NORTH
AMERICAN
DRÄGER

Technical Service Manual

Narkomed GS
Anesthesia System

LIST OF EFFECTIVE PAGES

Dates of issue for original and changed pages are:

Original	-	10 Feb 1997
Rev. A		15 Aug 1997
Rev. B		15 Oct 1997
Rev. C		5 Dec 1997

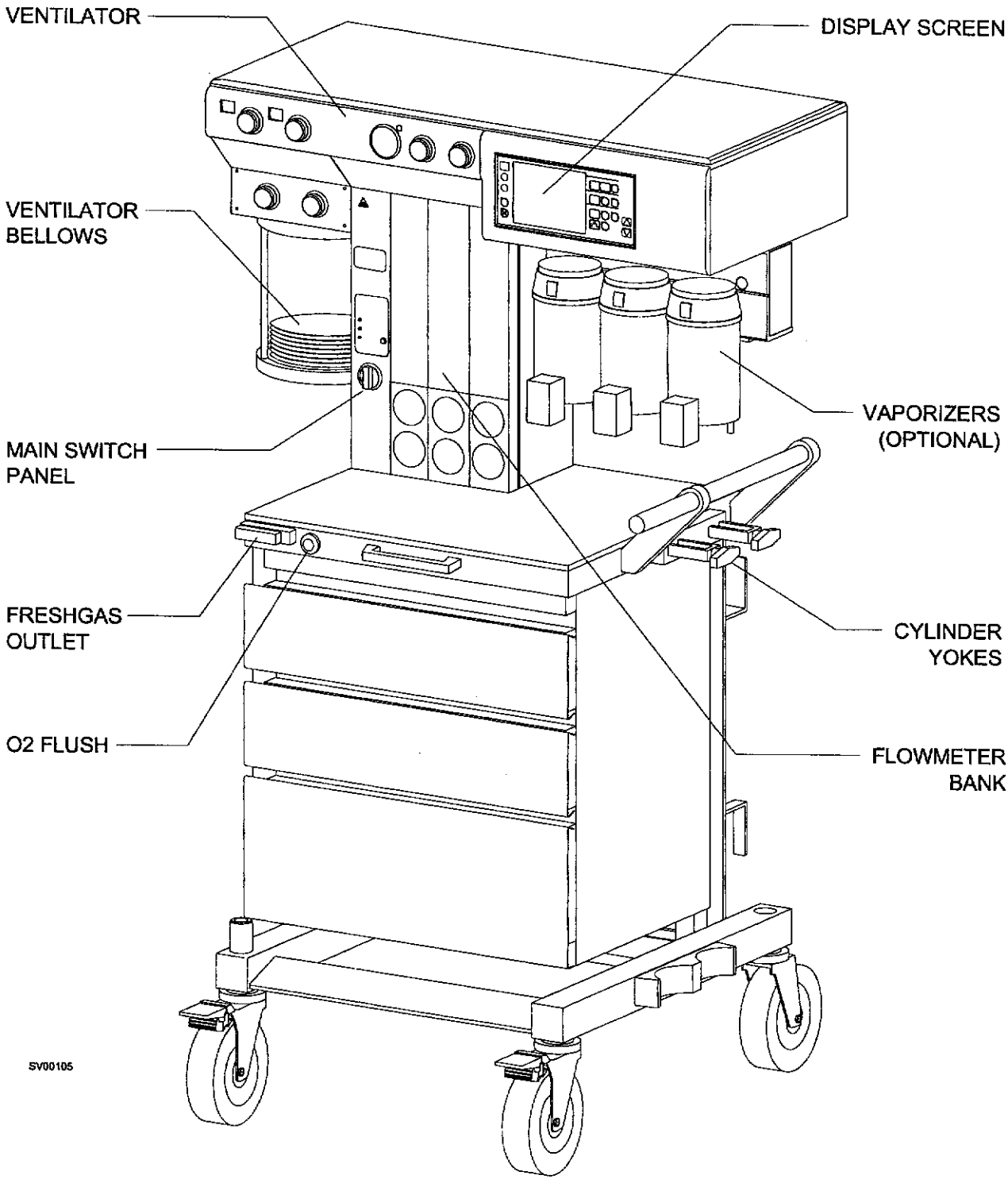
Total number of pages in this publication is 208 consisting of the following:

Page No.	Revision
Cover	C
A	C
i	-
ii	-
iii	-
1-0	-
1-1	-
1-2 added	A
2-1 thru 2-8	-
3-1 thru 3-12	-
4-1 thru 4-68	-
5-1	A
5-2 thru 5-13	-
5-14, 5-15	B
5-16, 5-17	-
6-1 thru 6-3	-
6-4, 6-5	A
6-6 thru 6-37	-
6-38	A
6-39 thru 6-47	-
7-1, 7-2	-
8-1	A
8-2	-
8-3	A
8-4	-
8-5	A
8-6	-
8-7	C
8-8 thru 8-10	-
8-11	A
8-12 thru 8-14	-
8-15	A
8-16 thru 8-18	-
8-19	A
8-20	-
8-21	A
8-22 thru 8-36	-
8-37	A
8-38, 8-39	-
8-40, 8-41	A
8-42	C
8-43	C
8-44, 8-45 added	A

DESCRIPTION **PAGE**

DESCRIPTION **PAGE**

DESCRIPTION **PAGE**


VENTILATOR
DISPLAY SCREEN
VENTILATOR BELLOWS
VAPORIZERS (OPTIONAL)
MAIN SWITCH PANEL
FRESHGAS OUTLET
CYLINDER YOKES
O2 FLUSH
FLOWMETER BANK
SV00105

1.0 Recommendations

Because of the sophisticated nature of North American Dräger anesthesia equipment and its critical importance in the operating room setting, it is highly recommended that only appropriately trained and experienced professionals be permitted to service and maintain this equipment. Please contact North American Dräger's Technical Service Department at (800) 543-5047 for service of this equipment.

North American Dräger also recommends that its anesthesia equipment be serviced at three-month intervals. Periodic Manufacturer's Service Agreements are available for equipment manufactured by North American Dräger. For further information concerning these agreements, please contact us at (800) 543-5047.

North American Dräger products/material in need of factory repair shall be sent to:

North American Dräger
Technical Service Department
3124 Commerce Drive
Telford, PA 18969
(Include RMA Number)

HOW TO USE THIS MANUAL

The manual is divided into several sections. The DIAGNOSTICS section describes self-test and service diagnostics for checking the system functions. An understanding of the on-board service capabilities is necessary before any attempt is made to troubleshoot the unit. The TROUBLESHOOTING section lists error codes and provides troubleshooting guides to assist the TSR in locating the source of a problem. The REPLACEMENT PROCEDURES section contains instructions for removal and replacement of the assemblies that are considered field-replaceable. The ADJUSTMENT AND CALIBRATION PROCEDURES section contains the field procedures needed to restore original system specifications. The Periodic Manufacturer's Service (PMS) PROCEDURE section outlines the steps required to verify the electrical, mechanical and pneumatic safety of the unit and also identifies components requiring periodic replacement.

GENERAL TROUBLESHOOTING GUIDELINES

Troubleshooting the Narkomed GS should always begin by communicating with those who observed or experienced a problem with the unit. This may eliminate unnecessary troubleshooting steps. Once a general problem is identified, refer to the troubleshooting flow charts in Section 3 to determine the proper corrective action to be taken.

After a component has been replaced, verify that the unit is operating properly by running the appropriate diagnostic procedure. The PMS PROCEDURE in Section 6 must also be performed after any component has been replaced.

The general arrangement of the Narkomed GS Anesthesia System is shown on the opposite page.

WARNINGS are used in this manual before procedures which if not performed correctly could result in personal injury.

CAUTIONS are used in this manual to alert service personnel to the possibility of damage to the equipment if a procedure is not performed correctly.

Copyright

Trademark Notices

Disclaimer

The content of this manual is furnished for informational use only and is subject to change without notice. N.A.D., Inc. assumes no responsibility or liability for any errors or inaccuracies that may appear in this manual.

2.0 DIAGNOSTICS

The Narkomed GS contains a diagnostic system that monitors certain system functions and records their operational status. Following a brief System Startup display at power up, the diagnostics screen shown in Figure 2-1 appears. This display includes one of three messages at the completion of the diagnostics:

FUNCTIONAL: This message indicates that the NARKOMED GS has passed all power-up tests and is fully functional. The machine will proceed to the MACHINE MONITOR screen after a short delay.

CONDITIONALLY FUNCTIONAL: This message indicates that a minor problem has been detected. The NARKOMED GS will retain this display until any key is pressed, then the MACHINE MONITOR screen will be displayed.

NON-FUNCTIONAL: This message indicates that a serious problem has been detected. The machine will not proceed into the MACHINE MONITOR or SYSTEM MONITOR screen.

The PREVENTIVE MAINTENANCE DUE message will appear on the screen if the current date exceeds the Periodic Manufacturer's Service due date stored in the machine.

Further diagnostic functions are available through service screens that can be called up at the display panel. The following paragraphs provide a description of each service screen that can be accessed at the display. If no display is present upon system power-up, refer to Section 3 of this manual for troubleshooting assistance.

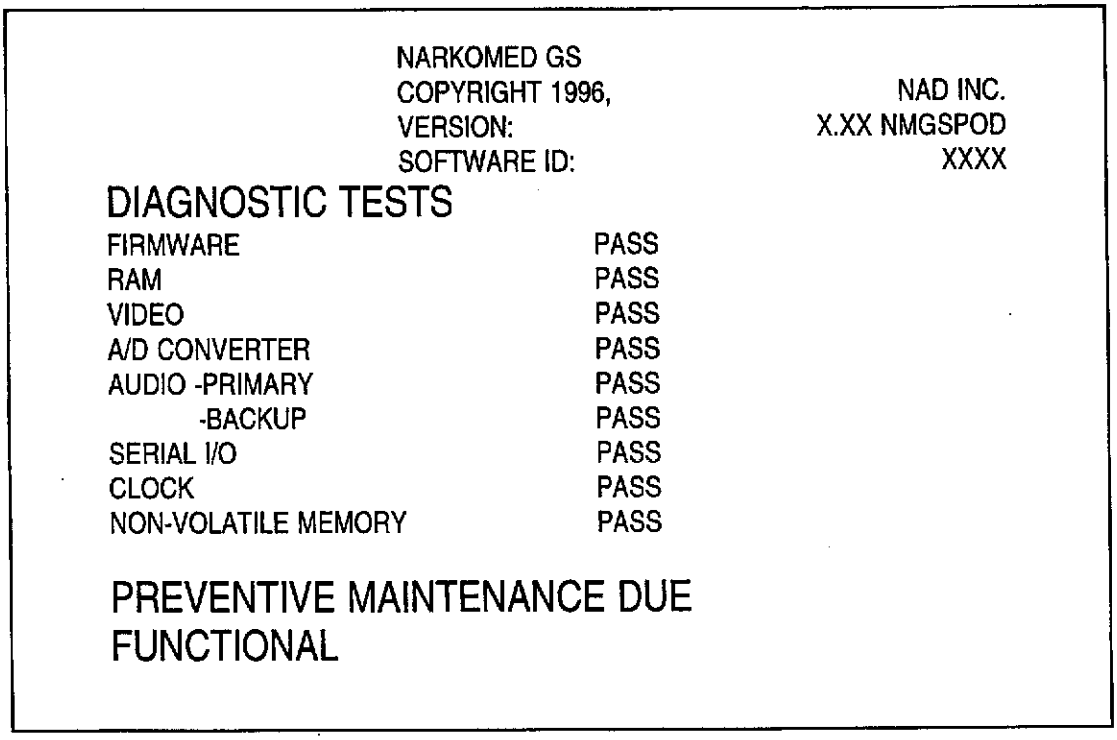


Figure 2-1: POWER-UP DIAGNOSTICS SCREEN

2.1 Main Service Screen

2.1.1 View Mode

The Main Service Screen displays the machine serial number, the last service date, hours run since last service and total hours run.

To access the Main Service Screen, press and hold the Oxygen High Limit and Volume Low Limit keys, and press the ▲ key. The View Mode service screen shown in Figure 2-2 will then appear.

Press the ▲ key to proceed to the Service Mode (described in the next paragraph), or press the key next to EXIT to return to the monitoring screen.

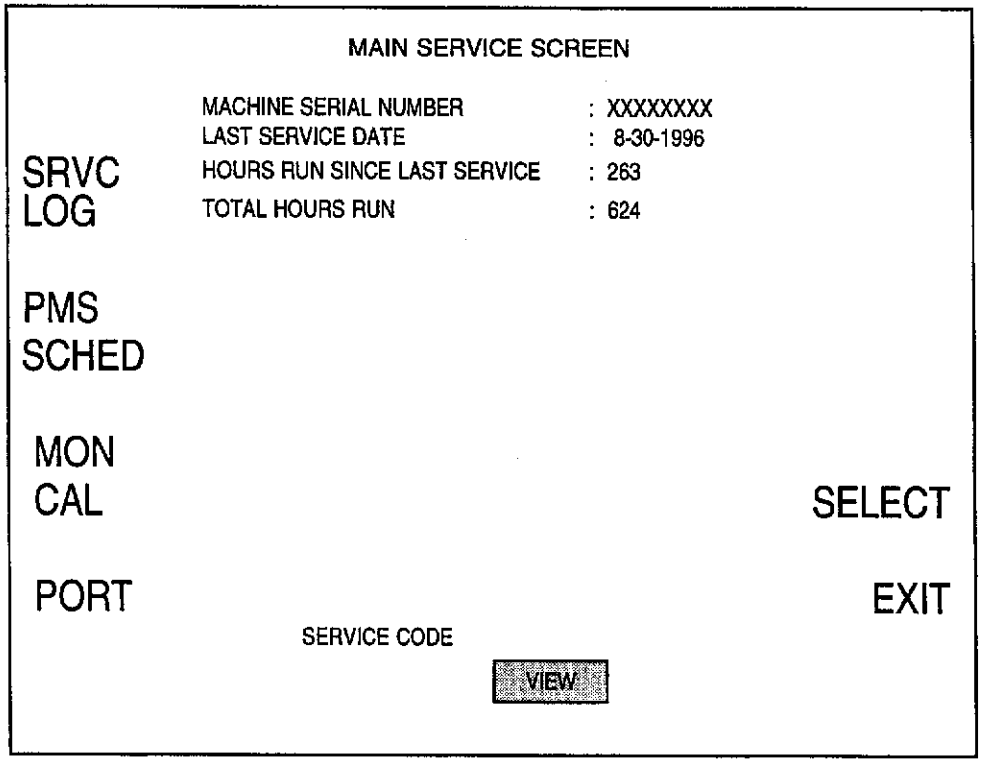


Figure 2-2: MAIN SERVICE SCREEN, VIEW MODE

2.1.2 Service Mode

The Service Mode screen appears as shown in Figure 2-3. Press the key next to SELECT. Enter the first digit of your service code by using the ▼ and ▲ keys to display the desired number. Press the key next to SELECT to advance to the next digit, and enter the next and remaining I.D. characters in the same manner.

When this screen is entered, an entry is made in the Service Log.

To access any of the other service screens described on the following pages, press the key next to the desired function on the left side of the screen: Service Log, PMS Schedule, Monitor Calibration, or Port communication settings.

Pressing the key next to RESET will reset the HOURS RUN SINCE SRVCD to zero.

If desired, press the key next to EXIT to return to the monitoring screen.

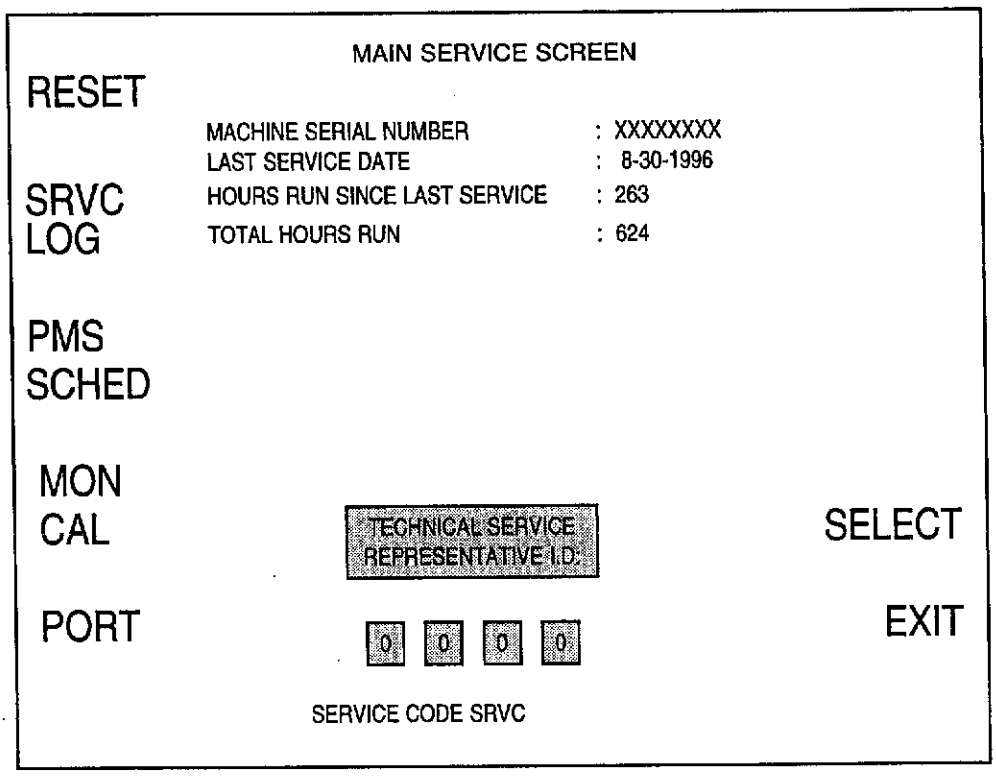


Figure 2-3: MAIN SERVICE SCREEN, SERVICE MODE

2.2 Service Log

From the Service Screen (described earlier), press the key next to SRVC LOG.

Figure 2-4 shows an example of the screen that will appear. This screen allows you to view the events recorded in the machine's service log. Use the [▼] and [▲] keys to scroll down or up through the log entries.

Press the key next to EXIT to return to the Main Service Screen.

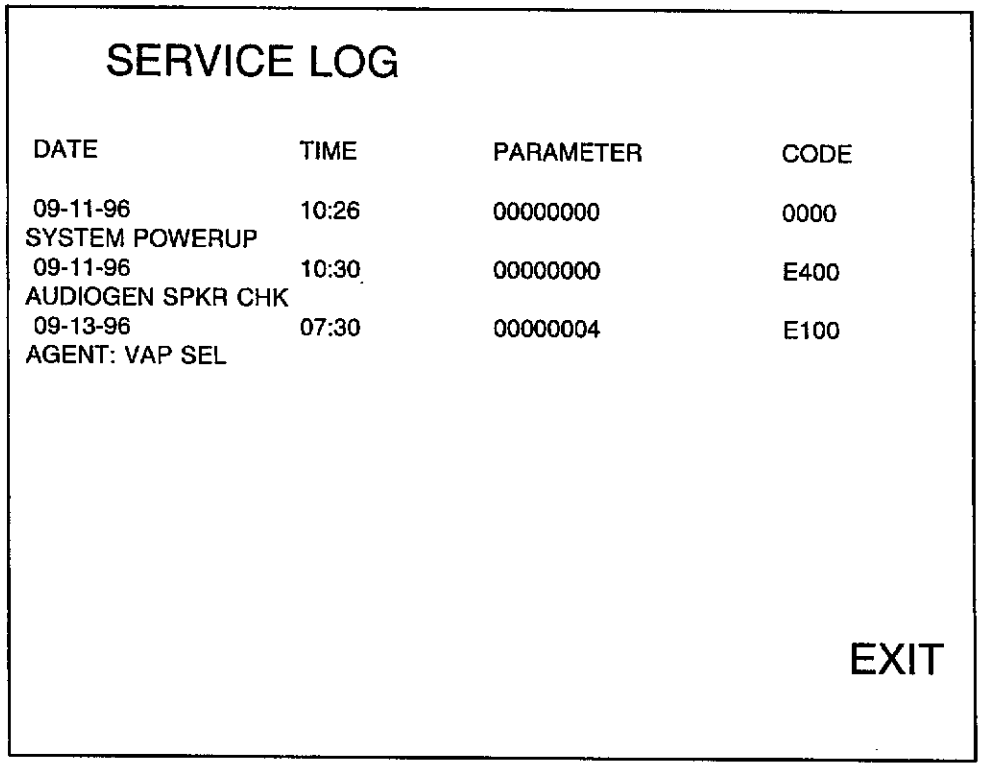


Figure 2-4: SERVICE LOG

2.3 PMS Criteria Screen

The PMS Criteria Screen allows you to select the month when the PREVENTIVE MAINTENANCE DUE message appears on the power-up diagnostics screen.

From the Service Screen (described earlier), press the hidden key next to PMS SCHED.

Figure 2-5 shows an example of the screen that will appear. Use the ▼ and ▲ keys to set the desired month.

Press the key next to EXIT to return to the Main Service Screen.

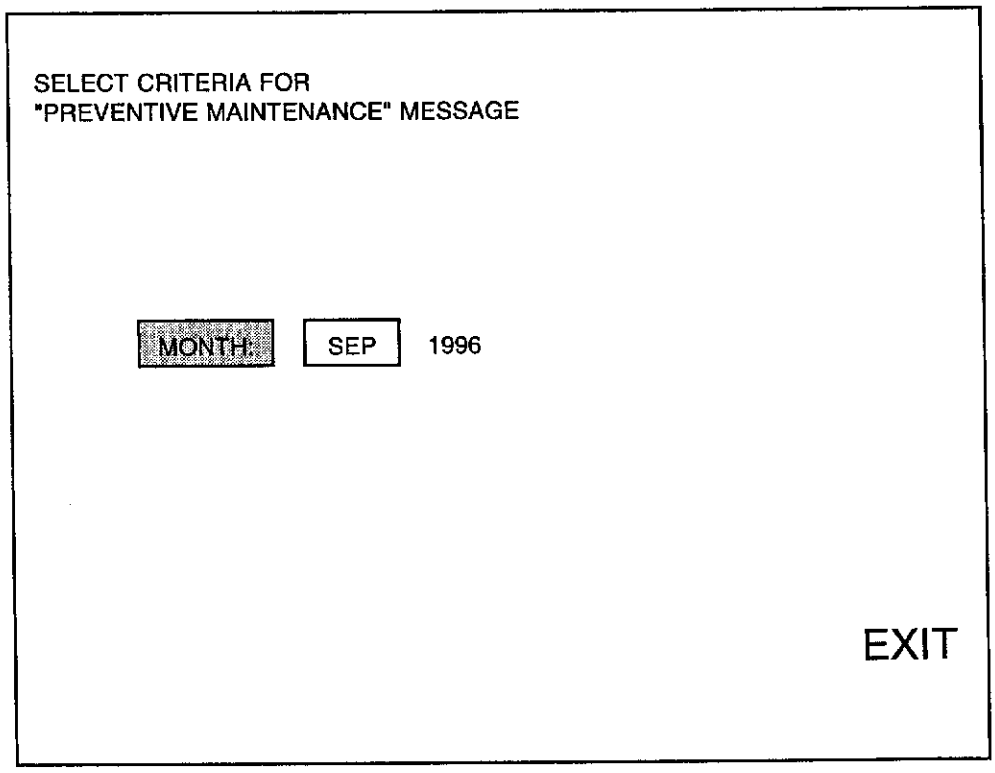


Figure 2-5: PMS CRITERIA SCREEN

2.4 Oxygen Monitor Service Screen

The Oxygen Monitor Service Screen shown in Figure 2-6 displays current readings for the O_2 cells, a zero calibration procedure, and the stored calibration values.

From the Service Screen (described earlier), press the key next to MON CAL.

To perform a zero calibration, follow the calibration procedure shown on the screen. Pressing the key next to ZERO stores the current values as the new zero calibration.

To proceed to the Pressure Monitor Service Screen, press the key next to PRES MON. To return to the Main Service Screen, press the key next to EXIT.

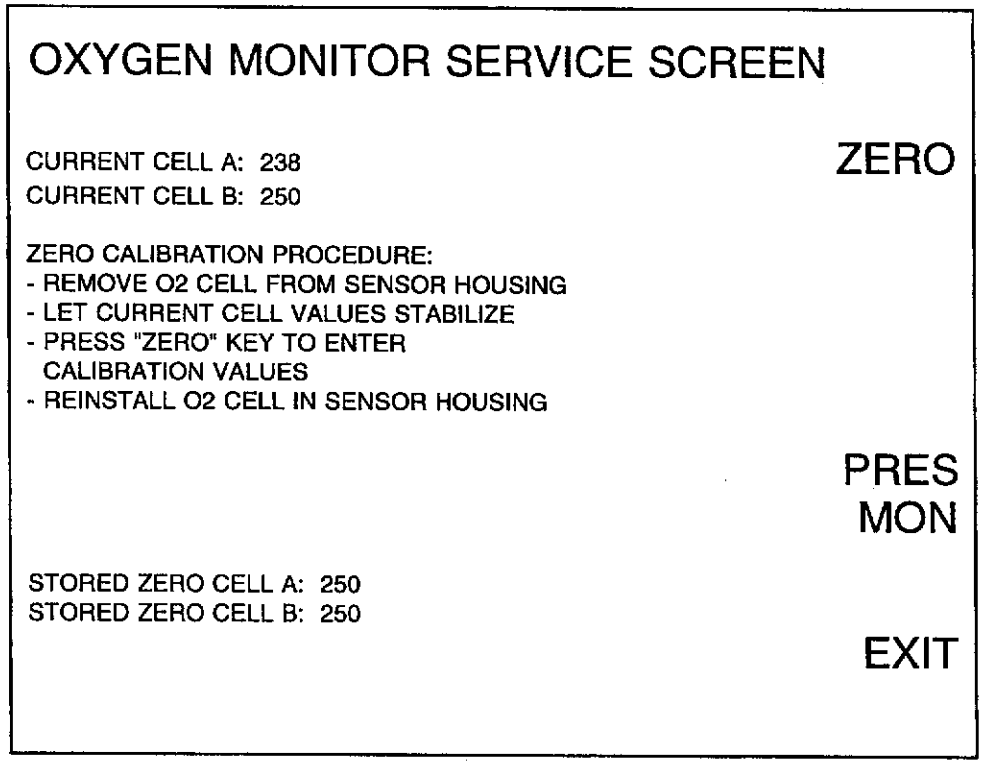


Figure 2-6: OXYGEN MONITOR SERVICE SCREEN

2.5 Pressure Monitor Service Screen

The Pressure Monitor Service Screen shown in Figure 2-7 displays the current reading for airway pressure, a procedure for zero and span calibration, and the stored calibration values.

To enter the Pressure Monitor Service Screen from the Oxygen Monitor Service Screen (described earlier), press the key next to PRES MON (ref. Figure 2-6).

To perform a zero calibration, follow the procedure shown on the screen. Pressing the key next to ZERO stores the current value as the new zero calibration.

To perform a span calibration, follow the procedure shown on the screen. Pressing the key next to SPAN stores the current value as the new span calibration.

To return to the Oxygen Monitor Service Screen, press the key next to OXY MON. To return to the Main Service Screen, press the key next to EXIT.

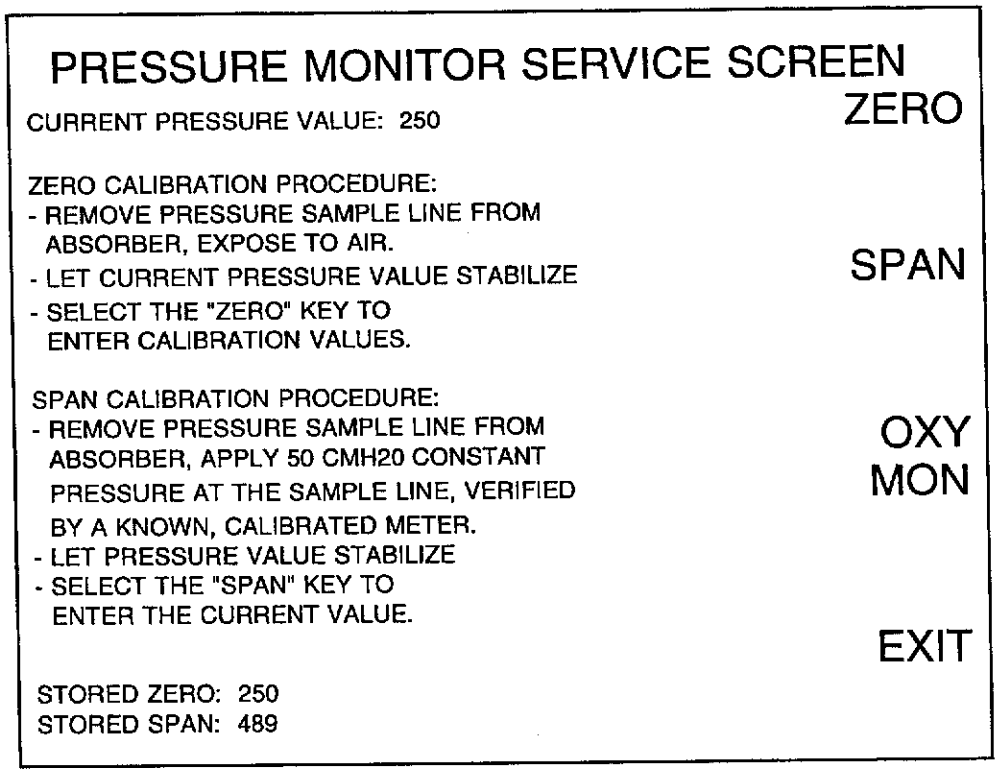


Figure 2-7: PRESSURE MONITOR SERVICE SCREEN

2.6 Serial Port Configuration Screen

The Serial Port Configuration screen shown in Figure 2-8 allows you to set the machine parameters for communicating with external devices.

From the Service Screen (described earlier), press the key next to PORT.

Use the [▼] and [▲] keys to change the settings; press the key next to SELECT to move to the next setting.

Press the key next to EXIT to return to the Main Service Screen.

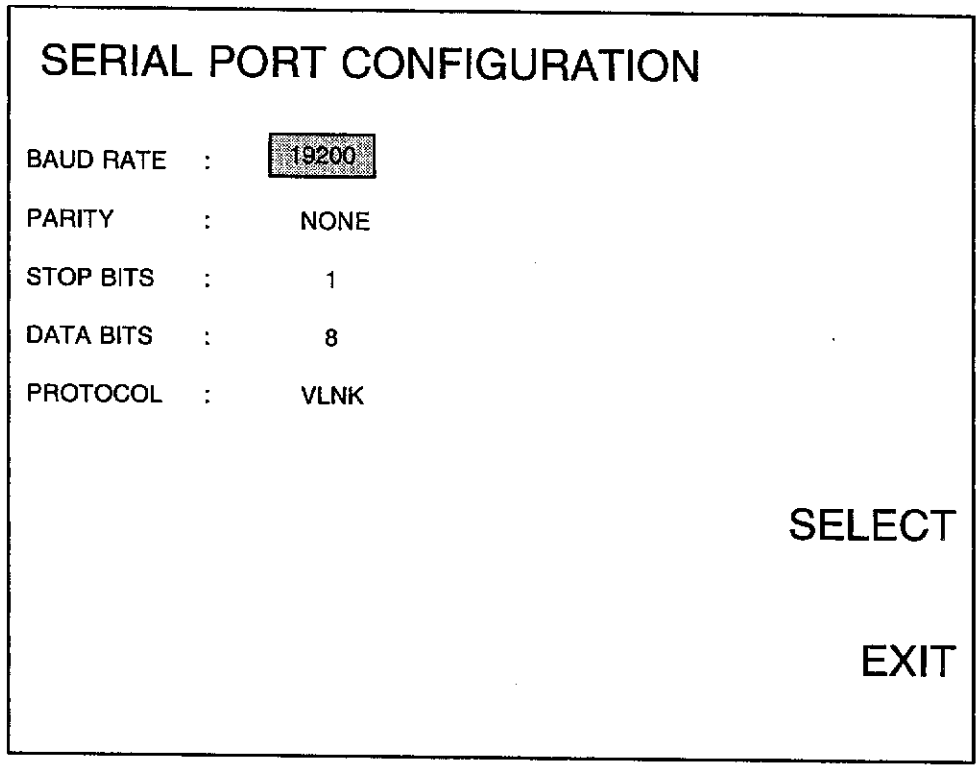


Figure 2-8: SERIAL PORT CONFIGURATION SCREEN

3.0 TROUBLESHOOTING

This section contains information to assist the North American Dräger qualified Technical Service Representative (TSR) in locating electrical faults affecting the NARKOMED GS monitoring and display devices. Since most troubleshooting efforts begin with verifying power supply voltages, the following paragraph outlines the voltage distribution scheme within the machine along with test points for each of the voltages.

3.1 Power Supply and Voltage Distribution

In the NARKOMED GS, +5VDC, +12VDC and -12VDC are supplied to J14 on the processor board; +8VDC is supplied to J4 on the alarm channel and is also distributed to the ventilator controller via J3 on the alarm channel. These voltages can be measured at the connectors shown in Figure 3-1. Output voltage of the primary power supply is measured at J3 on the Condor supply. Table 3-1 lists the acceptable range for each voltage under normal load conditions. Figure 3-2 shows a block diagram of the NARKOMED GS, including the primary and secondary voltage distribution scheme.

TABLE 3-1: TEST POINTS AND ALLOWABLE RANGES

PROCESSOR	VOLTAGE	ACCEPTABLE RANGE
J14-10 (Blk)	+ 5 VDC	4.80 to 5.25 VDC
J14-4 (Blu)	+ 12 VDC	11.65 to 12.85 VDC
J14-13 (Red)	- 12 VDC	-11.50 to -13.00 VDC
J14-15 (Brn)	Common	
Lamp J14-1 (Brn)	+12 VDC	
Lamp J14-3 (Orn)	Common	
ALARM CHANNEL	VOLTAGE	ACCEPTABLE RANGE
J3-9 (Wht)	+ 8 VDC	7.70 to 8.30 VDC
J3-3 (Orn)	Common	
CONDOR PWR SUPP	VOLTAGE	ACCEPTABLE RANGE
J3-1 (Brn)	+ 15 VDC	14.0 to 16.0 VDC
J3-8 (Wht)	Common	

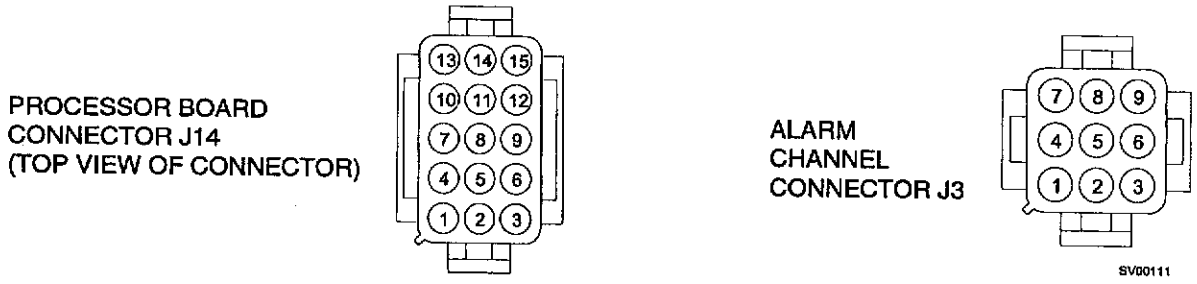


Figure 3-1: POWER SUPPLY VOLTAGE TEST POINTS

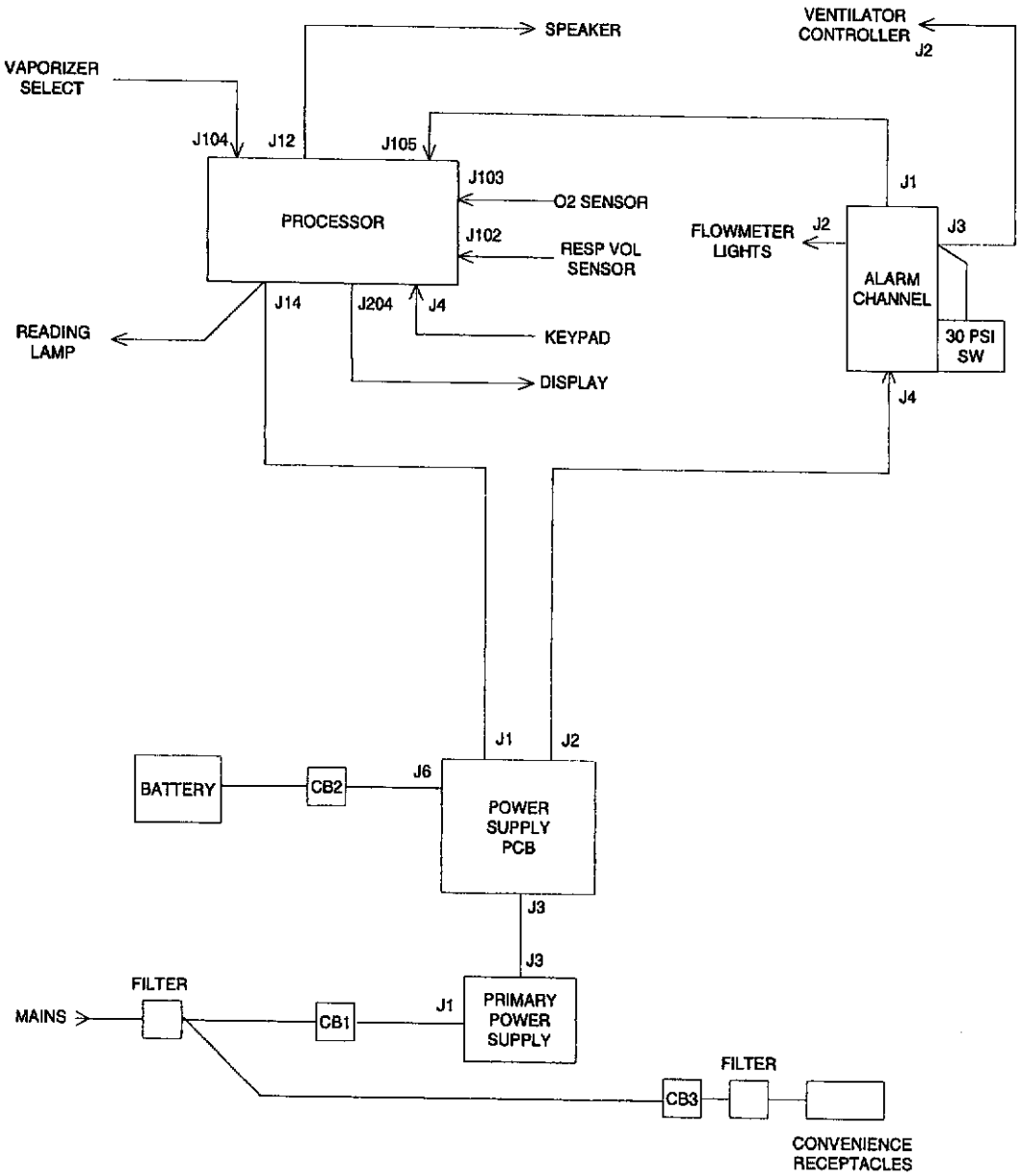


Figure 3-2: NARKOMED GS BLOCK DIAGRAM (ELECTRICAL)

NOTE: The Narkomed GS will not turn on, or operate, unless the power cable is connected to J14 on the processor board. Disconnecting this cable breaks a sense connection that automatically powers down +5V, +12V, -12V, and +8V.

3.2 Battery

While the machine is operating from an AC line, the battery voltage at full charge should be within the range of 13.50 to 14.80 VDC. Battery voltage can be measured at the battery terminals. During battery operation, the low battery cutoff voltage should be within the range of 10.5 to 10.0 VDC.

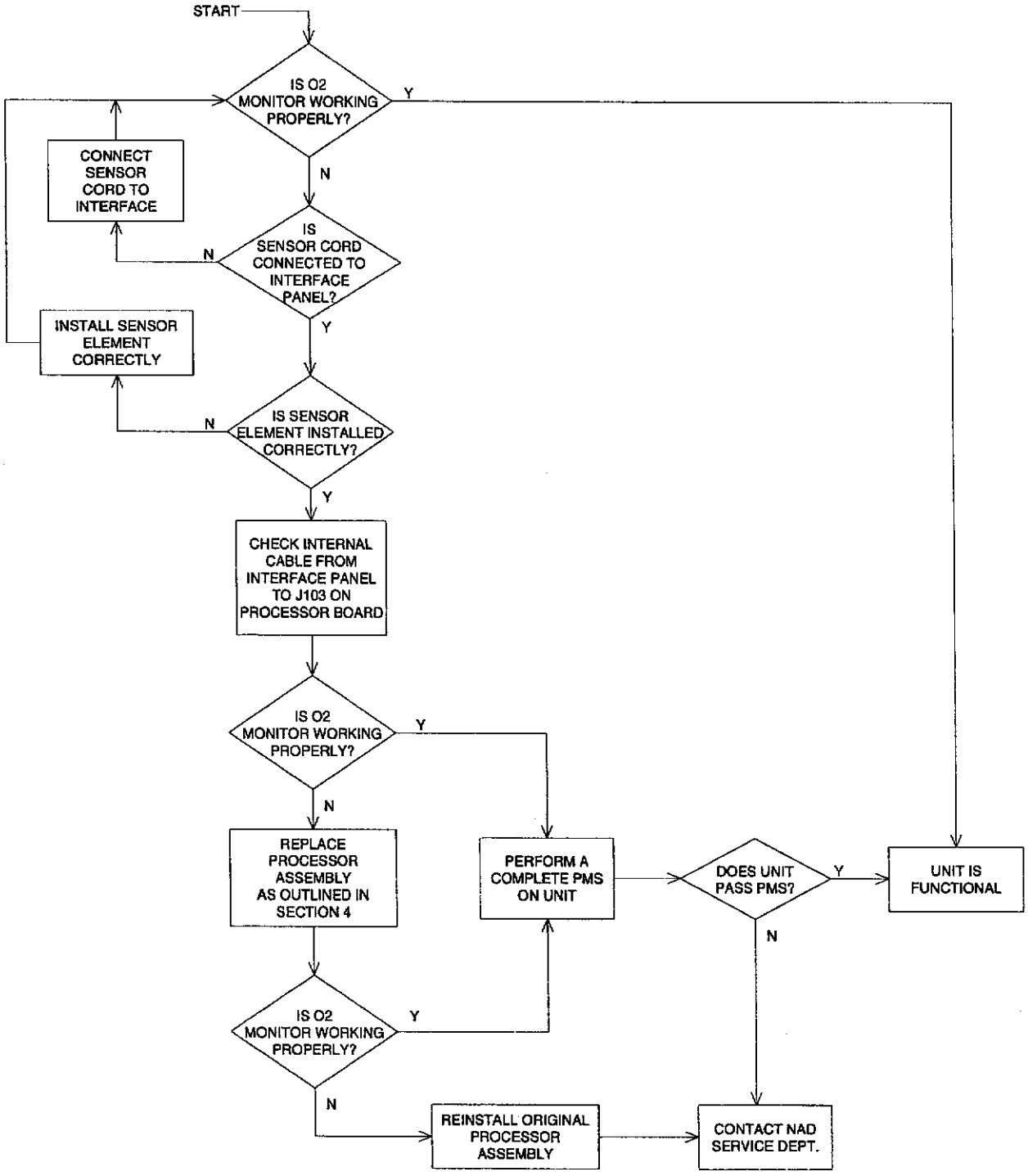
3.3 Troubleshooting Guides

Table 3-2 lists common failure modes and symptoms (excluding simultaneous multiple faults) for the monitoring and display devices in the NARKOMED GS. Each failure mode or symptom is keyed to a troubleshooting guide flow chart at the back of this section to assist the TSR in locating a problem. These flow charts assume that the machine is plugged into an AC outlet with the correct voltage, and the machine is not running on its backup battery.

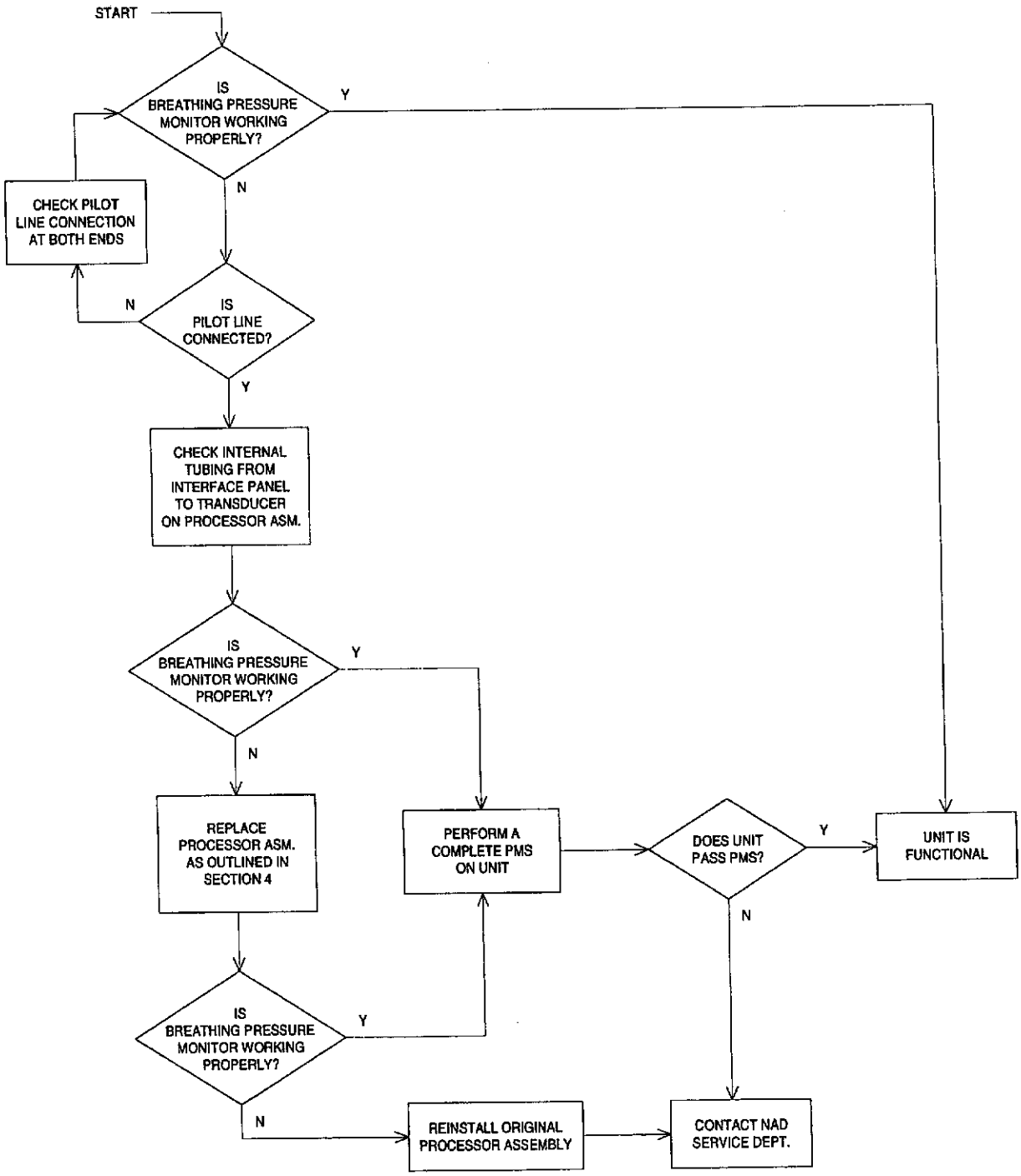
TABLE 3-2: NARKOMED GS FAILURE MODE AND SYMPTOM LIST

FAILURE MODE / SYMPTOM	CORRECTIVE ACTION
Loss of O_2 Monitor	Guide 1
Loss of Breathing Pressure Monitor	Guide 2
Loss of Respiratory Volume Monitor	Guide 3
No Audio Alarms	Guide 4
Serial Port Communication Failure	Guide 5
No Oxygen Supply Pressure Alarms	Guide 6
Display Blank Upon System Power-up	Guide 7
Keypad Inoperative	Guide 8
Ventilator Inoperative	Guide 9

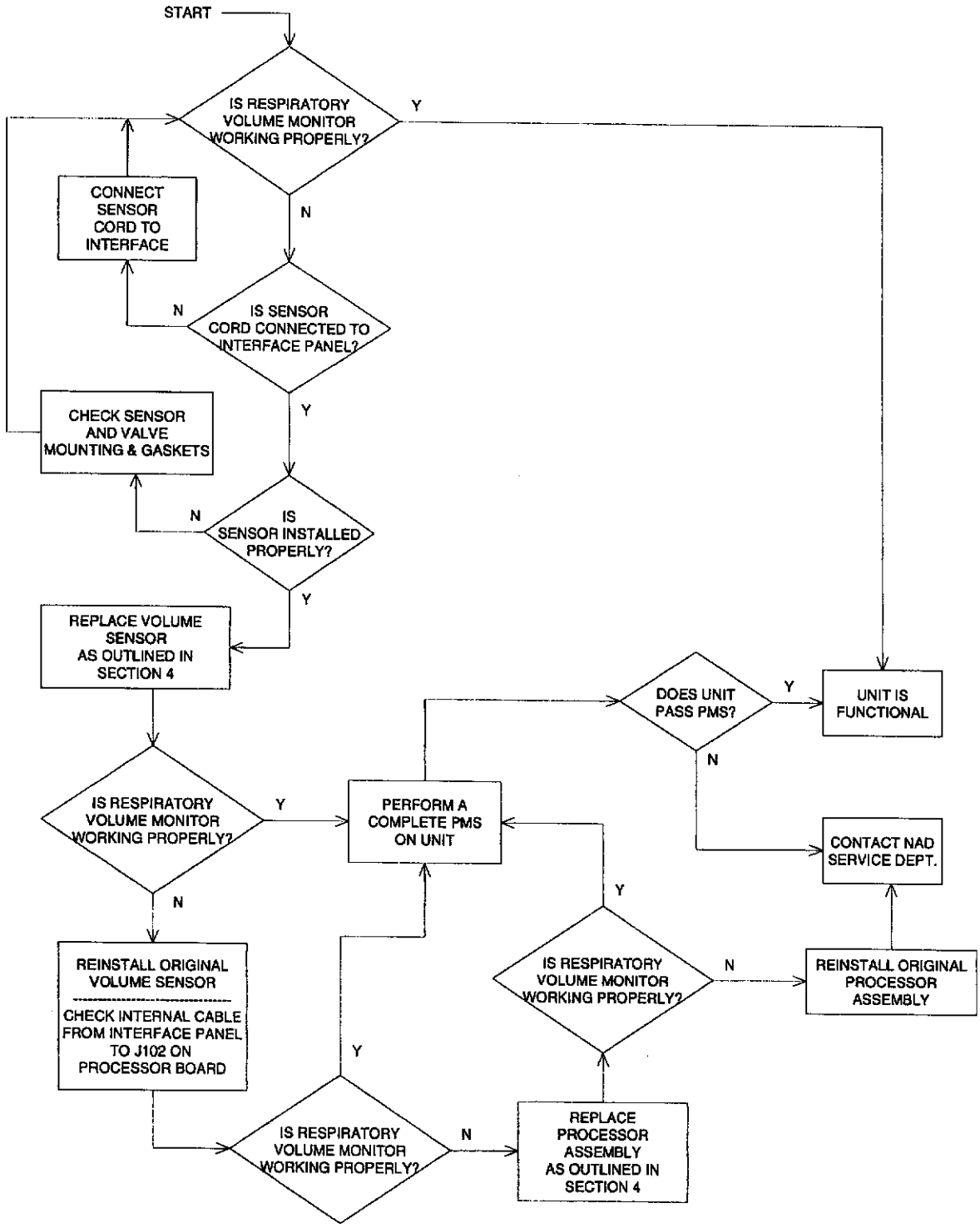
GUIDE 1: Loss of O_2 Monitor



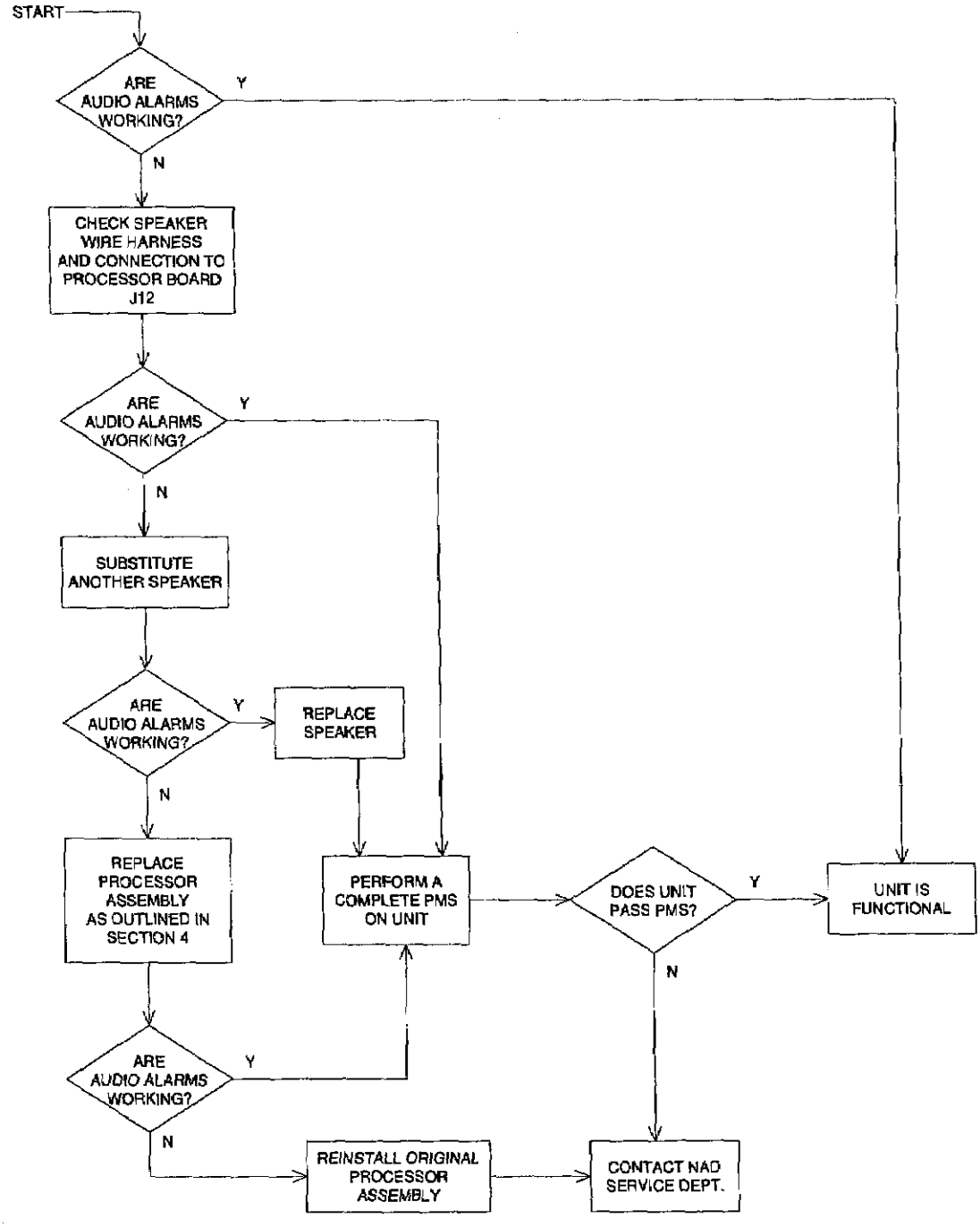
GUIDE 2: Loss of Breathing Pressure Monitor



