millennium™
oxygen concentrator

Service Manual

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Millennium Oxygen Concentrator System Service Manual

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Limited Warranty

Respironics warrants that the Millennium Oxygen Concentrator System shall be free from defects of workmanship and materials and will perform in accordance with the product specifications for a period of three years from the date of sale by Respironics. An additional two year warranty can also be purchased from Respironics. If the product fails to perform in accordance with the product specifications, Respironics will repair or replace – at its option – the defective material or part. Respironics will pay customary freight charges from Respironics to the dealer location only. This warranty does not cover damage caused by accident, misuse, abuse, alteration, and other defects not related to materials or workmanship.

Respironics disclaims all liability for economic loss, loss of profits, overhead, or consequential damages which may be claimed to arise from any sale or use of this product. Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

This warranty is given in lieu of all other express warranties. In addition, any implied warranty, including any warranty of merchantability or fitness for the particular purpose, is limited to three years unless the additional two year warranty is purchased. Some states do not allow limitations on how long an implied warranty lasts, so the above limitation may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

To exercise your rights under this warranty, contact your local authorized Respironics dealer or contact Respironics at:

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Overview: Millennium Oxygen Concentrator System Technical Service Manual

Warranty		Details the Respironics warranty policy for the Millennium Oxygen Concentrator System.
Table of Contents		Lists the chapters included in this manual.
Chapter 1:	**Introduction**	Introduces the Millennium Oxygen Concentrator System and gives Technical Support contact information.
Chapter 2:	**Warnings, Cautions, & Notes**	Lists the Warnings, Cautions, and Notes.
Chapter 3:	**Specifications, Description, Features, & Theory of Operation**	Provides specifications, a functional description, theory of operation, and alarm system summary for the Millennium Oxygen Concentrator System.
Chapter 4:	**System Setup Procedures**	Details system setup procedures.
Chapter 5:	**Verification Procedures**	Gives instructions for the battery, cycle time, and oxygen verification tests.
Chapter 6:	**Maintenance**	Details the routine maintenance schedules that should be followed by the user and dealer, as well as detailed instructions for dealer compressor maintenance.
Chapter 7:	**Troubleshooting and Diagnostics**	Provides a troubleshooting table and diagnostic information.
Chapter 8:	**Repair & Replacement**	Describes detailed procedures of removing and installing all major components within the unit. Includes graphics and photographs for visual identification.
Chapter 9:	**Testing**	Provides post replacement testing procedures and a Testing Data Sheet.

Overview (Continued)

Appendix A: Tools and Equipment	Details the necessary tools, supplies, and test equipment required for servicing and testing.
Appendix B: Schematic	Provides a system schematic.

NOTE: The system schematic is proprietary and is to be used for reference only.

Appendix C: Receiving Inspection Checks	Provides a Receiving Inspection Checks chart to record the inspection, installation, and check out procedures.
Index:	Provides an alphabetical listing of key components and terms.

Chapter 1: Introduction

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Chapter 1: Introduction

1.1 Millennium Oxygen Concentrator System Overview

The Millennium Oxygen Concentrator System (Millennium) is intended to provide supplemental oxygen to persons requiring low flow oxygen therapy. This device is not intended to be life supporting nor life sustaining. Millennium produces concentrated oxygen from room air for delivery to a patient. The oxygen from the air is concentrated using a molecular sieve and a pressure swing adsorption process.

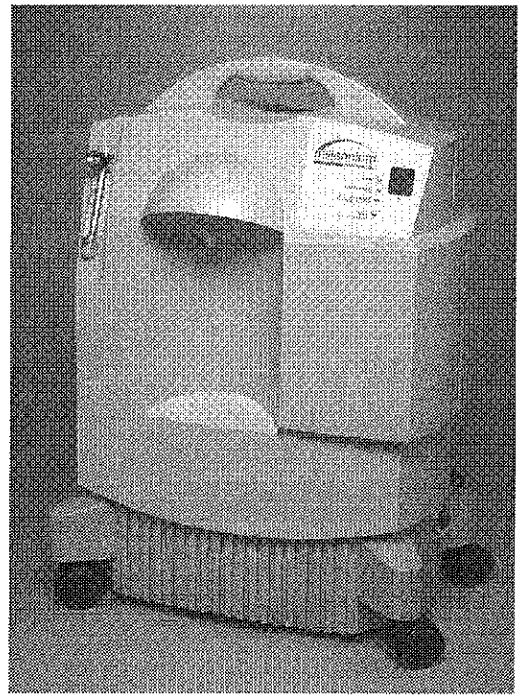

Figure 1-1
Front View of Millennium

Respironics holds itself harmless for any injury or damage resulting from repairs, modifications, or adjustments outside the scope of this manual, including installation and maintenance by anyone other than trained, certified technicians.

1.2 Service Notice

This manual is intended to be used by trained service technicians. The information provided in this manual will allow the service technician to perform the service and maintenance required on Millennium. Warranty repairs may be performed by a factory authorized service center or Customer Satisfaction Center (CSC).

1.3 Technical Support Statement

Respironics is committed to customer satisfaction and may be contacted with any questions or for technical support. For technical assistance or replacement part ordering information, contact your nearest Respironics Customer Satisfaction Center (CSC).

For additional information or technical support, contact:

U.S. and Canada

Phone: **1-800-669-9234**
1-800-421-8754
Fax: **Available from your nearest CSC**

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Chapter 2: Warnings, Cautions, & Notes

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Chapter 2: Warnings, Cautions, & Notes

The following terms are used throughout this manual to identify possible safety hazards, conditions that may result in equipment or property damage, or important information that must be considered. It is important to read, understand, and follow them at all times.

WARNING:	Indicates the possibility of injury to the patient, operator, or technician.
CAUTION:	Indicates the possibility of damage to the device.
NOTE:	Places emphasis on an operating characteristic or important consideration.

