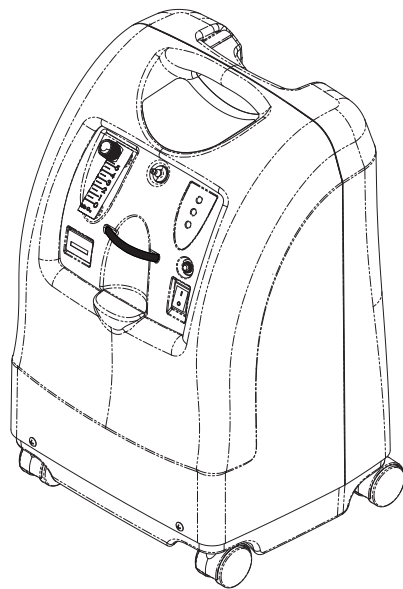


**Perfecto<sub>2</sub>**<sup>TM</sup>  
**Oxygen Concentrator**  
**(HomeFill<sup>®</sup> Compatible)**

**Model IRC5PO2AW (Sensored)**  
**Model IRC5PAW (Non-Sensored)**



**DEALER:** Keep this manual. The procedures in this manual **MUST** be performed by a qualified technician.

For more information regarding  
Invacare products, parts, and services,  
please visit [www.invacare.com](http://www.invacare.com)



Yes, you can.<sup>®</sup>

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## **⚠ WARNING**

**DO NOT OPERATE THIS EQUIPMENT WITHOUT FIRST READING AND UNDERSTANDING THIS MANUAL. IF YOU ARE UNABLE TO UNDERSTAND THE WARNINGS, CAUTIONS, AND INSTRUCTIONS, CONTACT INVACARE TECHNICAL SERVICES BEFORE ATTEMPTING TO USE THIS EQUIPMENT - OTHERWISE SERIOUS INJURY OR PROPERTY DAMAGE MAY RESULT.**

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## **⚠ WARNING**

**Invacare products are specifically designed and manufactured for use in conjunction with Invacare accessories. Accessories designed by other manufacturers have not been tested by Invacare and are not recommended for use with Invacare products.**

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## **PERFECTO<sub>2</sub> PARTS COMPATIBILITY**

**The Platinum concentrator and the Perfecto<sub>2</sub> concentrator share many similar components. However, there are some components that are NOT cross compatible and they are specific to each model.**

**Parts that can be used for Perfecto<sub>2</sub> repairs are listed in the Perfecto<sub>2</sub> parts catalog, form number 08\_076. Please reference this catalog before replacing any parts. Use of incorrect parts could result in injury or property damage.**

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# SPECIAL NOTES

Signal words are used in this manual and apply to hazards or unsafe practices which could result in personal injury or property damage. Refer to the table below for definitions of the signal words.

SIGNAL WORD	MEANING
DANGER	Danger indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.
WARNING	Warning indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
CAUTION	Caution indicates a potentially hazardous situation which, if not avoided, may result in property damage or minor injury or both.

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## NOTICE

**THE INFORMATION CONTAINED IN THIS DOCUMENT IS SUBJECT TO CHANGE WITHOUT NOTICE.**

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### **DANGER**

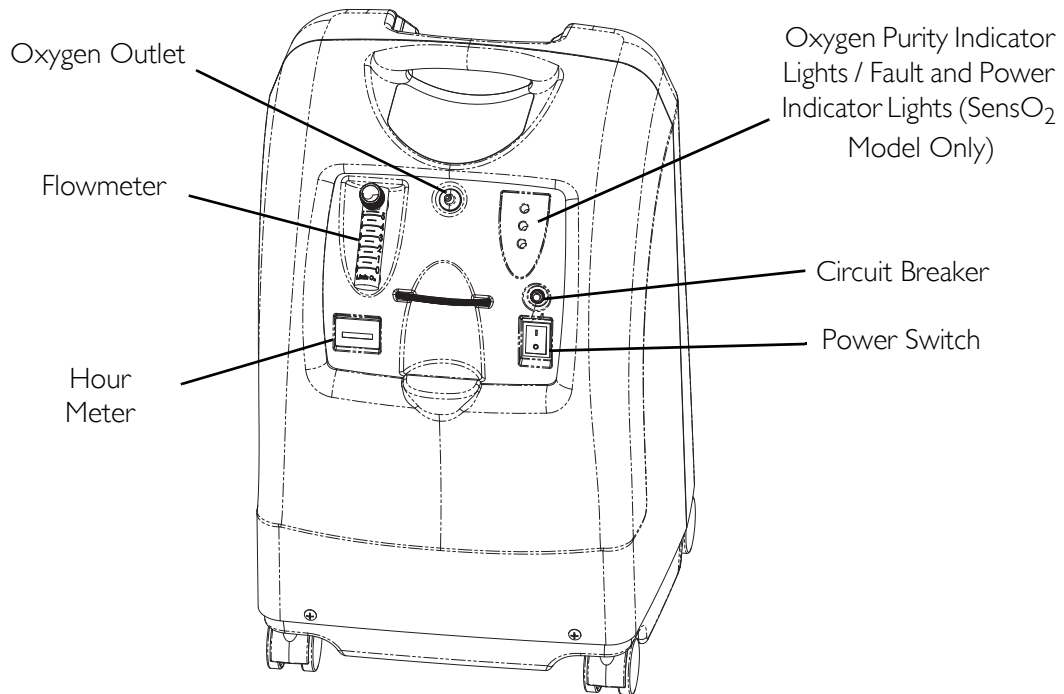
**DO NOT SMOKE** while using this device. Keep all matches, lit cigarettes, candles, or other sources of ignition out of the room in which this product is located and away from where oxygen is being delivered.

**NO SMOKING** signs should be prominently displayed. Textiles and other materials that normally would not burn are easily ignited and burn with great intensity in oxygen enriched air. Failure to observe this warning can result in severe fire, property damage and cause physical injury or death.

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# FEATURES

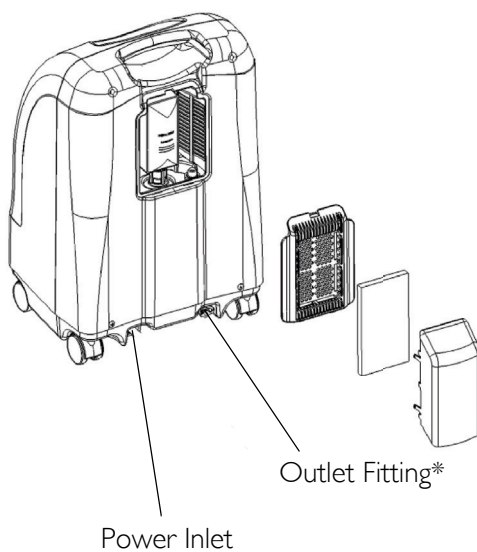
## FRONT VIEW



### ACCESSORIES (NOT SHOWN):

PreciseR<sub>x</sub><sup>TM</sup> Pediatric Flowmeter Accessory - IRCPF16AW

HomeFill home oxygen compressor - IOH200AW



*\*NOTE: This outlet fitting is to be used only for filling oxygen cylinders with the HomeFill home oxygen compressor. The outlet fitting does not affect concentrator performance. Refer to the HomeFill owner's manual, part number 1145804 - Northern, 1145805 - Southern, 1145806 - Scandinavian, for connection and operating instructions. When not in use, the plug provided with the concentrator should be inserted into the outlet fitting. For more information about the HomeFill, contact your Invacare dealer.*

# TYPICAL PRODUCT PARAMETERS



Electrical Requirements:	230 VAC $\pm$ 10% (253 VAC/207 VAC), 50 Hz
Rated Current Input:	1.4 A
Sound Level:	39.5 dBA Average
Altitude:	Up to 1828 m (6,000 ft) above sea level without degradation of concentration levels. Not recommended for use above 1828 m (6,000 ft)
Oxygen Output Concentration Levels: <i>NOTE: Stated concentration levels achieved after initial warm-up period (approximately 30 minutes).</i>	95.6% to 87% at 0.5 to 5 L/min
Maximum Outlet Pressure:	34.5 kPa $\pm$ 3.45 kPa. (5 p.s.i. $\pm$ 0.5 p.s.i.)
Flow Range:	0.5 to 5 L/min For flowrates less than 1 L/min, we recommend the use of the Invacare Pediatric Flowmeter IRCPFI6AW Accessory
Low Flow Alarm:	0 L/min to 0.5 L/min Rapid Audible Alarm Beeping (No Accessories Connected)
Average Power Consumption:	280 W (Operating @ 3 L/min)
Pressure Relief Mechanism Operational at:	241 kPa $\pm$ 24.1 kPa (35 p.s.i. $\pm$ 3.5 p.s.i.)
Change in maximum recommended flow when back pressure of 7kPa is applied:	0.7 L/min
Filters:	Cabinet, Outlet HEPA and Compressor Inlet
Safety System:	Current overload or line surge shutdown. High temperature compressor shutdown. High Pressure Alarm w/compressor shutdown. Low Pressure Alarm w/compressor shutdown. Battery Free Power Loss Alarm. SensO <sub>2</sub> Oxygen System (SensO <sub>2</sub> Model) Low Flow Alarm
Width:	38.1 cm $\pm$ 1 cm (15 in. $\pm$ 3/8 in)
Height:	58.4 cm $\pm$ 1 cm (23 in. $\pm$ 3/8 in)
Depth:	30.5 cm $\pm$ 1 cm (12 in $\pm$ 3/8 in)
Weight:	21 kg $\pm$ 1 kg (45 lbs $\pm$ 2 lbs)
Shipping Weight:	23 kg $\pm$ 1 kg (50 lbs $\pm$ 2 lbs)
Operating Ambient Temperature:	50°F - 95°F (10°C - 35°C) at 20-60% relative humidity
Exhaust:	Less than Ambient +19°C (+ 35°F)
Oxygen Output:	Less than Ambient +3°C (+ 6°F)
Cabinet:	Impact Resistant flame-retardant plastic cabinet that conforms to UL 94-V0
Electrical:	No extension cords




TYPICAL PRODUCT PARAMETERS

Placement:	No closer than 7.62 cm (3 inches) from any wall, furniture, draperies, or similar surfaces
Tubing:	2.1 m (7 ft) cannula with a maximum 15.2 m (50 ft) of Crush-Proof Tubing (DO NOT pinch)
Relative Humidity:	20 to 60%
Time of Operation:	Up to 24 hours per day
Recommended Storage and Shipping Temperature:	-29°C to 65°C (-20°F to 150°F), at 15-95% relative humidity
Standards and Regulatory Listing:	IRC5PO2AW/IRC5PAW IEC/EN61000-3-2 IEC/EN61000-3-3 IEC/EN 60601-1, A1, A2 IEC/EN 60601-1-2  IRC5PO2AW Models Only ISO8359 MDD
CE marked model	IRC5PO2AW

**IRC5PO2AW INDICATORS**

LABEL SYMBOL	O <sub>2</sub> PURITY	INDICATOR LIGHTS (LED)
O <sub>2</sub>	SYSTEM OKAY O <sub>2</sub> over 85% (± 2%)	GREEN Indicator Light
	O <sub>2</sub> Between 73% (± 3%) to 85% (±2%)	YELLOW Indicator light A. YELLOW Solid B. YELLOW Flashing Sensor Failure Call a qualified technician.
	SYSTEM FAILURE O <sub>2</sub> Below 73% (±3%)	RED Indicator Light Continuous Audible Alarm Sieve-GARD Compressor Shut-down.

**IRC5PAW INDICATORS**

LABEL SYMBOL	STATUS	INDICATOR LIGHTS (LED)
I/O	SYSTEM OKAY	GREEN Indicator Light
	SYSTEM FAILURE	RED Indicator light Continuous Audible Alarm Sieve-GARD™ Compressor Shutdown Call a qualified technician

# SECTION I—IMPORTANT SAFEGUARDS

## Important Safeguards

In order to ensure the safe installation, assembly and operation of the Perfecto<sub>2</sub> concentrator these instructions **MUST** be followed.

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### **⚠ WARNING**

This section contains important information for the safe operation and use of this product.

---

### **⚠ DANGER**

**Risk of electric shock. DO NOT disassemble. Refer servicing to qualified service personnel. No user serviceable parts.**

**TO REDUCE THE RISK OF BURNS, ELECTROCUTION, FIRE OR INJURY TO PERSONS.**

**DO NOT place or store product where it can drop into water or other liquid.**

**DO NOT reach for product that has fallen into water. Unplug IMMEDIATELY.**

**A spontaneous and violent ignition may occur if oil, grease or greasy substances come in contact with oxygen under pressure. These substances **MUST** be kept away from the oxygen concentrator, tubing and connections, and all other oxygen equipment. **DO NOT use any lubricants unless recommended by Invacare.****

---

## Operating Information

For optimum performance, Invacare recommends that each concentrator be on and running for a minimum of 30 minutes at a time. Shorter periods of operation may reduce maximum product life.

A product should **NEVER** be left unattended when plugged in. Make sure the Perfecto<sub>2</sub> is Off when not in use.

**DO NOT** connect the concentrator in parallel or series with other oxygen concentrators or oxygen therapy devices.

Keep the oxygen tubing, cord, and unit out from under such items as blankets, bed coverings, chair cushions, clothing and away from heated or hot surfaces, including space heaters, stoves and similar electrical appliances.

## Radio Frequency Interference

This equipment has been tested and found to comply with EMC limits specified by IEC/EN 60601-1-2. These limits are designed to provide a reasonable protection against electromagnetic interference in a typical medical installation.

Other devices may experience interference from even the low levels of electromagnetic emissions permitted by the above standards. To determine if the emissions from the Perfecto<sub>2</sub> is causing the interference, turn the Perfecto<sub>2</sub> Off. If the interference with the other device(s) stops, then the Perfecto<sub>2</sub> is causing the interference. In such rare cases, interference may be reduced or corrected by one of the following measures:

- Reposition, relocate, or increase the separation between the equipment.
- Connect the equipment into an outlet on a circuit different from that to which the other device(s) is connected.

Avoid creation of any spark near medical oxygen equipment. This includes sparks from static electricity created by any type of friction.

# SECTION 2—INSTALLATION/ SEQUENCE OF OPERATION

## Verification of Battery Free Power Loss Alarm

Check the Perfecto<sub>2</sub> concentrator for proper operating conditions.

1. If the unit has been in below-freezing temperatures, allow it to warm up to room temperature before operating.
2. The concentrator may need to be turned on for four to five seconds to charge the Battery Free Power Loss Alarm. Connect power cord to outlet and turn the concentrator on. Turn flow control knob counterclockwise and flow will begin IMMEDIATELY. Set flow rate to five L/min. Let the unit run for 30 minutes, then turn unit off.
3. Unplug the power cord and press On/Off (I/O) switch to the On (I) position. An intermittent audible alarm will sound. This confirms proper operation of the Battery Free Power Loss Alarm. Turn On/Off switch Off (O).
4. Connect power cord to outlet and turn on concentrator. Unit will beep on start-up.
5. Check the oxygen concentration per specifications after 30-40 minutes running time.

## Sequence of Operation

Turning On (I) the power switch applies 230 VAC to the compressor motor, hour meter, transformer, cooling fan and the printed circuit (P.C.) board.

Room air enters the compressor via the cabinet filter and the compressor inlet filter. The air is compressed by the WOB-L pistons in the compressor to a pressure of 144.79 kPa (21 p.s.i.).

As increased pressure creates increased temperature, a heat exchanger is used to lower the temperature before the air enters the 4-way valve. It is then channeled to a sieve bed containing the adsorption material. Restriction downstream of the sieve bed causes pressure to build up inside the sieve bed which is necessary for the adsorption process. A small amount of relatively pure oxygen enters the top of the second bed through a restrictive leak in the pressure equalization (P.E.) valve with the balance entering a storage tank. The nitrogen removed is exhausted back from the bed through the 4-way valve into room air. A muffler is located at the exhaust end of the valve to muffle the sound of the exhaust as it exits the concentrator.

The oxygen not being used to exhaust is channeled into the storage tank. The pressurized oxygen is regulated down to 34.4 kPa (5 p.s.i.), enters an accurate flow-measuring device, flows through Outlet HEPA filter and check valve, then out to the patient.

The electrical activation of the 4-way Valve is accomplished every 8 to 15 seconds by the pressure sensor and P.C. Board electronics when the pressure reaches a set point of 144.79 kPa (21 p.s.i.) output flows 4 L/min and above or 110.32 kPa (16 p.s.i.) output flows 3 L/min and below. The time between cycles is dependent on altitude, flow rate and internal environmental factors.

A P.E. valve opens just prior to the shift of the 4-way valve. This allows highly concentrated oxygen to enter the just exhausted bed from the top. This additional pressure allows the bed to start its cycle at a higher pressure. The P.E. valve will close just after the shift of the 4-way valve.

If main power is lost, the Battery Free Power Loss Alarm will sound a short "BEEP", with a long pause after. All units are equipped with a diagnostic alarm system that signals if the pneumatic pressure or electrical systems malfunction. The troubleshooting guide in this manual explains the alarm system signals and reasons, in detail. Refer to [Troubleshooting](#) on page 16.

## **SensO<sub>2</sub> Oxygen Sensor Technology - Ceramic Zirconia Sensor**

### **Technical Description**

The oxygen being produced by the concentrator flows out of the product tank and into the flowmeter. A small flow of oxygen produced by the unit is sent through a precision orifice to the oxygen sensor mounted on the printed circuit board.

As the oxygen enters the sensor, it passes through a screen and contacts the sensing disk.

Electric current flowing through a metal film resistor heats the disk in excess of 300°C. Oxygen molecules contact the electrode of the disk and pick-up extra electrons to become oxygen ions. These oxygen ions are attracted to the electrode on the bottom of the zirconia sensing disk. Because of the crystal structure of the zirconia, only oxygen ions can pass through. When the oxygen ions reach the bottom electrode, the extra electrons are released from the oxygen ions and oxygen molecules return to the air. The number of electrons is directly related to the oxygen concentration. The electrons travel to the P.C. board where they are counted and the oxygen concentration reading is calculated.

A microprocessor on the P.C. board contains software that interprets the signal being received from the sensor. It compares the signal to clinically acceptable limits. Signals outside of the clinically acceptable limits generate responses in the form of lights, audible indicators, and/or system shut-down.

### **Operating Sequence**

Once the power switch has been turned on (I), the SensO<sub>2</sub> circuit will wait five minutes for the concentrator to begin producing clinically acceptable oxygen and the oxygen sensor to stabilize. The GREEN light will illuminate (indicating normal system operation) while the oxygen sensor is warming up.

After five minutes, if the oxygen purity exceeds  $85\% \pm 2\%$ , the GREEN light will continue to illuminate.

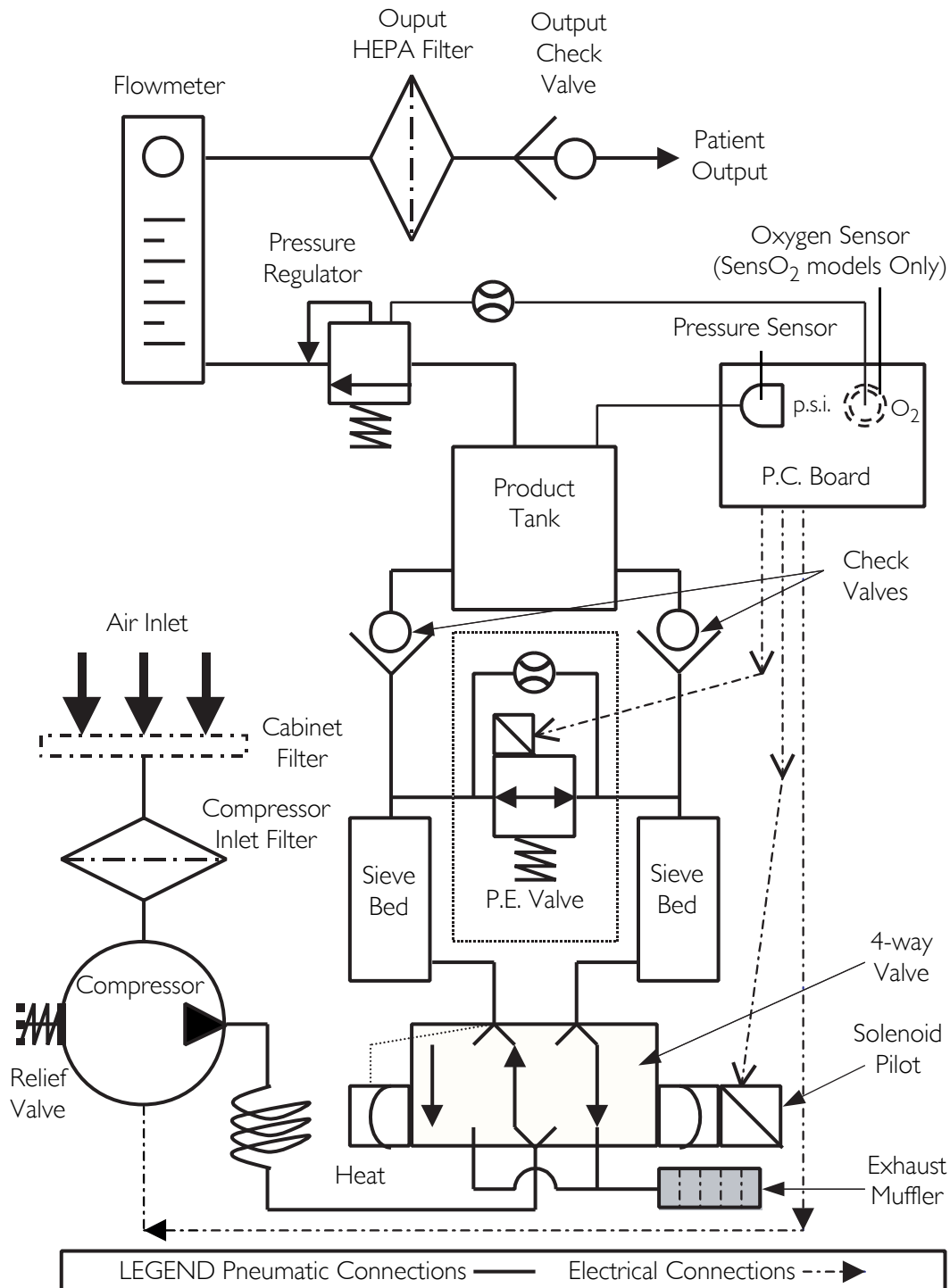
If the oxygen level is not above  $85\% \pm 2\%$  after the first five minutes, the system will continue to monitor the  $O_2$  and wait for a maximum of 30 minutes from start-up to reach  $85\% \pm 2\%$  before activating an alarm. Environmental factors such as low voltage, high altitude, or age of the machine will affect the time required to reach  $85\% \pm 2\%$ .

If the oxygen level is not above  $85\% \pm 2\%$  within the first 30 minutes, the oxygen concentration alarm sequence will activate and the unit will shut down.

When oxygen concentration is above  $85\% \pm 2\%$ , the sensor measures oxygen purity every 10 minutes. If a reading falls below  $85\% \pm 2\%$ , a YELLOW light will illuminate. If the oxygen purity falls below  $73\% \pm 3\%$  the RED light/Alarm/Shut-Down mode will activate.

# SECTION 3—PNEUMATIC DIAGRAM

Perfecto<sub>2</sub> Oxygen Concentrator



# SECTION 4—TROUBLESHOOTING

SYMPTOM	PROBABLE CAUSE	SOLUTION
Normal Operation: Internal Status Indicators: RED: Off GREEN: Off Unit plugged in, power switch on. Single beep on start up.	No Problems.	System Okay.
Power loss: Internal Status Indicators: RED: Off GREEN: Off Unit unplugged, power switch on, alarm off.	No Problems.	Battery Free Circuit drained. Plug in cord and turn power switch ON (I) to recharge.
Power loss: Internal Status Indicators: RED: Off GREEN: Off Unit plugged in, power switch , alarm off, battery Free circuit drained.	No power at outlet.	Check electrical outlet with a table lamp or voltmeter set on VAC scale. If outlet isn't working, check protective device in home's electrical panel or consult an electrician. Also ensure that unit is properly plugged in. DO NOT use extension cords. Move to another outlet or circuit.
	Power cord: a. Frayed. b. Broken or damaged spade. c. Spade connector from power cord loose or disconnected (inside back of unit).	a. Reattach cord. b. Replace power cord connectors on plug. c. Reattach connector.
	On/Off (I/O) switch. a. Disconnected wire. b. Faulty switch.	Check all electrical connections to the ON/OFF (I/O) switch for any disconnected wires.  If the concentrator does not come on at all and wiring is intact, color code and remove wires one at a time. Remove and replace with new one. Transfer wires from old switch to new switch one at a time to the matching contact.
	Circuit breaker tripped.	Reset breaker. NOTE: Breaker may trip to safeguard concentrator during a power surge. If breaker trips IMMEDIATELY, there is a probable short in the unit. Check for pinched or charred wires. If the breaker does not trip, run unit for approximately two hours. The circuit breaker should be less than 10 ohms. If breaker trips again, there is an internal problem. Contact Invacare Technical Service.



SYMPTOM	PROBABLE CAUSE	SOLUTION
Power Loss: (Continued) Internal Status Indicators: RED: Off GREEN: Off Unit plugged in, power switch, alarm off. Battery Free circuit drained.	P.C. board. a. P.C. board damaged.  b. Loose or damaged connector.	a. Replace P.C. Board. Refer to <u>Replacing P.C. Board</u> on page 58. b. Repair or replace connector.
Internal Power Loss Senso <sub>2</sub> : Internal Status Indicators: RED: Off GREEN: Off Alarm may or may not be on. Control Panel Indicators: RED: Off YELLOW: Off GREEN: Off Fan operates, Compressor not operating.	Transformer assembly. a. Faulty.  b. Connector loose or disconnected.  c. Faulty wiring.	a. Replace. Refer to <u>Replacing the Transformer</u> on page 61. b. Reattach connector.  c. Replace transformer assembly. Refer to <u>Replacing the Transformer</u> on page 61.
	P.C. board faulty.	Replace P.C. board. Unit requires retiming after P.C. board replacement. Refer to <u>Replacing P.C. Board</u> on page 58.
High Pressure: Internal Status Indicators:  RED: One Flash GREEN: Two Flashes  Unit plugged in, power switch on, continuous alarm. Compressor shut down.	P.C. board: a. Malfunction   b. Disconnected wire.  c. Shifting valve at pressures greater than 25 p.s.i. for Perfecto <sub>2</sub> .	a. Set flow to max L/min. for concentrator. Check voltage across Pilot Valve 1 on volt DC scale. If meter reads 0 volts when unit is turned on, replace P.C. board b. Check spade connectors on pilot valves 1 or 2 and connectors on P.C. board. c. Replace P.C. board. Unit requires retiming after P.C. board replacement. Refer to <u>Replacing P.C. Board</u> on page 58.
	4-way Valve: a. Not shifting.   b. Bad coil.  c. Coil resistance.	a. Check voltage. If voltage rises to approximately 24 volts D.C. when unit shuts down, P.C. board is functioning properly. Replace the valve if shorted or open. Refer to <u>Replacing 4-Way Valve and/or Manifold Assembly</u> on page 65. b. Replace 4-way valve. Refer to <u>Replacing 4-Way Valve and/or Manifold Assembly</u> on page 65. c. Coil should read 175 ohms ± 20.

