

**Dräger**medical

A Dräger and Siemens Company

# Operator's Instruction Manual

Part Number: 4113801-007

Rev: G

Date: 30 January 2004

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## **Narkomed GS Anesthesia System**

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**WARNING:** For a full understanding of the performance characteristics of this anesthesia machine, the user should carefully read this manual before operating.

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# 1

## Introduction

This section introduces you to the Narkomed GS anesthesia machine.

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## Operator's Responsibility for Patient Safety

Draeger Medical anesthesia products are designed to provide the greatest degree of patient safety that is practically and technologically feasible. The design of the equipment, the accompanying literature, and the labeling on the equipment take into consideration that the purchase and use of the equipment are restricted to trained professionals, and that certain inherent characteristics of the equipment are known to the trained operator. Instructions, warnings, and caution statements are limited, therefore, to the specifics of the Draeger Medical design. This publication excludes references to hazards which are obvious to a medical professional, to the consequences of product misuse, and to potentially adverse effects in patients with abnormal conditions. Product modification or misuse can be dangerous. Draeger Medical disclaims all liability for the consequences of product alterations or modifications, as well as for the consequences which might result from the combination of Draeger Medical products with products supplied by other manufacturers if such a combination is not endorsed by Draeger Medical.

The operator of the anesthesia system must recognize that the means of monitoring and discovering hazardous conditions are specific to the composition of the system and the various components of the system. It is the operator, and not the various manufacturers or suppliers of components, who has control over the final composition and arrangement of the anesthesia system used in the operating room. Therefore, the responsibility for choosing the appropriate safety monitoring devices rests with the operator and user of the equipment.

Patient safety may be achieved through a variety of different means depending on the institutional procedures, the preference of the operator, and the application of the system. These means range from electronic surveillance of equipment performance and patient condition to simple, direct contact between operator and patient (direct observation of clinical signs). The responsibility for the selection of the best level of patient monitoring belongs solely to the equipment operator. To this extent, the manufacturer, Draeger Medical, disclaims responsibility for the adequacy of the monitoring package selected for use with the anesthesia system. However, Draeger Medical is available for consultation to discuss monitoring options for different applications.

## Limitation of Liability

Draeger Medical's liability, whether arising from or related to the manufacture and sale of the products, their installation, demonstration, sales representation, use, performance, or otherwise, including any liability based upon Draeger Medical's product warranty, is subject to and limited to the exclusive terms of Draeger Medical's limited warranty, whether based upon breach of warranty or any other cause of action whatsoever, regardless of any fault attributable to Draeger Medical and regardless of the form of action (including, without limitation, breach of warranty, negligence, strict liability, or otherwise).

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**Furthermore, buyer acknowledges that the consideration for the products, equipment, and parts sold reflects the allocation of risk and the limitations of liability referenced herein.**

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Federal law restricts this device to sale by, or on the order of, a physician.

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## Disclaimer

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

## Recommendations

In the interest of patient safety, Draeger Medical strongly advocates the use of an oxygen analyzer, pressure monitor, and either a volume monitor or an end-tidal CO<sub>2</sub> monitor in the breathing circuit at all times.

Because of the sophisticated nature of Draeger Medical 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 DrägerService at (800) 543-5047 for service of this equipment.

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

## Symbol Definition

The following symbols appear on the label on the back of the Narkomed GS and are defined below.



**CAUTION:** Refer to accompanying documents before operating equipment.

**ATTENTION:** Consulter les documents ci-joints avant de faire fonctionner l'appareil.



**CAUTION:** Risk of electric shock, do not remove cover. Refer servicing to an authorized representative of DrägerService.

**ATTENTION:** Risque de choc électrique, ne pas enlever le couvercle. Ne faire réparer que par un représentant technique autorisé de Draeger Medical.



Degree of protection against electric shock: Type B.

Protection contre le risque de choc électrique: Type B.



These additional symbols are used on other locations of the Narkomed GS to provide quick and easy recognition of product functions:



OXYGEN CONCENTRATION



BREATHING PRESSURE



BREATHING VOLUME



AUDIBLE ALARM DISABLE



THRESHOLD PRESSURE ALARM LIMIT

## Purpose of This Manual

This manual provides operating instructions for the Narkomed GS Anesthesia System. It is intended for use by trained clinical professionals familiar with accepted medical procedures, practices, and terminology used in delivery of anesthesia and patient monitoring.

## How This Manual Is Organized

All users of the Narkomed GS must read this manual completely before using the machine. In order to make this document more convenient for future reference, it has been divided into several independent sections.

“Section 2 - General Description” provides a summary of Narkomed GS features and functions.

“Section 3 - Daily Checkout” contains the checkout procedures that must be done on a daily basis.

“Section 4 - Preuse Checkout” contains the checkout procedures to be performed between successive cases.

Sections 5 through 15 provide detailed instructions on the use and operation of each functional component of the system.

“Section 16 - Routine Maintenance and Cleaning” provides cleaning, maintenance, and replacement procedures.

“Section 17 - Specifications” contains the specifications for all system components.

The Appendix lists spare and replacement parts for the machine.

## Conventions Used in This Manual

This manual has been set up with several conventions to help organize the information contained in it. Please read about these conventions carefully so that you understand their significance in the manual.

### Typefaces

Different typefaces are used throughout the manual to differentiate between narrative information and machine messages and labels.

### Warnings and Cautions

All parts of this manual contain warning and caution statements about the Narkomed GS.

- *Warning* statements give important information that, if ignored, could lead directly to personal injury.
- *Caution* statements give important information that, if ignored, could lead directly to equipment damage and indirectly to personal injury.

## General Warnings and Cautions

The following list of warnings and cautions apply to general operation and maintenance of the Narkomed GS. Warnings and cautions about installing and operating specific parts appear with those topics.

**WARNING:** Any person involved with the setup, operation, or maintenance of the Narkomed GS anesthesia system must be thoroughly familiar with this instruction manual.

**WARNING:** This anesthesia system will not respond automatically to certain changes in patient condition, operator error, or failure of components. The system is designed to be operated under the constant surveillance and control of a qualified operator.

**WARNING:** No third-party components shall be attached to the anesthesia machine, ventilator, or breathing system (except for certain approved exceptions). Contact DrägerService for further information.

**WARNING:** When moving the anesthesia machine, remove all monitors and equipment from the top shelf, remove the absorber system, and use only the machine handles or push/pull bars. The anesthesia machine should only be moved by people who are physically capable of handling its weight. Draeger Medical recommends that two people move the anesthesia machine to aid in maneuverability. Exercise special care so that the machine does not tip when moving up or down inclines, around corners, and across thresholds (for example, in door frames and elevators). Do not attempt to pull the machine over any hoses, cords, or other obstacles on the floor.

**CAUTION:** Although the Narkomed GS is designed to minimize the effects of ambient radio-frequency interference, machine functions may be adversely affected by the operation of electrosurgical equipment or short wave or microwave diathermy equipment in the vicinity.

**CAUTION:** Communications with external equipment may be temporarily affected by electromagnetic interference due to the use of electrosurgical equipment.

**CAUTION:** Do not place more than 100 pounds on top of the Narkomed GS monitor housing.

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# 2

## General Description

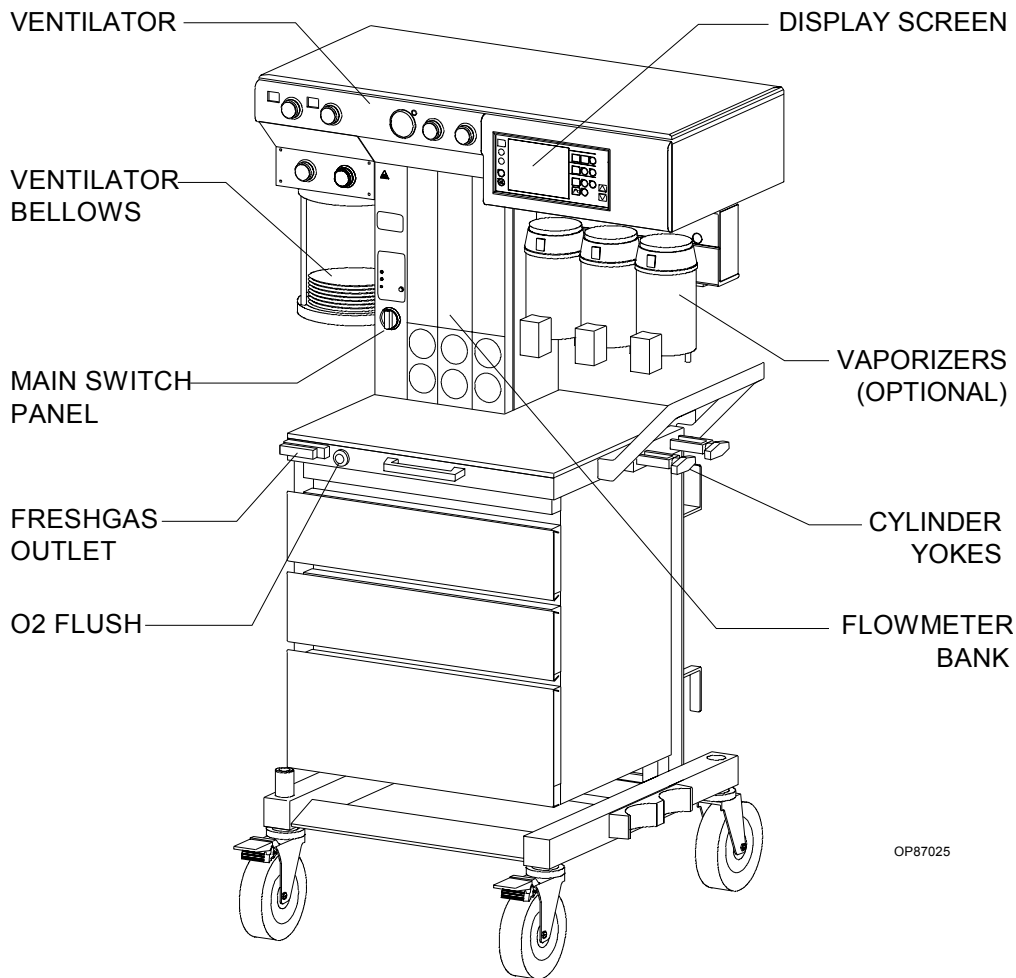
This section introduces you to the Narkomed GS anesthesia machine.

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## Overview

The Narkomed® GS is a continuous flow anesthesia system. All Narkomed GS machines are equipped with a monitoring system and pneumatic circuitry for delivering gases and anesthetic vapor. A front view of the Narkomed GS is shown in Figure 2-1.