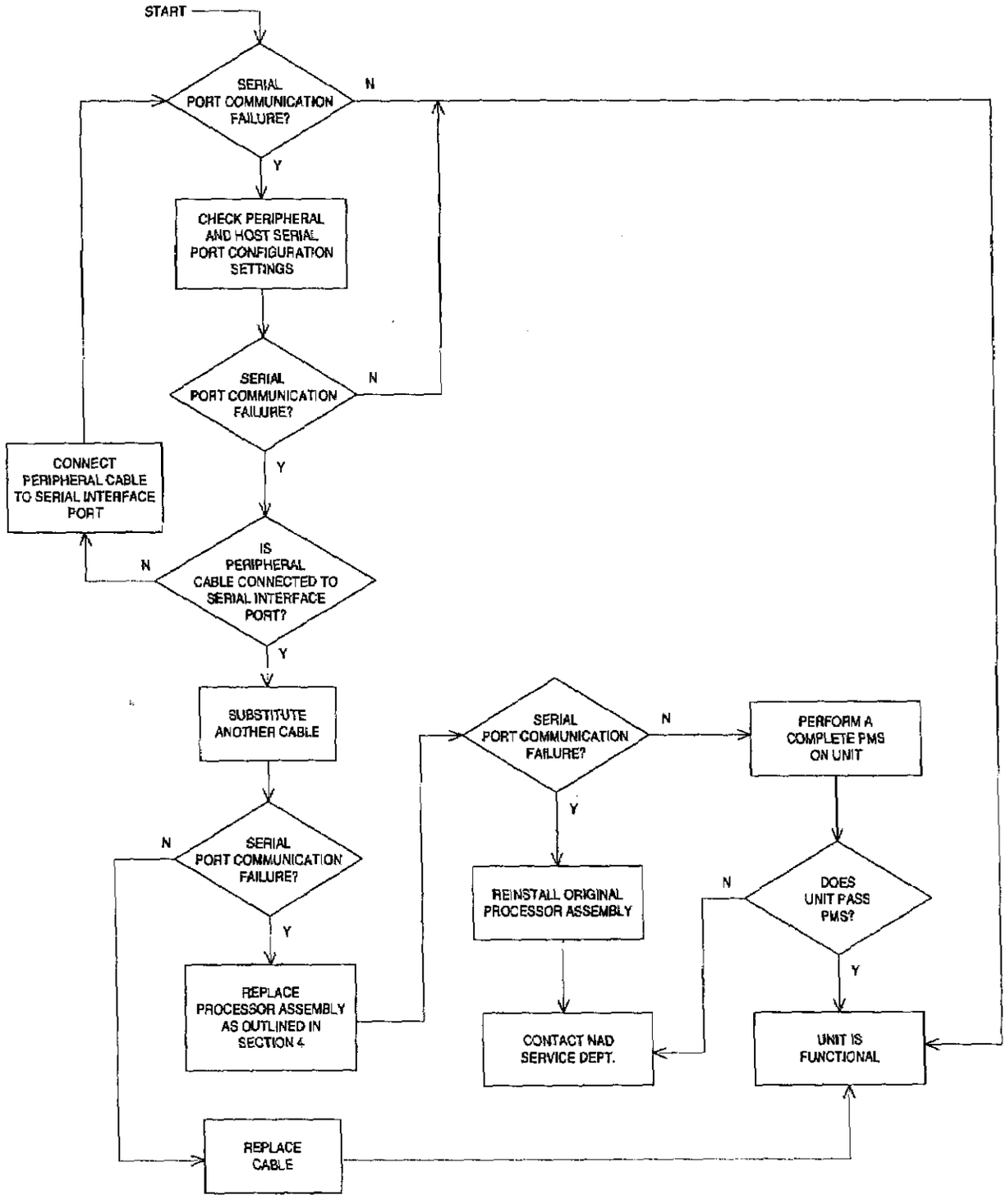
GUIDE 3: Loss of Respiratory Volume Monitor



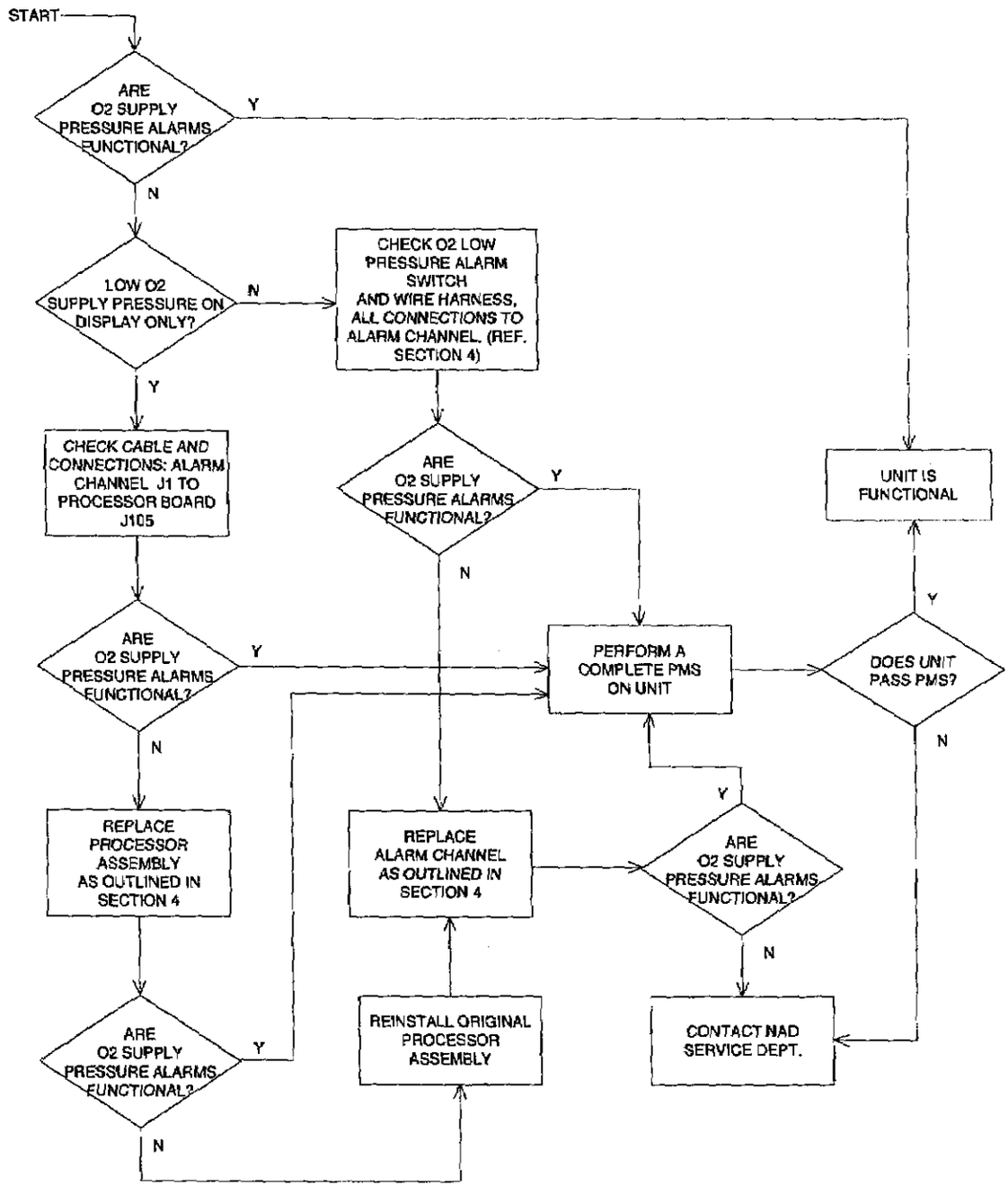
GUIDE 4: No Audio Alarms



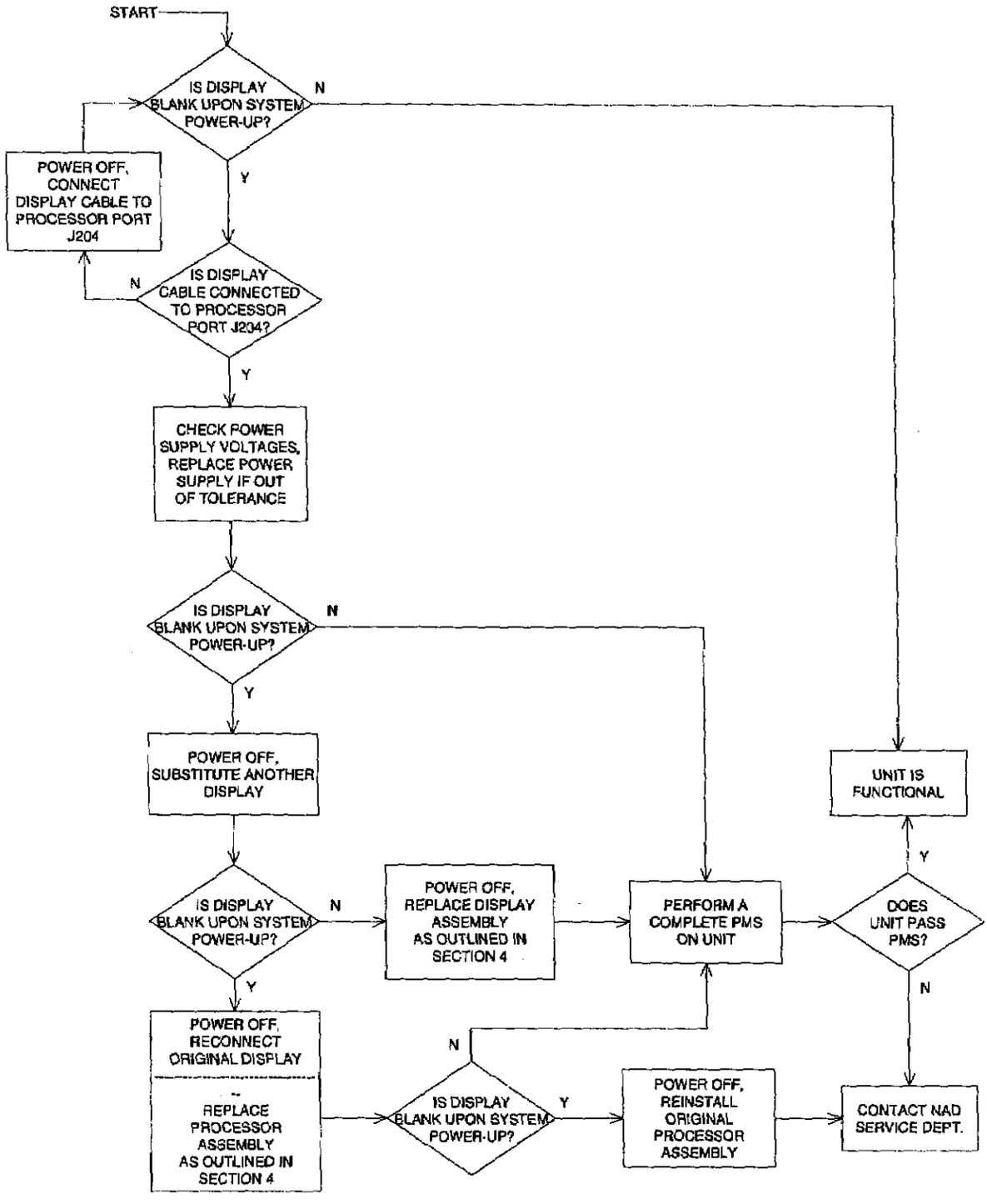
GUIDE 5: Serial Port Communication Failure



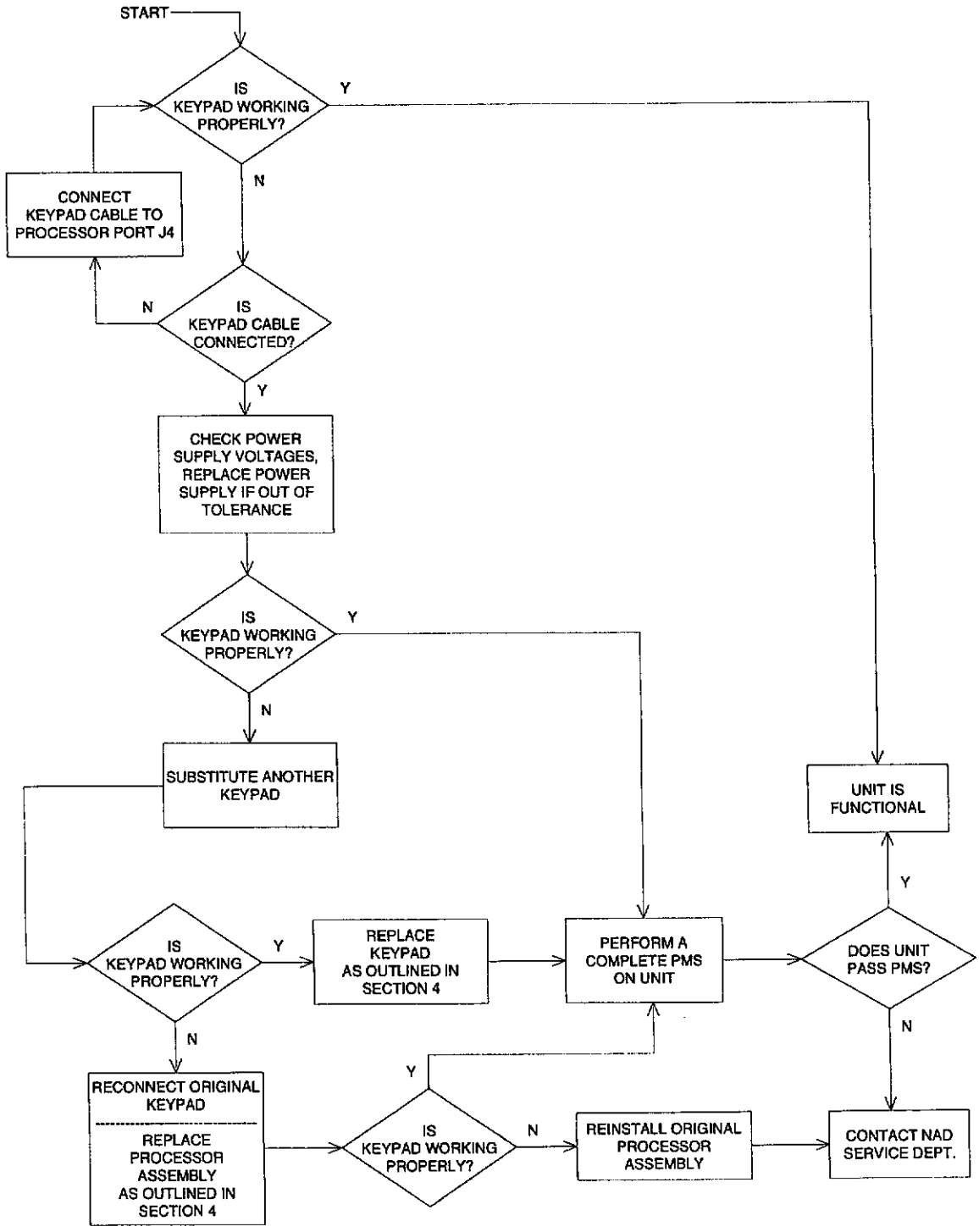
GUIDE 6: No O_2 Supply Pressure Alarms



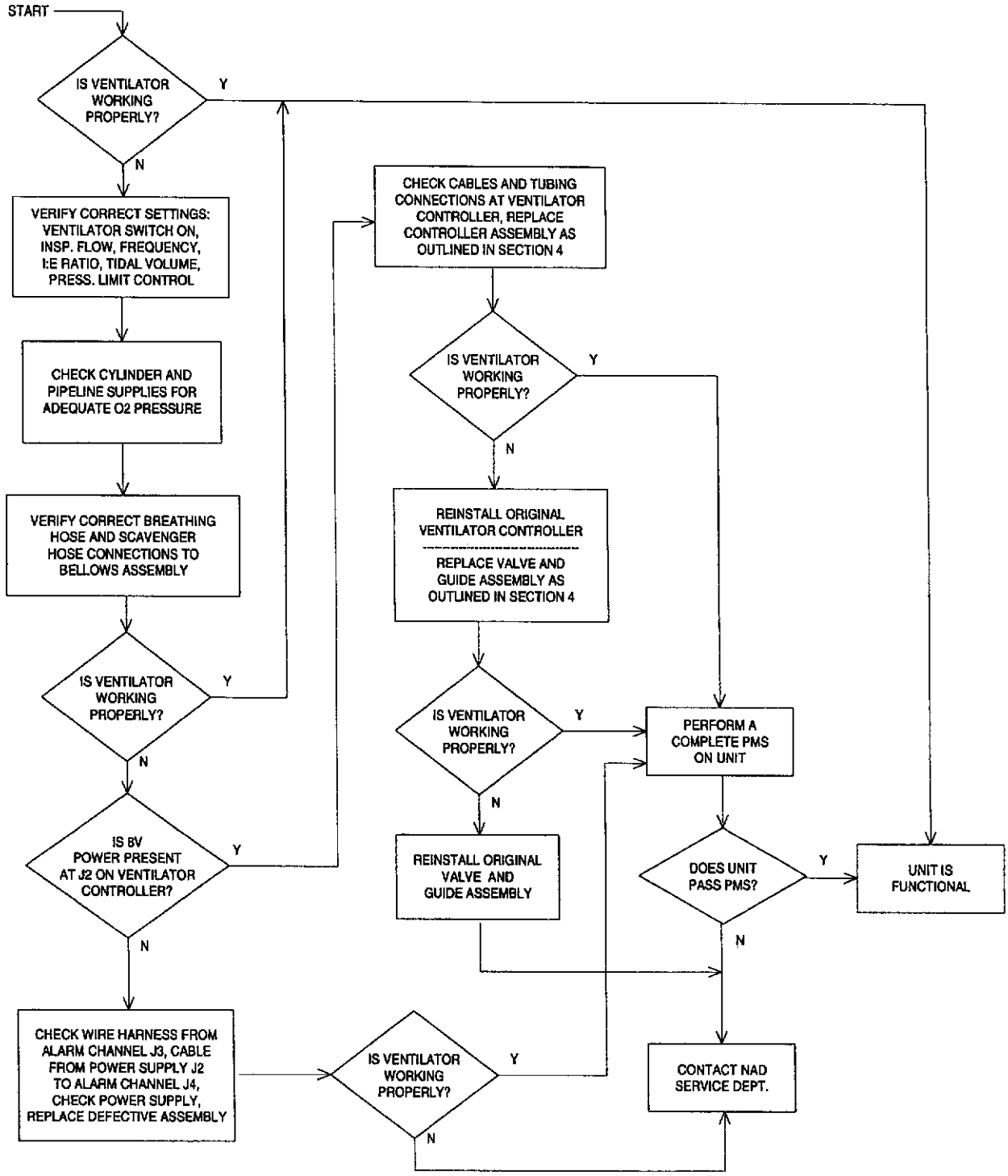
GUIDE 7: Display Blank Upon System Power-up



GUIDE 8: Keypad Inoperative



GUIDE 9: Ventilator Inoperative



4.0 REPLACEMENT PROCEDURES

This section outlines removal and replacement procedures for the field-replaceable assemblies of the NARKOMED GS Anesthesia System.

These procedures are to be performed only by a North American Dräger qualified Technical Service Representative (TSR).

The following are the only procedures authorized by North American Dräger to be performed in the field. All other service procedures shall be referred to NAD's Technical Service Department.

NOTE: **The PMS PROCEDURE given in Section 6 must be performed after any replacement, removal, calibration or adjustment procedure.**

4.1 Cylinder Yoke Assemblies

Each cylinder yoke contains a replaceable filter and check valve assembly. Replacement of this assembly requires that the yoke be removed from the anesthesia machine. Figure 4-1 shows a typical cylinder yoke mounting arrangement. Access to the yoke mounting screws and gas line connection requires that the table top be removed from the machine.

4.1.1 Disconnect all pipeline hoses and set the System Power switch to ON.

4.1.2 Close all cylinder valves except the O_2 valve.

4.1.3 Set the oxygen flow to 5 liters per min.

4.1.4 Open the other gas flow control valves to drain pressure from the system.

4.1.5 Close the O_2 cylinder valve, and close the flow control valves. Press the O_2 Flush valve to drain oxygen pressure from the system.

4.1.6 Set the System Power switch to STANDBY.

4.1.7 Remove the cylinder where the yoke is to be replaced.

WARNING: Store the cylinder in a safe place and lay it on its side.

4.1.8 Loosen the screws holding the table top to the machine and lift out the table top.

4.1.9 Pull the writing tray out to its fully extended position.

4.1.10 Disconnect the gas line fitting at the yoke and remove the two yoke mounting screws.

4.1.11 Remove the filter and check valve assembly from the yoke and install a replacement assembly.

NOTE: If the entire yoke assembly is being replaced, verify that the pin indexing arrangement and the label are in agreement with the gas designation stamped on the mounting surface of the yoke. Refer to the parts list in Section 8.

NOTE: If the yoke spacer is removed from the frame rail of the machine, be sure to re-install it in its original position.

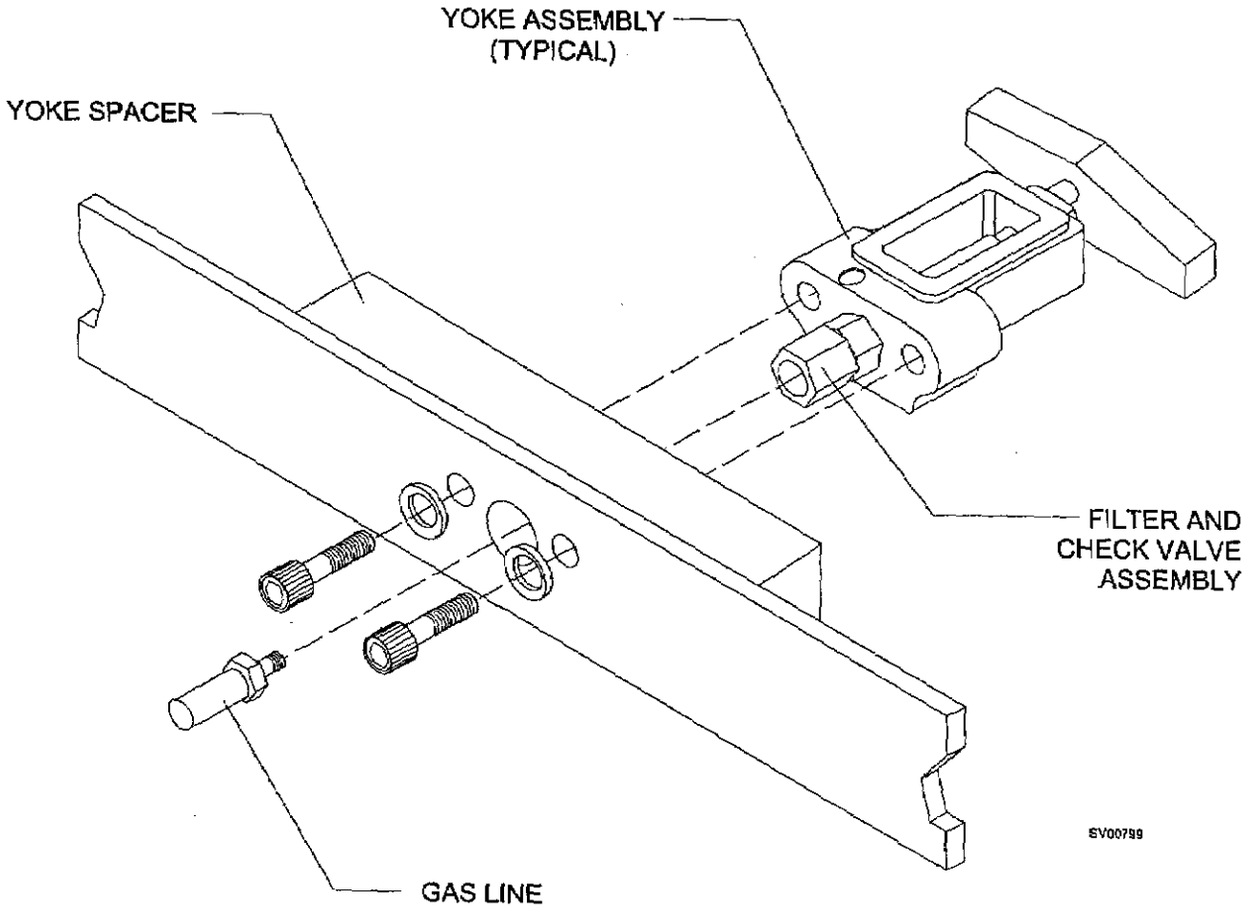


Figure 4-1: CYLINDER YOKE ASSEMBLY

4.1.12 Position the yoke on the spacer, and install the two mounting screws and lockwashers. Tighten the screws securely. Connect the gas line fitting to the yoke.

4.1.13 If a new cylinder is being installed, remove the old sealing washer from the gas inlet of the yoke and install a new washer.

4.1.14 Install the correct cylinder in the yoke, making sure that the index pins are properly engaged before tightening the handle bolt. The cylinder should hang vertically after the handle is tight.

4.1.15 Perform the following leak test on the yoke assembly:

4.1.15.1 Open the cylinder valve and check for a pressure indication on the corresponding gauge at the gas instrumentation panel.

NOTE: The cylinder used for this test must contain the following minimum pressure:

O_2	: 1000 Psi
N_2O	: 700 Psi
HE	: 1000 Psi
CO_2	: 800 Psi
AIR	: 1000 Psi
N_2	: 1000 Psi

4.1.15.2 Close the cylinder valve and remove the cylinder from the yoke.

4.1.15.3 For any gas, the pressure should not drop more than 50 Psi in two minutes.

4.1.16 Re-install the cylinder in the yoke.

4.1.17 Reinstall the table top and tighten its retaining screws.

4.1.18 Replace the pipeline hoses.

4.1.19 Perform the PMS Procedure given in Section 6.

4.2 Cylinder Pressure Regulators

Access to the cylinder pressure regulators requires that the table top be removed from the anesthesia machine. Figure 4-2 shows the mounting arrangement of the regulators and typical connections.

4.2.1 Disconnect all pipeline hoses and set the System Power switch to ON.

4.2.2 Close all cylinder valves except the O_2 valve.

4.2.3 Set the oxygen flow to 5 liters per min.

4.2.4 Open the other gas flow control valves to drain pressure from the system.

4.2.5 Close the O_2 cylinder valve, and close the flow control valves. Press the O_2 Flush valve to drain oxygen pressure from the system.

4.2.6 Set the System Power switch to STANDBY.

4.2.7 Remove the cylinder corresponding to the regulator to be replaced.

4.2.8 Loosen the screws holding the table top to the machine and lift out the table top.

4.2.9 Pull the writing tray and the top cabinet drawer out to their fully extended position.

4.2.10 Disconnect the compression fittings at the regulator.

4.2.11 Loosen the two setscrews holding the regulator to its mounting bracket and remove the regulator.

4.2.12 Record the serial number of the regulator that was removed, and record the serial number of the replacement regulator.

NOTE: If fittings must be installed in the replacement regulator, use Loctite #271 (red). Refer to the parts list in Section 8.

NOTE: For Canadian machines, verify that the correct relief valve is installed in the regulator. Refer to the parts list in Section 8 for CSA items.

4.2.13 Position the replacement regulator in its mounting bracket, and connect the three compression fittings. Do not tighten the fittings yet.

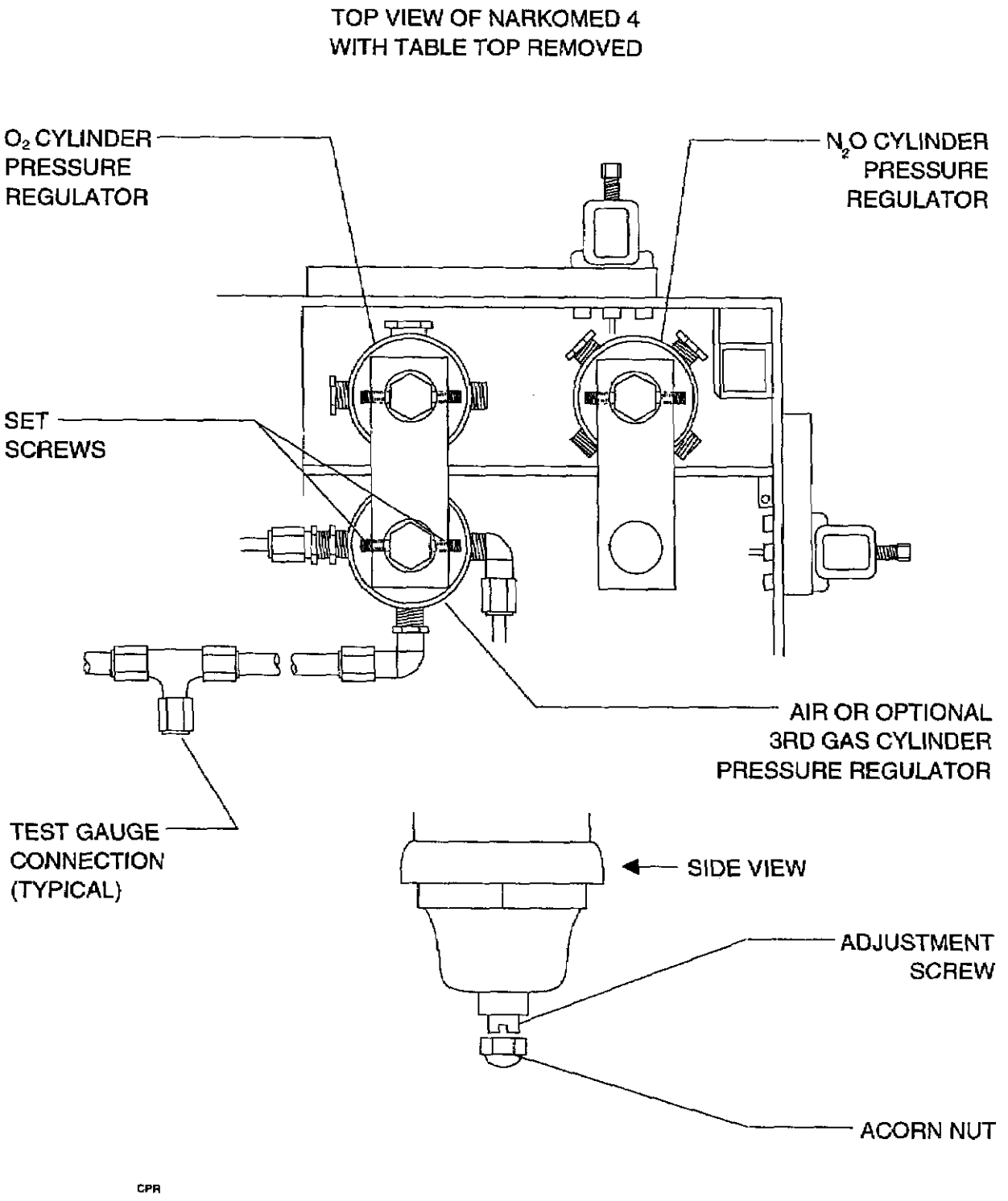


Figure 4-2: CYLINDER PRESSURE REGULATORS

4.2.14 Tighten the regulator mounting setscrews to a torque of 50 to 55 in. lbs.

4.2.15 Tighten the compression fittings.

4.2.16 Locate the TEE fitting in the ¼ in. diameter regulator output line, and remove the plug from the TEE fitting.

4.2.17 Set the regulator output pressure in accordance with the Cylinder Pressure Regulator Adjustment given in Section 5.

4.2.18 Perform the following leak test on the high pressure side of the regulator:

4.2.18.1 Open the cylinder valve and check for a pressure indication on the corresponding gauge at the gas instrumentation panel.

NOTE: The cylinder used for this test must contain the following minimum pressure:

O_2 : 1000 Psi
N_2O : 700 Psi
HE : 1000 Psi
CO_2 : 800 Psi
AIR : 1000 Psi
N_2 : 1000 Psi

4.2.18.2 Close the cylinder valve and remove the cylinder from the yoke.

4.2.18.3 For any gas, the pressure should not drop more than 50 Psi in two minutes.

4.2.19 Re-install the cylinder in the yoke.

4.2.20 Reinstall the table top and tighten its retaining screws.

4.2.21 Connect the pipeline hoses.

4.2.22 Perform the PMS Procedure given in Section 6.

4.3 Cylinder Cutoff Valves (Canada)

Access to the cylinder cutoff valves requires removal of the table top from the anesthesia machine. Figure 4-3 shows typical locations of the O_2, Air or 3rd gas, and N_2O cutoff valve assemblies. The instructions apply to all three assemblies.

NOTE: Replacement of the O_2 Cutoff Valve Assembly shall be performed every 24 months. Documentation shall be created by the service person and a copy distributed to the owner institution. Testing of the O_2 Cutoff Valve shall be performed at each PMS. (Perform the flow test given at the end of the following procedure)

4.3.1 Disconnect all pipeline hoses and set the System Power switch to ON.

4.3.2 Close all cylinder valves except the O_2 valve.

4.3.3 Set the oxygen flow to 5 liters per min.

4.3.4 Open the other gas flow control valves to drain pressure from the system.

4.3.5 Close the O_2 cylinder valve, and close the flow control valves. Press the O_2 Flush valve to drain oxygen pressure from the system.

4.3.6 Set the System Power switch to STANDBY.

4.3.7 Loosen the screws holding the table top to the machine and lift out the table top.

4.3.8 Pull the writing tray and the top cabinet drawer out to their fully extended position.

4.3.9 Disconnect the compression fittings indicated at points marked C on the illustration.

4.3.10 Disconnect the flexible tubing from the cutoff valve assembly at the point marked A on the illustration.

4.3.11 Remove the cylinder cutoff assembly.

4.3.12 Connect the flexible tubing to the replacement cutoff valve assembly and secure it with the hose clamp.

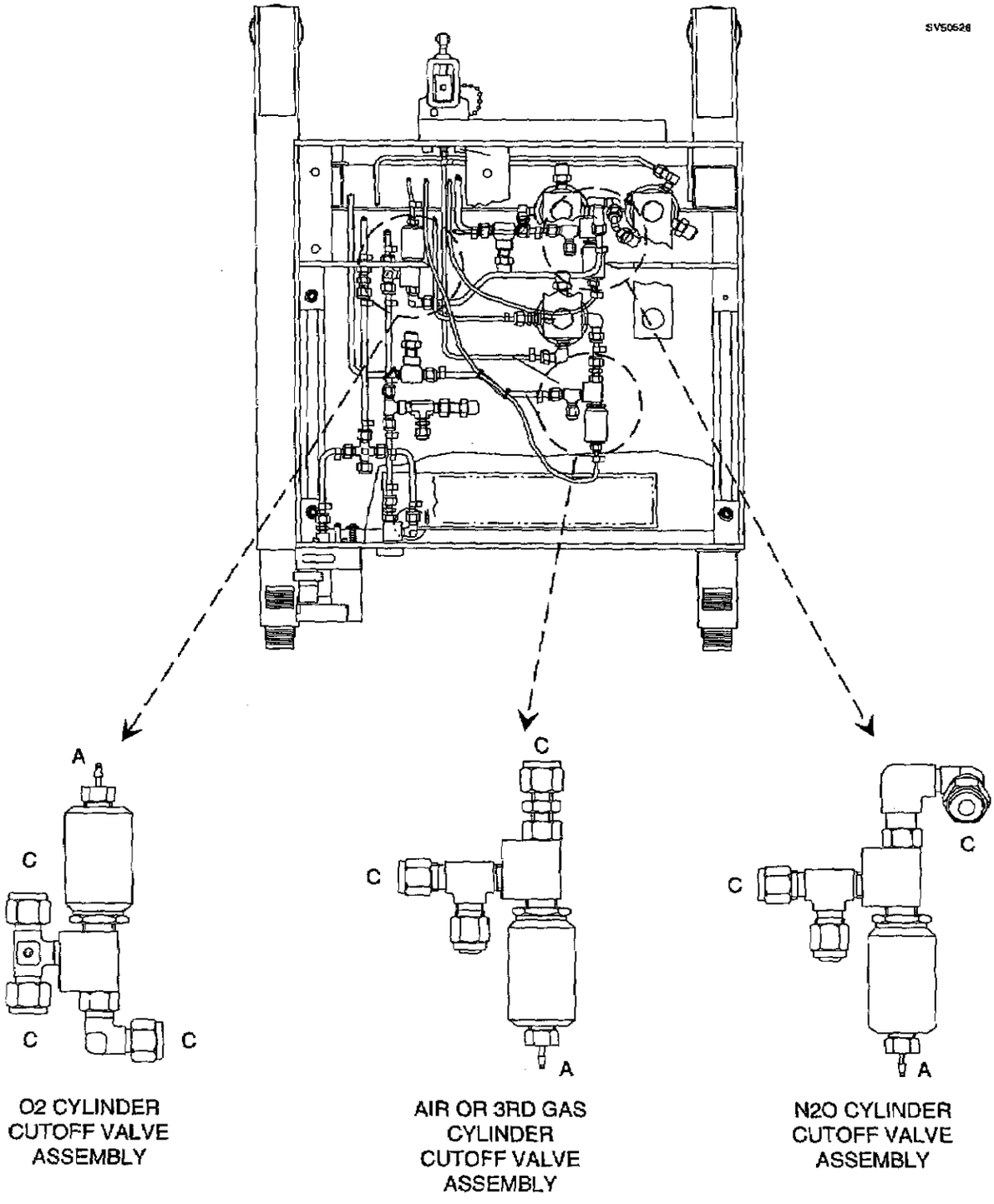


Figure 4-3: CYLINDER CUTOFF VALVES (CANADA)

4.3.13 Connect and tighten the compression fittings at points marked C on the illustration.

4.3.14 Perform the following test: --Remove the plug from the test gauge connection at the Tee fitting in the regulator outlet piping, and install a test gauge.

NOTE: The cylinders used for this test must contain the following minimum pressure: O_2 : 1000 PSI AIR : 1000 PSI
O_2+He : 1000 PSI N_2O : 745 PSI

--Set the System Power switch to ON.
--For the O_2 cutoff valve: open the O_2 cylinder valve and set the oxygen flow to 4 liters per min.
--For the N_2O cutoff valve: open the O_2 cylinder valve and the N_2O cylinder valve. Set each flow to 4 liters per min.
--Verify that regulator outlet pressure is between 43 and 49 PSI.
--Connect the pipeline hoses and pressurize to 50 PSI.
--Turn off the pipeline supply and observe the pipeline pressure gauge.
--The cutoff valve shall open when the pipeline pressure drops through the range of 45 to 40 PSI.
--Close the cylinder valve(s), and close the flow control valve(s).
--Disconnect test pressure gauge and reinstall the plug in the regulator outlet piping.

4.3.15 Reinstall the table top and tighten its retaining screws.

4.3.16 Connect the pipeline hoses.

4.3.17 Perform the PMS Procedure given in Section 6.

O_2 Flow Test:

--Disconnect all pipeline supplies.
--Install a full O_2 cylinder on the machine, and open the cylinder valve.
--Turn the System Power switch to ON.
--Set the Inspiratory Flow control to maximum high, and turn the ventilator switch to ON.
--Set the oxygen flow to 10 l/min.
--Verify that the oxygen flow does not drop below 8 l/min. while the ventilator is running.
--Press and hold the O_2 FLUSH button while observing the O_2 flowmeter, and verify that the oxygen flow does not drop below 8 l/min.
--If the oxygen flow in either of the above two steps drops below 8 l/min., replace the O_2 cutoff valve assembly.

4.4 Cylinder and Pipeline Pressure Gauges

Replacement of the cylinder and pipeline pressure gauges requires that the plexiglass front cover be removed from the gas instrumentation panel, and also the rear cover for access to the gauge connections. Figure 4-4 shows gauge mounting and connection details.

4.4.1 Disconnect all pipeline hoses and set the System Power switch to ON.

4.4.2 Close all cylinder valves except the O_2 valve.

4.4.3 Set the oxygen flow to 5 liters per min.

4.4.4 Open the other gas flow control valves to drain pressure from the system.

4.4.5 Close the O_2 cylinder valve, and close the flow control valves. Press the O_2 Flush valve to drain oxygen pressure from the system.

4.4.6 Set the System Power switch to STANDBY.

4.4.7 Remove the screws holding the rear cover, and remove the cover.

4.4.8 Loosen the screws holding the table top to the machine and lift out the table top.

4.4.9 Remove the screws holding the flowmeter shield and vapor box front cover panel, and remove the panel.

4.4.10 Remove the oxygen flow control knob. The knob has two setscrews.

NOTE: If the knob must be rotated to allow access to a setscrew, carefully note its position so that it can be re-assembled in the same position with the "Off Stop" properly set.

4.4.11 Remove the two screws holding the knob guard in place, and remove the knob guard.

4.4.12 Carefully remove the plexiglass cover from the front of the flowmeter housing.

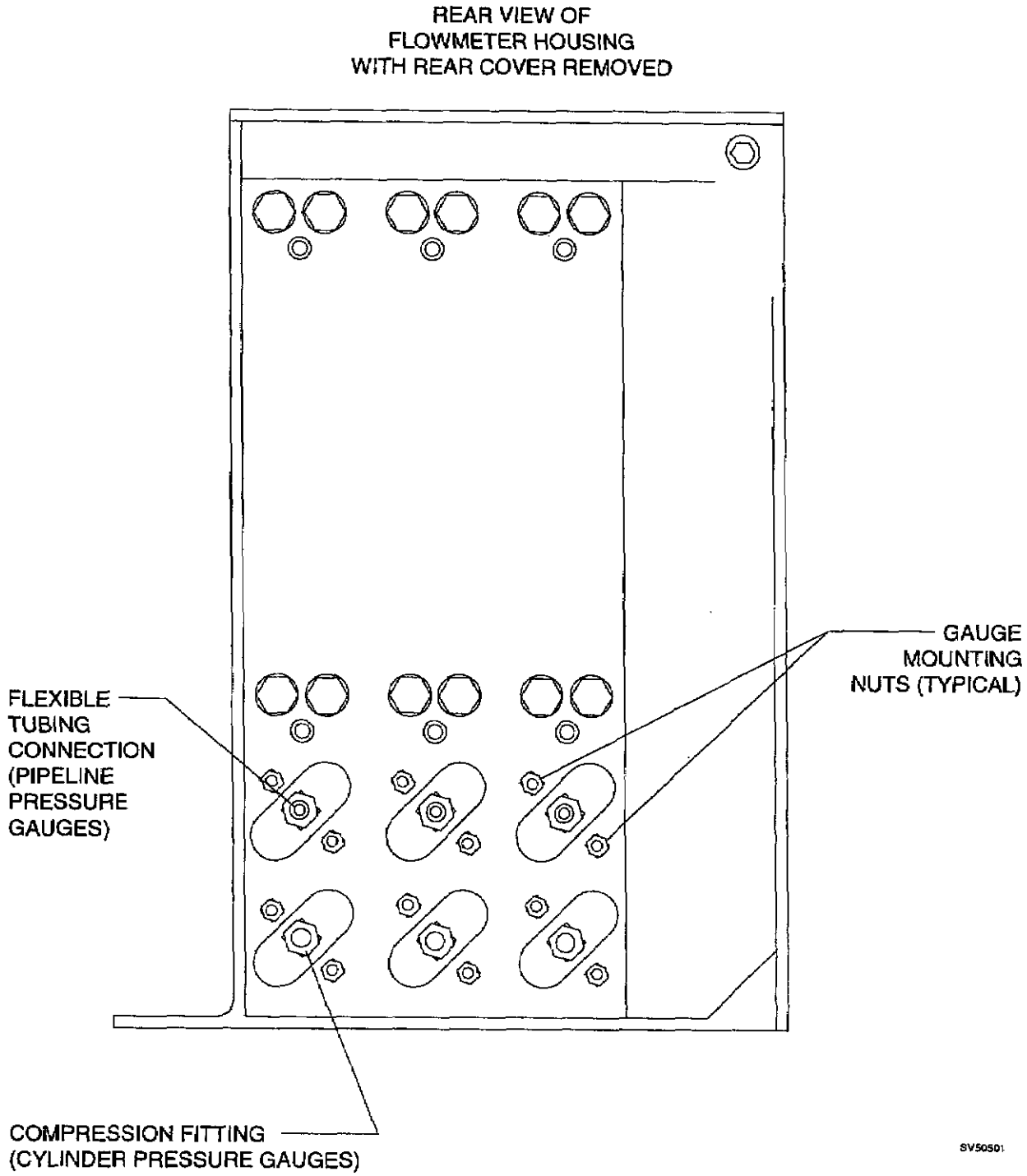


Figure 4-4: CYLINDER AND PIPELINE PRESSURE GAUGES

NOTE: Intermediate assemblies may need to be removed to allow access to the gauge connections and mounting hardware. Be sure to keep a record of the disassembly sequence so that all tubing can be correctly re-assembled.

4.4.13A For the cylinder pressure gauges:

Disconnect the compression fitting at the back of the gauge.

Remove the gauge mounting nuts, and remove the gauge from the front of the panel.

Install the replacement gauge in the panel using the flat washers, lock washers and mounting nuts that were previously removed.

Connect the gas line to the gauge and tighten the compression fitting.

4.3.13B For the pipeline pressure gauges:

Locate the flexible tubing connecting the gauge to the pipeline inlet assembly and disconnect the tubing.

Remove the gauge mounting nuts, and remove the gauge from the front of the panel.

Disconnect the flexible tubing from the gauge.

Connect a new 7-inch length of tubing (8-inch for the air pipeline pressure gauge) to the replacement gauge and secure it with a hose clamp.

Place the gauge in the panel and secure it with the flat washers, lock washers and mounting nuts that were previously removed.

Place a hose clamp on the other end of the flexible tubing; connect the tubing to the pipeline inlet assembly and secure it with the hose clamp.

4.4.14 If a cylinder pressure gauge was replaced, perform the following leak test:

4.4.14.1 Open the cylinder valve and check for a pressure indication on the corresponding gauge at the gas instrumentation panel.

NOTE: The cylinder used for this test must contain the following minimum pressure:

O_2	: 1000 Psi
N_2O	: 700 Psi
HE	: 1000 Psi
CO_2	: 800 Psi
AIR	: 1000 Psi
N_2	: 1000 Psi

4.4.14.2 Close the cylinder valve and remove the cylinder from the yoke.

4.4.14.3 For any gas, the pressure should not drop more than 50 Psi in two minutes.

4.4.15 Re-install the cylinder in the yoke.

4.4.16 Place the plexiglass cover over the gauges and flow tubes, and ensure that the cover is fitted properly over the flow control valves.

4.4.17 Place the knob guard over the flow control valves and install its two retaining screws.

4.4.18 Install the oxygen flow control knob and tighten its setscrews. If the knobs are installed properly, their labels will be straight when the knobs are against their clockwise stops.

4.4.19 Replace the front plate at the top of the plexiglass cover and secure it with the hardware that was previously removed.

4.4.20 Replace the rear cover and its retaining screws.

4.4.21 Reinstall the table top and tighten its retaining screws.

4.4.22 Connect the pipeline hoses.

4.4.23 Perform the PMS Procedure given in Section 6.

4.5 Flowmeters

The flowmeter tubes are held by compression in gaskets at the top and bottom of each tube. Each upper gasket is seated in an adjustable retainer that allows removal of the tube as shown in Figure 4-5. Access to the flow tubes and their retainers requires removal of the plexiglass cover on the gas instrumentation panel.

4.5.1 Disconnect all pipeline hoses and set the System Power switch to ON.

4.5.2 Close all cylinder valves except the O_2 valve.

4.5.3 Set the oxygen flow to 5 liters per min.

4.5.4 Open the other gas flow control valves to drain pressure from the system.

4.5.5 Close the O_2 cylinder valve, and close the flow control valves. Press the O_2 Flush valve to drain oxygen pressure from the system.

4.5.6 Set the System Power switch to STANDBY.

4.5.7 Loosen the screws holding the table top to the machine and lift out the table top.

4.5.8 Remove the screws holding the flowmeter shield and vapor box front cover panel, and remove the panel.

4.5.9 Remove the oxygen flow control knob. The knob has two setscrews.

NOTE: If the knob must be rotated to allow access to a setscrew, carefully note its position so that it can be re-assembled in the same position with the "Off Stop" properly set.

4.5.10 Remove the two screws holding the knob guard in place, and remove the knob guard.

4.5.11 Carefully remove the plexiglass cover from the front of the flowmeter housing.

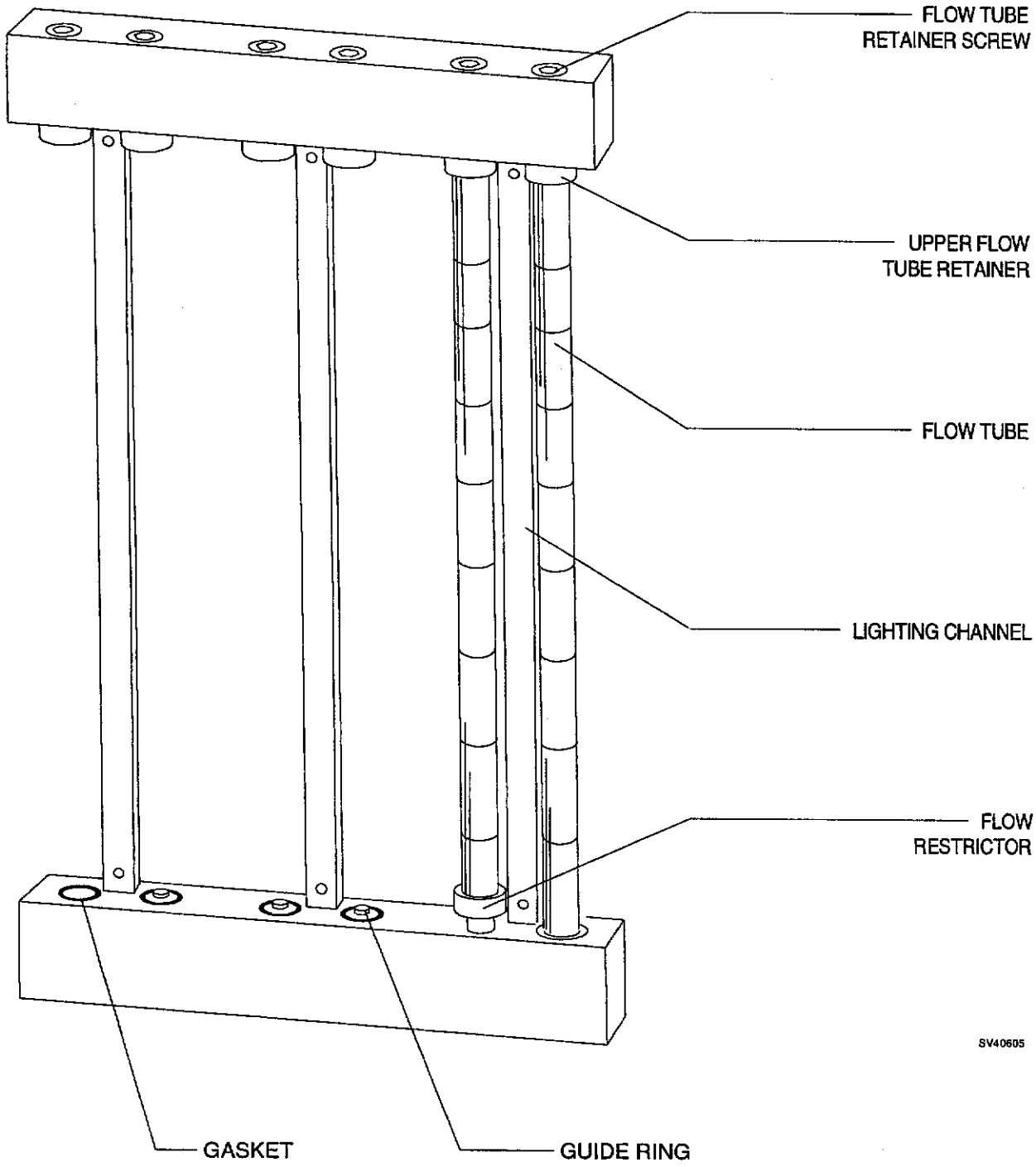


Figure 4-5: FLOWMETERS

4.5.12 Loosen the screw directly above the flowmeter tube to be replaced. Turning the screw counter clockwise will raise the upper flow tube retainer. Raise the retainer far enough to be able to pull the top of the tube outward, and remove the tube.

NOTE: If the bottom of the tube is seated in a flow restrictor, be sure that the arrangement of the restrictor and its gaskets is not disturbed.

4.5.13 Make sure that the replacement flow tube bears the correct markings and has a ball.

4.5.14 Place the bottom of the flowmeter tube into the guide ring of the lower gasket seal, and position the top of the flow tube into the center guide ring of the top gasket seal. It will be easier to hold the tube if the adjacent lighting channel is pulled forward and temporarily removed.

CAUTION: The flowmeter tube must be properly centered over the guide rings or damage to the flowmeter tube may occur.

4.5.15 Ensure that the markings on the flow tube are facing forward, and turn the upper retainer screw clockwise until the flow tube is firmly held in place.

CAUTION: Do not over-tighten the screw as the flowmeter tube may break.

4.5.16 Perform the following leak test on the system:

4.5.16.1 Disconnect the absorber hose from the fresh gas outlet. Ensure that all flow control valves are closed.

4.5.16.2 Connect a test gauge and B.P. bulb to the fresh gas outlet, and pressurize the system to 50 cm H_2O.

4.5.16.3 The pressure should not drop more than 10 cm H_2O in thirty seconds.

4.5.17 Disconnect the test gauge and re-connect the absorber hose to the fresh gas outlet.

4.5.18 Replace any lighting channels that were previously removed.

4.5.19 Place the plexiglass cover over the gauges and flow tubes, and ensure that the cover is fitted properly over the flow control valves.

4.5.20 Place the knob guard over the flow control valves and install its two retaining screws.

4.5.21 Install the oxygen flow control knob and tighten its setscrews. If the knobs are installed properly, their labels will be straight when the knobs are against their clockwise stops.

4.5.22 Replace the front plate at the top of the plexiglass cover and secure it with the hardware that was previously removed.

4.5.23 Reinstall the table top and tighten its retaining screws.

4.5.24 Connect the pipeline hoses.

4.5.25 Perform the PMS Procedure given in Section 6.

4.6 Flow Control Valves

The flow control valves have replaceable elements that are removable from the front of the gas instrumentation panel as shown in Figure 4-6. Each flow control knob has a clockwise positive stop arrangement that prevents damage to the valve seat. Whenever a valve cartridge is replaced, the "off stop" must be set as outlined in the following procedure.

4.6.1 Disconnect all pipeline hoses and set the System Power switch to ON.

4.6.2 Close all cylinder valves except the O_2 valve.

4.6.3 Set the oxygen flow to 5 liters per min.

4.6.4 Open the other gas flow control valves to drain pressure from the system.

4.6.5 Close the O_2 cylinder valve and the O_2 flow control valve. Press the O_2 Flush valve to drain oxygen pressure from the system.

4.6.6 Set the System Power switch to STANDBY.

4.6.7 Remove the oxygen flow control knob.

4.6.8 Remove the two screws holding the knob guard in place, and remove the knob guard.

4.6.9 Remove the knob (if not already removed) from the valve that is being replaced, and remove the stop pin nut.

4.6.10 Remove the flow control valve by holding it at the wrench flats and turning it counter-clockwise.

4.6.11 Install the replacement flow control valve in the valve body.

CAUTION: Before tightening the cartridge, rotate the valve shaft several turns counter-clockwise to prevent bottoming the valve element into the seat when the cartridge is tightened.