## SECTION 4—TROUBLESHOOTING

SYMPTOM	PROBABLE CAUSE	SOLUTION
<p><b>LOW PRESSURE:</b> Internal Status Indicators: RED: One Flash GREEN: One Flash</p> <p>Or</p> <p>RED: One Flash GREEN: Three Flashes</p> <p>Control Panel Indicators: RED: On YELLOW: Off GREEN: Off</p> <p>Unit plugged in, power switch on, continuous audible alarm. Compressor shut down (Failure to cycle due to low pressure).</p>	Compressor inlet filter dirty or plugged.	Replace compressor inlet filter. Refer to <a href="#">Replacing the Compressor Inlet HEPA Filter</a> on page 26.
	Compressor: a. Leaks at fittings or tubing b. Leaking or defective relief valve. c. Insufficient voltage at outlet.  d. Worn cup seals or gaskets.	a. Replace or repair. b. Repair leak or replace. c. DO NOT use extension cords. Use another outlet. d. Rebuild top end of compressor. Refer to <a href="#">Rebuilding the Thomas Model 2660 Compressor</a> on page 34.
	Heat exchanger: a. Leak at tubing or body chamber. b. Inspect tubing and heat exchanger.	a. Replace or retighten. b. Replace or retighten tubing. Replace heat exchanger. Refer to <a href="#">Replacing Heat Exchanger Assembly</a> on page 51.
	Regulator cracked or leaking.	Replace regulator. Refer to <a href="#">Replacing Regulator</a> on page 48.
	P.E. valve leaking.	Replace P.E. Valve. Check voltage at P.E. valve connector on 24 volt D.C. scale. The P.E. Valve activates or energizes approximately one second prior to the activation of the 4 way valve with approximately 24 volts. If voltage is in excess of 24 volts consistently, replace the P.C. board. Refer to <a href="#">Replacing P.C. Board</a> on page 58. If the P.C. board voltage acts normally, replace the P.E. valve. Refer to <a href="#">Replacing P.E. Valve</a> on page 42. Note: Check for leaks starting at the compressor output through all the pneumatic connections. Major leaks will cause system pressures to remain below adequate shift (exhaust) pressures and will cause compressor shutdown.
<p>Defective Parts: Internal Status Indicators: RED: One Flash GREEN: Five Flashes</p> <p>Or</p> <p>RED: Two Flashes GREEN: Three Flashes</p> <p>Control Panel Indicators: RED: On YELLOW: Off GREEN: Off</p> <p>Unit plugged in, power switch on, continuous audible alarm. Compressor shut down.</p>	Defective main valve coil.	a. Replace main valve. b. Replace main valve coil.
	Connector loose.	Reattach connector.
	Defective P.E. valve coil. (Resistance 80 ohms ± 10.)	Replace P.E. coil if shorted or open on resistance check. Refer to <a href="#">Replacing P.E. Valve</a> on page 42.
	Defective P.E. valve.	Replace P.E. valve. Refer to <a href="#">Replacing P.E. Valve</a> on page 42.
	Connector loose.	Reattach connector.
Defective P.C. board.	Replace P.C. board. Refer to <a href="#">Replacing P.C. Board</a> on page 58.	

SYMPTOM	PROBABLE CAUSE	SOLUTION
Unit not operating: Alarm: On or Off Internal Status Indicators: RED: Two Flashes GREEN: Four Flashes Or RED: Two Flashes GREEN: Five Flashes	P.C. board Failure.	Replace P.C. board. Refer to <a href="#">Replacing P.C. Board</a> on page 58.
Low Concentration: NOTE: Check for O <sub>2</sub> purity using a calibrated Oxygen Analyzer at Test Point 1 (oxygen outlet) of the concentrator.  Internal Status Indicators: RED: Two Flashes GREEN: One Flash 73% Shutdown Control Panel Indicators: SensO <sub>2</sub> ONLY: RED: On YELLOW: Off GREEN: Off  For SensO <sub>2</sub> units, the RED indicator will signal extremely low purity and will be accompanied by a continuous audible alarm and a system shutdown. Repairs are required.	Cabinet filters dirty.	Clean or replace. Refer to <a href="#">Cleaning the Cabinet Filter</a> on page 24, <a href="#">Replacing the Outlet HEPA Filter</a> on page 25, and <a href="#">Replacing the Compressor Inlet HEPA Filter</a> on page 26.
	Compressor inlet filter dirty.	Replace inlet filter. Refer to <a href="#">Replacing the Compressor Inlet HEPA Filter</a> on page 26.
	Compressor: a. Defective.  b. Faulty capacitor.  c. Bad motor windings. d. Worn seals.  e. Bad bearings. f. Leak at fittings or tubing. g. Leaky or defective relief valve. h. Insufficient voltage (outlet).	a. Replace compressor. Refer to <a href="#">Replacing Compressor Assembly</a> on page 31. b. Replace capacitor. Refer to <a href="#">Replacing Capacitor</a> on page 33. c. Replace compressor. d. Rebuild top end of compressor. Refer to <a href="#">Rebuilding the Thomas Model 2660 Compressor</a> on page 34. e. Replace compressor. f. Replace fittings or tubing. g. Replace relief valve. h. DO NOT use extension cords.
	Heat exchanger: a. Leak at tubing or body chamber. b. Inspect tubing and heat exchanger.	a. Replace or retighten. b. Replace or retighten tubing. Replace heat exchanger. Refer to <a href="#">Replacing Heat Exchanger Assembly</a> on page 51.
	Regulator cracked or leaking.	Replace. Refer to <a href="#">Replacing Regulator</a> on page 48.
	Exhaust muffler dirty or plugged.	Replace. Refer to <a href="#">Replacing the Muffler Assembly</a> on page 26.
	Fan: a. Not operating. Unit overheating.  b. Faulty fan.	a. Leads to fan disconnected. Reconnect. b. Replace. Refer to <a href="#">Replacing Cooling Fan</a> on page 55.
	Sieve beds defective.	Replace. Refer to <a href="#">Checking Sieve Bed Pressure</a> on page 85.
	Tubing kinked or blocked.	Repair or replace.
	P.C. board: a. Shifts at wrong pressures.	Check pressure at product tank. Pressure should rise to 144.79 kPa (21 p.s.i.) at shift point. If not, replace P.C. Board. Refer to <a href="#">Replacing P.C. Board</a> on page 58.

## SECTION 4—TROUBLESHOOTING

SYMPTOM	PROBABLE CAUSE	SOLUTION
Low Concentration (Continued)	Flowmeter: a. Flowmeter opened beyond maximum flow rate. b. Cracked or broken fitting. c. Input tubing leaking or loose.	a. Return flow to maximum setting. b. Replace fitting. c. Repair or replace. Refer to <u>Replacing Flowmeter</u> on page 63.
	Timing.	To accommodate for varying tolerances when replacing components, an adjustable timer is used to control the shifting of the Pressure Equalization (P.E.) valve. Refer to <u>Timing</u> on page 73.
	P.E. valve: a. Bad coil. b. Restrictor blockage.	a. Replace P.E. valve. b. Replace P.E. valve. Refer to <u>Replacing P.E. Valve</u> on page 42.
	Inspect P.C. board restrictor tubing for kinks or tears.	Replace P.C. board. Unit may need retiming after board replacement. Refer to <u>Replacing P.C. Board</u> on page 58.
Fluctuating Flow:	Regulator/Flowmeter: a. Incorrectly set regulator. b. Flowmeter malfunction.	a. Check pressure at oxygen outlet. Adjust regulator. b. If flow is still unstable, check for leaks starting at the compressor outlet fitting through all pneumatic connections. If no leaks are found and flow is still fluctuating, replace the regulator. If pressure at test point is within spec (5 p.s.i. $\pm$ 0.5 max. [34.4 kPa $\pm$ 6.89]), replace flowmeter. Refer to <u>Replacing Flowmeter</u> on page 63.
	Outlet HEPA filter: a. Dirty or plugged	a. If low flow conditions persist, replace outlet HEPA filter. Refer to <u>Replacing the Outlet HEPA Filter</u> on page 25.
Unit Excessively Loud:	Pneumatic exhaust: a. Muffler cracked, damaged or missing. b. Muffler tubing disconnected or damaged.	a. Replace. Refer to <u>Replacing the Muffler Assembly</u> on page 26. b. Reconnect or replace tubing.
	Compressor inlet filter missing and/or orange sticker removed.	a. Replace compressor inlet filter. Refer to <u>Replacing the Compressor Inlet HEPA Filter</u> on page 26.
	Compressor removed.	a. Replace Compressor. Refer to <u>Replacing Compressor Assembly</u> on page 31.
	Incorrect style of inlet filter (aftermarket).	a. Replace with factory OEM sound reduced style inlet HEPA filter.

SYMPTOM	PROBABLE CAUSE	SOLUTION
Unit Overheats:	Base exhaust vent plugged or restricted.	Place unit at least 7.62 cm (3-inches) from any wall. DO NOT place unit on pile or shag carpeting that may restrict air flow.
	Cabinet filters dirty or blocked.	Clean or replace. Refer to <u>Cleaning the Cabinet Filter</u> on page 24.
	Fan: a. Leads to fan disconnected. b. Defective fan.  c. Fan installed upside down.	a. Reconnect leads. b. Replace fan. Refer to <u>Rebuilding the Thomas Model 2660 Compressor</u> on page 34. c. Install fan with air flow arrow pointing down.
	Heat exchanger: a. Dirty or plugged. b. Damaged.	a. Clean heat exchanger. b. Replace heat exchanger. Refer to <u>Replacing Heat Exchanger Assembly</u> on page 51.
	Compressor: a. Defective.  b. Faulty capacitor.  c. Bad motor windings. d. Worn seals. e. Bad bearings.	a. Replace compressor. Refer to <u>Replacing Compressor Assembly</u> on page 31. b. Replace capacitor. Refer to <u>Replacing Capacitor</u> on page 33. c. Replace compressor. d. Replace compressor. e. Replace compressor.
	Line voltage excessive (surge).	Have line voltage inspected by certified electrician. A voltage regulator may be required and is obtainable from your local electric company.
Oxygen Purity: Good Internal Status Indicators: Control Panel Indicators: RED: Off YELLOW: On GREEN: On After 30 minutes of run time, unit operates normally, oxygen purity within normal range. GREEN or YELLOW panel indicator should illuminate.	P.C. board defective.	Replace P.C. board. Refer to <u>Replacing P.C. Board</u> on page 58. Unit may need retiming after P.C. board replacement. Refer to <u>Timing</u> on page 73.

## SECTION 4—TROUBLESHOOTING

SYMPTOM	PROBABLE CAUSE	SOLUTION
Unit Not Operating, Internal Status Indicators: RED: Off GREEN: Off Control Panel Indicators: RED: Off YELLOW: Off GREEN: Off Power Switch ON. Continuous audible alarm.	Transformer assembly: a. Assembly connector disconnected. b. Faulty transformer assembly.	a. Reattach connector. b. Replace transformer assembly. Refer to <u>Replacing the Transformer</u> on page 61.
Unit Operating, Internal Status Indicators: RED: Three Flashes GREEN: One Flash Control Panel Indicators: RED: Off YELLOW: Flashing GREEN: On	Internal repairs required.	Replace SensO <sub>2</sub> circuit board. Refer to <u>Replacing P.C. Board</u> on page 58.
Low-Flow Alarm does not activate on flows less than 0.5 L/min.	System leak.	Repair leak in product tank, regulator, tubing, fittings, or flow meter.
	Defective check valves.	Replace check valves. Refer to <u>Replacing Check Valves</u> on page 46.

# SECTION 5—CABINET

## Removing Cabinet

### **⚠ DANGER**

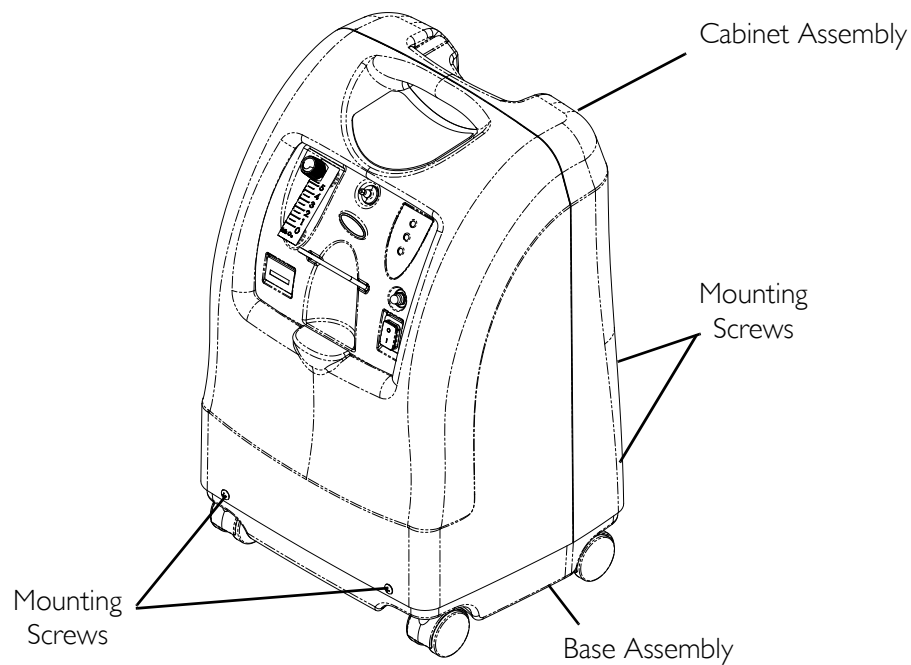
To prevent electrical shock, **ALWAYS** disconnect concentrator from electrical outlet before servicing.

*NOTE: For this procedure, refer to FIGURE 5.1.*

1. Unplug unit.
2. Remove the four mounting screws that secure cabinet assembly to the base assembly.
3. Lift the cabinet straight up.

*NOTE: When required, vacuum inside of the cabinet and exposed foam insulation.*

4. To re-install cabinet, reverse STEPS 2-3.



**FIGURE 5.1** Removing Cabinet

# SECTION 6—PREVENTIVE MAINTENANCE

## **⚠ DANGER**

To prevent electrical shock, ALWAYS disconnect concentrator from electrical outlet before servicing.

*NOTE: The Perfecto<sub>2</sub> AW Concentrators are specifically designed to minimize routine preventive maintenance. In places with high dust or soot levels, maintenance may need to be performed more often. The following MUST be performed at a minimum of one year in service to assure years of additional reliability. Refer to Troubleshooting on page 16 for plugged filter symptoms. Power should be disconnected before beginning preventive maintenance on the Invacare concentrator.*

## **Cleaning the Cabinet Filter**

*NOTE: For this procedure, refer to FIGURE 6.1 on page 24.*

*NOTE: There is one cabinet filter located on the back of the cabinet.*

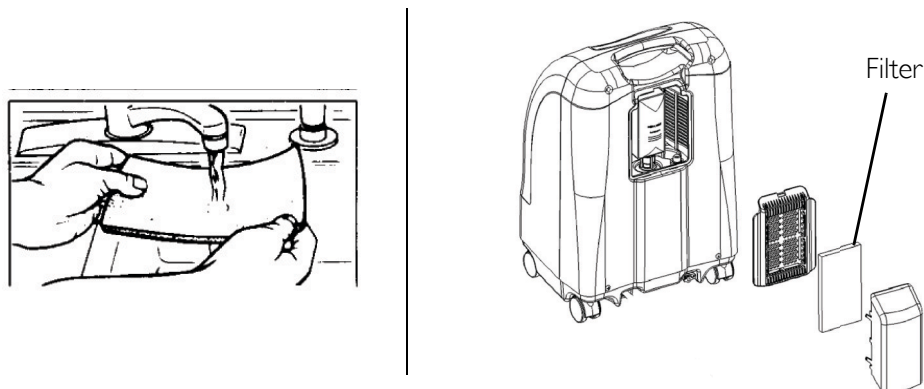
1. Inspect the filter monthly. Remove and clean as needed.

*NOTE: Environmental conditions that may require more frequent inspection and cleaning of the filter include but are not limited to: high dust, air pollutants etc.*

2. Clean the cabinet filter with a vacuum cleaner or wash in warm soapy water and rinse thoroughly.
3. Dry the filter thoroughly before reinstallation.

## **CAUTION**

DO NOT operate the concentrator without the filter installed.



**FIGURE 6.1** Cleaning the Cabinet Filter



## Replacing the Outlet HEPA Filter

### Check the Outlet HEPA Filter

*NOTE: The outlet HEPA filter can be checked by performing the following procedure.*

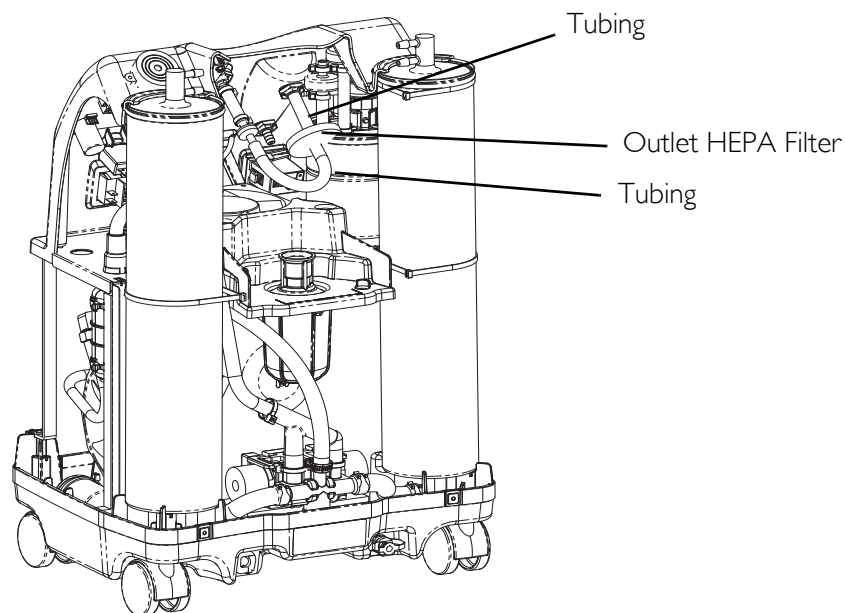
1. Turn the concentrator on and adjust the flowmeter to the maximum flow of the unit.
2. Observe the flowmeter's flow indicator while connecting a 15.24 m (50 ft) cannula tube to the outlet barb of the concentrator (not shown).
3. If the flow indicator fluctuates, the outlet HEPA filter may need replacement. Refer to [Troubleshooting](#) on page 16.

### Replace the Outlet HEPA Filter

*NOTE: For this procedure, refer to FIGURE 6.2.*

*NOTE: Perform this procedure as needed depending on the outlet HEPA filter check results.*

1. Unplug the unit.
2. Remove the cabinet. Refer to [Removing Cabinet](#) on page 23
3. For easier access to the outlet HEPA filter, remove the compressor inlet HEPA filter by grasping the compressor inlet filter, pull outward and up until filter is dislodged from rubber base (FIGURE 6.3).
4. With a flat head screwdriver, remove the tubing from both sides of the existing outlet HEPA filter by prying the tubing away from the outlet HEPA filter.
5. Discard existing outlet HEPA filter.
6. Connect tubing to both sides of the new outlet HEPA filter as shown below.
7. Install cabinet. Refer to [Removing Cabinet](#) on page 23.



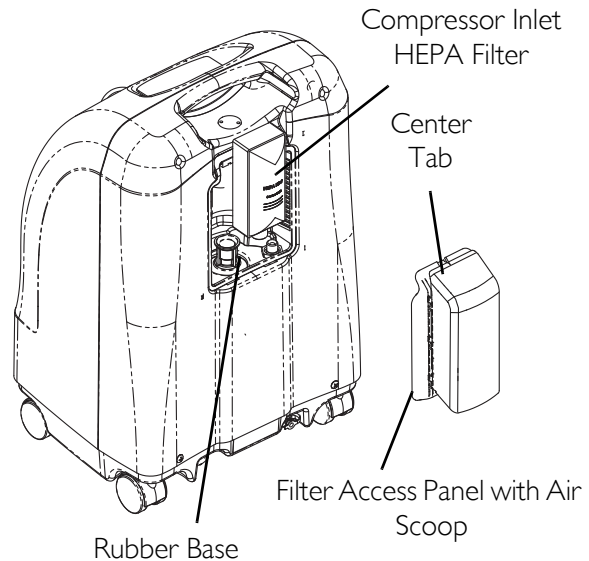
**FIGURE 6.2** Replace the Outlet HEPA Filter

## Replacing the Compressor Inlet HEPA Filter

*NOTE: For this procedure, refer to FIGURE 6.3 on page 26.*

*NOTE: Perform this procedure as needed depending upon the environment the concentrator is used in.*

1. Unplug the unit.
2. Remove the filter access panel with air scoop by pressing down on center tab and pulling panel out.
3. Grasp the compressor inlet HEPA filter, pull outward and up until filter is dislodged from rubber base.
4. Discard the existing compressor inlet HEPA filter.
5. Install new compressor inlet filter by inserting the filter into the rubber base.
6. Push the filter down until the rubber base touches the edge of the filter.
7. Reinstall the filter access panel.



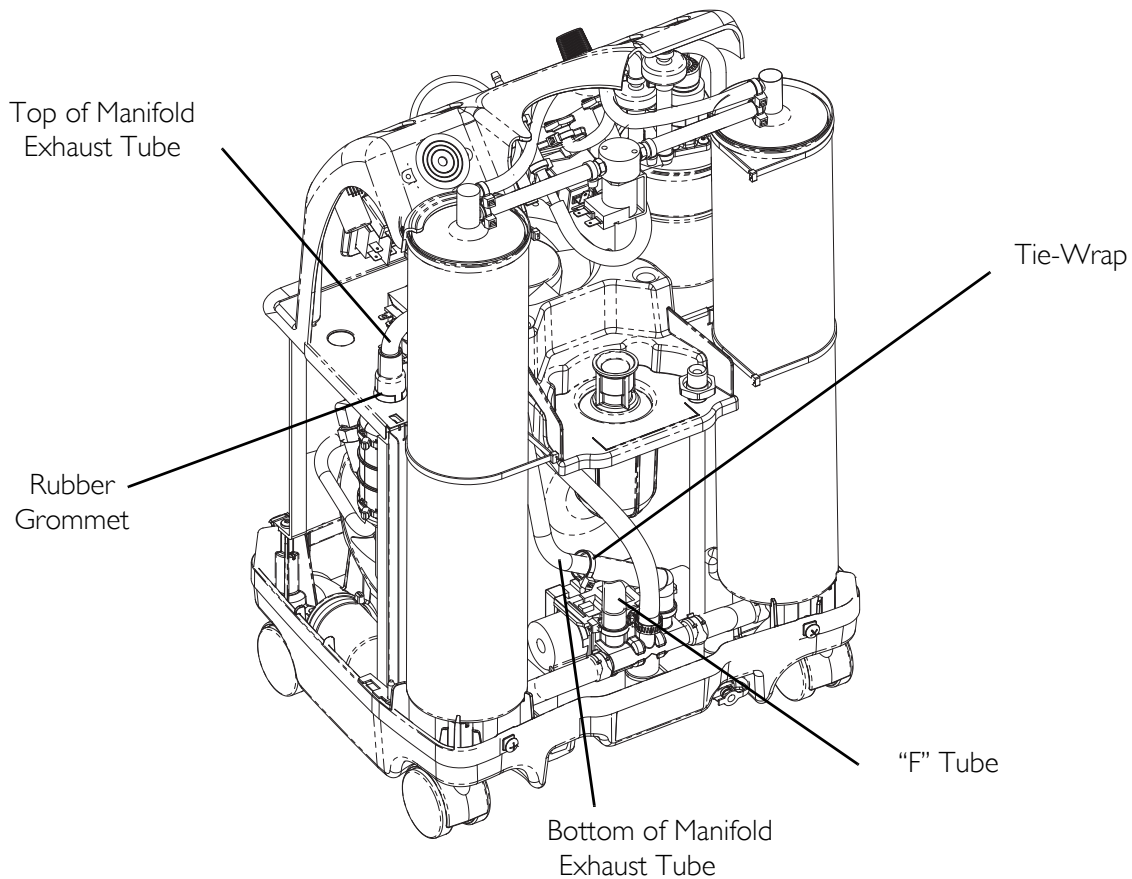
**FIGURE 6.3** Replacing the Compressor Inlet HEPA Filter

## Replacing the Muffler Assembly

*NOTE: For this procedure, refer to FIGURE 6.4 on page 27 and FIGURE 6.5 on page 28.*

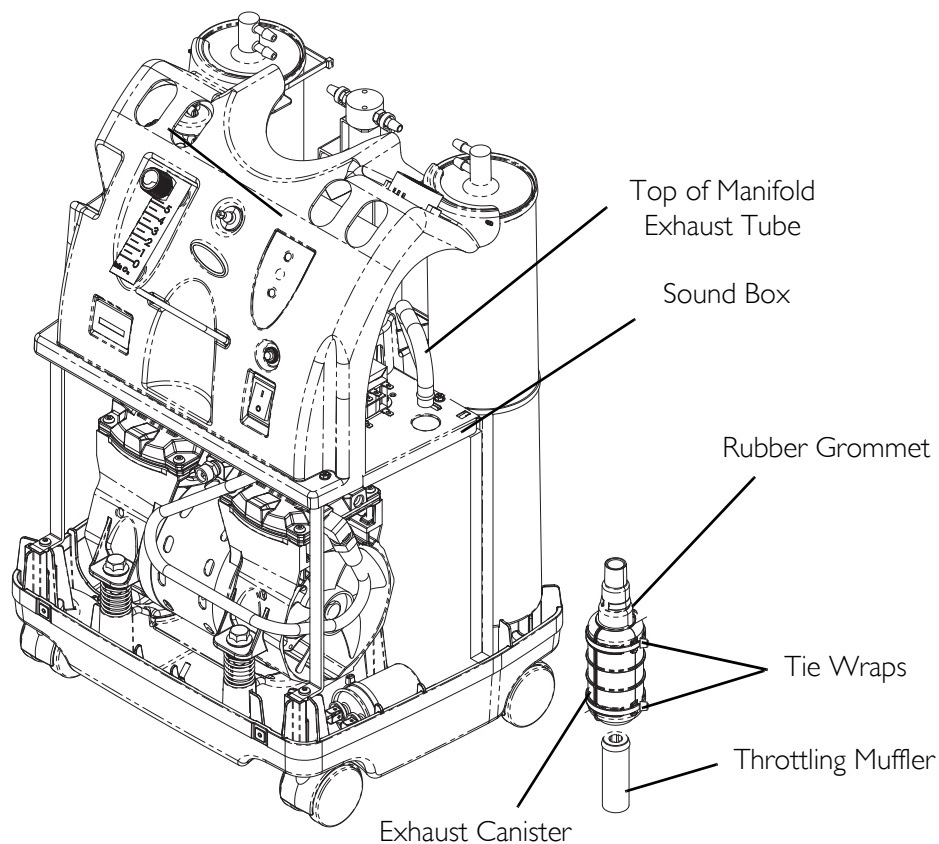
*NOTE: The following should be performed at 20,000 hour intervals although these procedures can be performed as needed depending upon the environment the concentrator is exposed to.*

1. Unplug unit.
2. Remove cabinet. Refer to [Removing Cabinet](#) on page 23.
3. Cut tie wrap that secures the bottom of the manifold exhaust tube to the "F" tube.
4. Remove the bottom of the manifold exhaust tube from the "F" tube.
5. Disconnect and remove the top of the manifold exhaust tube from the grommet.

