizer surfaces.

7.2 PERIODIC INSPECTION

In order to maintain a cryogenic system in good operating condition, certain system components should be inspected on a periodic basis. Those components requiring periodic inspection are relief valves, solenoid valves, hoses, and the control panel. In systems operated in areas with extreme hot or cold climates, inspection intervals should be shortened.

7.3 STORAGE AND TRANSPORT

DO NOT transport the Pro V8 with liquid cylinders attached. Disconnect all hoses and ensure that they are securely fastened to the frame before transport.

7.4 TROUBLESHOOTING

The following table provides some troubleshooting procedures. The table is arranged in a Trouble/Cause/Solution format. Note that probable causes for specific problems are listed in descending order of significance. Repair procedures required, as listed in the Solution column, may be found in the REPAIR section on page 27. Perform procedures in order listed and exactly as stated (Refer to drawings as required to locate system components identified in the troubleshooting guide.)

Problem	Cause	Solution
System does not deliver product	No power	Ensure the system is plugged in and turned on
	Main supply valve closed	Ensure all appropriate valves are open between liquid cylinders and house line
	Manual override engaged	Back out hand valves on the bottom of solenoid valves by rotating them counterclockwise
	Cylinders are empty	Make sure to periodically check the level of the cylinders to ensure there is no down time
	Leak in supply line	Check all hoses for leaks and ensure all connections are tight
Left Bank pressure sensor reading incorrectly	Cable break	Trace wire connections and repair affected connection
	Sensor is defective	Repair/Replace sensor

Problem	Cause	Solution
Right Bank pressure sensor reading incorrectly	Cable break	Trace wire connections and repair affected connection
	Sensor is defective	Repair/Replace sensor
Leaking safety relief valve	Valve improperly seated	Reseat or replace valve as required.
	Damaged seat.	Replace valve.
Solenoid valve not closing	Manual override engaged	Back out hand valves on the bottom of solenoid valves by rotating them counterclockwise
	Dirt or ice under seat.	Reseat or replace valve as required.
Uneven product draw	Closed liquid cylinder valve	Check all liquid cylinder valve to ensure the liquid and vent valves are fully open for the 3 front tanks and that the gas use valve is fully open on the pusher tank
	Uneven Pressure builder setting	Ensure liquid cylinders are maintained at the appropriate PB setting for the cylinders in use
Unable to keep pressure	Closed gas use valve on pusher tank	Check all liquid cylinder valve to ensure the liquid and vent valves are fully open for the 3 front tanks and that the gas use valve is fully open on the pusher tank
	Overdrawing the system	Reduce flow rate
	Cylinders are empty	Make sure to periodically check on the level of the cylinders to ensure there is no down time
	Leaking safety relief valve	Ensure all safety relief valves are properly maintained. If a safety relief valve is defective please refer to proper liquid cylinder valve replacement procedures
	Leak in supply line	Check all hoses for leaks and ensure all connections are tight
System economizes too much	Not drawing enough product	Ensure the product usage keeps up to the published NER for the cylinders in use. If not the system may economize too much. The more the system economizes the smaller the reserve supply will be.

7.5 REPAIR

Plumbing should always be allowed to return to ambient temperature before repair work is performed. Vent or drain the system as necessary before replacing any component(s) exposed to pressure or to cryogenic liquid.

When repair of damaged components is required (in those instances when a spare part is not readily available), follow the instructions below.

When disassembly of an assembly is required, removed parts should be coded to facilitate reassembly. Reassembly of components should always be performed in the reverse manner in which they are disassembled. Parts removed during disassembly should be protected from damage, thoroughly cleaned, and stored in protective polyethylene bags if not immediately reinstalled.

Clean all metal parts with a good industrial cleaning solvent. All rubber components should be washed in a soap and warm water solution. Air dry all cleaned parts using an oil-free, clean, low-pressure air source. Before reassembly, make sure that all parts are thoroughly cleaned and have been degreased. Cleaning will prevent valves and regulators from freezing while in service and prevent contamination of the liquid product.

After removing components, plug pipe openings as soon as possible to prevent contamination. Plastic pipe plugs of a clean plastic film may be used for this purpose.

7.5.1 VALVE REPAIR

When a defective valve is suspected, remove and repair the assembly as described in this manual. If a safety relief valve fails, the defective assembly should be discarded and a new valve installed.