4.6.12 Replace the stop pin nut.

4.6.13 Replace the knob guard and secure it with the two mounting screws.

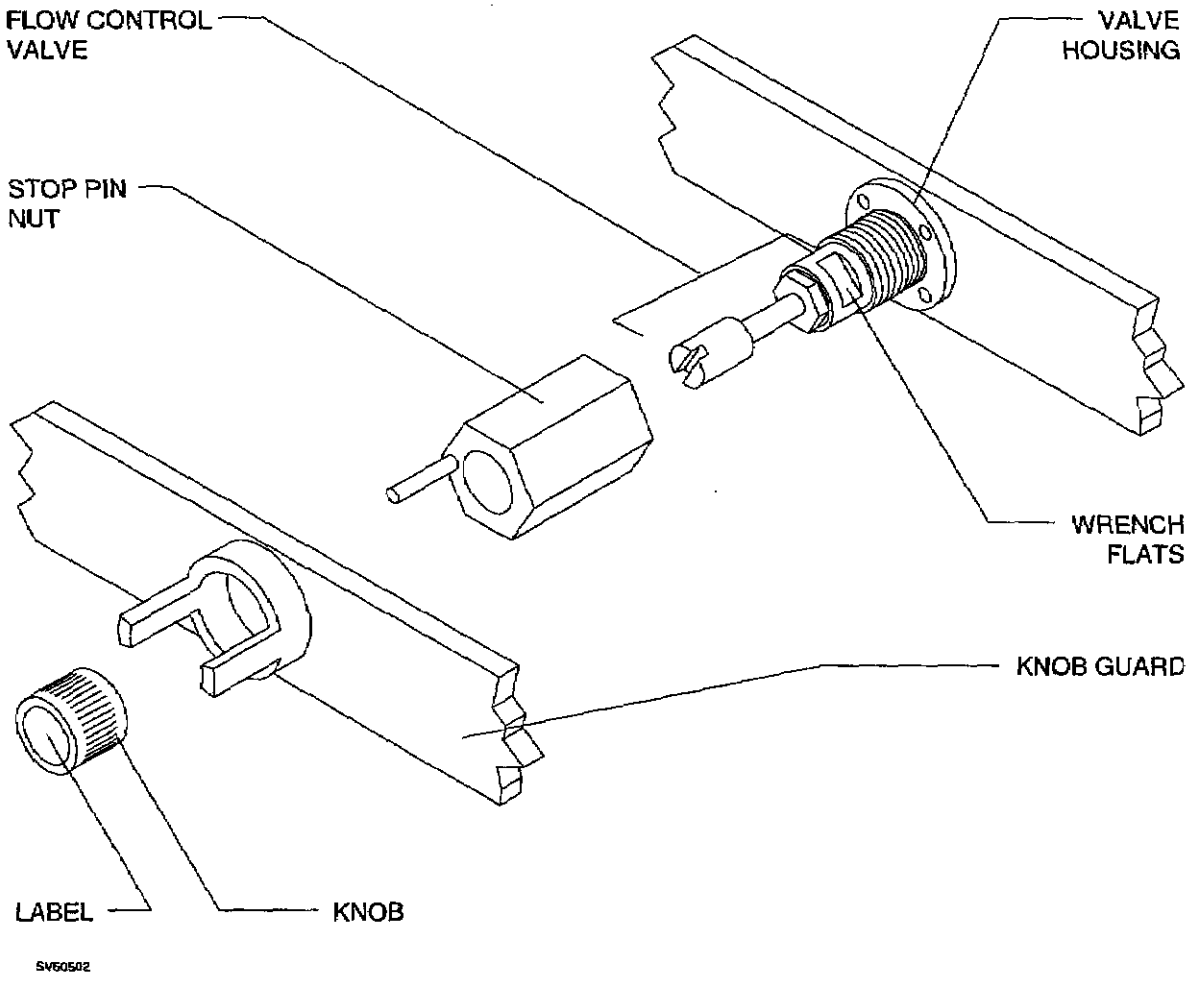


Figure 4-6: FLOW CONTROL VALVES

4.6.14 Turn the System Power switch to ON.

4.6.15A For the O_2 flow control valve:

Open the oxygen cylinder valve.

Turn the flow control valve clockwise until the flow rate will not drop any further. (If the machine has been modified to eliminate the minimum flow feature, turn the valve until the flow rate is zero.)

4.6.15B For the other gas flow control valves:

Open the oxygen cylinder valve, and open the cylinder valve corresponding to the flow control valve replacement.

Set the oxygen flow rate to four liters per minute.

Turn the other gas flow control valve clockwise until the flow rate is zero.

4.6.16 Place the knob on the flow control valve shaft and turn it clockwise until it engages the stop pin. Tighten one of the knob setscrews.

4.6.17 Turn the knob in both directions and ensure that the flow can be controlled over its entire range. When the valve is closed, the knob should be against the clockwise stop. Tighten the remaining setscrew.

4.6.18 If the knob label is not horizontal when the valve is closed, remove the label and install a new label in the correct position.

4.6.19 Connect the pipeline hoses.

4.6.20 Perform the PMS Procedure given in Section 6.

4.7 Auxiliary Oxygen Flow Meter

The auxiliary oxygen flowmeter is attached to the side of the machine's flowmeter housing by two screws (or by a stud and nut arrangement) - accessible from inside the housing. A flexible O_2 supply tube from the flowmeter connects to a hose barb fitting at the system power switch. Figure 4-7 shows a typical mounting and tubing arrangement.

4.7.1 Disconnect all pipeline hoses and close all cylinder valves.

4.7.2 Press the O_2 Flush button to drain oxygen pressure from the system.

4.7.3 Turn the System Power switch to STANDBY and remove AC power from the machine.

4.7.4 Remove the back cover from the flowmeter housing.

4.7.5 Cut the tie strap on the flexible tube at the system power switch, and remove the tube.

4.7.6 Remove the screws (or nuts) securing the auxiliary O_2 flowmeter, and remove the flowmeter.

4.7.7 Position the replacement flowmeter at the side of the flowmeter housing (feed the flex tubing through the clearance hole) and secure the auxiliary O_2 flowmeter with the two screws (or nuts) that were previously removed.

4.7.8 Connect the flex tubing to the hose barb fitting behind the Clippard valve, and secure it with a tie strap.

4.7.9 Reinstall the flowmeter housing back cover.

4.7.10 Connect the pipeline hoses and restore AC power to the machine.

4.7.11 Perform the PMS Procedure given in Section 6.

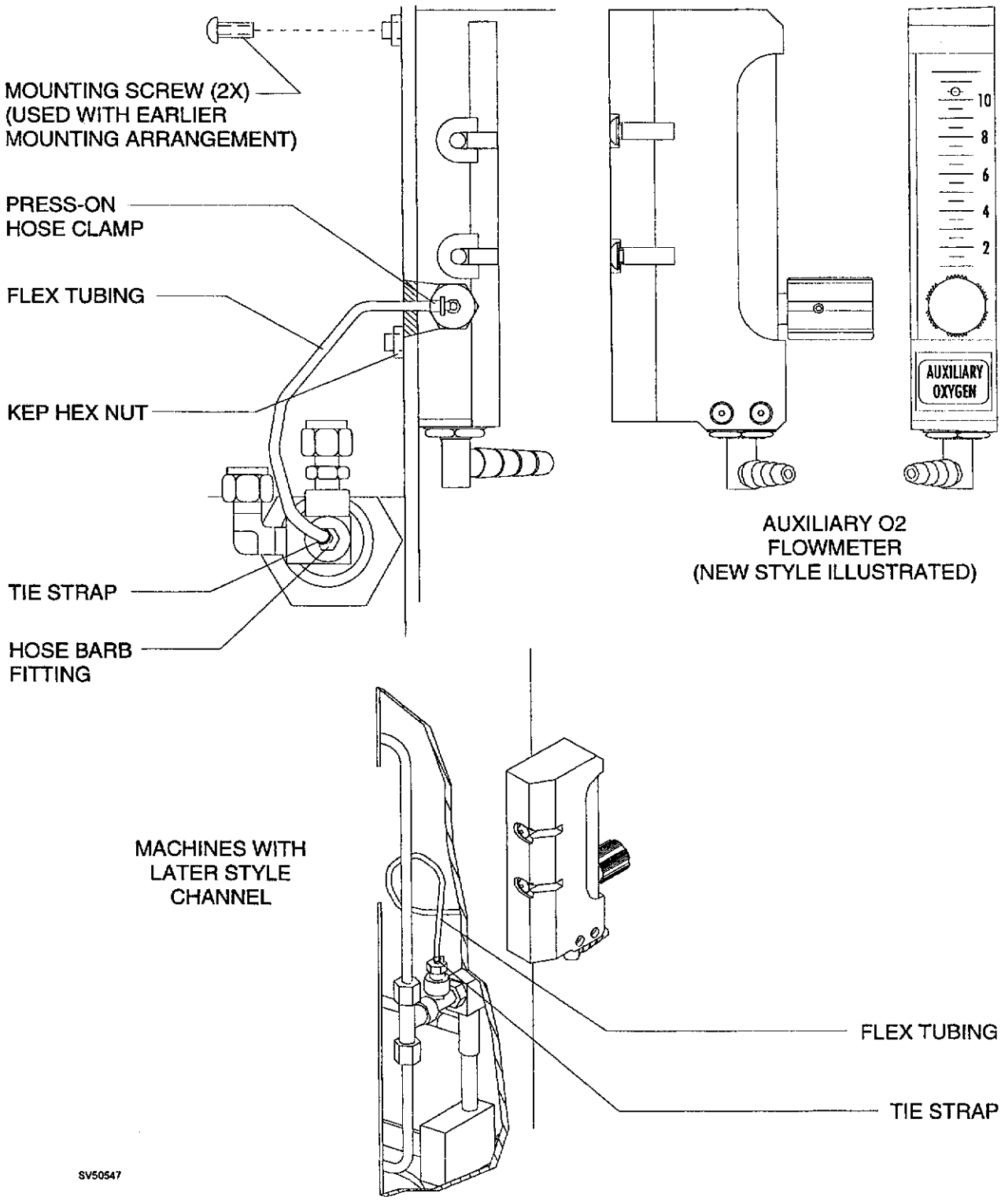


Figure 4-7: AUXILIARY O_2 FLOWMETER

4.8 Oxygen Supply Pressure Failure Protection Device

The oxygen supply failure protection devices (failsafe assemblies) are located within the flowmeter housing. Access to these assemblies requires removal of the rear cover. Figure 4-8 shows a typical arrangement of a failsafe assembly and its connections.

4.8.1 Disconnect all pipeline hoses and set the System Power switch to ON.

4.8.2 Close all cylinder valves except the O_2 valve.

4.8.3 Set the oxygen flow to 5 liters per min.

4.8.4 Open the other gas flow control valves to drain pressure from the system.

4.8.5 Close the O_2 cylinder valve and the O_2 flow control valve. Press the O_2 Flush valve to drain oxygen pressure from the system.

4.8.6 Set the System Power switch to STANDBY.

4.8.7 Remove the screws holding the rear cover, and remove the cover.

4.8.8 Disconnect the flexible O_2 control line.

4.8.9 Disconnect the compression fittings at the side ports and at the check valve, and remove the assembly.

NOTE: If fittings must be installed in the replacement block assembly, use Loctite #271 (red). Fittings are listed in Section 8.

4.8.10 Install the replacement failsafe assembly, and tighten the three compression fittings.

4.8.11 Connect the flexible tubing to the control port, and secure the connection with the hose clamp.

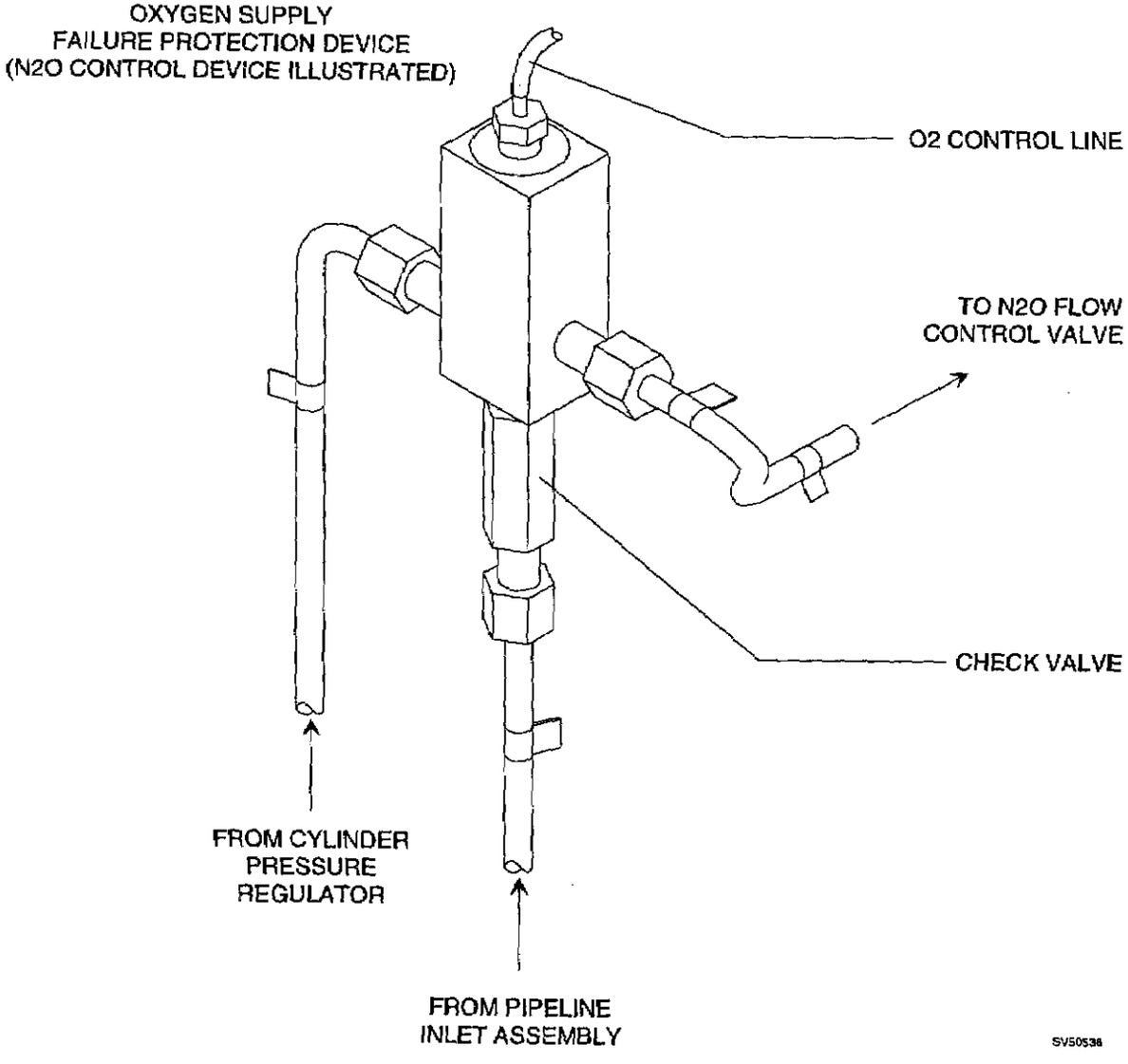


Figure 4-8: OXYGEN SUPPLY FAILURE PROTECTION DEVICE

4.8.12 Perform the following test:

4.8.12.1 Open the cylinder valves.

4.8.12.2 Set the System Power switch to ON.

4.8.12.3 Set the oxygen flow to five liters per minute.

4.8.12.4 Set the other gas flow to five liters per minute.

4.8.12.5 Close the oxygen cylinder valve.

4.8.12.6 As the oxygen flow decreases, the other gas flow should stop.

4.8.12.7 Set the System Power switch to STANDBY.

4.8.13 Reinstall the rear cover and its retaining screws.

4.8.14 Connect the pipeline hoses.

4.8.15 Perform the PMS Procedure given in Section 6.

4.9 Alarm Channel and Oxygen Supply Pressure Alarm Switch

The alarm channel assembly includes the oxygen supply pressure alarm switch, the alarm circuit board, and the system power switch.

NOTE: Service replacement alarm channel assemblies are supplied without the O_2 supply pressure alarm switch and wire harness.

Whenever the alarm channel is replaced, the oxygen supply pressure alarm switch must be tested to ensure that its operating point is set correctly. Removal of the alarm channel requires removal of the upper flowmeter cover plate, and removal of the flowmeter housing rear cover. The alarm channel assembly is held in place by two screws from the back. Figure 4-9 shows a rear view of the assembly and its connections.

4.9.1 Disconnect all pipeline hoses and set the System Power switch to ON.

4.9.2 Close all cylinder valves except the O_2 valve.

4.9.3 Set the oxygen flow to 5 liters per min.

4.9.4 Open the other gas flow control valves to drain pressure from the system.

4.9.5 Close the O_2 cylinder valve and the O_2 flow control valve. Press the O_2 Flush valve to drain oxygen pressure from the system.

4.9.6 Set the System Power switch to STANDBY, and remove AC power from the machine.

4.9.7 Disable the circuit breakers on the power supply by pulling out each button with a knife or sharp object.

4.9.8 Remove the screws holding the flowmeter shield and vapor box front cover panel, and remove the panel.

4.9.9 Remove the screws holding the flowmeter housing rear cover, and remove the cover.

4.9.10 Loosen the screws holding the table top, and lift out the table top.

4.9.11 Disconnect the cables from J1, J2, J3 and J4 on the alarm circuit board.

4.9.12 Disconnect the compression fitting on the O_2 line nearest to the oxygen supply pressure alarm switch.

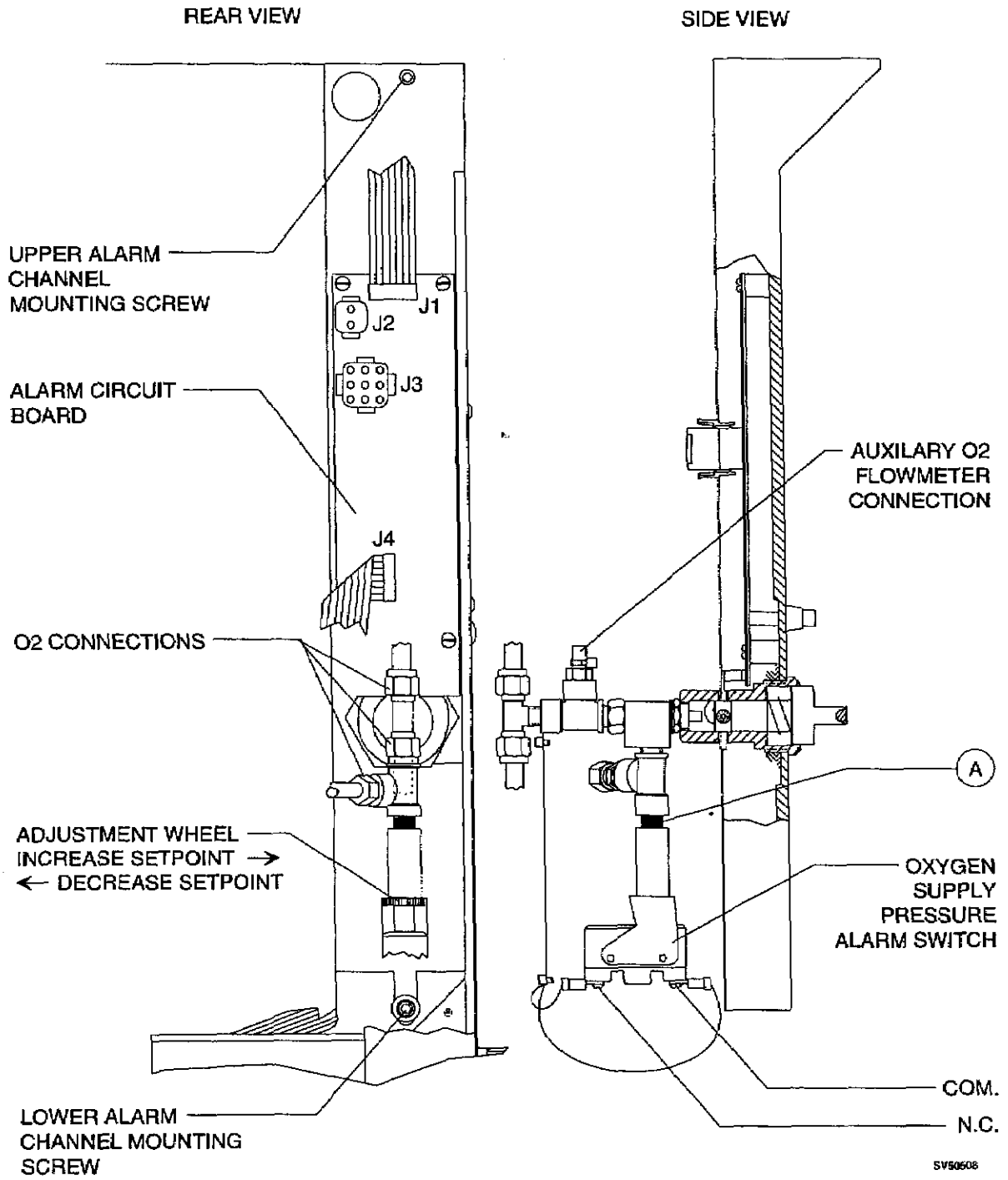


Figure 4-9: ALARM CHANNEL AND OXYGEN SUPPLY PRESSURE ALARM SWITCH

4.9.13 Disconnect the remaining two O_2 lines at the top and bottom of the tee fitting.

4.9.14 If the machine is equipped with an auxiliary O_2 flowmeter, cut the tie strap on its flexible line and carefully remove the flex line from the hose barb.

4.9.15 From the back of the flowmeter housing, remove the upper and lower alarm channel mounting screws.

4.9.16 At the front of the machine, pull the alarm channel assembly forward, and feed the flowmeter lights wire harness through the hole at the top of the alarm channel.

4.9.17 Disconnect the orange and orange/white wires from the oxygen supply pressure alarm switch.

4.9.18 The following steps apply to replacement of the oxygen supply pressure alarm switch.

4.9.19 Remove the alarm switch from the assembly at point Ⓐ as shown in the illustration.

4.9.20 Install the replacement alarm switch with sealing tape on the threads, and ensure that the switch is oriented on the assembly as shown in the illustration.

4.9.21 Connect the orange and orange/white wires to the replacement switch in the same manner as the original.

4.9.22 Feed the flowmeter lights wire harness through the hole at the top of the alarm channel, and set the alarm channel assembly into place.

4.9.23 Install the upper and lower alarm channel mounting screws.

4.9.24 If applicable, reconnect the flex line from the auxiliary O_2 flowmeter and install a new tie strap at the hose barb.

4.9.25 Reconnect the the O_2 lines, and tighten the three compression fittings.

4.9.26 Reconnect the cables to J1, J2, J3 and J4 on the alarm circuit board.

4.9.27 Reinstall the front flowmeter cover with the screws that were previously removed.

4.9.28 Pull the writing tray out to its fully extended position.

4.9.29 Locate the tee fitting in the ¼ in. diameter output line of the O_2 regulator and remove the plug from the tee fitting.

4.9.30 Connect a dedicated O_2 test gauge to the tee fitting.

4.9.31 Connect AC power to the machine and enable the circuit breakers by pressing their buttons in.

4.9.32 Open an oxygen cylinder valve and turn the System Power switch to ON.

4.9.33 Set the oxygen flow to five liters per minute.

4.9.34 Close the oxygen cylinder valve.

4.9.35 As the pressure drops, the O_2 SUPPLY alarm should activate when the pressure is between 40 and 34 psi as shown on the test gauge.

4.9.36 If the alarm activates when the pressure is below 34 psi or above above 40 psi, turn the adjustment wheel (see illustration), repeat the test and adjust as necessary to bring the set point into the correct range.

4.9.37 Turn the System Power switch to STANDBY.

4.9.38 Disconnect the test gauge and replace the plug in the regulator line tee fitting.

4.9.39 Reinstall the table top and tighten its retaining screws.

4.9.40 Reinstall the flowmeter housing rear cover and its retaining screws.

4.9.41 Connect the pipeline hoses.

4.9.42 Perform the PMS Procedure given in Section 6.

4.10 Oxygen Ratio Controller

The Oxygen Ratio Controller (ORC) is part of the N_2O flowmeter sub-assembly and is located within the flowmeter housing. The ORC is accessible by removing the rear flowmeter housing cover. Figure 4-10 shows a typical ORC location and mounting arrangement, with a detail of the O-rings and filter.

4.10.1 Disconnect all pipeline hoses and set the System Power switch to ON.

4.10.2 Close all cylinder valves except the O_2 valve.

4.10.3 Set the oxygen flow to 5 liters per min.

4.10.4 Open the other gas flow control valves to drain pressure from the system.

4.10.5 Close the O_2 cylinder valve and the O_2 flow control valve. Press the O_2 Flush valve to drain oxygen pressure from the system.

4.10.6 Set the System Power switch to STANDBY.

4.10.7 Remove the press-on clamp securing the flexible O_2 line to the ORC, and carefully disconnect the tubing from the hose barb.

4.10.8 Remove the three screws holding the ORC to the flowmeter sub-assembly, and carefully remove the ORC from the flowmeter housing.

4.10.9 Install the 6 in. length of flexible tubing with a blue N_2O label on the replacement ORC (see detail view in illustration) Secure each connection with a press-on hose clamp.

Position the replacement ORC at the back of the N_2O flowmeter sub-assembly; be sure that its O-rings and filter are in place, and install its three mounting screws.

4.10.10 Connect the flexible O_2 line to the ORC and secure it with the press-on hose clamp.

4.10.11 Open the O_2 and N_2O cylinder valves.

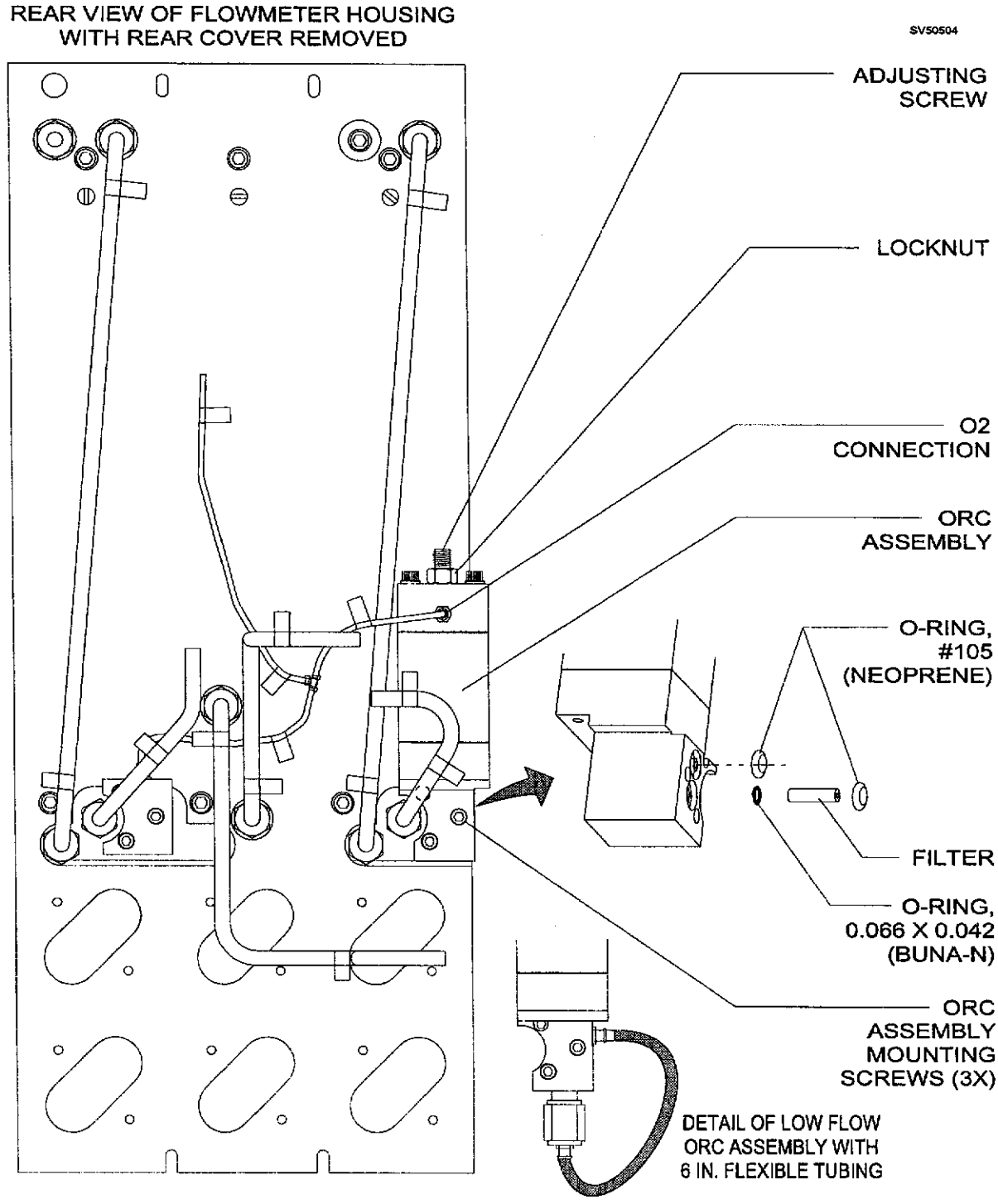


Figure 4-10: OXYGEN RATIO CONTROLLER

4.10.12 Perform the ORC adjustment procedure given in Section 5 of this manual.

4.10.13 Reinstall the flowmeter housing rear cover.

4.10.14 Perform the PMS Procedure given in Section 6.

4.11 Vaporizers

Each vaporizer is held to the machine by two metric sized hex screws. These screws are located at the back of the vaporizer manifold, and are accessible by removing the cover from the interlock mechanism as shown in Figure 4-11. Before removing a vaporizer from the machine, it must be completely drained and dried in accordance with the procedure given below. Be sure to have a suitable packing or storage container available in which to place the vaporizer.

CAUTION: The following steps must be performed in the sequence given.

4.11.1 Turn the System Power switch to ON.

4.11.2 Set all vaporizer handwheels to their Zero or OFF position.

WARNING: Do not inhale anesthetic vapors as this could result in personal injury.

4.11.3 Remove the filler and drain plugs, and drain the vaporizer into a suitable container. Dispose of the residual agent in an approved manner.

4.11.4 Turn the vaporizer handwheel to the maximum concentration setting.

4.11.5 Set the oxygen flow to 10 l/min. for at least 20 minutes.

WARNING: This procedure must be performed in a well ventilated area and without personnel present.

4.11.6 Turn the vaporizer handwheel to 0 (zero), and replace the filler and drain plugs.

4.11.7 Turn the oxygen flow off, and turn the System Power switch to STANDBY.

4.11.8 Remove the back cover from the vaporizer interlock mechanism.

4.11.9 While holding the vaporizer, remove the mounting screws and carefully separate the vaporizer from the machine. Note the arrangement of gaskets so that the replacement vaporizer can be installed in the same manner.

4.11.10 Place the vaporizer in a suitable container for transport or storage.

WARNING: Do not tilt a vaporizer that contains anesthetic agent more than 45 degrees. Failure to observe this precaution will render the handwheel calibration invalid.

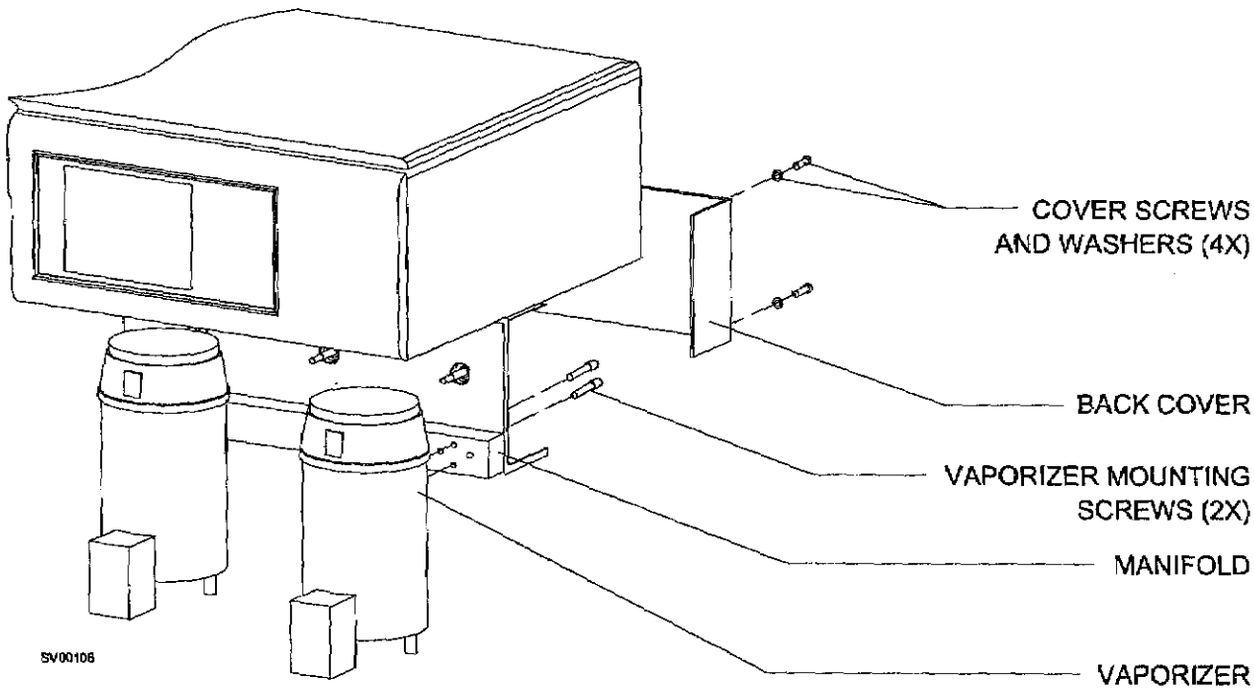


Figure 4-11: VAPORIZER INSTALLATION

NOTE: Should a vaporizer containing anesthetic agent be accidentally tilted more than 45 degrees, it must be drained and flushed in accordance with instructions given in the manual supplied with the vaporizer.

4.11.11 Set the handwheel on the replacement vaporizer to its Zero position.

4.11.12 Install the replacement vaporizer on the machine (be sure the O-rings are in place) and tighten the mounting screws to a torque of 24 to 26.5 inch pounds.

4.11.13 Perform the following test on the interlock mechanism:

4.11.13.1 Turn the center vaporizer handwheel ON. The left and the right vaporizer handwheels should be locked in their Zero position.

4.11.13.2 Turn the center vaporizer OFF and turn the left vaporizer ON.

4.11.13.3 Turn the left vaporizer OFF and turn the right vaporizer ON. The center and the left vaporizer handwheels should be locked in their Zero position.

NOTE: If the vaporizer interlock mechanism is not working properly, refer to the adjustment procedure given in Section 5.

4.11.14 Reinstall the back cover on the vaporizer interlock mechanism.

4.11.15 Perform the PMS Procedure given in Section 6.

4.12 O_2 Flush Valve

The O_2 flush valve is located at the front of the machine next to the fresh gas outlet. Access to the flush valve requires removal of the table top. Figure 4-12 shows the mounting and assembly details of the flush valve.

4.12.1 Turn the System Power switch to STANDBY.

4.12.2 Disconnect all pipeline hoses.

4.12.3 Close the O_2 cylinder valve.

4.12.4 Press the O_2 Flush valve to drain oxygen pressure from the system.

4.12.5 Loosen the screws holding the table top to the machine and lift out the table top.

4.12.6 Hold the O_2 Flush button in and rotate it until one of its set screws are visible through an access hole in the guard ring, and loosen the set screw.

4.12.7 Turn the O_2 Flush button 180 degrees, hold it in and loosen the other set screw.

4.12.8 Remove the O_2 Flush button and washer from the valve shaft.

4.12.9 Disconnect the two compression fittings at the valve.

NOTE: Do not lose the flow restrictor located at the right-angle fitting. This restrictor will be transferred to the replacement valve assembly.

4.12.10 The O_2 Flush valve is retained by the guard ring on the front of the machine frame. Hold the body of the Clippard valve with an open end wrench; insert a rod or hex wrench through the holes in the guard ring (or use a spanner wrench), and un-screw the guard ring from the front of the frame rail.

4.12.11 Assemble the replacement O_2 Flush valve, spacer, internal tooth lock washer and guard ring through the frame and tighten the assembly, making sure that the valve is mounted straight.

4.12.12 Connect the compression fittings to the valve. Be sure the flow restrictor is in place at the right-angle fitting.

4.12.13 Place the washer and the O_2 Flush button on the valve shaft.

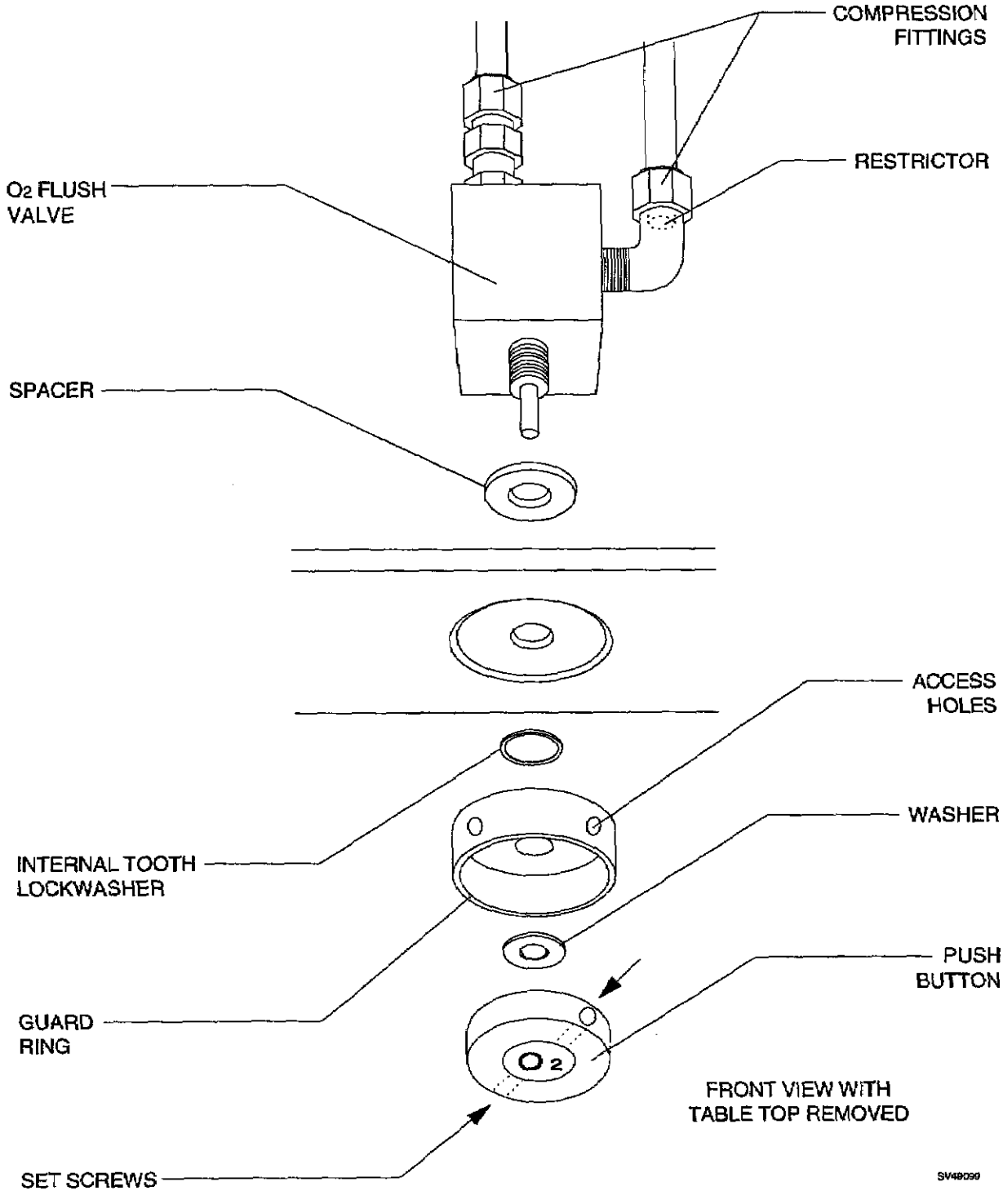


Figure 4-12: O_2 FLUSH VALVE

4.12.14 Hold the O_2 Flush button in and turn it until a set screw is visible through an access hole in the guard ring. Tighten the set screw. Rotate the button 180 degrees until the other set screw is visible, and tighten the set screw.

4.12.15 Disconnect the absorber fresh gas hose from the fresh gas outlet. Connect a test gauge and B.P. bulb to the fresh gas outlet, and perform the following test:

4.12.15.1 Open the oxygen cylinder valve and allow the pressure to stabilize. (The cylinder pressure must be at least 1000 psi for this test.)

4.12.15.2 Release any pressure that is indicated on the test gauge.

4.12.15.3 Over the next 60 seconds, the test gauge should not show a pressure increase greater than 2 cm H_2O.

4.12.15.4 Increase the pressure to 50 cm H_2O.

4.12.15.5 The pressure should not drop more than 10 cm H_2O in the next 30 seconds.

4.12.15.6 Disconnect the test gauge from the fresh gas outlet.

4.12.15.7 Close the oxygen cylinder valve.

4.12.15.8 The pressure should not drop more than 50 psi in two minutes.

4.12.15.9 Connect a volumeter to the fresh gas outlet, and reset the volumeter to zero.

4.12.15.10 Press the O_2 Flush button and observe the flow rate. It should be between 45 and 65 liters per minute.

4.12.15.11 Disconnect the volumeter from the fresh gas outlet.

4.12.16 Connect the absorber fresh gas hose to the fresh gas outlet.

4.12.17 Reinstall the table top and tighten its mounting screws.

4.12.18 Connect the pipeline hoses.

4.12.19 Perform the PMS Procedure given in Section 6.

4.13 AV-2+ Ventilator Controller Assembly

The Ventilator Controller assembly is attached to the left front panel of the ventilator box and includes electrical and pneumatic components. Figure 4-13 shows the mounting screw locations and connections to the ventilator controller.

4.13.1 Turn the System Power switch to STANDBY and remove AC power from the machine.

4.13.2 Disconnect all pipeline hoses and close all cylinder valves.

CAUTION: The controller circuit board contains static sensitive devices. Use ESD protection when handling the controller assembly.

4.13.3 Remove the two screws securing the left end of the ventilator controller panel.

4.13.4 Pull the left side of the panel outward, slide it to the left until the locking tab on the right side of the panel is clear of its receptacle, then pull the assembly out far enough to gain access to its connections.

4.13.5 Disconnect the alarm channel wiring harness from J2 on the controller circuit board, and disconnect the Man/Auto selector interface cable from J7 on the circuit board.

4.13.6 Disconnect the following large and small diameter pneumatic tubing (the letters are keyed to the illustration):

A: Small dia. tube from solenoid to rear vent fitting on bellows box
B: Large dia. tube from supply valve to venturi
C: Small dia. tube to auto-ranging valve
D: Large dia. tube from main switch (O_2 supply)

4.13.7 Remove the controller assembly from the machine.

4.13.8 Position the replacement controller assembly in the ventilator box and reconnect the four pneumatic lines.

4.13.9 Reconnect the alarm channel wire harness to J2 on the controller circuit board, and the Man/Auto selector interface cable to J7 on the circuit board.

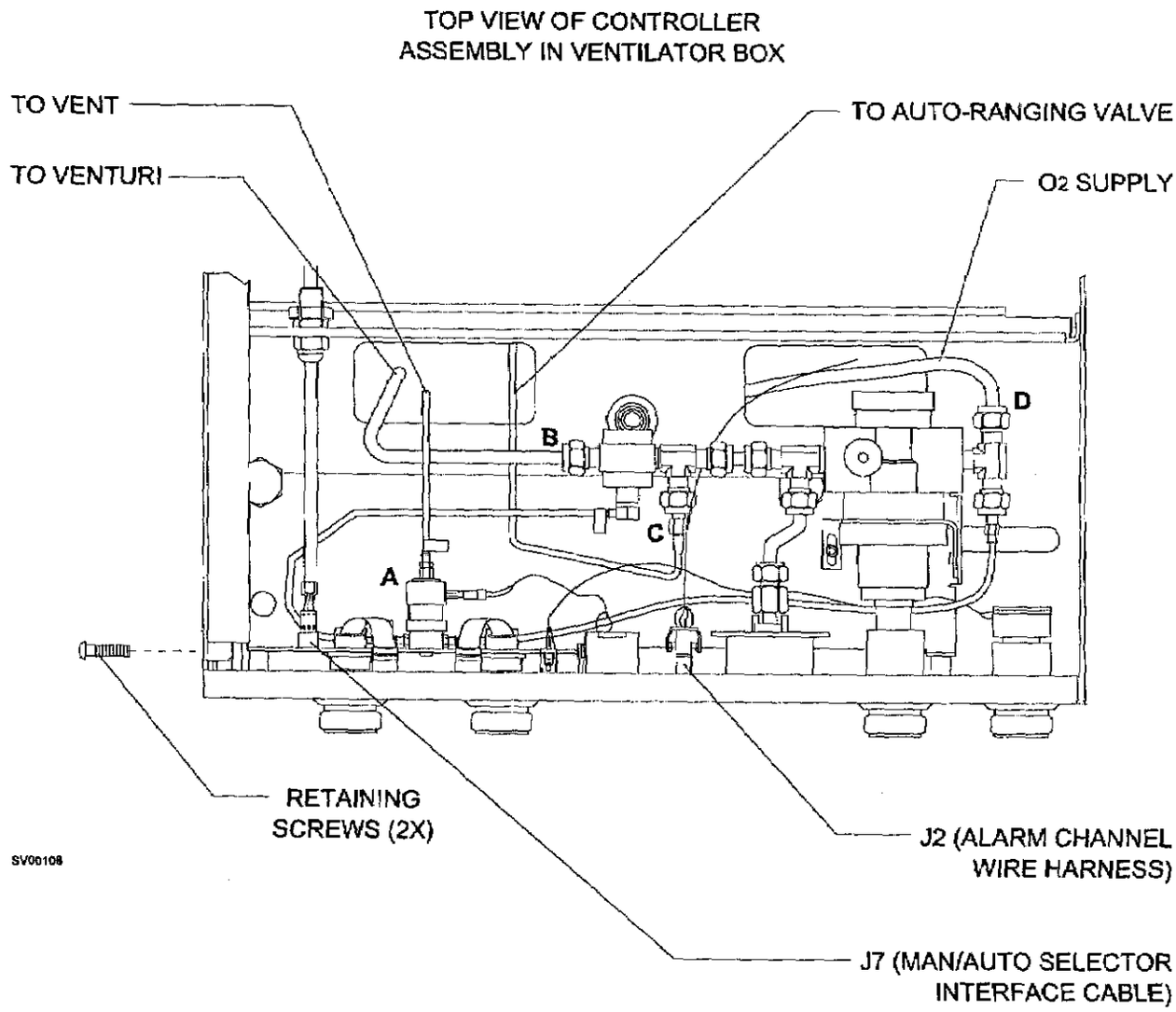


Figure 4-13: AV2+ VENTILATOR CONTROLLER ASSEMBLY

4.13.10 Slide the controller into the ventilator box, carefully fit the locking tab into its receptacle at the right side of the panel, and slide the assembly to the right until it is properly seated.

4.13.11 Reinstall the two retaining screws at the left side of the panel.

4.13.12 Perform the PMS Procedure given in Section 6.

4.14 Ventilator Bellows Valve and Guide Assembly with Pressure Limit Control

The Ventilator Bellows Valve and Guide Assembly, and the Pressure Limit Control are located in the bellows box on the left side of the machine. Access to the components requires removal of the bellows box front panel, and removal of the upper bellows support plate from the bellows box. Figure 4-14 shows the pneumatic connections and the mounting arrangement of the components.

4.14.1 Turn the System Power switch to STANDBY, and remove AC power from the machine.

4.14.2 Close all cylinder valves, and disconnect the pipeline hoses from the machine.

4.14.3 Press the O_2 Flush button to relieve pressure from the system.

4.14.4 Adjust the TIDAL VOLUME control to raise the volume indicator to its minimum setting.

4.14.5 Disconnect the breathing hose and the scavenger hose from the bellows assembly. Loosen the wing nuts and remove the bellows assembly.

4.14.6 Remove the canister from the bellows box by pulling it downward.

4.14.7 Unscrew the bellows adjustment tube from the bellows valve assembly.

4.14.8 Remove the screws holding the bellows box front panel and knob assemblies, and remove the panel.

4.14.9 Loosen the rear support plate screw, and remove the two front support plate screws.

4.14.10 Pull the support plate forward, then lower it to a point where the tubing connections are accessible.

4.14.11 Disconnect the large diameter tubing from the venturi, and the small diameter tubing from the auto-ranging valve.

4.14.12 Carefully remove the assembly from the machine.

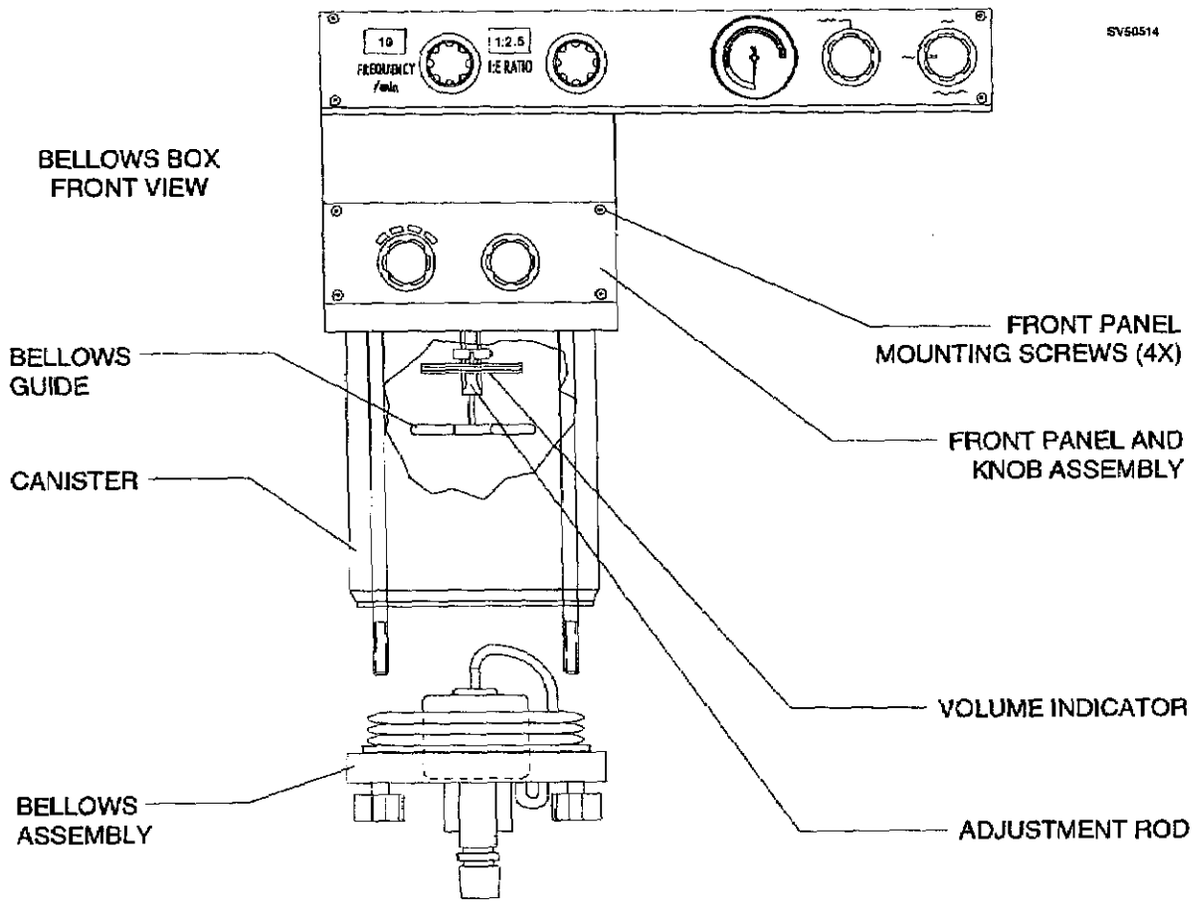


Figure 4-14: TIDAL VOLUME ADJ. & VALVE CASE ASSEMBLY

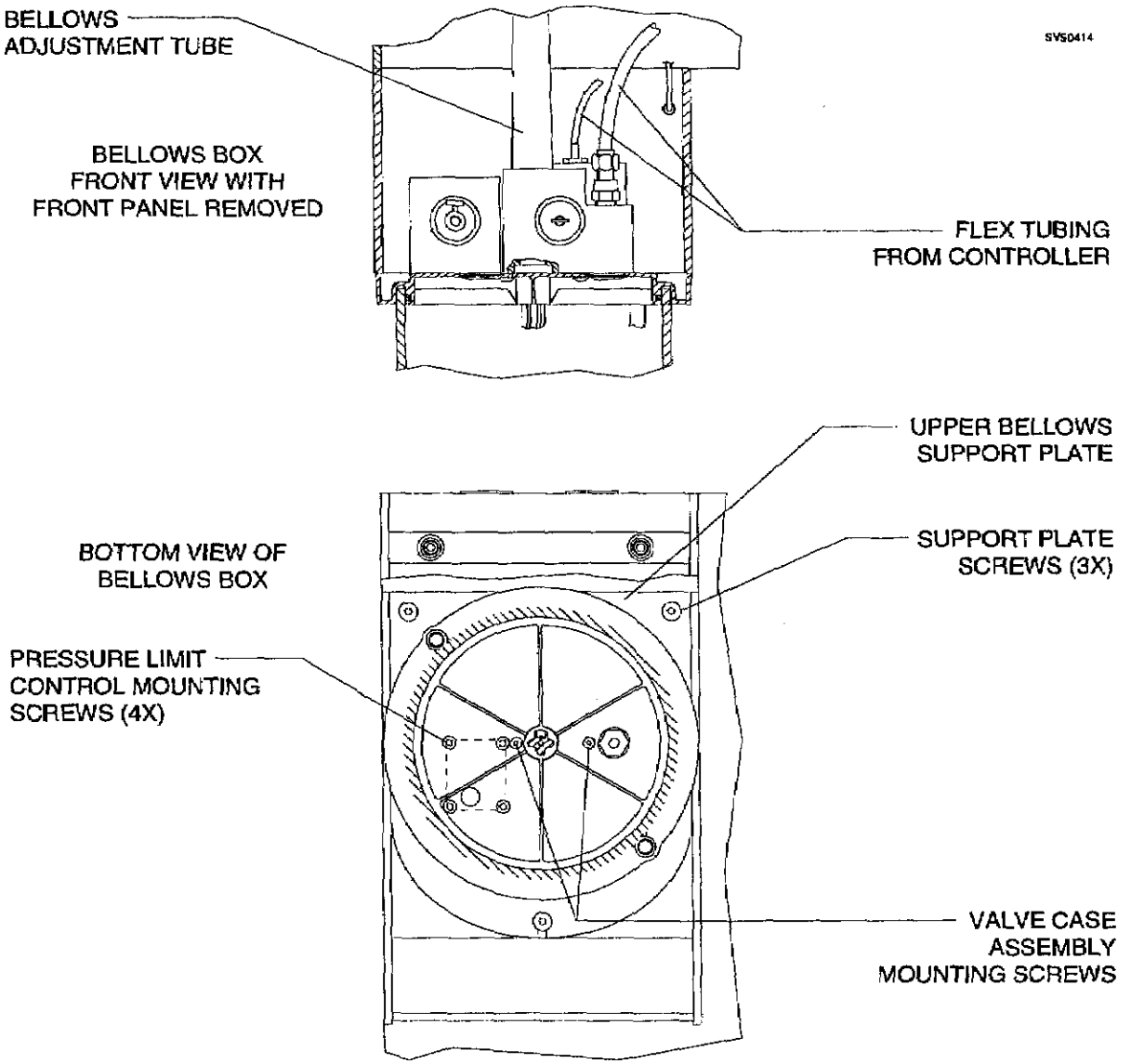


Figure 4-14: TIDAL VOLUME ADJ. & VALVE CASE ASSEMBLY (continued)

4.14.13 Unscrew the bellows adjustment tube from the replacement bellows valve.

4.14.14 Position the support plate in the bellows box and reconnect the large and small diameter tubing that was previously removed.

4.14.15 Slide the support plate up and to the rear until it is seated properly in the bellows box.

4.14.16 Reinstall the two front support plate screws, and tighten the rear support plate screw.

4.14.17 Reinstall the bellows adjustment tube on the bellows valve.

4.14.18 Place the bellows box front panel into position, ensure that the slots in the knob assemblies are correctly aligned with their drive pins on the bellows adjustment and pressure limit control shafts, and reinstall the screws holding the front panel to the machine.

4.14.19 Replace the bellows canister; ensure that its markings are facing forward.

4.14.20 Replace the bellows assembly and tighten the wing nuts holding it in place.

4.14.21 Reconnect any hoses that were previously removed from the bellows assembly.

4.14.22 Reconnect the pipeline hoses and AC power cord.

4.14.23 Perform the PMS Procedure given in Section 6.

4.15 Caster

Each caster is retained by a set screw in the side of the lower frame rail as shown in Figure 4-15. Caster replacement requires that the machine be tilted to provide enough clearance for the caster stem to be withdrawn from the bottom of the frame rail.

WARNING: Do not tilt the machine more than 10 degrees or raise the casters more than 3½ inches from the floor. Failure to observe this precaution may result in a tip-over, causing personal injury. Vaporizers containing anesthetic agent may also be damaged.

4.15.1 Obtain a brace capable of supporting one side of the machine with its casters two to three inches from the floor.

4.15.2 Remove all unsecured equipment and accessories from the machine.

4.15.3 Lock the front casters.

4.15.4 Using at least two people, tilt the machine until the casters on one side are raised two to three inches from the floor, and position the support brace under the frame rail between the front and back casters.