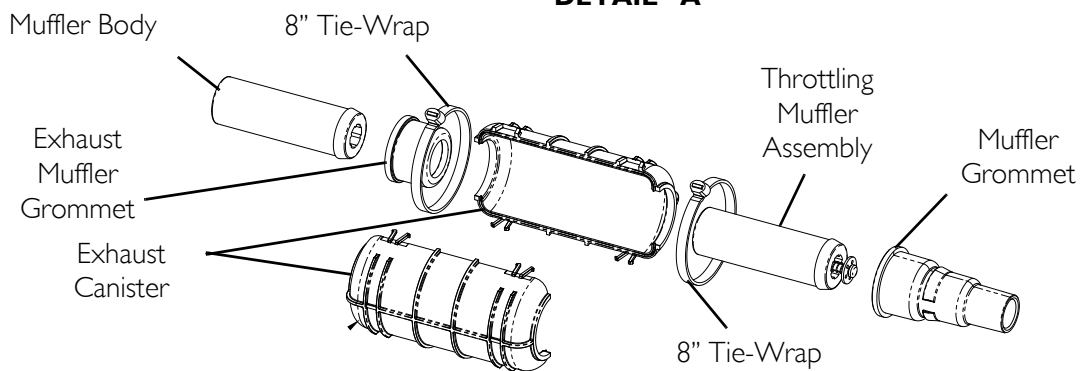


**FIGURE 6.4** Replacing the Muffler Assembly

6. Push the muffler assembly down through the opening in the sound box.
7. Cut the two tie wraps around the muffler assembly.
8. Separate the muffler assembly (Detail "A" in FIGURE 6.5).
9. Inspect the components to ensure they are clear.
10. Do one of the following:
  - Replace exhaust canister and throttling muffler if plugged or restricted.
  - Install only new throttling muffler if exhaust canister is in good condition.
11. Install new/existing muffler assembly by reversing STEPS 2-10.
12. Reinstall cabinet. Refer to Removing Cabinet on page 23.



**DETAIL "A"**



**FIGURE 6.5** Replacing the Muffler Assembly

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## Cleaning the Heat Exchanger

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### **⚠ DANGER**

To prevent electrical shock, **ALWAYS** disconnect concentrator from electrical outlet before servicing.

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*NOTE: For this procedure, refer to FIGURE 6.6 on page 29.*

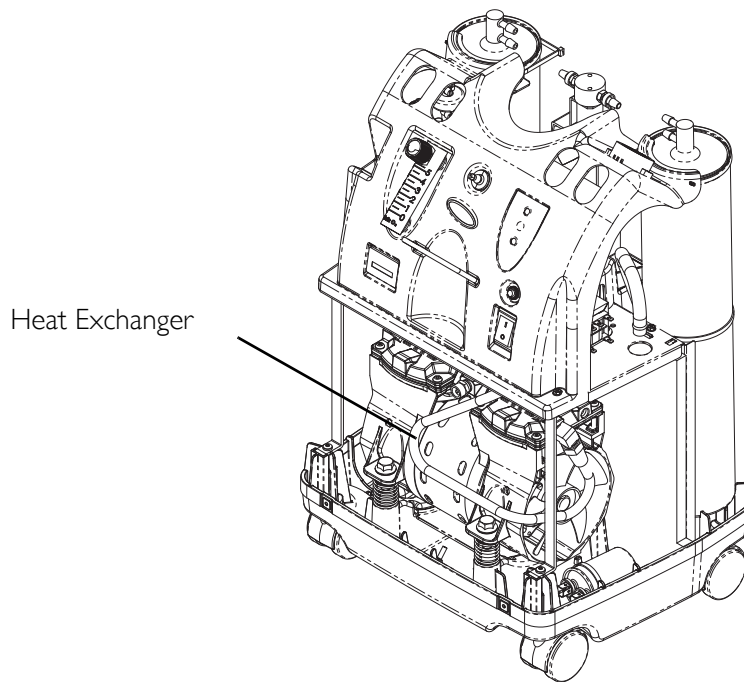
1. Unplug unit.
  2. Remove cabinet. Refer to Removing Cabinet on page 23.
- 

### **CAUTION**

Use care not to deform heat exchanger when installing, removing or cleaning.

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3. Remove excess dirt using compressed air or vacuum.
4. Reinstall cabinet. Refer to Cabinet on page 23.



**FIGURE 6.6** Cleaning the Heat Exchanger

**PREVENTIVE MAINTENANCE RECORD INVACARE PERFECTO<sub>2</sub> OXYGEN  
CONCENTRATOR**

Model No. IRC \_\_\_\_\_

Serial No. \_\_\_\_\_

On Each Inspection

<b>Record Date Of Service</b>											
Record Elapsed Hours on Hour Meter											
Clean Cabinet Filters											
Check Prescribed L/min. Flow Rate											
<b>Annually, During Preventive Maintenance Schedule, Or Between Patients</b>											
Clean/Replace Cabinet Filters											
Check outlet HEPA Filter*											
Check Compressor Inlet Filter*											
Check Oxygen Concentration (SensO <sub>2</sub> models)											
Check Power Loss Alarm											
<b>As Required or as otherwise noted</b>											
Clean Heat Exchanger											
Replace Exhaust Muffler											
Rebuild Top End Compressor											
<b>Every 180 Days</b>											
Check oxygen Concentration (Units without SensO <sub>2</sub> )											

\*NOTE: Refer to Preventive Maintenance section of Service Manual.

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# SECTION 7—COMPRESSOR

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## **⚠ DANGER**

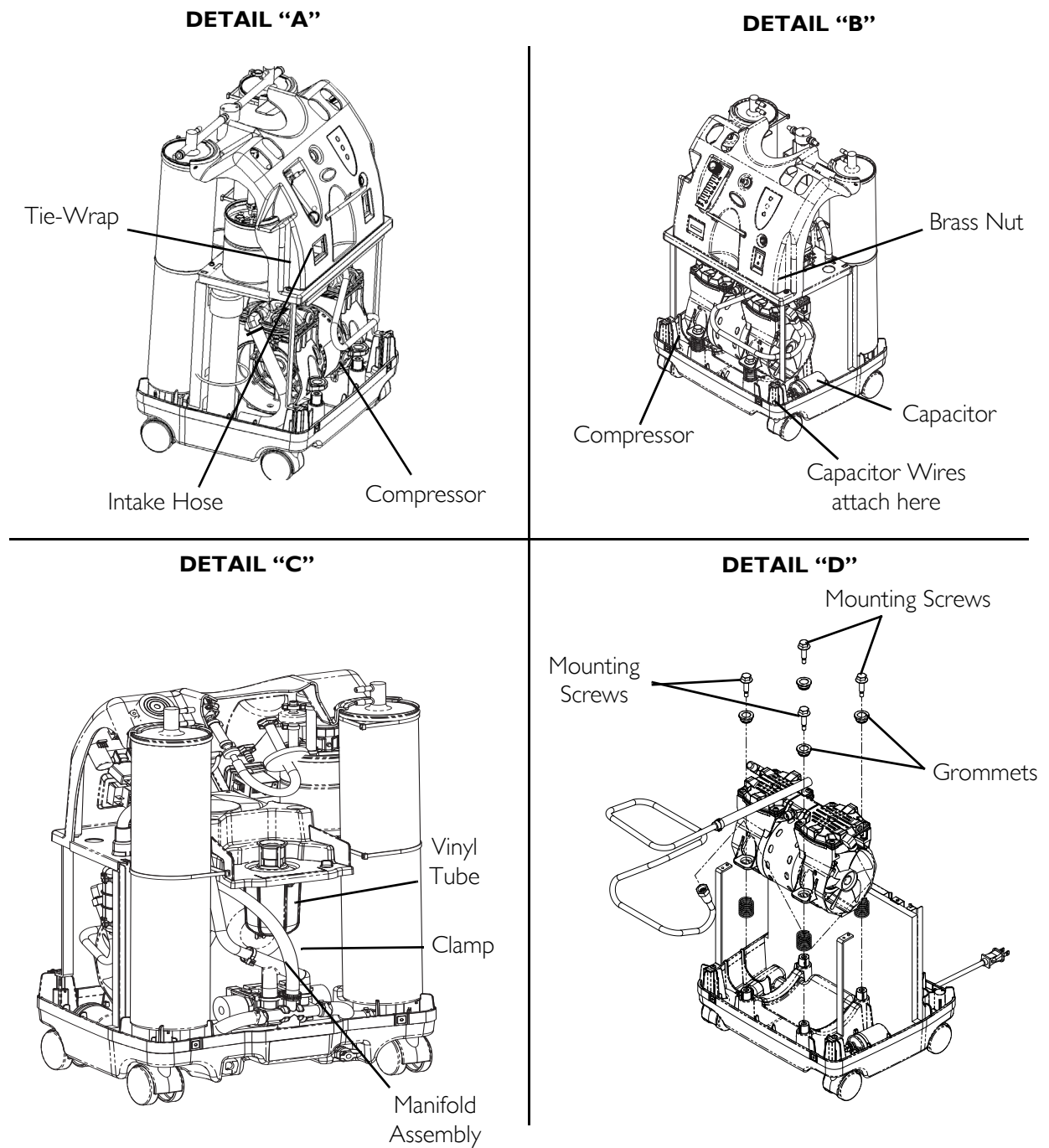
To prevent electrical shock, ALWAYS disconnect concentrator from electrical outlet before servicing.

---

## Replacing Compressor Assembly

NOTE: For this procedure, refer to FIGURE 7.1 on page 32 and FIGURE 7.2 on page 33.

1. Unplug unit.
2. Remove the cabinet. Refer to Removing Cabinet on page 23.
3. Cut the tie wrap that secures the intake hose to the compressor assembly (Detail “A”).
4. Disconnect intake hose from compressor assembly (Detail “A”).
5. Remove compressor wires from wire clamps or tie-wraps (not shown).
6. Disconnect compressor connector from the main harness connector (not shown).
7. Disconnect capacitor wires from the top of the capacitor (Detail “B”).
8. Disconnect brass nut from compressor (Detail “B”).
9. On the backside of the Perfecto<sub>2</sub>, loosen the clamp that secures the vinyl tube to the manifold assembly and remove the vinyl tube from the manifold assembly (Detail “C”).
10. On the front side of the Perfecto<sub>2</sub>, pull heat exchanger with vinyl tube out of base assembly (Detail “D”).
11. Remove the four mounting screws that secure the compressor to the base assembly (Detail “D”).
12. Tilt compressor assembly forward and lift out.
13. Reverse STEPS 3-12 to install new compressor assembly.
14. Secure compressor to base assembly with four screws and springs. Torque screws to 3.4 N-M (30 ± 5 in-lbs).
15. Reinstall the cabinet. Refer to Removing Cabinet on page 23.
16. Run unit and inspect for leaks. Refer to Leak Test on page 76.



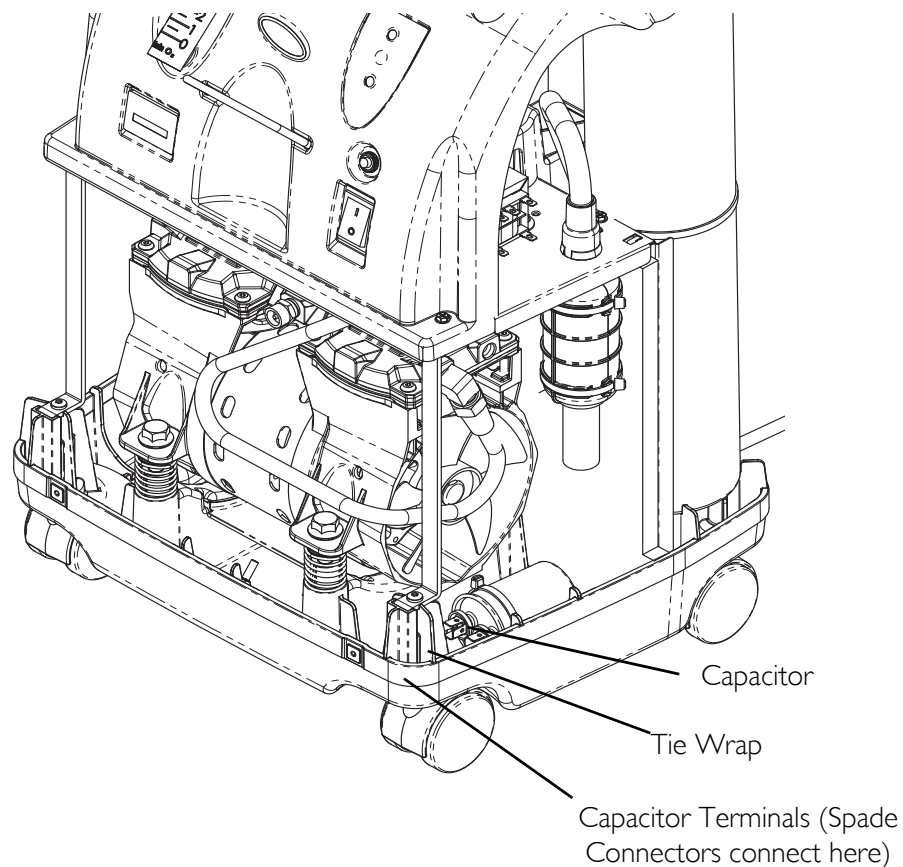
**FIGURE 7.1** Replacing Compressor Assembly



## Replacing Capacitor

*NOTE: For this procedure, refer to FIGURE 7.2.*

1. Unplug the unit.
2. Remove the cabinet. Refer to Removing Cabinet on page 23.
3. Using needlenose pliers, disconnect the spade connectors from the capacitor terminals.
4. Cut the tie wrap that secures the capacitor to the base of the concentrator.
5. Remove the capacitor from the concentrator base.
6. Install new capacitor by reversing STEPS 3-6.
7. Re-install the cabinet. Refer to Removing Cabinet on page 23.



**FIGURE 7.2** Replacing Capacitor

## Rebuilding the Thomas Model 2660 Compressor

### **⚠ DANGER**

To prevent electrical shock, ALWAYS disconnect concentrator from electrical outlet before servicing.

*NOTE: This kit is designed for rebuilding the Thomas Model 2660 Series compressor. The model number is located on the front of the compressor. Compressor number for this kit is 2660CHI39-111. If the compressor has a different model number than those listed, this kit will not work.*

The Thomas 2660 Series Compressor Rebuild Kit (p/n 1153686) contains the following:

DESCRIPTION	QUANTITY
Teflon® Piston Cups	2
Aluminum Piston Sleeves	2
Flapper Valves - Intake and Exhaust	4
Valve Keepers	4
O-Ring - Sleeve	2
Valve Plate Gaskets	2
Head Mounting Screws	8
Valve Screws	4
Valve Restraints	2
Piston Cup Retainer Screws	2

#### Tools Required:

- Torque wrench that has an Nm or inch-pound scale (for head screws, set screws, flapper valve screw, and pipe plugs)
- Torx® T-25 drive for torque wrench (for head screws)
- Torx T-27 drive for torque wrench (for retainer screws)
- 1/8-inch Allen wrench attachment for torque wrench (for eccentric set screw)
- 5/32-inch Allen wrench attachment for torque wrench
- Flat blade screwdriver attachment or 1/4-inch hex socket for torque wrench (for flapper valve screw)
- Two flat blade screwdrivers
- Rubber Mallet
- Phillips® screwdriver attachment for torque wrench (for retainer screws)

### **CAUTION**

DO NOT lubricate or use oil on any moving parts. The compressor eccentric uses a precision sealed bearing. Therefore, additional lubrication is not necessary.

## Removing Compressor and Compressor Heads

### Compressor

1. Unplug concentrator and carefully remove compressor from concentrator. Refer to Replacing Compressor Assembly on page 31.

### Compressor Head Plate

*NOTE: For this procedure, refer to FIGURE 7.3.*

1. Clean loose dirt from the outside of the compressor.
2. Use the Torx T-25 torque wrench and loosen the eight head screws.
3. Note head placement before removing compressor head plate.
4. Remove the compressor head plate.

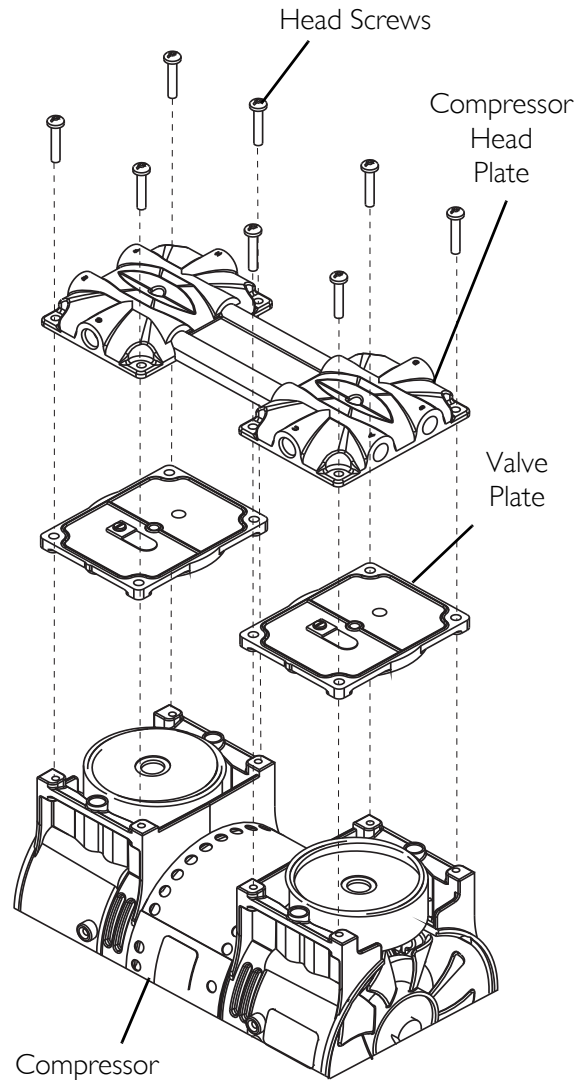
### Valve Plates

*NOTE: For this procedure, refer to FIGURE 7.3.*

1. Note the position of the plates before removing.
2. Lift off the valve plate on one side.
3. Repeat for the other side.

*NOTE: Note the position of the tab on valve plate for reassembly.*

*NOTE: To avoid confusion, ONLY service one end of the compressor at a time.*



**FIGURE 7.3** Removing Compressor and Compressor Heads - Rebuilding the Compressor - Compressor - Compressor Head Plate - Valve Plates

**Fan**

*NOTE: For this procedure, refer to FIGURE 7.4.*

1. Using two flat blade screwdrivers, pry the fan off of the motor shaft under the center housing. **DO NOT** pry under the fan blades.

*NOTE: Note position/orientation of fan for reassembly.*

**Connecting Rod and Eccentric Assembly**

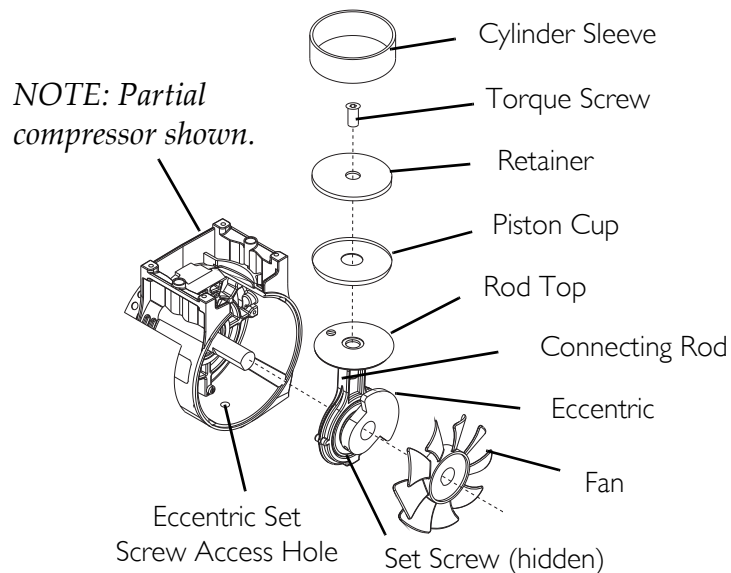
*NOTE: For this procedure, refer to FIGURE 7.4.*

1. Rotate shaft to align the eccentric's set screw with the access hole in the bottom of the compressor housing.
2. Insert the 1/8-inch Allen wrench into the access hole in the bottom of the compressor housing.
3. Loosen the set screw  $\frac{1}{4}$  turn.
4. Rotate connecting rod to top dead center ( $180^\circ$ ) and slide the connecting rod/eccentric assembly off the shaft through the opening in the housing.
5. Secure the rod assembly in a fixture.
6. Remove the sleeve from the connecting rod and discard.

**Piston Cup**

*NOTE: For this procedure, refer to FIGURE 7.4.*

1. Remove the torque screw (discard) from the piston cup retainer (retain for reassembly).
2. Remove the piston cup (discard) and wipe debris from the top of the connecting rod with a clean damp cloth.



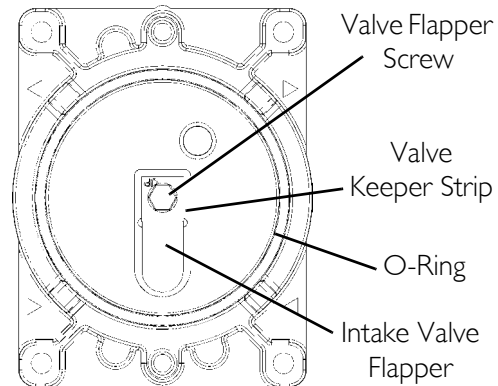
*NOTE: As the piston travels up and down it will also rock from side-to-side. This is a feature of the WOB-L Piston.*

**FIGURE 7.4** Removing Compressor and Compressor Heads - Rebuilding the Compressor - Fan - Connecting Rod and Eccentric Assembly - Piston Cup

**O-ring, Intake Valve Keeper and Valve Keeper Strip**

*NOTE: For this procedure, refer to FIGURE 7.5.*

1. Remove the O-ring, intake valve flapper and valve keeper strip from the bottom of the valve plate. Discard all.
2. Clean the bottom of the valve plate with a clean, soft cloth.



**FIGURE 7.5** Removing Compressor and Compressor Heads - Rebuilding the Compressor - O-ring, Intake Valve Keeper and Valve Keeper Strip

**Exhaust Valve Flapper, Valve Restraint and Valve Keeper Strip**

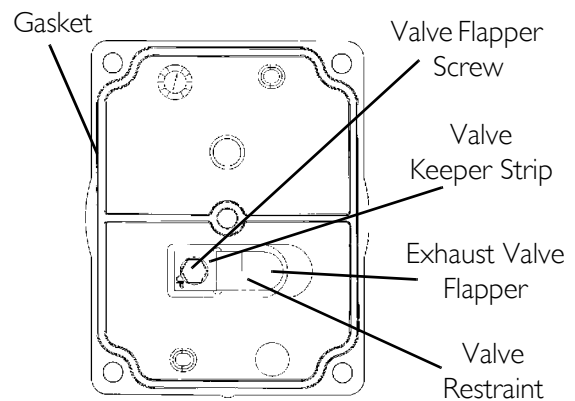
*NOTE: For this procedure, refer to FIGURE 7.6.*

1. Remove the exhaust valve flapper, valve restraint and valve keeper strip from the top of the valve plate. Discard all.
2. Clean the top of the plate with a clean, soft cloth.

**Gasket**

*NOTE: For this procedure, refer to FIGURE 7.6.*

1. Remove the old gasket from the top of the valve plate and discard.
2. Clean the valve plate with a clean, soft cloth.



**FIGURE 7.6** Removing Compressor and Compressor Heads - Rebuilding the Compressor - Exhaust Valve Flapper, Valve Restraint and Valve Keeper Strip

## Rebuilding the Compressor

*NOTE: Before reassembly, wipe any residue from all components with a clean soft cloth.*

### Gasket

*NOTE: For this procedure, refer to FIGURE 7.6 on page 37.*

1. Install new gasket; seating the gasket firmly in the groove at the top of the valve plate with your finger or blunt object.

---

### CAUTION

Make sure that the gasket is not twisted when seated in the groove of the top of the valve plate.

---

### Exhaust Valve Flapper, Valve Restraint and Valve Keeper Strip

*NOTE: For this procedure, refer to FIGURE 7.6 on page 37.*

1. Install the new exhaust valve flapper, valve restraint and valve keeper strip to the top of the valve plate with the valve flapper screw.