2.1 WARNINGS

2.1.1 Safety

- Oxygen generated by this concentrator is supplemental and should not be considered life supporting or life sustaining. In certain circumstances, oxygen therapy can be hazardous; any user should seek medical advice prior to using this device.
- Where the prescribing physician has determined that an interruption in the supply of oxygen, for any reason, may have serious consequences to the user, an alternate source of oxygen should be available for immediate use.
- Keep the unit away from heat and/or open flame as oxygen greatly accelerates combustion.
- Do not smoke when the concentrator is operating or a patient is using oxygen.
- Do not use greases, oils, or any petroleum based solvent or cleaner on or near the unit.
- Use extreme caution when handling the compressor capacitor as it holds an electrical charge until it is properly discharged.
- Avoid handling the molecular sieve material. Respironics recommends the return of the sieve canister assembly to Respironics for any service that involves sieve disposal.

2.1.2 Operational

- Never modify the power cord or use adapters, extension cords, etc. The unit is double insulated and does not require a 3-prong power plug. Any modification to the power cord could alter this safety feature.

Operational (Continued)

- A physician must prescribe use of a humidifier with the Millennium. Use of only bubble type humidifiers is recommended and connections must be secure and free of leaks.
- Federal (U.S.) law restricts this device to sale by, or on the order of, a licensed physician. This device should be used only under the supervision of a physician.
- If the Millennium Oxygen Concentrator has been subjected to sub freezing temperatures for an extended period of time, it should be allowed to warm up to the stated operating temperatures before power up. Failure to do so could result in improper performance and or alarm conditions until the unit reaches normal operating temperatures.
- Do not turn on unit while any filter is wet or moist.

2.2 CAUTIONS

- Place the unit where cooling airflow is unrestricted. Be sure to inform the user not to position the unit close to drapery or curtains that might restrict the airflow.
- When using liquid leak detector, be careful not to allow it to contact electrical parts.
- Make sure connections of fittings, tubing, and hoses are secure.
- Be cautious when using thread sealants because they can cause extensive damage to the internal parts of the unit if allowed within tubing or fittings.
- Clean all exterior cabinet surfaces periodically by wiping with a damp cloth, using a mild detergent and/or hospital disinfectant.
- Use only Respironics or factory-authorized replacement parts and accessories.

2.3 NOTES

- Make sure the flow meter is set at the patient's prescribed flow rate.
- Make sure there are no kinks in the user's oxygen tubing. If necessary, use a non-kink style delivery tube (unit will go into an audible and visual alarm if the tubing is kinked or the flowmeter is turned completely off).

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Chapter 3: Specifications, Description, Features, & Theory of Operation

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Chapter 3: Specifications, Description, Features, & Theory of Operation

3.1 Overview

This chapter provides a physical and functional description of the Millennium Oxygen Concentrator System (Millennium). This unit's specifications are listed, the theory of operation is described, and the external controls and indications are identified.

3.2 Specifications

3.2.1 Performance Requirements

Voltage	120 VAC – 60 Hz 230 VAC – 50 Hz
Flow Rate	Variable from 0.5 to 5 lpm Variable from 0.5 to 4 lpm
Oxygen Concentration*	92 ± 4% @ 5 lpm 94 ± 2% @ 0.5 to 4 lpm 92 ± 4% @ 4 lpm 94 ± 2% @ 0.5 to 3 lpm
Oxygen Outlet Pressure (No Flow)	6.0 ± 1.0 psig
Operating Pressure	27 ± 2 psig @ 5 lpm 186 kPa ± 13.8 kPa@4 lpm
Back Pressure Effect	0 kpa @ 5 lpm 7 kpa @ 4.9 lpm
Operating Temperature	55 – 90°F 15 – 32°C
Storage / Transport Temperature	-30 – 160°F -34 – 71°C
Storage / Humidity	Up to 95%, non-condensing Up to 95%, non-condensing
Storage / Transport Atmospheric Pressure	790 – 525 mm Hg 790 – 525 mm Hg
Altitude: Model 600 and 605	Up to 7,500 ft. Up to 2,286 m
Power Consumption	480W 390W
Sound Pressure Level (dBA) (ISO 8359, Clause 26.2)	60 Hz – 49.8 dBA 50 Hz – 45.5 dBA

* Oxygen concentration levels are for operation within specified temperature and altitude ranges. Operation outside specified ranges may decrease oxygen concentration levels.

3.2.2 Dimensions

Width	18.9 in. 48.0 cm
Depth	13.3 in. 33.78 cm
Height	26.8 in. 68.07 cm
Weight	49.9 in. 22.68 kg
Shipping Weight	56 lbs 25.4 kg

3.2.3 Safety Features

Pressure Relief Valve	40 ± 3 psig	303 ± 20.7 kPa
Compressor Compartment Thermal Protection with Self Reset	167°F	75°C

3.2.4 Alarm Conditions

Visual red Light Emitting Diode (LED) and audible sound alert:

- Start-up test;
- Power failure;
- PCB failure; and
- High and low pressure.

Oxygen percentage indicator (Model 605): $O_2 < 70\%$.

3.2.5 Alert Conditions

Visual yellow LED with intermittent audible alarm and red LED:

- no oxygen flow.

Oxygen percentage indicator (model 605): $70\% O_2 < 85\%$.

3.2.6 Power Indication

Visual, green LED (next to power switch).

3.2.7 Oxygen Percentage Indicator (Model 605)

Warning Conditions:	Blinking yellow LED after unit is turned on and until $O_2 > 85\%$.
Normal Oxygen:	Visual green LED when $O_2 > 85\%$.

3.3 Functional Description

3.3.1 Front Cabinet

The unit's front cabinet external controls, indicators, and connections are identified in Figure 3-1, and are described in Table 3-1.