7.5.1.1 THE MAGNATROL VALVES

Unless valve component parts are available in inventory, a defective valve should be replaced with a new assembly.

1. Release pressure in the vessel by opening the vent valve.
2. Remove the valve seat assembly.
3. Disassemble the valve and inspect all piece parts.
4. Clean all metallic parts with a good industrial cleaner, and all rubber & Teflon parts in a warm water and soap solution.
5. Air dry all components using a clean low pressure air source.
6. Replace all worn, deformed or damaged parts.
7. Reassemble the valve. Make sure that mating surfaces are clean and properly seated. If the repaired valve is not to be reinstalled immediately, seal it in a polyethylene bag for storage. Apply a label to the bag such as "CLEAN VALVE. DO NOT OPEN BAG UNLESS UNIT IS TO BE INSTALLED."

7.5.2 TRANSMITTER REPAIR

It is advised that a defective transmitter be replaced with a new unit and return the defective one to your local Chart distributor or to the factory for repairs. This is because a special instrument is normally

required for making transmitter repairs. However, before replacing transmitters there are a number of checks that can be performed.

The major cause of gauge malfunction is a leakage in the gauge line. Therefore, as a first check, make certain that gauge lines are leak tight. Other gauge tests include:

- Check transmitter lines for obstructions
- Ensure connection lines are properly mated
- Check to see if there is a cable break between the transmitter and the electronic controls

If the above checks fail to correct the problem, remove and replace the transmitter.

When returning the transmitter to Chart for repair, indicate the nature of the difficulty experienced with the gauge in your letter of transmittal.

7.5.3 TESTING AFTER REPAIR

After making repairs requiring disassembly or part replacement, leak test all valves and piping joints that were taken apart and reconnected. Do not return the system to service until all leaks have been corrected or retested.

8. ACCESSORIES

8.1 SOLENOID VALVE OPTIONS

Item Master Description	Chart P/N	Manufacture Info	Used on
VALVE SOLENOID 1/2 120/60 VAC	10831035	MAGNATROL 500 PSI CRYO	20604725
VALVE SOLENOID 1/2 FPT 120VAC	10925509	MAGNATROL 500 PSI CRYO W/MNL SHUT-OFF	20695006

Figure 7: Solenoid with manual override

8.2 FINAL LINE REGULATOR

The final line regulator is used to reduce the pressure of the gas exiting the vaporizer to a usable pressure for the end use application. It is suitable for all services and tank types and allows a maximum flow of 5200 SCFH (nitrogen). For the maximum recommended regulator settings for each tank type, see Section 4, SYSTEM SPECIFICATIONS. The regulator comes standard with each Pro V8 unit.

Figure 8: Final Line Regulator

8.3 VALVE MANIFOLD

The final outlet of gas from the Pro V8 is through the valve manifold. The valve manifold is a versatile feature that allows the end user to direct gas to multiple locations or applications without additional modifications. Different fittings can be threaded in each valve to easily transfer the system between end users.