*NOTE: Torque flapper screws to 1.36 N-M (12 inch-lbs).*

### O-ring, Intake Valve Flapper and Valve Keeper Strip

*NOTE: For this procedure, refer to FIGURE 7.5 on page 37.*

1. Install the new valve keeper strip on top of the new intake valve flapper so that the word "UP" is visible. Fasten with the valve flapper screw.
2. Install the new O-ring, seating it firmly into the groove with your finger or blunt object.

*NOTE: Torque flapper screws to 1.36 N-M (12 inch-lbs).*

### Piston Cup

*NOTE: For this procedure, refer to FIGURE 7.4 on page 36.*

1. Place cylinder sleeve over rod top with smooth edge facing up.
2. Place piston cup on rod top making sure it is centered.
3. Place retainer on top of piston cup and seat retainer in rod top pocket, making sure the retainer and cup align properly along with screw holes.
4. Insert new screw into rod top and torque to 3.39 N-M (30 inch-lbs).

### Connecting Rod/Eccentric Assembly

*NOTE: For this procedure, refer to FIGURE 7.4 on page 36.*

1. With gloved-hand or clean cloth, pre-form piston cup if necessary.
2. Gently slide cylinder sleeve up and over cup to fully form it.

---

**CAUTION**

DO NOT lubricate or use oil on any moving parts. The compressor eccentric uses a precision sealed bearing.

DO NOT crimp the piston cup when you replace the sleeve. If the cup is crimped, it **MUST** be replaced.

- 
3. With bearing side of connecting rod/eccentric assembly facing the center (motor) of the compressor, slide the assembly onto the shaft bringing it flush to the motor bearing.

*NOTE: Make sure the eccentric set screw is positioned over the flat of the shaft.*

4. Using the access hole, tighten set screw to 4.2 N-M (40 inch-lbs) (Detail "A" of FIGURE 7.4).
5. Hold the sleeve down to the housing with one hand and slowly rotate the eccentric with the other hand to ensure all the components are aligned properly.

**Fan**

*NOTE: For this procedure, refer to FIGURE 7.4 on page 36.*

1. Reinstall the fan onto the shaft in original orientation. Secure into position using a rubber mallet.

**Valve Plate**

*NOTE: For this procedure, refer to FIGURE 7.3 on page 35.*

1. With the sleeve located and firmly seated on the housing, replace the valve plate in the same manner as it was.
2. Repeat STEP 1 for other valve plate.

*NOTE: Make sure the top edge of the sleeve locates in the O-ring groove in the bottom of the valve plate.*

---

**CAUTION**

Make sure that the O-ring is not twisted when seated in the groove of the bottom of the valve plate.

---

**Compressor Heads**

*NOTE: For this procedure, refer to FIGURE 7.3 on page 35.*

1. Place the heads on top of the valve plates.
2. Tighten the head screws in a criss-cross pattern to 4.2 N-M (40 inch-lbs).

## Compressor

---

### **WARNING**

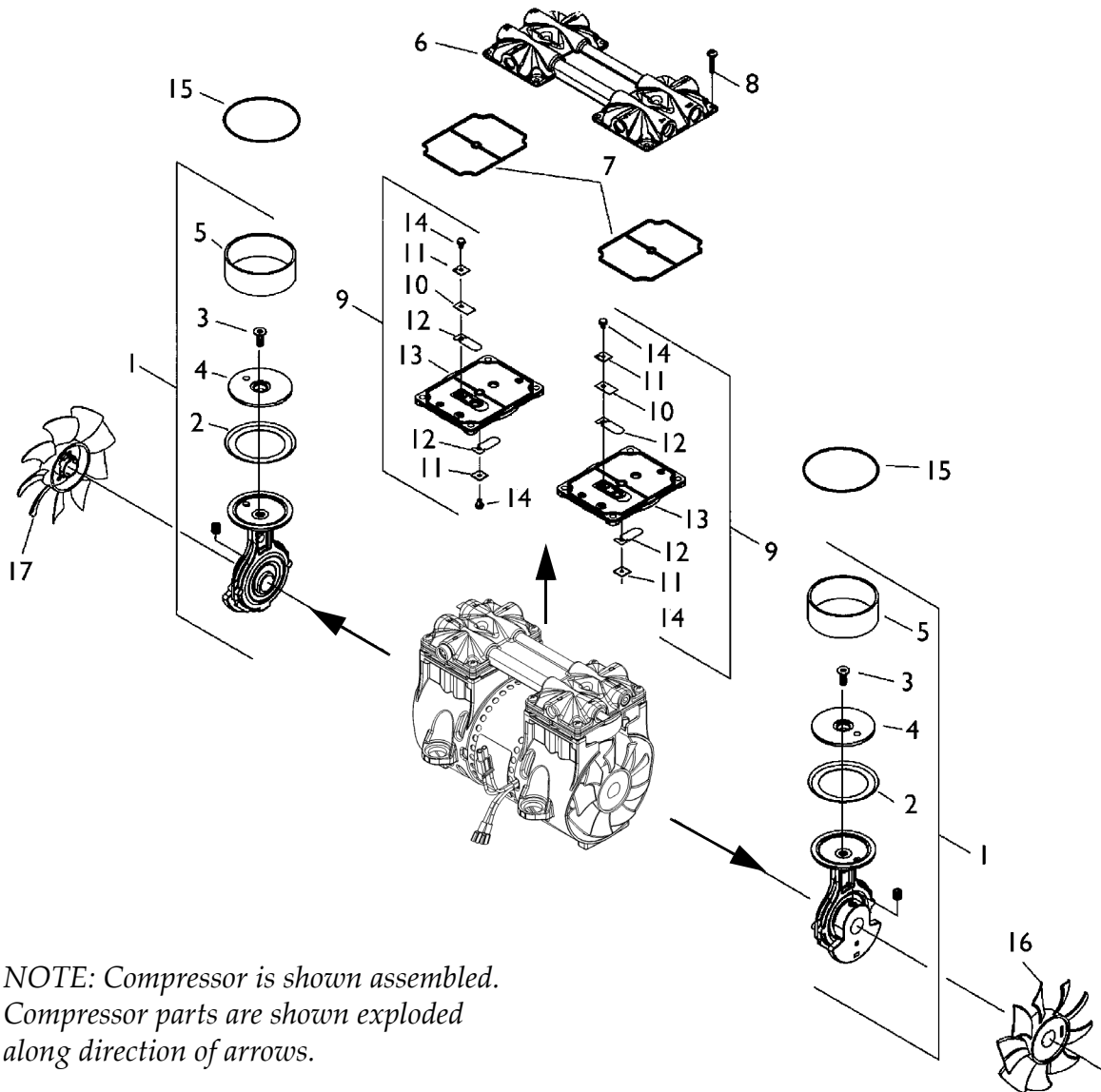
To avoid personal injury or property damage, rotate the fan by hand prior to connecting the unit to a power source. Check for suction at the air inlet by placing your finger over the port as you rotate the fan. You should feel a slight suction with each rotation of the fan. If you DO NOT feel a suction but you feel or hear a thump as you turn the fan, DO NOT connect the unit to a power source. Review the assembly procedure for possible error.

---

*NOTE: For this procedure, refer to FIGURE 7.7 on page 41.*

1. Reinstall compressor. Refer to Replacing Compressor Assembly on page 31.
2. Run unit and check for leaks around compressor hoses and compressor tubes. Refer to Leak Test on page 76.
3. Take pressure readings to ensure proper system pressures. Refer to Checking Sieve Bed Pressure on page 85.





*NOTE: Compressor is shown assembled.  
Compressor parts are shown exploded  
along direction of arrows.*

COMPRESSOR PARTS LEGEND	
1. Connecting Rod, Eccentric & Bearing Assembly	10. Valve Restraint
2. Piston Cup	11. Valve Keeper Strip
3. Screw - Piston Cup Retainer	12. Valve Flapper - Intake & Exhaust
4. Piston Cup Retainer	13. Valve Plate
5. Cylinder Sleeve	14. Screw - Valve Flapper
6. Head	15. O-Ring Valve Plate
7. O-Ring - Head Gasket	16. Fan - Gray
8. Screw - Head	17. Fan - Black
9. Valve Plate Assembly	

**FIGURE 7.7** Compressor Exploded View

# SECTION 8—P.E. VALVE

## Replacing P.E. Valve

---

### **⚠ DANGER**

To prevent electrical shock, ALWAYS disconnect concentrator from electrical outlet before servicing.

---

*NOTE: For this procedure, refer to FIGURE 8.1 on page 43.*

1. Unplug unit.
  2. Remove cabinet. Refer to Removing Cabinet on page 23.
  3. Remove the compressor inlet HEPA filter. Refer to Replacing the Compressor Inlet HEPA Filter on page 26.
  4. Remove spade connectors from P.E. valve terminals.
  5. Remove tie-wraps from P.E. valve tubing.
  6. Remove P.E. valve assembly from tubing.
- 

### **CAUTION**

If P.E. valve is not to be installed IMMEDIATELY, plug the P.E. valve tubing to prevent sieve bed contamination.

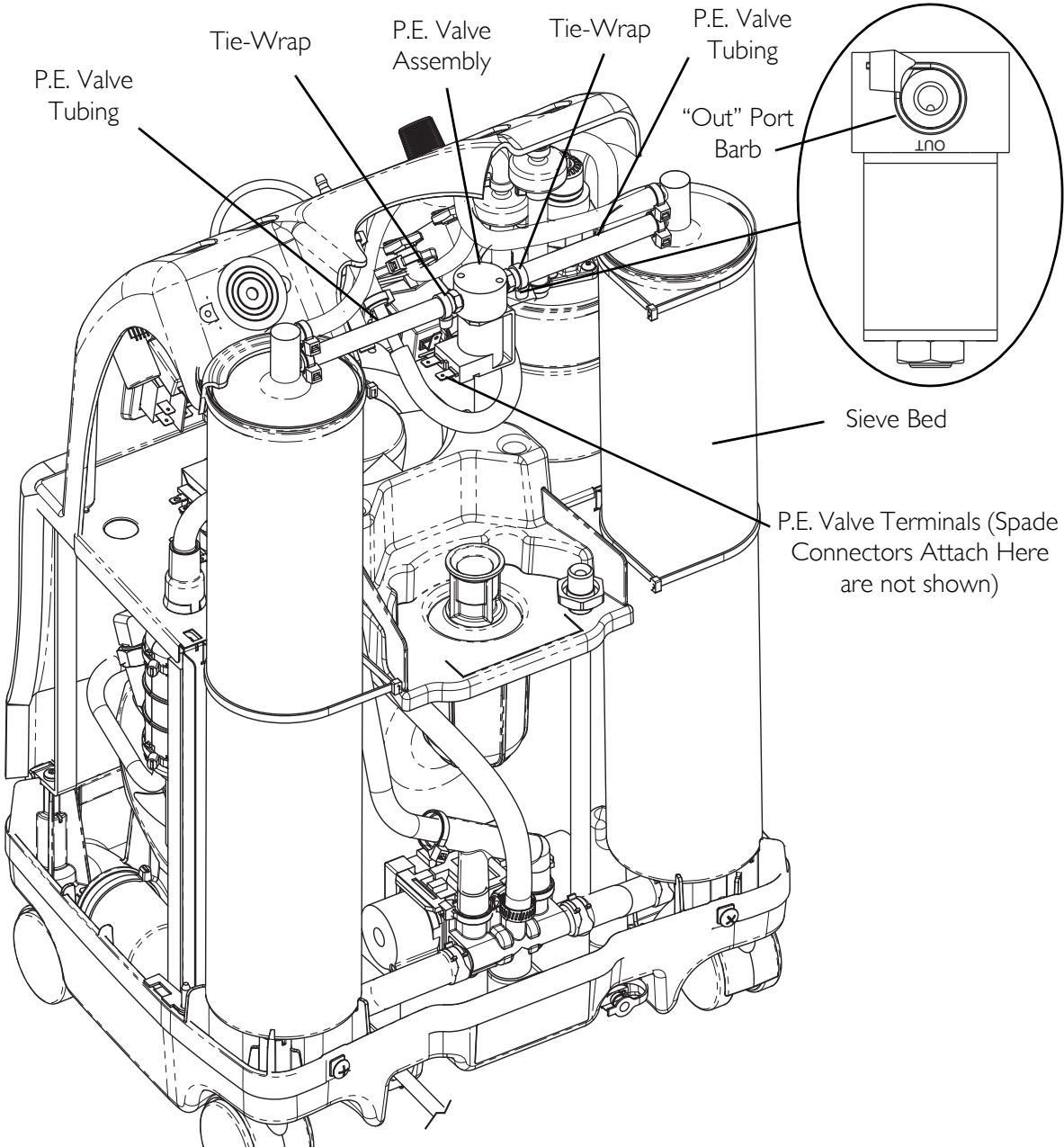
---

7. Install new P.E. Valve assembly IMMEDIATELY, by reversing STEPS 3-5.
8. Reinstall the compressor inlet HEPA filter. Refer to Replacing the Compressor Inlet HEPA Filter on page 26.

*NOTE: Retiming of the concentrator is necessary. Refer to Timing on page 73.*

*NOTE: To ensure proper orientation, the “out” port barb should face to the left side sieve bed when viewing from behind the unit.*

9. Run unit and check for leaks. Refer to Leak Test on page 76.
10. Reinstall cabinet. Refer to Removing Cabinet on page 23.



**FIGURE 8.1** Replacing P.E. Valve

## SECTION 9—SIEVE BEDS

### Replacing Sieve Beds

---

#### **⚠ DANGER**

To prevent electrical shock, ALWAYS disconnect concentrator from electrical outlet before servicing.

---

*NOTE: For this procedure, refer to FIGURE 9.1 on page 45.*

*NOTE: ALWAYS replace sieve beds in pairs to ensure that both beds are in optimum condition.*

1. Unplug unit.
  2. Remove cabinet. Refer to Removing Cabinet on page 23.
  3. Remove compressor inlet HEPA filter. Refer to Replacing the Compressor Inlet HEPA Filter on page 26.
  4. Remove tie wraps and disconnect P.E valve tubing and check valve tubing from top of sieve beds.
  5. Remove the four large tie-wraps (two on each sieve bed).
  6. Tilt sieve beds back and lift up. Rest sieve beds on rear of base.
  7. Using a hose clamp tool, remove the clamp and reinforced tubing from bottom of both sieve beds and remove sieve beds.
- 

#### **CAUTION**

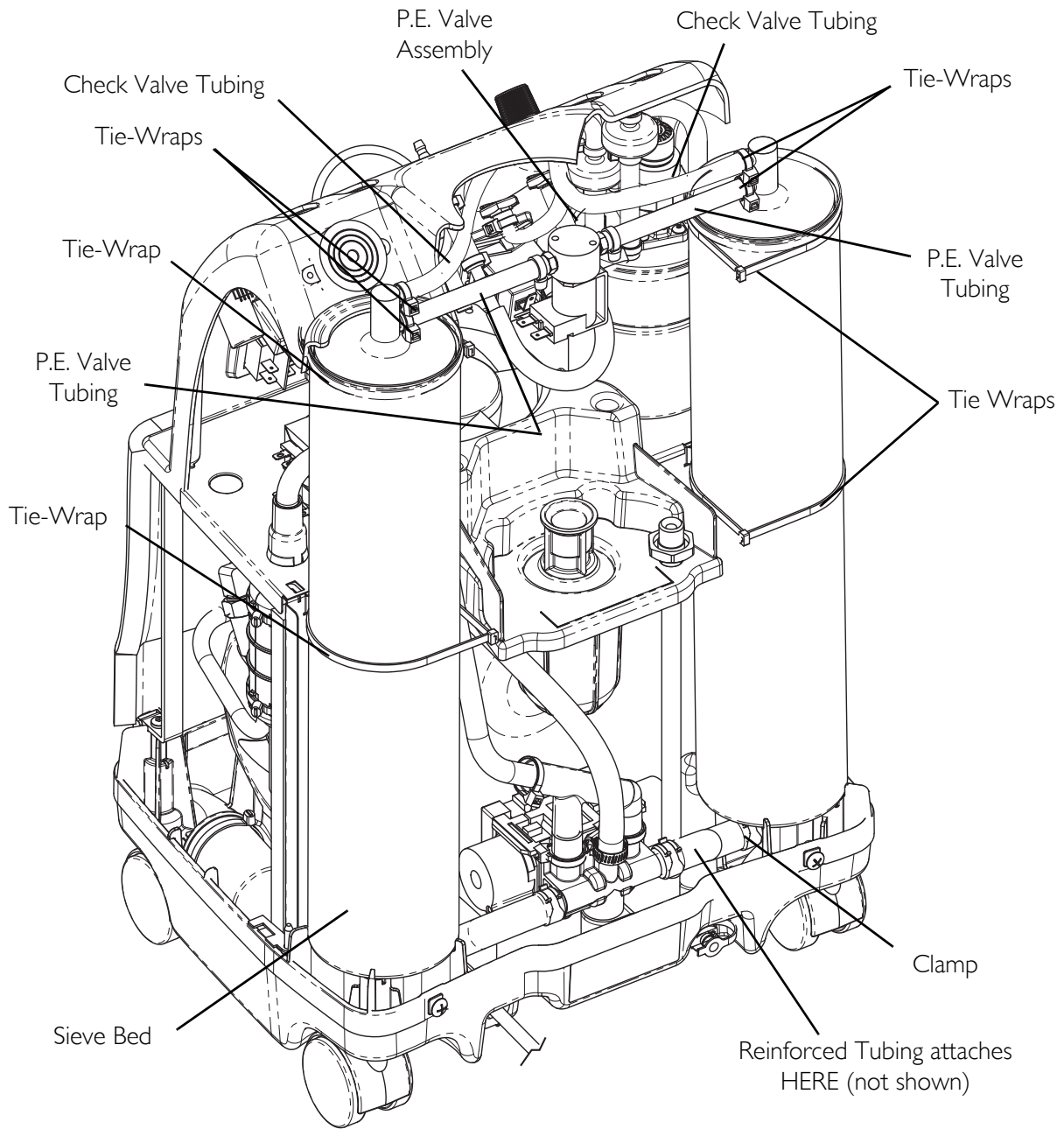
DO NOT remove plastic caps from new sieve bed fittings until ready to install new beds. Severe sieve contamination can occur if uncapped beds are exposed to air.

---

8. Remove plastic caps from the top and bottom fittings of the new sieve beds.
9. Install new sieve beds reversing STEPS 3-7.

*NOTE: After replacing sieve beds, retiming is necessary. Refer to Timing on page 73.*

10. Run unit and check for leaks. Refer to Leak Test on page 76.
11. Reinstall cabinet. Refer to Removing Cabinet on page 23.



*NOTE: Compressor Inlet HEPA Filter removed from illustration for clarity.*

**FIGURE 9.1** Replacing Sieve Beds

# SECTION 10—CHECK VALVES

## Replacing Check Valves

---

### **⚠ DANGER**

To prevent electrical shock, ALWAYS disconnect concentrator from electrical outlet before servicing.

---

*NOTE: For this procedure, refer to FIGURE 10.1 on page 47.*

1. Unplug unit.
2. Remove cabinet. Refer to Removing Cabinet on page 23.

*NOTE: Replace one or both check valves when performing this procedure. The check valves are one-way directional and can be checked by passing air through them. Air should flow in one direction only.*

3. It may be necessary to remove the compressor HEPA inlet filter. Refer to Replacing the Compressor Inlet HEPA Filter on page 26.
  4. Remove tie-wraps from top and bottom of the check valve(s) and disconnect check valve(s) from ¼-inch PVC tubing.
- 

### **⚠ WARNING**

The check valves are one-way directional and MUST be installed correctly. The letters “VAC” are printed on the check valves. The check valves MUST be installed with the “VAC” on the underside of the check valve. Low system pressures and eventual bed contamination will result if check valves are not properly installed.

---

### **CAUTION**

DO NOT put a check valve on the regulator outlet tubing. Otherwise, damage may result. The regulator outlet tubing is identified by the flow arrow on the side of the regulator which points to it.

---

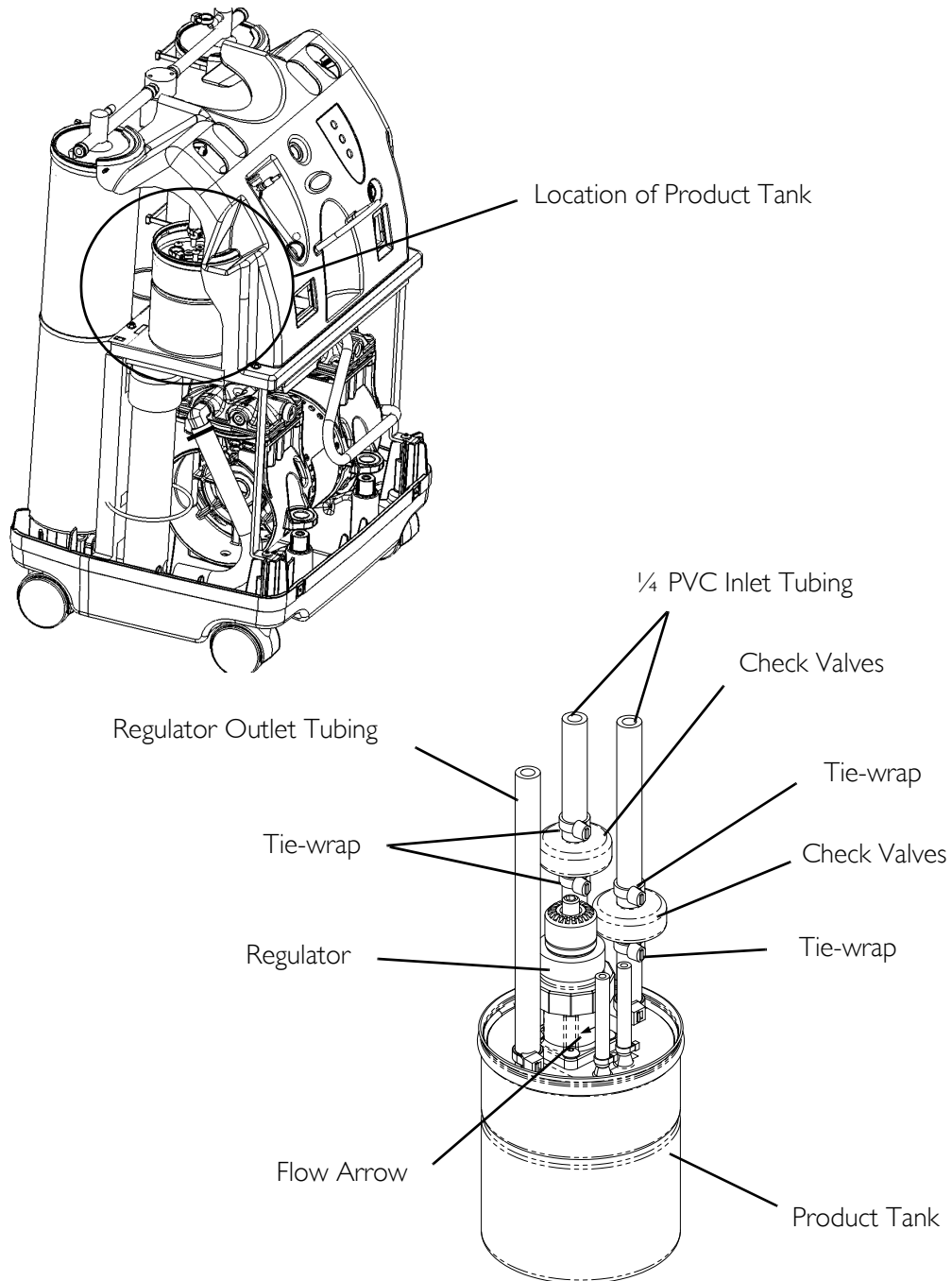
5. Install the new check valve(s) into the ¼-inch PVC tubing on inlet tubing only.
6. Make sure “VAC” is on the underside of the check valve to ensure proper orientation of check valves when installing.
7. Secure the check valve(s) by installing new tie-wraps to the ¼ inch PVC tubing where previously removed.

*NOTE: If ¼ inch PVC tubing is damaged in any way, replace the section of ¼ inch PVC tubing before installing check valve(s).*

*NOTE: Ensure check valves are not crossed. Left barb product tank check valve goes to left barb on sieve bed. Right barb product tank check valve to right barb on sieve bed.*

---

8. Reinstall compressor inlet HEPA filter. Refer to Replacing the Compressor Inlet HEPA Filter on page 26.
9. Run units and check for leaks. Refer to Leak Test on page 76.
10. Reinstall cabinet. Refer to Removing Cabinet on page 23.



**FIGURE 10.1** Replacing Check Valves

# SECTION 11—REGULATOR

## Replacing Regulator

---

### **⚠ DANGER**

To prevent electrical shock, ALWAYS disconnect concentrator from electrical outlet before servicing.

---

*NOTE: For this procedure, refer to FIGURE 11.1 on page 49.*

1. Unplug unit.
2. Remove cabinet. Refer to Removing Cabinet on page 23.

*NOTE: On concentrator models with the SensO<sub>2</sub> unit ONLY, remove the 1/8-inch tubing to oxygen sensor housing.*

3. Remove the four mounting screws that secure regulator to product tank cap.
4. Remove regulator from product tank lid ensuring that the O-rings are removed.

*NOTE: Clean mounting surface of product tank cap. Ensure that the two "O" rings for the NEW regulator are installed onto the ports (underside) of the NEW regulator before installation.*

---

### **⚠ WARNING**

Ensure proper installation of regulator. Note flow arrow on regulator. This MUST face toward the regulator outlet tubing or flow will be interrupted causing system shutdown.