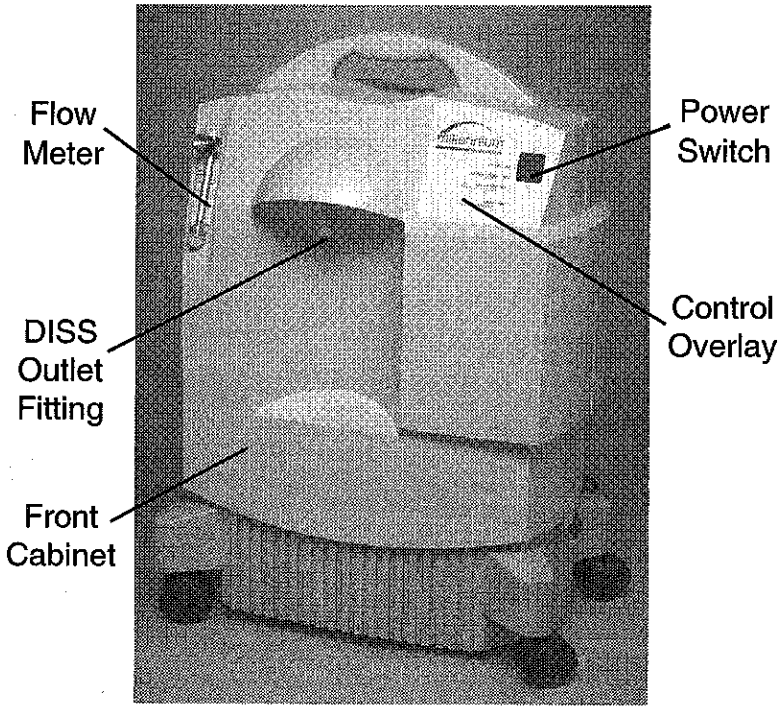


Figure 3-1
Front Cabinet

Item Name	Function
ALARM Red Light	Visually indicates unit is in alarm condition. The red Alarm light goes off and audible alarm stops within a two seconds of turn on.
Oxygen Percentage (Model 605 only) Indicator green, yellow, and red lights.	Monitors the percentage of concentrated oxygen produced by the unit. At start up the lights flash momentarily then after approximately a two minute delay, one of the lights will illuminate according to the operating status.
Control Overlay	Alarm red light, ON green light, oxygen percentage.
ON Green Light	Illuminates when unit is powered.
I/O Power Switch	Used to turn the unit on or off.
Flow Meter	Used to set and indicate amount of oxygen flowing from unit to patient. Adjustable from 0.5 to 5.0 lpm.
DISS Outlet Fitting	A male DISS fitting used to connect the matting connector from the humidifier bottle or the patient's cannula.

Table 3-1
Millennium Front Cabinet External Controls, Indicators, and Connections

3.3.2 Rear Cabinet and Sides

The unit's rear cabinet external components and connections are identified in Figures 3-2 & 3-3 and are described in Table 3-2.