Figure 9: Valve Manifold

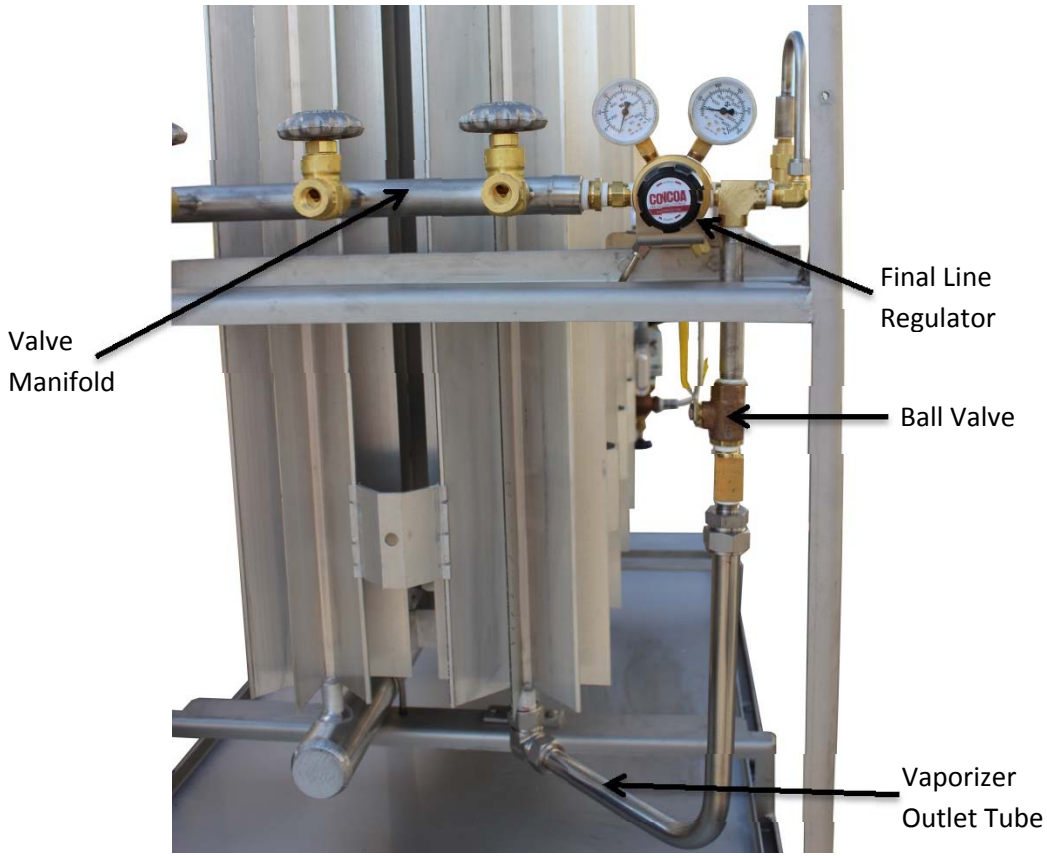


Figure 10: Vaporizer Outlet, Final Line Regulator, and Valve Manifold

8.4 HOSE/FITTING KITS

Chart PN	Item Master Description	Qty in kit	Description	Service
20686726	KIT HOSE/FITTING PRO V8 MANIFOLD N2 SERVICE	N/A	Nitrogen hose/fitting kit (contains all nitrogen parts)	Nitrogen
20606200	TRANS HOSE 1/2”X6’OAL 90D INERT GAS USE	2	Gas use hose	
20604829	TRANS HOSE 1/2”X6’OAL 90D INERT VENT / LIQ	12	Vent/liquid hose	
1110072	CONN BRS 1/2ODTX3/8MPT 45D FL CGA-295	18	Connection for use on vent manifold and dead heads	
1110122	CONN BRS 1/2ODTX1/2MPT 45D FL	6	Connection for use on liquid manifold	
4010022	OUTLET .375MPT INERT	8	Gas use connection	
20686727	KIT HOSE/FITTING PRO V8 MANIFOLD AR SERVICE	N/A	Argon hose/fitting kit (contains all argon parts)	Argon
20606200	TRANS HOSE 1/2"X6'OAL 90D INERT GAS USE	2	Gas use hose	
20604829	TRANS HOSE 1/2"X6'OAL 90D INERT VENT / LIQ	12	Vent/liquid hose	
1110072	CONN BRS 1/2ODTX3/8MPT 45D FL CGA-295	18	Connection for use on vent manifold and dead heads	
1110122	CONN BRS 1/2ODTX1/2MPT 45D FL	6	Connection for use on liquid manifold	
4010022	OUTLET .375MPT INERT CGA-580	8	Gas use connection	
20686728	KIT HOSE/FITTING PRO V8 MANIFOLD O2 SERVICE	N/A	Oxygen hose/fitting kit (contains all oxygen parts)	Oxygen
20686725	TRANS HOSE 1/2"X6'OAL 90D O2 GAS USE	2	Gas use hose	
20686724	TRANS HOSE 1/2"X6'OAL 90D O2 VENT / LIQ	12	Vent/liquid hose	
1110112	CONN BRS 5/8ODTX3/8MPT 45D FL	18	Connection for use on vent manifold and dead heads	
1110912	CONN BRS 5/8ODTX1/2MPT 45D FL	6	Connection for use on liquid manifold	
4010012	OUTLET .375MPT OXYGEN CGA-540	8	Gas use connection	
20686729	KIT HOSE/FITTING PRO V8 MANIFOLD CO2 SERVICE	N/A	Carbon dioxide hose/fitting kit (contains all carbon dioxide parts)	Carbon Dioxide
20689377	TRANS HOSE 1/2"X6'OAL 90D	2	Gas use hose	
20689378	TRANS HOSE 1/2"X6'OAL 90D	12	Vent/liquid hose	
13222817	CONN BRS CO2 VENT/LIQ CGA-622	24	Connection for use with vent/liquid hoses	
4010562	CONN BRS CO2 GAS USE CGA-320	8	Gas use connection	