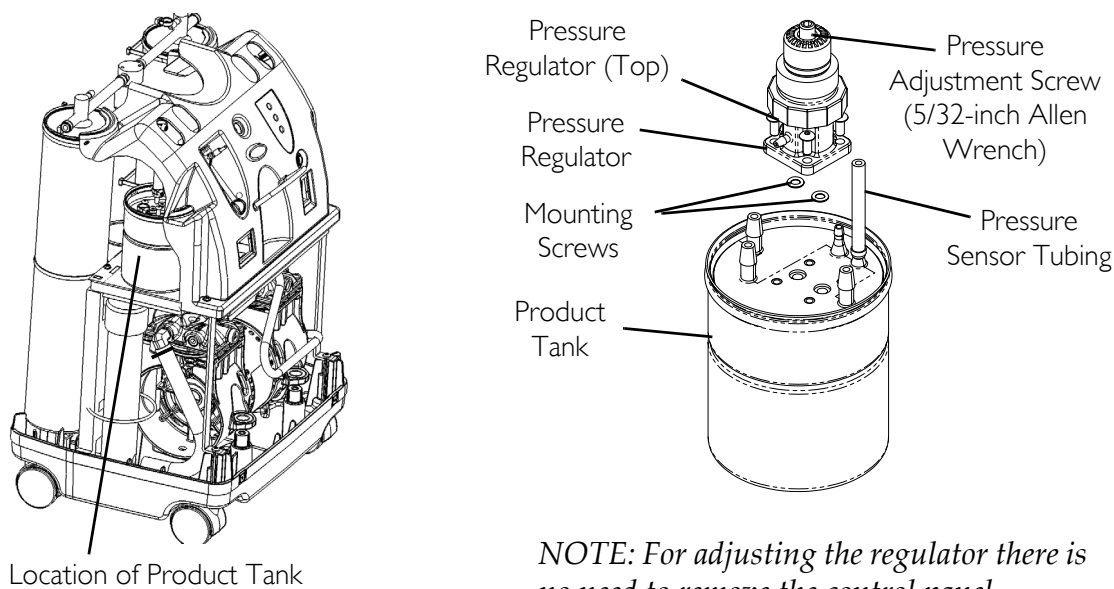
---

5. Install new regulator onto product tank by reversing STEPS 3 and 4.
6. Torque mounting screws to .56 N-M ± .11 (5 ± 1 inch-lbs).

*NOTE: On units with SensO<sub>2</sub>, reinstall 1/8-inch tubing to oxygen sensor housing.*

7. Adjust regulator pressure if necessary. Refer to Adjusting Regulator on page 49.
8. Run unit and check for leaks. Refer to Leak Test on page 76.
9. Reinstall cabinet. Refer to Removing Cabinet on page 23.





*NOTE: For adjusting the regulator there is no need to remove the control panel.*

**FIGURE 11.1** Replacing Regulator

## Adjusting Regulator

*NOTE: For this procedure, refer to FIGURE 11.1.*

1. Turn unit on (I).
2. Install pressure gauge onto oxygen outlet.

*NOTE: Use a 0 - 3.4 N-M (30 p.s.i.) pressure gauge.*

*NOTE: Check O<sub>2</sub> pressure at oxygen outlet. It should read a steady  $34.5 \pm 3.45$  kPa ( $5 \pm 0.5$  p.s.i.). If pressure is not in specification, proceed to STEP 3. If pressure falls within specification, no adjustment is needed.*

3. Unplug unit.
4. Remove cabinet. Refer to [Removing Cabinet](#) on page 23.
5. Plug unit in and turn power switch on (I).
6. Using the access hole located on the control panel, locate the pressure adjustment screw in center of pressure regulator top.
7. Insert a 5/32-inch Allen wrench into the pressure adjustment screw.
8. While reading pressure gauge, do one of the following:
  - Turn pressure adjustment screw or adjustment knob, clockwise to increase output pressure; or
  - Turn pressure adjustment screw or adjustment knob, counterclockwise to decrease output pressure.
9. Adjust until pressure reads a steady  $34.5 \pm 3.45$  kPa ( $5 \pm 0.5$  p.s.i.).

10. Once required pressure is achieved, reinstall cabinet. Refer to Removing Cabinet on page 23.
11. Refer to Troubleshooting on page 16 if you are unable to adjust or maintain  $34.5 \pm 3.45$  kPa ( $5 \pm 0.5$  p.s.i.).

*NOTE: After ten minutes of run time, retest output pressure of concentrator to insure proper operation and/or spec levels.*

# SECTION 12—HEAT EXCHANGER ASSEMBLY

## Replacing Heat Exchanger Assembly

---

### **⚠ DANGER**

To prevent electrical shock, ALWAYS disconnect concentrator from electrical outlet before servicing.

---

*NOTE: For this procedure, refer to FIGURE 12.1 on page 52.*

*NOTE: The heat exchanger assembly contains three components: heat exchanger, nine inch vinyl tube and connecting component.*

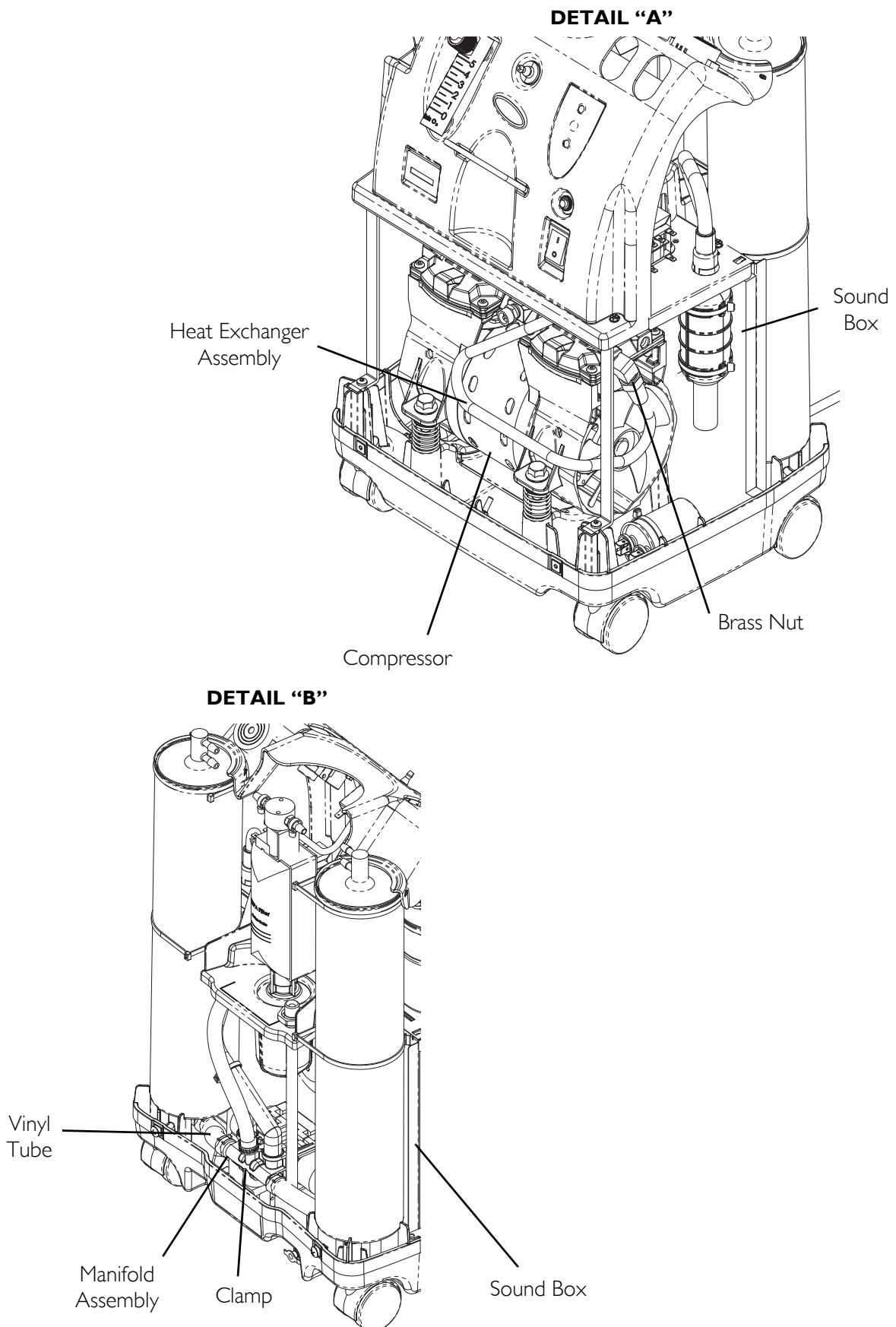
1. Unplug unit.
2. Remove cabinet. Refer to [Removing Cabinet](#) on page 23.

---

### **CAUTION**

Use care not to deform heat exchanger when installing, removing or cleaning.

- 
3. Disconnect brass nut that secures the heat exchanger assembly to the compressor (Detail "A").
  4. On the backside of the Perfecto<sub>2</sub>, loosen the clamp that secures the vinyl tube to the manifold assembly and remove the vinyl tube from the manifold assembly. (Detail "B").
  5. Remove heat exchanger assembly by pulling vinyl tube through sound box.
  6. Reverse STEPS 3-5 to install new heat exchanger.
  7. Run unit and check for leaks. Refer to [Leak Test](#) on page 76.
  8. Reinstall cabinet. Refer to [Removing Cabinet](#) on page 23.



**FIGURE 12.1** Replacing Heat Exchanger Assembly

# SECTION 13—CONTROL PANEL

## Removing Control Panel

### **⚠ DANGER**

To prevent electrical shock, ALWAYS disconnect concentrator from electrical outlet before servicing.

Before handling any P.C. boards, you need to be properly grounded to prevent static damage to the components of the board. A Static Cuff MUST be worn and properly grounded using an alligator clip. Electrical conduit or a water pipe is normally sufficient when a known good ground is not available. Care should be taken to ensure that the alligator clip contacts with bare metal surface.

*NOTE: For this procedure, refer to FIGURE 13.1 on page 54.*

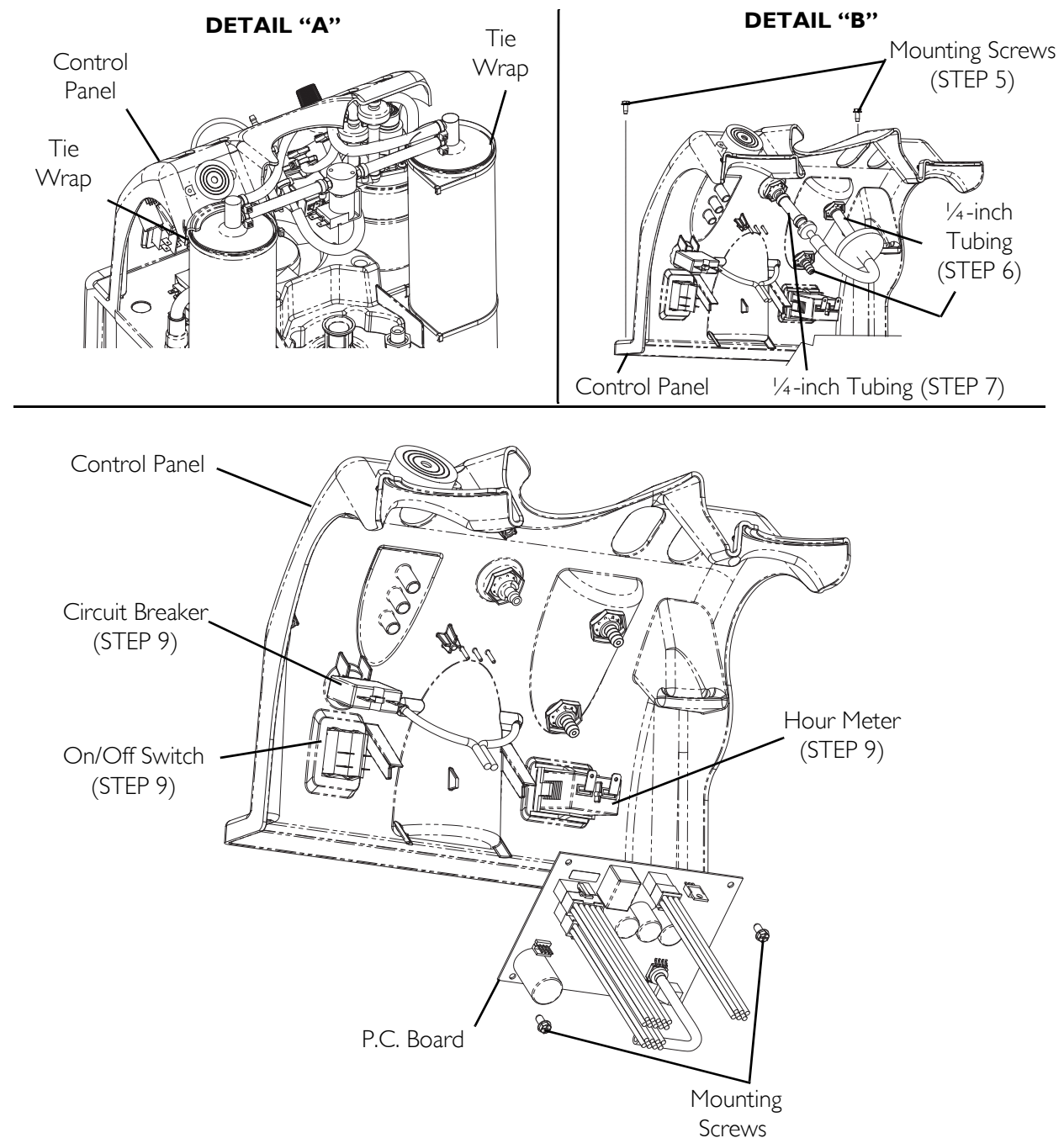
Tools Required:

- Diagonal cutters
  - Flathead screwdriver
  - ¼-inch ratchet, ¼-inch socket, and ¼-inch extension
  - Pliers
  - Tie-wraps
  - Ground strap (cuff)
1. Unplug unit.
  2. Remove cabinet. Refer to Cabinet on page 23.
  3. Cut the two tie wraps that secure the control panel to the sieve beds (Detail “A”).
  4. Cut the two tie wraps that secure the P.E. valve assembly to the control panel (not shown).
  5. Remove the two mounting screws that secure the control panel to the sound box (Detail “B”).
  6. Remove the ¼-inch I.D. tubing from the top and bottom barbed fittings of the flowmeter (Detail “B”).
  7. Cut tie wrap and remove ¼-inch I.D. tubing from the patient outlet barbed fitting behind the control panel (Detail “B”).
  8. Remove the two mounting screws that secure the P.C. board to the control panel.

*NOTE: Before performing STEP 9, code all wires to ensure correct reinstallation.*

9. Remove spade connectors from circuit breaker, hour meter and On/Off (I/O) switch. (Jumper wire harness from On/Off switch to circuit breaker does not have to be removed).
10. Remove the hour meter. Refer to Replacing Hour Meter on page 64.

11. Remove the On/Off switch. Refer to Replacing On/Off Switch on page 62
12. Remove the circuit breaker by twisting the locknut on the outside of the control panel.
13. Discard existing control panel.
14. Install new control panel by reversing STEPS 3-12.
15. Run unit and check for leaks at pressure sensor tubing on product tank cap. Refer to Leak Test on page 76
16. Reinstall cabinet. Refer to Removing Cabinet on page 23.



**FIGURE 13.1** Removing Control Panel

# SECTION 14—COOLING FAN

## Replacing Cooling Fan

---

### **⚠ DANGER**

To prevent electrical shock, ALWAYS disconnect concentrator from electrical outlet before servicing.

---

*NOTE: For this procedure, refer to FIGURE 14.1 on page 57.*

1. Unplug unit.
2. Remove cabinet. Refer to Cabinet on page 23.
3. Remove control panel. Refer to Removing Control Panel on page 53.
4. Remove compressor inlet HEPA filter. Refer to Replacing the Compressor Inlet HEPA Filter on page 26.
5. Remove the three mounting screws that secure the resonator housing to the soundbox. Two mounting screws are installed in the top. The other mounting screw is located on the backside of the housing near the bottom (Detail “A”).
6. Move the resonator housing back slightly for access to the cooling fan. Disconnect the intake hose on the compressor assembly if necessary (Detail “A”).
7. Disconnect spade connectors from fan terminals on side of cooling fan.

*NOTE: The cooling fan is fastened to the soundbox with four rubber grommets on each corner.*

8. Lift cooling fan up and dislodge the rubber grommets from the soundbox (Detail “B”).
9. Remove the rubber grommets from the existing cooling fan (Detail “C”).
10. Note the orientation of the installed rubber grommets. There are two recessed areas on the rubber grommet. The larger recessed area of the grommet is installed in the fan. The smaller recessed area is installed in the sound box.
11. Inspect rubber grommets for damage. If damage is found, do not use. Order new rubber grommets before installing fan.
12. Install rubber grommets into new cooling fan with larger recessed area installed in the fan. (Detail “C”).

---

### **CAUTION**

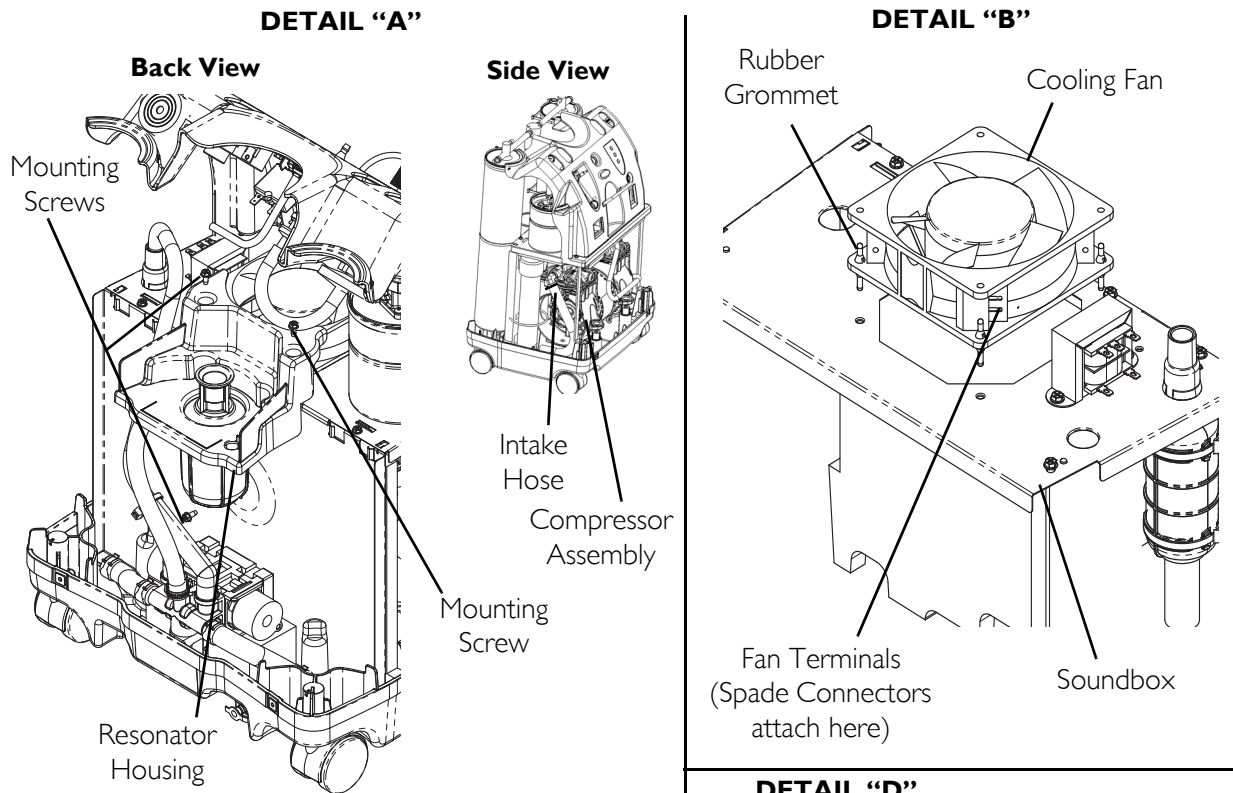
Fan MUST be positioned properly so air from the fan blows DOWN onto the compressor (see air flow arrow on back of fan) or damage to the unit will occur.

---

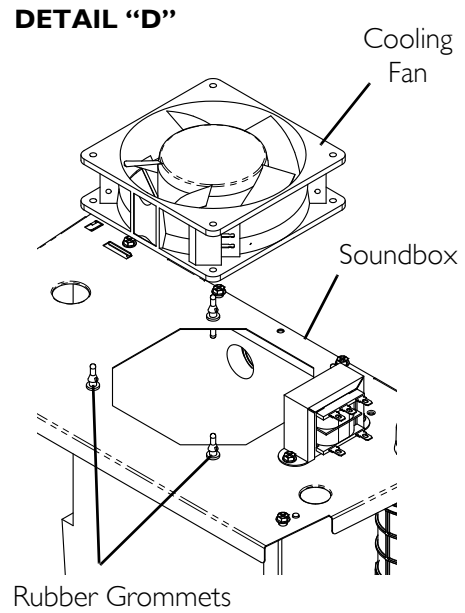
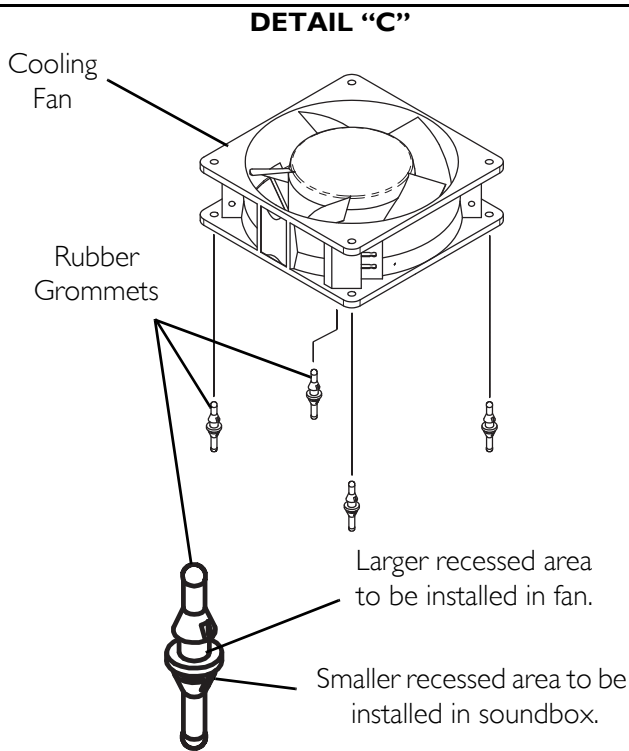
13. Position cooling fan onto soundbox (Detail “B”).
14. Pull rubber grommets down into the sound box. (Detail “D”).

15. Connect spade connectors to fan terminals on side of cooling fan (Detail “B”).
16. Move resonator housing back into position (Detail “A”).
17. Secure the resonator housing to the soundbox with the three mounting screws. Two in the top and one on the back near the bottom of the housing (Detail “A”).
18. If necessary, reconnect the intake valve on the compressor assembly.
19. Reinstall control panel. Refer to Removing Control Panel on page 53.
20. Reinstall compressor inlet HEPA filter. Refer to Replacing the Compressor Inlet HEPA Filter on page 26.
21. Plug unit in and check for leaks. Refer to Leak Test on page 76.
22. Run unit for at least 30 minutes. If unit runs properly, replace cover. If not, call Invacare Technical Service.
23. Reinstall cabinet. Refer to Cabinet on page 23.





*NOTE: Sieve Beds are not shown for clarity.*



*NOTE: Cooling fan removed from rubber grommets to show proper installation of grommets in soundbox.*

**FIGURE 14.1** Replacing Cooling Fan

# SECTION 15—P.C. BOARD

## Replacing P.C. Board

---

### **⚠ DANGER**

To prevent electrical shock, ALWAYS disconnect concentrator from electrical outlet before servicing.

---

### **CAUTION**

Follow these pre-cautions to prevent damage to the P.C. boards:

Before handling any P.C. boards, you need to be properly grounded to prevent static damage to the components of the board. A Static Cuff MUST be worn and properly grounded using an alligator clip. Electrical conduit or a water pipe is normally sufficient when a known good ground is not available. Care should be taken to ensure that the alligator clip contacts with bare metal surface.

When removing quick disconnect terminals, DO NOT pull on wire itself as damage to the connection may occur. Hold down the P.C. board with one hand and pull upward with other hand with a slight rocking motion to remove the terminals.

Before installing any P.C. boards, ensure that all insulators are in place.

---

*NOTE: For this procedure, refer to FIGURE 15.1 on page 60.*

1. Unplug unit.
  2. Remove cabinet. Refer to [Removing Cabinet](#) on page 23.
  3. Remove control panel. Refer to [Removing Control Panel](#) on page 53.
  4. Do the following:
    - A. Disconnect wiring harnesses from PC board.
- 

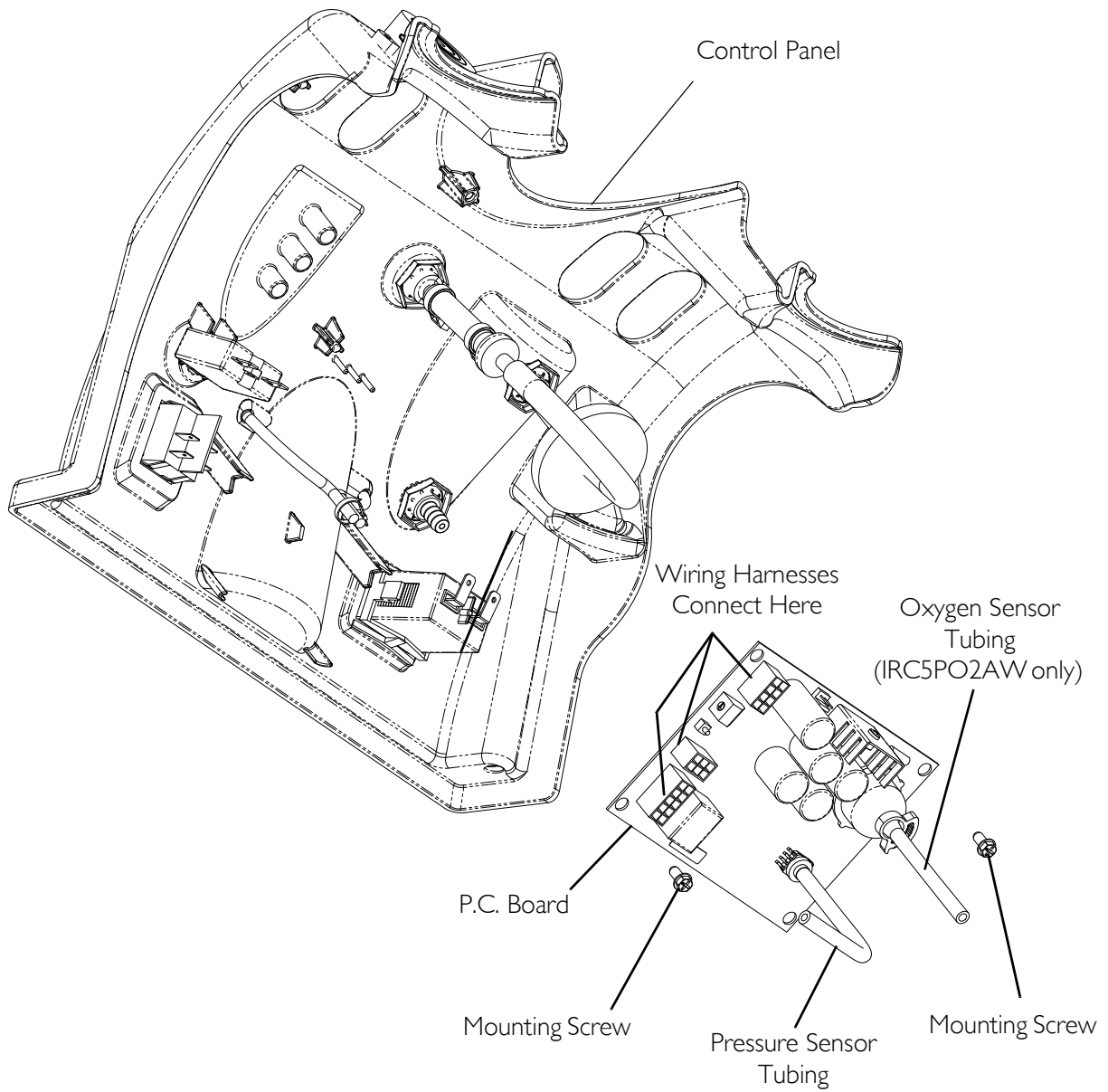
### **⚠ WARNING**

DO NOT remove oxygen sensor tubing from P.C. board. Remove from regulator ONLY. DO NOT remove the pressure sensor tubing from P.C. board. Remove from top of product tank only. Damage to oxygen sensor assembly or pressure sensor could occur. A faulty sensor may result in improper oxygen delivery and harm to the user.