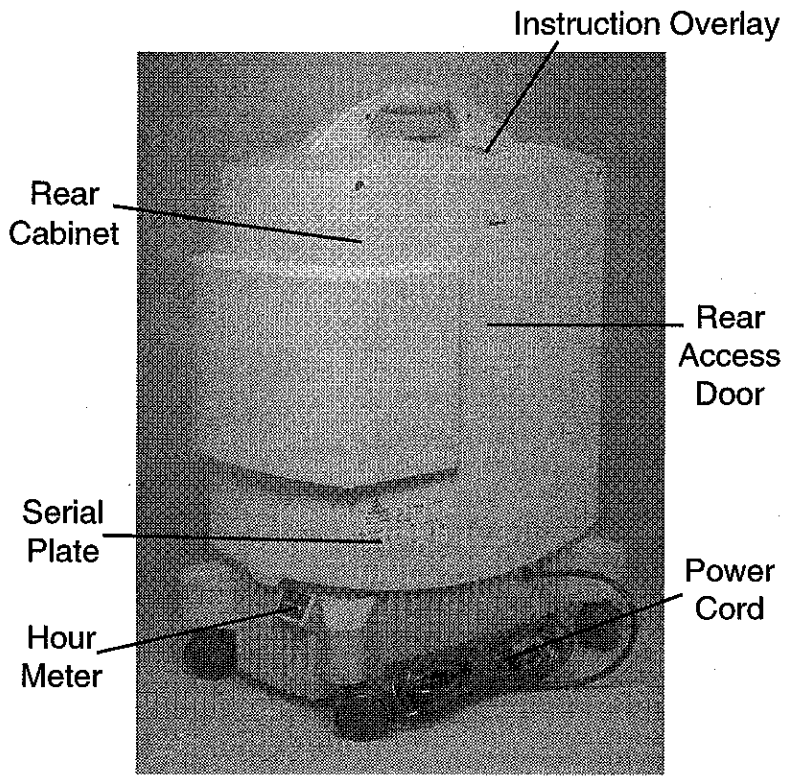


Figure 3-2
Rear Cabinet

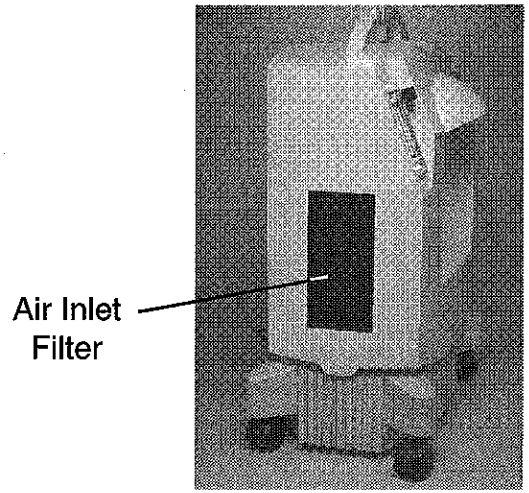


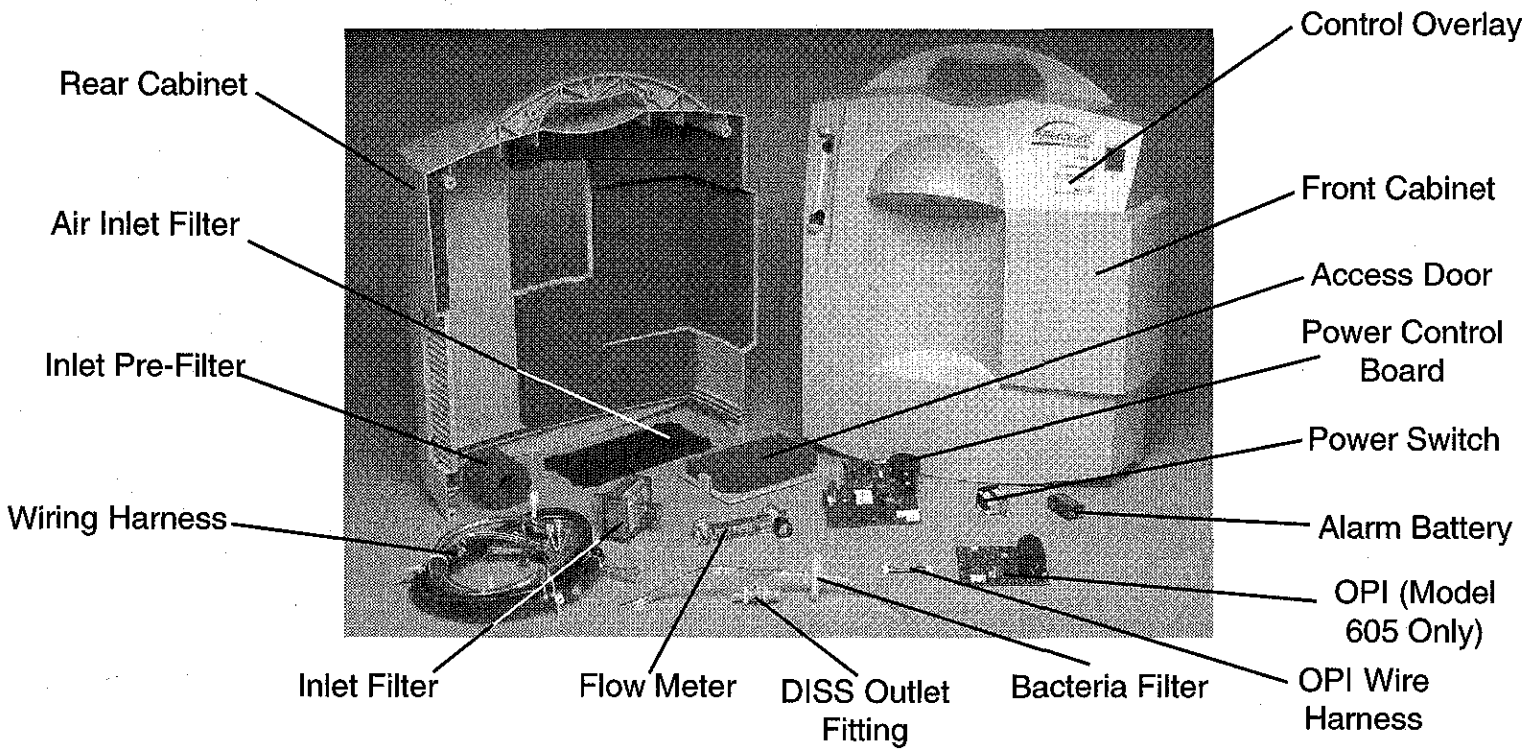
Figure 3-3
Side View

Item Name	Function
Pre-Inlet Filter	Filters the air that enters the concentrator.
Power Cord	Used to connect unit to AC power receptacle.
Rear Access Door	Allows access to the inlet pre-filter and inlet filters and battery.
Instruction Overlay	A quick reference list of operating instructions (located on top of the rear cabinet).
Hour Meter	Indicates cumulative hours of unit operations (Cannot be reset).
Serial Plate	Lists Model and Serial Numbers, Requirements, and Specifications.

Table 3-2
Millennium Rear Cabinet Sides and External Components

3.3.3 Internal Components

For more detailed information on the internal components of Millennium, please refer to Chapter 8, Repair & Replacement.



Internal Components (Continued)