9. PARTS LIST

Item	Description	Qty	Chart PN	Manufacturer PN
1	NIPPLE TOE SS 1/2"NPT SCH 40	2	11855733	
2	VALVE CHECK BRS 1/2FPTX1/2FPT	8	11051090	GENERANT CV-503B-T-5 02
3	MANIFOLD 1"PS VALVE	1	20726105	
4	MANIFOLD 1"PS VENT	2	20611000	
5	MANIFOLD 1"PS LIQUID LEFT	1	20612450	
6	MANIFOLD 1"PS LIQUID RIGHT	1	20610999	
7	VALVE CHECK BRS 3/8FPTX3/8FPT	2	13436268	GENERANT CV-373B-T-1X 02
8	HALF COUPLING SS 1/4"NPT	1	1211231	
9	VALVE SOLENOID 1/2 120/60 VAC	2	10831035*	MAGNATROL 500 PSI CRYO
10	VAPORIZER AMBIENT PRO V8	1	20636840	
11	FRAME CS PRO V8 MANIFOLD	1	20641348	
12	CONTROL PANEL PRO V8 MANIFOLD	1	20606188	CONTROL ASSEMBLIES 502885B
13	TEE SS 1/2"PS SCH 10 BW	2	1413721	
14	WASHER FLAT SS .313 NOM 18-8	12	292767	
15	WASHER SPLIT SS 5/16 18-8 B18	8	2910611	
16	NUT HEX SS 5/16-18	12	2910691	
17	HHCS SS 5/16-18X1"LG	4	2910751	
18	FLOW ORIFICE .029 DIA 3/8"MXF	6	20690887	MCMASTER-CARR #2712T46-029
19	CROSS BRS 3/8FPT	2	1210952	PARKER #2205P-6
20	CONN SS 1/2ODTX1/2MPT	4	11357232	SWAGELOK SS-810-1-8-SC10
21	TEE SS DROP 1/2ODTX1/2ODTX1/4O	2	20690884	SWAGELOK SS-810-3-8-4
22	NIPPLE HEX BRS 1/2NPT SCH 40	5	1310102	PARKER # 1/2FF-B
23	TUBE SS 1/2OD CV INPUT PRO V8	2	20693887	
24	TUBE SS 1/2OD SOL IN PRO V8	2	20693889	
25	PG 4"DIAL 0-600PSI/BAR/KG/CM2	1	10737241	WIKA #50928082 1/4"NPT
26	TUBE SS 1/4OD TEE OUT-L PRO V8	1	20693890	
27	PIPE SS 1 9/16" LONG	1	20691243	
28	STAUFF CLAMP 1/2PS	3	3411226	STAUFF #3213-PP-E-GREEN
29	HHCS SS 1/4-20X2"LG	10	2952051	
30	WASHER FLAT SS .250NOM	40	2910591	
31	WASHER SPLIT SS 1/4 18-8 B18	32	2910601	
32	NUT HEX SS 1/4-20	32	2910671	
33	INSERT PLS PIPE CLAMPS	28	10955484	PLS #EH-A PP
34	CONN SS 1ODTX1/2MPT	2	13671022	SWAGELOK #SS-1610-1-8
35	ELBOW SS 90D 1ODTX1ODT	2	20693893	SWAGELOK # SS-1610-9
36	CONN BRS 1/2ODTX1/2MPT 45D FL	6	1110122	PARKER # 48F-8-8
37	ELBOW SS 90D 3/8ODTX3/8MPT	2	10MC009	SWAGELOK # SS-600-2-6 B31.3
38	RV TUBE S/A	2	10854923	