---

- B. Disconnect pressure sensor tubing from product tank, not P.C. Board.
    - C. For concentrators that have O<sub>2</sub> sensor, disconnect the oxygen sensor tubing from regulator fitting. Refer to [Replacing Regulator](#) on page 48.
  5. Remove the two mounting screws on top corners of P.C. board.
  6. Position new P.C. board.
-

7. Secure new P.C. board in place with existing mounting screws. Be sure all tie-wraps removed from tubing connections are replaced.
8. Do the following:
  - A. Connect wiring harnesses to P.C. board.
  - B. Connect pressure sensor tubing to product tank.
  - C. For concentrators that have O<sub>2</sub> sensor, connect the oxygen sensor tubing to regulator fitting.
9. Reinstall control panel. Refer to Removing Control Panel on page 53.
10. Run concentrator to ensure unit operates to specifications.
11. After replacing P.C. board, retiming may be necessary. Refer to Timing on page 73.
12. Check for leaks at pressure sensor tubing on product tank cap. Refer to Leak Test on page 76.
13. Reinstall cabinet. Refer to Removing Cabinet on page 23.



**FIGURE 15.1** Replacing P.C. Board

# SECTION 16—TRANSFORMER

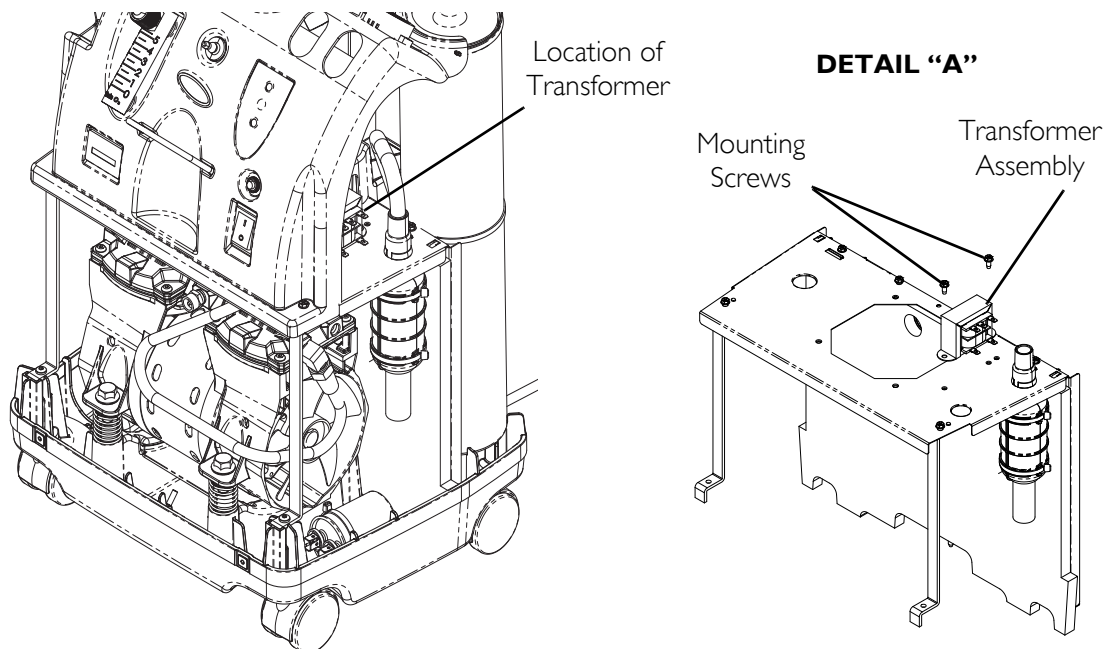
## Replacing the Transformer

### **⚠ DANGER**

To prevent electrical shock, ALWAYS disconnect concentrator from electrical outlet before servicing.

*NOTE: For this procedure, refer to FIGURE 16.1 on page 61.*

1. Unplug unit.
2. Remove cabinet. Refer to Removing Cabinet on page 23.
3. Locate the transformer located on the sound box.
4. Code all wires before disconnecting for proper re-connections.
5. Remove the two mounting screws that secure the transformer to the soundbox.
6. Note orientation of transformer on soundbox before removing for proper reinstallation
7. Remove the existing transformer and discard.
8. Install new transformer in orientation noted in STEP 7.
9. Connect all wires as noted from STEP 4.
10. Reinstall cabinet. Refer to Cabinet on page 23.



**FIGURE 16.1** Replacing the Transformer

# SECTION 17—ON/OFF SWITCH

## Replacing On/Off Switch

### ⚠ DANGER

To prevent electrical shock, ALWAYS disconnect concentrator from electrical outlet before servicing.

NOTE: For this procedure, refer to FIGURE 17.1 on page 62.

1. Unplug unit.
2. Remove cabinet. Refer to Removing Cabinet on page 23.
3. Remove control panel. Refer to Removing Control Panel on page 53.
4. Remove and code the four spade connectors from back of existing On/Off switch.
5. Compress retaining grips on back of existing On/Off switch and push switch out through front of control panel.

NOTE: Ensure proper orientation of the On/Off (I/O) switch and wiring connections before installation. Refer to FIGURE 17.1, Detail "A" and Detail "B" below.

### CAUTION

DO NOT install the On/Off (I/O) switch upside down. Universal Off (O) symbol should be at bottom and Universal On (I) symbol should be at the top. Possible damage to the concentrator may result if not properly installed.

6. Reverse STEP 4 to secure new On/Off (I/O) switch.
7. Reinstall control panel. Refer to Removing Control Panel on page 53.
8. Reinstall cabinet. Refer to Removing Cabinet on page 23.

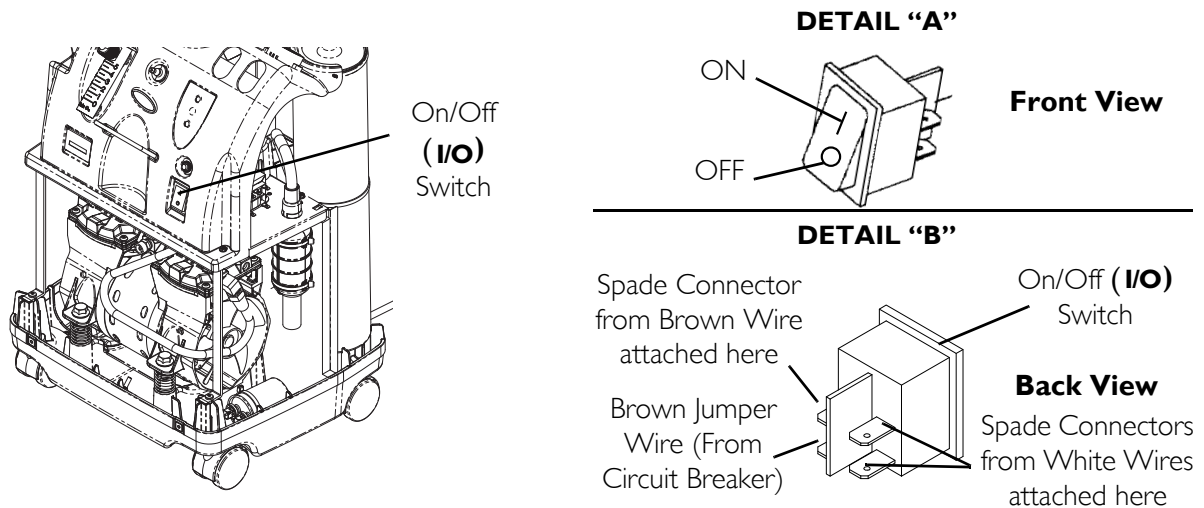


FIGURE 17.1 Replacing On/Off Switch

# SECTION 18—FLOWMETER

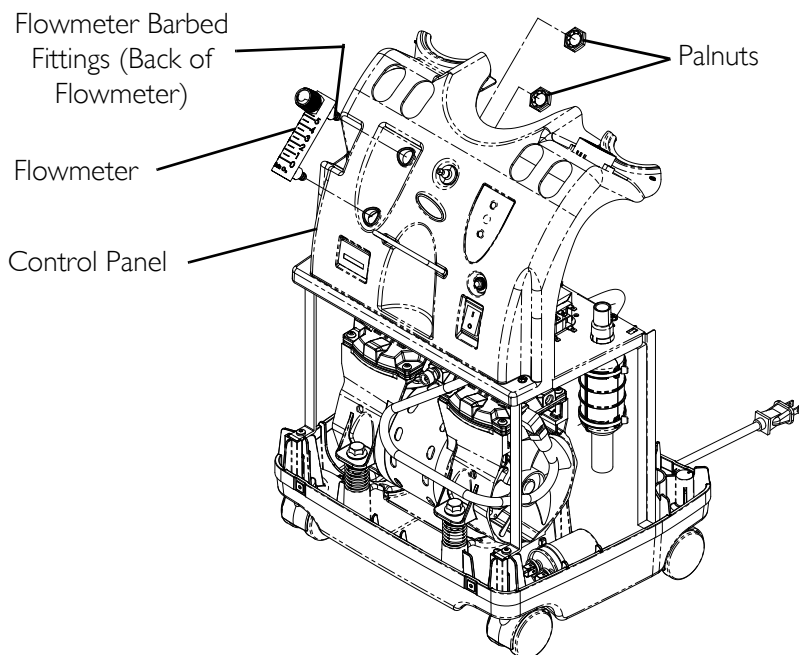
## Replacing Flowmeter

### **⚠ DANGER**

To prevent electrical shock, ALWAYS disconnect concentrator from electrical outlet before servicing.

*NOTE: For this procedure, refer to FIGURE 18.1 on page 63.*

1. Unplug unit.
2. Remove cabinet. Refer to Removing Cabinet on page 23.
3. Note the location of the PVC tubing for accurate replacement after new flowmeter is installed.
4. Remove control panel. Refer to Removing Control Panel on page 53.
5. Remove palnuts that secure flowmeter to the control panel.
6. Remove flowmeter from front of control panel.
7. Install new flowmeter reversing STEPS 4-5.
8. Reinstall control panel. Refer to Removing Control Panel on page 53.
9. Run unit and check for leaks where 1/4-inch PVC tubing engages flowmeter barbed fittings. Refer to Leak Test on page 76.
10. Reinstall cabinet. Refer to Removing Cabinet on page 23.



**FIGURE 18.1** Replacing Flowmeter

# SECTION 19—HOUR METER

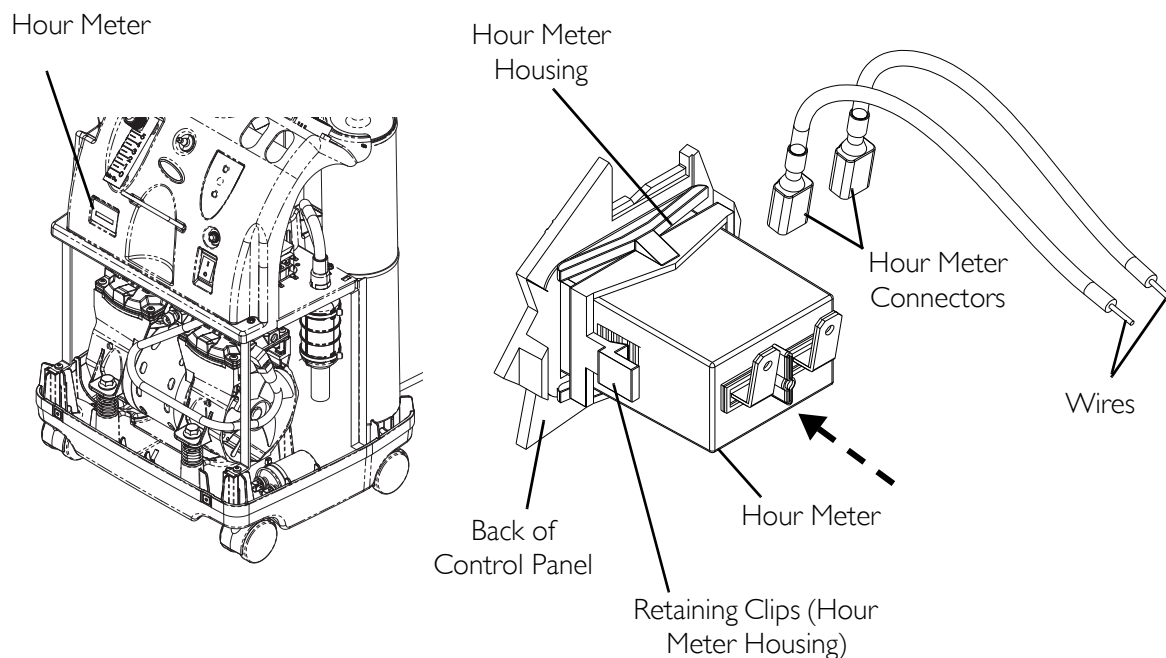
## Replacing Hour Meter

### **⚠ DANGER**

To prevent electrical shock, ALWAYS disconnect concentrator from electrical outlet before servicing.

*NOTE: For this procedure, refer to FIGURE 19.1.*

1. Unplug unit.
2. Remove cabinet. Refer to Removing Cabinet on page 23.
3. Remove control panel. Refer to Removing Control Panel on page 53.
4. Remove and label the two hour meter connectors and wires connected to back of hour meter.
5. Spread retaining clips on hour meter housing that secure hour meter to control panel.
6. Remove hour meter by pushing meter through front of control panel.
7. Install new hour meter reversing STEPS 4-6.
8. Reinstall control panel. Refer to Removing Control Panel on page 53.
9. Reinstall cabinet. Refer to Removing Cabinet on page 23.



**FIGURE 19.1** Replacing Hour Meter



---

# SECTION 20— 4-WAY VALVE/ MANIFOLD ASSEMBLY

---

## **⚠ DANGER**

To prevent electrical shock, ALWAYS disconnect concentrator from electrical outlet before servicing.

---

## **CAUTION**

This is a maintenance free valve. Opening the valve will void any and all warranties applicable to the valve.

---

## **Replacing 4-Way Valve and/or Manifold Assembly**

*NOTE: For this procedure, refer to FIGURE 20.1 on page 67.*

1. Unplug unit.
2. Remove cabinet. Refer to [Removing Cabinet](#) on page 23.
3. Cut the one tie wrap that secures the manifold exhaust tube to the “F” tube.
4. Remove the manifold exhaust tube from the “F” tube.
5. Cut the two tie wraps that secure the “F” tube to the 4 way valve/manifold assembly.
6. Remove the “F” tube from the 4 way valve/manifold assembly.
7. Using a hose clamp tool, remove the clamps that secure the vinyl tubes to the 4-way valve/manifold assembly.
8. Remove the vinyl tubes from both sides of the 4 way valve/manifold assembly.
9. Note the orientation of the 4-way valve/manifold assembly before removing for correct re-installation.
10. Lift 4-way valve/manifold assembly up and out of the base of the concentrator.
11. Disconnect spade connectors located on the side of the 4 -way valve assembly (Not shown).
12. Remove the four mounting screws that secure the 4-way valve/manifold assembly together (Detail “A”).
13. Replace the necessary component(s). (i.e. - 4-way valve, manifold or both).
14. Loosely install mounting screws through 4-way valve and into manifold assembly.

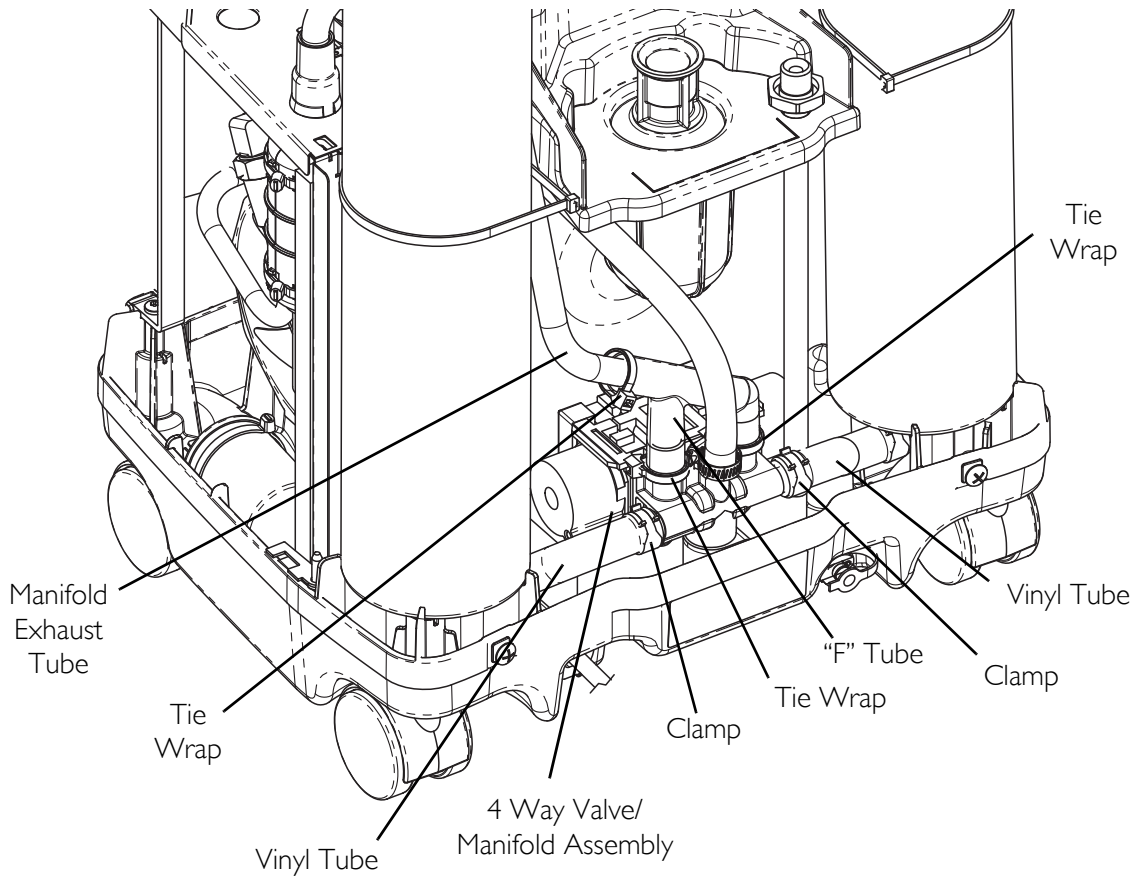
*NOTE: Ensure the manifold gasket is in place on 4-way valve before installing.*

**CAUTION**

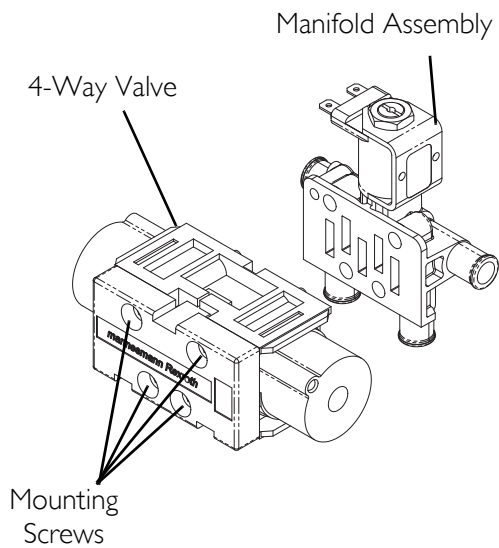
Torque sequence and specification **MUST** be adhered to or possible damage to the 4-way valve could result.

---

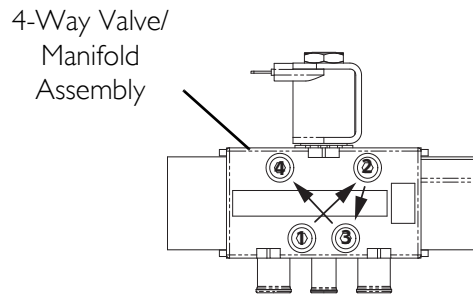
15. Tighten mounting screws in the sequence described below (Detail “B”).
16. Pre-torque the mounting screws to  $1.1 \text{ N-M} \pm 0.2 \text{ N-M}$  (10 inch-lbs  $\pm$  2 inch-lbs) using the torque sequence.
17. The mounting screws can be now be torqued to  $2.5 \text{ N-M} \pm 0.2 \text{ N-M}$  (22  $\pm$  2 inch-lbs) in the same sequence.
18. Connect spade connectors located on the side of the 4 -way valve assembly.
19. Position the 4-way valve/manifold assembly in the base of the concentrator on the foam block in the orientation noted in STEP 9.
20. Slide the vinyl tubes onto each side of the manifold/valve assembly.
21. Using a hose clamp tool, secure the vinyl tubes to the 4-way valve/manifold assembly with the clamps.
22. Install the “F” tube into the 4-way valve/manifold assembly.
23. Secure the “F” tube to the 4 way valve/manifold assembly with two tie wraps.
24. Install the manifold exhaust tube into the “F” tube.
25. Secure the manifold exhaust tube to the “F” tube with a tie wrap.
26. Install cabinet. Refer to Removing Cabinet on page 23.



**DETAIL "A"**



**DETAIL "B"**



*NOTE: The numbers above indicate the mounting screw torque sequence: pre-torque to 1.1 N-M ± 0.2 N-M (10 ± 2 inch-lbs), then torque to 2.5 N-M ± 0.2 N-M (22 ± 2 inch-lbs).*

**FIGURE 20.1** Replacing 4-Way Valve and/or Manifold Assembly

## Replacing Pilot Valve Poppets and O-Rings

---

### **⚠ DANGER**

To prevent electrical shock, ALWAYS disconnect concentrator from electrical outlet before servicing.

---

*NOTE: For this procedure, refer to FIGURE 20.2 on page 70.*

1. Unplug unit.
  2. Remove cabinet. Refer to Cabinet on page 23.
  3. Remove the 4-way valve/manifold assembly. Refer to Replacing 4-Way Valve and/or Manifold Assembly on page 65.
  4. Locate pilot valve on 4-way valve/manifold assembly.
  5. Hold pilot valve stem with the flat blade screwdriver and turn the 9/16-inch locknut counterclockwise one complete turn.
  6. Unscrew the pilot valve stem assembly from the manifold while leaving the coil with yoke and locknut intact on stem.
  7. Remove pilot valve poppet from inside the pilot valve stem.
- 

### **CAUTION**

DO NOT remove the coil yoke from the coil. The washer between the bottom of the yoke and the bottom of the coil MUST not be removed. Otherwise, components may be damaged in reassembly.

---

8. Set aside the coil with yoke and pilot valve stem assembly with the wires still intact.
- 

### **⚠ WARNING**

DO NOT use sharp tools to remove O-ring from plastic manifold opening. Damage to the plastic manifold and/or plastic manifold airflow passage may occur. Damage to airflow may result in improper oxygen delivery and harm to the user. Refer to Detail "A" in FIGURE 20.2.

---

9. Remove poppet and O-ring from manifold opening (Detail "A").
  10. Discard old poppet and O-ring.
  11. Install new O-ring into the opening in the plastic manifold housing (Detail "A").
- 

### **CAUTION**

DO NOT overtighten pilot valve stem when installing it into plastic manifold. Damage to the rubber "O" ring and/or plastic manifold may occur.

---

12. Install new slotted poppet into the bottom of the pilot valve stem with tapered end facing to the bottom.
13. Install pilot valve stem and new slotted poppet with coil (with yoke and locknut intact) into manifold opening.
14. Use a flat blade screwdriver, and tighten pilot valve stem clockwise until snug. Torque to  $2.82 \text{ N-M} \pm .565$  (25 inch-lbs  $\pm$  5 inch-lbs).
15. Install new label onto pilot valve coil yoke.
16. Position pilot valve coil with yoke at an approximate  $90^\circ$  angle to the right as viewed from the front of valve.
17. Use the flat blade screwdriver and hold the pilot valve-stem in place.
18. Tighten locknut clockwise with the 9/16-inch wrench until snug to secure the stem and coil with yoke. DO NOT overtighten. Torque to  $2.26 \pm .34 \text{ N-M}$  (20 inch-lbs  $\pm$  3 inch-lbs).

---

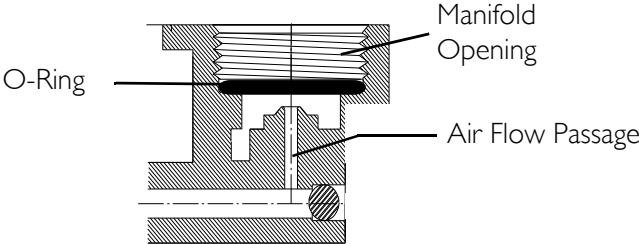
**CAUTION**

DO NOT overtighten locknut when installing it onto pilot valve stem. Damage to the plastic manifold may occur.