Figure 2-1. Narkomed GS Anesthesia System, Front View



## Gas Delivery System

The pneumatic system can simultaneously deliver up to four gases and one anesthetic agent (from a selection of up to three). Oxygen and nitrous oxide are standard on all Narkomed GS machines. Optional gases are air and carbon dioxide. Gas is supplied to the system through pipelines and cylinders. Connections for oxygen and nitrous oxide are standard on all machines, and a pipeline connection for air is also available. Gas cylinder yokes are available for up to two oxygen cylinders and two nitrous oxide cylinders, plus one additional cylinder for a third gas.

**Color Coding** Each connection, valve, gauge, and flowmeter is labeled and color-coded for the appropriate gas, as shown in Table 2-1 below.

**Table 2-1. Gas System Color Coding**

GAS	MARKING	USA	GERMANY	ISO
Air	AIR	Yellow	Yellow	Black/White Checkered
Carbon Dioxide	CO <sub>2</sub>	Gray	Black	Gray
Nitrous Oxide	N <sub>2</sub> O	Blue	Gray	Blue
Oxygen	O <sub>2</sub>	Green	Blue	White

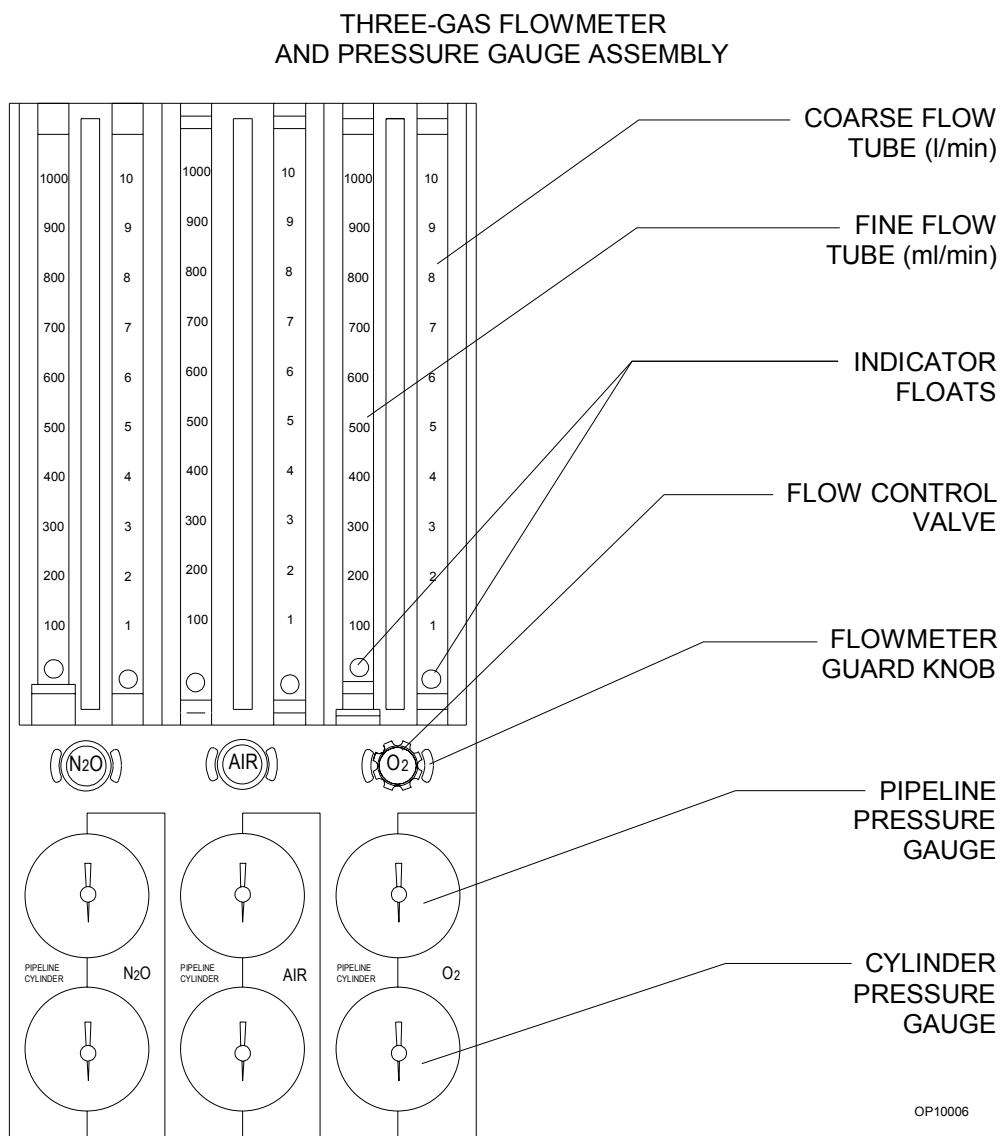
**Gas Entry Via Pipeline**

Gas from the hospital pipelines enters the Narkomed GS through hoses connected to indexed pipeline inlets located on the side of the flowmeter housing. The indexed connector system reduces the risk of delivering the wrong gas to a patient by preventing incorrect connection of gas pipes. The inlets include check valves, which prevent back flow leakage into the atmosphere (when supply hoses are not connected) or into the attached supply hoses (when reserve cylinders are in use). Each pipeline connection is equipped with a filter to prevent foreign material from entering the internal gas piping of the Narkomed GS. Pipeline gases should be supplied at 50–55 psi.

**Pipeline Pressure Gauges**

The anesthesia machine includes pipeline pressure gauges for oxygen and nitrous oxide. On machines equipped with air, a pipeline pressure gauge for air is also included. The gauges are located directly below their corresponding flowmeters and flow control valves, and are labeled and color-coded for their respective gases. Concentric scales in psi and kPa indicate the pipeline supply pressure. A typical pressure gauge and flowmeter arrangement is shown in Figure 2-2.

Figure 2-2. Three-Gas Flowmeter and Pressure Gauge Assembly



When the machine is connected to an active pipeline supply, each gauge should indicate 50–55 psi. A deviation from within this range indicates that the pipeline gas supply system is improperly adjusted and may adversely affect the operation of the Narkomed GS. A fluctuating pipeline supply pressure, for example, would cause a corresponding fluctuation of the flow of gas delivered from that pipeline. An excessively low pipeline pressure may activate the corresponding reserve cylinder and deplete its contents (if the reserve cylinder valve was left in the open position).

**CAUTION:** To ensure that gas supplies are at adequate pressure, pipeline pressure gauges should indicate steady pressures of 50–55 psi.



**Gas Entry Via  
Cylinder  
Yokes**

The Narkomed GS can be equipped with a maximum of two oxygen and two nitrous oxide cylinder hanger yokes. An additional yoke for an optional third gas is also available. To prevent a cylinder from being improperly connected, the yokes are labeled, color-coded, and keyed for gas-specific cylinders using the pin-indexed safety system.

A filter within each yoke prevents foreign material from entering the internal gas piping of the Narkomed GS. A check valve in each yoke prevents leakage into the atmosphere if the cylinder is not mounted on the yoke. When the machine is configured with two yokes for the same gas, the check valve prevents movement of gas from one cylinder to the other. If a cylinder is not mounted to a yoke, the attached yoke plug should be placed between the yoke handle's threaded bolt and the yoke's gas inlet.

When attaching a cylinder, make sure that only one washer is installed between the cylinder and the yoke gas inlet. Using multiple washers may compromise the pin-indexed safety system. Be sure to verify the integrity of both index pins whenever you install a new cylinder.

**WARNING:** Check cylinder yokes for the presence of two index pins each time you attach a cylinder to the machine. Use only one cylinder gasket per yoke; using more than one gasket could cause leakage of the cylinder gas and compromise the pin-indexed safety system.

Cylinders attached to the hanger yokes must contain gas at the recommended pressures outlined in Table 2-2. (Indicated pressures are of E-size cylinders at 70°F, or 21°C.) Cylinders measuring less than the minimum recommended pressure (PSI - MIN) should be replaced with new, full cylinders.

**Table 2-2. Recommended Cylinder Gas Pressures**

<b>GAS</b>	<b>PSI - FULL*</b>	<b>PSI - MIN</b>
Air	1900	1000
Carbon Dioxide	838	600
Nitrous Oxide	745	600
Oxygen	1900	1000

\* typical full load

### Cylinder Pressure Gauges

Each cylinder gas circuit has a cylinder pressure gauge, located at the bottom of the flowmeter panel on the front of the machine (see Figure 2-2 on page 2-4.) Each gauge is labeled and color-coded for its respective gas. When a cylinder's valve is open, its pressure gauge indicates the gas pressure in the cylinder. The dial is marked with concentric scales for psi and kPa. If two reserve cylinders of the same gas are open at the same time, the gauge indicates the pressure in the cylinder having the higher pressure.

For non-liquefied gases (oxygen, air), the indicated pressure is proportional to the gas content of the cylinder. For liquefied gases (nitrous oxide, carbon dioxide), the gauge indicates the vapor pressure of the liquefied gas in the cylinder. This pressure remains constant until all of the liquid in the cylinder has vaporized. When the liquid has vaporized, the cylinder pressure decreases proportionally as gas is removed from the cylinder.

### Oxygen Supply Pressure Failure Protection Device (OFPD)

An oxygen failure protection device (OFPD) is a pneumatically operated valve that protects the patient in the event of partial or complete loss of oxygen pressure. Each gas circuit in the anesthesia machine, except the oxygen circuit, is controlled by one of these valves. These valves, in turn, are controlled by the gas pressure in the oxygen supply line. When oxygen pressure is adequate, the valves remain open for an unrestricted gas flow. Loss of oxygen pressure causes the valves to close to a degree that is proportional to the loss. The result is a restriction or shut down of the flow of all gases except oxygen.

Reductions of gas flow are indicated on the flowmeters. In addition, if the oxygen supply pressure drops below approximately 37 psi, an oxygen supply pressure alarm is activated, causing the following events to occur:

- The Caution message O<sub>2</sub> SUPPLY LOW appears on the alarm display.
- The red O<sub>2</sub> SUPPLY PRESSURE indicator on the main switch panel lights.
- An intermittent audible alarm sounds.
- A 7-second whistle may sound, depending on the machine's configuration.

**NOTE:** When one source of oxygen pressure (either pipeline or reserve cylinders) fails, but the other source is able to maintain proper pressure within the machine's oxygen supply lines, the oxygen supply pressure alarm is not activated.