4.15.5 Remove the plastic cap in the side of the frame rail to provide access to the caster stem set screw.

4.15.6 Loosen the set screw and remove the caster.

4.15.7 Insert the replacement caster into the frame and hold it in its seated position.

4.15.8 Tighten the caster stem set screw and replace the plastic cap in the frame rail.

4.15.9 Using at least two people, tilt the machine, remove the support brace and carefully lower the machine to the floor.

4.15.10 Check for proper operation of the caster and ensure that the front casters lock properly.

4.15.11 Perform the PMS Procedure given in Section 6, including a vaporizer calibration verification.

4.15.12 Replace any unsecured equipment and accessories that were previously removed.

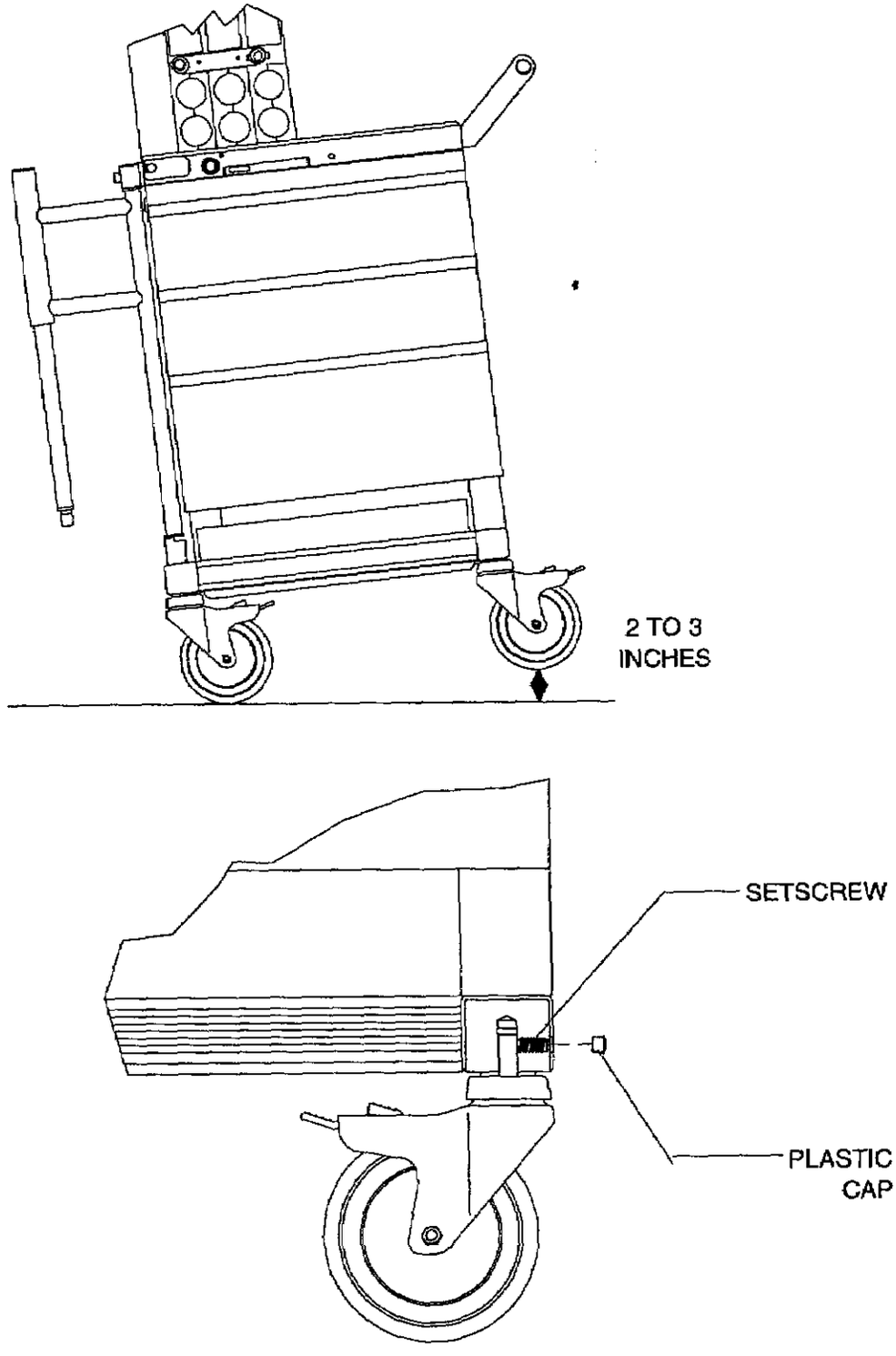


Figure 4-15: CASTER REPLACEMENT

4.16 Battery

The backup battery is located in the bottom of the power supply compartment on the back of the machines. Access to the battery requires removal of the power supply compartment cover. Figure 4-16 shows the battery connection and mounting arrangement.

4.16.1 Turn the System Power switch to STANDBY and remove AC power from the machine.

4.16.2 Disable the circuit breakers on the back panel by pulling out each button with a knife or sharp object.

WARNING: Ensure that AC power is removed from the machine before opening the power supply compartment cover. Failure to observe this precaution may cause injury by electric shock.

4.16.3 Remove the screws holding the power supply compartment cover, and remove the cover.

4.16.4 Loosen the captive mounting screw holding the battery retainer bar, and remove the retainer bar.

4.16.5 Disconnect the battery wire harness from the battery terminals. Note the wire color and position of the wires so that the harness can be reinstalled in the same manner.

4.16.6 Remove the battery from the compartment.

4.16.7 Ensure that the replacement battery is wrapped in a protective bag in the same manner as the original.

Place the replacement battery in the compartment, with the terminals oriented as shown in the illustration.

4.16.8 Reinstall the battery retainer bar by placing its tab through the slot in the bracket, and tightening the captive mounting screw at the other end of the bar.

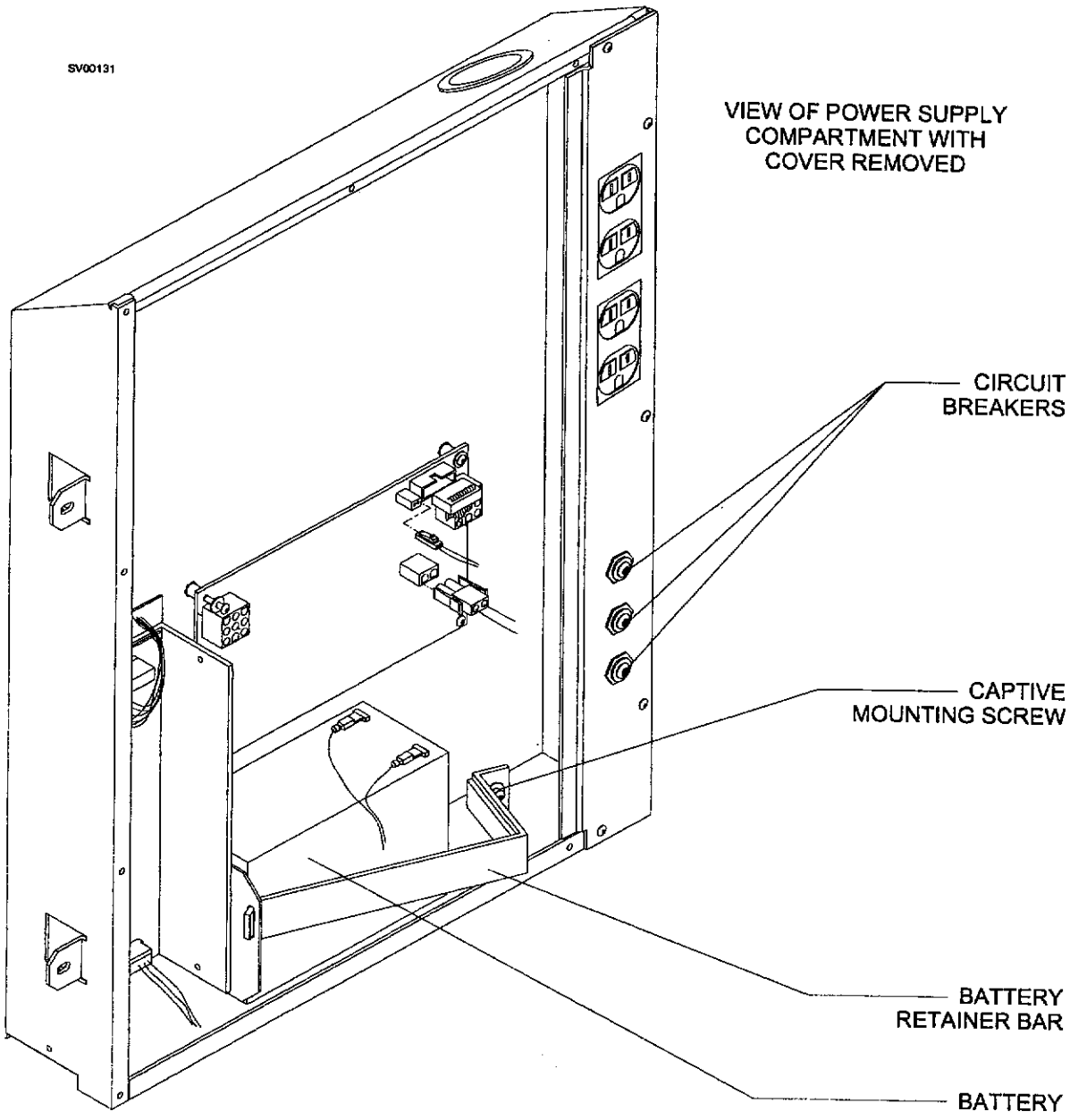


Figure 4-16: BATTERY REPLACEMENT

4.16.9 Connect the battery wire harness to the battery terminals with the black wire to the (-) terminal, and the yellow wire to the (+) terminal.

4.16.10 Reinstall the power supply compartment cover with the screws that were previously removed.

4.16.11 Enable the circuit breakers and restore power to the machine.

4.16.12 Perform the PMS Procedure given in Section 6.

4.17 Primary Power Supply

The primary power supply is located in the power supply compartment on the back of the machine. Access to the primary power supply requires removal of the power supply compartment cover. Figure 4-17 shows the primary power supply connection and mounting arrangement.

4.17.1 Turn the System Power switch to STANDBY and remove AC power from the machine.

4.17.2 Disable the circuit breakers on the side of the power supply compartment by pulling out each button with a knife or sharp object.

WARNING: Ensure that AC power is removed from the machine before opening the power supply compartment cover. Failure to observe this precaution may cause injury by electric shock.

4.17.3 Remove the screws holding the power supply compartment cover, and remove the cover.

4.17.4 Disconnect the input wire harness from J1 on the power supply, and disconnect the output wire harness from J3.

4.17.5 Loosen the captive mounting screw holding the battery retainer bar, and remove the retainer bar.

4.17.6 Remove the four nuts holding the mounting plate bracket and power supply to the back of the compartment, and remove the assembly from the compartment.

4.17.7 Separate the power suply from the mounting plate bracket by removing the four retaining screws from the back of the plate.

4.17.8 Install the replacement power supply on the mounting plate bracket using the hardware removed in the previous step.

4.17.9 Reinstall the mounting plate bracket in the power supply compartment with the four nuts that were previously removed.

4.17.10 Reinstall the battery retainer bar and tighten its captive mounting screw.

4.17.11 Connect the output wire harness to J3 on the power supply, and the input wire harness to J1.

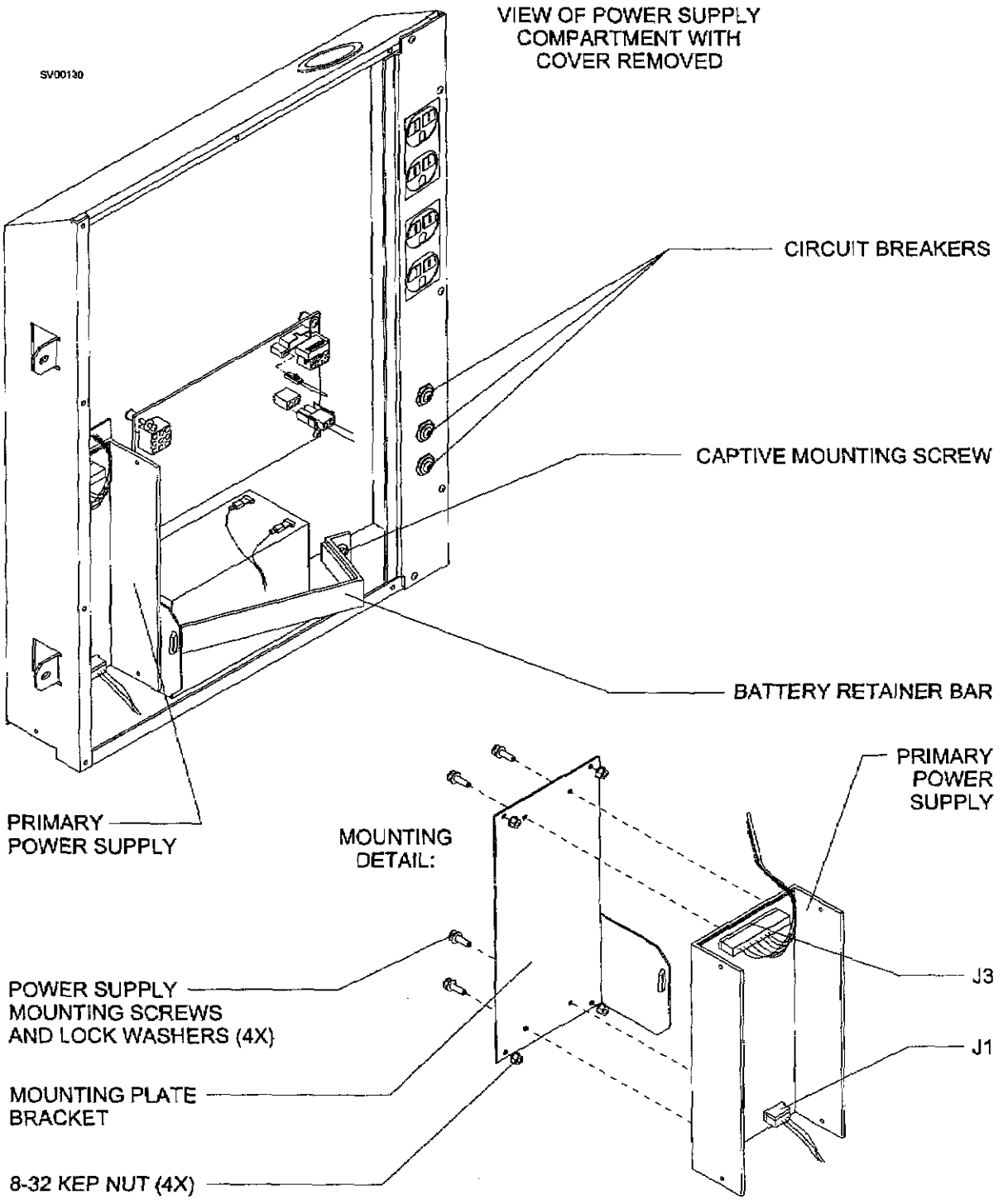


Figure 4-17: PRIMARY POWER SUPPLY REPLACEMENT

4.17.12 Reinstall the power supply compartment cover with the screws that were previously removed.

4.17.13 Enable the circuit breakers and restore power to the machine.

4.17.14 Perform the PMS Procedure given in Section 6.

4.18 Power Supply PCB

The power supply PCB is located in the power supply compartment on the back of the machine. Access to the power supply PCB requires removal of the power supply compartment cover. Figure 4-18 shows the power supply PCB connection and mounting arrangement.

4.18.1 Turn the System Power switch to STANDBY and remove AC power from the machine.

4.18.2 Disable the circuit breakers on the side of the power supply compartment by pulling out each button with a knife or sharp object.

WARNING: Ensure that AC power is removed from the machine before opening the power supply compartment cover. Failure to observe this precaution may cause injury by electric shock.

4.18.3 Remove the screws holding the power supply compartment cover, and remove the cover.

4.18.4 Disconnect the following from the power supply PCB:

J1: Output wire harness to processor PCB
J2: Ribbon cable from alarm channel PCB
J5: Power ON indicator lamp
J6: Battery wire harness
J3: Wire harness from primary power supply

4.18.5 Remove the four screws and lock washers holding the power supply PCB, and remove the assembly.

4.18.6 Install the replacement power supply PCB assembly using the hardware removed in the previous step.

4.18.7 Re-connect the cables and wire harnesses that were previously disconnected.

4.18.8 Reinstall the power supply compartment cover with the screws that were previously removed.

4.18.9 Enable the circuit breakers and restore power to the machine.

4.18.10 Perform the PMS Procedure given in Section 6.

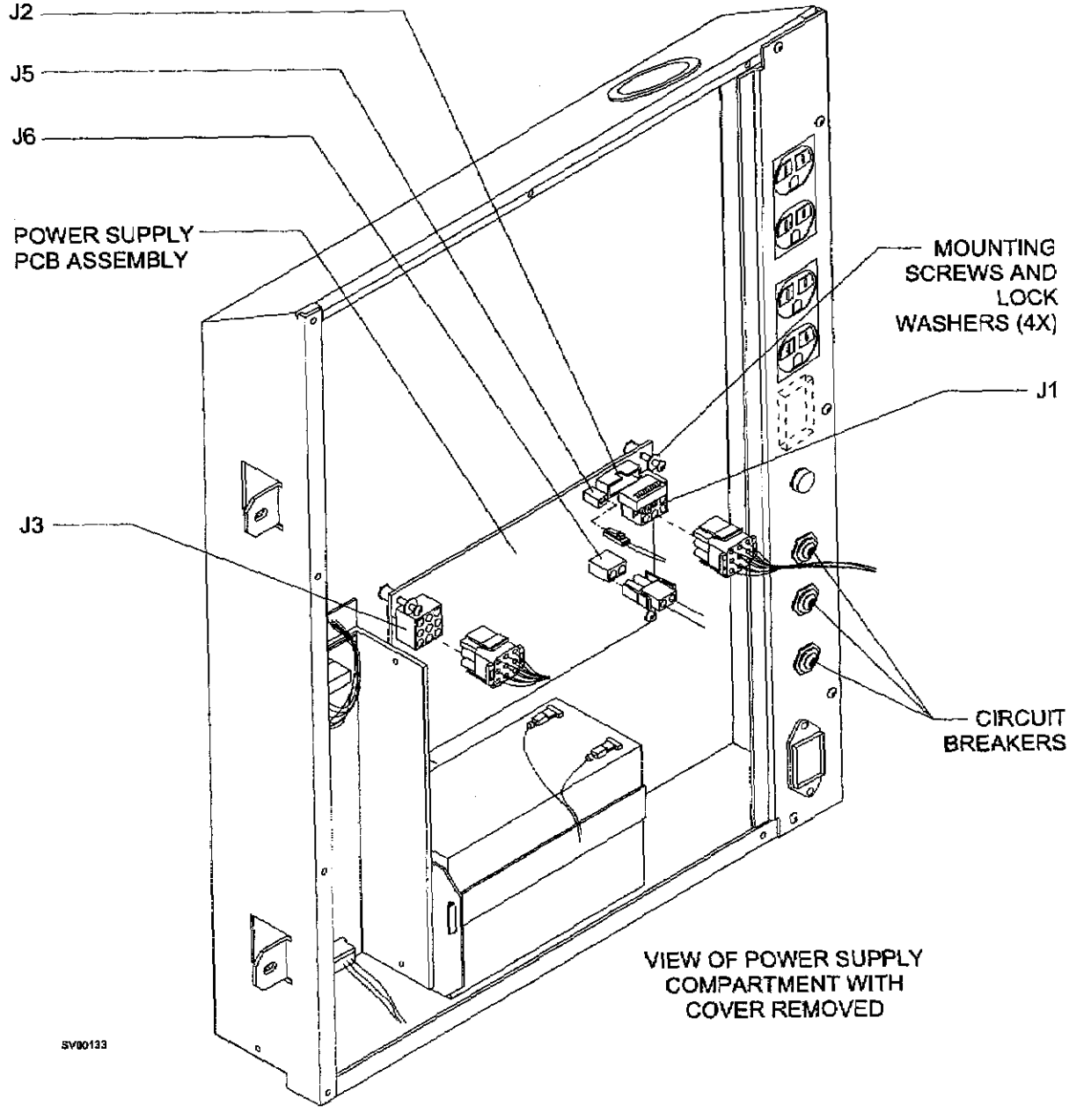


Figure 4-18: POWER SUPPLY PCB ASSEMBLY REPLACEMENT

4.19 Lamp Assembly

The lamp assembly contains a 12V lamp, rocker switch and wire harness as shown in Figure 4-19. The tab on the left side of the assembly fits into a rectangular opening in the underside of the display assembly, and the lamp assembly is retained by a single screw.

4.19.1 Turn the System Power switch to STANDBY.

4.19.2 Remove the lamp assembly retainer screw; lower and turn the assembly to remove it from the opening in the bottom of the display assembly.

4.19.3 Carefully separate the in-line connector on the wire harness.

NOTE: The next four steps apply if you are replacing the bulb (and not the entire assembly).

CAUTION: Do not touch the glass envelope of the bulb, as finger oil will damage the bulb.

4.19.4 Firmly grasp the lamp assembly, and slide the black heat sink from the assembly.

4.19.5 Remove the bulb by sliding it out of the socket.

4.19.6 Install the replacement bulb in the socket in the same manner as the original.

4.19.7 Reinstall the lamp heat sink.

4.19.8 Join the connector on the replacement lamp assembly to the wire harness on the machine.

4.19.9 Install the replacement lamp assembly in the underside of the display assembly by inserting the tab into the opening, then raise the lamp assembly into position and reinstall the retainer screw.

4.19.10 Turn the System power switch to ON and verify that the lamp is working properly.

4.19.11 Perform the PMS Procedure given in Section 6.

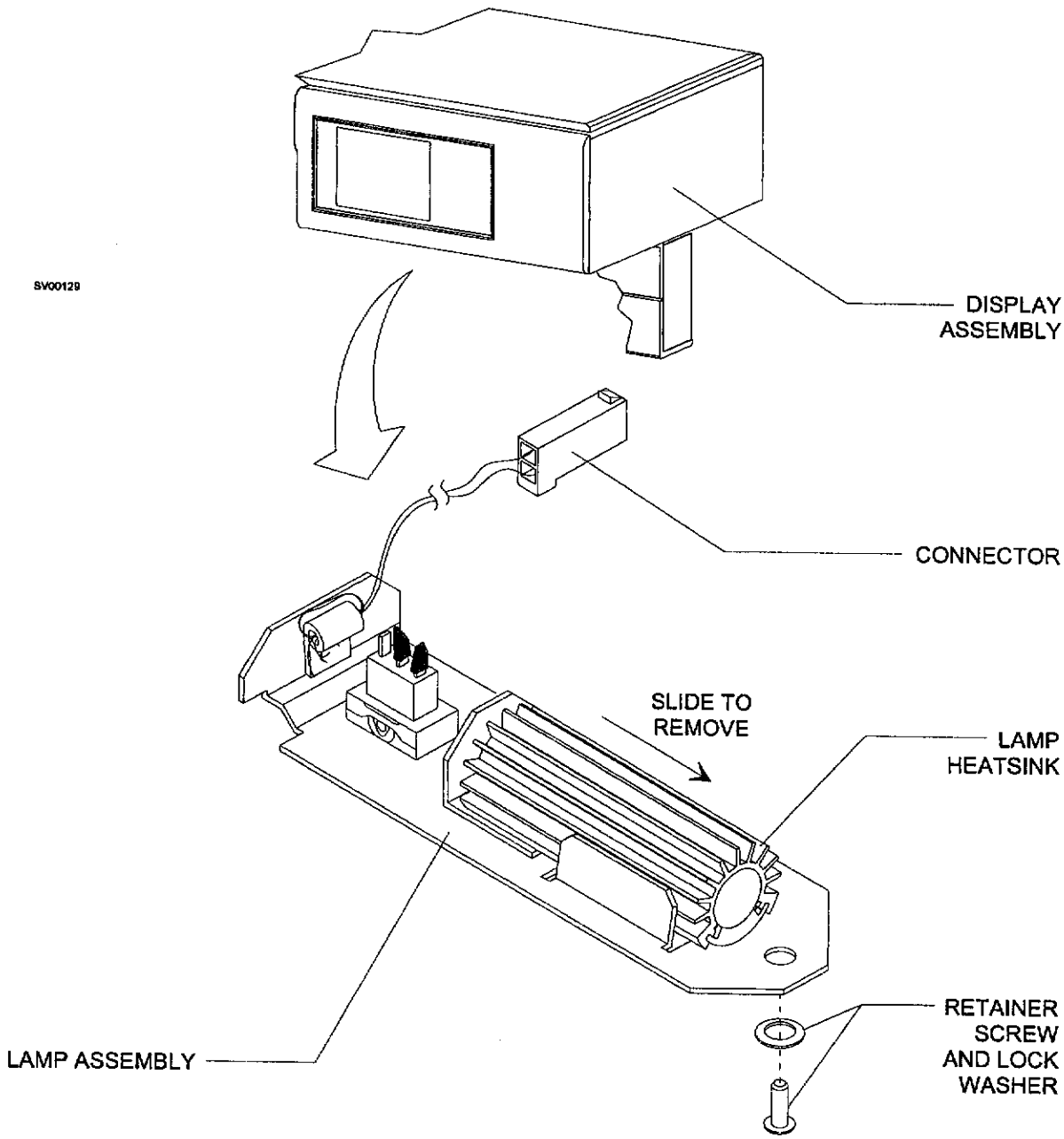


Figure 4-19: LAMP ASSEMBLY REPLACEMENT

4.20 Processor Assembly

Access to the processor assembly requires removal of the vent box back panel, and removal of the processor mounting screws. The assembly can then be pulled out for access to the cables. Figure 4-20 shows the mounting arrangement and cable connections to the processor board.

4.20.1 Turn the System Power switch to STANDBY and remove AC power from the machine.

4.20.2 Disconnect the following items from their connectors at the underside of the vent box:

Data cable
Volume sensor interface cable
O_2 sensor interface cable
Breathing pressure line (quick-disconnect fitting)

CAUTION: The processor board contains static sensitive devices. Use ESD protection when handling the processor assembly.

4.20.3 Remove the vent box back panel screws.

4.20.4 At the underside of the vent box, remove the three screws holding the processor assembly to the vent box.

4.20.5 Pull the processor assembly outward and then down to gain access to its cables.

4.20.6 Disconnect the following from the processor board:

J104: Vaporizer select switch wire harness
J105: Alarm channel ribbon cable
J14: Power supply wire harness
J4: Keypad ribbon cable
J204: Display ribbon cable

4.20.7 Inspect the jumper on JP6 (top PCB) on the replacement processor assembly and ensure it is installed on both pins of JP6 before installing the processor assembly.

NOTE: This jumper is not placed on both pins of JP6 in order to prevent backup battery drain while the processor assembly is in stock.

4.20.8 Carefully remove the processor assembly from the vent box.

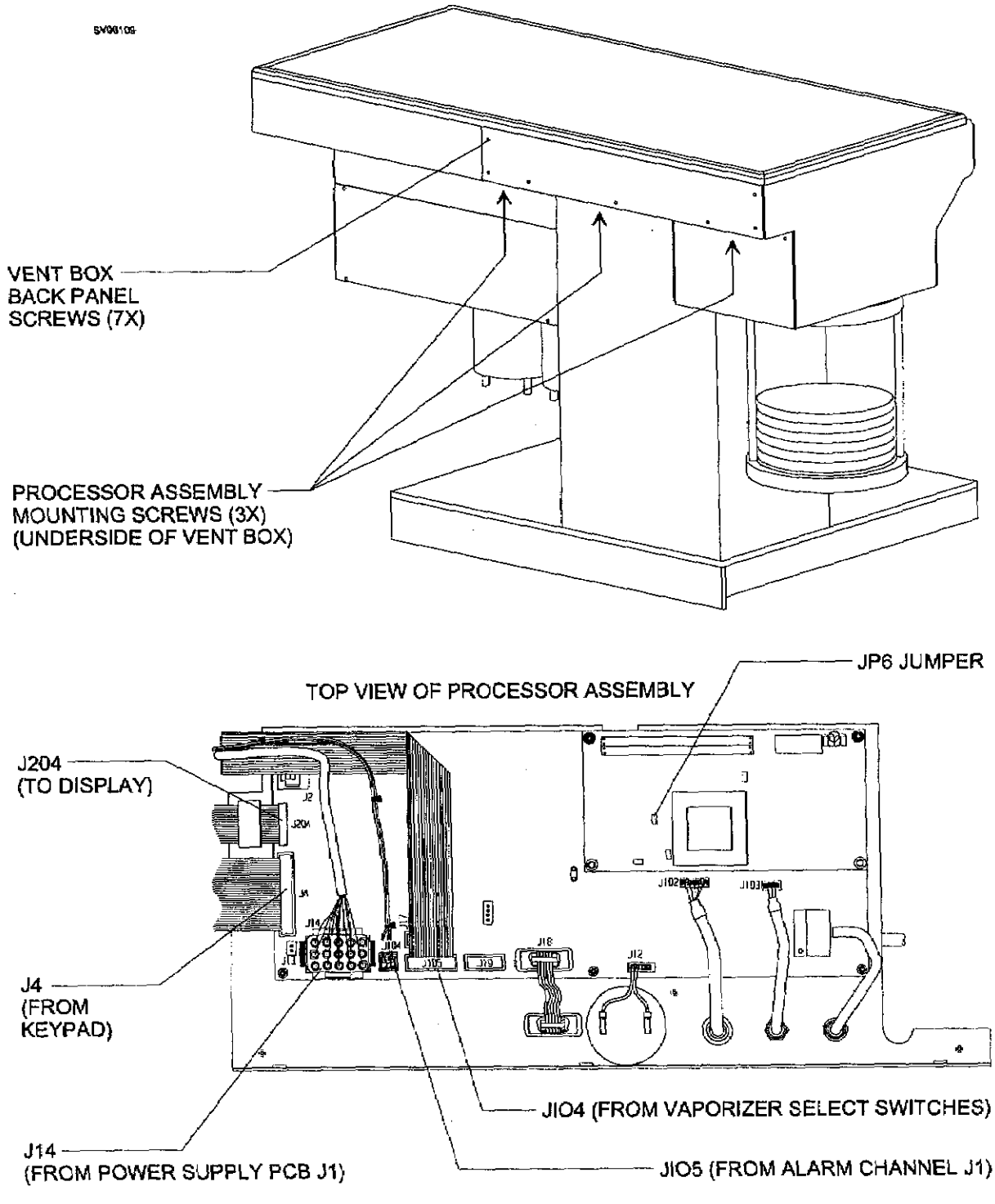


Figure 4-20: PROCESSOR ASSEMBLY REPLACEMENT

4.20.9 Carefully position the replacement processor assembly in the vent box, and connect all of the cables previously disconnected.

4.20.10 Slide the processor assembly into the vent box, making sure that its back apron is under the vent box.

Reinstall the three processor assembly mounting screws up through the processor chassis and into the threaded inserts in the vent box.

4.20.11 Reinstall the vent box back panel with the screws that were previously removed.

4.20.12 Restore power to the machine and observe the Power-Up Diagnostic display (see Section 2) to verify that the replacement processor is working properly.

4.20.13 Access the secondary service screen and enter the machine serial number and vaporizer configuration into memory. Contact the North American Dräger Technical Service Department for access instructions if necessary.

4.20.14 Perform the PMS Procedure given in Section 6.

4.21 Keypad and Display Panel

The keypad (switch panel) and display panel comprise a sandwich assembly held between the front bezel and a bezel plate on the back as shown in Figure 4-21. The keypad and the display panel are independently replaceable, as outlined in the following disassembly and re-assembly sequence.

4.21.1 Turn the System Power switch to STANDBY and remove AC power from the machine.

4.21.2 Remove the bezel retainer screws at the right side of the display box.

4.21.3 Pull the right side of the bezel outward, slide it to the right until the locking tab on the left side of the bezel is clear of its receptacle, then pull the assembly out far enough to gain access to its connections.

4.21.4 Disconnect the ground wire and ribbon cables from the bezel assembly.

4.21.5 Remove the display panel cover from the back of the assembly.

4.21.6 Separate the bezel plate from the bezel by removing the four bezel plate screws, and lift out the keypad and display panel.

4.21.7 Remove the four nuts holding the display panel to the keypad, and remove the display panel.

NOTE: If you are replacing the keypad, transfer the spacers to the studs on the replacement keypad.

4.21.8 Assemble the keypad (or replacement keypad) and the display panel (or replacement display panel) using the nuts and lock washers that were previously removed.

4.21.9 Place the keypad and display panel into the bezel, and reattach the bezel plate using the screws and lock washers that were previously removed.

4.21.10 Reinstall the display panel cover using the screws and lock washers that were previously removed.

4.21.11 Re-connect the ribbon cables and ground wire.

4.21.12 Slide the bezel assembly into the display box, carefully fit the locking tab into its receptacle at the left side of the panel, and slide the assembly to the left until it is properly seated.

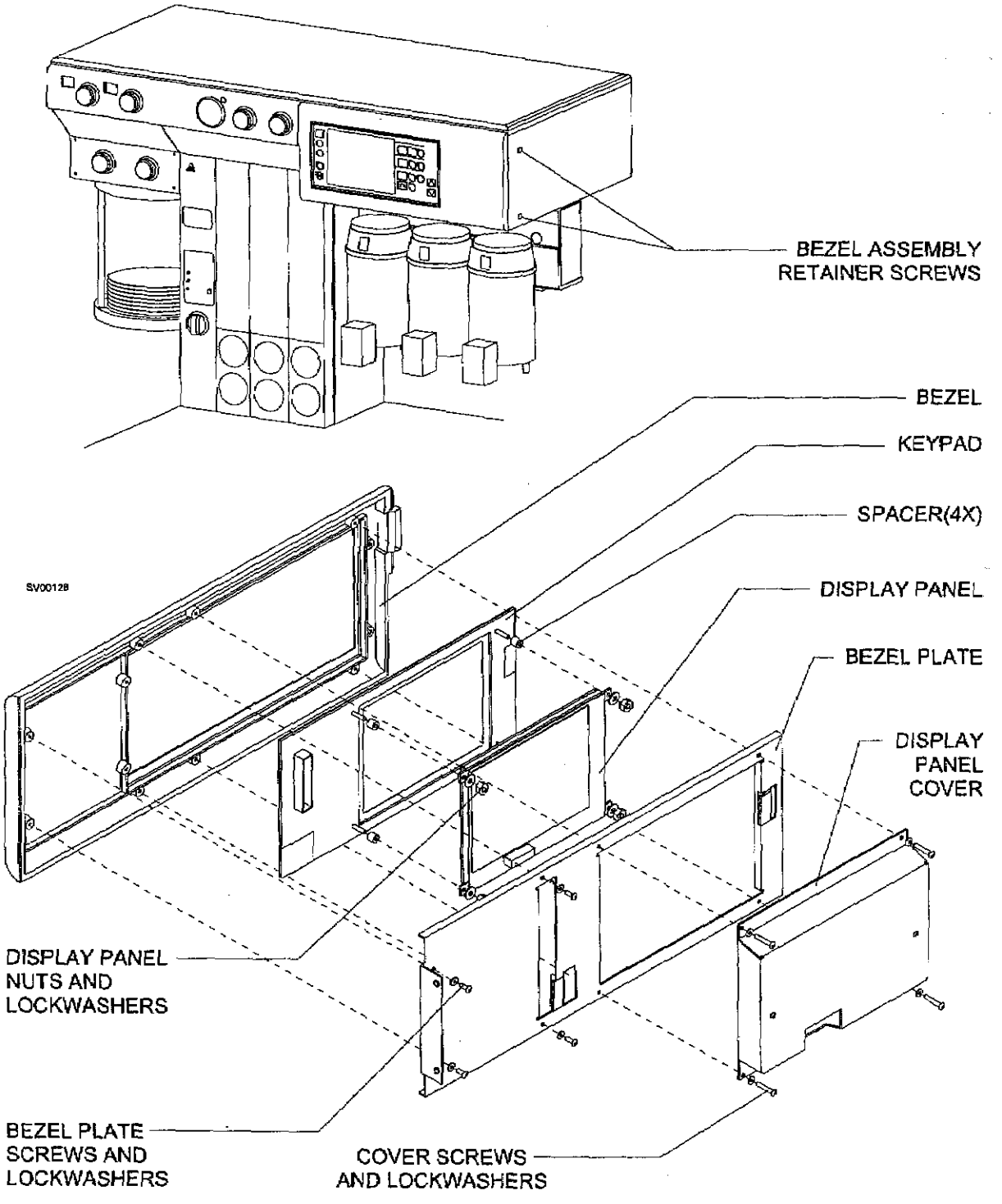


Figure 4-21: KEYPAD AND DISPLAY PANEL REPLACEMENT

4.21.13 Reinstall the bezel assembly retaining screws at the right side of the display box.

4.21.14 Perform the PMS Procedure given in Section 6.

4.22 SPIROMED Respiratory Volume Sensor

The respiratory volume sensor is installed between the top of the absorber assembly and the expiratory valve. Figure 4-22 shows the volume sensor mounting and gasket arrangement, and its interface cable connection on the underside of the vent box.

4.22.1 Turn the System Power switch to STANDBY.

4.22.2 Disconnect the sensor plug from the volume sensor receptacle on the vent box.

4.22.3 Remove the expiratory valve by unscrewing the valve retaining nut.

4.22.4 Remove the volume sensor from the absorber assembly by unscrewing its retaining nut.

CAUTION: Do not twist the body of the sensor when loosening the retaining nut. Hold the sensor while loosening the retaining nut to prevent damage to the unit.

4.22.5 Install the replacement volume sensor on the absorber assembly. Ensure that the gasket is seated properly and hand tighten the retaining nut.

4.22.6 Install the expiratory valve on the sensor. Ensure that the gasket is seated properly and hand tighten the valve retaining nut.

4.22.7 Connect the sensor plug to the volume sensor receptacle on the vent box.

4.22.8 Restore power to the machine and perform the respiratory flow monitor calibration procedure given in Section 5.

4.22.9 Perform the PMS Procedure given in Section 6.

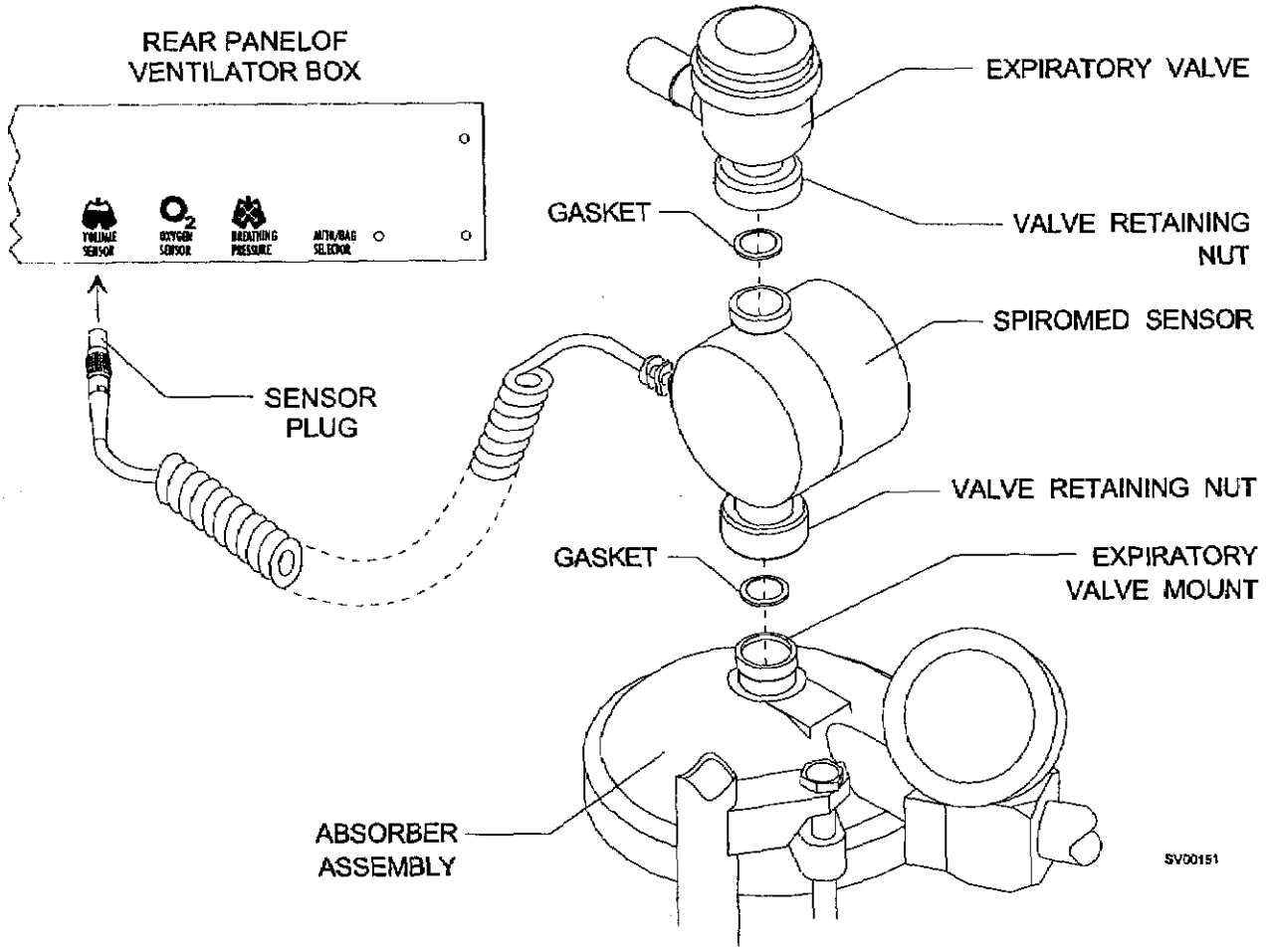


Figure 4-22: RESPIRATORY VOLUME SENSOR

4.23 Oxygen Sensor

The oxygen sensor is located on top of the inspiratory valve. Figure 4-23 shows the arrangement of the sensor capsule and its housing, and also its interface cable connection on the underside of the vent box.

4.23.1 Turn the System Power switch to STANDBY.

4.23.2 Pull the oxygen sensor housing from the inspiratory valve dome. (It is a press fit.)

4.23.3 Unscrew the cover from the sensor housing and remove the sensor capsule.

4.23.4 Remove the replacement sensor capsule from its shipping container and install it in the housing. Ensure that the copper rings on the capsule mate with the electrical contacts in the sensor housing.

4.23.5 Wait 15 minutes to allow the sensor capsule to stabilize.

4.23.6 Restore power to the machine and perform the 21% calibration procedure for the oxygen monitor given in Section 5.

4.23.7 Press the sensor assembly into the inspiratory valve dome.

4.23.8 Perform the PMS Procedure given in Section 6.

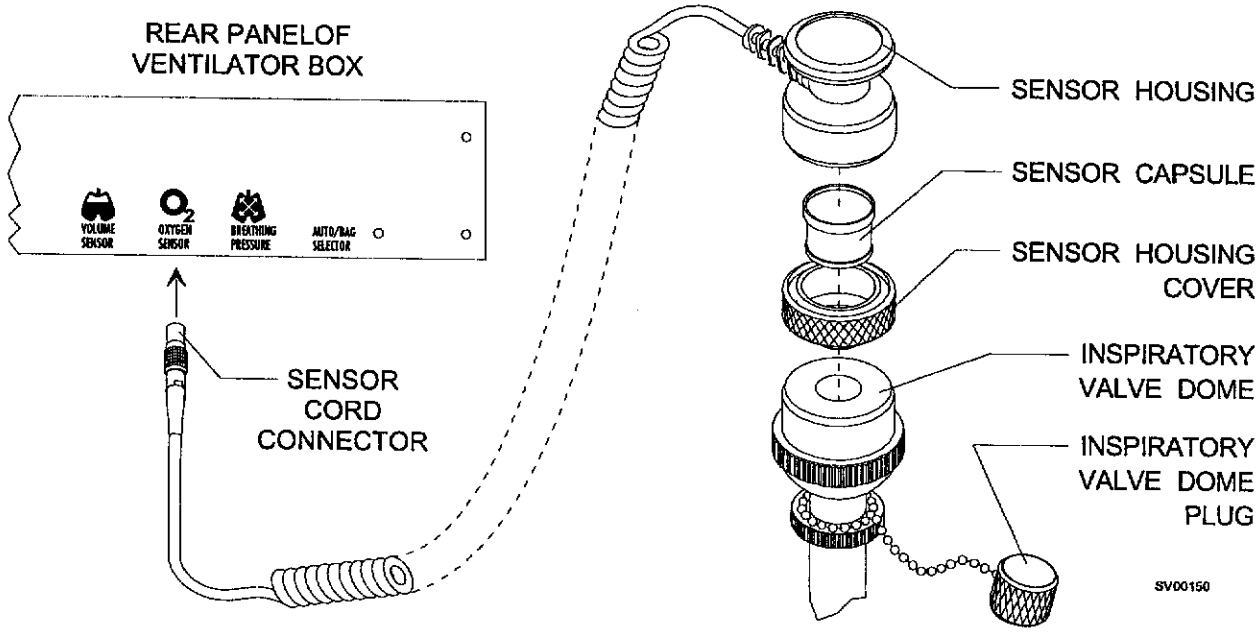


Figure 4-23: OXYGEN SENSOR REPLACEMENT

5.0 ADJUSTMENT AND CALIBRATION PROCEDURES

Equipment Required:

-- Test Gauge for setting cylinder pressure regulators,
NAD Part No. S000063A

-- Oxygen Monitor for adjusting Oxygen Ratio Controller

-- Test fixture with breathing pressure line connector, TEE connector, gauge, and inflation device, for breathing pressure monitor calibration

-- Exclusion system adjustment gauge (0.066 in.), NAD Part No. 4114238

5.1 Cylinder Pressure Regulator Adjustment (except CO_2)

5.1.1 Disconnect all pipeline hoses and set the System Power switch to ON.

5.1.2 Close all cylinder valves except the O_2 valve.

5.1.3 Set the oxygen flow to 4 liters per min.

5.1.4 Open the other gas flow control valves to drain pressure from the system.

5.1.5 Close all of the flow control valves and press the O_2 Flush valve to drain oxygen pressure from the system.

5.1.6 Turn the System Power switch to STANDBY.

5.1.7 Loosen the screws holding the table top to the machine and lift out the table top.

5.1.8 Pull the writing tray out to its fully extended position.

5.1.9 Locate the TEE fitting in the ¼ in. diameter regulator output line, and remove the plug from the TEE fitting.

5.1.10 Connect a test gauge to the TEE fitting.

5.1.11 Open the cylinder valve and set the System Power switch to ON.

5.1.12 Set the gas flow to 4 liters per min.

5.1.13 Remove the acorn nut on the bottom of the regulator to expose the adjusting screw. Turn the screw until the test gauge indicates 46 psi. [On Canada machines, set the pressure to 50 psi for O_2, N_2O and Air.]

5.1.14 Replace the acorn nut on the bottom of the regulator.

5.1.15 Close the cylinder valve and allow pressure to drain from the system.

5.1.16 Close all of the flow control valves and set the System Power switch to STANDBY.

5.1.17 Disconnect the test gauge from the TEE fitting and replace the plug in the fitting.

5.1.18 Replace the table top and tighten its retaining screws.

5.1.19 Connect the pipeline hoses.

5.1.20 Perform the PMS Procedure given in Section 6.

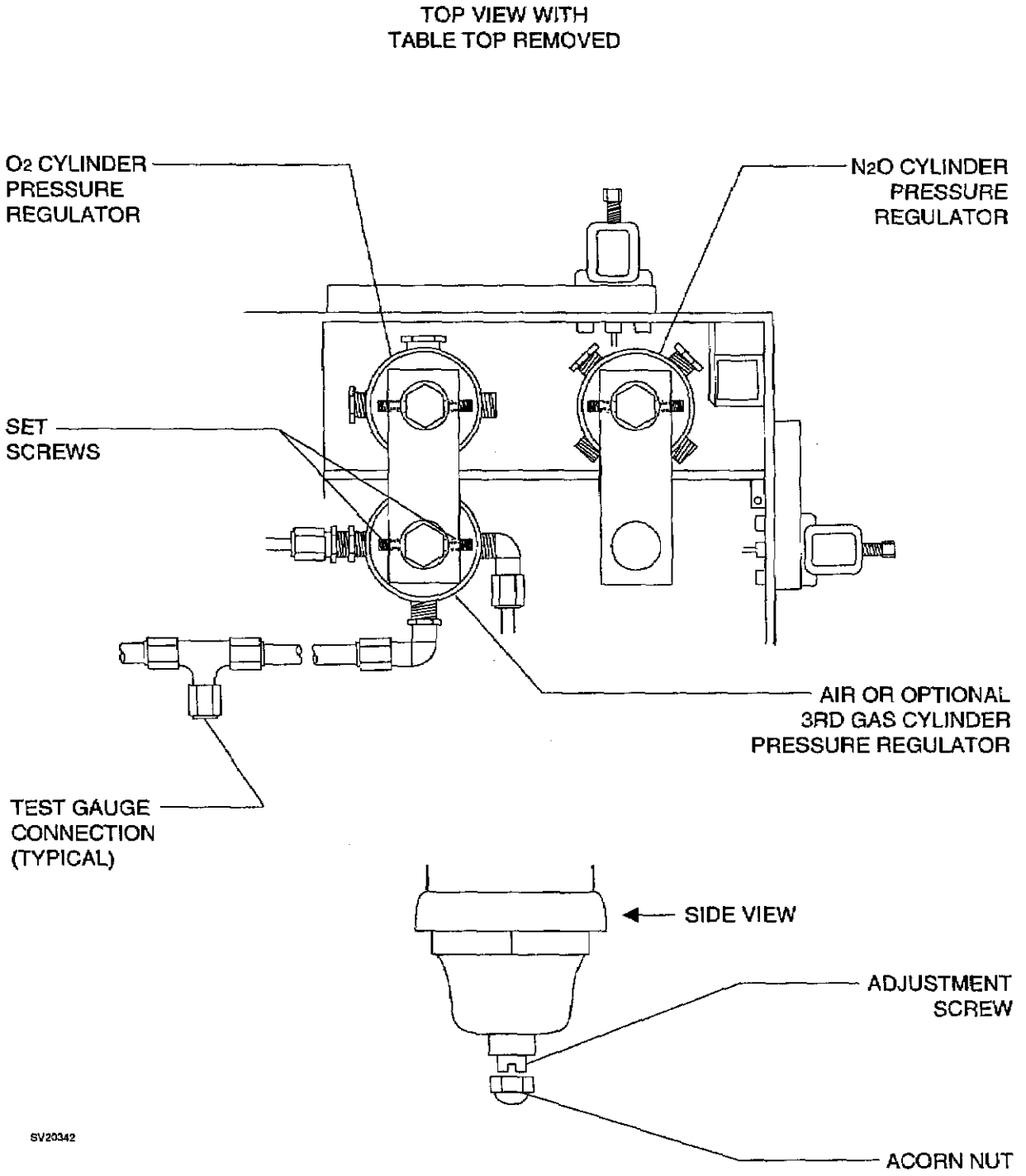


Figure 5-1: CYLINDER PRESSURE REGULATOR ADJUSTMENT

5.1A CO_2 Cylinder Pressure Regulator Adjustment

5.1.1.A Perform Steps 5.1.1 thru 5.1.7.

5.1.2.A Open the CO_2 cylinder valve and set the System Power switch to ON.

5.1.3.A Fully open the CO_2 flow control valve.

5.1.4.A Remove the acorn nut on the bottom of the CO_2 regulator to expose the adjusting screw. Turn the screw until the CO_2 flowmeter indicates 550 ml/min.

5.1.5.A Replace the acorn nut on the bottom of the regulator.

5.1.6.A Close the cylinder valve and allow pressure to drain from the system.

5.1.7.A Close the flow control valve and set the System Power switch to STANDBY.

5.1.8.A Replace the table top and tighten its retaining screws.

5.1.10.A Connect the pipeline hoses.

5.1.11.A Perform the PMS Procedure given in Section 6.

5.2 Oxygen Supply Pressure Alarm Switch Adjustment

5.2.1 Disconnect all pipeline hoses and set the System Power switch to ON.

5.2.2 Close all cylinder valves except the O_2 valve.

5.2.3 Set the oxygen flow to 5 liters per min.

5.2.4 Open the other gas flow control valves to drain pressure from the system.

5.2.5 Close the O_2 cylinder valve, and close the flow control valves. Press the O_2 Flush valve to drain oxygen pressure from the system.

5.2.6 Turn the System Power switch to STANDBY.

5.2.7 Remove the rear cover from the flowmeter housing. Remove the table top and pull the writing tray out to its fully extended position.

5.2.8 Locate the TEE fitting in the ¼ in. diameter regulator output line, and remove the plug from the TEE fitting.

5.2.9 Connect a dedicated O_2 test gauge to the TEE fitting.

5.2.10 Open the O_2 cylinder valve and turn the System Power switch to ON.

5.2.11 Set the oxygen flow to 5 liters per min.

5.2.12 Close the oxygen cylinder valve.

5.2.12 As the pressure drops, the O_2 SUPPLY alarm should activate when the pressure is between 40 and 34 psi as shown on the test gauge.

5.2.13 If the alarm activates when the pressure is below 34 psi or above 40 psi, turn the adjustment wheel (see illustration), repeat the test and adjust as necessary to bring the set point into the correct range.

5.2.14 Turn the System Power switch to STANDBY.

5.2.15 Disconnect the test gauge and replace the plug in the regulator line TEE fitting.

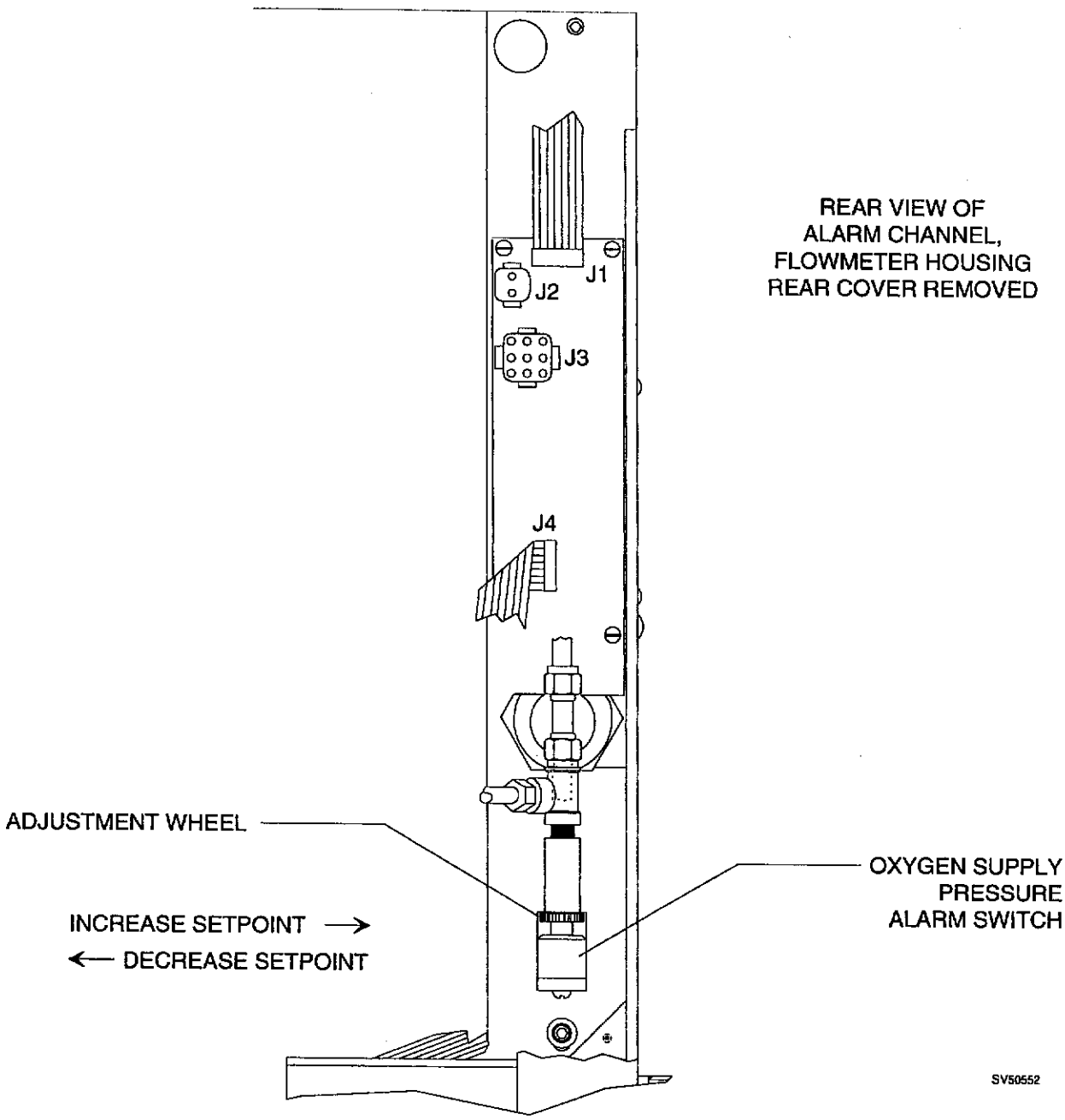


Figure 5-2: OXYGEN SUPPLY PRESSURE ALARM SWITCH

5.2.16 Replace the table top and tighten its retaining screws.

5.2.17 Replace the rear cover and its retaining screws.

5.2.18 Connect the pipeline hoses.

5.2.19 Perform the PMS Procedure given in Section 6.

5.3 Oxygen Ratio Controller (ORC) Adjustment

5.3.1 Remove the rear cover of the flowmeter housing.

5.3.2 Connect a calibrated oxygen monitor to the fresh gas outlet.

5.3.3 Disconnect the pipeline hoses.

5.3.4 Pinch the N_2O bypass line on the ORC. See Figure 5-3.

5.3.5 Open the oxygen and nitrous oxide cylinder valves.

5.3.6 Set the System Power switch to ON.

5.3.7 Close the O_2 and N_2O flow control valves.

5.3.8 Set the O_2 flow control valve to 10 l/min.

5.3.9 Set the N_2O flow control valve to 10 l/min.

5.3.10 Set the O_2 flow control valve to 800 ml/min for one (1) minute. Verify that the O_2 concentration indicates 21% to 29% O_2.