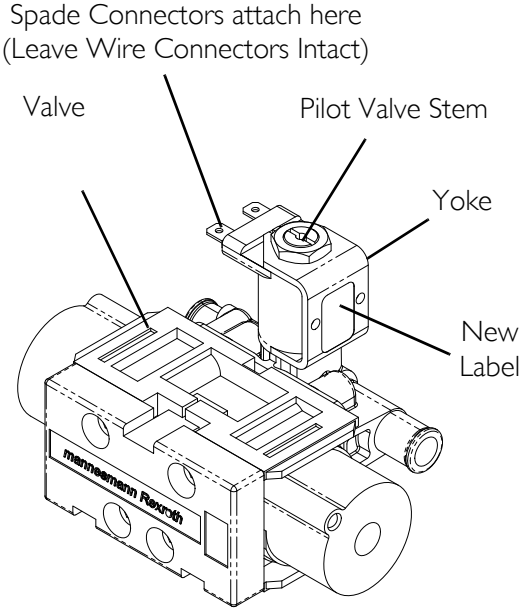
---

19. Plug power cord in and turn concentrator ON (I) to ensure proper operation.
20. Reinstall cabinet. Refer to [Removing Cabinet](#) on page 23.
21. If any difficulties are encountered in this installation, contact Invacare Technical Service at (800) 832-4707.

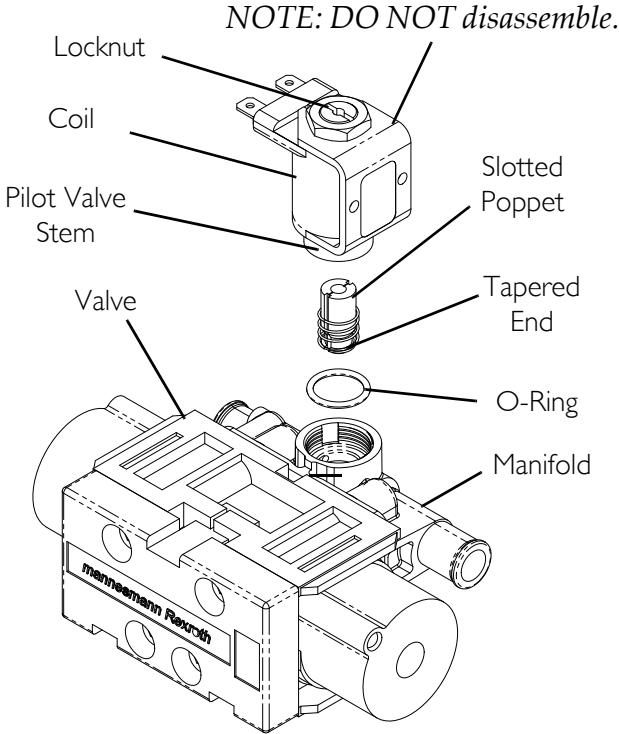
**DETAIL "A"**



**Assembled View**



**Exploded View**



**FIGURE 20.2** Replacing Pilot Valve Poppets and O-Rings

# SECTION 21—PURITY INDICATORS

## SensO<sub>2</sub> Alarm Indicators

### **⚠ DANGER**

To prevent electrical shock, ALWAYS disconnect concentrator from electrical outlet before servicing.

*NOTE: For this procedure, refer to FIGURE 21.1 on page 72.*

### Operation

The Perfecto<sub>2</sub> with SensO<sub>2</sub> Concentrator is equipped with an oxygen purity indicator. This feature monitors the purity level of the oxygen generated by the concentrator. If purity falls below alarm thresholds, indicator lights on the control panel will illuminate.

*NOTE: Concentrator may be used during the initial start warm-up time (approximately 30 minutes) while waiting for the O<sub>2</sub> purity to reach maximum.*

When the unit is turned on, the GREEN light will come on (SYSTEM OK/O<sub>2</sub> greater than 85%). After five minutes, the oxygen sensor will be operating normally and will control the indicator lights depending on oxygen concentration values. The explanation of the indicator light functions are listed below:

### IRC5PO2AW Indicator Lights Explanation

*NOTE: Indicator lights are visible only when lit.*

GREEN light (O<sub>2</sub>) - Normal Operation.

YELLOW light (⚠)- Call supplier IMMEDIATELY. You may continue to use the concentrator unless instructed otherwise by your supplier. Be certain that backup oxygen is nearby.

RED light (⚠)- Total unit shutdown. Switch IMMEDIATELY to backup oxygen supply. Call supplier IMMEDIATELY.

GREEN light - with YELLOW light flashing - Call supplier IMMEDIATELY. Oxygen sensor malfunctioning; you may continue to use the concentrator.

### IRC5PAW Indicator Lights Explanation

RED light (⚠)- Total Unit Shut-Down. Switch IMMEDIATELY to a back-up oxygen supply. Call Supplier IMMEDIATELY.

GREEN light (I/O) - On/Off. System okay.

Model IRC5PO2AW

Model IRC5PAW

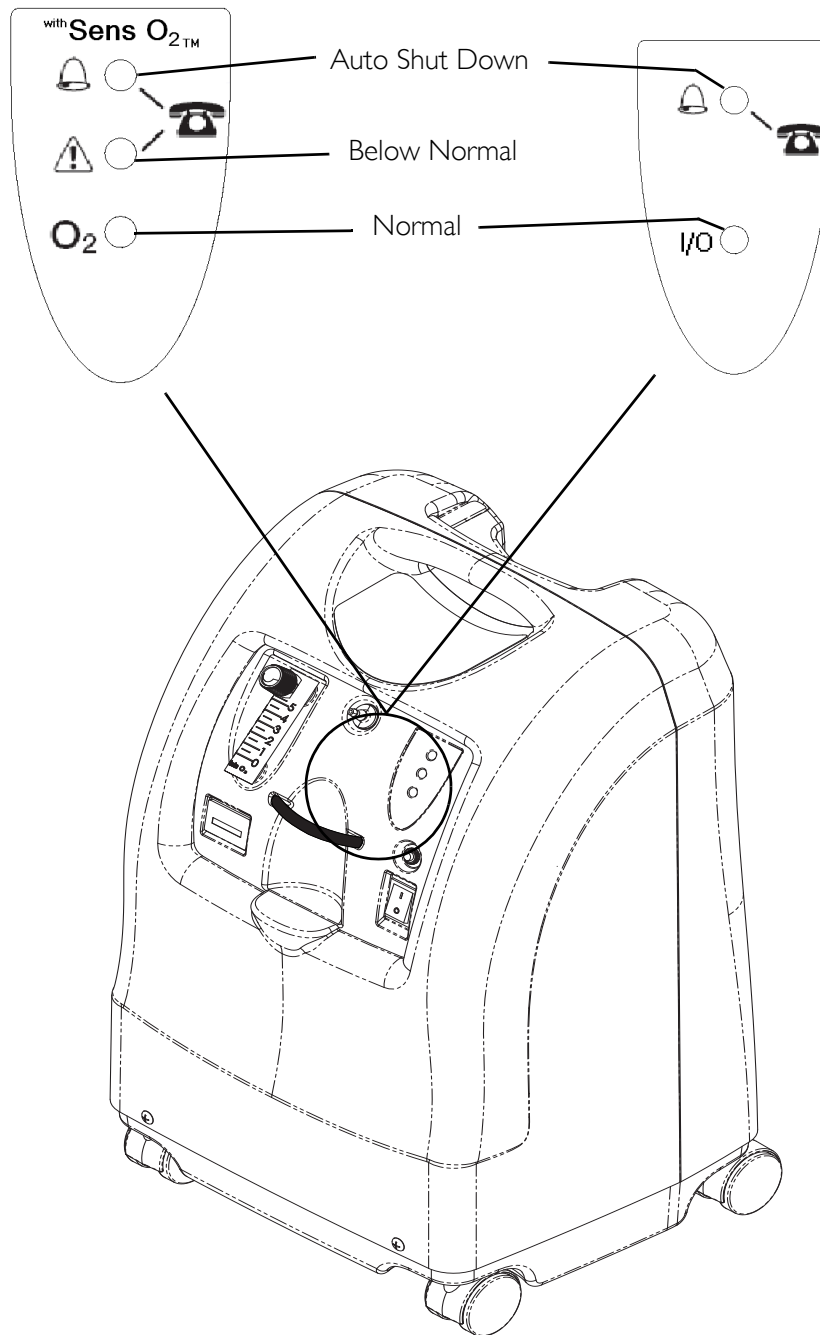


FIGURE 21.1 Display Control Panel



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# SECTION 22—TIMING

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## **⚠ DANGER**

To prevent electrical shock, ALWAYS disconnect concentrator from electrical outlet before servicing.

Use extreme care when making adjustments to the timing switch. DO NOT allow screwdriver or your hands to contact the P.C. Board when unit is plugged in and/or on. Turn unit off and unplug before adjusting timing switch. Electrical shock is possible.

---

To accommodate the varying tolerances when replacing components, an adjustable timer is used to control the shift time of the pressure equalization (P.E.) valve. The SensO<sub>2</sub> board allows for automatic (microprocessor controlled) adjustments of the P.E. shift times. Non-SensO<sub>2</sub> boards allow for manual adjustment.

## **Autotuning (Model IRC5PO2AW Only)**

---

## **⚠ WARNING**

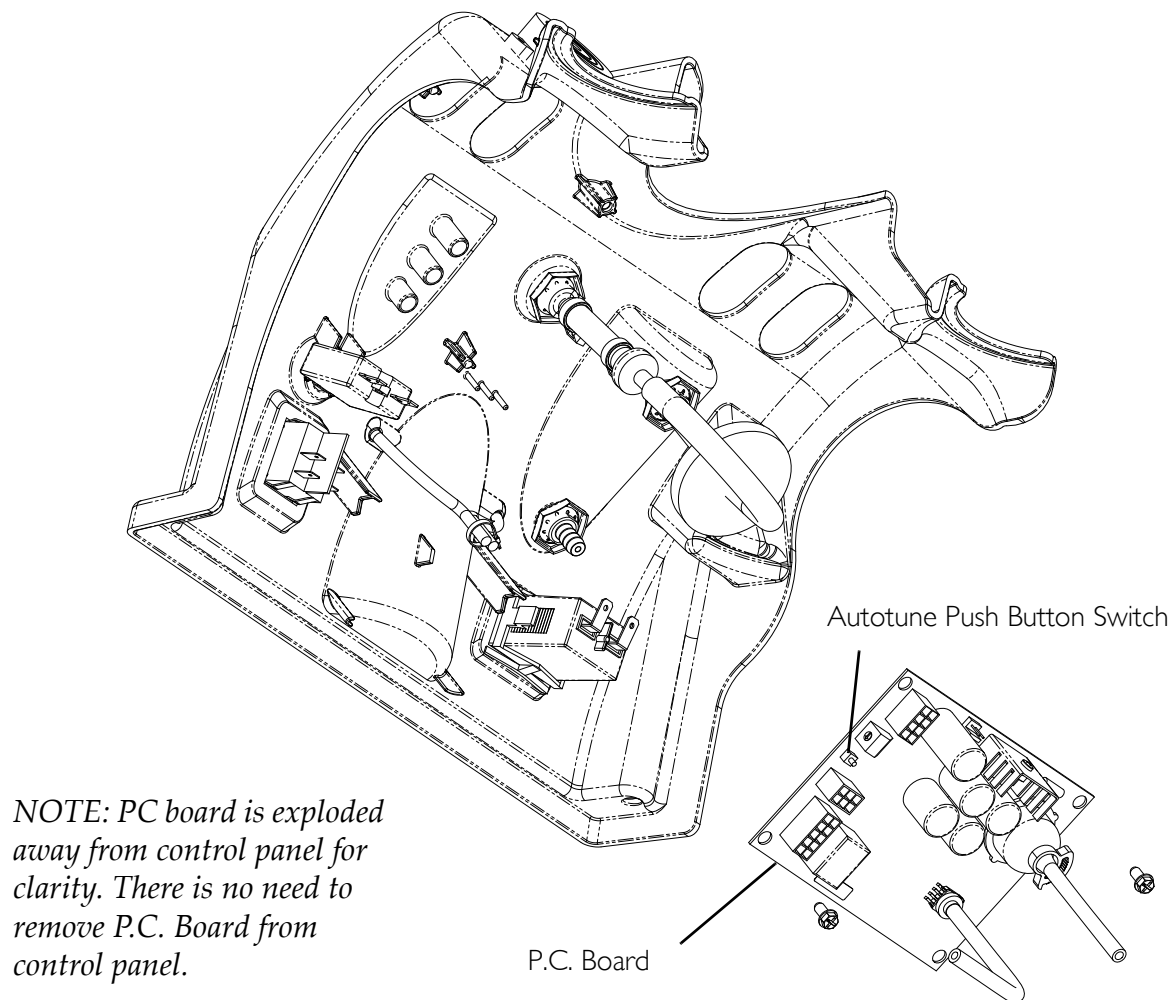
DO NOT push the autotune button while powering up. Otherwise, the factory settings will be erased.

---

*NOTE: For this procedure, refer to FIGURE 22.1 on page 74.*

1. Turn power off (●) and unplug the unit.
2. Remove cabinet. Refer to [Removing Cabinet](#) on page 23.
3. Plug the unit in and turn the power on (I).
4. Locate the P.C. board.
5. Wait for the main valve shift to indicate one of the following:
  - If the P.C. board is new, the front panel RED indicator light will slowly blink, indicating autotune has initiated.
  - If the P.C. board is used and has performed autotuning before, press and release the small push button on the P.C. board. The front panel RED indicator light will slowly blink, indicating the unit is autotuning and automatically adjusting the P.E. valve timing.
6. Set the output flow to 5.0 L/min.
7. The GREEN (onboard) diagnostic light will flash the current value of the P.E. valve timing number.
8. Place the cover back on the unit but DO NOT install the cover screws. Let the unit run until autotuning is completed.
9. When autotuning is complete, the RED front panel indicator light will change from a slow blinking to a flashing of the final P.E. valve timing number.

10. Turn the unit off and then back on. The timing value is stored in memory for future use.
11. If the unit is turned off before an autotune cycle is completed, the P.E. valve timing will not be stored or updated. If the board is new, autotuning **MUST** be successfully completed before the unit can be placed into service.
12. After a successful autotune, run the unit for 30 minutes and verify that the oxygen concentration output of the unit is within specification.
13. If the oxygen output concentration is not within specification, rerun the autotune again.
14. Reinstall the cover screws.



**FIGURE 22.1** Autotuning (Model IRC5PO2AW Only)

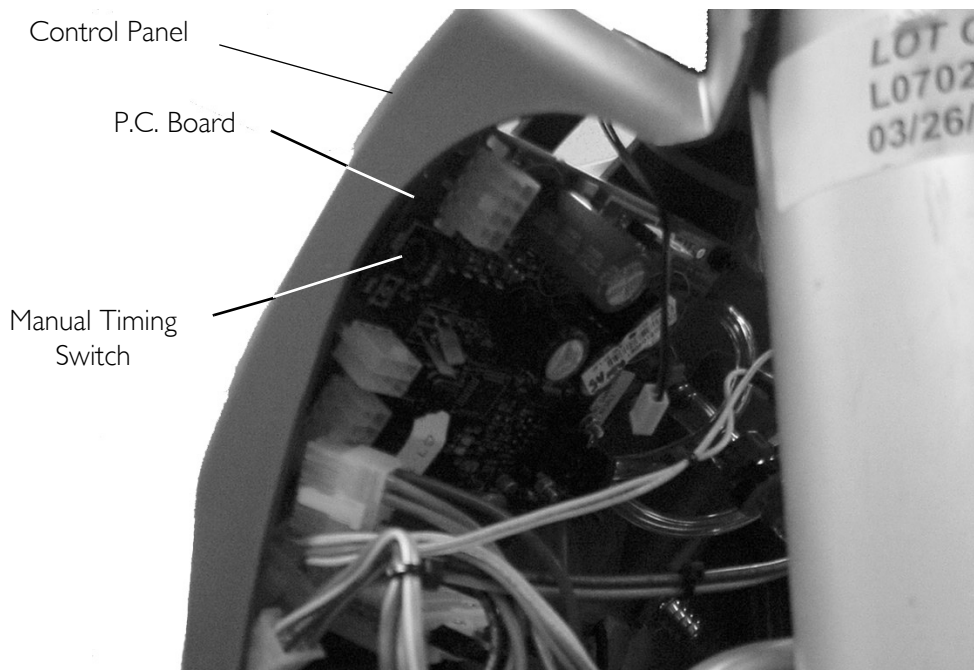
## Manual Tuning (Model IRC5PAW Only)

*NOTE: For this procedure, refer to FIGURE 22.2.*

1. Turn power off (O) and unplug the unit.
2. Remove cabinet. Refer to [Removing Cabinet](#) on page 23.
3. Plug unit in but DO NOT turn on (I) until instructed to below.
4. Locate the timing switch on the P.C. board.
5. Insert a small common or flathead screwdriver into the adjustment screw of the timing switch.
6. Set the timing switch initially at the number “7” position.
7. Turn unit on (I) and set to max flow setting.
8. Wait 15 minutes for unit to stabilize.
9. If after 15 minutes of run time the concentration is below specification, change setting to the number “6” position.
10. Let unit run ten minutes. If concentration is lower still, change the setting to position “8”.

*NOTE: You will find that the concentrator will perform better at either the higher or lower setting. The normal adjustment range is between timing positions 3 and A.*

11. Continue to change setting one step at a time (up or down) until the concentration is the highest value achievable.
12. Once concentration has reached specification, retiming is complete.
13. Reinstall cabinet. Refer to [Removing Cabinet](#) on page 23.



**FIGURE 22.2** Manual Tuning (Model IRC5PAW Only)

## SECTION 23—LEAK TEST

---

### **⚠ DANGER**

To prevent electrical shock, ALWAYS disconnect concentrator from electrical outlet before servicing.

---

### **Leak Test**

*NOTE: For this procedure, refer to FIGURE 23.1 on page 77.*

1. Unplug unit.
  2. Remove cabinet. Refer to Removing Cabinet on page 23.
  3. Plug in unit.
  4. Turn the concentrator on (I).
  5. Let concentrator run for 20 minutes.
- 

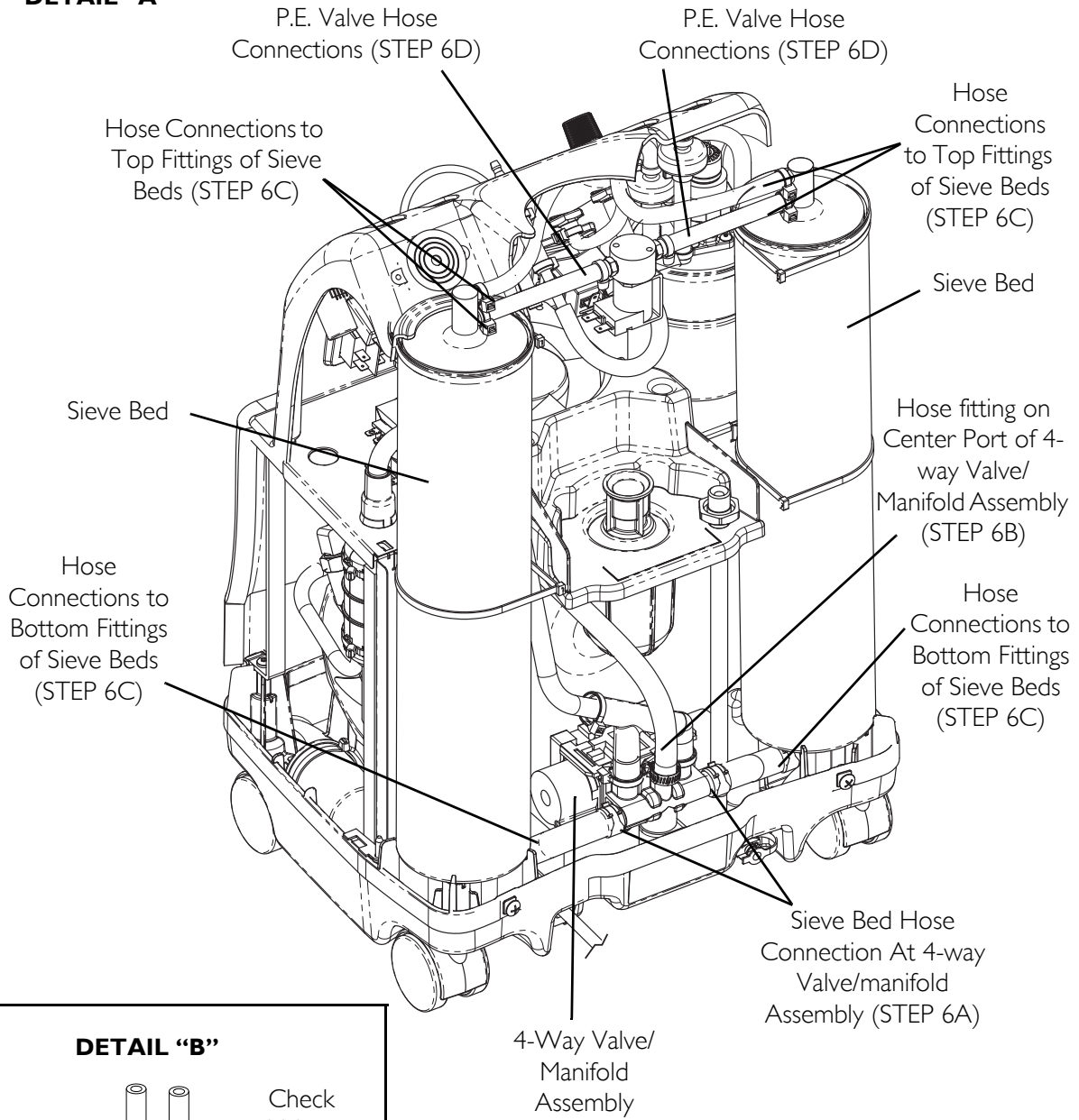
### **⚠ WARNING**

Apply small amount of leak test solution to fittings only. Avoid all other components. DO NOT leak test 4-way valve body. Carefully leak test for pressure leaks around sieve bed hoses at 4-way valve. DO NOT allow leak test solution to enter into 4-way valve and system.

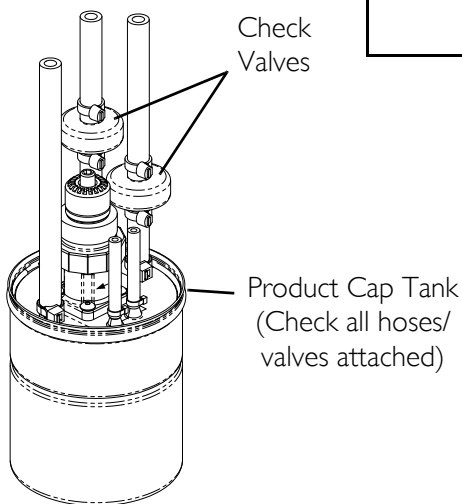
---

6. With "leak-test" solution or equivalent soapy water, leak test the following:
  - A. The two sieve bed hose connection at the 4-way valve/manifold assembly (Detail "A").
  - B. Leak test the hose fitting on center port of 4-way valve/manifold assembly.
  - C. Hose connections to top and bottom fittings of sieve beds.
  - D. P.E. valve hose connections.
  - E. Hose fittings at product tank cap and check valves (Detail "B").
  - F. Both fittings on heat exchanger assembly (Detail "C").
7. Replace any tubing that appears cracked, worn, etc.
8. Re-install cabinet. Refer to Removing Cabinet on page 23.
9. Refer to Typical Product Parameters on page 8 for concentration levels. If low concentrations are observed, refer to Troubleshooting on page 16.

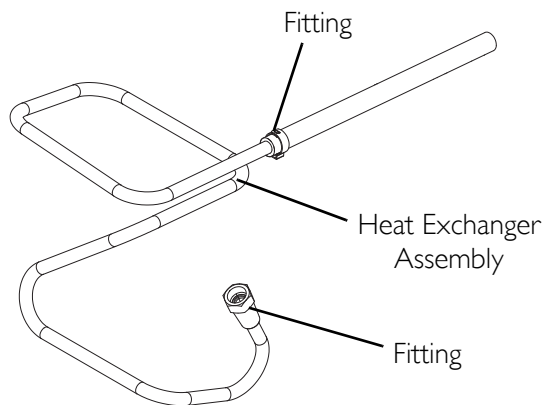
**DETAIL "A"**



**DETAIL "B"**



**DETAIL "C"**



**FIGURE 23.1** Leak Test

## 4 Way Valve Function Test

*NOTE: For this procedure, refer to FIGURE 23.1 on page 77.*

The 4-way valve used in the Perfecto<sub>2</sub> Series Concentrators does have an acceptable tolerance of leakage per RexRoth<sup>®</sup>.

By nature of the valve design it is possible for the valve to experience small leaks, and still operate without affecting the overall performance of the unit. The valve is assembled where the components that make up the valve “Snap” together. The only screws in the valve are for securing the valve to the manifold assembly.

According to RexRoth there is an acceptable leak specification of 60 cc per minute at 137.89 kPa (20 p.s.i.) on each valve. Valves that have leaks within this specification will function properly without any adverse effects to the performance of the concentrator. A leak in the amount of 60 cc or less would be indicative of the type of small leak you would notice where the end caps connect to the main body or where the three pieces of the main body connect together. A 60 cc leak would not be noticeable when examining the system pressure swings.