Item	Description	Qty	Chart PN	Manufacturer PN
39	RELIEF VALVE 1/4" MPT 550 PSI	5	1812702	REGO #PRV9432T550
40	ELBOW SS 90D 1/2ODTX3/8MPT	2	11550999	SWAGELOK #SS-810-2-6
41	TUBE PRO V8 VAPORIZER INLET	1	20691064	
42	BSHG HEX BRS 3/4MPTX1/2FPT	4	11392716	PARKER #209P-12-8 B31.3
43	CONN SS 1/2ODTX1/4FPT	2	11547976	SWAGELOK #SS-810-7-4
44	TUBE SS 1/2"OD MAN-OUT PRO V8	2	20693894	
45	ANGLE SS 1X1X.125 6"LG PRO V8	2	20693895	
46	TUBE PRO V8 VAPORIZER OUTLET	1	20691063	
47	U-BOLT SS 2-1/2"PS 3/8-16UNC	2	15081448	T304 3.63DPX3.00ID 1-1/4LG THD
48	WASHER SPLIT SS 3/8 18-8 B18	4	2910871	
49	BRACKET ASSY VAP BACK PRO V8	1	20693896	
50	BRACKET ASSY VAP FRONT PRO V8	1	20693898	
51	HHCS SS 1/4-20X2-1/2"LG	4	2911821	
52	VALVE BALL BRS 1/2FPT S/SS	1	12962291	
53	NIPPLE SS 1/2NPT X 6"	1	1312061	
54	TEE STREET BRS 1/2FPT X 1/2MPT	2	1212082	
55	RV TUBE S/A MPV	3	11774431	
56	HHCS SS 3/8-16NC X 1"LG	2	292000	
57	LOCKNUT SS 3/8-16 18-8 B18	2	2913671	
59	BRACKET ASSY VAP BASE PRO V8	1	20694104	
60	U-BOLT SS 1.000"OD 1/4-20UNCX	2	11631596	
61	STAUFF CLAMP 1/2OD	2	3411396	STAUFF # 2127-PP-E-GREEN
62	WASHER FLAT SS 18-8 3/8ID X 1" OD	2	2913711	
63	STAUFF CLAMP 1/4OD	2	3410556	STAUFF # 1064-PP-E-GREEN
64	HHCS SS 1/4-20X1-3/4"LG	2	2911891	
65	STAUFF CLAMP 1PS	11	3411256	STAUFF # 5334-PP GREEN
66	BOLT HEX SS .250-20UNCX3.00LG	16	20544209	
67	WELD PLATE SP 5000 SERIES	3	3411121	STAUFF #SP-5 SS
68	BRACKET ASSY VAP R-BASE PRO V8	1	20694276	
69	STAUFF CLAMP 1OD	2	3411236	STAUFF # 3254-PP-E-GREEN
70	WELD PLATE SP 3000 SERIES	2	3411111	STAUFF # SP-3 SS
71	HHCS SS 1/4-20 X 1-1/2”LG	4	14188681	
72	CONN SS 1/4ODTX1/4FPT	2	11698184	SWAGELOK # SS-400-7-4
73	TRANSMITTER PRESS 0-500PSIG	2	12765289	DWYER #626-14-GH-P1-E3-S1-SPCL
74	CONDUIT 1/2" FLEXIBLE NON-	3	10923992	
75	HHCS SS 1/4-20 X 1/4"LG	2	2913101	
76	CONDUIT OUTLET ASSY1/2"FPT-A10	2	14271805	APPLB50DCG THREADED A10
77	CONDUIT FTG 1/2" STRAIGHT	2	10924012	

Item	Description	Qty	Chart PN	Manufacturer PN
78	LABEL TRIANGLE GAS USE	2	3811599	
79	LABEL TRIANGLE VENT	6	3811609	
80	LABEL TRIANGLE LIQUID	6	3811589	
81	VALVE BRS SHUTOFF 3/8FPT	8	11905981	REGO # T9453
82	NIPPLE HEX BRS 3/8NPT SCH 40	4	1310072	PARKER # 216P-6 B31.3
83	ELBOW BRS 90D 3/8OD X 1/2MPT	3	13726821	SWAGELOK # SS-1610-2-16
84	REGULATOR .500FPT HIGH FLOW	1	20725962	CONCOA # 6223502-01-000
85	BRKT ASSY PRO V8 STAUFF SUPPORT	1	20730246	
86	LABEL CHART LOGO 8-1/4 X 2-1/4"	1	11391211	

* For manual override solenoid (to open the normally closed valve), see Section 8.1 SOLENOID VALVE OPTIONS on page 30.

10. EXPLODED VIEW