5.3.11 Decrease the oxygen flow rate.

5.3.12 If the nitrous oxide flow does not stop when the oxygen flow rate is between 325 and 350 ml per minute, loosen the adjusting screw locknut and turn the adjusting screw (counter-clockwise to decrease N_2O flow, clockwise to increase N_2O flow). Tighten the locknut.

5.3.13 Repeat steps 5.3.7 thru 5.3.12 until no further adjustment is needed.

5.3.14 Adjust the oxygen flow to a point where the nitrous oxide flowmeter indicates 10 liters per minute.

5.3.15 The oxygen concentration should be between 21% and 29% oxygen.

5.3.16 Slowly decrease the oxygen flow to 800 ml/min. The nitrous oxide flow should decrease proportionally, and the oxygen concentration should remain between 21% and 29% oxygen.

5.3.17 Reduce the O_2 flow to 500 ml/min. Verify that the N_2O flow is greater than or equal to 600 ml/min.

5.3.18 The nitrous oxide flow should stop when the flow of oxygen is between 250 and 400 ml per minute.

5.3.19 Un-pinch the N_2O bypass line on the ORC.

5.3.20 Close the O_2 flow control valve, and fully open the N_2O flow control valve. Verify that the O_2 concentration is 22 - 31%.

5.3.21 Close the N_2O flow control valve and turn the System Power switch to STANDBY.

5.3.22 Reconnect the pipeline hoses.

5.3.23 Replace the flowmeter housing rear cover.

5.3.24 Perform the PMS Procedure given in Section 6.

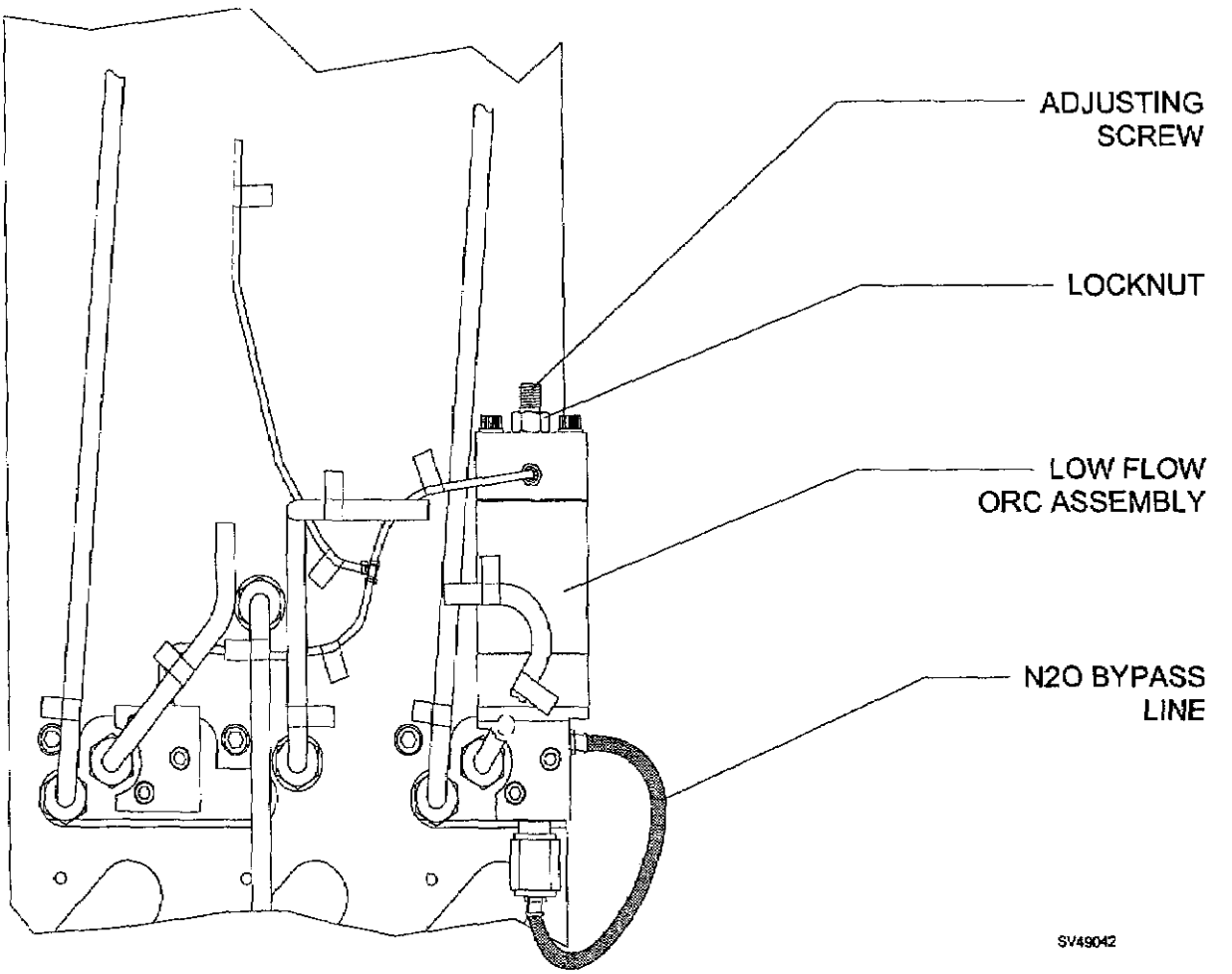


Figure 5-3: OXYGEN RATIO CONTROLLER ADJUSTMENT

5.4 Oxygen Sensor Calibration

5.4.1 Turn the System Power switch to ON.

5.4.2 Enter the Main Service Screen and select the Service Mode (ref. Section 2).

5.4.3 Enter the Oxygen Monitor Service Screen.

5.4.4 Zero Calibration

5.4.4.1 Remove the oxygen sensor capsule from its housing and allow several minutes for the displayed offset readings to stabilize.

NOTE: The difference between the displayed CELL A and CELL B readings should be no greater than 8.

5.4.4.2 Press the key next to ZERO to store the current values as the new zero calibration.

5.4.4.3 Reinstall the sensor capsule in its housing.

5.4.5 21% Calibration

5.4.5.1 Expose the sensor to ambient air only (away from any open part of the breathing system) and allow it to stabilize for several minutes.

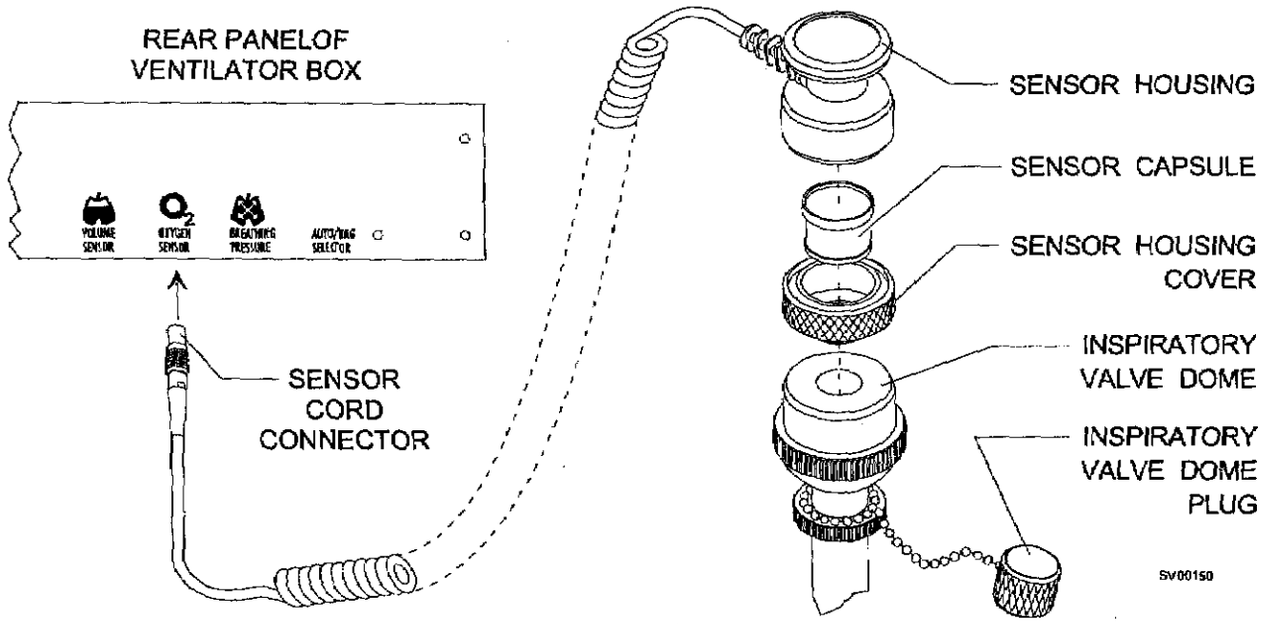
5.4.5.2 Press the key next to EXIT to return to the Main Service Screen. Press the key next to EXIT again to return the display to normal operation.

5.4.5.3 Press the CAL key to initiate the 21% O_2 calibration.

During calibration, the LED next to the CAL key lights, and the label CAL appears in the oxygen monitor window. Following successful calibration, the currently sensed oxygen concentration appears in the oxygen monitor window.

5.4.5.4 When calibration is complete, reinstall the sensor assembly in the inspiratory valve dome.

NOTE: If the O_2 sensor will not calibrate properly, refer to the Oxygen Monitoring section of the Narkomed GS *OPERATOR'S INSTRUCTION MANUAL* for further information.



OXYGEN MONITOR SERVICE SCREEN

CURRENT CELL A: 238
CURRENT CELL B: 250

ZERO

ZERO CALIBRATION PROCEDURE:
- REMOVE O2 CELL FROM SENSOR HOUSING
- LET CURRENT CELL VALUES STABILIZE
- PRESS "ZERO" KEY TO ENTER
  CALIBRATION VALUES
- REINSTALL O2 CELL IN SENSOR HOUSING

PRES
MON

STORED ZERO CELL A: 250
STORED ZERO CELL B: 250

EXIT

Figure 5-4: OXYGEN MONITOR SERVICE SCREEN

5.5 Breathing Pressure Monitor Calibration

5.5.1 Turn the System Power switch to ON.

5.5.2 Enter the Main Service Screen and select the Service Mode (ref. Section 2).

5.5.3 Proceed to the Pressure Monitor Service Screen.

5.5.4 Zero Calibration

5.5.4.1 Disconnect the pressure sample line from the absorber and let the current pressure value stabilize.

5.5.4.2 Press the key next to ZERO to store the current value as the new zero.

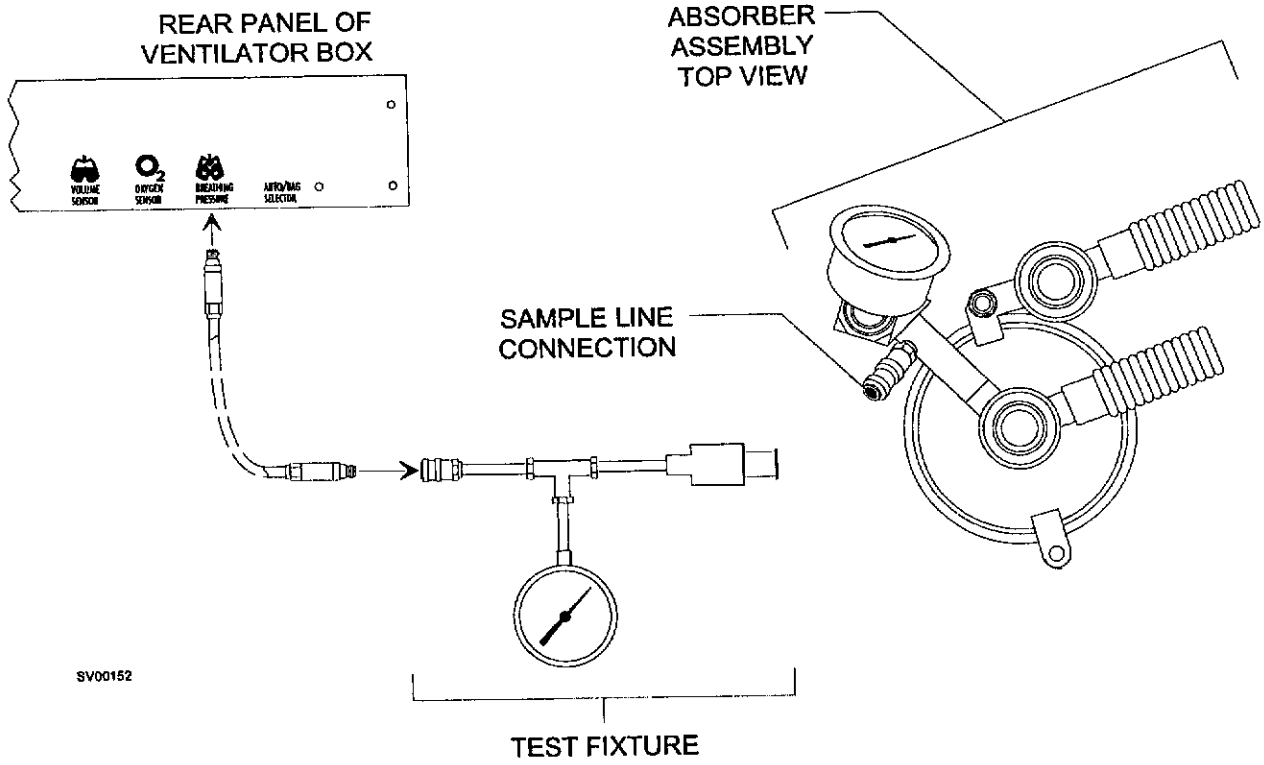
5.5.5 Span Calibration

5.5.5.1 With a test fixture connected as shown in Figure 5-6, apply a pressure of 50 cm H_2O to the pressure sample line.

5.5.5.2 When the displayed current value is stabilized, press the key next to SPAN to store the current value as the new span calibration.

5.5.6 Disconnect the test fixture.

5.5.7 Press the key next to EXIT to return to the Main Service Screen.



PRESSURE MONITOR SERVICE SCREEN

CURRENT PRESSURE VALUE: 250

ZERO

ZERO CALIBRATION PROCEDURE:
- REMOVE PRESSURE SAMPLE LINE FROM ABSORBER, EXPOSE TO AIR.
- LET CURRENT PRESSURE VALUE STABILIZE
- SELECT THE "ZERO" KEY TO ENTER CALIBRATION VALUES.

SPAN

SPAN CALIBRATION PROCEDURE:
- REMOVE PRESSURE SAMPLE LINE FROM ABSORBER, APPLY 50 CMH20 CONSTANT PRESSURE AT THE SAMPLE LINE, VERIFIED BY A KNOWN, CALIBRATED METER.
- LET PRESSURE VALUE STABILIZE
- SELECT THE "SPAN" KEY TO ENTER THE CURRENT VALUE.

OXY MON

EXIT

STORED ZERO: 250
STORED SPAN: 489

Figure 5-5: PRESSURE MONITOR SERVICE SCREEN

5.6 Vaporizer Interlock Adjustment

The following procedure describes the interlock adjustment on a 3-vaporizer machine. The same principles apply on a 2-vaporizer machine.

5.6.1 Turn the System Power switch to STANDBY.

5.6.2 Remove the cover from the vaporizer interlock mechanism.

5.6.3 Turn the center vaporizer handwheel to an ON position.

5.6.4 Turn the center plunger adjustment screw until the distance between the plunger block and the small pins on the horizontal shafts is approximately 0.066 in. See Figure 5-6.

5.6.5 Set the left vaporizer handwheel to the center of its OFF position.

5.6.6 Turn the left vaporizer plunger adjustment screw until the bevel on the plunger block just touches the bevel on the horizontal shaft*. Once the bevels are touching, turn the adjustment screw counter-clockwise 1¼ turns.

5.6.7 Repeat Step 5.6.5 for the right vaporizer.

5.6.8 Repeat Step 5.6.6 for the right vaporizer.

5.6.9 Turn the center vaporizer handwheel to OFF.

5.6.10 Turn the left vaporizer handwheel to an ON position.

5.6.11 Repeat Step 5.6.5 for the center vaporizer.

5.6.12 Repeat Step 5.6.6 for the center vaporizer.

5.6.13 Turn the left vaporizer handwheel to OFF.

5.6.14 Set all the vaporizers to the extreme of their OFF position. Verify that each vaporizer can be turned on.

5.6.15 Verify that no more than one vaporizer can be turned on at a time.

5.6.16 Reinstall the cover over the vaporizer interlock mechanism.

5.6.17 Perform the PMS Procedure given in Section 6.

* Verify that the handwheel is still in the center of its OFF position.

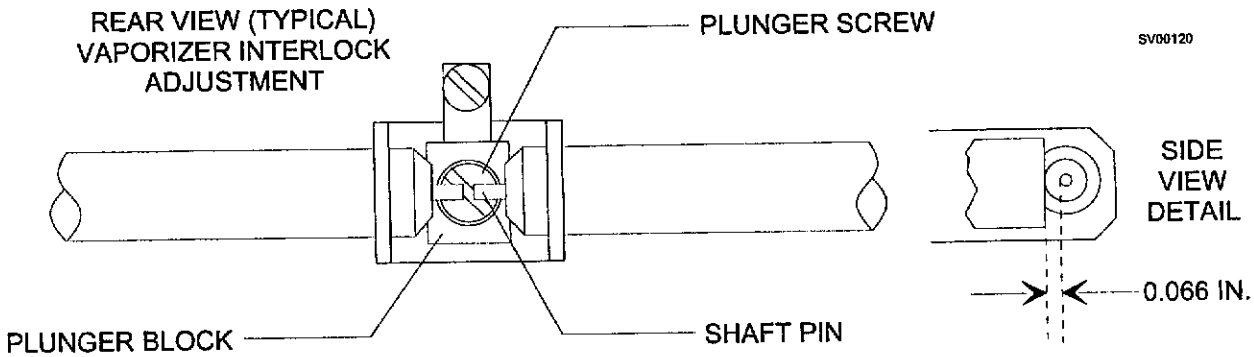


Figure 5-6: VAPORIZER INTERLOCK MECHANISM

5.7 Vaporizer Select Switch Adjustment

5.7.1 Turn the System Power switch to STANDBY.

5.7.2 Remove the cover from the vaporizer interlock mechanism.

NOTE: The vaporizer handwheel must be in the zero or OFF position.

5.7.3 Turn the nylon actuator adjustment screw (see Figure 5-7) counter-clockwise several turns, or until it is no longer pushing the microswitch actuator.

5.7.4 Slowly turn the nylon screw clockwise until the microswitch is activated - as evidenced by an audible click; continue turning the nylon screw clockwise an additional two turns.

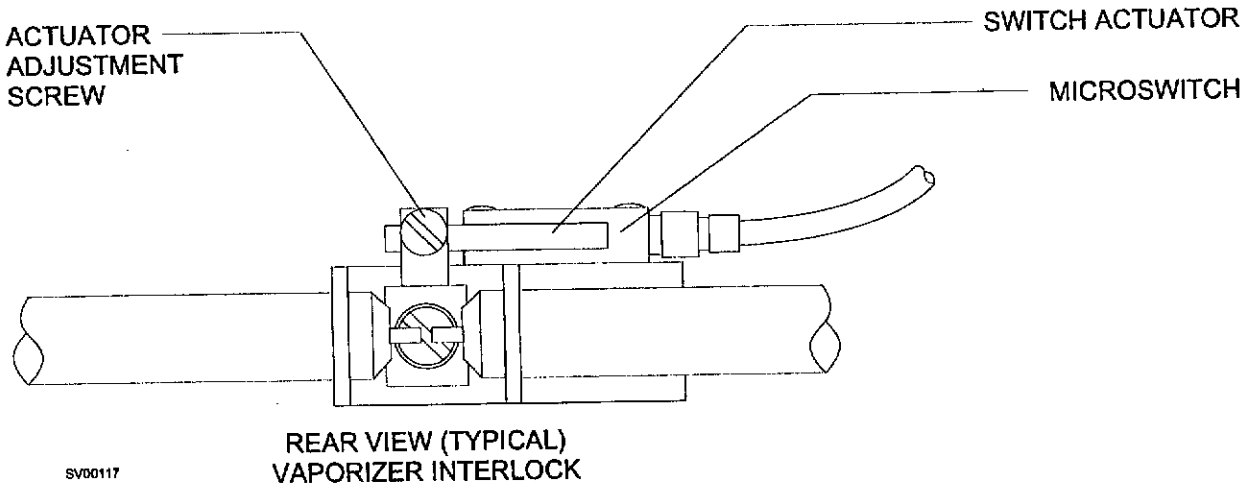


Figure 5-7: VAPORIZER SELECT SWITCH ADJUSTMENT

PM Certification Procedure for Narkomed 2B/2C/GS Anesthesia System

7. Proceed with PM Certification procedure in accordance with SP00152, SP00150 or SP00169. If any tests fail refer to the "Failure Codes" listing to determine correct certification level starting point. Failure codes shall be documented on the "RECOMMENDATIONS / GENERAL COMMENTS" section of the PM Certification form and on the Executive Summary. If a test fails that has not been identified by the "Failure Codes" list, consult with Draeger Medical, Inc. to assess the proper certification level.

8. Based on the "EQUIPMENT CONDITION" inspect the machine for any "NAD RECOMMENDATIONS" that would apply. Use the Narkomed 2B, 2C or GS section of the "RECOMMENDATION GUIDELINES INDEX". Note all applicable NAD recommendations on the Executive Summary. NOTE: If using a carbon form, indicate the Equipment Condition number and to see reverse side under the "RECOMMENDATIONS / GENERAL COMMENTS" section of the form.

9. Determine the correct certification level of the machine based on the combined lowest common denominator of "Equipment Conditions" and "Failure Codes". If the machine is at least conditionally certified fill out the "PM CERTIFICATION" label. Check the box(s) on the validation label where appropriate. Write the month and year, (three months from date of PM Certification) next to "NEXT VISIT DUE:" If certification level is "D", machine shall not receive a "PM CERTIFICATION" label. Any machine not receiving a PM Certification label shall receive a "WARNING NOT CERTIFIED" label. This label shall be placed at a prominent location on the left side of the machine after all other previous PMS and Vigilance Audit Validation labels have been removed.

10. In the "CERTIFICATION LEVEL" section of the PM Certification form, record the last visit certification level, the current certification level and the next visit due month and year, (three months from date of PM Certification) in the spaces provided.

11. If applicable, remove the previous PM CERTIFICATION VALIDATION label and attach the new label in a prominent location on the rear of the anesthesia machine.

12. Check the appropriate boxes on the "PM CERTIFICATION NOTICE" label, (part # S0100011). If the machine is not certified, the last box of this notice label shall be marked. Attach this notice to the flow shield of the anesthesia machine.

13. Have the customer sign each PM Certification form or the Executive Summary, and review the equipment conditions and the recommendations with the customer.

14. Return top copy to Draeger Medical, Inc. Service Department, keep middle copy for service organization records, give bottom copy to customer.

6.0 PMS PROCEDURE, NARKOMED GS

The procedures in this section shall be performed in their entirety each time a component is removed, replaced, calibrated, adjusted and during all scheduled Periodic Manufacturer's Service (PMS) visits. A PMS Checklist form, available

6.1 ELECTRICAL SAFETY

(✓) 6.1.1 Protective Ground Continuity

6.1.1.1 Turn the System Power switch to STANDBY.

NOTE: Do not plug the safety analyzer power cord into a line isolation monitor, as inaccurate readings may occur.

Plug the unit into the safety analyzer, and plug the power cord of the safety analyzer into an AC receptacle.

NOTE: The BIOTECH 501 PRO will automatically test the source outlet for open ground (or ground resistance of 31 Ω or higher), reverse polarity, open neutral and open line. (The latter two conditions will prevent the analyzer from powering up.)

6.1.1.2 Set the safety analyzer function switch to the GROUND WIRE RESISTANCE position. Attach the test lead to the SINGLE LEAD connector of the analyzer. Connect the other end of the red test lead to the ground socket of the front panel outlet on the safety analyzer. Verify a displayed resistance of 0.000 Ω or, if necessary, press the CALIBRATE key on the front panel of the analyzer to zero the device.

6.1.1.3 Set the safety analyzer GROUND switch to NORMAL. Set the POLARITY switch to OFF.

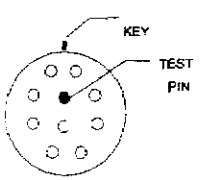
6.1.1.4 The safety analyzer shall indicate 0.1 Ω or less with its test lead applied to the following points:

--Cylinder yoke
--Serial port cable retaining nut on processor
--Each convenience outlet ground socket
--Each Auxiliary Outlet Strip ground socket

(✓) 6.1.2 Circuit Isolation

6.1.2.1 Disconnect the respiratory volume sensor cord from the interface panel.

6.1.2.2 With a multimeter set to its highest resistance range, check for continuity between the serial port cable retaining nut on processor and the circuit common at the sensor interface connector test pin shown in the illustration. There shall be no continuity between these points.



(✓) 6.1.3 Convenience Outlet and Auxiliary Outlet Strip

NOTE: This test will check the convenience outlets and the auxiliary strip outlets for fault conditions such as open ground (>31 Ω), reverse polarity, open line and open neutral. This is done each time the BIOTECH 501 PRO is powered up and allowed to cycle through its self test.

6.1.3.1 Shut off and unplug the safety analyzer. Remove the anesthesia machine plug from the analyzer, and plug it into the same outlet that was being used by the analyzer.

6.1.3.2 Plug the safety analyzer into the first convenience outlet to be tested, and turn the analyzer power switch ON. Allow the analyzer to cycle through its Auto Test sequence. If no wiring fault is indicated, shut off the analyzer and move its plug to the next convenience outlet. Test this outlet in the same manner, and continue until all convenience outlets and auxiliary strip outlets are tested.

6.1.4 Chassis Leakage Current

6.1.4.1 Turn the anesthesia machine System Power switch to ON and set the safety analyzer to the CHASSIS LEAKAGE CURRENT position.

6.1.4.2 Attach the safety analyzer test lead to a cylinder yoke.

(✓) 6.1.4.3 Record the total leakage current with the Polarity and Ground switches set as follows:

Ground	Polarity
Open	Normal
Normal	Normal
Open	Reversed
Normal	Reversed

Verify that the leakage current is 75* microamps or less in each of the switch positions (110 microamps or less for the 220/240 volt power supply option).

*100 microamps if external monitors are plugged into convenience outlets.

(✓) 6.2 SELF-DIAGNOSTICS

6.2.1 Connect the pipeline supply or open the cylinders.

6.2.2 Turn the System Power switch to ON.

6.2.3 Verify that the following is displayed on the alarm CRT:

FIRMWARE	PASS	NARKOMED GS
RAM	PASS	COPYRIGHT 1996, NAD, INC.
VIDEO	PASS	VERSION X.XX NMGS POD
A/D CONVERTER	PASS	SOFTWARE ID. XXXX
AUDIO - PRIMARY	PASS	
- BACKUP	PASS	
SERIAL I/O	PASS	
CLOCK	PASS	
NON-VOLATILE MEMORY	PASS	

FUNCTIONAL

(✓) 6.2.4 Record the machine software version on the header of the checklist form.

(✓) **6.3 BATTERY CIRCUIT**

6.3.1 Is "ON" LED lighted? __ (Y)

6.3.2 With the System Power switch ON, unplug the AC power cord.

6.3.3 Is yellow "AC PWR FAIL" LED lighted as long as the power cord is unplugged? __ (Y)

6.3.4 Does the "AC PWR FAIL" message appear in the Advisory display? __ (Y)

6.3.5 Press and hold the "BATTERY TEST" button.

6.3.6 Is green Battery Test LED lighted as long as "BATTERY TEST" button is depressed? __ (Y)

6.3.7 Release the "BATTERY TEST" button.

6.3.8 Restore AC power to the machine.

6.3.9 Does the "AC PWR FAIL" message disappear and the LED extinguish?

(✓) **6.4 CONFIGURATION**

6.4.1 Press the CONFIG key.

6.4.2 The CONFIGURE screen is displayed.

6.4.3 Verify the correct Time and Date.

6.4.4 Adjust the Volume to the highest setting.

6.5 SERVICE DATA

6.5.1 Press and hold the Oxygen High Limit key and the Volume Low Limit key, and then press the [▲] key.

6.5.2 The Main Service Screen appears.

(✓) 6.5.3 Record the Last Service Date on the PMS form.

(✓) 6.5.4 Record the Hours Run Since Last Service on the PMS form.

(✓) 6.5.5 Record the Total Hours Run on the PMS form.

6.5.6 Select and enter the Service Log.

6.5.7 Verify any pertinent information from the Service Log. Contact the Draeger Medical, Inc. Technical Service Department if necessary.

6.5.8 Press EXIT to return to the Main Service screen.

6.5.9 Select the SRVC Service Code.

6.5.10 Select and enter your Technical Service Rep. I.D. number.

(✓) 6.5.11 Press the RESET key. This resets the last service date to the current date and resets the hours run since last service to zero.

6.5.12 Press the PMS SCHED key.

(✓) 6.5.13 Select and enter the month of the next service due date. The internal clock of the machine limits the amount of date advance to a maximum of six months from the current service date.

6.6 CALIBRATIONS

6.6.1 To bring up the Oxygen Monitor Service Screen, press the Mon Cal key.

6.6.2 Remove the oxygen sensor from the valve dome adapter, and remove the oxygen sensor capsule from the oxygen sensor housing.

(✓) 6.6.3 When the CURRENT CELL A and CURRENT CELL B readings have stabilized, press the ZERO key and verify that the new offset values are stored.

NOTE: The higher the offset, the higher the calculated oxygen concentration appears at high concentrations.

6.6.4 Put the oxygen sensor capsule into the oxygen sensor housing.

6.6.5 Press the PRESS MON key.

6.6.6 Disconnect the Baromed breathing pressure sensor line from the absorber and expose it to air.

6.6.7 Let the Current Pressure Value stabilize and press the ZERO key to store the value.

6.6.8 Connect a test fixture and a calibrated digital pressure manometer to the breathing pressure sensor line.

6.6.9 Pressurize the circuit to 50 cm H_2O and allow the Current Value to stabilize.

(✓) 6.6.10 Press the SPAN key and verify that the new span values are stored.

6.6.11 Release the pressure, disconnect the manometer and test fixture, and reconnect the breathing pressure sensor line to the absorber.

6.6.12 Press EXIT to return to the Main Service screen.

6.6.13 Press EXIT to return to normal operation.

(✓) 6.7 A SCAVENGER, A/C - if applicable

6.7A.1 Scavenger, A/C Cleaning

6.7A.1.1 Remove all scavenger hoses one at a time, and drain all accumulated moisture. Inspect all scavenger hoses for deterioration and replace any worn hoses.

6.7A.1.2 Remove the safety relief valve housing by unscrewing it in a counter-clockwise direction.

6.7A.1.3 Inspect the rubber O-ring and replace if worn.

6.7A.1.4 Remove the safety relief valve from its housing by twisting it out in a counter-clockwise direction. The tips of needle-nose pliers can be used to turn the valve. Be careful not to damage the valve disk.

6.7A.1.5 Remove any accumulated lint or dust from the valve with a soft brush. The valve may be further cleaned with a low flow of clean air or oxygen. The scavenger body can be cleaned with a moist cloth.

6.7A.1.6 Reinstall the valve into the housing, making sure that it is threaded all the way into the housing and that the plastic washer is properly seated on its upper surface.

6.7A.1.7 Make sure that the interior of the valve body is completely dry. Reinstall the valve housing onto the scavenger body, making sure that the O-ring is properly seated.

6.7A.2 Scavenger, A/C Positive Pressure Relief Test

6.7A.2.1 Connect a 19 mm scavenger hose between the bottom of the absorber pole and the right-hand port on the scavenger (with later design absorber pole, this hose connects directly from the scavenger to the APL valve). Connect a short 19 mm scavenger hose between the APL valve and the port on the rear of the absorber pole (not used with later design absorber pole). Connect a 19 mm scavenger hose between the ventilator relief valve and the left-hand port on the scavenger.

6.7A.2.2 Connect a short 22 mm breathing hose from the inspiratory valve to the expiratory valve on the absorber or the expiratory hose terminal on the ultrasonic flow sensor, if applicable.

6.7A.2.3 Set the Man/Auto valve to the AUTO position.

6.7A.2.4 If the absorber system or ventilator bellows are equipped with a PEEP valve, turn the PEEP valve control knob fully counter-clockwise.

6.7A.2.5 Set the oxygen flow to 10 l/min. and occlude the 19 mm scavenger terminal labeled EXHAUST.

6.7A.2.6 After the ventilator bellows inflates, the flow of oxygen will exit the system through the positive pressure safety relief valve. At this point, the absorber system breathing pressure gauge shall indicate a pressure of 10.0 cm H_2O or less.

(✓) **6.7B SCAVENGER, OPEN RESERVOIR - if applicable**

6.7B.1 Scavenger, Open Reservoir Cleaning

6.7B.1.1 Remove all scavenger hoses one at a time and drain all accumulated moisture. Inspect all scavenger hoses for deterioration and replace any worn hoses.

6.7B.1.2 Disconnect the hospital vacuum source from the scavenger.

6.7B.1.3 If applicable, remove the scavenger flow control needle valve assembly. Inspect the needle valve and seat for lint or dust accumulation. Clean with compressed air if necessary, and reinstall the needle valve assembly.

6.7B.1.4 Remove the scavenger mounting screws.

6.7B.1.5 Remove the two screws securing the access panel at the bottom of the scavenger canister.

6.7B.1.6 Remove and inspect the silencer; replace if needed.

6.7B.1.7 Remove the reservoir canister from the scavenger body by unscrewing the four socket head cap screws located at the top of the canister.

6.7B.1.8 Remove the flowmeter from its housing by turning it counter-clockwise. Inspect the tube and clean with compressed air if needed.

6.7B.1.9 Reassemble the scavenger assembly, and reactivate the vacuum source.

6.7B.2 Scavenger, Open Reservoir Negative Pressure Relief

6.7B.2.1 Connect a 19 mm scavenger hose between the bottom of the absorber pole and the right-hand port on the scavenger (with later design absorber pole, this hose connects directly from the scavenger to the APL valve). Connect a 19 mm scavenger hose between the APL valve and the rear port on the absorber pole (not used on later design absorber pole). The left-hand scavenger port may be capped for this test, or may be connected to the ventilator relief valve. Connect a DISS vacuum hose to the threaded terminal on the left side of the scavenger. Alternatively, an adapter can be used to attach a wall suction hose to the hose barb fitting on the adapter.

6.7B.2.2 Connect a short 22 mm breathing hose from the inspiratory valve to the expiratory valve on the absorber or the expiratory hose terminal on the ultrasonic flow sensor, if applicable. Set the Man/Auto selector valve to the BAG position. Turn the APL valve control knob fully counter-clockwise.

6.7B.2.3 Verify that the suction waste gas disposal system is active.

6.7B.2.4 Adjust the scavenger needle valve until the flowmeter indicates between the white lines. Close all flow control valves on the anesthesia machine. Occlude the absorber breathing bag terminal.

6.7B.2.5 Install a scavenger adapter with a hose barb (P/N 4108114) between the 19 mm hose terminal of the scavenger, and the scavenger hose. Connect a calibrated test pressure monitor to the hose barb on the adapter and observe the pressure reading on the test gauge. The gauge shall indicate a pressure of 0 to -0.5 cm H_2O.

6.7B.3 Scavenger, Open Reservoir Positive Pressure Relief

6.7B.3.1 Turn the scavenger needle valve fully clockwise (closed).

6.7B.3.2 Open the oxygen flow control valve on the anesthesia machine to a flow of 10 l/min. and occlude the absorber breathing bag terminal.

6.7B.3.3 The flow of oxygen shall now exit the system through the relief ports around the top of the canister. The test pressure gauge shall indicate a pressure less than 1.0 cm H_2O.

6.7B.3.4 After the test, adjust the scavenger needle valve for a flowmeter indication halfway between the two white lines.

(✓) **6.7C SCAVENGER INTERFACE - if applicable**

6.7C.1 Scavenger Inspection

6.7C.1.1 Check all scavenger hoses and reservoir bag for deterioration. Replace all worn components.

6.7C.2 Primary Negative Relief Valve Cleaning:

6.7C.2.1 Remove the plastic valve cover on the front surface of the scavenger body by turning it in a counter-clockwise direction.

6.7C.2.2 Remove the valve and washer from the scavenger body by turning it counter-clockwise. A needle-nose pliers may be used to turn the valve, but use care not to damage the valve's fragile disk.

6.7C.2.3 Brush any accumulated lint or dust off the valve with a soft brush. The valve may be further cleaned with a low flow of clean air or oxygen.

6.7C.2.4 Reinstall the plastic washer and valve into the scavenger body. Replace the valve cover.

6.7C.3 Secondary Negative Relief Valve Cleaning:

6.7C.3.1 Unscrew the chrome plated valve housing on the left side of the scavenger body by turning its fitting counter-clockwise with a wrench.

6.7C.3.2 Unscrew the valve from the housing by turning it in a counter-clockwise direction.

6.7C.3.3 Brush any accumulated lint or dust off the valve with a soft brush. The valve may be further cleaned with a low flow of clean air or oxygen.

6.7C.3.4 Reinstall the valve in the housing, and then reinstall the housing into the scavenger body. Note: This valve does not require washers or O-rings.

6.7C.4 Positive Relief Valve Cleaning:

6.7C.4.1 Remove the valve housing on the right side of the scavenger body by turning it counter-clockwise.

6.7C.4.2 Inspect the rubber O-ring and replace if worn.

6.7C.4.3 Remove the valve from the housing by turning it counter-clockwise. A needle-nose pliers may be used to turn the valve, but use care not to damage the valve's fragile disk.

6.7C.4.4 Brush any accumulated lint or dust off the valve with a soft brush. The valve may be further cleaned with a low flow of clean air or oxygen.

6.7C.4.5 Reinstall the valve and plastic washer into the housing.

6.7C.4.6 Reinstall the valve housing onto the scavenger body, making sure that the O-ring is properly seated.

6.7C.5 Negative Pressure:

6.7C.5.1 Connect a 22mm breathing hose between the absorber's inspiratory valve and expiratory valve or expiratory hose terminal on the ultrasonic flow sensor, if applicable. Set the Man/Auto valve to the BAG position. Turn the APL valve fully counter-clockwise. Occlude the bag mount connector.

6.7C.5.2 Verify that the suction waste gas disposal system is active.

6.7C.5.3 Close all flow control valves on the machine. Adjust the scavenger needle valve to allow typical suction through the scavenger.

6.7C.5.4 Install a scavenger adapter (P/N 4108114) with a hose barb between the 19mm hose terminal of the scavenger and the scavenger hose. Connect a test monitor to the hose barb adapter and observe the pressure reading on the test gauge. The gauge shall indicate a pressure of <-1.0 cmH_2O.

6.7C.6 Positive Pressure:

6.7C.6.1 Close the scavenger needle valve by turning it fully clockwise.

6.7C.6.2 Push the O_2 Flush button to inflate the scavenger reservoir bag. Open the oxygen flow control valve to 10 l/min.

6.7C.6.3 Observe the pressure reading on the test gauge. The gauge shall indicate a pressure of <10.0 cmH_2O.

6.7C.6.4 Remove the test equipment. Readjust the scavenger needle valve to allow typical suction through the scavenger.

6.7D SUCTION REGULATOR

6.7D.1 Verify that the suction bottle is attached to the suction regulator.

6.7D.2 Verify that vacuum is attached to the ¾ in. DISS vacuum connection.

6.7D.3 Set the vacuum on/off valve to the OFF (vertical) position.

6.7D.4 Connect a digital pressure meter to the collecting inlet stem of the suction bottle.

6.7D.5 Set the digital pressure meter to the mmHg scale.

6.7D.6 Turn the vacuum control knob fully counter-clockwise.

(✓) 6.7D.7 What is the vacuum indicated on the digital pressure meter? (0)

6.7D.8 Turn the vacuum control knob fully clockwise and verify that the vacuum control knob stops.

6.7D.9 Set the vacuum on/off valve to the ON position.

6.7D.10 Set the regulator to indicate 250 mmHg.

(✓) 6.7D.11 What is the vacuum indicated on the digital pressure meter? (200-300 mmHg)

6.7D.12 Return all controls to their original positions.

6.8 BREATHING SYSTEM

(✓) 6.8.1 Absorber System Inspection

6.8.1.1 Remove the inspiratory and the expiratory valve domes.

6.8.1.2 Is there a broken or bent pin on the valve assembly?
Inspiratory ___ (N) Expiratory ___ (N)

6.8.1.3 Is there a broken pin on the valve domes?
Inspiratory ___ (N) Expiratory ___ (N)

6.8.1.4 Is the valve disc in good condition?
Inspiratory ___ (Y) Expiratory ___ (Y)

6.8.1.5 Are the valve dome washers in good condition? ___ (Y)

6.8.1.6 Reinstall the inspiratory and expiratory valve domes.

6.8.1.6A Remove the ultrasonic flow sensor connector hose - if applicable.

6.8.1.6B Is the connector hose, connector, and O-ring in good condition? ___ (Y) - if applicable.

6.8.1.6C Remove the ultrasonic flow sensor from the mounting bracket - if applicable.

6.8.1.6D Remove the flow housing/transducer assembly from the electronics housing - if applicable.

6.8.1.6E Remove both transducers from the flow housing; examine each O-ring and condition of all components, then reassemble - if applicable.

6.8.1.7 Remove the inspiratory and expiratory valve assemblies.

6.8.1.8 Remove the Spiromed sensor, if applicable.

6.8.1.9 Are all washers in good condition? ___ (Y)

6.8.1.10 Reinstall the inspiratory valve.

6.8.1.10A Reinstall the expiratory valve and the connector hose between the expiratory valve and the ultrasonic flow sensor - if applicable.

6.8.1.11 Are the two (2) spring clips on the absorber rods? ___ (Y)

6.8.1.12 Inspect the following: canisters and gaskets, dust cup and O-ring, condition of soda lime.

6.8.1.13 Are the absorber canisters and dust cup in good condition? ___ (Y)

6.8.1.14 Is the cm H_2O gauge at zero (0)? ___ (Y)

6.8.1.15 Remove the O_2Med sensor plug from the inspiratory valve dome adapter and examine the two O-rings at the bottom of the plug.

This page left intentionally blank

6.8.1.16 Reinstall the O_2Med sensor plug into the inspiratory valve dome adapter.

6.8.1.17 Examine the two O-rings at the bottom of the sensor.

6.8.2 This section intentionally left blank

(✓) 6.8.3 Lubrication, Spiromed Sensor - if applicable

6.8.3.1 Locate the four lateral holes at the sides of the Spiromed sensor marked by printed arrows.

CAUTION: Use only Sensor Lubrication Kit P/N 2218180 for the following procedure.

6.8.3.2 Remove the protective cover from the pipette and open the lubricant bottle.

6.8.3.3 Dip the tip of the pipette into the lubricant and draw one drop of lubricant into the pipette by pulling the pin upwards.

6.8.3.4 Insert the pipette into one of the four holes as far as it will go. Push the pin forward to its stop to inject lubricant into the hole.

6.8.3.5 Repeat the procedure on the three remaining holes.

6.8.3.6 Wipe any lubricant residue from the exterior of the sensor.

6.8.3.7 Reattach the sensor to the absorber top dome.

6.8.3.8 Reattach the expiratory valve to the sensor.

6.8.4 Freshgas Leak

6.8.4.1 Turn the System Power switch to STANDBY.

6.8.4.2 Remove the 15 mm connector from the FRESHGAS OUTLET.

6.8.4.3 Is the common gas outlet assembly in good condition? ___ (Y)

6.8.4.4 Connect a digital pressure manometer and Fresh Gas Leak Test Device to the freshgas outlet.

6.8.4.5 Apply 50 cm H_2O of pressure to the system.

(✓) 6.8.4.6 After thirty (30) seconds, what is the pressure on the manometer? ___ (>40 cm H_2O)

6.8.4.7 Turn on the left mounted vaporizer to the first graduated marking.

6.8.4.8 Apply 50 cm H_2O of pressure to the system.

(✓) 6.8.4.9 After thirty (30) seconds, what is the pressure on the manometer? ___ (>40 cm H_2O)

6.8.4.10 Turn off the vaporizer.

6.8.4.11 Remove the test equipment from the Fresh Gas Outlet.

6.8.4.12 Turn the System Power switch to ON.

6.8.4.13 Open the O_2 flow control valve to 5 l/min., purge the system for 5 seconds, then close the O_2 flow control valve.

6.8.4.14 Turn the System Power switch to STANDBY.

(✓) 6.8.4.15 Turn on the center mounted vaporizer to the first graduated marking, repeat Steps 6.8.4.4 and 6.8.4.8 thru 6.8.4.14. ___ (>40 cm H_2O)

(✓) 6.8.4.16 Turn on the right mounted vaporizer to the first graduated marking, repeat Steps 6.8.4.4 and 6.8.4.8 thru 6.8.4.14. ___ (>40 cm H_2O)

6.8.4.17 Reconnect the 15 mm connector from the absorber system to the FRESHGAS OUTLET.

6.8.4.18 Is the FRESHGAS OUTLET label on the freshgas outlet? ___ (Y)

6.8.5 Breathing System Leak

6.8.5.1 Verify the System Power switch is at STANDBY.

6.8.5.2 Close all flow control valves.

6.8.5.3 Interconnect the inspiratory valve and expiratory valve or expiratory hose terminal on the ultrasonic flow sensor, if aplicable with a 12-inch hose.

6.8.5.4 Attach a test terminal with a cuff inflation bulb (P/N S010159) to the bag mount.

6.8.5.5 Set the Man/Auto selector valve to BAG.

6.8.5.6 Close the APL valve.

6.8.5.7 Apply 50 cm H_2O pressure to the absorber system.

(✓) 6.8.5.8 After 30 seconds, what is the pressure in the absorber system? ___ cm H_2O (≥30)

6.8.6 APL Valve

6.8.6.1 Open the APL valve to its stop.

6.8.6.2 Turn the SYSTEM POWER switch to ON.

6.8.6.3 Set the oxygen flow to 8 l/min.

(✓) 6.8.6.4 What is the pressure on the absorber pressure gauge? ___ cm H_2O (≤3)

6.8.6.5 Close the oxygen flow control valve, turn the System Power switch to STANDBY, and remove the test terminal from the bag mount.

6.8.7 Absorber Flow Direction and Leak

6.8.7.1 Expiration Valve Leak

6.8.7.1.1 Close the APL valve.

6.8.7.1.2 Connect a 22mm hose between the inspiration valve and the bag mount.

6.8.7.1.3 Connect a test terminal to the expiration valve or expiratory hose terminal on the ultrasonic flow sensor, if applicable.

6.8.7.1.4 Connect a Capnomed flowmeter to the test terminal.

6.8.7.1.5 Turn the System Power switch to ON, turn up the oxygen flow until the system pressurizes to 30 cmH_2O.

(✓) 6.8.7.1.6 What is the value indicated on the flowmeter?___ (_60ml/min).

6.8.7.1.7 Remove all test equipment, and turn the System Power switch to STANDBY.

6.8.7.2 Inspiration Valve Leak

6.8.7.2.1 Connect a test terminal to the inspiratory valve.

6.8.7.2.2 Connect a tee fitting (P/N 4109292) and calibrated pressure meter to the test terminal.

6.8.7.2.3 Connect a pressure bulb to the open port of the tee adapter.

6.8.7.2.4 Connect another test terminal to the bag connector.

6.8.7.2.5 Connect a Capnomed flowmeter to the test terminal on the bag mount.

6.8.7.2.6 Pressurize the system to 30 cmH_2O.

(✓) 6.8.7.2.7 What is the value indicated on the flow meter?___ (_60 ml/min).

6.8.7.2.8 Remove all test equipment.

6.8.7.3 Flow Direction

6.8.7.3.1 Attach a breathing circuit with a 3-liter bag at the Y-piece to the inspiration valve and expiration valve or the expiratory hose terminal on the ultrasonic flow sensor, if applicable.

6.8.7.3.2 Attach a 3-liter bag to the swivel bag mount.

6.8.7.3.3 Turn the System Power switch to ON.

6.8.7.3.4 Set the O_2 flow to 4 l/min.

6.8.7.3.5 Inflate the simulated lung by briefly using the O_2 Flush.

6.8.7.3.6 Partially open the APL valve.

6.8.7.3.7 Squeeze the breathing bag attached to the bag mount at a rate of approximately 10 BPM. Readjust the APL valve if required to properly ventilate the simulated lung.

(✓) 6.8.7.3.8 Observe the operation of each unidirectional valve disc at eye level and make sure the inspiratory valve disc raises only during the inspiration phase, and the expiratory valve raises only during the exhalation phase. Watch the valves until satisfied that both valves operate correctly, and move freely without sticking.

6.8.7.3.9 Remove the breathing circuit.

6.8.7.3.10 Open the APL valve.

(✓) 6.8.8 Absorber PEEP Valve w/By-Pass - if applicable

6.8.8.1 Connect a 12 in. hose between the inspiratory and expiratory valves, and set the O_2 flow to 5 l/min.

* 6.8.8.2 Place the PEEP bypass in the ON position.

6.8.8.3 Adjust the absorber PEEP valve clockwise to the maximum position.

6.8.8.4 Does the PEEP valve adjust smoothly? ___ (Y)

6.8.8.5 What is the maximum PEEP? ___ cm H_2O (15-22)

* 6.8.8.6 Place the PEEP bypass in the OFF position.

6.8.8.7 Does the PEEP return to $\leq$3 cm H_2O? ___(Y)

6.8.8.8 Adjust the absorber PEEP valve counterclockwise to its minimum position.

6.8.8.9 Close the O_2 flow control valve.

* These items apply only to machines with a PEEP by-pass.

6.8.9 Bain Circuit Adapter - if applicable

6.8.9.1 Close the APL valve by turning the knob fully clockwise.

6.8.9.2 Insert the O_2 sensor plug into the O_2 sensor inlet on the Bain Circuit.

6.8.9.3 Attach a test terminal with a cuff inflation bulb (P/N S010159) to the Breathing Bag port on the Bain Circuit.

6.8.9.4 Attach a cmH_2O digital pressure meter to the female quick connect connection on the Bain Circuit.

6.8.9.5 Occlude the expiration port on the Bain Circuit.

6.8.9.6 Apply 50cmH_2O to the Bain Circuit via test terminal and inflation bulb.

(✓) 6.8.9.7 After 30 seconds, what is the pressure on the cmH_2O digital pressure meter? (45 to 50 cmH_2O)

6.8.9.8 Verify that the pressure indicated on the cmH_2O gauge is within 3 cmH_2O of the digital pressure meter reading.

6.8.9.9 Open the APL valve by turning the knob fully counter-clockwise.

6.8.9.10 Connect a test hose from the fresh gas outlet to the Expiration port of the Bain Circuit.

6.8.9.11 Set the O_2 flow to 10 L/min.

(✓) 6.8.9.12 What is the pressure on the cmH_2O digital pressure meter? (_ 3 cmH_2O)

6.8.9.13 Verify that the pressure indicated on the cmH_2O gauge is within 3 cmH_2O of the digital pressure meter reading.

6.8.9.14 Remove the test terminal and inflation bulb from the Breathing Bag port.

6.8.9.15 Return all controls to their original positions.

(✓) 6.9 MANUAL SPHYGMOMANOMETER - if applicable

6.9.1 Insert the male Luer fitting of the Sphygmomanometer squeeze bulb-hose assembly into the female Luer fitting labeled BP BULB on the front of the machine.

6.9.2 Wrap the blood pressure cuff around an "E" cylinder.

6.9.3 Hand-pump the squeeze bulb until pressure of 200 mm Hg is indicated on the Sphygmomanometer gauge on the machine. Pinch the hose adjacent to the Luer fitting to assure that the hose-bulb is not the source of any leak.

6.9.4 After thirty (30) seconds, what is the pressure on the Sphygmomanometer gauge? ___ mm Hg (190-200)

6.9.5 Bleed the pressure.

6.9.6 The Sphygmomanometer should indicate within the band.

6.9.7 Attach a test gauge in series with the sphygmomanometer gauge being tested.

6.9.8 Hand-pump the squeeze bulb until the machine gauge indicates 100 mm Hg.

6.9.9 What does the test gauge indicate? ___ mm Hg (90-110).

6.9.10 Hand-pump the squeeze bulb until the machine gauge indicates 200 mm Hg.

6.9.11 What does the test gauge indicate? ___ mm Hg (180-220).

6.9.12 Hand-pump the squeeze bulb until the machine gauge indicates 300 mm Hg.

6.9.13 What does the test gauge indicate? ___ mm Hg (210-390).

6.9.14 Remove the test gauge.

6.9.15 Remove the blood pressure cuff from the "E" cylinder.

(✓) 6.10 VAPOR EXCLUSION SYSTEM

6.10.1 Set all vapors to zero (0).

6.10.2 Adjust the handwheel on the left vapor (viewed from the front of the machine) to any concentration above zero (0).

6.10.3 Deleted

6.10.4 Deleted

6.10.5 Is it possible to adjust the center vapor? ___ (N)

6.10.6 Is it possible to adjust the right (viewed from the front of the machine) vapor? ___(N)

6.10.7 Adjust the handwheel on the left vapor to zero (0).

6.10.8 Adjust the handwheel on the center vapor to any concentration above zero 0).

6.10.9 Deleted

6.10.10 Is it possible to adjust the left vapor? ___ (N)

6.10.11 Is it possible to adjust the right vapor? ___ (N).

6.10.12 Adjust the handwheel on the center vapor to zero (0).

6.10.13 Adjust the handwheel on the right vapor to any concentration above zero (0).

6.10.14 Deleted

6.10.15 Is it possible to adjust the left vapor? ___ (N).

6.10.16 Is it possible to adjust the center vapor? ___ (N).

6.10.17 Adjust the handwheel on the right vapor to zero (0).

6.11 YOKES & GAUGES

(✓) 6.11.1 Yokes & Check Valves

6.11.1.1 Turn the System Power switch to STANDBY.

6.11.1.2 Disconnect all pipeline hoses and close all cylinder valves.

6.11.1.3 Remove cylinder or yoke plug from each yoke assembly.

6.11.1.4 Do all the yoke handles adjust smoothly? ___ (Y)

6.11.1.5 Are the two (2) yoke pins installed securely in each yoke? ___ (Y)

6.11.1.6 Is there only one (1) cylinder washer on each yoke assembly? ___ (Y)

6.11.1.7 Is there a yoke plug attached to each yoke assembly? ___ (Y)

6.11.1.8 Is the proper gas I.D. label affixed to each yoke assembly? ___ (Y)

6.11.1.9 Attach a cylinder to each yoke assembly, open the cylinder valve, let the pressure stabilize, close the cylinder valve, and remove the cylinder from the yoke assembly.