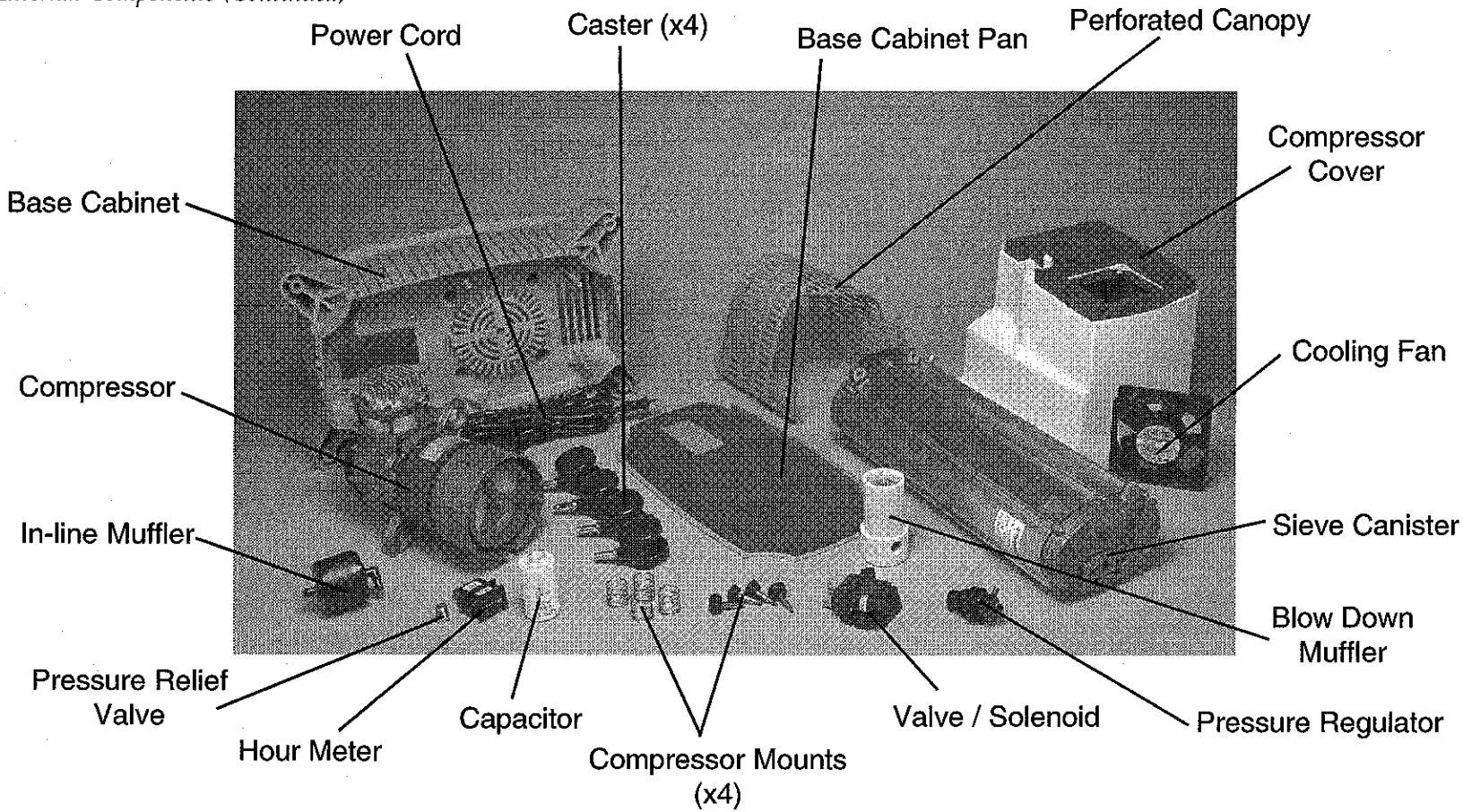


Figure 3-4
Internal Components

3.4 Theory of Operation

The Millennium Oxygen Concentrator System (Millennium) supports patients and health care providers in producing highly concentrated oxygen for therapeutic breathing purposes.

Air we breath is normally a mixture of 21% oxygen, 78% nitrogen, and 1% argon and other gases. Millennium uses a compressor and molecular sieve to remove nitrogen from the air. The concentrated oxygen exits the DISS Outlet fitting to the user.

3.4.1 Pneumatic Operation

Refer to Figure 3-5 while reading the following discussion.

The room air enters the unit through an inlet filter mounted on the side of the cabinet. The primary system air is drawn through a foam air inlet filter (1) mounted on the side of the cabinet. The primary system air is drawn through the inlet pre-filter (2) and then through the inlet filter (3) by the compressor (4). The exhaust air then passes through the in-line muffler (5) to the supply chamber.

The compressor exhaust air is cooled by the supply chamber (6) and distributed using an SMC pneumatic valve/solenoid assembly (7). At start up, valve (7) is de-energized allowing compressed air to flow into both sieve canisters (8) until the pressure sensor builds up to switching pressure. At switching pressure, a 12 volt signal is received at valve/solenoid (7a) closing the input and allowing compressed air to continue through sieve bed (8a) for 6.25 seconds absorbing the Nitrogen and allowing the Oxygen to flow through check valve (9a) and into the product tank (10). At 5 liters of flow (4 liters international) approximately 1/3 of the Oxygen is deposited into the product tank and 2/3 is passed through orifice (11) in to sieve bed (8b) to purge the Nitrogen from the sieve bed, which exits through the exhaust port of the valve/solenoid (7b) to exhaust chamber (13) through blow down muffler (14) to outside air in a time of 6.25 seconds.

At the end of this cycle the unit will balance for 1 second which de-energizes valve / solenoid (7b) and allows compressed air to flow into both sieve canisters. The pressure reaches the max switching pressure and sends a 12 volt signal to valve / solenoid (7b) and the adsorption cycle starts over in the sieve canister (8b). Oxygen is in a continuous flow from the product can (10) through the regulator (15) through the flow meter (16) to the bacteria filter (17) to the patient.

Pneumatic Operation (Continued)