<b>Flowmeters</b>	<p>Flowmeters, located directly above their corresponding flow control valves, display the delivered flow rate of each gas in the fresh gas mixture. Dual flowmeter tubes (fine and coarse) are used in tandem for oxygen, nitrous oxide, and air (if provided). When other gases are supplied, single flowmeter tubes are used. All flowmeters are labeled at each end of the flowtube. A typical flowmeter arrangement is shown in the Flowmeter and Pressure Gauge Assembly figure earlier in this section.</p> <p>Each flowmeter has a float indicator. To determine the flow rate, read the flowmeter scale at the center of the float.</p>
<b>Low-Flow Flowmeters (Optional)</b>	<p>For low-flow anesthesia, the Narkomed GS can be configured with low-flow, dual-tube flowmeters for oxygen and nitrous oxide. These flowmeters function the same way as the standard dual-tube flowmeters, but they are calibrated to provide greater resolution for low-flow anesthesia.</p>
<b>Minimum Oxygen Flow</b>	<p>The oxygen dispensing system incorporates a calibrated bypass flow of 150 ±50 ml/min (at 50 psi pipeline pressure), which delivers this volume of oxygen even if the oxygen flow control valve is fully closed.</p>
<b>Flow Control Valves</b>	<p>A needle valve is located below the fine flowmeter tube for each gas. This valve is used to adjust the flow of gas. Turning the valve knob counterclockwise increases flow; turning the knob clockwise decreases flow. A zero stop prevents damage to the flow control valve seats. If necessary, a Draeger Medical qualified technical service representative can readjust the stop.</p> <p>Each flow control knob is identified by its color code and chemical symbol. The oxygen flow control valve is also touch-coded with a deeply fluted knob.</p> <p><b>CAUTION:</b> The flow of oxygen cannot be completely shut off (see “Minimum Oxygen Flow” earlier in this section). Do not force the oxygen flow control knob in an effort to shut off the minimum flow; forcing the knob can damage the valve seat.</p>
<b>Oxygen Flush</b>	<p>A manually operated, self-closing oxygen flush valve is located on the front of the machine. A bezel is mounted around the pushbutton in order to prevent accidental engagement. The valve, when actuated, delivers an unmetereed oxygen flow of approximately 55 l/min directly to the Narkomed GS's fresh gas common outlet. The SYSTEM POWER switch does not have to be in the ON position to use the oxygen flush.</p>

**Oxygen Ratio  
Controller  
(ORC)**

The ORC is a pneumatic oxygen/nitrous oxide interlock system. It maintains a fresh gas oxygen concentration of  $25 \pm 4\%$  and permits independent control of the oxygen and nitrous oxide flows.

The ORC proportionally limits the nitrous oxide flow whenever the selected oxygen and nitrous oxide flow control valve settings would otherwise result in a hypoxic fresh gas mixture. For example, if you open the nitrous oxide flow control valve excessively without making a corresponding increase in the oxygen flow control valve setting, the flow of nitrous oxide will not increase even though its flow control valve setting has been greatly increased. Similarly, if you decrease the oxygen flow without also decreasing the nitrous oxide flow, the nitrous oxide flow will automatically drop in proportion to the oxygen flow.

**WARNING:** In circle systems the gas mixture in the patient circuit is not necessarily the same as that in the fresh gas flow. This is particularly true at low fresh gas flow rates when the patient rebreathes a significant portion of previously exhaled gases. It is important that the gas mixture in the patient circuit be monitored, and that the fresh gas flow be adjusted to meet the requirements of the patient as well as to compensate for any patient uptake, system leakage, or gas withdrawn through sample lines and not returned.

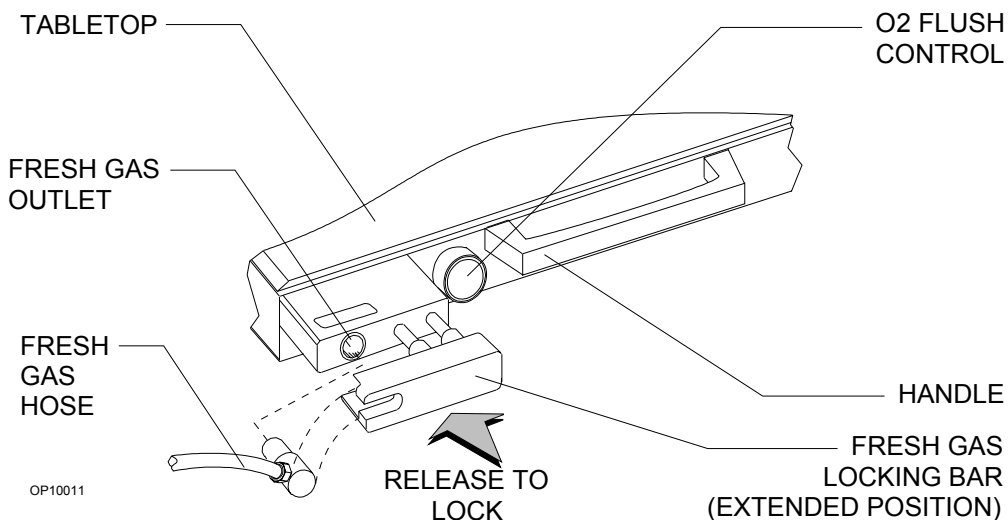
**WARNING:** The ORC interlocks only the flows of oxygen and nitrous oxide. Hypoxic fresh gas concentrations are possible if carbon dioxide is used as an additional gas.

**Fresh Gas Outlet**

The fresh gas outlet delivers the fresh gas mixture (consisting of oxygen, nitrous oxide, optional gases, and vapors of a liquid anesthetic) to the patient breathing system. It is located on the front of the anesthesia machine. See Figure 2-3.

The outlet's 15 mm cylindrical female fitting is designed to accept a 15 mm male fitting on the absorber fresh gas hose. The male fitting slides into a retaining slot in the spring-loaded safety locking bar to prevent inadvertent disconnection of the fresh gas hose. The 15 mm male fitting on the fresh gas hose is unique to Draeger Medical design, and cannot be replaced by a hose from any other manufacturer.

Figure 2-3. Fresh Gas Outlet



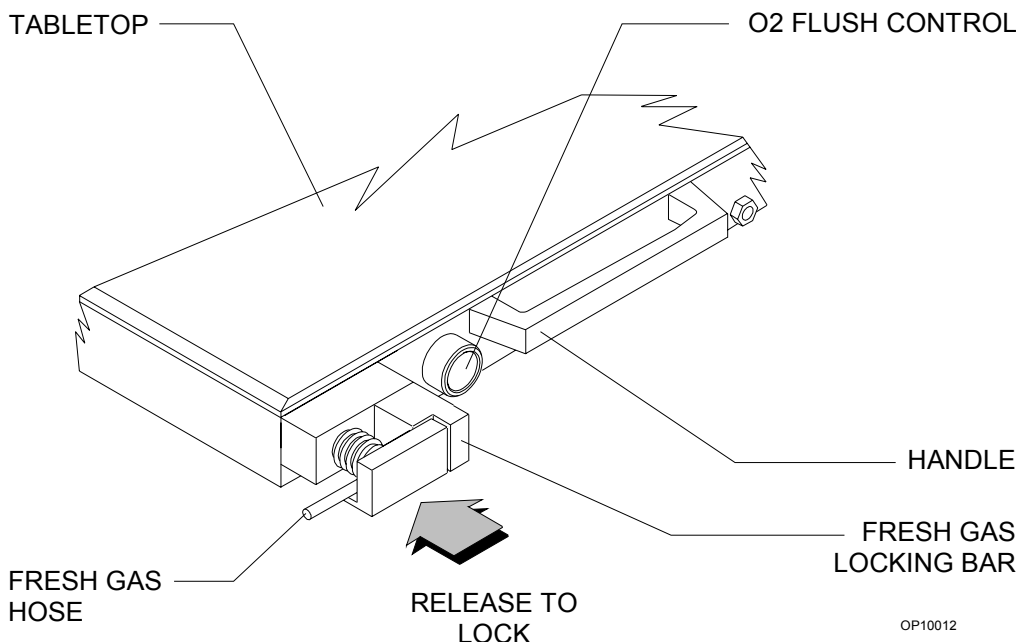
**Fresh Gas Outlet (Canada)**

The fresh gas outlet delivers the fresh gas mixture (consisting of oxygen, nitrous oxide, optional gases, and vapors of a liquid anesthetic) to the patient breathing system. It is located on the front of the anesthesia machine. See Figure 2-4.

The fresh gas outlet has a dual fitting that lets you use a gas hose with either of the following types of fittings:

- A 15 mm male fitting, such as those supplied with Draeger Medical Absorbers and Bain Circuit Adapters. When using a 15 mm fitting, place the spring-loaded locking bar over the male fitting to secure it to the female fitting.
- A 22 mm female fitting with a load-bearing threaded mount, such as those for Magill circuits or ISO-type non-rebreathing adapters. When using an ISO-type non-rebreathing adapter, swing the spring-loaded locking bar to the side to gain access to the threaded load-bearing fitting.

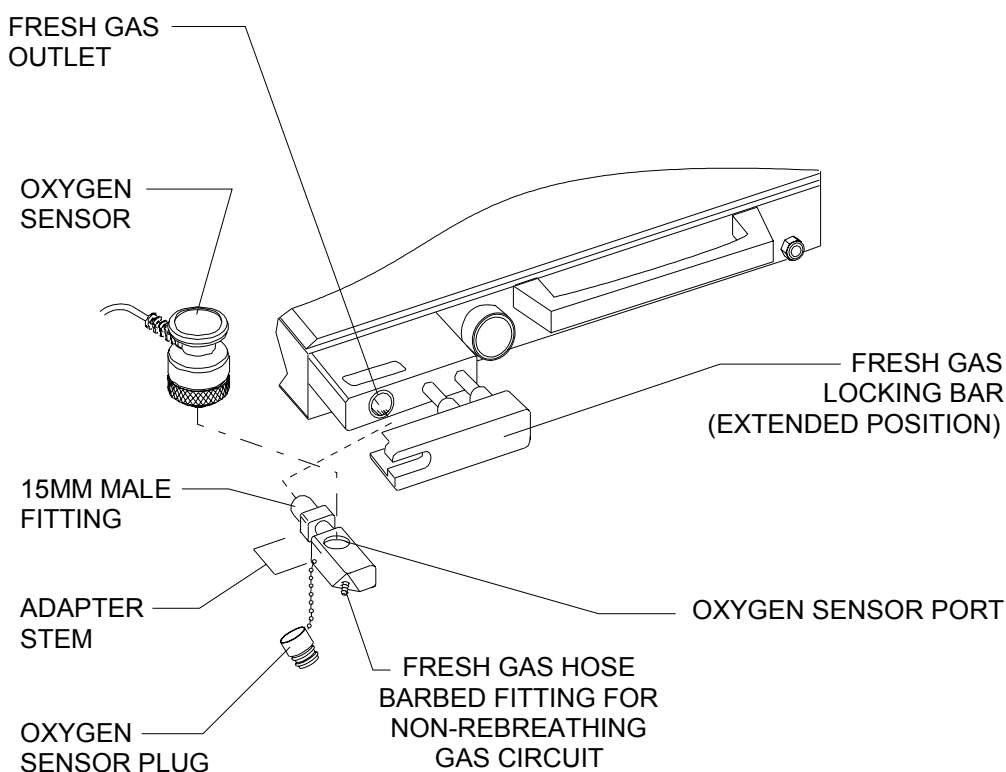
**Figure 2-4. Fresh Gas Outlet (Canada)**



**Fresh Gas Oxygen Sensor Adapter**

The optional fresh gas adapter allows the Narkomed GS to monitor the fresh gas oxygen concentration when using a non-rebreathing circuit (other than a Bain Circuit). The fresh gas adapter fits securely into the fresh gas outlet of the anesthesia machine. It incorporates a port for an oxygen analyzer sensor and a fitting for a non-rebreathing circuit. See Figure 2-5.