6.11.1.10 Does the yoke check valve assembly prevent the escape of excessive pressure? ___ (Y)

6.11.1.11 Attach the cylinders to the yokes.

(✓) 6.11.2 Cylinder Gauges

6.11.2.1 Are the pressure gauges correct for the gases indicated by the flowmeters? ___ (Y)

6.11.2.2 Is the gauge closest to the table top for cylinder supply pressure? ___ (Y)

6.11.2.3 Bleed all pressure from the cylinder circuit.

6.11.2.4 Are the cylinder gauges at zero (0) PSI? ___ (Y)

6.11.2.5 Open the cylinder valves.

6.11.2.6 Do the cylinder pressure gauges respond properly? ___ (Y)

(✓) 6.11.3 Pipeline Gauges

6.11.3.1 Are the gauges right below the flowmeters for pipeline supply pressure? ___ (Y)

6.11.3.2 Are the pipeline pressure gauges at zero (0) PSI? ___ (Y)

6.11.3.3 Connect the pipeline supply.

6.11.3.4 Do the pipeline pressure gauges respond properly? ___ (Y)

6.11.3.5 Are the correct gas identification labels affixed at each of the pipeline inlets? ___ (Y)

6.11.3.6 Does the back panel identify each of the pipeline inlets properly? ___ (Y)

6.11.3.7 Disconnect the pipeline hoses.

6.12 HIGH PRESSURE REGULATOR

6.12.1 Verify the System Power switch is ON.

6.12.2 Verify all cylinder valves are closed except the O_2 valve.

6.12.3 Set the oxygen flow to 4 liters per min.

6.12.4 Open the other gas flow control valves to drain pressure from the system.

6.12.5 Close the O_2 cylinder valve, and press the O_2 Flush valve to drain oxygen pressure from the system.

6.12.6 Turn the System Power switch to STANDBY.

6.12.7 Remove the table top from the machine and remove the top cabinet drawer. Refer to replacement procedure 4.2.

6.12.8 Locate the TEE fitting in the ¼ in. diameter O_2 regulator output line, and remove the plug from the TEE fitting.

6.12.9 Connect a dedicated O_2 test gauge to the TEE fitting.

NOTE: Two test gauges are required to avoid contamination of the O_2 circuit from the other gases: a dedicated test gauge for O_2, and a second test gauge for the other gases.

6.12.10 Open the O_2 cylinder valve. Turn the System Power switch to ON, and turn the gas selector switch to ALL GASES - if applicable.

6.12.11 Verify the oxygen flow is 4 liters per min.

(✓) 6.12.12 On the test gauge, what is the regulator output press.? ___PSI (40-49)

NOTE: Leave the dedicated O_2 test gauge connected for later use in the Oxygen Supply Pressure Alarm Test.

6.12.13 Turn the System Power switch to STANDBY.

6.12.14 For the other pressure regulators, locate their corresponding TEE fittings in the ¼ in. diameter regulator output line, and remove the plug from the TEE fitting (one at a time).

6.12.15 Connect the second test gauge to the TEE fitting.

6.12.16 Open the corresponding cylinder valve and set the System Power switch to ON.

6.12.17 Set the corresponding flow to 4 l/min.

(✓) 6.12.18 On the second test gauge, what is the regulator output pressure? ___ PSI (40 - 49)

6.12.19 Depressurize the gas circuit.

6.12.20 Remove the test gauge and replace the plug in the TEE fitting.

(✓) 6.12.21 Repeat Steps 6.12.13 thru 6.12.20 for all other gases except CO_2 circuits.

6.13 HIGH PRESSURE LEAK

(✓) 6.13.1 *Oxygen High Pressure Leak*

6.13.1.1 Verify the System Power switch is at STANDBY.

6.13.1.2 Open one (1) oxygen cylinder valve.

6.13.1.3 Let the pressure stabilize.

6.13.1.4 Close the oxygen cylinder valve and remove the cylinder.

6.13.1.5 Observe the oxygen cylinder pressure gauge.

6.13.1.6 After two (2) minutes, what is the pressure loss? ___ PSI (<50)

6.13.1.7 Attach the cylinder.

(✓) 6.13.2 Nitrous Oxide High Pressure Leak

6.13.2.1 Turn the System Power switch to ON.

6.13.2.2 Open one (1) oxygen cylinder valve and one (1) nitrous oxide cylinder valve.

6.13.2.3 Adjust the oxygen flow to 4 l/min.

6.13.2.4 Let the pressure stabilize.

6.13.2.5 Close the nitrous oxide cylinder valve and remove the cylinder.

6.13.2.6 Observe the nitrous oxide cylinder pressure gauge.

6.13.2.7 After two (2) minutes, what is the pressure loss? ___ PSI (<50)

6.13.2.8 Attach the cylinder.

6.13.2.9 Close the oxygen flow control valve.

(✓) 6.13.3 (_)Air High Pressure Leak - if applicable

6.13.3.1 Open the air cylinder valve.

6.13.3.2 Let the pressure stabilize.

6.13.3.3 Close the air cylinder valve and remove the cylinder.

6.13.3.4 Observe the air cylinder pressure gauge.

6.13.3.5 After two (2) minutes, what is the pressure loss? ___ PSI (<50)

6.13.3.6 Attach the air cylinder.

(✓) 6.13.4 Oxygen-Helium High Pressure Leak - if applicable

6.13.4.1 Open the oxygen-helium cylinder valve.

6.13.4.2 Let the pressure stabilize.

6.13.4.3 Close the oxygen-helium cylinder valve and remove the cylinder.

6.13.4.4 Observe the oxygen-helium cylinder pressure gauge.

6.13.4.5 After two (2) minutes, what is the pressure loss? ___ PSI (<50)

6.13.4.6 Attach the oxygen-helium cylinder.

(✓) 6.13.5 Carbon Dioxide High Pressure Leak - if applicable

6.13.5.1 Open the carbon dioxide cylinder valve.

6.13.5.2 Let the pressure stabilize.

6.13.5.3 Close the carbon dioxide cylinder valve and remove the cylinder.

6.13.5.4 Observe the carbon dioxide cylinder pressure gauge.

6.13.5.5 After two (2) minutes, what is the pressure loss? ___ PSI (<50)

6.13.5.6 Attach the carbon dioxide cylinder.

6.14 OXYGEN SUPPLY FAILURE PROTECTION

6.14.1 Nitrous Oxide O.F.P.D.

6.14.1.1 Open and close the oxygen cylinder valve.

6.14.1.2 Open the nitrous oxide cylinder valve.

6.14.1.3 Set the O_2 and N_2O flows to 4 l/min.

(✓) 6.14.1.4 Does the flow of nitrous oxide cease when the oxygen pressure is depleted? ___ (Y)

6.14.1.5 Connect the O_2 pipeline supply.

6.14.1.6 Close the nitrous oxide cylinder valve and bleed the pressure from the circuit.

6.14.1.7 Connect the N_2O pipeline supply.

6.14.1.8 Disconnect the O_2 pipeline supply.

(✓) 6.14.1.9 Does the flow of nitrous oxide cease when the oxygen pressure is depleted? ___ (Y)

6.14.1.10 Close the nitrous oxide flow control valve.

6.14.1.11 Disconnect the N_2O pipeline supply.

6.14.2 Air O.F.P.D. - if applicable

6.14.2.1 This step intentionally left blank.

6.14.2.2 Open the air cylinder valve - if applicable.

6.14.2.3 Connect the air pipeline hose - if applicable.

6.14.2.4 Open one (1) oxygen cylinder valve.

6.14.2.5 Set the air flow to 4 l/min; set the oxygen flow to 4 l/min.

6.14.2.6 Close the oxygen cylinder valve.

(✓) 6.14.2.7 Does the flow of air cease when the oxygen pressure is depleted? ___ (Y)

6.14.2.8 Close the air flow control valve.

6.14.2.9 Disconnect the air pipeline hose - if applicable.

6.14.3 Oxygen-Helium O.F.P.D. - if applicable

6.14.3.1 This step intentionally left blank.

6.14.3.2 Open the oxygen-helium cylinder valve.

6.14.3.3 Open one (1) oxygen cylinder valve.

6.14.3.4 Set the oxygen-helium flow to 4 l/min; set the oxygen flow to 4 l/min.

6.14.3.5 Close the oxygen cylinder valve.

(✓) 6.14.3.6 Does the flow of oxygen-helium cease when the oxygen pressure is depleted? ___ (Y)

6.14.3.7 Close the oxygen-helium flow control valve.

6.14.4 Carbon Dioxide O.F.P.D. - if applicable

6.14.4.1 This step intentionally left blank.

6.14.4.2 Open the cylinder of carbon dioxide.

6.14.4.3 Open one (1) oxygen cylinder valve.

6.14.4.4 Set the carbon dioxide flow to 500 ml; set the oxygen flow to 4 l/ min.

6.14.4.5 Close the oxygen cylinder valve.

(✓) 6.14.4.6 Does the flow of carbon dioxide cease when the oxygen pressure is depleted? ___ (Y)

6.14.4.7 Close the carbon dioxide flow control valve.

6.14.5 (Deleted)

6.14.6 (Deleted)

6.14.7 Oxygen Supply Pressure Alarm

6.14.7.1 If not already connected, connect a dedicated O_2 test gauge to the TEE fitting in the O_2 regulator output line.

6.14.7.2 Open and close an oxygen cylinder.

6.14.7.3 Set the oxygen flow to 2 l/min.

(✓) 6.14.7.4 What is the pressure on the dedicated O_2 test gauge when the "O2 SUPPLY PRESSURE" LED turns on? ___ PSI (34 - 40)

6.14.7.5 Does the O2 SUPPLY LOW message appear in the Caution display? ___ (Y)

6.14.7.6 Bleed the remaining O_2 pressure from the system, then close the flow control valve.

6.14.7.7 Remove the test gauge from the TEE fitting in the O_2 regulator output line and replace the plug.

6.15 FLOWMETERS

(✓) 6.15.1 Oxygen Flowmeter

6.15.1.1 Open the O_2 cylinder valve.

6.15.1.2 Is it possible to adjust the flow of oxygen over the full range of the flowmeters? ___ (Y)

6.15.1.3 Close the O_2 cylinder valve and bleed the pressure.

6.15.1.4 Connect the O_2 pipeline supply, and verify the operation of the oxygen flowmeter.

6.15.1.5 Is the correct flow control knob and label attached to the oxygen flow control valve? ___ (Y)

6.15.1.6 Close the oxygen flow control valve.

6.15.1.7 This step intentionally left blank.

(✓) 6.15.1.8 What is the minimum flow of oxygen? ___ ml (100-200 ml/min)

(✓) 6.15.2 Nitrous Oxide Flowmeter

6.15.2.1 Set the oxygen flow to 4 l/min.

6.15.2.2 Open the nitrous oxide cylinder valve.

6.15.2.3 Is it possible to adjust the flow of nitrous oxide over the full range of the flowmeter? ___ (Y)

6.15.2.4 Close the nitrous oxide cylinder valve and bleed the pressure.

6.15.2.5 Connect the N_2O pipeline supply, and verify the proper operation of the N_2O flowmeter.

6.15.2.6 Is the correct flow control knob and label attached to the N_2O flow control valve? ___ (Y)

6.15.2.7 Close the oxygen and nitrous oxide flow control valves.

(✓) 6.15.3 Air Flowmeter - if applicable

** 6.15.3.1 Open the air cylinder valve.

** 6.15.3.2 Is it possible to adjust the flow of the air over the full range of the flowmeter? ___ (Y)

** 6.15.3.3 Close the air cylinder valve and bleed the pressure.

6.15.3.4 Close the air flow control valve.

6.15.3.5 Connect the Air pipeline supply (if applicable) and verify the proper operation of the air flowmeter.

6.15.3.6 Close the air flow control valve and disconnect the Air pipeline supply.

6.15.3.7 Is the correct flow control knob and label attached to the air flow control valve? ___ (Y)

(✓) 6.15.4 Oxygen-Helium Flowmeter - if applicable

6.15.4.1 Open the oxygen-helium gas cylinder valve.

6.15.4.2 Is it possible to adjust the flow of the oxygen-helium over the full range of the flowmeter? ___ (Y)

6.15.4.3 Close the oxygen-helium flow control valve.

6.15.4.4 Is the correct flow control knob and label attached to the oxygen-helium flow control valve? ___ (Y)

(✓) 6.15.5 Carbon Dioxide Flowmeter - if applicable

6.15.5.1 Open the carbon dioxide gas cylinder valve.

6.15.5.2 Is it possible to adjust the flow of the carbon dioxide over ~~its range~~ of ~~800~~ ml/min.? ___ (Y) 500ml MAX

6.15.5.3 Close the carbon dioxide flow control valve.

6.15.5.4 Is the correct flow control knob and label attached to the carbon dioxide flow control valve? ___ (Y)

** These items do not apply to 4-gas machines.

6.16 O_2 MED

6.16.1 Disconnect the oxygen sensor cable from the Oxygen Sensor interface.

6.16.2 The following message shall appear on the display: O2 SENS DISC.

6.16.3 Reconnect the O_2 Med sensor.

6.16.4 The following message shall appear on the display: CAL O2 SENSOR.

6.16.5 Press the Cal key.

NOTE: Make sure that the sensor has stabilized in ambient air for several minutes.

(✓) 6.16.6 After calibration is completed, what is the oxygen concentration? ___ % (21)

6.16.7 This step intentionally left blank.

6.16.8 The warning INSP O2 LOW shall appear on the display and the warning heading shall be flashing. There shall be a continuous audible alarm.

6.16.9 What is the low oxygen alarm default? ___ % (30)

6.16.10 This step intentionally left blank.

6.16.11 Select the OXYGEN LOW alarm limit. Does a box appear around the low alarm limit? ___ (Y)

6.16.12 Verify that the low alarm limit has a range from 18 to 99%.

6.16.13 Place the oxygen sensor into the inspiratory valve dome adapter, set the Man/Auto selector BAG, close the APL valve. Attach a 12-inch hose to the inspiratory valve and occlude the bag mount.

6.16.14 Set the oxygen flow to 4 l/min.

6.16.15 Set the low limit to 18, and verify that the INSP O2 LOW message has cleared.

6.16.16 Select the OXYGEN HIGH alarm limit. Does a box appear around the high alarm limit? ___ (Y)

6.16.17 What is the high oxygen alarm default? ___ % (100)

6.16.18 Verify that the high alarm limit has a range from 100 to 19%.

6.16.19 Set the high alarm limit to 95.

6.16.20 The message INSP O2 HIGH shall appear as an Advisory.

6.16.21 Return the high alarm limit to 100.

6.16.22 The INSP O2 HIGH message shall disappear.

(✓) 6.16.23 Within 3 minutes, what is the oxygen concentration? ___ % (97-100)

6.17 OXYGEN CONCENTRATIONS

6.17.1 Oxygen + Nitrous Oxide Concentration

6.17.1.1 Verify the oxygen flow is at 4 l/min.

6.17.1.2 Depress the O_2 Flush button for 5 seconds.

6.17.1.3 Does the O_2Med read 97-100% after the value stabilizes?__(Y)

6.17.1.4 Set the nitrous oxide flow to 2 l/min.

(✓) 6.17.1.5 After the value stabilizes, what is the oxygen concentration? ___ % (64-70)

6.17.1.6 Close the nitrous oxide flow control valve.

6.17.2 Oxygen + Air Concentration - if applicable

6.17.2.1 Depress the O_2FLUSH button for 5 seconds.

6.17.2.2 Does the O_2Med read 97-100% after the value stabilizes?__(Y)

6.17.2.3 This step intentionally left blank.

6.17.2.4 Set the air flow to 2 l/min.

(✓) 6.17.2.5 After the value stabilizes, what is the O_2 concentration? ___%(71-77)

6.17.2.6 Close the air cylinder valve and bleed the pressure from the circuit - if applicable.

6.17.2.7 Close the air flow control valve.

6.17.3 Oxygen + Helium and Oxygen Concentration - if applicable

6.17.3.1 Depress the "O_2 FLUSH" for 5 seconds.

6.17.3.2 After the value stabilizes, does the O_2 Med read 97-100%? ___ (Y)

6.17.3.3 This step intentionally left blank.

6.17.3.4 Verify the oxygen flow is at 4 l/min.

6.17.3.5 Set the oxygen-helium flow to 2 l/min.

(✓) 6.17.3.6 After the value stabilizes, what is the O_2 concentration? ___%(72-78)

6.17.3.7 Close the oxygen-helium cylinder valve and bleed the pressure from the circuit.

6.17.3.8 Close the oxygen-helium flow control valve.

6.17.4 Oxygen + Carbon Dioxide Concentration - if applicable

6.17.4.1 Depress the O_2FLUSH button for 5 seconds.

6.17.4.2 Set the oxygen flow to 1000 ml.

6.17.4.3 After the value stabilizes, does the O_2MED read 97-100%?___(Y)

6.17.4.4 this step intentionally left blank.

6.17.4.5 Set the carbon dioxide flow to 500 ml.

(✓) 6.17.4.6 What is the O_2 concentration after the value stabilizes? ___%(64-70)

6.17.4.7 Close the carbon dioxide cylinder valve and bleed the pressure from the circuit.

6.17.4.8 Close the carbon dioxide flow control valve.

(✓) **6.18 AUXILIARY OXYGEN FLOWMETER - if applicable**

6.18.1 Close the auxiliary oxygen flowmeter flow control valve.

6.18.2 Connect a cm H_2O pressure manometer to the outlet.

6.18.3 Is there an increase in pressure? ___ (N)

6.18.4 Apply a pressure of 50 cm H_2O to the manometer.

6.18.5 After 30 seconds, what is the pressure on the manometer? ___(>40 cm H_2O)

6.18.6 Remove the gauge and test fixture.

6.18.7 Is it possible to adjust the flow over the full range of the auxiliary oxygen flowmeter? ___ (Y)

6.18.8 Set the flow rate to 5 l/min.

6.18.9 Hold the sensor from a calibrated O_2Med at the auxiliary oxygen flowmeter outlet.

6.18.10 After the value stabilizes, what is the oxygen concentration? ___ % (97-100)

6.18.11 Remove the O_2Med sensor from the auxiliary oxygen flowmeter, and insert it into the inspiratory valve dome adapter.

6.18.12 Close the flowmeter flow control valve.

6.19 A OXYGEN RATIO CONTROLLER

6.19A.1 This step intentionally left blank.

6.19A.2 Depress the O_2FLUSH for 5 seconds.

6.19A.3 Set the oxygen flow to 1000 ml/min.

6.19A.4 Open the nitrous oxide flow control valve to the stop position.

(✓) 6.19A.5 What is the oxygen concentration after the value stabilizes? ___ % (21-29)

6.19A.6 Adjust the oxygen flow to 1.5 l/min.

(✓) 6.19A.7 What is the oxygen concentration after the value stabilizes? ___ % (21-29)

6.19A.8 Adjust the oxygen flow to 2 l/min.

(✓) 6.19A.9 What is the oxygen concentration after the value stabilizes? ___ % (21-29)

6.19A.10 Adjust the oxygen flow to 4 l/min.

(✓) 6.19A.11 What is the oxygen concentration after the value stabilizes? ___ % (21-29)

6.19A.12 Reduce the O_2 flow to 500 ml/min. Verify that the N_2O flow is greater than or equal to 600 ml/min.

6.19A.13 Close the oxygen flow control valve.

(✓) 6.19A.14 What is the flow of nitrous oxide? ___ ml/min. 375-750 ml/min

6.19A.15 What is the oxygen concentration with the O_2 flow control valve closed?___% (>21)

6.19A.16 Close the nitrous oxide flow control valve.

6.20 BAROMED

6.20.1 Disconnect the breathing pressure sensor line from the absorber.

6.20.2 Connect a test pressure gauge and syringe to the breathing pressure sensor line.

6.20.3 Select the THRESHOLD PRES alarm limit. Does a number appear to the left of the threshold line on the waveform? ___ (Y).

6.20.4 What is the threshold alarm default? ___ cm H_2O (12)

6.20.5 Verify that the threshold alarm limit has a range from 5 to 30 cm H_2O.

6.20.6 Adjust the threshold to 10 cm H2O.

6.20.7 Select the PRESSURE HIGH alarm limit. Does a box shall appear around the High Pressure Alarm Limit? ___ (Y)

6.20.8 What is the high alarm limit default? ___ cm H_2O (50)

6.20.9 Verify that the high alarm limit has a range from 30 to 120 cm H_2O.

6.20.10 Set the high alarm limit to 65 cm H_2O, and exit from the set up menu.

6.20.11 Increase the pressure to 25 cm H_2O, then decrease the pressure to 20 cm H_2O. (You must perform this step within 10 seconds, otherwise a continuing pressure condition will prevail and will prevent completionof the test.)

6.20.12 Does the THRESHOLD LOW message appear in the Advisory column? ___ (Y)

6.20.13 Set the Man/Auto valve to AUTO, and turn the ventilator ON.

6.20.14 Bleed the pressure and start a stopwatch.

NOTE:Apnea Pressure alarm times are valid only with ventilator ON.

(✓) 6.20.15 What is the time when APNEA-PRESSURE appears in the Caution column? ___ sec (13-17)

(✓) 6.20.16 What is the time when the APNEA-PRESSURE appears in the Warning column? ___ sec (26-34)

6.20.17 After the APNEA-PRESSURE alarm is displayed as a Warning, slowly increase the test pressure.

(✓) 6.20.18 At what pressure does the APNEA-PRESSURE alarm deactivate? ___ cm H_2O (7-13)

6.20.19 Adjust the threshold to 18 cm H_2O.

6.20.20 Increase the pressure to 20 cm H_2O, maintain the pressure, and start a stopwatch.

(✓) 6.20.21 What is the time when CONTINUOUS PRES appears as a Warning? ___ sec (12-18)

(✓) 6.20.22 Decreasing the pressure slowly, what is the pressure at which the CONTINUOUS PRES alarm deactivates? ___ cm H_2O (15-21)

6.20.23 Slowly increase the pressure.

(✓) 6.20.24 At what pressure does the VENT PRESSURE HI alarm activate? ___ cm H_2O (62-68)

6.20.25 Bleed the pressure.

6.20.26 Slowly create a sub-atmospheric pressure.

(✓) 6.20.27 At what pressure does the SUB ATM PRESSURE alarm activate? ___ cm H_2O (-7 to -13)

6.20.28 Disconnect the test gauge and syringe; reconnect the breathing pressure sensor line to the absorber.

6.20.29 Does the SUB ATM PRESSURE alarm deactivate? ___(Y)

6.20.30 Press the Breathing Pressure OFF key.

6.20.31 Verify that the APNEA ALARM cannot be selected to OFF when the ventilator switch is ON.

6.21 VENTILATOR

NOTE: Set the Pressure Limit control to MAX, and the PEEP valve to the minimum position, if applicable. Readjustment of inspiratory flow to limit the inspiratory plateau may be required to reduce erratic tidal volumes and breath rates caused by artiface volumes.

6.21.1 Set the Man/Auto selector to BAG.

6.21.2 Set the FREQUENCY to 10 BPM.

6.21.3 Set the I:E RATIO to 1:2.

6.21.4 Set the Tidal Volume to 1000 ml.

6.21.5 Attach a patient circuit to the absorber system.

6.21.6 Adjust the O_2 flow to 3 l/min.

6.21.7 Is LED illuminated in Breathing Volume OFF key? (Y) (If No, press the OFF key.)

6.21.8 Is the VOL-ALARMS OFF message displayed in the Advisory column? (Y) (If No, press the Volume Alarm key.)

6.21.9 Turn the ventilator on.

6.21.10 Verify the FAULT indicator turns on (Y)

6.21.11 Set the Man/Auto selector switch to AUTO.

6.21.12 Verify the FAULT indicator turns off (Y)

6.21.13 Do the LEDs in the Breathing Volume OFF and Breathing Pressure OFF keys extinguish? (Y)

6.21.14 Adjust the INSPIRATORY FLOW to the maximum of the LOW zone.

6.21.15 Occlude the Y-piece with your thumb.

6.21.16 Inflate the bellows by momentarily pressing the O_2 Flush.

(✓) 6.21.17 What is the peak inspiratory pressure? ___ cm H_2O (>30 cm H_2O)

6.21.18 Attach a test lung to the Y-piece.

6.21.19 Using a stopwatch, time the inspiratory phase.

(✓) 6.21.20 What is the inspiratory time? ___ seconds (1.8-2.2)

6.21.21 Using a stopwatch, time the expiratory phase.

(✓) 6.21.22 What is the expiratory time? ___ seconds (3.6-4.4)

** 6.21.23 Press and hold the EXTENDED RANGE switch and scroll the I:E ratio dial counter-clockwise and verify the extended I:E values increment (2:1, 3:1 and 4:1); return the I:E ratio to 2:1.

** 6.21.24 Using a stopwatch, time the inspiratory phase.

✓** 6.21.25 What is the inspiratory time? ___ seconds (3.6 - 4.4)

** 6.21.26 Using a stopwatch, time the expiratory phase.

✓** 6.21.27 What is the expiratory time? ___ seconds (1.8 - 2.2)

(✓) 6.21.28 Adjust the FREQUENCY and I:E RATIO through the following settings and verify that the ventilator cycles properly:

FREQ.	I:E RATIO	FREQ.	I:E RATIO	FREQ.	I:E RATIO
11	1:1	44	1:2.5	77	1:4
22	1:1.5	55	1:3	88	1:4.5
33	1:2	66	1:3.5	99	1:4.5

6.22 BELLOWS DRIVE GAS LEAK: ADULT

6.22.1 Remove the ventilator hose from the VENTILATOR HOSE terminal.

6.22.2 Attach a test terminal to the bellows assembly ventilator hose terminal.

6.22.3 Connect a flowmeter test stand (P/N S000081) to the test terminal.

6.22.4 Set the FREQUENCY to 1 BPM.

6.22.5 Set the I:E RATIO to 1:1.

6.22.6 Set the INSPIRATORY FLOW to the maximum.

(✓) 6.22.7 What is the flow indicated during the inspiratory phase? ___ (<50 ml)

6.22.8 Remove the test terminal and flowmeter test stand.

6.22.9 Turn the ventilator and all ventilation alarms OFF.

6.23 SPIROMED or Ultrasonic Flow Sensor

6.23.1 Press the Breathing Volume LOW LIMIT key. Does a box appear around the Minute Volume Alarm Limit? ___(Y)

6.23.2 What is the low minute volume alarm default? ___ (1.0)

6.23.3 Verify that the minute volume has a low alarm limit range from at least 0.2 to 10.0 by increments of 0.1.

6.23.4 Adjust the low minute volume alarm to 2.0 liters. Turn on the ventilator (with the breathing circuit open) and start a stop watch.

6.23.5 This step intentionally left blank.

(✓) 6.23.6 What is the time when APNEA-VOLUME appears as a Caution? ___ sec (26-34)

(✓) 6.23.7 What is the time when APNEA-VOLUME appears as a Warning? ___ sec (52-68)

(✓) 6.23.8 Within one (1) minute, does the MINUTE VOLUME LOW message appear as a Caution? ___ Y

6.23.9 Insert a test minute volumeter in between the Spiromed sensor (or absorber, if the system is equipped with the ultrasonic flow sensor) and the exhalation valve.

6.23.10 Reconnect the ventilator hose to the Ventilator Hose terminal.

6.23.11 Adjust the FREQUENCY to 6 BPM.

6.23.12 Adjust the I:E RATIO to 1:2.

6.23.13 Adjust the flow to the maximum of the LOW zone.

6.23.14 Adjust the oxygen flow to 2 l/min.

6.23.15 Adjust the Tidal Volume to 200 ml.

6.23.16 After the first breath is detected, do the APNEA-VOLUME Warning message and the MINUTE VOLUME LO Caution message deactivate? ___ (Y)

6.23.17 Adjust the low alarm limit above the indicated minute volume.

6.23.18 Does the MINUTE VOLUME LO message appear as a Caution? ___ (Y)

6.23.19 Adjust the low alarm limit below the indicated minute volume.

6.23.20 Does the MINUTE VOLUME LO Caution message deactivate? ___ (Y)

6.23.21 Increase the tidal volume to 1000 ml and the frequency to 10 BPM.

6.23.22 Press the O_2 Flush momentarily to inflate the bellows.

6.23.23 Readjust the inspiratory flow as necessary to fully collapse the bellows.

(✓) 6.23.24 Are the tidal and minute volumes on the machine and on the test volumeter within 20% of each other? ___ (Y)

6.23.25 Create a reverse flow by loosening the expiratory valve dome. If equipped with an ultrasonic flow sensor, remove the breathing hose from the flow sensor. Connect a test terminal and a Riken aspirator (negative pressure squeeze bulb) to the 22 mm male port of the flow sensor. Disconnect the hose attached to the exhalation valve. Compress and release the aspirator.

(✓) 6.23.26 Each time a reverse flow greater than 20 ml is detected, does the REVERSE FLOW message appear as an Advisory? ___ (Y)

6.23.27 Tighten the expiratory valve dome. If equipped with an ultrasonic flow sensor, remove the test terminal and aspirator from the flow sensor and reconnect the patient circuit hose. Reconnect the hose between the expiratory valve and the flow sensor.

6.23.28 Disconnect the respiratory volume sensor cord from the VOLUME SENSOR interface.

6.23.29 Do the VOL SENSOR DISC appear as an Advisory, and is LED illuminated in the Breathing Volume OFF key? ___ (Y)

6.23.30 Connect the respiratory volume sensor cord to the VOLUME SENSOR interface and verify that the alarms clear.

6.24 A BELLOWS: ADULT - if applicable

6.24A.1 Set the FREQUENCY to 10 BPM.

6.24A.2 Set the I:E RATIO to 1:2.

6.24A.3 Adjust the O_2 flow to 300 ml/min.

6.24A.4 Adjust the INSPIRATORY FLOW to MED.

6.24A.5 Adjust the Tidal Volume to 200 ml.

6.24A.6 Press the O_2 Flush momentarily to inflate the bellows.

(✓) 6.24A.7 What is the Tidal Volume on the test volumeter? ___ ml (125-250)

6.24A.8 Adjust the Tidal Volume to 1000 ml, and the fresh gas flow to 3 L/min.

6.24A.9 Press the O_2 Flush momentarily to inflate the bellows.

(✓) 6.24A.10 What is the Tidal Volume on the test volumeter? ___ ml (900-1100)

6.24A.11 Adjust the O_2 flow to 5 l/min.

6.24A.12 Adjust the Tidal Volume to maximum.

6.24A.13 Remove the test lung and attach a 3 liter breathing bag. Adjust the INSPIRATORY FLOW to fully compress the bellows.

NOTE: Bag should be placed on a flat horizontal surface to reduce artifact volume.

(✓) 6.24A.14 What is the Tidal Volume on the test volumeter? ___ ml (_1400)

6.24B VENTILATOR RELIEF VALVE: ADULT

6.24B.1 Adjust the O_2 flow to 10 l/min.

6.24B.2 Adjust the INSPIRATORY FLOW to fully compress the bellows.

6.24B.3 Adjust the I:E RATIO to 1:3, and the FREQUENCY to 10.

6.24B.4 Adjust the Tidal Volume to 1200 ml.

(✓) 6.24B.5 What is the PEEP? ___ cm H_2O (_3)

6.24B.6 Adjust the O_2 flow to 500 ml.

(✓) 6.24B.7 Does the ventilator deliver the full Tidal Volume during 5 consecutive cycles? ___ (Y)

6.24B.8 Does the bellows stop adjust smoothly? ___ (Y)

6.25 A BELLOWS: PEDIATRIC EXTERNAL - if applicable

6.25A.1 Set the ventilator frequency to 10 BPM.

6.25A.2 Set the I:E Ration to 1:2.

6.25A.3 Adjust the tidal volume to 300 ml/min.

6.25A.4 Turn the ventilator ON.

6.25A.5 Adjust the Inspiratory Flow control on the ventilator to Medium.

6.25A.6 Adjust the fine flow control of the Ped Bellows attachment fully clockwise.

6.25A.7 Set the O_2 to 3 l/min.

6.25A.8 Occlude the 15mm patient side of the Y-piece and fill the bellows by pressing the O_2 Flush button.

6.25A.9 Observe the absorber breathing pressure gauge as the ventilator cycles.

6.25A.10 What is the pressure when the bellows completes its downward travel? ___cmH_2O >30

6.25A.11 What is the pressure when the bellows completes its upward travel? ___cmH_2O _3

6.25A.12 Attach a test lung onto the patient circuit Y-piece.

6.25A.13 Fill the bellows by pressing the O_2 Flush button.

6.25A.14 Verify that with the Pediatric Bellows Fine Flow Control turned fully counter-clockwise the bellows does not collapse during inspiration. Readjust the knob to the fully clockwise position.

6.25A.15 Adjust the O_2 flow to 10 l/min.

(✓) 6.25A.16 What is the PEEP? ___cmH_2O (_3)

6.25A.17 Adjust the O_2 flow to 500 ml/min.

(✓) 6.25A.18 Does the ventilator deliver the full tidal volume during 5 consecutive cycles? ___(Y)

6.25A.19 Set the ventilator frequency to 20 BPM, and the I:E ratio to 1:1.

6.25A.20 Adjust the O_2 flow to 3 l/min.

(✓) 6.25A.21 What is the tidal volume on the test volumeter? ___ml (>250)

6.25A.22 Remove the ventilator hose from the ventilator hose terminal.

6.25A.23 Attach a test terminal to the bellows assembly ventilator hose terminal.

6.25A.24 Connect a flowmeter test stand (P/N S000081) to the test terminal.

6.25A.25 Set the frequency to 1 BPM.

6.25A.26 Set the I:E RATIO to 1:1.

(✓) 6.25A.27 What is the flow indicated during the inspiratory phase? ___(<50 ml)

6.25A.28 Remove the test terminal and flowmeter test stand.

6.25A.29 Return all controls to their original position.

6.25B BELLOWS: PEDIATRIC INTERNAL - if applicable

6.25B.1 Set the ventilator frequency to 10 BPM.

6.25B.2 Set the I:E Ration to 1:2.

6.25B.3 Turn the ventilator ON.

6.25B.4 Adjust the Inspiratory Flow control on the ventilator to Medium.

6.25B.5 Set the O_2 to 3 l/min.

6.25B.6 Occlude the 15mm patient side of the Y-piece and fill the bellows by pressing the O_2 Flush button.

6.25B.7 Observe the absorber breathing pressure gauge as the ventilator cycles.

6.25B.8 What is the pressure when the bellows completes its downward travel? ___cmH_2O >30

6.25B.9 What is the pressure when the bellows completes its upward travel? ___cmH_2O _3

6.25B.10 Install a 3 L breathing bag onto the patient circuit Y-piece.

6.25B.11 Fill the bellows by pressing the O_2 Flush button.

6.25B.12 Adjust the O_2 flow to 10 l/min.

(✓) 6.25B.13 What is the PEEP? ___cmH_2O (_3)

6.25B.14 Adjust the O_2 flow to 500 ml/min.

6.25B.15 Adjust the inspiratory flow control until the bellows collapses entirely.

(✓) 6.25B.16 Does the ventilator deliver the full tidal volume during 5 consecutive cycles? ___(Y)

6.25B.17 Set the ventilator frequency to 20 BPM, and the I:E ratio to 1:1.

6.25B.18 Adjust the O_2 flow to 5 l/min.

6.25B.19 Adjust the inspiratory flow control until the bellows collapses to the 100 ml mark on the pediatric bellows assembly.

(✓) 6.25B.20 What is the tidal volume on the test volumeter? ___ml (65-135)

6.25B.21 Adjust the inspiratory flow control until the bellows collapses entirely.

(✓) 6.25B.22 What is the tidal volume on the test volumeter? ___ml (>240)

6.25B.23 Close the O_2 flow control valve.

6.25B.24 Remove the ventilator hose from the ventilator hose terminal.

6.25B.25 Attach a test terminal to the bellows assembly ventilator hose terminal.

6.25B.26 Connect a flowmeter test stand (P/N S000081) to the test terminal.

6.25B.27 Set the frequency to 1 BPM.

6.25B.28 Set the I:E RATIO to 1:1.

(✓) 6.25B.29 What is the flow indicated during the inspiratory phase? ___(<50 ml)

6.25B.30 Remove the test terminal and flowmeter test stand.

6.25B.31 Return all controls to their original position.

6.26 TRACE

(✓) 6.26.1 Verify that the display correctly tracks the Breathing Pressure and Volume waveform.

6.26.2 Turn the ventilator OFF.

6.27 PRESSURE LIMIT CONTROLLER

6.27.1 Turn the ventilator ON.

6.27.2 Set the Inspiratory Flow to the bottom of the low range.

6.27.3 Set the oxygen flow rate to 4 l/min.

6.27.4 Set the Pressure Limit Control to the MAX position.

6.27.5 Occlude the Y-piece with your thumb.

(✓) 6.27.6 Slowly increase the Inspiratory Flow setting until a peak pressure of 80 cm H_2O is achieved.

6.27.7 Set the Pressure Limit Control to 30.

(✓) 6.27.8 What is the peak pressure? ___ cm H_2O (27-33)

6.27.9 Set the Pressure Limit Control to the Min position.

(✓) 6.27.10 What is the peak pressure? ___ cm H_2O (9-15)

6.27.11 Remove your thumb from the Y-piece.

6.27.12 Set the Inspiratory Flow to the maximum of the LOW zone.

6.27.13 Close the oxygen flow control valve.

6.27.14 Turn the ventilator OFF.

6.28 This section intentionally left blank

(✓) **6.29 AUDIO SILENCE**

6.29.1 Turn the System Power switch to STANDBY, then turn it ON.

6.29.2 Verify the 120-sec. delay at power-up.

6.29.3 Create any warning alarm.

6.29.4 Press the Silence Alarms key (labeled with a crossed-out speaker).

6.29.5 Does the LED on the Silence Alarms key light? Is the audio alarm silenced for 120 sec.?

6.30 OXYGEN FLUSH VALVE

6.30.1 Press and release the O_2FLUSH button.

6.30.2 Does the flow of oxygen stop immediately? __ (Y)

6.30.3 Close the APL valve.

6.30.4 Connect a 12-inch hose to the inspiratory valve.

6.30.5 Set the Man/Auto selector to BAG.

6.30.6 Occlude the bag mount.

6.30.7 Insert the sensor from a calibrated O_2 Med into the valve dome adapter on the inspiratory valve.

6.30.8 Close all flow control valves.

6.30.9 Press the O_2FLUSH button.

(✓) 6.30.10 What is the O_2 concentration after the value stabilizes?___%O_2 (97-100)

6.30.11 Remove the O_2 Med sensor and install the plug.

6.30.12 Remove the test minute volumeter (P/N 2212300) from the absorber and connect it to the common gas outlet, using Fresh Gas Outlet Volume Test Device (P/N S010158).

6.30.13 Press and hold the O_2 FLUSH button for 15 seconds; multiply the value by 4.

(✓) 6.30.14 What is the oxygen flush flow rate? ___l/min. (45-65)

6.30.15 Remove the test minute volumeter and test fixture, and reconnect the fresh gas hose.

6.30.16 Turn the System Power switch to ON.

6.31 FINAL TESTS

(✓) 6.31.1 Operator's Instruction Manual

6.31.1.1 Verify that the availability/location of the machine's Operator's Instruction Manual is in close proximity of the machine.

(✓) 6.31.2 Lamp Test

6.31.2.1 Verify that the table lamp is working properly.

(✓) 6.31.3 Final Check

6.31.3.1 Verify that all cylinder pressure gauges indicate zero.

6.31.3.2 Verify that the pipeline hoses are connected to the hospital pipeline.

6.31.3.3 Verify that the APL valve knob is turned completely counter-clockwise (fully open).

6.31.3.4 Place the Auto/Man selector in the BAG position.

6.31.3.5 Verify that the O_2Med sensor is removed from the valve dome adapter.

6.31.3.6 Verify that the valve dome is plugged.

6.31.3.7 Verify that the machine is plugged into a live outlet.

6.31.3.8 Return all machine controls and settings to their original state.

7.0 SOFTWARE UPDATE PROCEDURE

This section outlines the software installation procedure, including the equipment needed and its connections.

Software updates to the Narkomed GS anesthesia system are done through a serial port connection to an external PC using the batch file LOADGS.BAT.

7.1 SOFTWARE TRANSFER TO PC VIA MODEM

Equipment required:

--Interface Cable, NAD Part No. 4109882 P (9-pin to 25-pin)
or 4110328 A (9-pin to 9-pin)
--IBM® PC or IBM PC Compatible configured with:

- PC-DOS or MS-DOS V3.3 or higher
- RS-232C Serial Port connected to COM 1
- Hard Drive or Floppy Drive
- Modem (or external modem)

7.1.1 Download the software to the hard disk or use Drive A (floppy drive) on the PC.

7.2 INSTALLING NMGS SOFTWARE FROM A PC

7.2.1 Set the System Power switch on the NARKOMED GS to STANDBY, and the power switch on the PC to OFF.

7.2.2 Connect the appropriate interface cable (9-pin or 25-pin) to COM 1 on the PC, and connect the other end of the cable to the NMGS serial interface Port as shown in Figure 7-1.

7.2.3 Power up the PC and wait for the DOS prompt to appear on the screen.

7.2.4 Set the PC to read the drive holding the software. For example: if the software was downloaded to drive A, type A: and press ENTER.

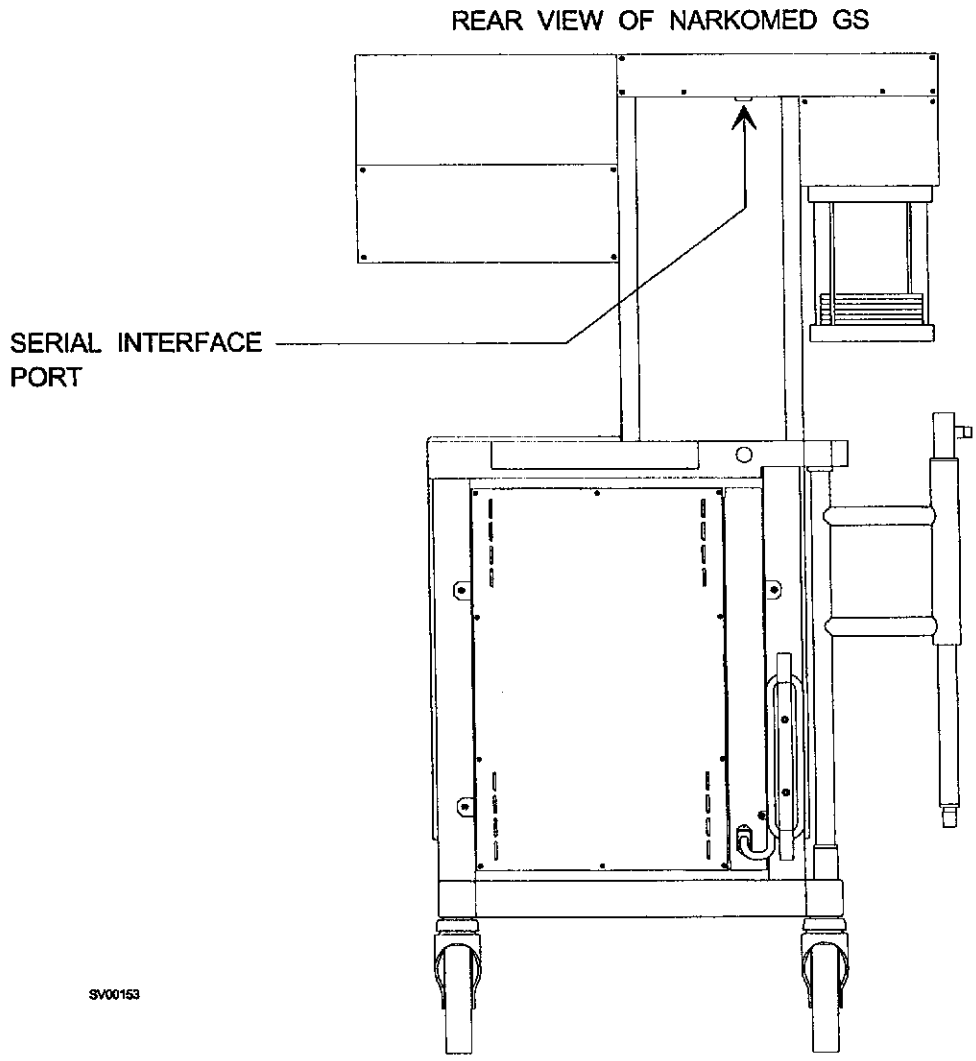


Figure 7-1: NARKOMED GS SERIAL PORT LOCATION

7.2.5 Type LOADNMGS and press ENTER.

7.2.6 Turn the System Power switch to ON.

7.2.7 As the software is downloading, the incremental number of bytes sent will be displayed on the PC screen. When the download is complete, the PC screen will display

```
\       Bytes sent:     0     Images sent:     1
```

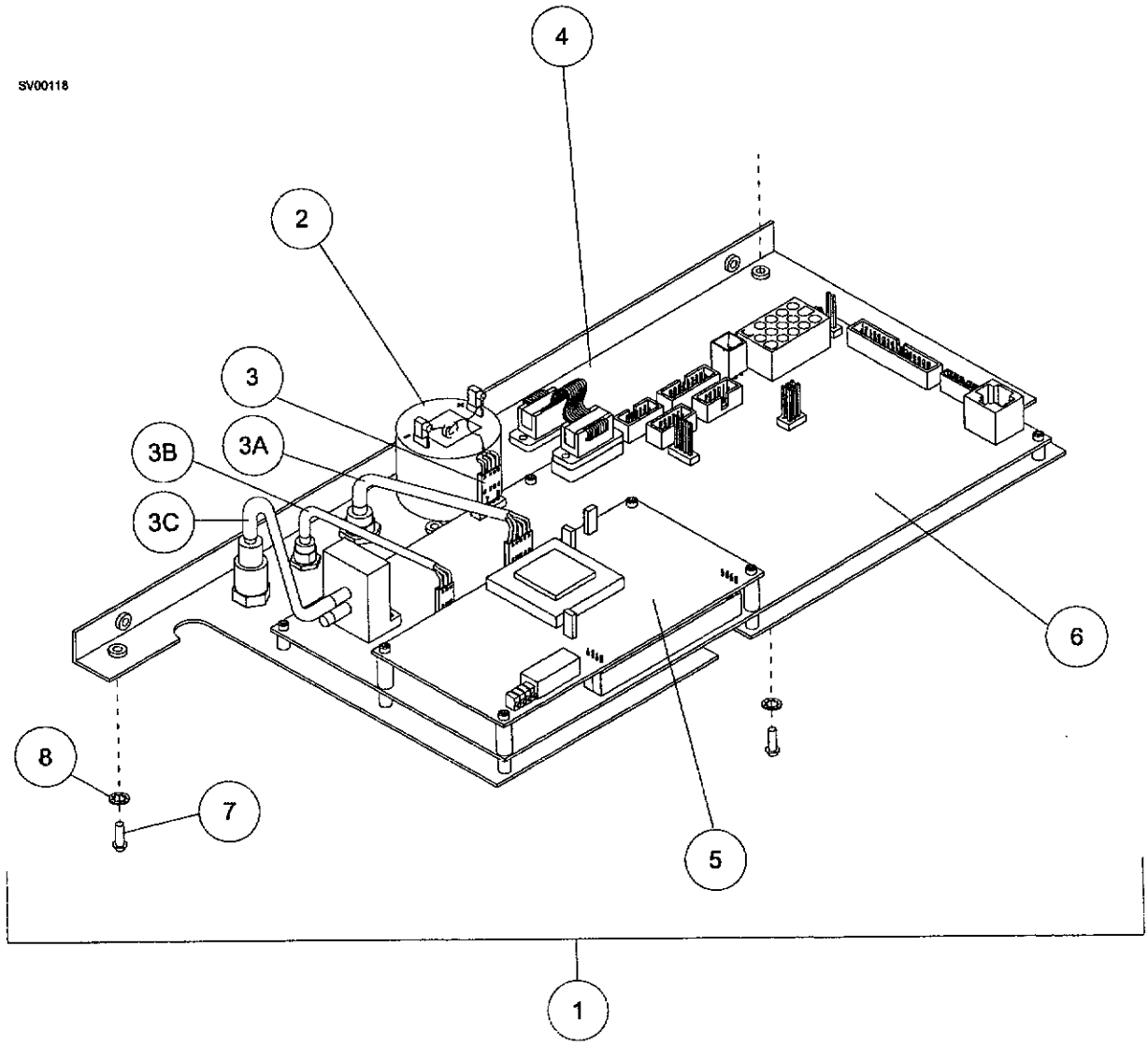
Software installation is complete when the machine resets.

7.2.8 Set the System Power switch on the NMGS to STANDBY, and the power switch on the PC to OFF. Disconnect the interface cable.

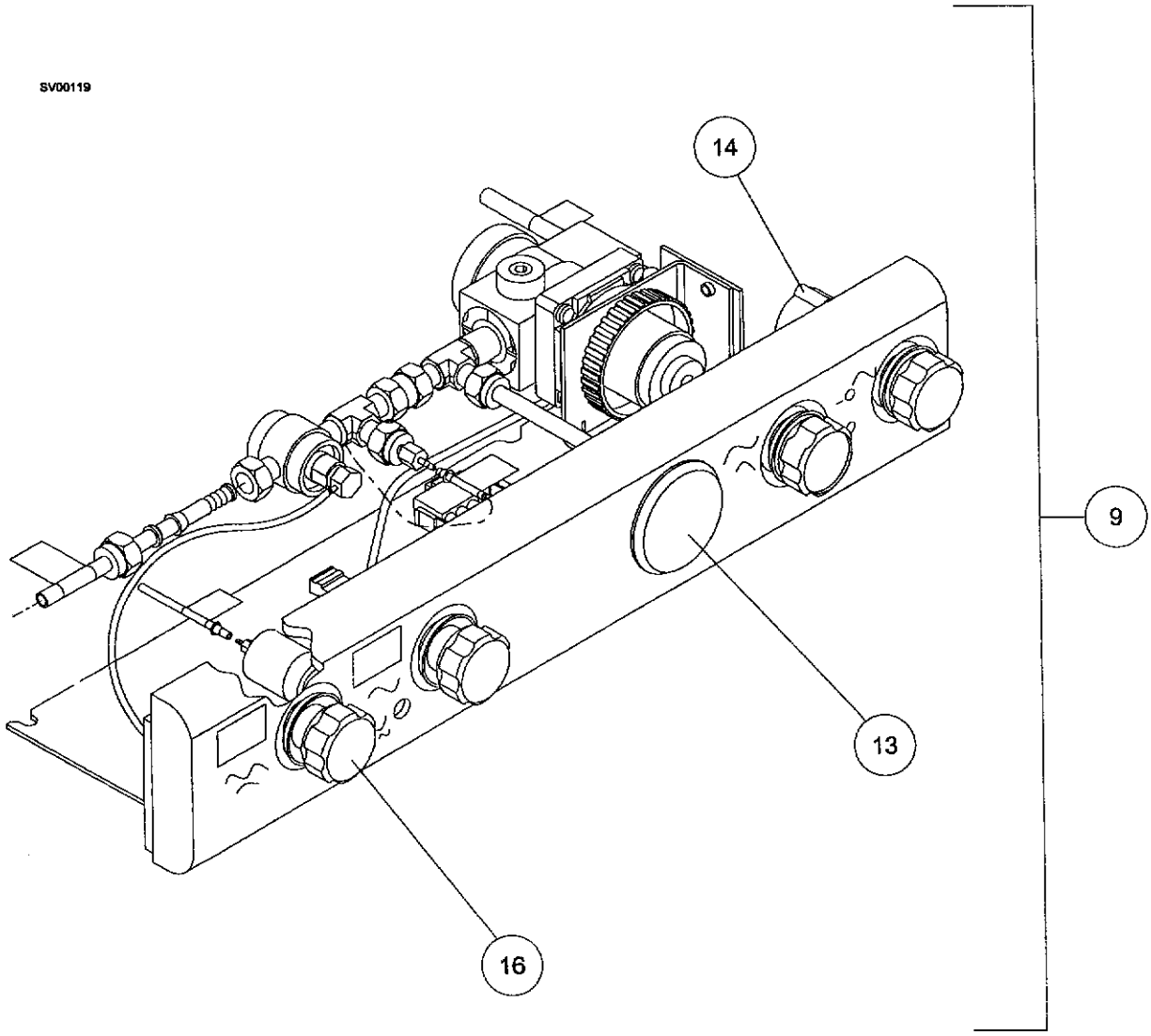
Part numbers for field-replaceable items on the Narkomed GS anesthesia system are listed on the following pages, along with part numbers for related hardware and cables.

The item numbers are keyed to the accompanying illustrations to aid in identifying the item and its location.