Millennium Oxygen Concentrator System Flow Diagram

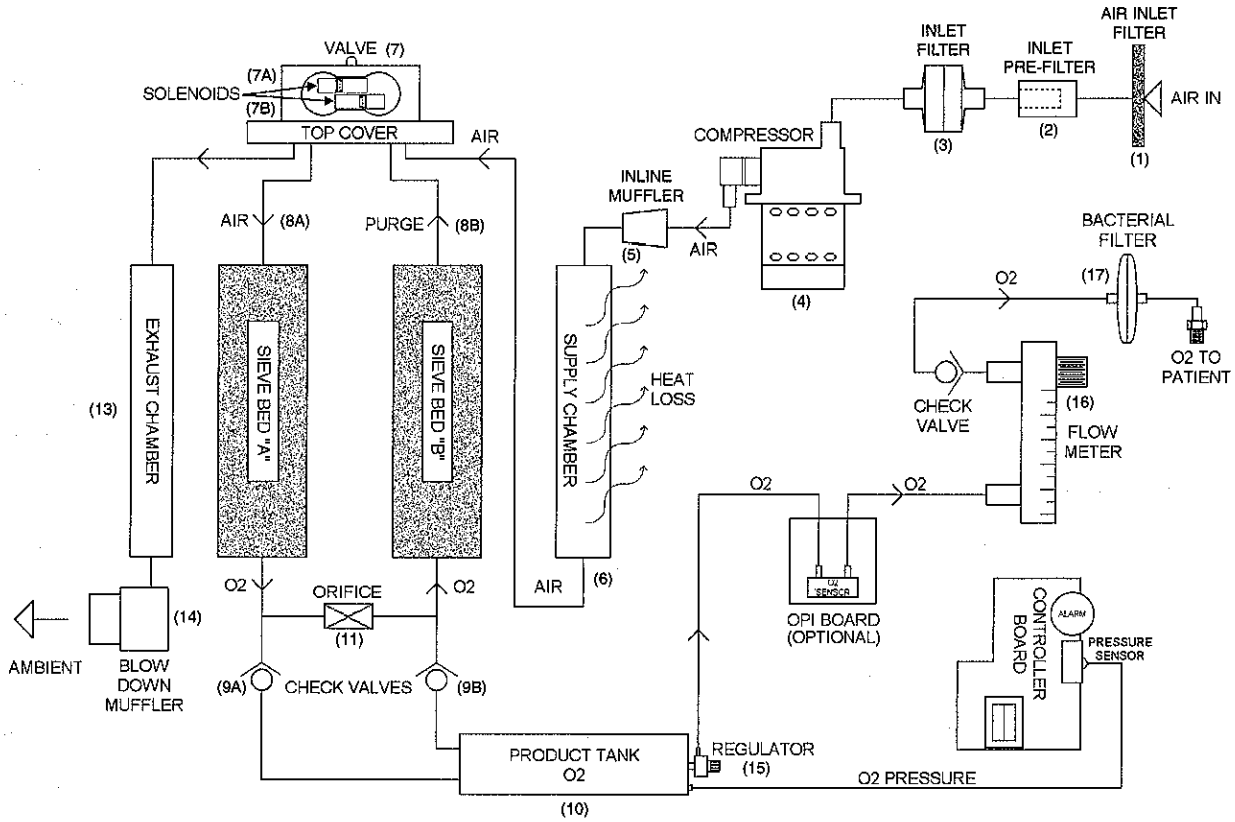


Figure 3-5
Pneumatic Block Diagram

3.4.2 Electrical Operation

Refer to Figure 3-6 while reading the following discussion.

Power is supplied from the two-prong plug to the power switch. When the power switch is ON, 120 VAC power is supplied to the compressor motor, hour meter, cooling fan, and the main circuit board.

The main circuit board consists of a linear power supply, pressure sensor, software driven microprocessor, green, yellow, and red LED's and audible alarm. The main circuit board provides the following functions:

- Transforms and rectifies the AC supply voltage to 12 VDC.\ for use by the board components, solenoids, and oxygen percentage indicator (OPI) board.
- Monitors the units pressure using a pressure transducer.
- Microprocessor controls the valve and solenoid pressure swing adsorption cycle, visual LED's, and audible alarm.

The oxygen percentage indicator board provides the following functions:

- Ultrasonically senses the percentage of concentrated oxygen produced by the unit.
- Outputs an analog voltage to the Main Control Board used to operate the green, yellow, and red LED's associated with the oxygen monitoring system.

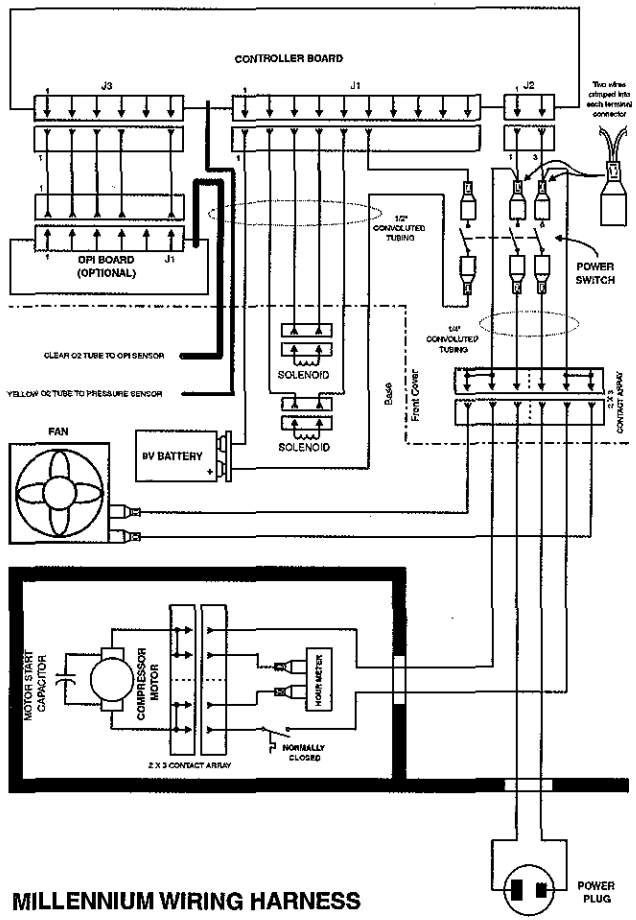


Figure 3-6
Electronic Component Block Diagram

Electrical Operation (Continued)

The 9-volt battery provides a power source to operate the audible alarm and the red LED alarm light in the event of an AC power failure.

3.5 Control Panel Description Operation

3.5.1 Alarms / Conditions

Conditions	Cause
• AC Power	On Solid Green LED.
• Normal Oxygen Condition	OPI units only (Model 605). Solid Green LED with no alarm sound.
• Low Oxygen Alert Condition	Solid Yellow LED with intermittent (every 2 seconds) audible alarm with Red LED.
• Alarm Condition	Solid Red LED and continuous audible alarm.
• Start-up Test	Light all LED's and sound audible alarm for 2 seconds after power on.
• Warm-up Condition	OPI units only (Model 605). Blinking Yellow LED with no alarm sound.