**Figure 2-5. Fresh Gas Oxygen Sensor Adapter**



OP20997

**WARNING:** The fresh gas oxygen sensor adapter measures the fresh gas oxygen concentration, not the inspiratory oxygen concentration. Depending on the fresh gas flow and the respiratory minute volume, the inspiratory oxygen concentration may be lower than fresh gas oxygen concentration due to rebreathing of previously exhaled gases.

**Auxiliary Oxygen Flowmeter (Optional)**

For the delivery of a metered flow of pure oxygen (for example, delivery of oxygen through a nasal cannula), an optional auxiliary oxygen flowmeter can be mounted on the left side of the flowmeter bank. This flowmeter can be used when the machine is turned off. A zero stop prevents damage to the flow control valve seat.

## Vaporizers

The Narkomed GS can be equipped with up to three fixed-mount vaporizers (Vapor 19.1) or up to two removable vaporizers (Vapor 19.3) for administering liquid anesthetics.

## Exclusion Systems

The Narkomed GS is equipped with one of two vaporizer exclusion systems, depending on the vaporizer model:

- fixed-mount vaporizer exclusion system (for the Vapor 19.1)
- removable vaporizer exclusion system (for the Vapor 19.3)

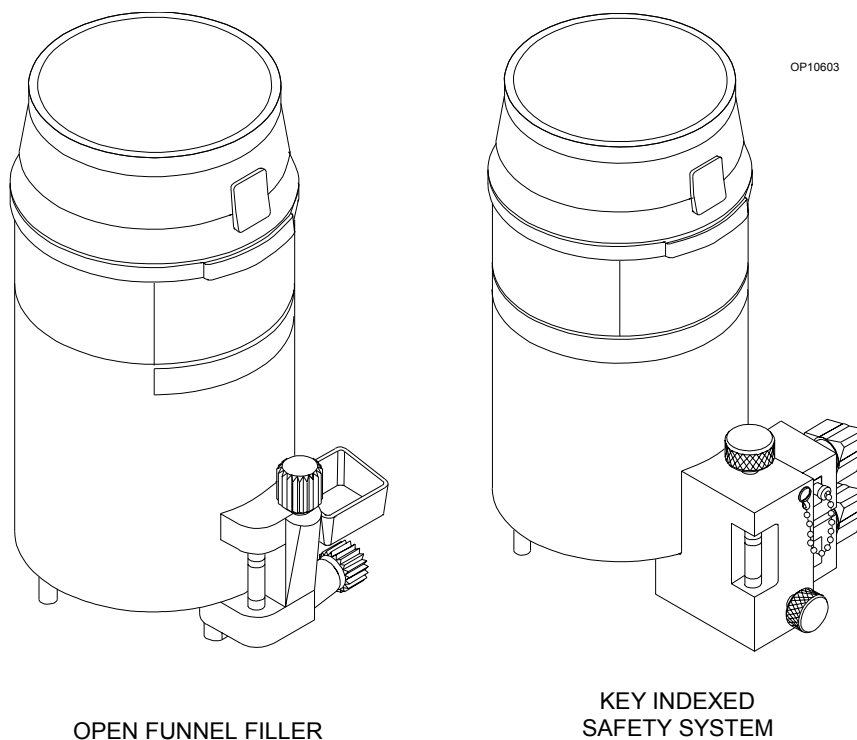
The purpose of the exclusion system is to prevent more than one vaporizer from being activated at a time. The exclusion system is incorporated into the vaporizer bank and requires all unused vaporizers to be locked in their zero percent positions.

**WARNING:** Only one vaporizer can be activated at a time. If the exclusion system permits simultaneous activation of more than one vaporizer, do not use the anesthesia machine. Contact a Draeger Medical qualified technical service representative for adjustment.

## Filling Systems

Two filling systems are available for the Vapor 19.1 and 19.3 vaporizers: the open funnel system and the key-indexed safety system. See Figure 2-6.

Figure 2-6. Filling Systems

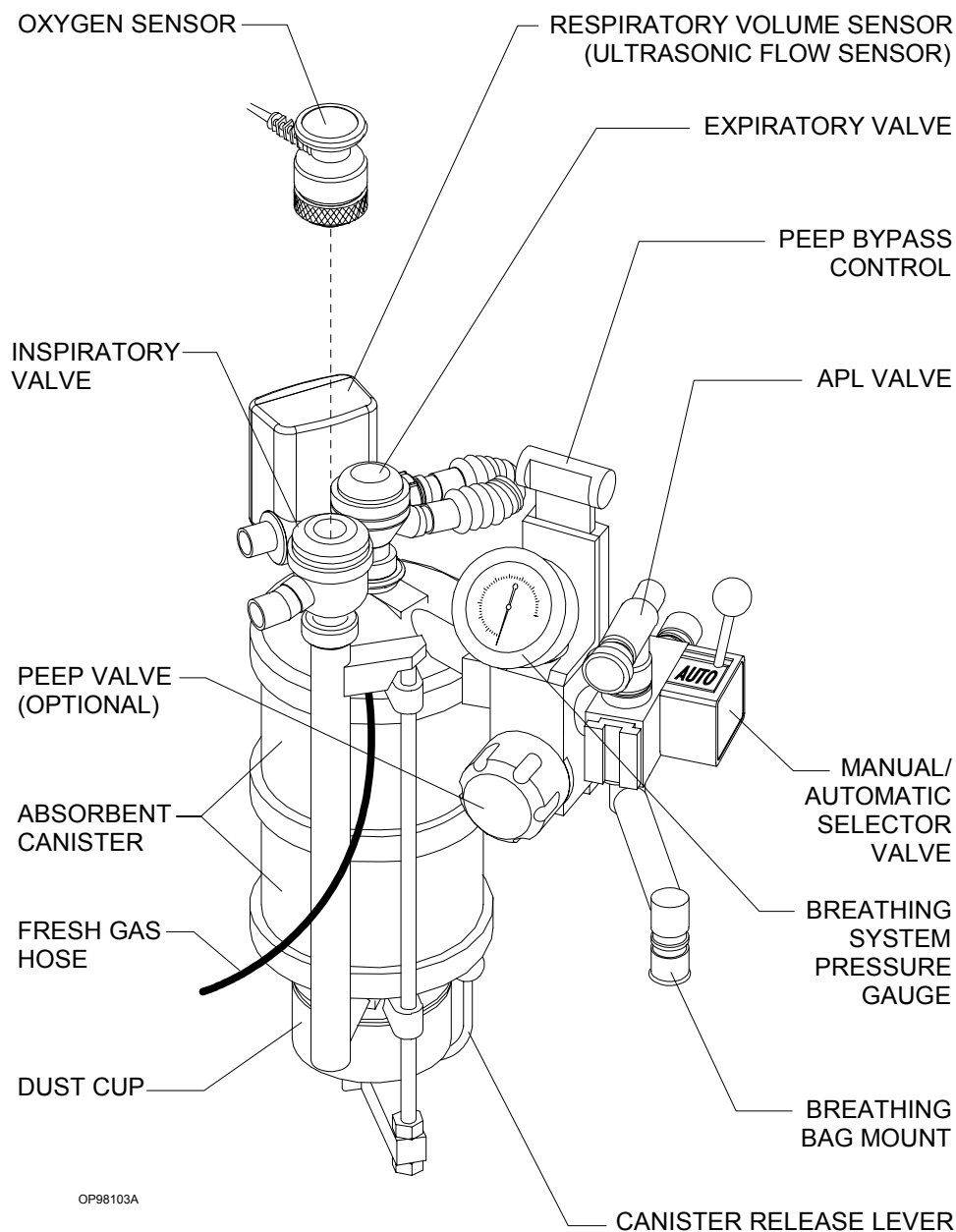




## Absorber

The absorber is a dual-canister system for absorbing exhaled carbon dioxide in the rebreathing circuit of the anesthesia machine. It incorporates an adjustable pressure limiter (APL) valve, a breathing system pressure gauge, a fresh gas line, and connections for sensing the following: breathing pressure, respiratory volume, frequency, and oxygen concentration. The absorber system is shown in Figure 2-7.

Figure 2-7. Absorber



The absorber system permits spontaneous, manually assisted, or automatic ventilation of the patient. The absorber incorporates a manual/automatic selector valve, which allows you to select either manual or automatic ventilation. An absorber with a positive end expiratory pressure (PEEP) valve is also available.

**WARNING:** Waste gas scavenging systems used with Draeger Medical absorber systems must have safety features to ensure that excessive subatmospheric pressure (lower than  $-0.5$  cm H<sub>2</sub>O) and excessive positive pressure (higher than  $+0.5$  cm H<sub>2</sub>O) are not possible at the connection point.

### Inspiratory and Expiratory Valves

The inspiratory and expiratory valves, labeled INSPIRATION and EXPIRATION, respectively, control the direction of gas flow in the absorber system. The valves are unidirectional, meaning that they permit gas to flow in one direction only.

- The inspiratory valve allows gas to flow toward the patient only, with no backflow to the absorber.
- The expiratory valve allows gas to flow to the absorber only, with no backflow to the patient.

The valves are *not* interchangeable. They must be connected to the correct mounts (inspiratory valve to inspiratory mount, expiratory valve to expiratory mount) to ensure the proper flow direction through the absorber system. Different size mounting threads on each valve prevent connection of a valve to the wrong mount.

**WARNING:** Do not use the inspiratory or expiratory valve if any one of these problems occurs:

- A pin in the valve body or plastic valve dome is bent, damaged, or missing.
- The valve disk is missing or damaged.
- The valve seat is damaged.

### Canisters

Each absorber unit contains two interchangeable transparent plastic canisters which house the absorbent. The absorbent, soda lime or barium hydroxide lime, can be purchased in either loose granular or prepacked cartridge form.