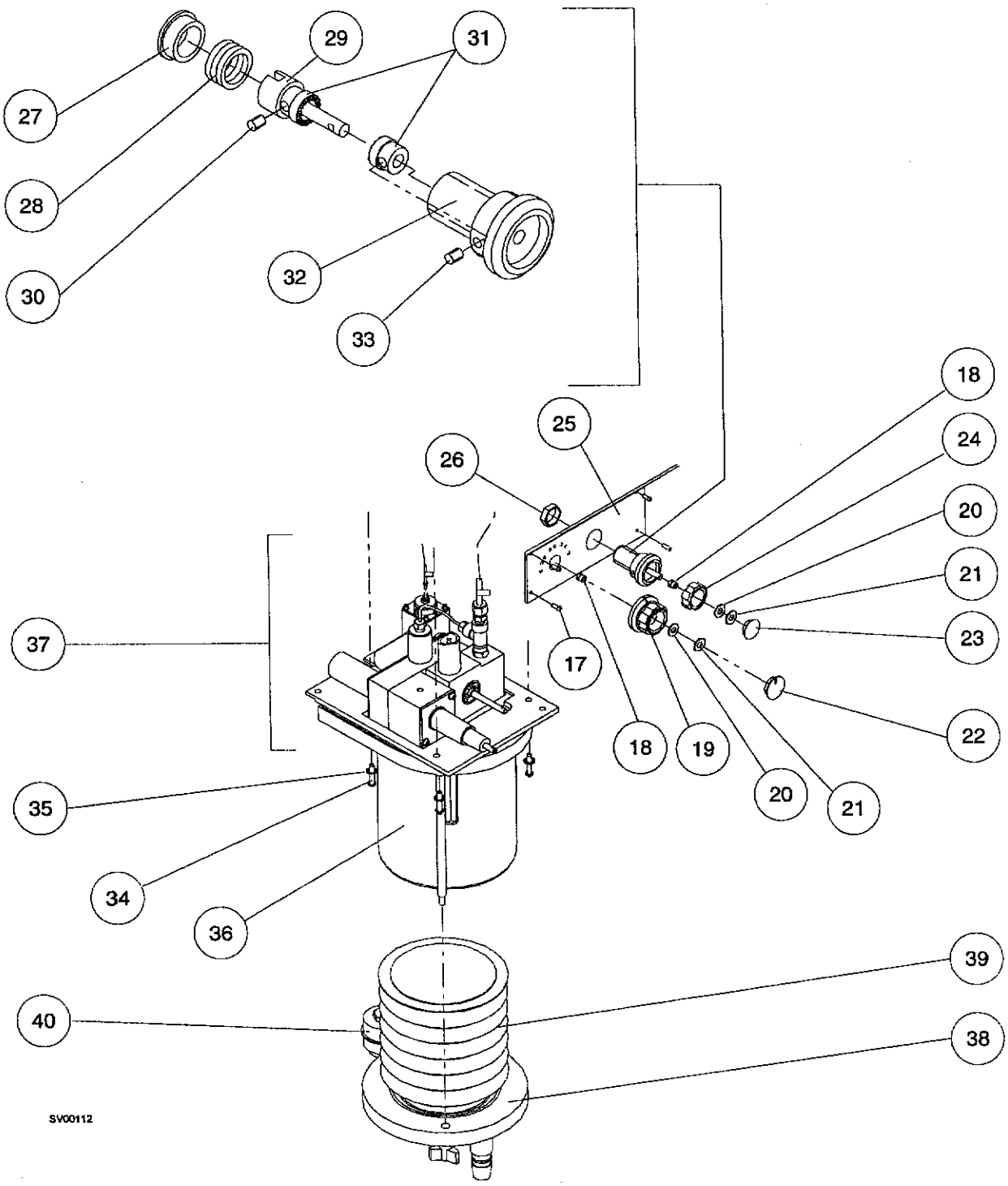
ASSEMBLY/PART PAGE


SV00118
4
2
3
3B
3A
3C
6
8
7
5
1

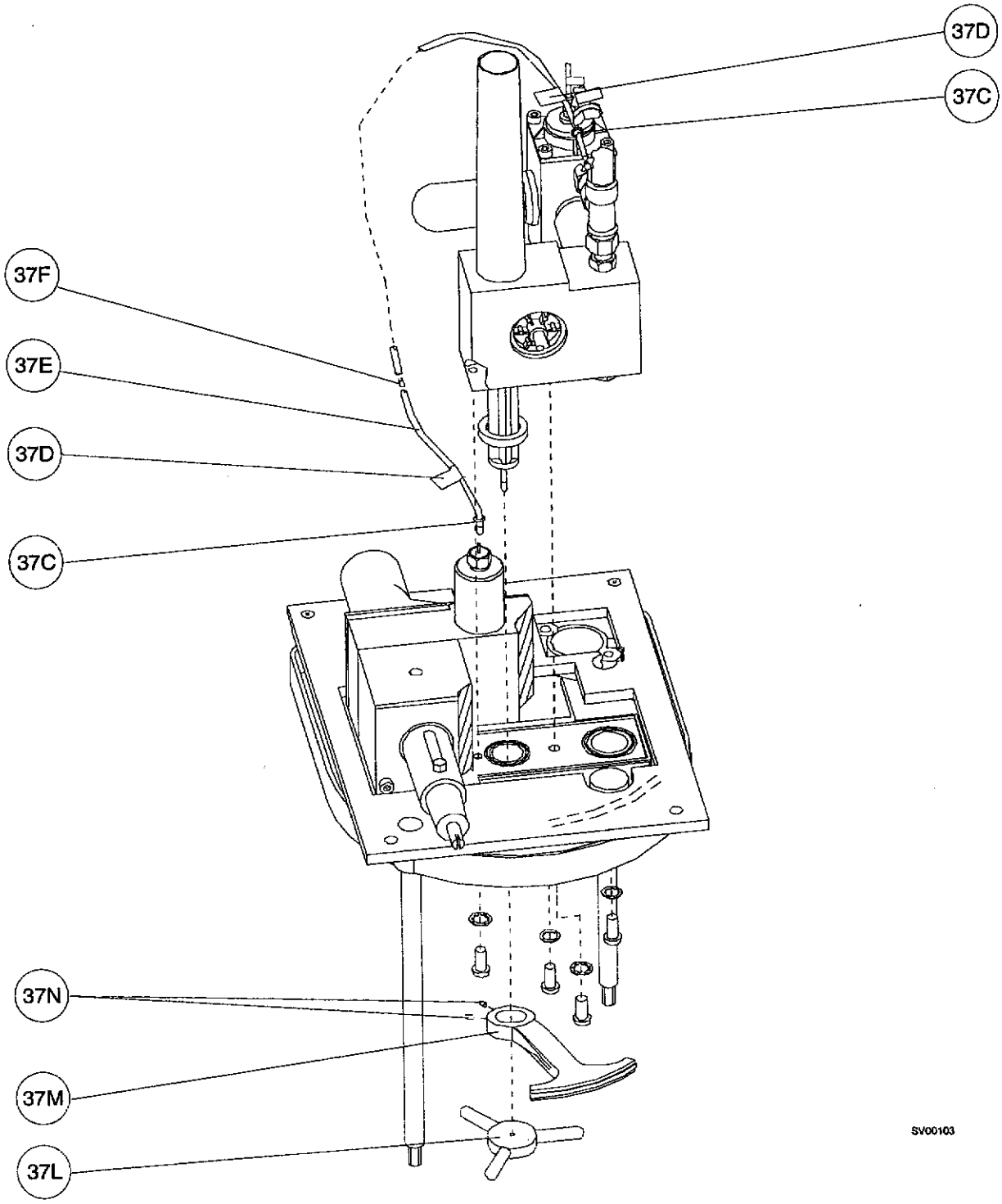
ITEM	DESCRIPTION	PART NUMBER
1	Processor Assembly (Ventilation Monitor Asm) (part of Vent/Bellows Asm 4113777)	SE4113780, 4113780
2	Speaker	4106335
3	Speaker Wire Harness	4112169-001
3A	Volume Interface Cable Assembly	4113910
3B	O_2 Interface Cable Assembly	4113909
3C	Hose, 0.13 ID, 8 in.	ML08007
	Fitting, 0.13 hose x ⅛ MPT	4102963
	Nut, Panel 9/16 - 18	4108156
	Quick-disconnect Fitting	4108155
4	Serial Port Connector and Cable Assembly	4113760
	The next two items are listed for reference only, and are not to be removed from the processor assembly in the field.	
5	PCB Asm, Common Processor	4113595
6	PCB Asm, Personality	4113549
7	Screw, 6-32 x ⅜ in. btn hd (3x)	HW09000
8	Lock Washer, #6 int-t (3x)	HW67015


SV00119
14
9
13
16

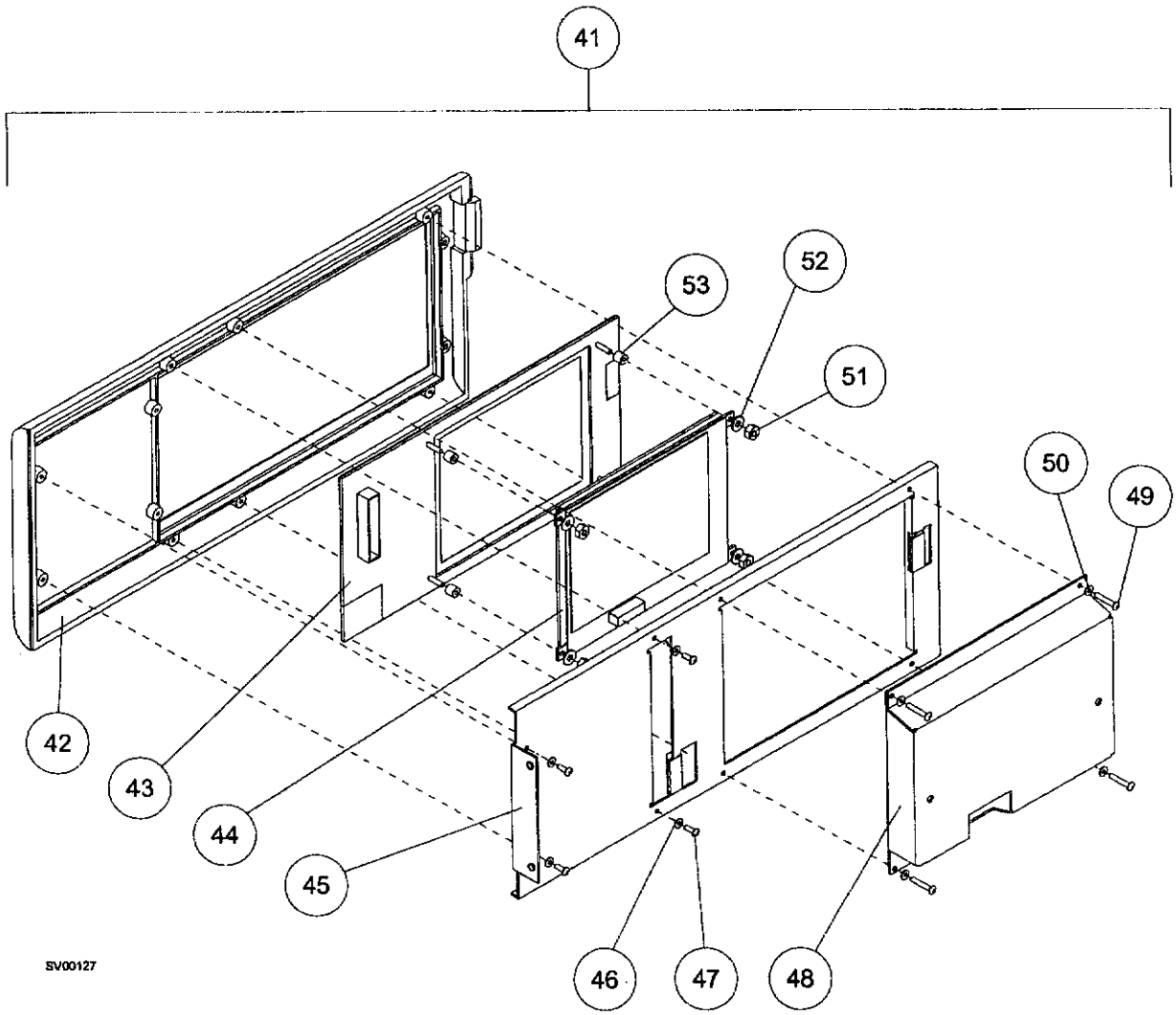
ITEM	DESCRIPTION	PART NUMBER
9	AV2+ Ventilator Controller Assembly (Bezel Assembly)	NAD color 4113132-001 Euro color 4113132-005
13	Gauge	4112251
14	On-off switch & wire harness	4113136
16	Knob (4x)	4113281
	Knob Cover (3x) (all except ON-OFF switch)	4113278-002
	Knob Cover (ON-OFF switch)	4113278-001
(Not shown)	Cable Assembly, Man/Auto Sensor Interface	4113908


27
28
30
29
31
32
33
18
24
20
21
23
22
25
26
17
18
19
20
21
37
35
34
36
39
40
38
SV00112

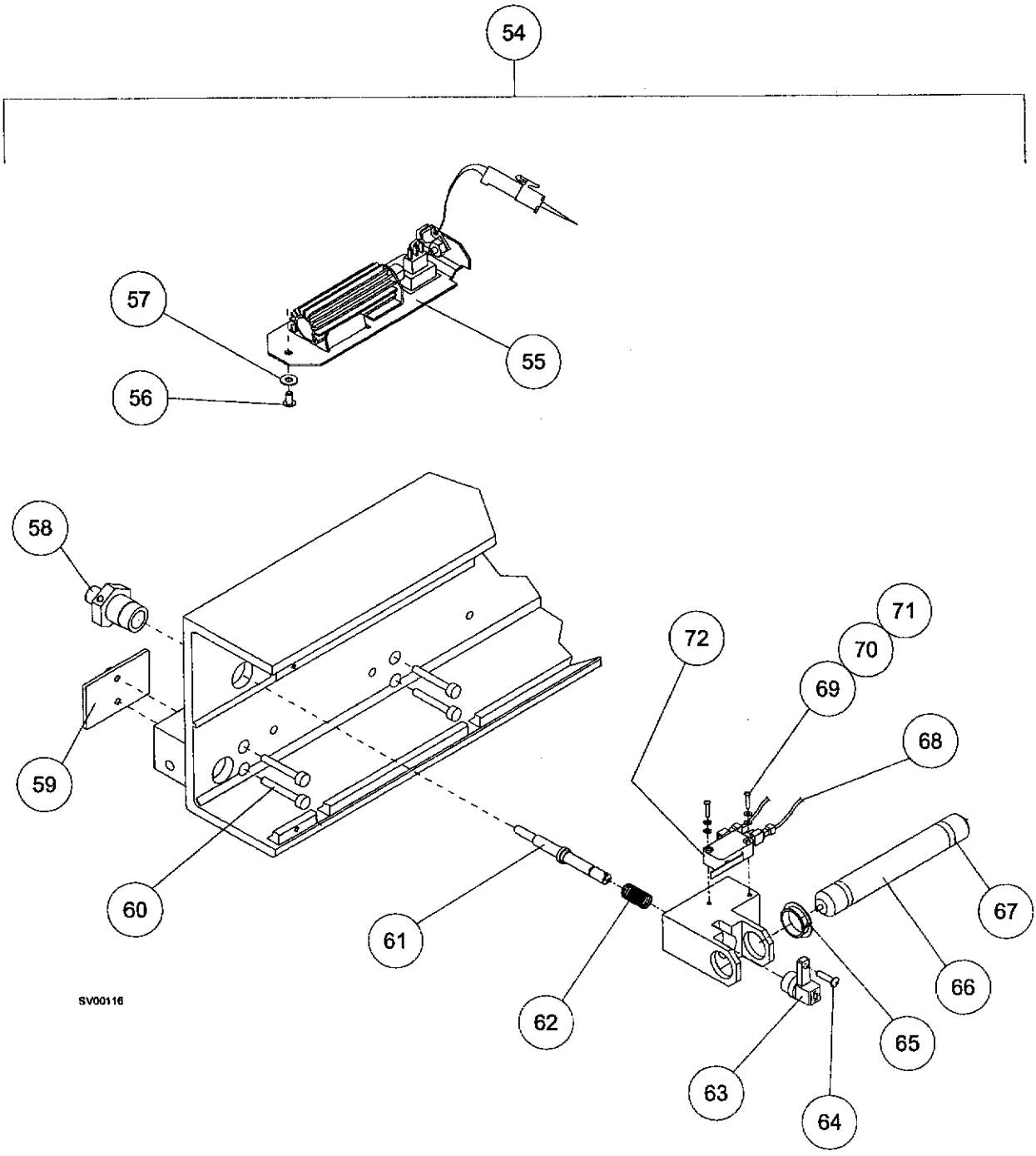
ITEM	DESCRIPTION	PART NUMBER
17	Screw, 6-32 x ⅜ in. Btn Hd Skt (4x)	HW09000
18	Collet	4112167
19	Knob, PLC Adj.	4113279
20	Flat Washer, #10	HW66003
21	Hex Nut, M5 x 0.5	4112066
22	Knob Cover	4113278-002
23	Knob Cover	4113278-002
24	Knob	4113280
25	Front Plate, Bellows Box	4112230
26	Panel Nut	4107460
27	Spring Retainer	4107546
28	Spring	4110975
29	Shaft	4112175
30	Set Screw, 6-32 x 3/16 in.	HW07002
31	Clutch	4107544
32	Housing	4112467
33	Set Screw, 6-32 x ¼ in.	HW04003
34	Screw, ¼-20 x 1 in. Btn Hd Skt (3x)	HW09057
35	Lock Washer, ¼ int-t (3x)	HW67017
36	Canister	4106948
	Tidal Volume Indicator	4108276
	Bellows Guide	4110735
37	Bellows Valve Assembly (Parts Breakdown listed on a subsequent page)	4112272
38	Bellows Assembly, Adult	4106935
	Tested Assembly	4106935-S01
39	Bellows Sub-assembly, Adult	4106930
	Urethane (Non-Latex) Bellows Sub-assembly, Adult	4106930-001
	O-ring #217 (neoprene)	4101817
40	Relief Valve Assembly	4108050
	Diaphragm Assembly	4110960


37D
37C
37F
37E
37D
37C
37N
37M
37L
SV00103

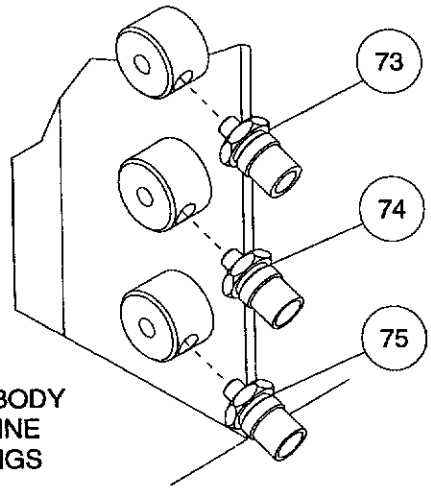
ITEM	DESCRIPTION	PART NUMBER
37 (Ref)	Bellows Valve Assembly	4112272
37C	Press-on Hose Clamp (2x)	4104161
37D	Label, O_2 Tubing (2x)	4109871
37E	Hose, 0.075 I.D.	ML08003
37F	Restrictor	4107639
37L	Bellows Top Guide	4110735
37M	Volume Indicator	4108276
37N	Set Screw, 6-32 x ¼ in. cup point (2x)	HW04003


41
53
52
51
50
49
42
43
44
45
46
47
48
SV00127

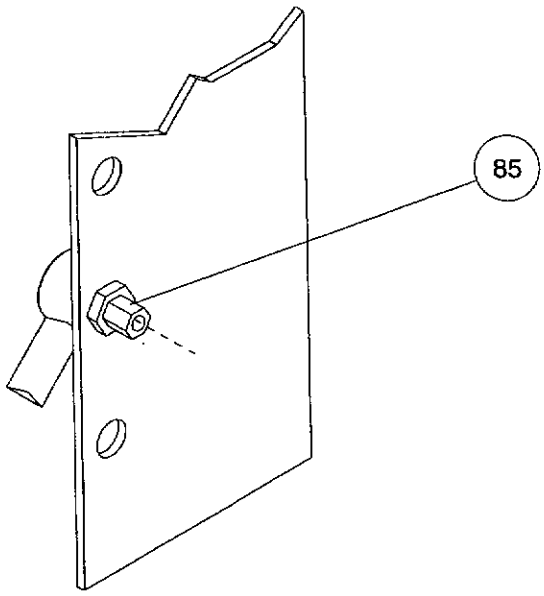
ITEM	DESCRIPTION	PART NUMBER
41	Bezel Assembly, 2-vapor machine . NAD color 4113831-001; Euro color 4113831-003	
	Bezel Assembly, 3-vapor machine . NAD color 4113831-002; Euro color 4113831-004	
42	Bezel, 2-vapor machine	4113741-001
	Bezel, 3-vapor machine	4113741-002
43	Keypad (switch panel)	4113715
44	Display Panel	4113755
45	Bezel Plate, 2-vapor machine	4113742-001
	Bezel Plate, 3-vapor machine	4113742-002
46	Lock Washer, #4 int-t (4x)	HW67011
47	Screw, 4-40 x 5/16 in. btn hd (4x)	HW09014
48	Display Panel Cover	4113726
49	Screw, 4-40 x 5/16 in. btn hd (4x)	HW09014
50	Lock Washer, #4 int-t (4x)	HW67011
51	Hex Nut, 4-40 (4x)	HW50002
52	Lock Washer, #4 int-t (4x)	HW67011
53	Spacer (4x)	4113200-001
	Keypad Cable, 30-cond. ribbon	4113763
	Display Panel Cable, 20-cond. ribbon	4113762-001

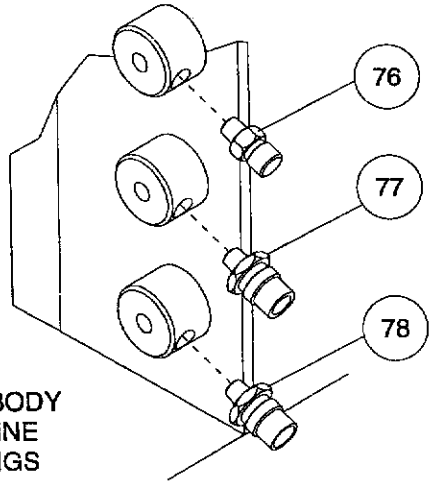

54
57
55
56
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
SV00116

ITEM	DESCRIPTION	PART NUMBER
54 ref	Display Assembly, 3-vapor machine	4113787-001
	Display Assembly, 2-vapor machine	4113787-002
55	Lamp and Switch Assembly	4113785
	Lamp	4114114
56	Screw, 6-32 x 5/16 in. btn hd	HW09022
57	Lock Washer, #6 int-t	HW67015
58	Bushing	4113734
59	Cover, Vapor Block	4112699
60	Vaporizer Mounting Screws, M4-0.7 x 1 3/16 cap skt hd	HW01072
61	Plunger	4113747
62	Spring	4110975-028
63	Rear Plunger Block	4113754
64	Screw, 6-32 x 7/16 in. pan hd sltd, nylon	HW02045
65	Bearing, Nylon (2x per shaft)	4113736
66	Shaft	4113733
67	Retaining Ring (2x per shaft)	4113850-001
68	Cable Assembly, 3-vapor machine	4113766-002
	Cable Assembly, 2-vapor machine	4113766-001
69	Screw, 4-40 x 5/8 in. cap skt hd (2x per switch)	HW01004
70	Lock Washer, #4 int-t (2x per switch)	HW67011
71	Flat Washer, #4 (2x per switch)	HW66001
72	Microswitch	4113735



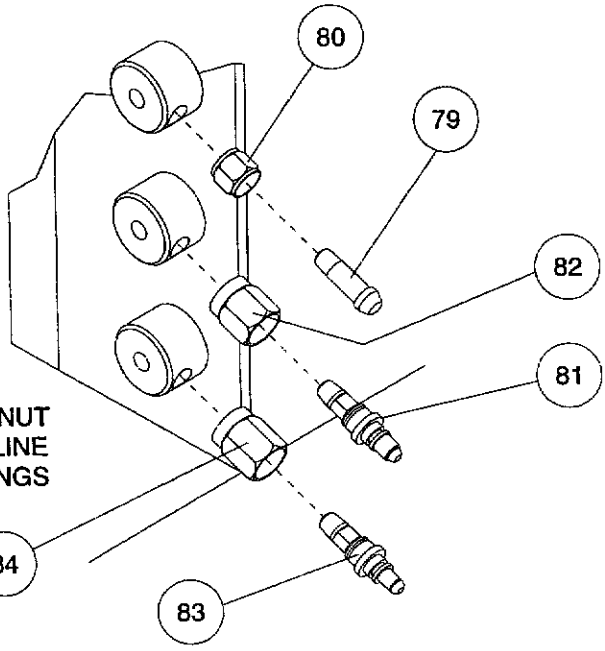
DISS BODY
PIPELINE
FITTINGS





NIST BODY
PIPELINE
FITTINGS

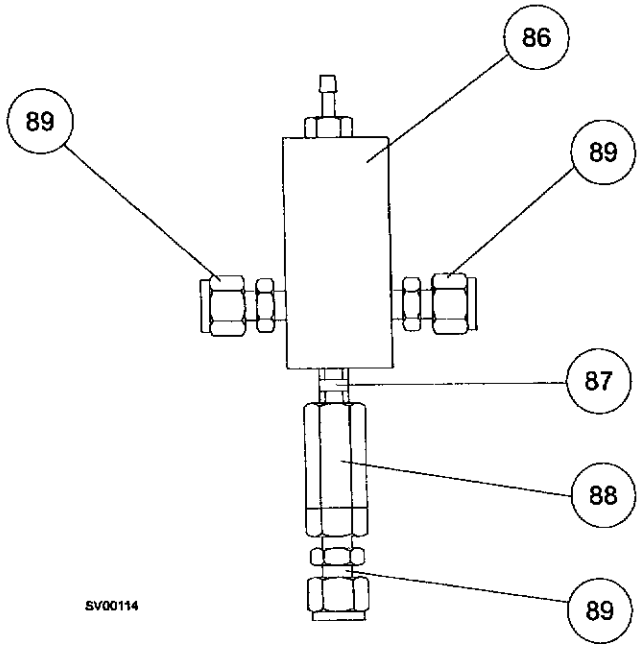
SV00113



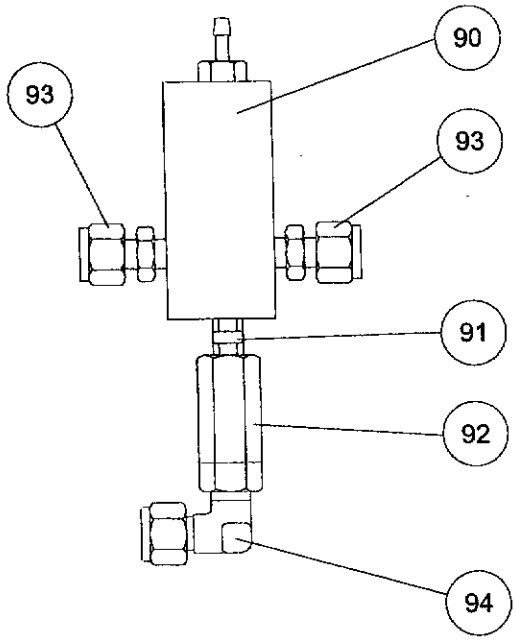
DISS NUT
PIPELINE
FITTINGS

ITEM	DESCRIPTION	PART NUMBER
	DISS Body Pipeline Fittings:	
73	O_2 DISS Fitting	4102563
74	Air DISS Fitting	4102886
75	N_2O DISS Fitting	4111384
	NIST Body Pipeline Fittings:	
76	O_2 Male NIST Connector	4110388
77	Air Male NIST Connector	4110386
78	N_2O Male NIST Connector	4111382
	DISS Nut Pipeline Fittings:	
79	O_2 DISS Nipple	4103877
80	O_2 DISS Nut	4102848
81	Air DISS Nipple	4111385
82	Air DISS Nut	4103120
83	N_2O DISS Nipple	4111383
84	N_2O DISS Nut	4102850
85	Pipeline Inlet Filter Asm (Typ., All Inlets)	4106198
	Filter	4102532
	Connector	4106897
	O-ring for N_2O DISS Nipple	4113494
	Pipeline Inlet Housing (old no.)	4113363
	Pipeline Inlet Housing (new part w/o recess for label)	4113974

N2O FAILSAFE ASSEMBLY

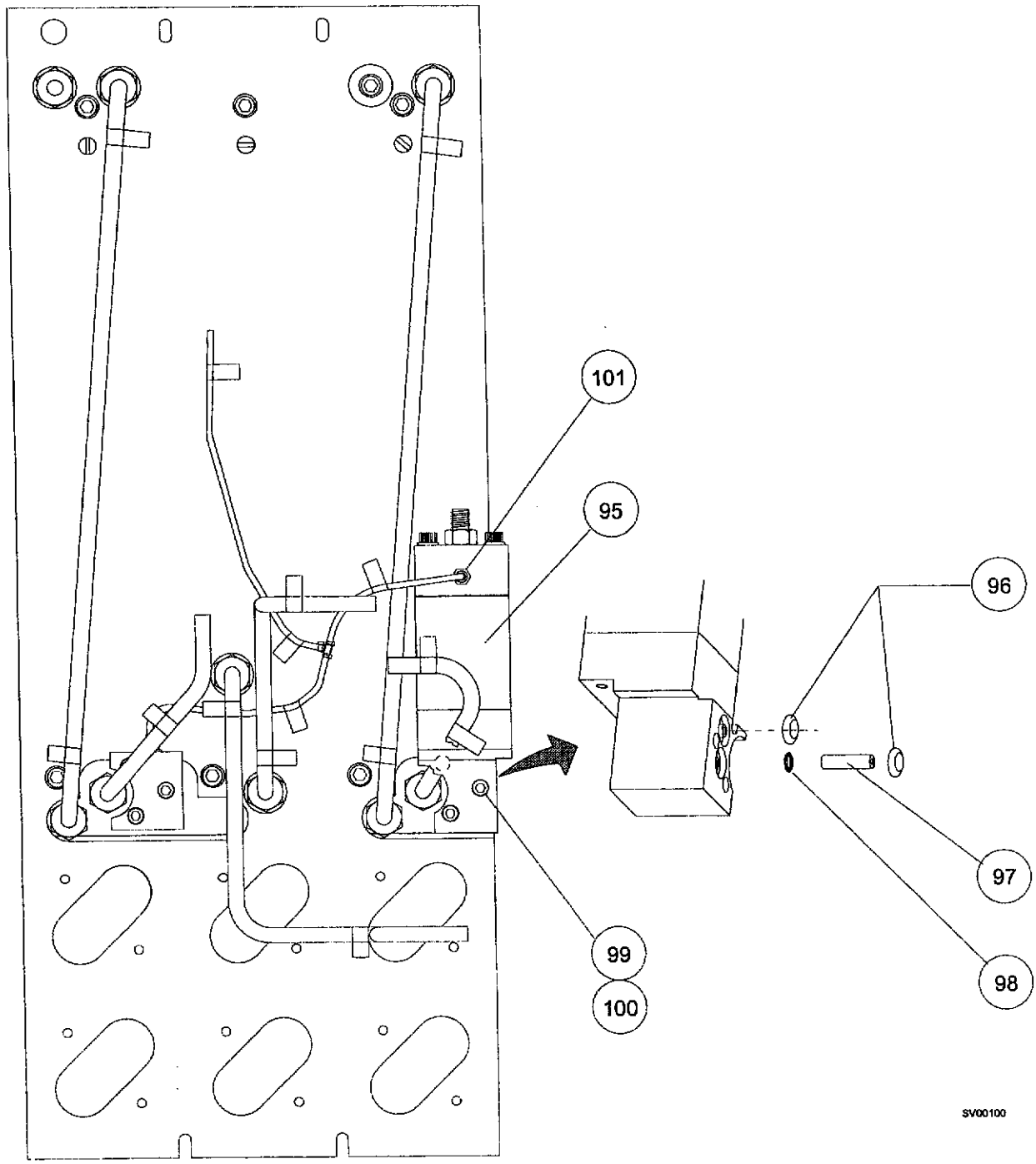


AIR OR THIRD GAS FAILSAFE ASSEMBLY

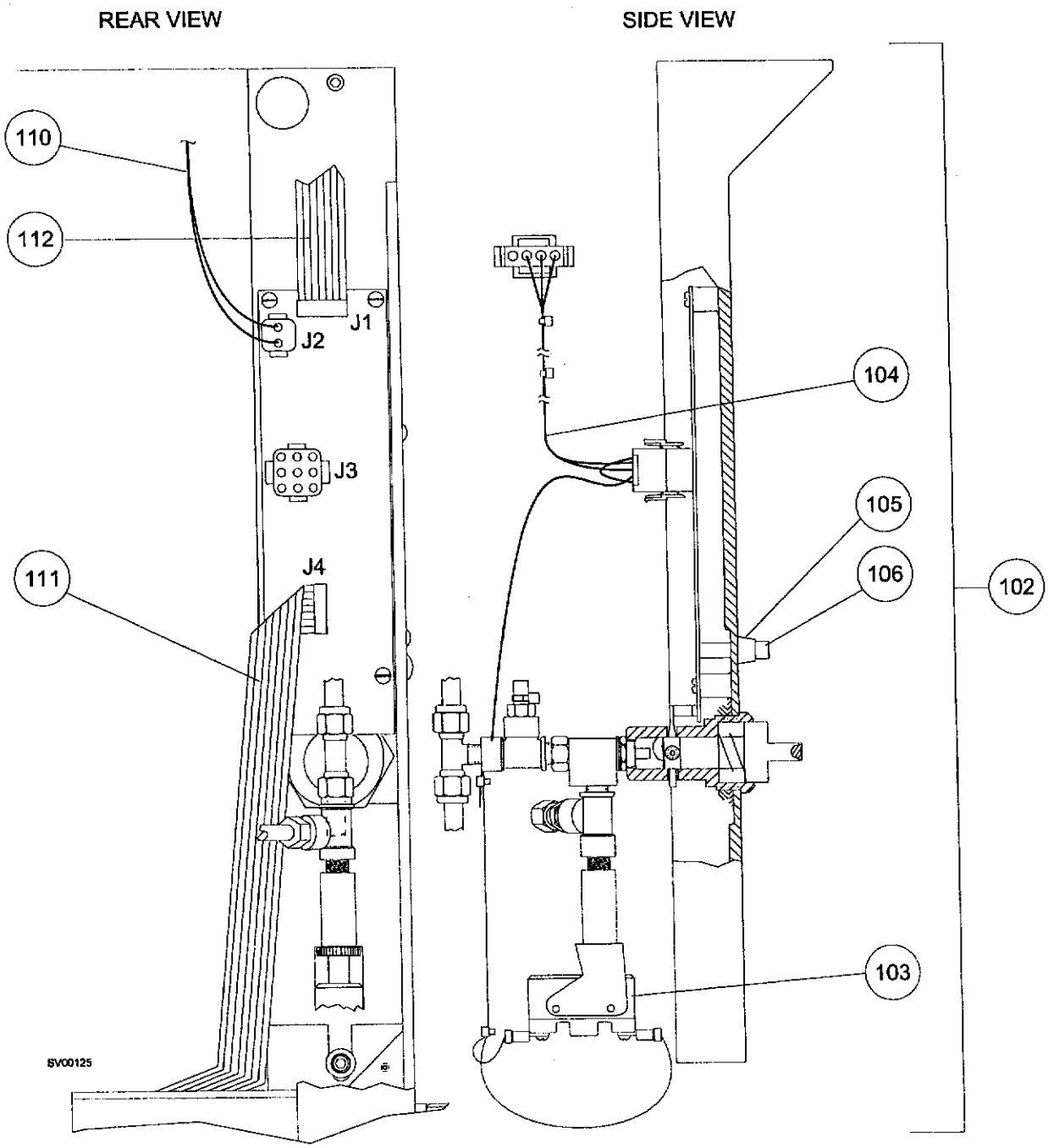


ITEM	DESCRIPTION	PART NUMBER
	N_2O Failsafe Assembly:	
86	Failsafe Block Asembly	4112043
87	Nipple, ⅛ NPT x ¾ in.	4102784
88	Check Valve, MJCV-1	4105815
89	Straight Fitting, ¼Tube x ⅛ MPT (3x)	4109408
	Air or 3rd Gas Failsafe Assembly:	
90	Failsafe Block Asembly	4112043
91	Nipple, ⅛ NPT x ¾ in.	4102784
92	Check Valve, MJCV-1	4105815
93	Straight Fitting, ¼Tube x ⅛ MPT (2x)	4109408
94	Elbow Fitting, ¼Tube x ⅛ MPT	4109410

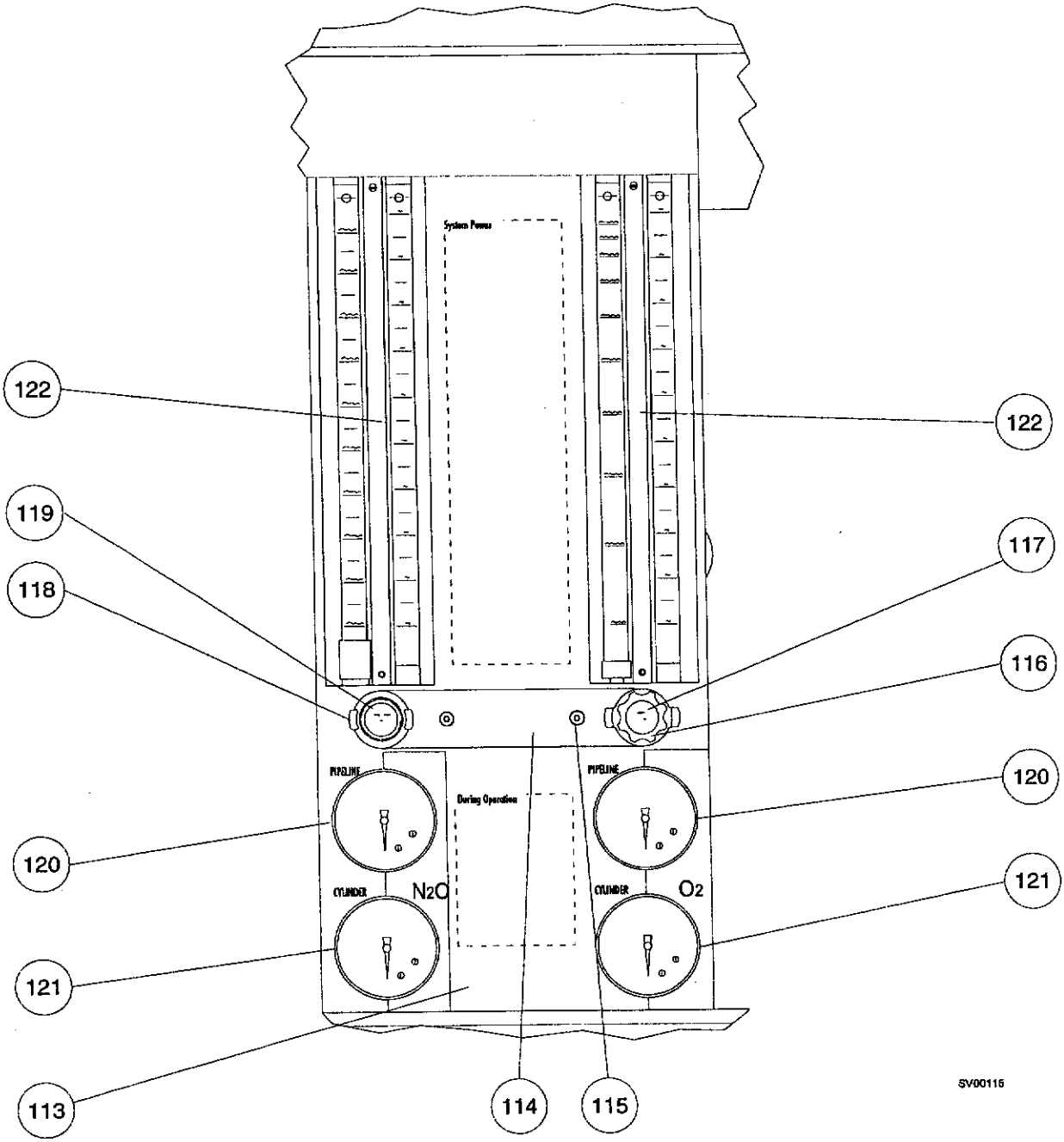
REAR VIEW OF FLOWMETER HOUSING
WITH REAR COVER REMOVED



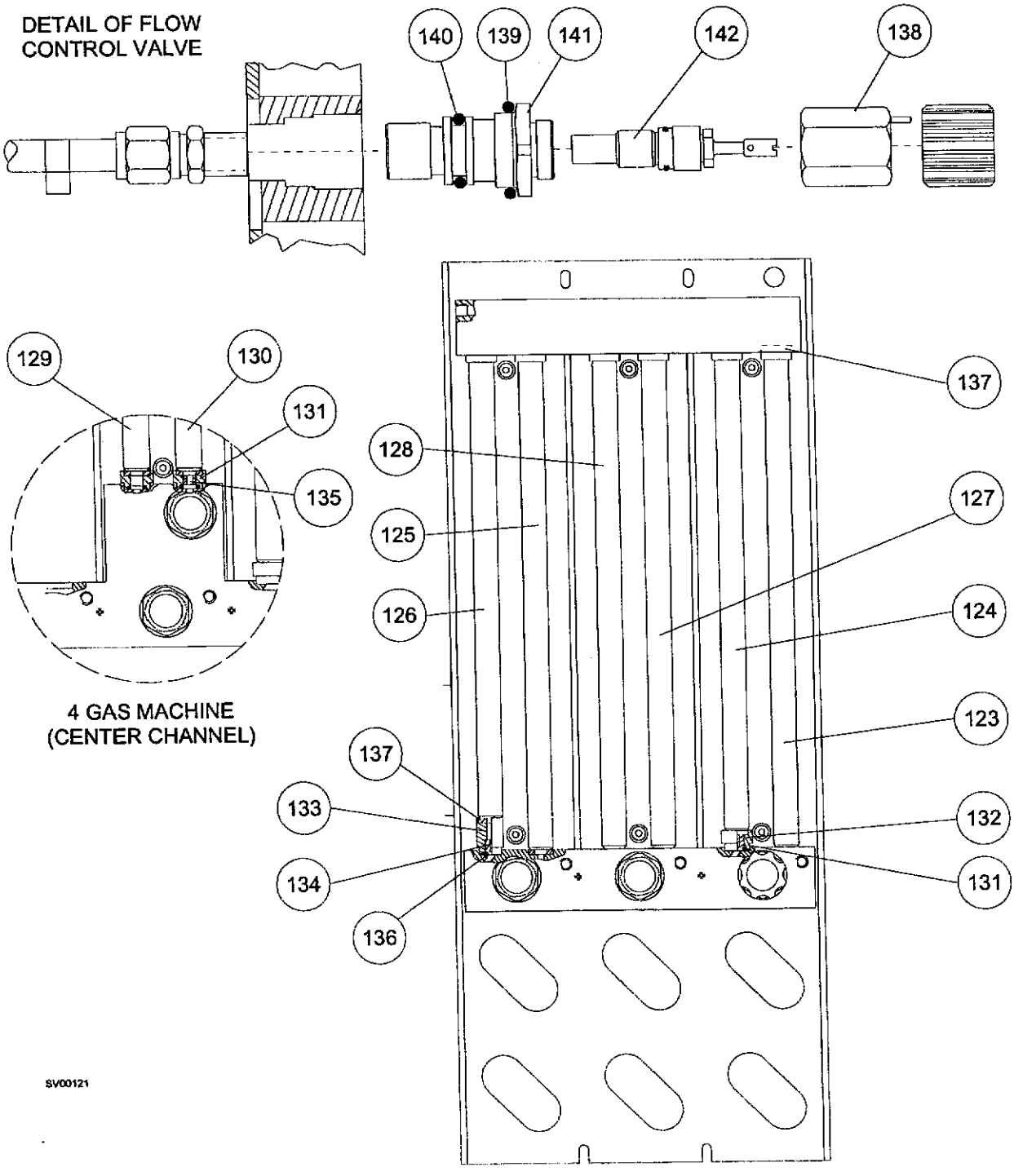
ITEM	DESCRIPTION	PART NUMBER
95	ORC Assembly (low flow design)	4113329-001
96	O-ring, #105 (Neoprene) (2x)	4111893
97	Filter	4111805
98	O-ring, 0.066 x 0.042 (Buna-n)	4111894
99	Screw, 8-32 x 1½ in. skt hd (3x)	HW01020
100	Lock Washer, #8 split (3x)	HW65001
101	Hose Clamp, Press-on (3x)	4104161


REAR VIEW
SIDE VIEW
110
112
J1
J2
J3
J4
111
104
105
106
102
103
SV00125

ITEM	DESCRIPTION	PART NUMBER
102	Alarm Channel Assembly	NAD color SE10029; Euro color SE10029-001
103	Oxygen Supply Pressure Alarm Switch	4106037
104	Wire Harness, Alarm Switch & J3 to Ventilator Controller J2	4112185
105	Housing, Push Button	4106046
106	Cap, Push Button	4106047
110	Wire Harness, Flowmeter Lights to Alarm Channel J2	4108594
111	Cable Assembly, Power Supply J2 to Alarm Channel J4	4112149-001
112	Cable Assembly, Alarm Channel J1 to Processor J105	4113081-003

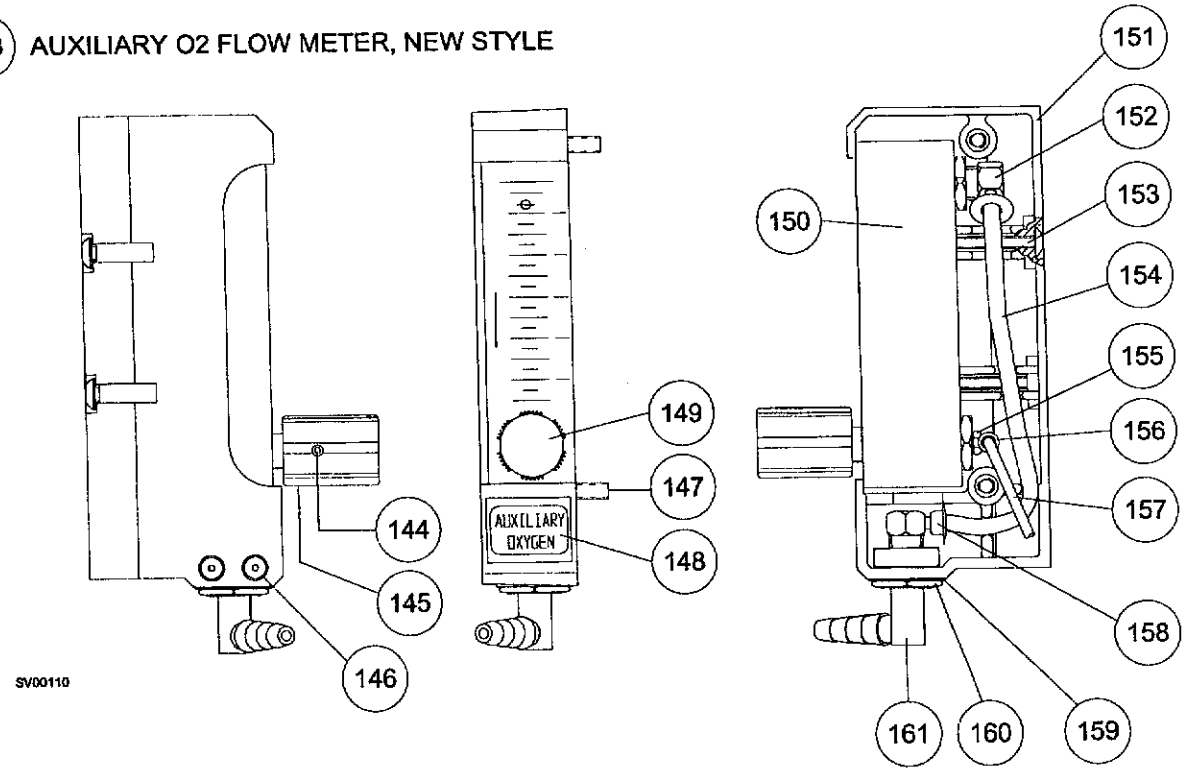

122
122
119
118
117
116
120
120
121
121
113
114
115
PIPELINE
PIPELINE
CYLINDER
CYLINDER
N2O
O2
SV00115

ITEM	DESCRIPTION	PART NUMBER
113	Shield, Flowmeter, 2 Gas N_2O/O_2, Domestic	4111824-001
	Shield, Flowmeter, 2 Gas N_2O/O_2, Canada	4111824-002
	Shield, Flowmeter, 2 Gas, Export	4111825
	Shield, Flowmeter, 3 Gas Air, Domestic	4111830-001
	Shield, Flowmeter, 3 Gas O_2-He, Domestic	4111831
	Shield, Flowmeter, 3 Gas Air, Canada	4111830-002
	Shield, Flowmeter, 3 Gas, Export, 6 Gauge	4111826
	Shield, Flowmeter, 3 Gas, Export, 5 Gauge	4111827
	Shield, Flowmeter, 4 Gas, Air/CO_2, Domestic	4111829-003
	Shield, Flowmeter, 4 Gas, Air/O_2-He, Domestic	4111829-001
	Shield, Flowmeter, 4 Gas, Air/O_2-He, Canada	4111829-002
	Shield, Flowmeter, 4 Gas, Export	4111828
114	Knob Guard, 2 Gas	4110621
	Knob Guard, 3 Gas	4110574
115	Screw, 6-32 x 7/16 btn hd (2x)	HW09017
116	Knob, O_2	4103156
117	Label, O_2 Flow Control Knob, Green (USA)	4103178
	White (UK, Canada)	4105981
	Blue (Germany)	4111266-002
118	Knob, Flow	4103736
119	Label, N_2O Flow Control Knob, Blue (USA, UK, Canada)	4103904
	Gray (Germany)	4111266-004
	Label, Air Flow Control Knob, Yellow (USA, Germany)	4103905
	Black/White (UK, Canada)	4105982
	Label, CO_2 Flow Control Knob, Gray (USA,UK, Canada)	4103908
	Black (Germany)	4111266-006
	Label, O_2-He Flow Control Knob, Green/Brown (USA)	4110951
	White/Brown (Canada)	4110952
120	Gauge, 100 psi	4110575-001
	Gauge, 7.0 bar	4110575-003
121	Gauge, 3000 psi	4110575-002
	Gauge,200 bar	4110575-004
122	Flowmeter Light Circuit Assembly	4107370

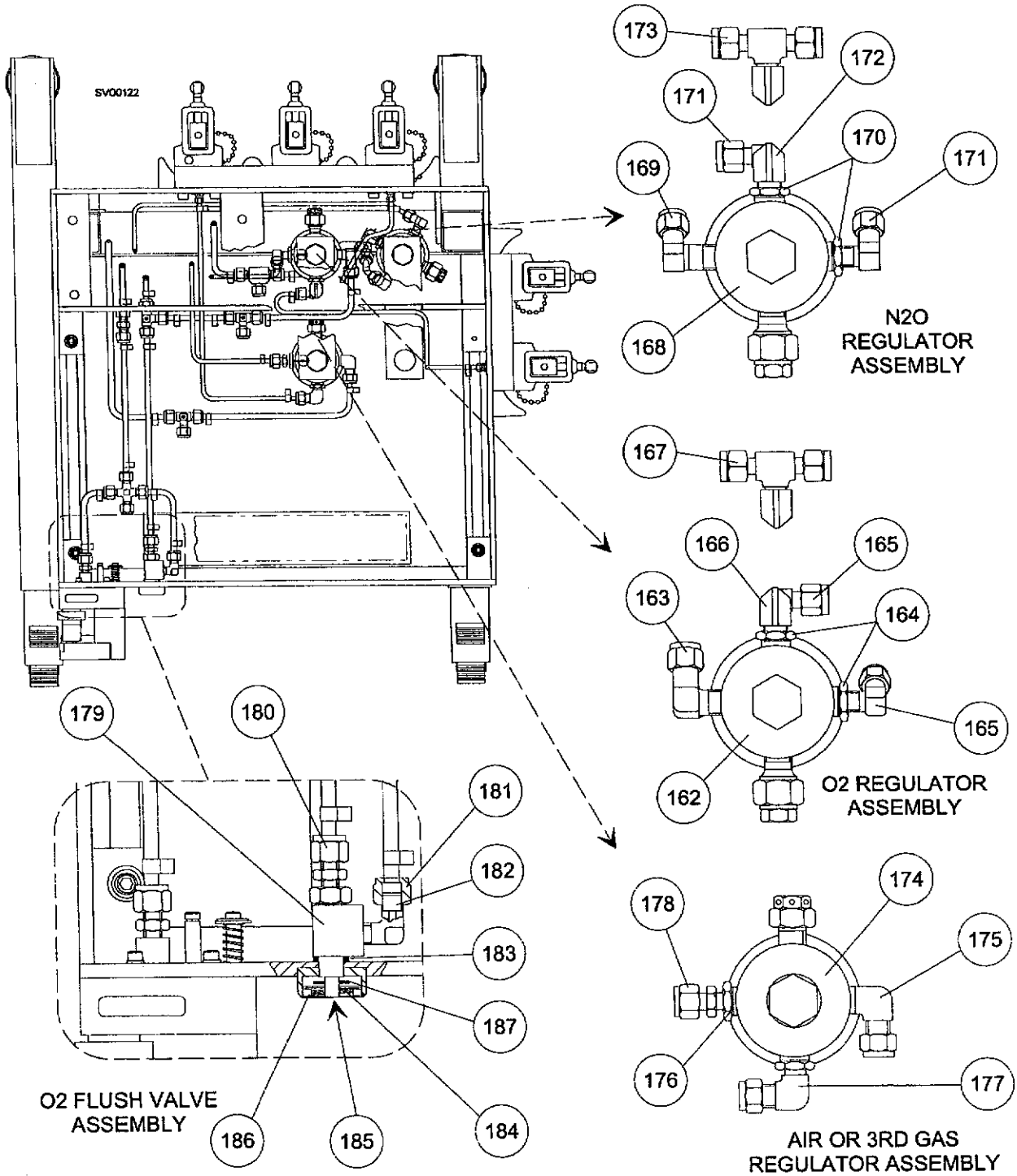

DETAIL OF FLOW CONTROL VALVE
140
139
141
142
138
129
130
131
135
4 GAS MACHINE (CENTER CHANNEL)
128
125
126
137
127
124
123
137
133
134
136
132
131
SV00121
3 GAS MACHINE

ITEM	DESCRIPTION	PART NUMBER
123	Flow Tube, O_2, 1-10 l/min	4112560-001
	Flow Tube, O_2, 0.6-10 l/min (Low Flow)	4112568-001
124	Flow Tube, O_2, 100-1000 ml/min	4112559-001
	Flow Tube, O_2, 20-500 ml/min (Low Flow)	4112567-001
125	Flow Tube, N_2O, 1-10 l/min	4112562-001
	Flow Tube, N_2O, 0.6-10 l/min (Low Flow)	4112564-001
126	Flow Tube, N_2O, 100-1000 ml/min	4112561-001
	Flow Tube, N_2O, 20-500 ml/min (Low Flow)	4112563-001
127	Flow Tube, Air, 1-10 l/min	4112566-001
128	Flow Tube, Air, 100-1000 ml/min	4112565-001
129	Flow Tube, Air, 0.2-10 l/min (4-gas machines)	4112558-001
130	Flow Tube, CO_2, 0.05-1.0 l/min (4-gas machines)	4112557-001
	Flow Tube, O_2-He, 2-10 l/min (4-gas machines)	4112569-001
131	O_2 Restrictor Housing	4103440
132	O_2 Restrictor, Red	4110738-003
133	N_2O Restrictor Housing	4111716
134	N_2O Restrictor, Black	4110738-005
135	Restrictor, Yellow (CO_2 only)	4110738-006
136	O-ring, #010, Neoprene (one per each restrictor housing)	4101872
137	Gasket, Large, 2x per Flow Tube	4102724
	Parts common to all flow control valves:	
138	Stop Pin Nut	4103382
139	O-ring, #018, Neoprene	4102336
140	O-ring, #112, Neoprene	4102141
141	Insert, Flow Control Valve	4111819
142	Valve, Flow Control	4103352

143 AUXILIARY O2 FLOW METER, NEW STYLE

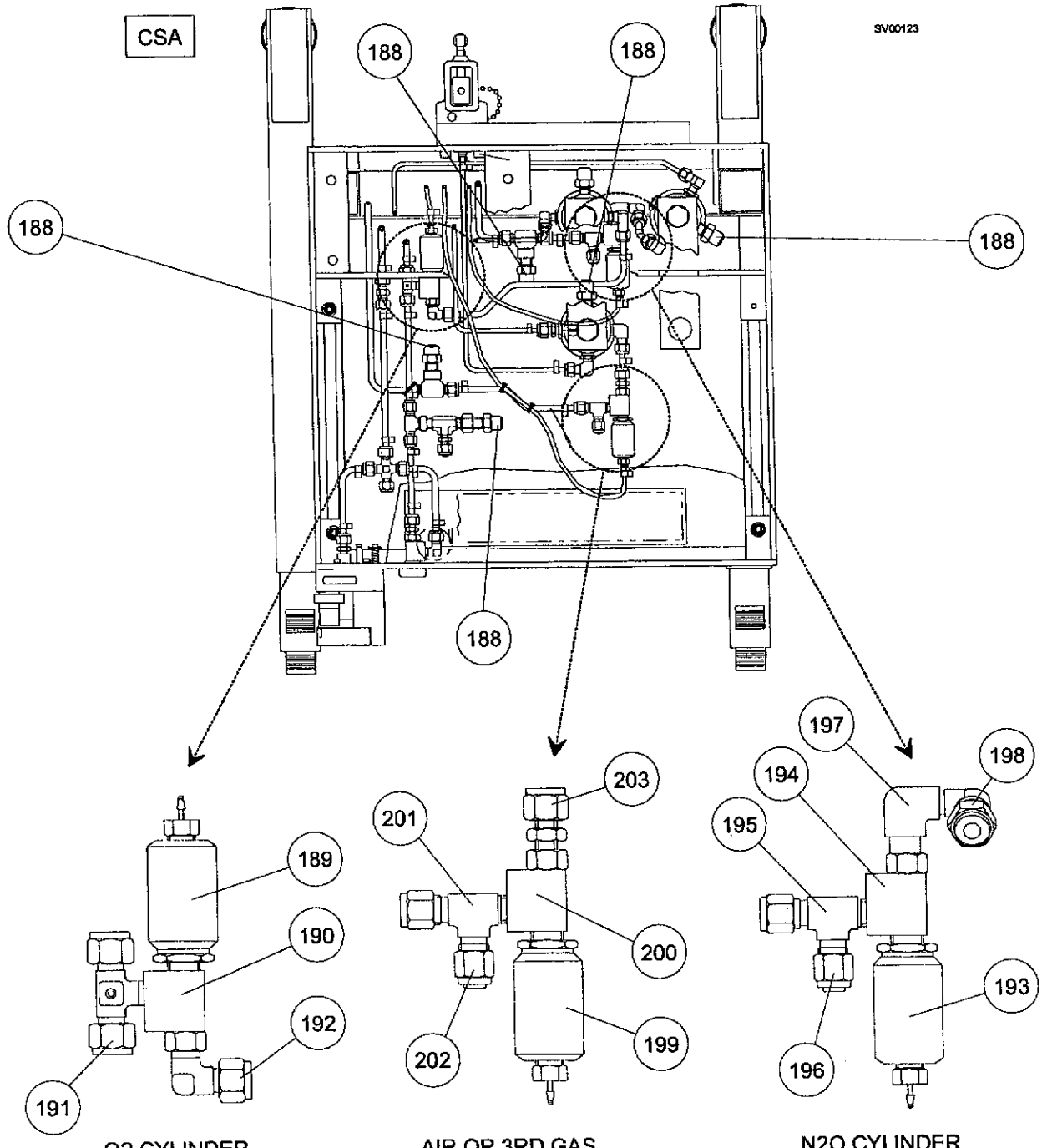


ITEM	DESCRIPTION	PART NUMBER
143	Auxiliary O_2 Flow Meter Assembly, new style	4109310
144	Set Screw, cup point, 6-32 x ¼ in.	HW04003
145	Knob	4111442
146	Screw, 6-32 x ¼ in., btn hd (2x)	HW09004
147	Set Screw, cup point, 10-32 x ⅞ (2x) (used as mtg stud)	HW04011
148	Label, AUXILIARY OXYGEN	4109381
149	Label, ⅝ w/dot and green & white rings	4109373
150	Flowmeter (incl. tube & valve)	4111460
151	Housing	4111053
152	Ell, ⅛ hose x ⅛ MPT (2x)	4111445
153	Screw, 10-32 x 1 1/16 in. btn hd (2x)	HW09043
154	Hose, 0.13 in. I.D., 4.63 in.	ML08007
155	Ell, 1/16 hose x 8-32M	4110173
156	Press-on hose clamp	4104161
157	Hose, 0.075 in. I.D., 7 in.	ML08003
158	Press-on hose clamp (2x)	4111495
	Label, O_2 tubing (2x) (not shown)	4109871
159	Lock washer, ⅝ int-t	4111444
160	Panel nut, ⅝-32	4111443
161	Bulkhead & hose barb asm	4111440


SV00122
173
172
171
170
171
169
168
N2O
REGULATOR
ASSEMBLY
167
166
165
163
164
165
162
O2 REGULATOR
ASSEMBLY
179
180
181
182
183
187
184
186
185
O2 FLUSH VALVE
ASSEMBLY
174
178
175
176
177
AIR OR 3RD GAS
REGULATOR ASSEMBLY

ITEM	DESCRIPTION	PART NUMBER
	O_2 Regulator Assembly:	
162	Regulator	4103590
163	Elbow Fitting, ¼ Tube x ¼ MPT	4109401
164	Straight Fitting, ¼ MPT x ⅛ FPT (2x)	4102906
165	Elbow Fitting, 3/16 Tube x ⅛ MPT (2x)	4109409
166	Elbow Fitting, ⅛ MPT x ⅛ FPT	4103513
167	Tee Fitting, 3/16 Tube x 3/16 Tube x ⅛ MPT [Replaces previous two items if machine has an additional O_2 yoke]	4109404
	N_2O Regulator Assembly:	
168	Regulator	4103591
169	Elbow Fitting, ¼ Tube x ¼ MPT	4109401
170	Straight Fitting, ¼ MPT x ⅛ FPT (2x)	4102906
171	Elbow Fitting, 3/16 Tube x ⅛ MPT (2x)	4109409
172	Elbow Fitting, ⅛ MPT x ⅛ FPT	4103513
173	Tee Fitting, 3/16 Tube x 3/16 Tube x ⅛ MPT [Replaces previous two items if machine has an additional N_2O yoke]	4109404
	Air or 3rd Gas Regulator Assembly	
174	Regulator	4103590
175	Elbow Fitting, ¼ Tube x ¼ MPT	4109401
176	Straight Fitting, ¼ MPT x ⅛ FPT (2x)	4102906
177	Elbow Fitting, 3/16 Tube x ⅛ MPT	4109409
178	Straight Fitting, 3/16 Tube x ⅛ MPT	4109415
	O_2 Flush Valve and Related Parts:	
179	Valve, Clippard, 2 way	4103340
180	Straight Fitting, ¼ Tube x ⅛ MPT	4109408
181	Elbow Fitting, ¼ Tube x ⅛ MPT	4109410
182	Restrictor	4101867
183	Spacer	4110792-006
184	Button, O_2 FLUSH	4103249
185	Label, ⅝ Dot, O_2, Green (USA)	4103178
	White (UK, Canada)	4105981
	Blue (Germany)	4111266-002
186	Set Screw, 3-48 x 3/16 (2x)	HW04020
187	Washer	4110792-021

See next page for CSA items.