Table 3-3
Alarm System Operation

Millennium Concentrator Control Panel

DISPLAY	CAUSE	
power	AC PowerOn	
normal oxygen	MODEL 605 ONLY	% O_2 > 85%
⚠ low oxygen *read mannual*	No O_2 Flow	70% < % O_2 < 85%
alarm *service required*	Power Loss Low Pressure High Pressure Control Failure	%O_2 < 70%

Chapter 4: System Setup Procedures

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Chapter 4: System Setup Procedures

4.1 Overview

These system setup procedures should be performed on the Millennium Oxygen Concentrator System (Millennium) at the following times to confirm that the unit is operating properly:

- before placing the unit with a patient; and
- periodically while the unit is in use.

4.2 System Setup

Step 1 When removing unit from shipping carton, check unit for damage caused during shipping. If damage is found, follow directions on shipping carton.

NOTE: If a unit is new, check for shipping damage. If damage is found, follow directions on the shipping carton.

Step 2 Verify that the cabinet is clean and correctly positioned.

Step 3 Remove the rear access door and check to see that the inlet pre-filter and the inlet filter are clean and in place. Also, check the air inlet filter.

Step 4 Before connecting the unit to a power source, perform the following procedure to check battery condition and alarm function.

a. Move the power switch to the ON (I) position. The alarm should sound and the red light emitting diode (LED) should illuminate.

b. Move the power switch to the OFF (0) position. The alarm and the red LED light should go off.

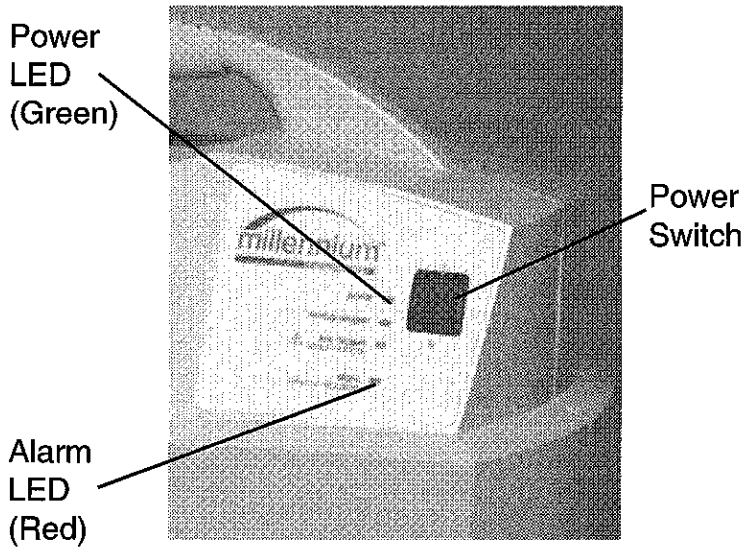

Figure 4-1
Millennium Control Panel

Step 5 Connect the power cord to a power source.

Step 6 Make a note of the hour meter reading.

System Setup (Continued)

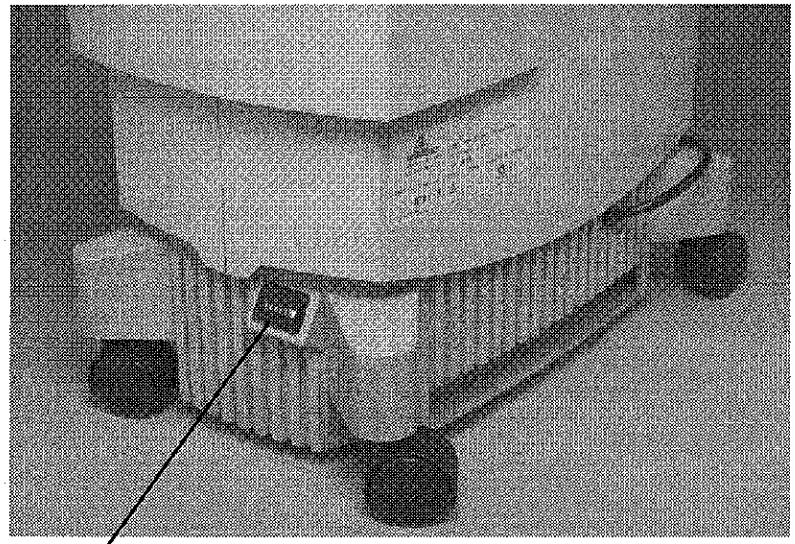

Figure 4-2
Location of the Hour Meter

Step 7 Turn on the unit by moving the power switch to the ON (I) position and verify the following:

- all LED's illuminate and audible alarm sounds for two seconds;
- the unit starts running; and
- the green power LED remains illuminated.

NOTE: If you have a Model 605 (which is equipped with the oxygen percentage indicator (OPI)). The yellow LED light will blink until the oxygen purity is above 85%. Then, the green normal oxygen LED illuminates.

Step 8 Adjust the flow meter to 5 lpm (international units to 4 lpm). Turning the flow meter knob clockwise decreases flow and counter-clockwise increases the flow.

Step 9 If the items above are working properly, continue with Step 9. If there is a problem, see Chapter 7-, Troubleshooting & Diagnostics.

Step 10 Attach a calibrated Oxygen Analyzer to the DISS outlet fitting. The oxygen concentration should be as specified in Section 3.2, Specifications.