### Dust Cup

A removable, transparent plastic cup below the bottom assembly collects absorbent dust and excess moisture which could cause increased flow resistance in the system.

**Breathing  
System  
Pressure  
Gauge**

The absorber system is equipped with a pressure gauge to enable quick visual determination of breathing circuit pressure. The gauge is marked for measurements from -20 to +80 cm H<sub>2</sub>O in increments of 2 cm H<sub>2</sub>O.

**WARNING:** Frequent observation of the breathing system pressure gauge is mandatory to ensure adequate pressure buildup and relief, regardless of the mode of operation.

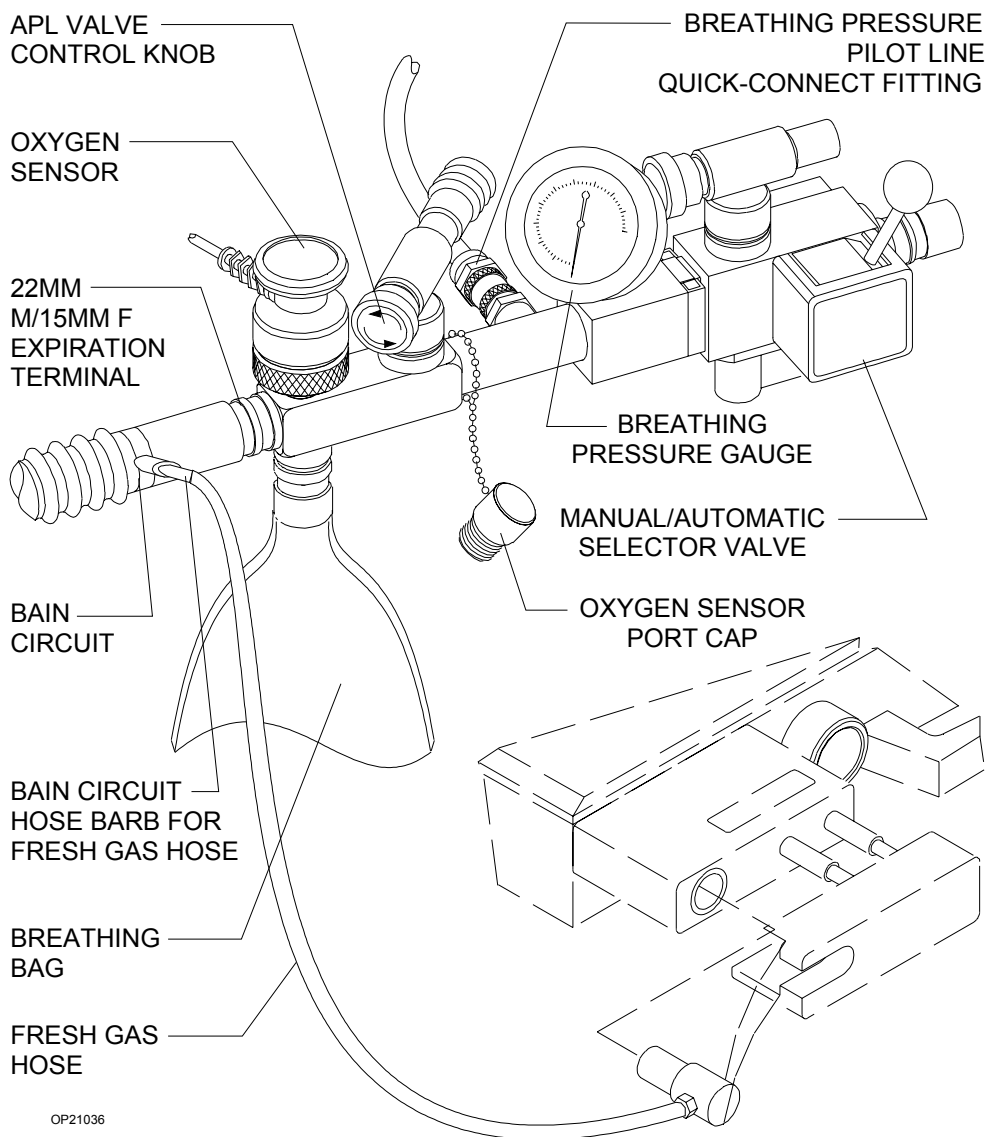
## Bain Circuit Adapters

Two types of Bain circuit adapters are available. One mounts to the absorber; the other mounts to the absorber pole.

### Absorber Mount

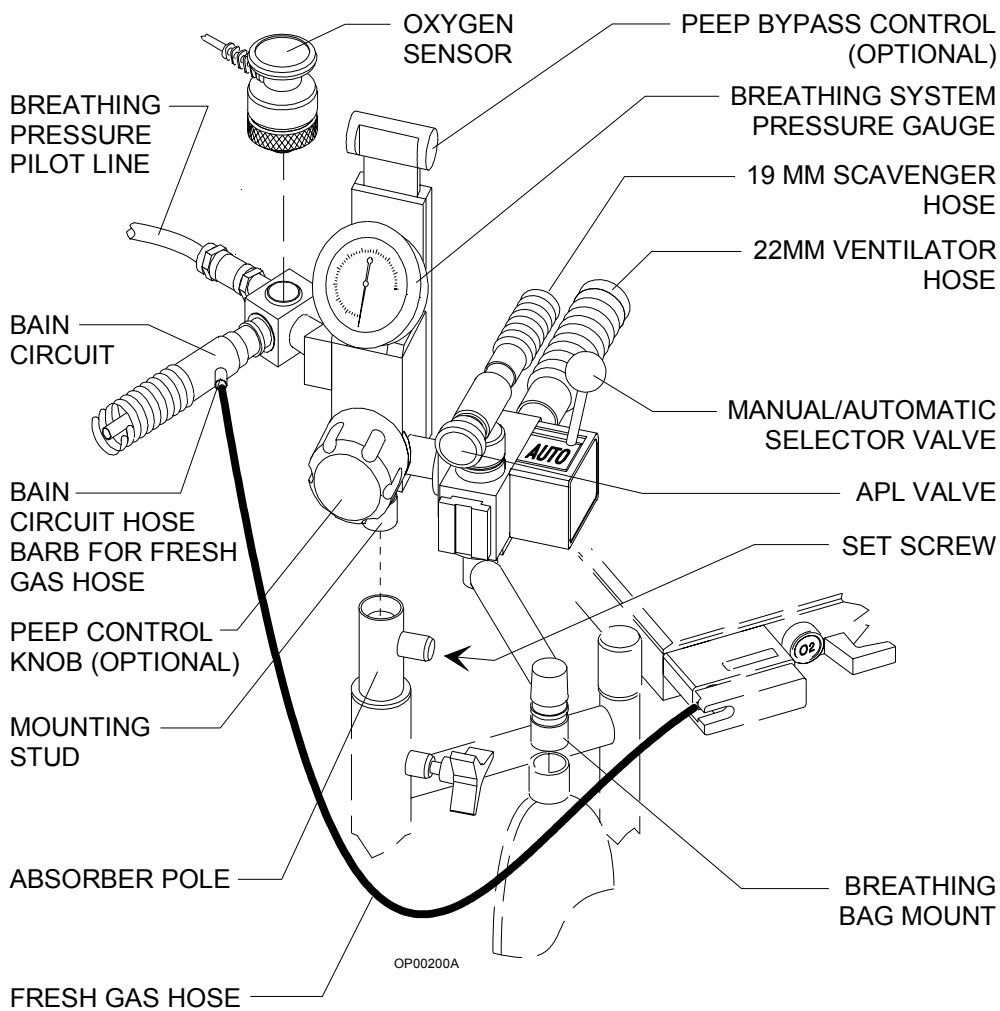
The absorber-mounted Bain circuit adapter, shown in Figure 2-8, mounts onto the manual/automatic selector valve of the absorber system. The adapter includes an adjustable pressure limiter (APL) valve, a breathing pressure gauge, a quick-connect fitting for the breathing pressure pilot line, a port for the oxygen sensor, a 15/22 mm port for non-rebreathing circuits, and a connector for a patient breathing bag.

Figure 2-8. Absorber Mount Bain Circuit Adapter



**Pole Mount** The pole-mounted Bain Circuit adapter, shown in Figure 2-9, mounts on the absorber pole. It may be supplied with or without a positive end-expiratory pressure (PEEP) valve.