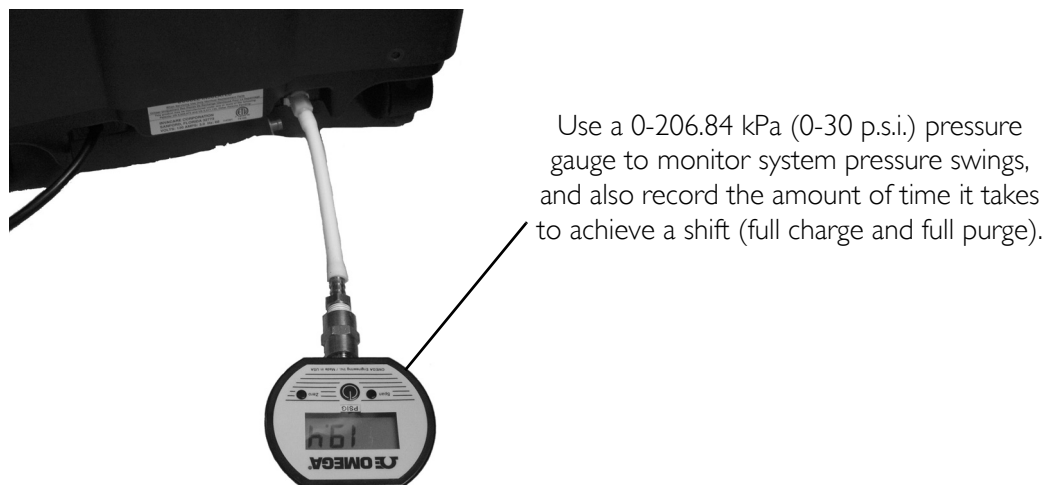
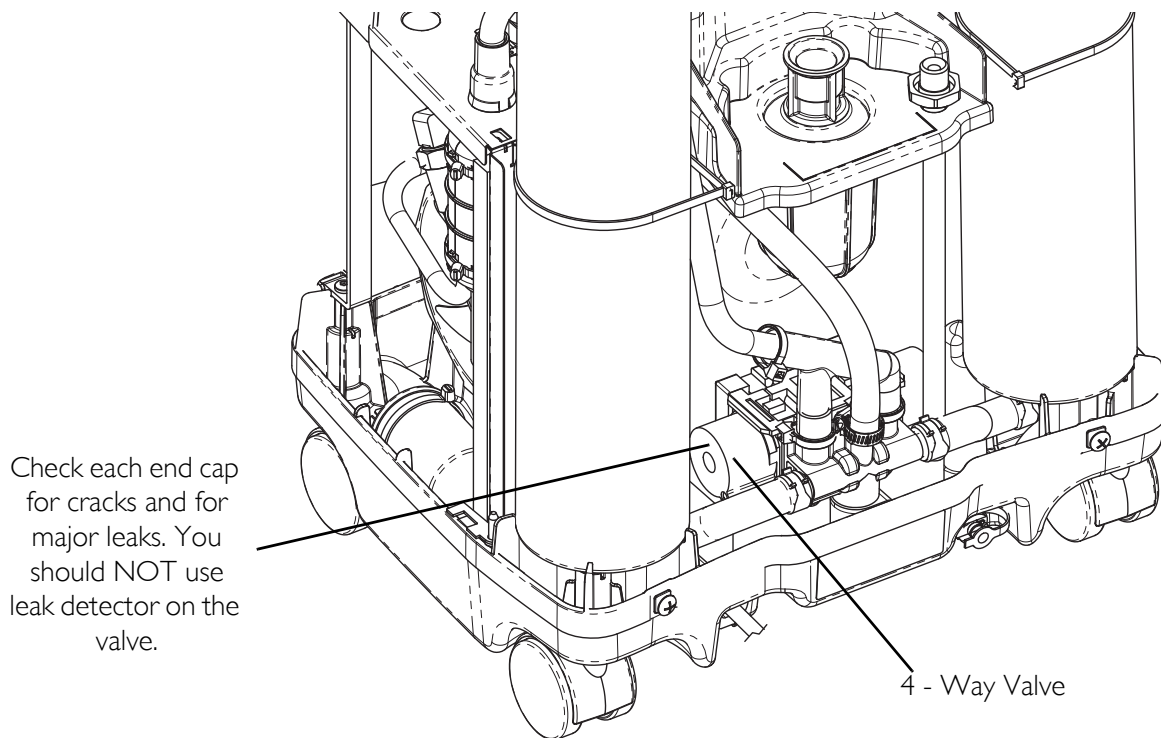
Leaks greater than 60 cc are indicative of cracks in the end caps, or a blown seal where the end cap connects to the main body of the valve. These leaks are detected by either reading the system swing pressures, noticing two consecutive swings not being equal or by hearing an audible leak every other cycle. Leaks of this extreme nature indicate the valve needs to be replaced.

Valves should only need to be replaced when the following conditions exist:

1. A visible crack is noted on either of the end caps or main body of the 4 way valve, regardless of the amount of leak.
2. A large leak is present on the valve that causes an imbalance in the sieve bed swing pressures. Example: Sieve Bed 1 pressure swings from 96.52 kPa (14 p.s.i.) to 110.32 kPa (16 p.s.i.), within 7-20 seconds and Sieve Bed 2 pressure swings from 89.63 kPa (13 p.s.i.) to 110.32 kPa (16 p.s.i.) slowly, and may take as long as 25-30 seconds before shifting (times over 30 second will shut down automatically).
3. Valve will not shift and the pilot valve solenoid and circuit board are working properly.

*NOTE: The concentrator's P.C.B. should exhibit an error code for High Pressure Failure (1 RED/ 2 GREEN).*

*NOTE: The best method to test the 4-way valve operation is by measuring the unit pressure swings. This can easily be done at the HomeFill port with a 0 - 206.84 kPa (0-30 p.s.i.) pressure gauge and a ¼" fill line adapter. Upon starting the unit should build pressure up to 110.32 kPa (16 p.s.i.) for output flows 3 L/min and below or 21 p.s.i. for output flows 4 L/min and above before its initial shift. After the initial shift the unit should shift consistently in equal amounts of time +/- 1 second (time recorded in seconds).*



**FIGURE 23.2** 4 Way Valve Function Test

# SECTION 24—ALARM TEST

## Alarm and Sensor Tests

---

### **⚠ DANGER**

To prevent electrical shock, ALWAYS disconnect concentrator from electrical outlet before servicing.

Check alarms periodically for proper function.

---

### **Power Loss Alarm**

With the unit running, remove the line cord from power source. The power loss alarm mode should sound the audible alarm IMMEDIATELY or within 30 seconds.

*NOTE: With the unit unplugged and inoperable for a short period of time, the battery free circuit will be drained. If power failure alarm does not sound with unit unplugged and power switch on, the battery free circuit is drained. It will recharge when unit is plugged in and switched on.*

### **Low Pressure Test**

*NOTE: For this procedure, refer to FIGURE 24.1 on page 81.*

1. There are two separate failure modes for Low Pressure:
  - Low product tank pressure. (Pressure in tank drops below a preset value, typically 48.26 kPa (7 p.s.i.).)
  - Failure to reach the set point pressure within a prescribed time limit, or Timeout Failure.

#### **Test One**

1. With unit running, set flow at maximum rating.
2. When the main valve switches, pull the stem on the compressor relief valve out as far as it will go and hold it.
3. The low pressure alarm should activate within 30 seconds. Refer to SensO<sub>2</sub> Alarm Threshold on page 83 for shutdown mode.

#### **Test Two**

1. With unit running, set flow at maximum rating.
2. Remove the pressure sensor tubing (tie-wrap) from the top of the product tank (not shown).
3. The low pressure alarm should activate within 30 seconds. Refer to SensO<sub>2</sub> Alarm Threshold on page 83 for shutdown mode.
4. Replace tubing and tie wrap.

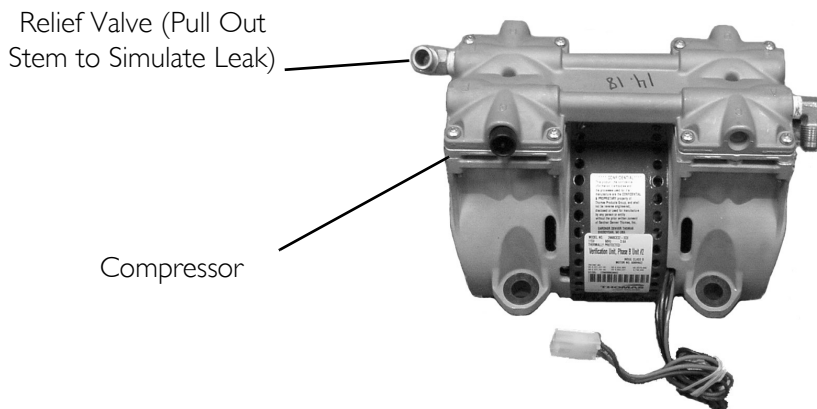


## Time-Out Test

*NOTE: For this procedure, refer to FIGURE 24.1.*

1. With unit off (●), disconnect the compressor connector from the main wiring harness.
2. Plug unit in and turn power on (I).
3. The Time-Out Failure alarm should activate within 40 seconds. Refer to SensO<sub>2</sub> Alarm Threshold on page 83 for shutdown mode.
4. Replace tubing and tie wrap.

*NOTE: If any alarm fails to perform to specification, contact Invacare Technical Service.*



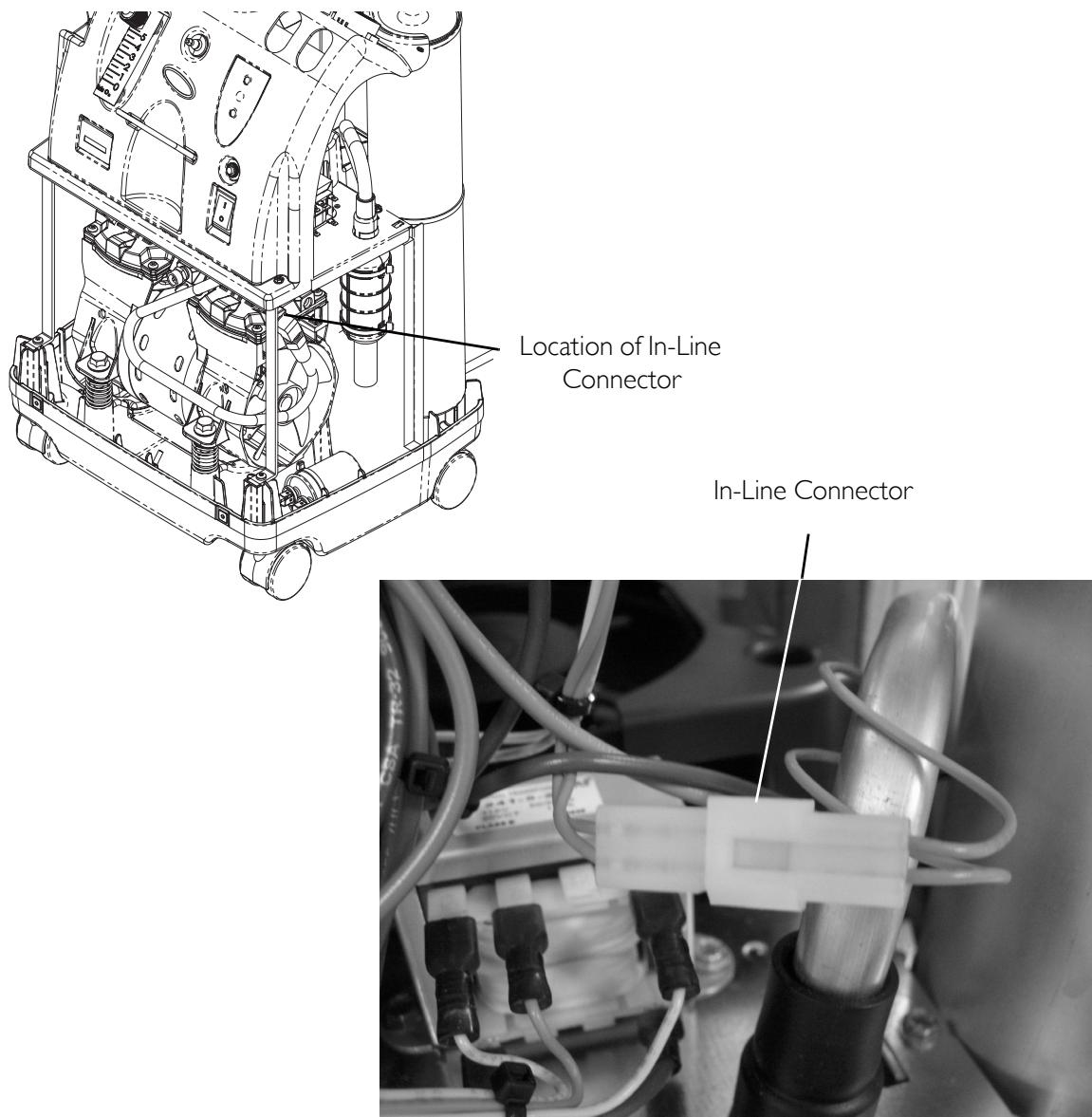
**FIGURE 24.1** Low Pressure Test - Time-Out Test

## High Pressure Test

*NOTE: For this procedure, refer to FIGURE 24.2 on page 82.*

- High Pressure - Occurs when pressure in product tank rises beyond a preset value, typically 158.58 kPa ± 6.89 kPa (23 p.s.i. ± 1 p.s.i.).
  - Main Valve Coil - Alarm sequence occurs when the main valve coil, connection or P.C. board circuitry has failed.
1. With the unit running and flow set at 5 L/min., disconnect in-line connector shown in FIGURE 24.2.
  2. The main valve coil alarm should activate within 40 seconds. Refer to SensO<sub>2</sub> Alarm Threshold on page 83 for shutdown mode (FIGURE 24.2).
  3. Replace tubing and tie wrap.

*NOTE: If any alarm fails to perform to specification, contact Invacare Technical Service.*



**FIGURE 24.2** High Pressure Test

## Oxygen Sensor

*NOTE: For this procedure, refer to FIGURE 24.3 on page 83.*

Alarm sequence occurs when concentration levels fall below a preset value, typically  $73\% \pm 3\%$  or  $85\% \pm 2\%$ . This failure indicates a catastrophic failure of any component mechanical or electrical.

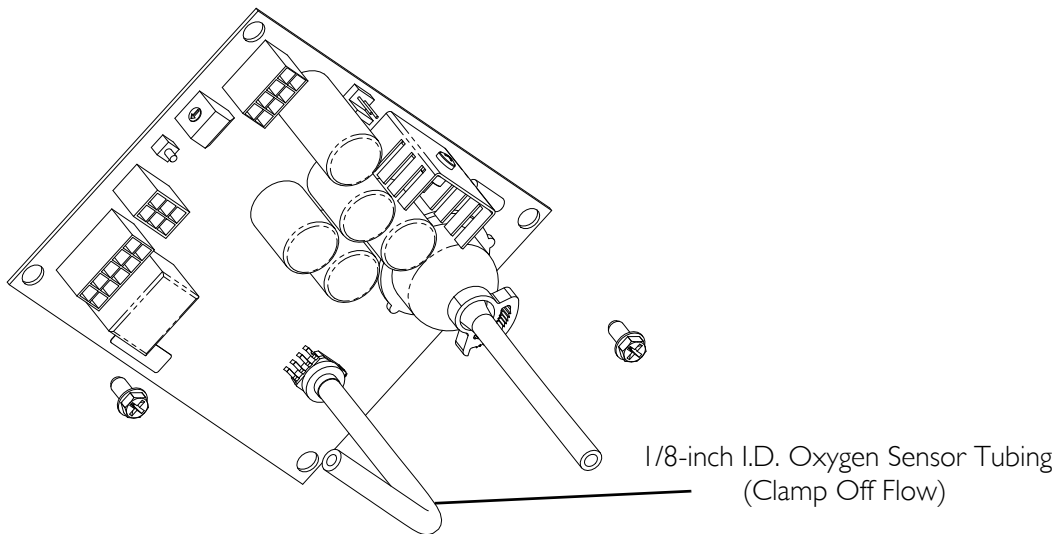
1. Turn unit on (I). Set output flow at 5 L/min.
2. Monitor the O<sub>2</sub> level.
3. With the O<sub>2</sub> level greater than 85% after five minutes, the GREEN panel indicator light will remain illuminated.

4. Slowly adjust flow beyond maximum rated flow until you can achieve a concentration level greater than 75% but less than 84%. Within 30 minutes, the YELLOW panel indicator light will illuminate and the unit will continue to run.
5. Clamp off the 1/8-inch oxygen sensor tubing between the oxygen sensor and the product tank regulator.

**⚠ WARNING**

Use care not to cut oxygen sensor tubing when clamping the oxygen sensor tubing.

6. Within 30 minutes, the Oxygen Sensor Alarm should activate and the RED panel light indicator will illuminate. The compressor will shut down with the alarm.



**FIGURE 24.3** Oxygen Sensor

**SENSO<sub>2</sub> ALARM THRESHOLD**

LABEL SYMBOL	STATUS	INDICATOR LIGHTS
O <sub>2</sub>	SYSTEM OKAY O <sub>2</sub> over 85% (± 2%)	GREEN Indicator Light
⚠	O <sub>2</sub> Between 73% (± 3%) to 85% (±2%)	YELLOW Indicator light A. YELLOW Solid B. YELLOW Flashing Sensor Failure Call a qualified technician.
🔔	SYSTEM FAILURE O <sub>2</sub> Below 73% (±3%)	RED Indicator light Continuous Audible Alarm Sieve-GARD™ Compressor Shutdown Call a qualified technician

**P.E. Valve Coil Test**

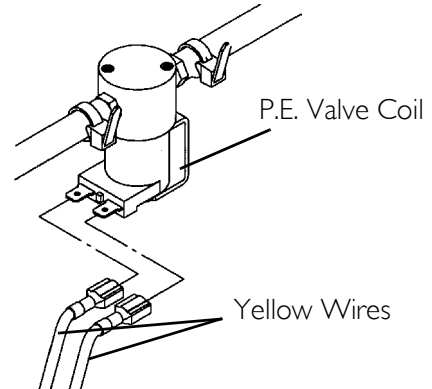
NOTE: For this procedure, refer to FIGURE 24.4.

NOTE: P.E. Valve Coil - Alarm sequence occurs when the P.E. Valve Coil, connection or P.C. Board Circuitry has failed.

1. With the unit running and flow set at 5 L/min., remove one YELLOW wire from the P.E. valve coil. The P.E. valve coil alarm should activate within 10 seconds.
2. Reinstall cabinet. Refer to Removing Cabinet on page 23.


NOTE: If any alarm fails to perform to specification, contact Invacare Technical Service.

NOTE: If problems arise during test, contact Invacare Technical Service for further assistance.



**FIGURE 24.4** P.E. Valve Coil Test

Use the chart in Preventive Maintenance on page 24 to record date and number of hours when preventive maintenance was performed on the concentrator or any repairs made.

 <b>OXYGEN CONCENTRATOR</b> Refer To Service Manual <b>DIAGNOSTIC ALARM SYSTEM</b>			
...ADJUSTMENTS BY UNAUTHORIZED PERSONNEL VOIDS WARRANTY...			
ALARM	LED FLASHES		PROBABLE CAUSE
	RED	GREEN	
BEEP AT START UP	0	0	NO PROBLEM, SYSTEM OK
SHORT BEEP WITH LONG PAUSE	0	0	MAIN POWER LOSS
CONTINUOUS	1	1	LOW PRESSURE; MAJOR LEAK
CONTINUOUS	1	2	HIGH PRESSURE; NO SWITCHING
CONTINUOUS	1	3	TIME OUT FAILURE; COMPRESSOR
CONTINUOUS	1	5	PILOT VALVE CIRCUIT
CONTINUOUS	2	1	73% SHUTDOWN; LOW O <sub>2</sub>
CONTINUOUS	2	3	PE VALVE COIL
CONTINUOUS	2	4	EEPROM FAILURE
CONTINUOUS	3	1	OXYGEN SENSOR FAILURE
NOTE: CYCLE POWER ON AND OFF FIVE (5) TIMES TO CLEAR INTERNAL FAULT CODE.			
<b>PREVENTIVE MAINTENANCE SCHEDULE</b>	Cabinet Filter(s). . . . .Clean Weekly, Replace as Needed Heat Exchanger. . . . .Clean as Needed Compressor Inlet Filter. .Check Annually or During Scheduled PM Outlet HEPA Filter. . . .Check Annually or During Scheduled PM Compressor. . . . .Rebuild as Needed Exhaust Muffler. . . . .Replace as Needed		
1115180			

# SECTION 25— SIEVE BED PRESSURE CHECK

## Checking Sieve Bed Pressure

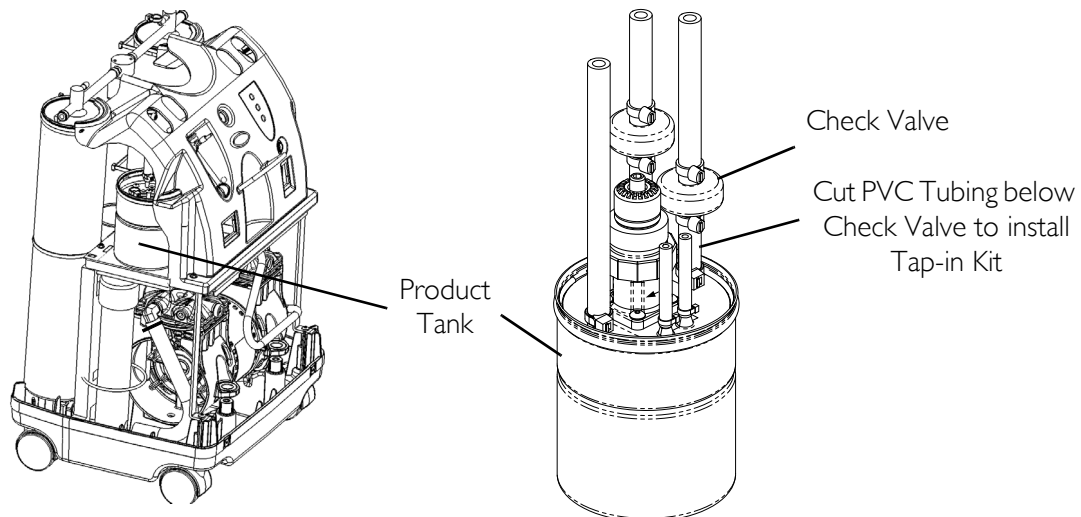
### **⚠ DANGER**

To prevent electrical shock, ALWAYS disconnect concentrator from electrical outlet before servicing.

### Disassembly

NOTE: For this procedure, refer to FIGURE 25.1.

1. Turn power off (●) and unplug unit.
2. Remove cabinet. Refer to Removing Cabinet on page 23.
3. Turn unit so the back faces you.
4. It may be necessary to remove compressor inlet HEPA filter. Refer to Replacing the Compressor Inlet HEPA Filter on page 26.



**FIGURE 25.1** Disassembly

### Pressure Testing

NOTE: For this procedure, refer to FIGURE 25.2 on page 86.

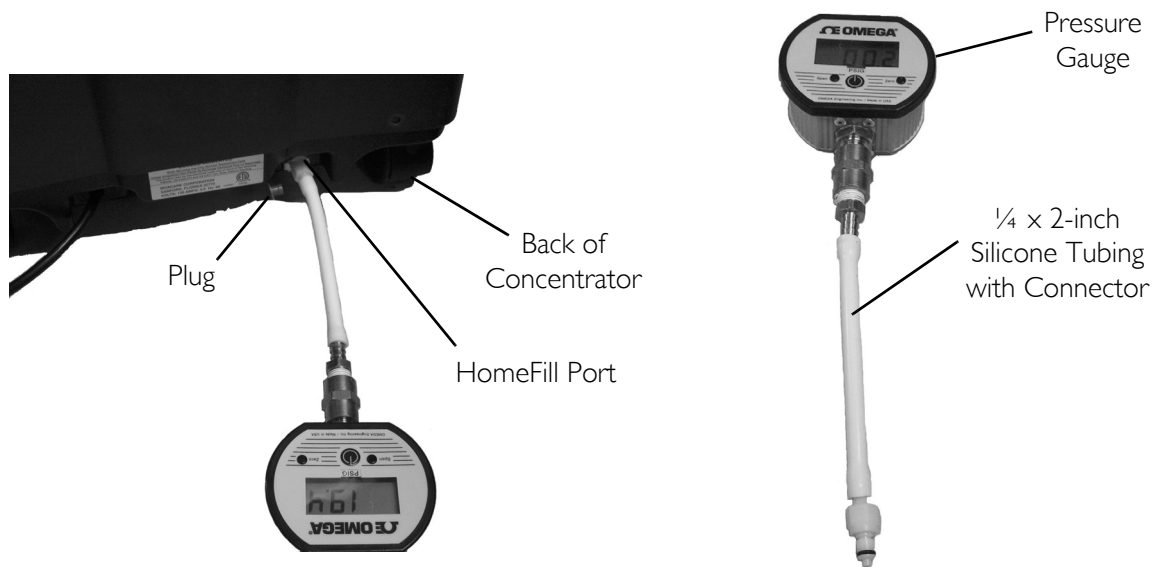
1. Connect pressure gauge to the  $\frac{1}{4}$  x 2-inch silicone tubing with connector (p/n 1131392).
2. Remove plug in HomeFill port in back of concentrator.
3. Connect  $\frac{1}{4}$  x 2-inch silicone tubing with connector to HomeFill port.

4. Check each connection to make sure it is tight.
5. Turn the concentrator On (I).

*NOTE: Adjust the concentrator to MAXIMUM rated liter flow to 5 L/min.*

*NOTE: Wait approximately five minutes to allow system pressures to achieve proper equilibrium before testing.*

6. The pressure in the concentrator should rise within 20 seconds to  $144.79 \text{ kPa} \pm 2.07 \text{ kPa}$  ( $21 \text{ p.s.i.g.} \pm 0.3 \text{ p.s.i.g.}$ ) and shift the 4-way valve to the opposite sieve bed.
7. After the 4-way valve shift, the pressure in the concentrator will drop to  $82.74 \pm 13.79$  ( $12 \text{ p.s.i.g.} \pm 2 \text{ p.s.i.g.}$ ) before rising within 20 seconds to  $144.79 \text{ kPa} \pm 2.07 \text{ kPa}$  ( $21 \text{ p.s.i.g.} \pm 0.3$ ) and shift the 4-way valve to the opposite sieve bed.
8. If pressure reading is  $144.79 \text{ kPa} \pm 2.07 \text{ kPa}$  ( $21 \text{ p.s.i.g.} \pm 0.3 \text{ p.s.i.g.}$ ) when both valve shifts are made, proceed to STEP 10.
9. If pressure in the concentrator does not fall into the specifications listed above, refer to Troubleshooting on page 16.
10. Turn the concentrator off (O).
11. Disconnect pressure gauge from the HomeFill port and reinstall plug.



**FIGURE 25.2** Pressure Testing

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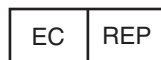
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