System Setup (Continued)

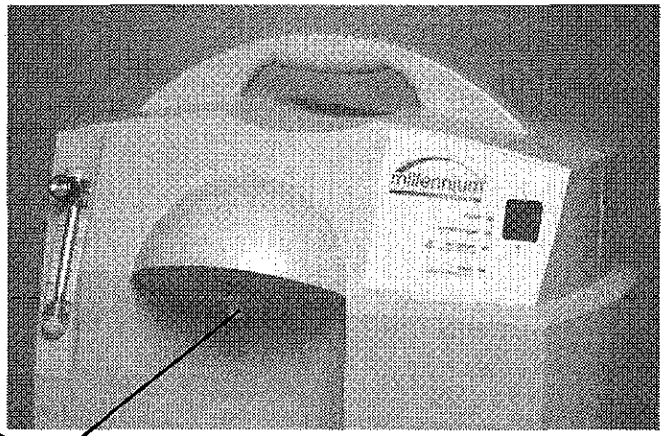

Figure 4-3
Location of the DISS Outlet Fitting

Step 11 This completes the system setup and performance verification.

Chapter 5: Verification Procedures

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Chapter 5: Verification Procedures

5.1 Overview

These verification procedures should be used to test the performance of the Millennium Oxygen Concentrator System (Millennium).

5.2 Battery Test and Replacement

Procedure:

Step 1 Test the condition of the 9-volt battery as follows.

a. With the unit disconnected from the power source, move the power switch to the ON (I) position and verify that the red LED alarm illuminates and the audible alarm sounds.

b. If the red LED does not illuminate or the audible alarm does not sound, install a new 9-volt battery. Be sure to move the power switch to the OFF (0) position, then proceed as follows.

1). Remove the rear access door.

2). Remove the inlet pre-filter and the inlet filter.

3). Locate the 9-volt battery and the battery holder clips. Remove the battery from its holder.

4). Remove the battery connector from the battery and check the no-load voltage with a digital multi-meter. If the voltage is less than 5 volts, install a new battery.

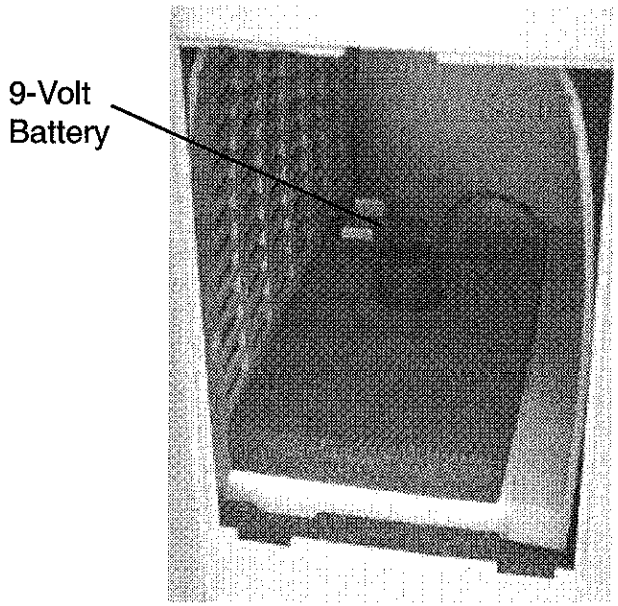

Figure 5-1
Location of the 9-volt Alarm Battery

5.3 System Pressure Test

Procedure:

The system pressure test is used to verify the internal operating pressures of the Millennium Oxygen Concentrator.

Step 1 Run the unit with the cabinets on for a minimum of one hour.

Step 2 Remove the front and rear cabinets from the unit (see Sections 8.4.4 and 8.4.5 for more detailed instructions).

Step 3 Disconnect the yellow pressure tubing from the fitting on the top of the sieve cannister assembly. Using the pressure gauge, "T" fitting, and short yellow tubing supplied with the Millennium tool kit, connect a pressure gauge to the long yellow pressure tubing and the sieve canister assembly.

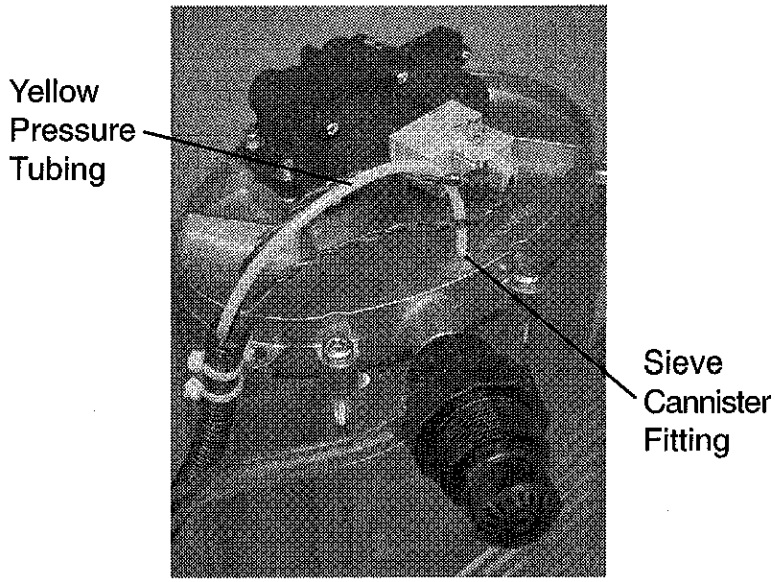

Figure 5-2
Connecting the Pressure Gauge

Step 4 Turn the unit on and set the flow to 5 lpm. Allow the unit to cycle for at least 2 minutes to stabilize.

Step 5 Hold the pressure gauge in a vertical position.

Step 6 Monitor the pressure gauge. Record the peak pressure for four cycles.

System Pressure Test (Continued)

Step 7 Confirm that the peak of each cycle is within the operating pressure of 27 ± 2 psig for normal operation. Confirm that all peaks are within 1 psig of each other.

NOTE: If the four cycles are not within specification, proceed to Section 7.3, System Pressure Test Table, for diagnostic information.

Step 8 Disconnect the pressure gauge, "T" fitting, and tubing. Reconnect the yellow tubing to the fitting on the top of the sieve canister.

Step 9 Install the front and rear cabinets (see Sections 8.4.4 and 8.4.5 for more detailed instructions).