Figure 2-9. Pole Mount Bain Circuit Adapter



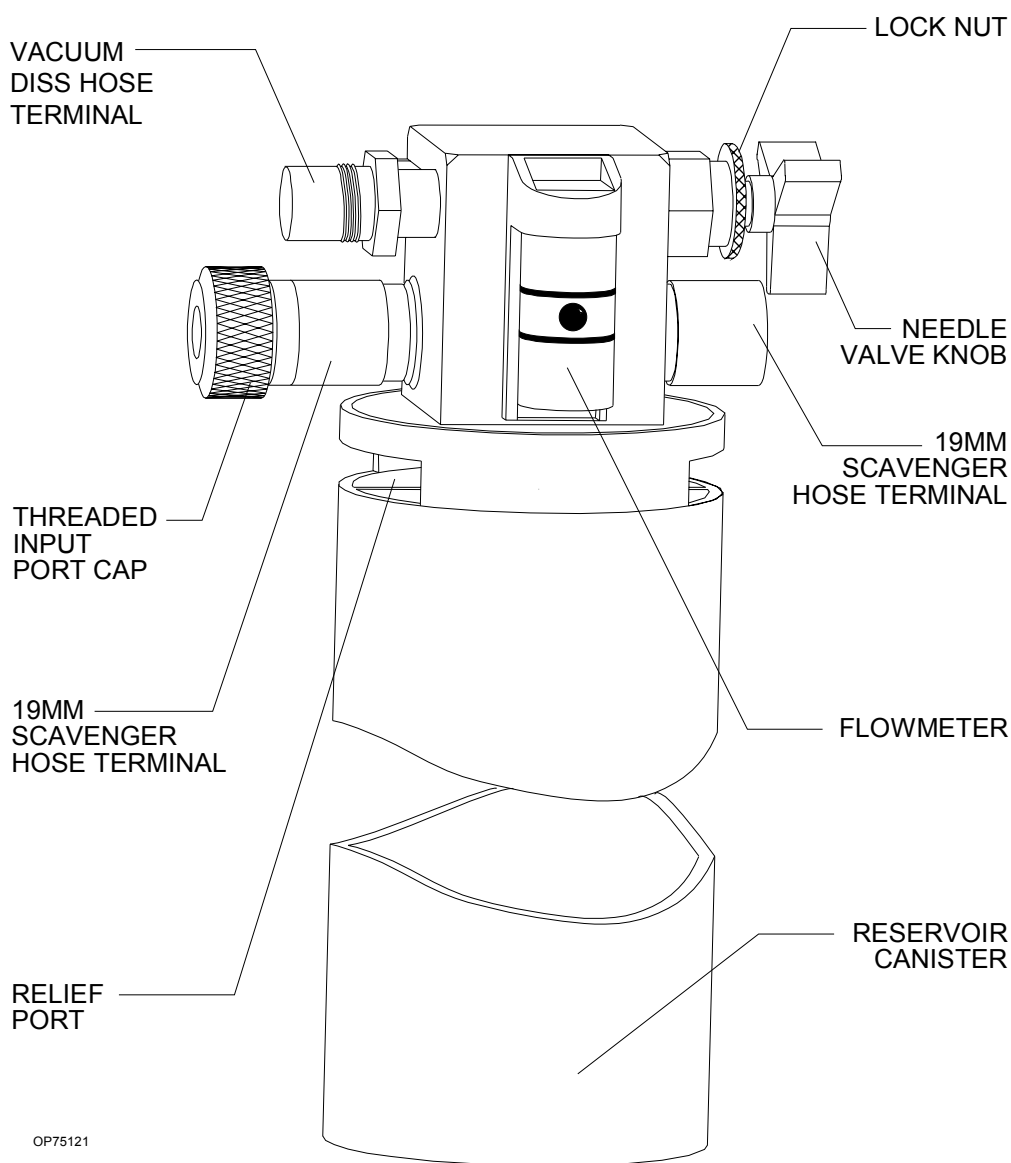
## Scavenger Systems

The Narkomed GS can be equipped with one of two kinds of scavenger systems, permitting the best match with the hospital's waste gas disposal system.

### Open Reservoir Scavenger

The open reservoir scavenger is used with suction (vacuum) waste gas disposal systems. This scavenger is an "open" system, featuring continually open relief ports to provide positive and negative pressure relief. The open reservoir scavenger is shown in Figure 2-10.

Figure 2-10. Open Reservoir Scavenger

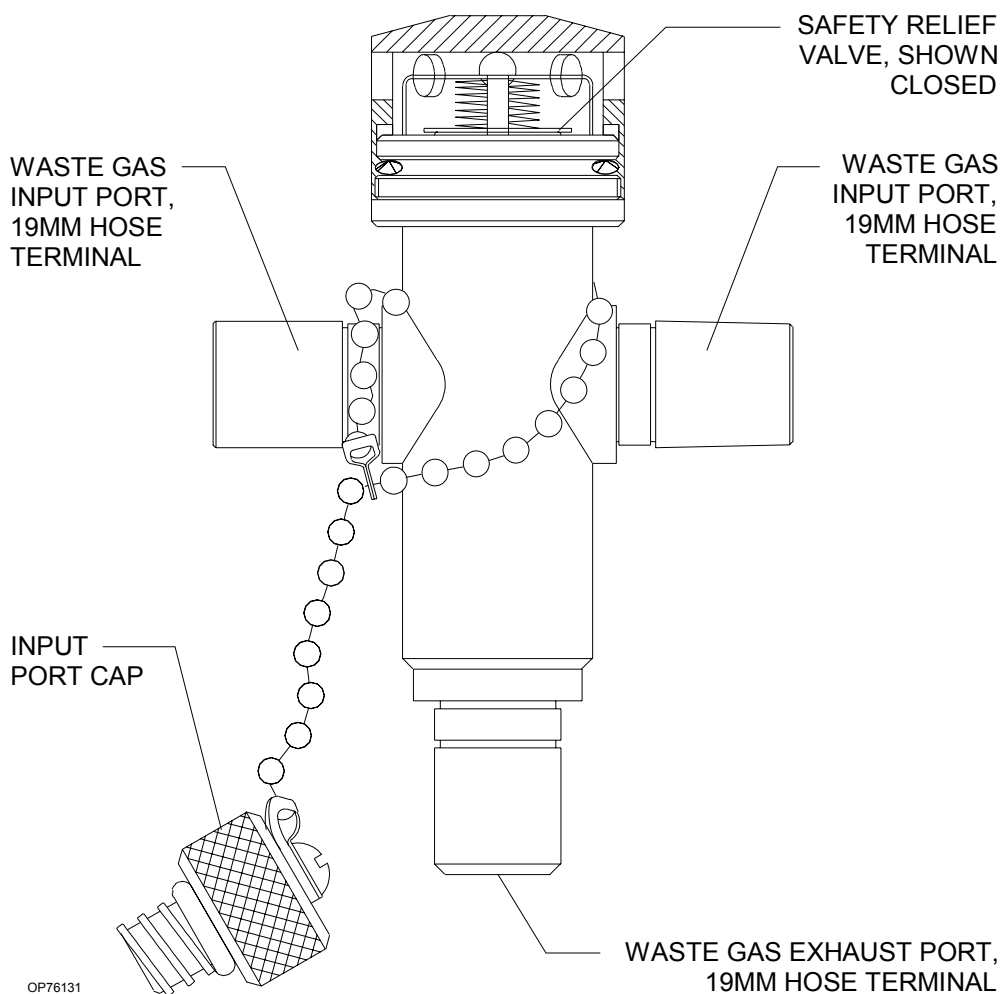


**Scavenger Interface for Passive Systems**

The scavenger interface for passive systems is used with non-recirculating HVAC systems (also called exhaust systems). This scavenger is a “closed” system, using a spring-loaded valve for positive pressure relief. See Figure 2-11.

**WARNING:** Do not use this device with a waste gas disposal system capable of applying a negative pressure to the scavenger interface (a suction or vacuum waste gas disposal system).

Figure 2-11. Scavenger Interface for Passive Systems



## AV2+ Ventilator

The AV2+ anesthesia ventilator is a volume preset, time cycled, pressure limited ventilator with electronic timing, pneumatic circuitry and independent controls for frequency, inspiratory to expiratory (I:E) ratio, inspiratory flow rate, tidal volume, and inspiratory pressure limiting.

Pneumatic power (bellows drive gas) to the ventilator is supplied through the hospital pipeline supply or through reserve cylinders on the anesthesia machine. The pressure of the supply gas must be between 40 and 60 psi. The ventilator will not function properly if this pressure drops below 32 psi. Electrical power is supplied by the Narkomed GS's AC power source, or, in event of AC power failure, by the backup battery. A fully charged battery can power the ventilator for approximately 30 minutes.

The anesthesia ventilator is designed for use with a Draeger Medical absorber system, which incorporates a manual/automatic selector valve. This valve allows you to select either the breathing bag and adjustable pressure limiter (APL) valve for manual ventilation, or the ventilator bellows for automatic ventilation.

During automatic ventilation, the manual/automatic selector valve isolates the absorber's APL valve from the breathing system. To compensate for the continuous introduction of fresh gas into the breathing system, the ventilator incorporates a relief valve mounted behind the bellows chamber.

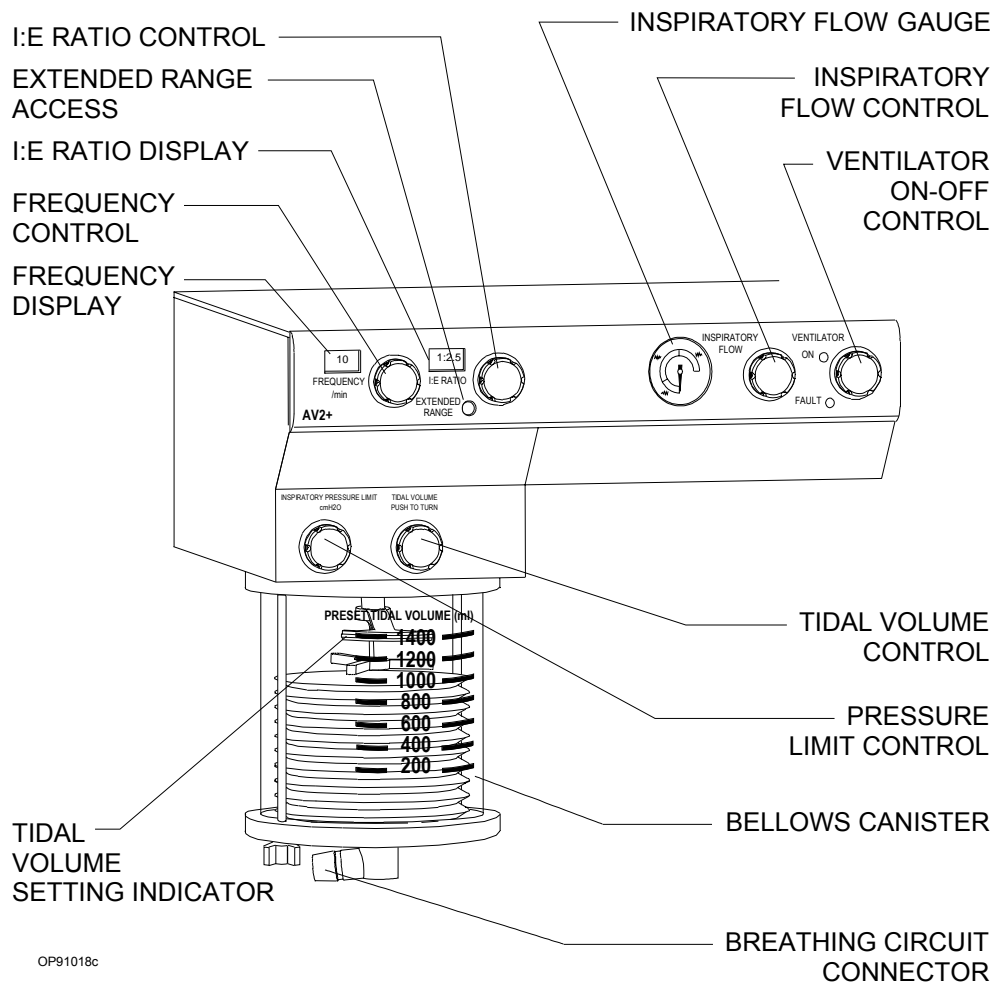
When the bellows is completely filled, any excess gas in the system is released to the scavenging system through the ventilator relief valve. As in any ascending bellows, the force needed to overcome gravity acting on the bellows causes a positive end-expiratory pressure (PEEP) within the breathing system. For the Narkomed GS, the PEEP is approximately 2 cm H<sub>2</sub>O.

The pressure limit control allows you to set the peak inspiratory pressure produced by the ventilator in order to help prevent barotrauma. The pressure limit control can also improve ventilation for patients with reduced lung compliance (neonatal/pediatric patients and patients with adult respiratory distress syndrome), because it limits the peak inspiratory pressure during the inspiratory phase of ventilation.

The AV2+ ventilator is shown in Figure 2-12.