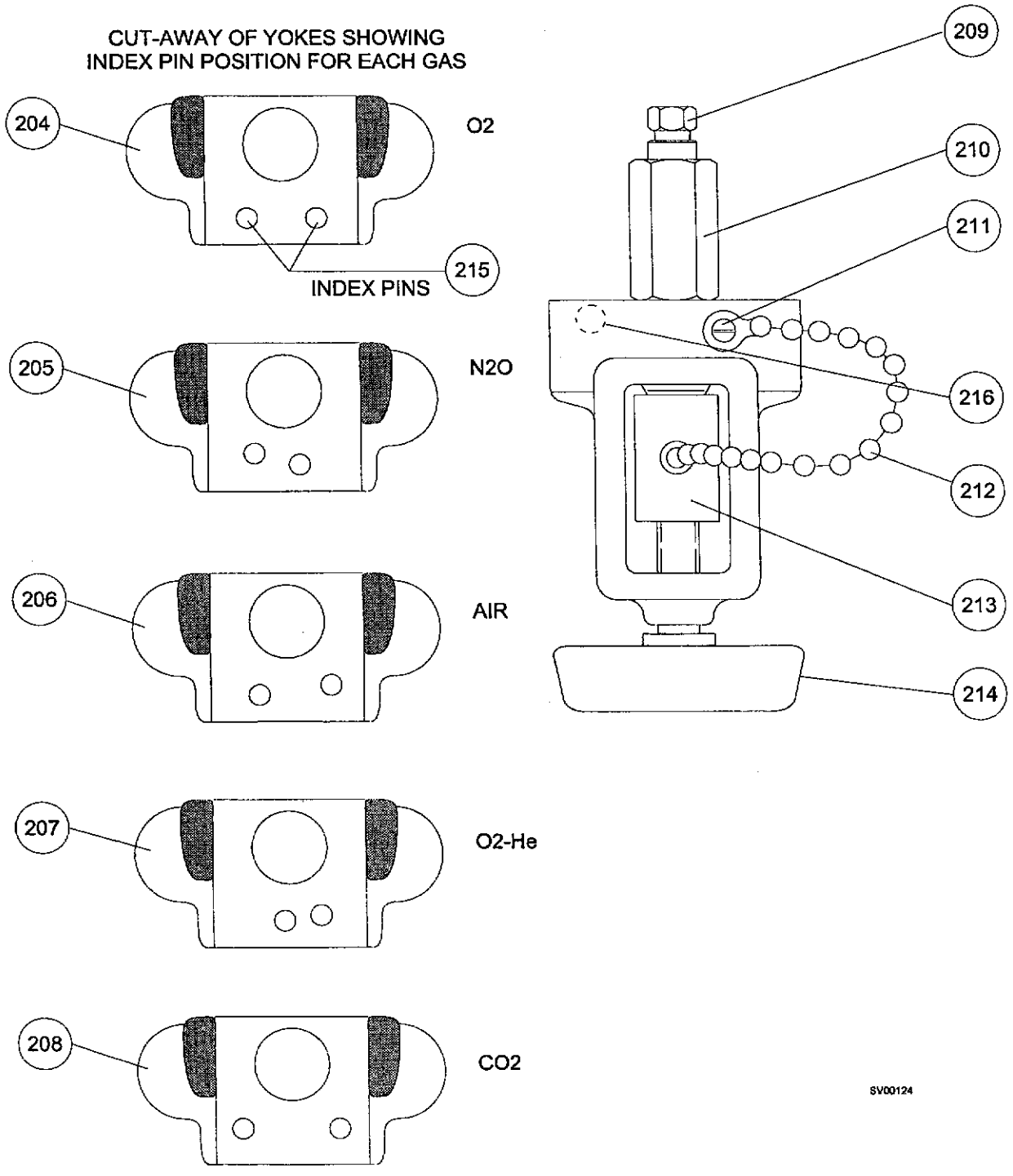


O2 CYLINDER CUTOFF VALVE ASSEMBLY

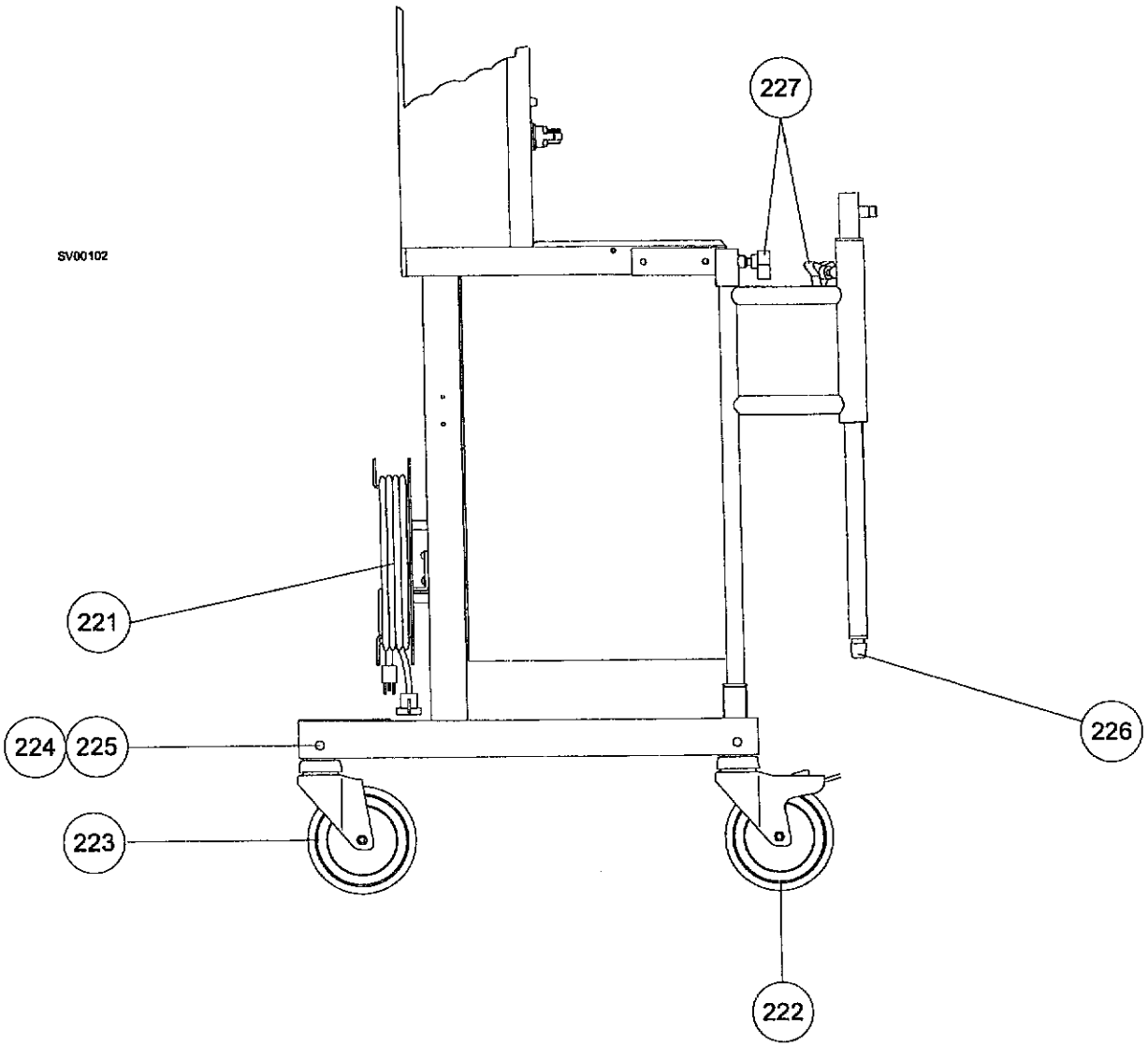
AIR OR 3RD GAS CYLINDER CUTOFF VALVE ASSEMBLY

N2O CYLINDER CUTOFF VALVE ASSEMBLY

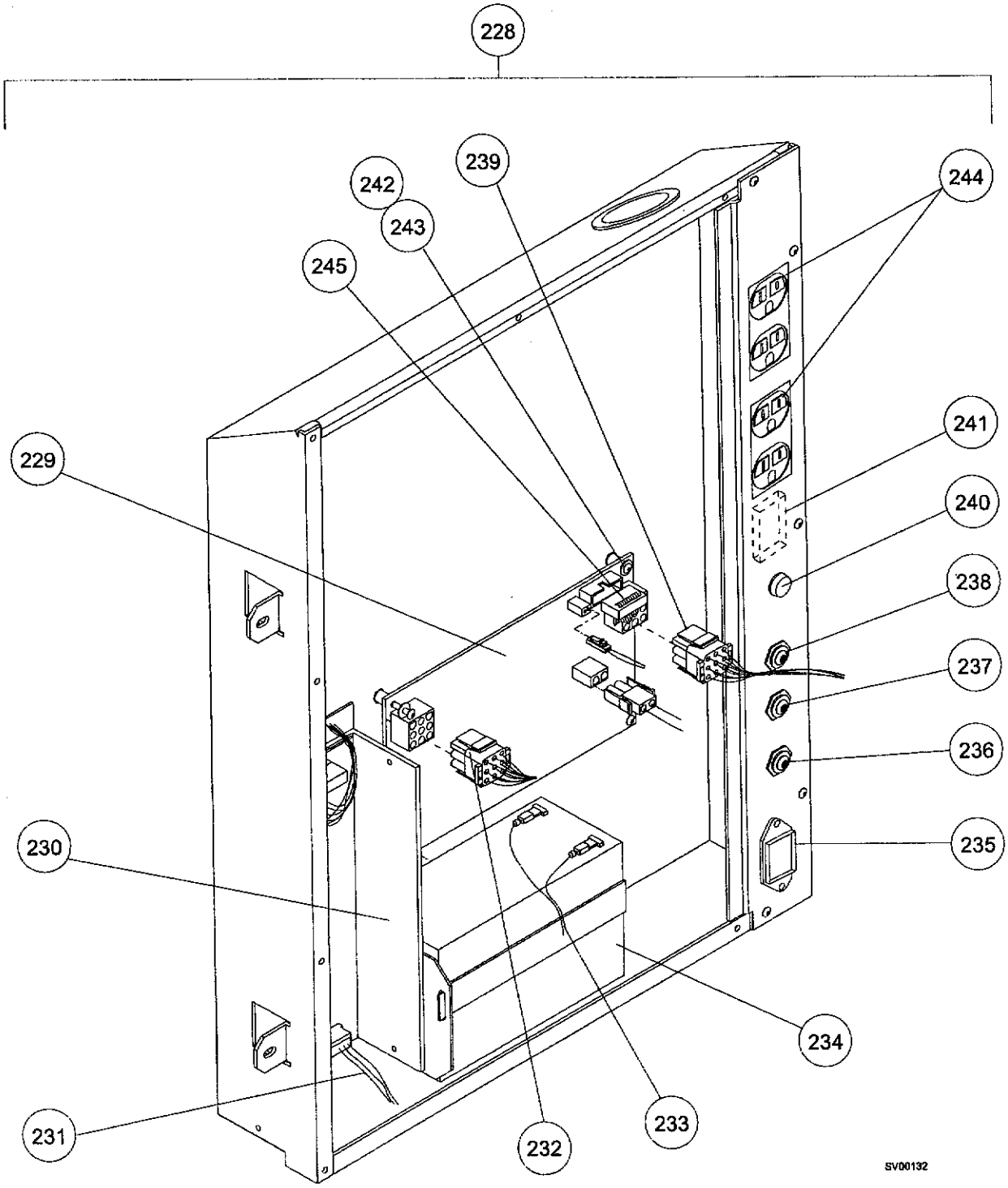
ITEM	DESCRIPTION	PART NUMBER
	CSA Items:	
188	Relief Valve, 70 psi (Canada)	4110364
	O_2 Cylinder Cutoff Valve Assembly (Canada)	
189	Pilot Actuator, Modified	4106498
190	Clippard Valve, MJVO-2	4106218
191	Tee Fitting, ¼ Tube x ¼ Tube x ⅛ MPT	4109406
192	Elbow Fitting, ¼ Tube x ⅛ MPT	4109410
	N_2O Cylinder Cutoff Valve Assembly (Canada)	
193	Pilot Actuator, Modified	4106498
194	Clippard Valve, MJVO-2	4106218
195	Tee Fitting, ¼ Tube x ⅛ MPT x ¼ Tube	4109407
196	Plug, ¼ Tube	4103072
197	Elbow Fitting, ⅛ MPT x ⅛ FPT	4103513
198	Elbow Fitting, ¼ Tube x ⅛ MPT	4109410
	Air or 3rd Gas Cylinder Cutoff Valve Assembly (Canada)	
199	Pilot Actuator, Modified	4106498
200	Clippard Valve, MJVO-2	4106218
201	Tee Fitting, ¼ Tube x ⅛ MPT x ¼ Tube	4109407
202	Plug, ¼ Tube	4103072
203	Straight Fitting, ¼ Tube x ⅛ MPT	4109408


CUT-AWAY OF YOKES SHOWING
INDEX PIN POSITION FOR EACH GAS
204
O2
215
INDEX PINS
205
N2O
206
AIR
207
O2-He
208
CO2
209
210
211
216
212
213
214
SV00124

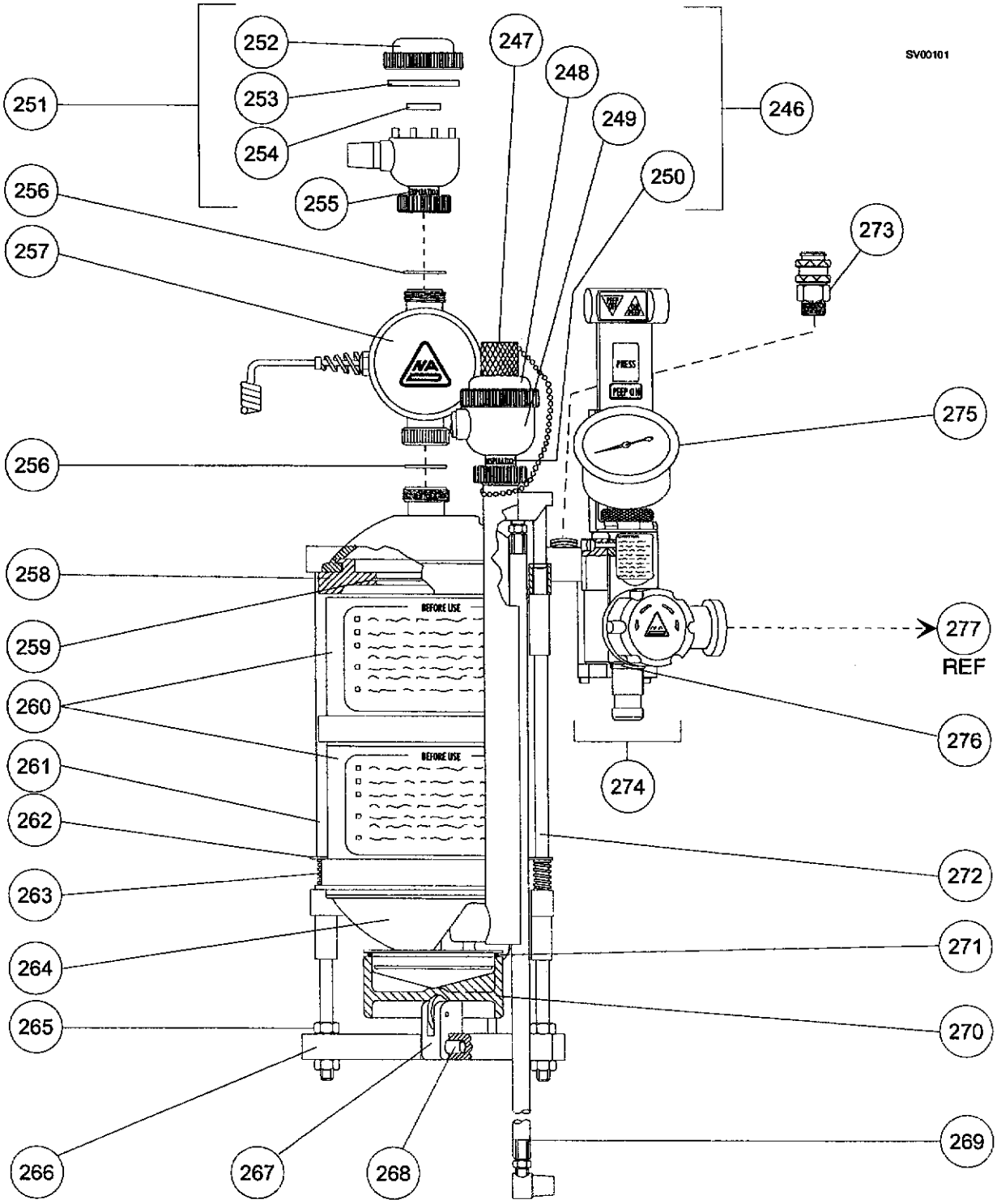
ITEM	DESCRIPTION	PART NUMBER
204	Yoke, O_2	1101620
205	Yoke, N_2O	1101621
206	Yoke, Air	1101625
207	Yoke, O_2-He	4110957
208	Yoke, CO_2	1101624
	Parts Common to All Yokes:	
209	Nut, 3/16 Tube	4104716
210	Check Valve Assembly	4111792
211	Screw, 10-32 x ⅜ in. rd hd	HW06006
212	Chain Assembly	4112495-003
213	Plug	1101655
	Plug assembly includes Items 212, 213	4112755-001
214	Plastic T-handle & bolt	4113536
215	Screw (Index Pin) (2x per yoke)	4105929
216	Yoke Labels:	
	Label, O_2, Green (USA)	1101768
	White (UK)	4103890
	Blue (Germany)	4111266-001
	Label, N_2O, Blue (USA, UK, Canada)	1101619
	Gray (Germany)	4111266-003
	Label, Air, Yellow (USA, Germany)	4102742
	Black/White (UK)	4103826
	Label, O_2-He, Green/Brown (USA)	4110950
	White/Brown (Canada)	4110942
	Label, CO_2, Gray (USA, UK)	1101639
	Black (Germany)	4111266-005


SV00102
227
221
224
225
223
226
222

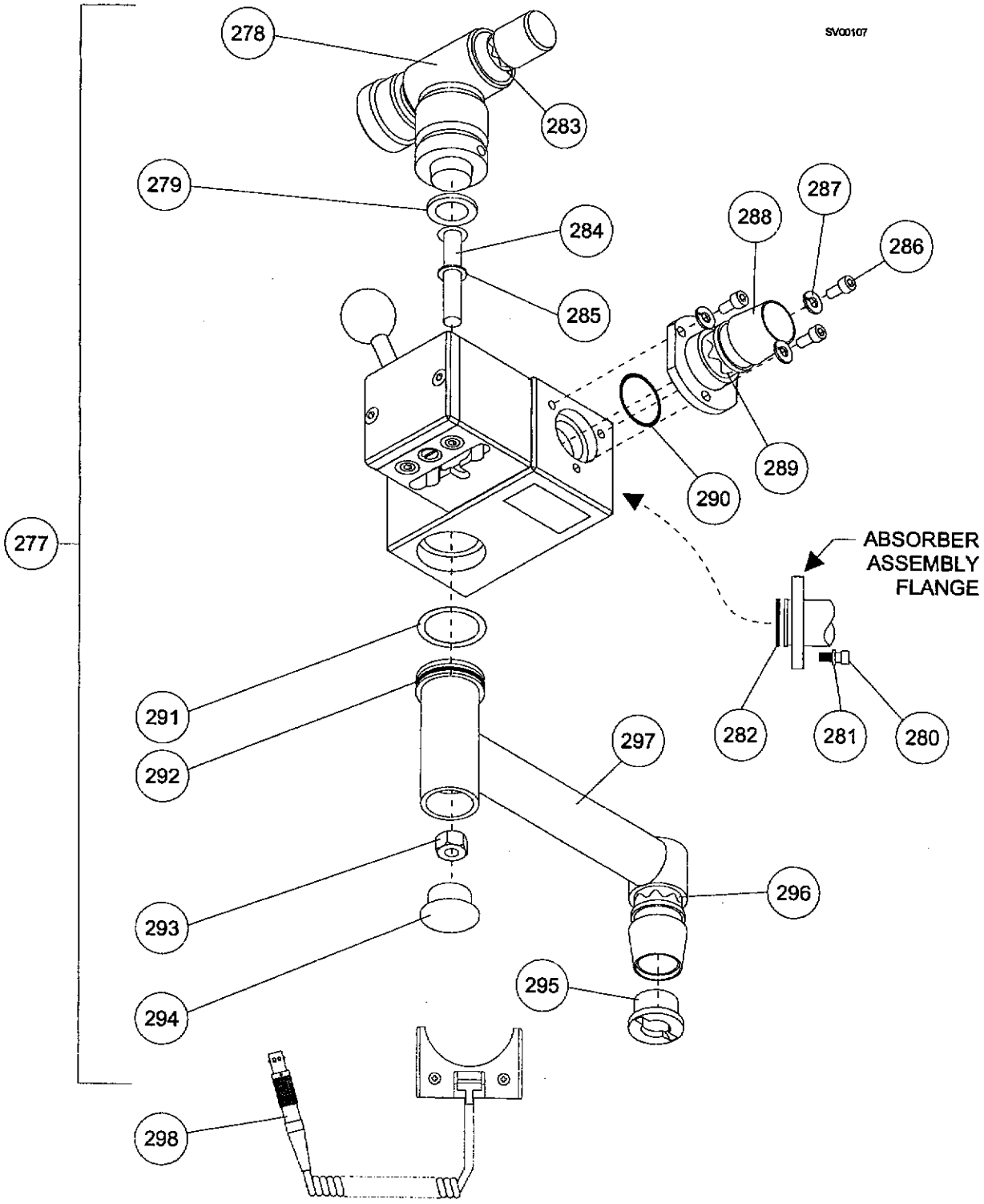
ITEM	DESCRIPTION	PART NUMBER
221	AC Power Cord Assembly	4109600
	AC Power Cord Assembly (Export)	4110625
222	Caster W/Brake (2x)	4111849
223	Caster W/O Brake (2x)	4111850
224	Setscrew, Caster (4x)	HW04017
225	Hole Plug, (4x)	4102729
226	Absorber Pole	1101724
227	Wing Screw, ⅜-16 x 1 in.	1100078


228
239
242
243
244
245
241
229
240
238
237
236
230
235
234
231
232
233
SV00132

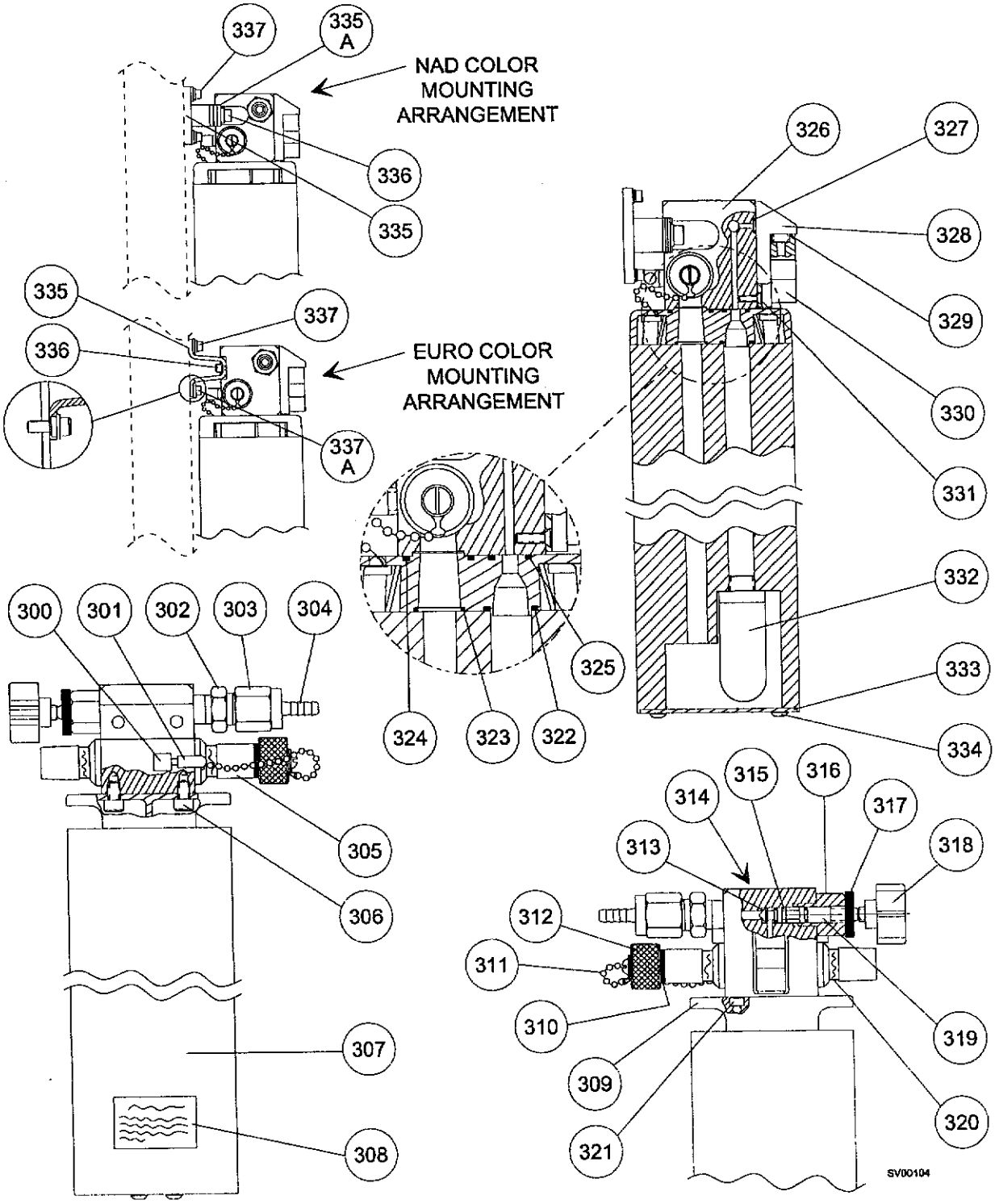
ITEM	DESCRIPTION	PART NUMBER
228	Power Supply Assembly, 110V	4113820-001
	Power Supply Assembly, 220V	4113820-002
229	Power Supply PCB Assembly	SE4113579, 4113579
230	Primary Power Supply	SE4113646, 4113646
231	Power Supply Input Wire Harness	4113767
	Pwr. Supply Mounting Hardware:	
	Screw, 6-32 x ¼ in. btn hd (4x)	HW09004
	Lock Washer, #6 int-t (4x)	HW67015
	Kep Nut, 8-32	HW55001
232	Wire Harness, Primary Power Supply to PCB Assembly	4113764-001
233	Battery Wire Harness	4113761-001
234	Battery, 12V	4106093
	Battery Bag	4110255
235	Power Entry, Outside Mount	4109577
	Mains Filter	4112003
236	Circuit Breaker, Mains	4110537-002
237	Circuit Breaker, Battery	4110923-004
238	Circuit Breaker, Convenience Outlets (not on 220V version)	4110537-008
239	Output Wire Harness (to J14 on Processor)	4113759
240	Lamp Assembly	4113833
241	Filter, Convenience Outlets (not on 220V version)	4112450
242	Screw, 6-32 x ⅜ in. btn hd (4x)	HW09000
243	Lock Washer, #6 int-t (4x)	HW67015
244	Duplex Oulet (2x) (not on 220V version)	4112574-001
245	Cable Asm, 14-cond. ribbon (to J4 on Alarm Channel)	4112149-001


SV00101
251
252
253
254
255
246
247
248
249
250
256
257
273
275
256
258
259
260
261
262
263
264
265
266
267
268
277
REF
276
274
272
271
270
269
PRESS
PEEP CPAP
BEFORE USE
BEFORE USE

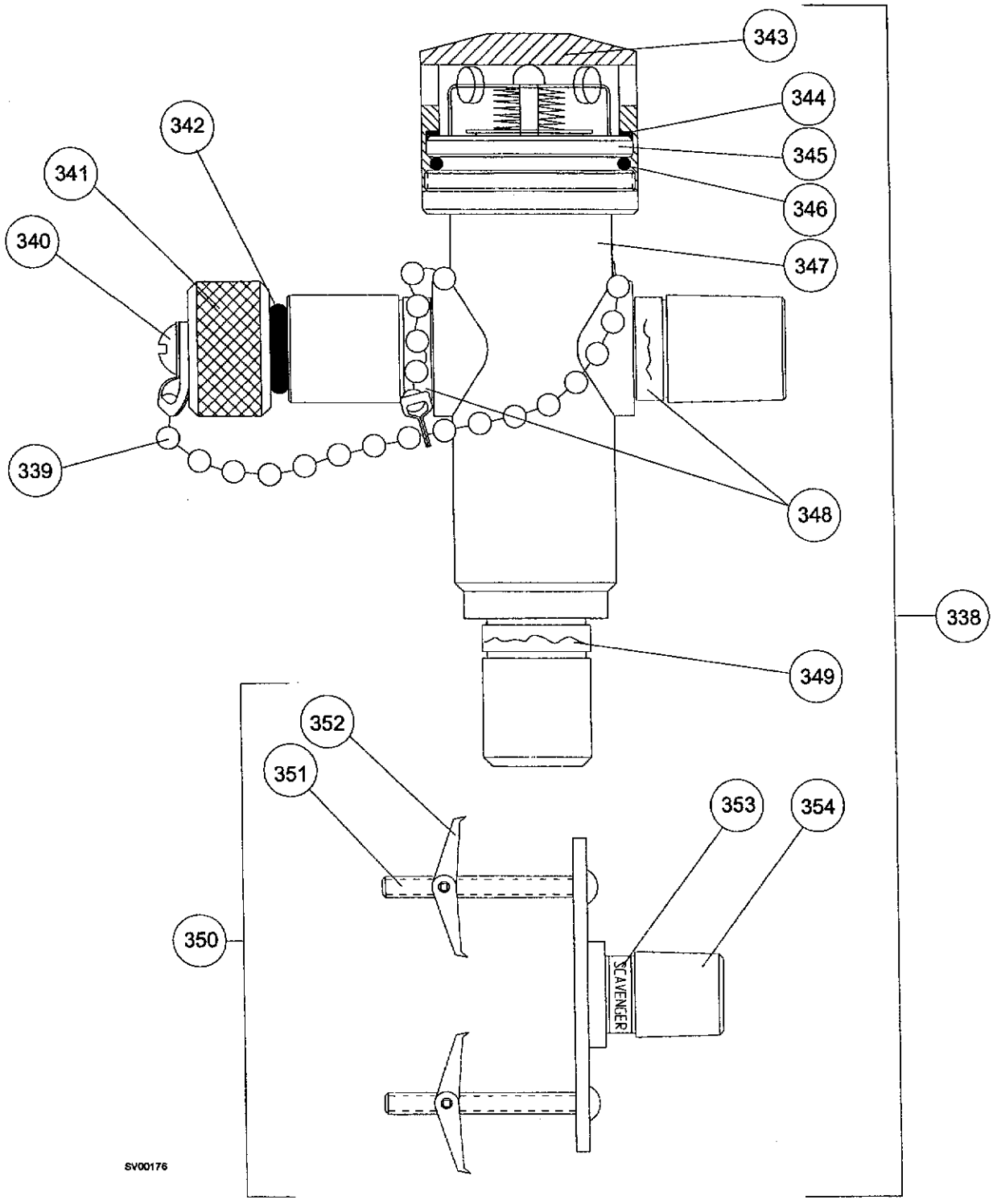
ITEM	DESCRIPTION	PART NUMBER
	Absorber Assembly	4109430
	Absorber Assembly with PEEP and bypass valve	4109431
246	Inspiratory Valve Assembly w/O_2 sensor mount (old number)	4107649
	Inspiratory Valve Assembly w/O_2 sensor mount (new number)	4112773-001
247	Plug Assembly, Oxygen Sensor	4106387
248	Dome & Label, Insp. Valve	4108329
249	Valve Asm	4112151
250	Label, Inspiration	1100559
251	Expiratory Valve Assembly	4112150
252	Dome	2109230
253	Gasket, Valve Dome (Both Valves)	2109231
254	Disk (Both Valves)	2123249
255	Label, Expiration	1100565
256	Gasket, Valve Mount	1101690
257	Spiromed Sensor	4106362
258	Gasket, Canister Top	4105848
259	Screen, Canister	1100022
260	Canister Assembly (2x)	4105851
261	Rod, Left	1101356
262	Clip, E-Ring (2x)	1100097
263	Spring (2x)	4110975-010
264	Bottom Sub-Assembly	4112932
	Gasket, absorber bottom (not shown)	1101001
265	Nut, ⅜-16 SS (4x)	HW50010
266	Cam Bar (2x)	1101018
267	Cam Assembly	1101015
268	Dowel Pin	1101017
269	Hose Assembly, Fresh Gas	4108577
270	Dust Cap	4106874
271	O-Ring	4102940
272	Rod, Right	1101355
273	Quick Disconnect Fitting (Breathing Pressure)	4108139
274	PEEP Bypass and Valve Assembly	4111527
275	Gauge Assembly, Breathing Pressure (Incl Mtg Ring and O-Ring)	4105853
	Replacement Cover	4113387
	Replacement Ring	4113388
276	O-Ring, #117, Silicone (2x)	4105766
	Breathing press hose asm (quick disc. ftg on each end)	4109368
	Breathing press hose asm (quick disc. ftg one end, Luer fitting other end)	4108528


SV00107
278
283
279
284
285
287
288
286
289
290
277
ABSORBER
ASSEMBLY
FLANGE
291
292
297
282
281
280
293
296
294
295
298

ITEM	DESCRIPTION	PART NUMBER
277	Valve, Man/Auto Selector	4112217-001
278	APL Valve	4104839
279	Fiber Washer	(Supplied with APL Valve)
280	Screw, Selector Valve Mounting, 8-32 x 7/16 in. Skt Hd Cap (3x)	HW01013
281	Lock Washer, Selector Valve Mounting, #8 int-t (3x)	HW67000
282	O-Ring, #117 (silicone)	4105766
283	Label, "Scavenger Hose"	4104806
284	Screw, 5/16-18 x 3¾ in. Rd Hd	HW06023
285	Spacer	4110792-070
286	Screw, 8-32 x 7/16 in. Skt Hd Cap (3x)	HW01013
287	Lock Washer, #8 split (3x)	HW65011
288	Connector Assembly, 22mm	4106744
289	Label, "Ventilator Hose"	1100563
290	O-Ring, #117 Silicone	4105766
291	Spacer	4110792-071
292	O-Ring, #120 EPDM	4112629-001
293	Nut, 5/16-18 Hexseal	4112613-001
294	Hole Plug, 3/16 in. dia.	4111663-001
295	Bag Connector	4102894
296	Label, "Breathing Bag"	1100561
297	Bag Mount Assembly	4112622-001
298	Man/Auto Sensor Cord Asm. (for AV-2+ ventilator)	4113126
	Oxygen Sensor Housing Assembly	4106363
	Oxygen Sensor Capsule	6803290


337
335 A
NAD COLOR MOUNTING ARRANGEMENT
336
335
335
337
336
EURO COLOR MOUNTING ARRANGEMENT
337 A
326
327
328
329
330
331
332
333
334
325
324
323
322
300
301
302
303
304
305
306
307
308
312
311
310
309
321
314
315
316
317
313
318
319
320
SV000104

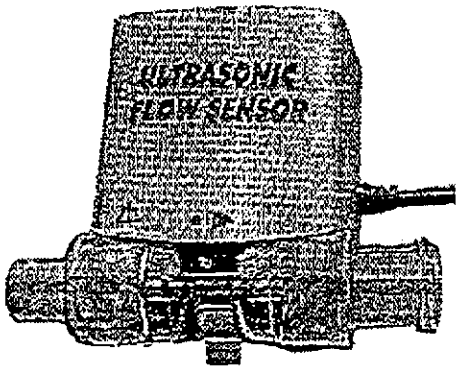
ITEM	DESCRIPTION	PART NUMBER
	Open Reservoir Scavenger Assembly	NAD color 4107624; Euro color 4107624-003
300	Elbow, ⅛ M x ¼ in. hose	4106881
301	Cap, Vinyl	4110045
302	Body, DISS VAC x ¼ MPT	4103669
303	Nut, DISS VAC	4103122
304	Hose Barb Nipple	4103123
305	19 mm Connector (2x)	4109315
306	Screw, ¼-20 x ⅜ in. skt hd (2x)	HW01033
307	Reservoir	NAD color 4110982; Euro color 4110982-001
308	Label, CAUTION	NAD color 4104294; Euro color 4104294-001
309	Reservoir Top	NAD color 4110979; Euro color 4110979-001
310	O-ring #112 (neoprene)	4102141
311	Chain, 8¼ lg	4112495-005
312	Plug	4102140
313	O-ring #008 (neoprene)	4102022
314	Label, ACTIVATE HOSP VAC	NAD color 4109305; Euro color 4109305-001
315	Retaining Ring	4110997
316	Nut, Valve Stem Retainer	4109316
317	Lock Nut, ⅜-24	4112137
318	Wing Nut	4105699
319	Spindle	4112138
320	Label, SCAVENGER HOSE (2x)	4104806
321	Screw, 10-32 x ¾ in. skt hd (4x)	HW01028
322	O-ring #019 (neoprene)	4106458
323	O-ring #015 (neoprene)	4104602
324	O-ring #019 (neoprene)	4106458
325	O-ring #013 (neoprene)	4102234
326	Block	NAD color 4111002; Euro color 4111002-001
327	O-ring, #008 (neoprene)	4102022
328	Flowmeter Housing	4110980
329	O-ring, #012 (neoprene)	1101523
330	Flowmeter	4112289
331	Screw, 6-32 x ⅜ in. flat hd (2x)	HW05006
332	Silencer	4110999
333	Reservoir Cap	4111000
334	Screw, 10-32 x ⅜ in. btn hd (4x)	HW09005
	NAD Color Mounting Arrangement:	
335	Bracket Assembly	4106231
335A	Mounting Bracket	4109314
336	Screw, ¼-20 x ½ in. skt hd (2x)	HW01034
	Lock Washer, ¼ int-t (2x)	HW67005
337	Mounting Hardware: Screw, 10-32 x ½ in. skt hd (2x)	HW01025
	Lock Washer, #10 split (2x)	HW65003
	Flat Washer, #10 (2x)	HW66003
	Euro Color Mounting Arrangement:	
335	Bracket	4114204
336	Screw, 8-32 x ½ in. skt hd (2x)	HW01014
	Lock Washer, #8 int-t (2x)	HW67000
337	Upper mounting screw hardware: Screw, 10-32 x ½ in. skt hd	HW01025
	Lock Washer, #10 split	HW65003
	Flat Washer, #10	HW66003
337A	Lower mtg screw pre-assembly: Screw, 10-32 x ½ in. skt hd	HW01025
	Flat Washer, #10	HW66003
	Spacer	4110791-037


343
344
342
345
341
346
340
347
339
348
338
349
352
351
353
354
350
SCAVENGER
SV00176

ITEM	DESCRIPTION	PART NUMBER
338	Scavenger, A/C	4106161
339	Chain assembly, 8¼ in.	4112495-006
340	Screw, round hd, 10-32 x ½ in.	HW06007
341	Plug	4102140
342	O-ring, #112 neoprene	4102141
343	Dust cover	1101527
344	Spacer	4110792-007
345	Valve 'A' 5 cm H_2O	2207032
346	O-ring, #027 neoprene	4101871
347	Body, solder assembly	4102105
348	Label, SCAVENGER HOSE (2x)	4104806
349	Label, EXHAUST	4106878
	Mounting hardware for scavenger:	
	Screw, 10-32 x ½ in. cap skt hd (2x)	HW01025
	Lock Washer, #10 split (2x)	HW65003
	Flat Washer, #10 (2x)	HW66003
	Scavenger Bracket. . . .NAD Color. . . 4106231 Euro Color	4114027
	Bracket Clamp. . . . . NAD Color. . . 1101301 Euro Color	1101301-001
	Screw, ¼-20 x 1 in. rd hd sltd (2x)	HW06010
350	Vent Grill Adapter (for 19 mm hose)	1101312
351	Screw, round hd, 10-24 x 3 in. (2x)	HW06012
352	Toggle nut (2x)	4101862
353	Label, SCAVENGER HOSE	4104806
354	Adapter assembly, 19 mm	1101609
	Hose Barb Adapter	4108114

Ultrasonic Flow Sensor

North American Dräger



Easy to clean

Technology Overview

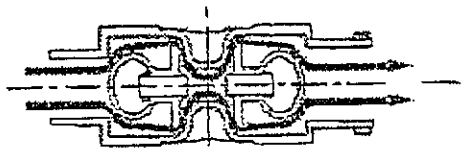
Click on the Flow Sensor for a product Brochure in Adobe Acrobat (pdf) format. (Download time is about 4 minutes at 28.8 bps)

If you need the PDF Acrobat Reader just click here.

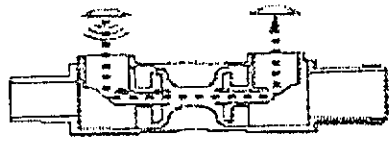
The diagram to the right depicts the simplicity in this new sensor design.

The sensor has no moving parts and does not rely on long pneumatic pathways and gas density for signal transmission and measurement.

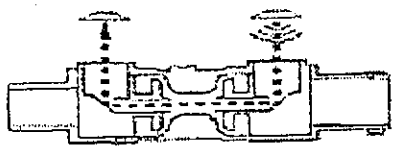
Instead, the Narkomed Ultrasonic Flow Sensor measures respiratory flow rate by means of two transducers which record the time of flight of ultrasonic pulses transmitted upstream and downstream in the respiratory flow path. Whenever a flow is present there is a difference in the time of flight. This difference is used to compute the flow velocity which is then multipled by the cross sectional area to yield flow volume.



Respiratory Flow Path



Downstream Ultrasonic Flow Path



Upstream Ultrasonic Flow Path

Theory of Operation	Time = Distance / Speed
The mathematics show that flow velocity can be directly determined from time of flight measurements.*	$T_1 = L / (C + V_g)$ $T_2 = L / (C - V_g)$

L = Propagation distance C = Speed of sound T_1 = Time-of-Flight downstream T_2 = Time-of-Flight upstream V_g = Velocity of gas (unknown)	Solving for V_g: $(1 / T_1) - (1 / T_2) = (C + V_g) / L - (C - V_g) / L$ $L * ((1/ T_1) - (1/ T_2)) = C + V_g - C + V_g$ $2 * V_g = L * (1/ T_1 - 1/ T_2)$
Flow velocity =	$V_g = (L / 2) * (1/ T_1 - 1/ T_2)$

* Note that Flow velocity determination is independent of the speed of sound. This is important in the anesthesia application since the speed of sound (C) and gas density is determined, in part, by gas composition. The effect can be particularly significant at low flow rates in sensors that utilize gas density for measuring flow. As the mathematics show, the NAD Ultrasonic Sensor accuracy is not impacted by this effect.

Upgrade Kit Part no.	Narkomed Anesthesia Machine	Availability
4114904	NMGS	Now
4114930	NM2C	TBA
4114953	NM4	TBA
4114952	NM2B	TBA

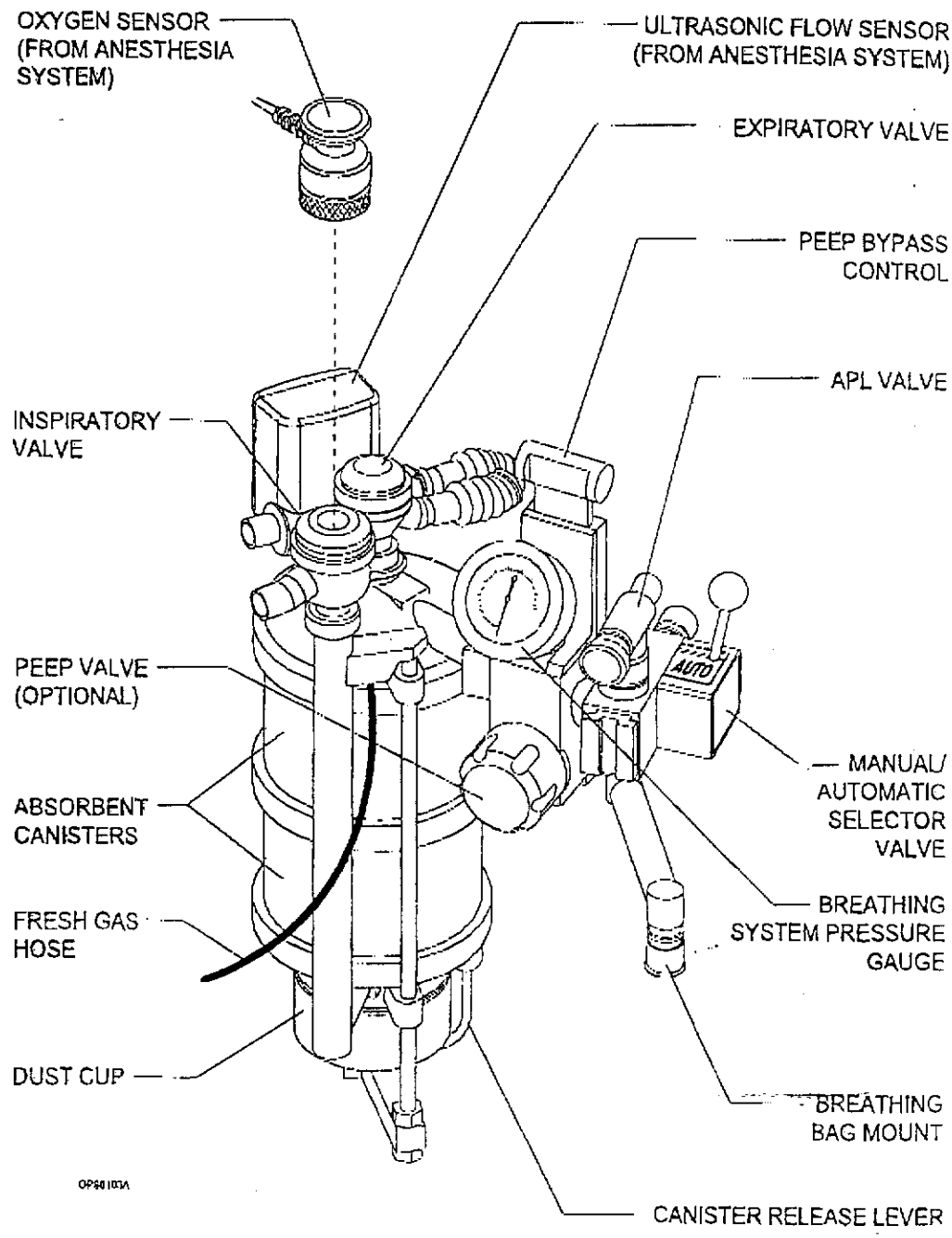


Figure 2-2: Absorber System with Ultrasonic Flow Sensor

THIS SHOWS LOCATION OF FLOW SENSOR

6.8 BREATHING SYSTEM

(✓) 6.8.1 Absorber System Inspection

6.8.1.1 Remove the inspiratory and the expiratory valve domes.

6.8.1.2 Is there a broken or bent pin on the valve assembly?
Inspiratory ___ (N) Expiratory ___ (N)

6.8.1.3 Is there a broken pin on the valve domes?
Inspiratory ___ (N) Expiratory ___ (N)

6.8.1.4 Is the valve disc in good condition?
Inspiratory ___ (Y) Expiratory ___ (Y)

6.8.1.5 Are the valve dome washers in good condition? ___ (Y)

6.8.1.6 Reinstall the inspiratory and expiratory valve domes.

6.8.1.6A Remove the ultrasonic flow sensor connector hose - if applicable.

6.8.1.6B Is the connector hose, connector, and O-ring in good condition? ___ (Y) - if applicable.

6.8.1.6C Remove the ultrasonic flow sensor from the mounting bracket - if applicable.

6.8.1.6D Remove the flow housing/transducer assembly from the electronics housing - if applicable.

6.8.1.6E Remove both transducers from the flow housing; examine each O-ring and condition of all components, then reassemble - if applicable.

6.8.1.7 Remove the inspiratory and expiratory valve assemblies.

6.8.1.8 Remove the Spiromed sensor, if applicable.

6.8.1.9 Are all washers in good condition? ___ (Y)

6.8.1.10 Reinstall the inspiratory valve.

6.8.1.10A Reinstall the expiratory valve and the connector hose between the expiratory valve and the ultrasonic flow sensor - if applicable.

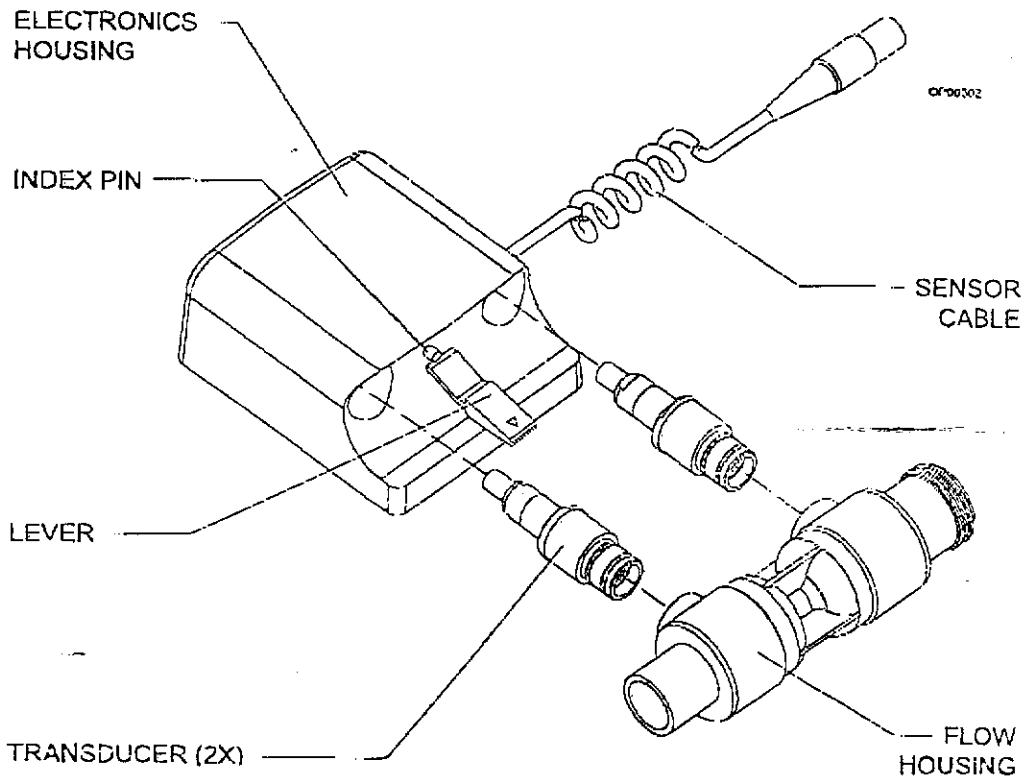
6.8.1.11 Are the two (2) spring clips on the absorber rods? ___ (Y)

Clearing Condensation in the Ultrasonic Flow Sensor

Depending on the conditions of use and the environment, condensation can accumulate in the flow sensor housing. Moderate amounts of condensation should not affect operation. Excessive condensation can result in erratic measurements or total loss of flow measurement.

To remove condensation:

1. Remove the connector hose assembly between the flow sensor and expiratory valve by turning the ring nut counterclockwise.
2. Remove the patient hose from the expiratory hose terminal on the flow sensor.
3. Lift the flow sensor off the bracket.
4. Press down on the lever under the flow housing and remove the flow housing/transducer assembly from the electronics housing.
5. Pull both transducers out of the flow housing.



6. Tip and shake the flow housing to release fluid trapped in the housing.

7. Make sure that all large droplets are cleared from the transducer ports.

8. Pat the transducers dry with a soft, lint-free cloth.

9. Press the transducers back into their ports in the flow housing.

10. Slide the electronics housing over the flow housing/transducer assembly. Be sure that it clicks into place.

    NOTE: If the flow housing/transducer assembly does not fit easily into the electronics housing, make sure the flow housing is facing the right direction. Compare the direction to the illustration on the electronics housing. The index pin on the electronics housing should align with the hole in the flow housing.

11. Slide the flow sensor onto the bracket.

12. Connect the patient hose to the expiratory hose terminal on the flow sensor.

13. Install the connector hose assembly between the flow sensor and the expiratory valve, and secure it by turning the ring nut clockwise.

Narkomed GS

To enter Service mode:

1.
Press the following keys:

Oxygen high alarm limit
&
Breathing Volume low alarm limit
&
UP arrow

2.
use up arrow to select SRVC
then press Select

Use up arrow and select key to enter your ID No

you are now in service level 1 and calibrate Oxygen sensor leads and pressure transducers.

To enter service level two:

Press the Oxygen high alarm limit once

use the up and down arrows to enter the following code:

UP to 2
down to 5
up to 6
then press select.

you are now in the config screen and can change the serial Number, Configure the Vapour ports, and switch on and off the O2 fail alarm.