Figure 2-12. AV2+ Ventilator

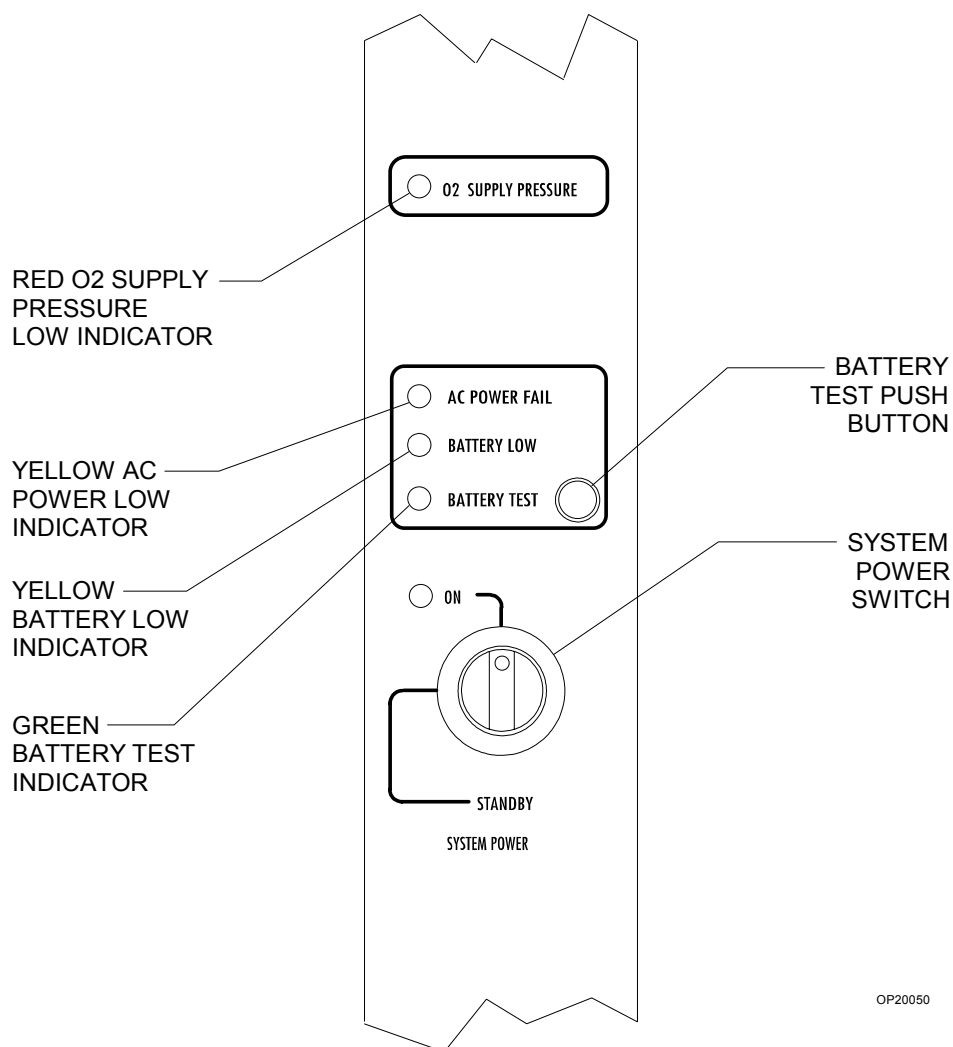


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## Main Switch Panel

The main switch panel, shown in Figure 2-13, is located between the ventilator bellows and flowmeter bank.

Figure 2-13. Main Switch Panel



### System Power Switch

The SYSTEM POWER switch on the Narkomed GS has two positions: ON and STANDBY. In the ON position, the gas (pneumatic) and electric power circuits are actuated, and the green LED indicator adjacent to the switch illuminates. In the STANDBY position, the switch shuts down the gas supplies, the monitoring system, and all electrical power to the machine except the convenience receptacles and battery charging circuit.

**AC Power Failure Indicator** The yellow AC POWER FAIL LED signals a disruption of AC power. The LED is illuminated whenever the battery supplies power to the monitoring system and the electronic ventilator. A three-pulse tone also sounds every 30 seconds. If the anesthesia machine's backup battery is completely discharged, the AC power failure indicator does not have power and will not function.

**Oxygen Supply Pressure Alarm** The oxygen supply pressure alarm is activated when the oxygen supply pressure in the system falls below approximately 37 psi. When the alarm is activated, the red O<sub>2</sub> SUPPLY PRESSURE indicator on the main switch panel lights. In addition, the Caution message O<sub>2</sub> SUPPLY LOW appears on the alarm display, and an intermittent audible alarm sounds. Depending on the anesthesia machine's configuration, a 7-second whistle may also sound.

**NOTE:** When one source of oxygen pressure (either pipeline or reserve cylinders) fails, but the other source is able to maintain proper pressure within the machine's oxygen supply lines, the oxygen supply pressure alarm is not activated.

## Power Supply System

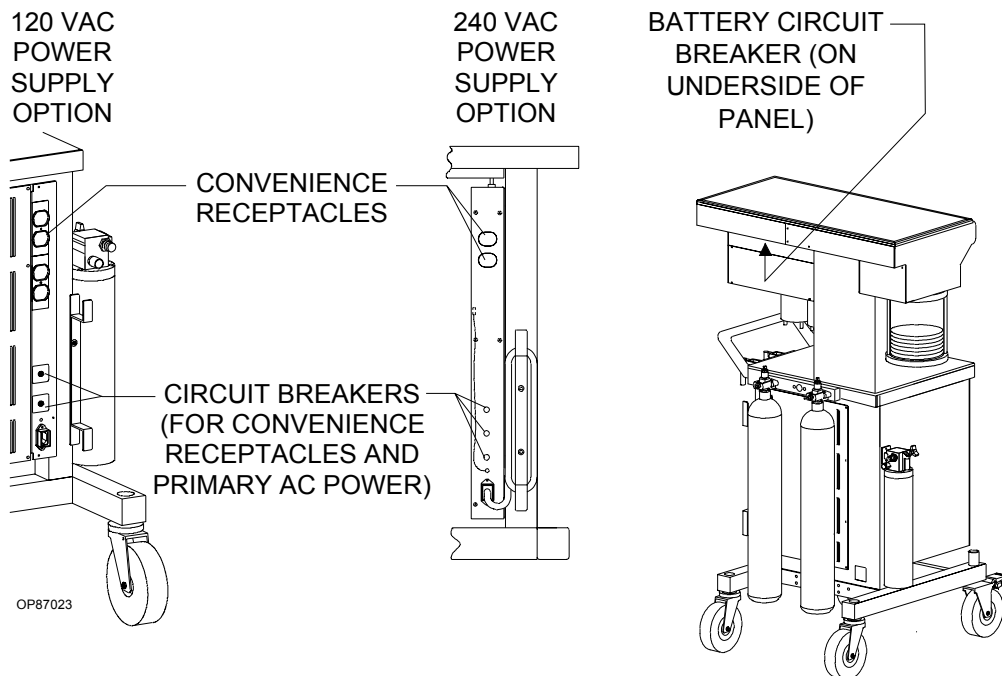
The Narkomed GS is equipped with a central power supply for the ventilator, alarm system, and monitoring system. When in use, the Narkomed GS must be plugged into an AC outlet.

**Convenience Receptacles** The Narkomed GS can be equipped with convenience receptacles, mounted vertically on the lower rear of the anesthesia machine (see Figure 2-14). Machines with the 120 VAC power supply can be equipped with four 120 VAC 50/60 Hz North American receptacles. Machines with the 240 VAC power supply can be equipped with two CEE7 receptacles. The receptacles are active whenever the Narkomed GS is plugged into an outlet, whether or not the machine is turned on.

The total current for devices plugged into the receptacles must not exceed 7 amps (for the 120 VAC power supply) or 5 amps (for the 240 VAC power supply). The convenience receptacle circuit is protected by separate circuit breaker(s). This circuit also incorporates an EMI filter, which minimizes interference to the anesthesia machine from devices plugged into the convenience receptacles.

**CAUTION:** Devices plugged into the convenience receptacles contribute to the anesthesia system's total leakage current. The total leakage current (for system and external devices combined) must not exceed 300 microamps.

Figure 2-14. Power Supply System



**Circuit Breakers**

The electrical system includes magnetic circuit breakers to protect machine functions. One circuit breaker is for backup battery power and is located at the rear of the machine on the underside of the display box. The other circuit breakers are located below the convenience receptacles, on the lower rear of the anesthesia machine: the bottom one is for primary AC power input and the top one (two with the 240 VAC power supply) is for the convenience receptacles. See Figure 2-14.

When the plunger is flush with the surface of its base, the circuit breaker is in its normal, closed position. A circuit breaker is open (tripped) when its plunger extends beyond its base. If a breaker is tripped, the cause must be found and corrected before using the anesthesia system.

**Backup Battery System**

The backup battery system consists of a rechargeable battery and a built-in battery charging system.

Although most hospitals have emergency generators to supply AC power when line power fails, a delay may occur before generator power comes on-line. The backup battery system automatically provides power between the time that line power fails and the emergency power system is activated. The backup battery also provides power if the anesthesia machine's power cord is accidentally unplugged during a case.

**Machine  
Functions on  
Backup  
Battery  
Power**

When the hospital's emergency generator comes on-line (or when a disconnected power cord is reconnected), the Narkomed GS automatically switches back to AC power and recharges its battery. The battery charging system charges the battery any time the power cord is connected to an active AC power source. The charger can recharge a fully discharged battery in approximately 12 hours.

If the machine is receiving AC power, but the battery voltage level is low due to a problem with the battery charging circuit or similar hardware malfunction, the Advisory message RESERVE BATT LOW appears on the alarm display.

If the hospital's primary AC power fails, the backup battery system is activated. All monitoring functions will continue for approximately 20 minutes if the battery is fully charged.

The following events signal activation of the backup battery system:

- The yellow AC POWER FAIL indicator on the anesthesia machine's alarm panel comes on.
- The Caution message AC POWER FAIL appears on the alarm display.
- A three-pulse pattern audio alarm sounds every 30 seconds.

When the battery reserve approaches depletion following an AC power loss:

- The yellow BATTERY LOW main switch panel indicator illuminates.  
**NOTE:** The BATTERY LOW indicator will only illuminate during an AC power loss when battery reserves are low.
- The Caution message AC BATTERY FAIL appears on the alarm display.

These alarms signify that approximately 10 minutes of backup battery power remains.

The gas supply system remains operative. However, since the ventilator is inoperative when battery power is cut off, you must perform manual ventilation by bag. The machine cannot provide monitoring or alarm functions until AC power is restored.

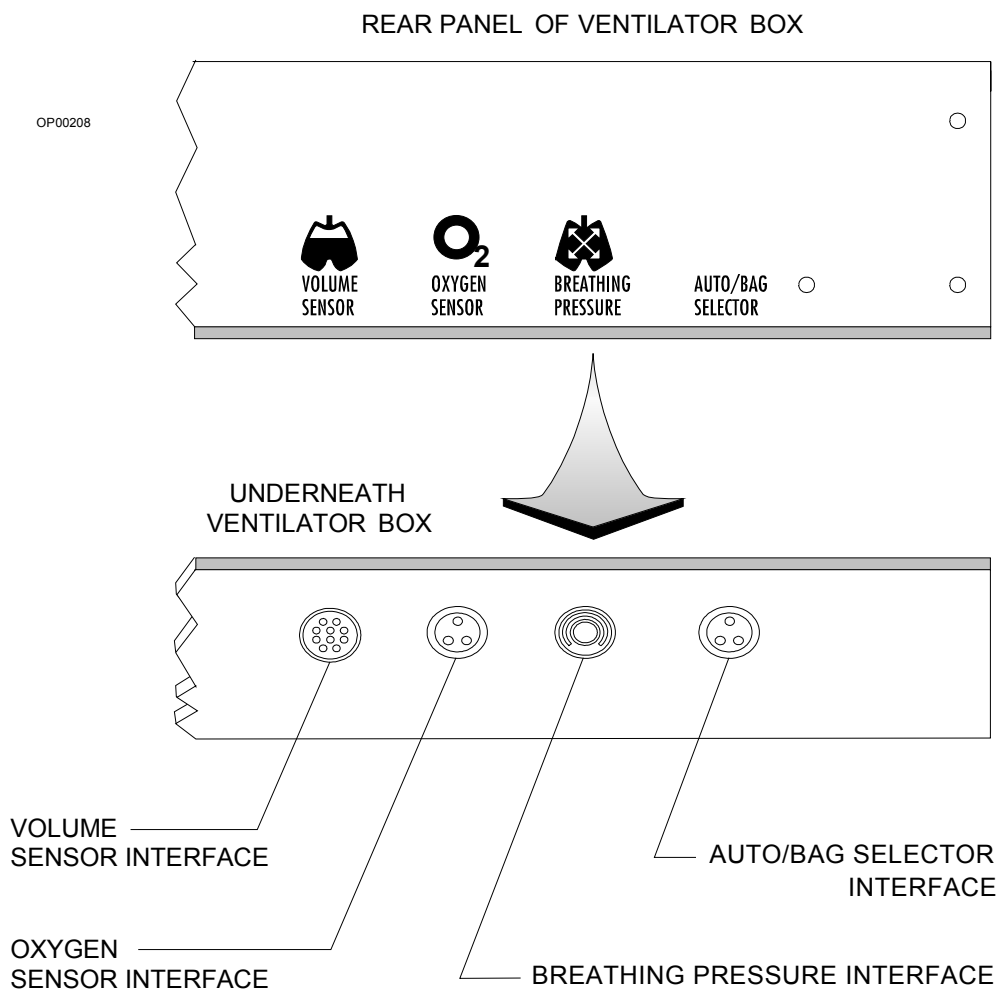
**NOTE:** If the Narkomed GS's power cord is not plugged into an active AC outlet for a period of 30 days or more, the backup battery may become depleted. Plugging the power cord into an active AC outlet for approximately 12 hours will recharge a depleted battery.

## Sensor Interfaces

Four sensor interfaces are located underneath the rear panel of the ventilator box as shown in Figure 2-15.

- A VOLUME SENSOR interface for the respiratory volume sensor cord
- An OXYGEN SENSOR interface for the oxygen sensor cord
- A BREATHING PRESSURE interface for the breathing pressure pilot line
- An AUTO/BAG SELECTOR interface for the manual/automatic selector valve interface cable

Figure 2-15. Sensor Interfaces



## Monitoring System

The anesthesia machine's monitoring system integrates the functions of the electronic monitors and organizes information from these monitors onto the screen, which is located on the front panel of the machine.

The Narkomed GS monitors the following measurements:

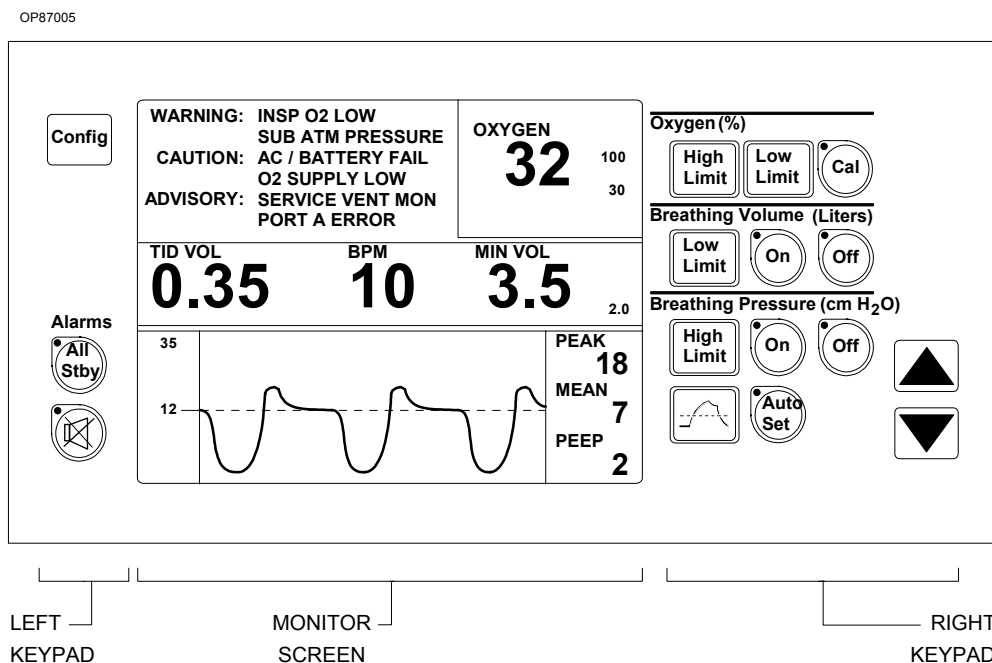
- oxygen concentration
- breathing pressure
- respiratory volume

The anesthesia machine also monitors key anesthesia system functions, such as oxygen supply pressure and backup battery status.

## Monitor Screen and Controls

All monitoring data and alarm messages are shown on the machine's monitor screen. The control keys on either side of the screen allow you to establish monitoring settings. With the left keypad, you can control system-wide settings, such as alarm annunciation and monitor configuration. With the right keypad, you can control settings for specific monitors: oxygen concentration, breathing pressure, and respiratory volume. See Figure 2-16.

Figure 2-16. Monitor Screen and Controls



## Alarm System

Alarms are organized into three categories, depending on the urgency of the alarm condition.

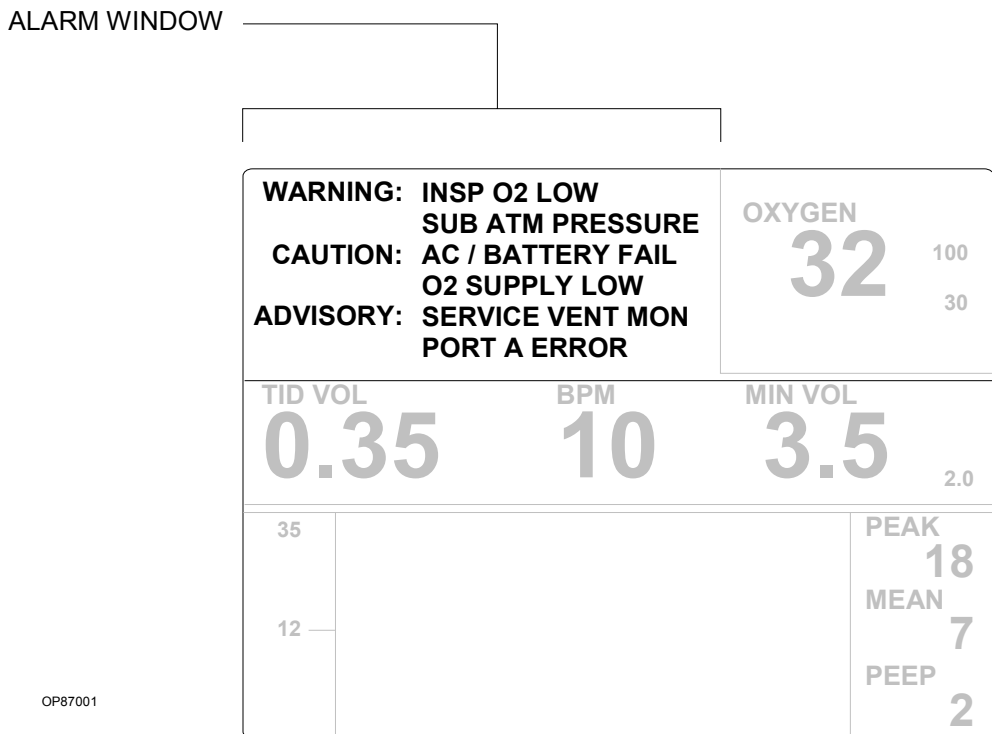
- **Warnings** - the highest priority alarms requiring an immediate response.
- **Cautions** - second priority alarms requiring a prompt response.
- **Advisories** - the lowest priority alarms requiring the operator's awareness

The Narkomed GS provides both visual and audible notification of the most urgent conditions.

## Alarm Display

The Narkomed GS presents messages for active alarm conditions in the Alarm window at the top of the monitor screen as shown in Figure 2-17. Messages are displayed for up to six of the highest priority active alarm conditions. Any additional, lower priority active alarm conditions are retained in the monitor's memory. Messages for these lower priority conditions are displayed when the higher priority alarm conditions have been resolved and their messages have been removed from the display.

Figure 2-17. Alarm Display





**NOTE:** If a warning or caution message is removed from the Alarm window before you have a chance to read it, you can view the message in the Alarm Log. The Alarm Log is a separate screen that displays a sequential record of up to 100 of the most recent warning and caution messages. For more information, see “Using the Alarm Log” on page 11-8.

### Alarm Annunciation

Each alarm category is associated with a specific audible signal.

- **Warnings** - a three-pulse tone pattern that is initially repeated every few seconds in a series of descending volume, and then constantly at full volume until the alarm condition is resolved.
- **Cautions** - a three-pulse tone pattern that is repeated every 30 seconds.
- **Advisories** - a single tone or no sound at all, depending on the urgency of the advisory.

Only the highest-priority, currently active alarm condition is annunciated. Tones for lower-priority alarm conditions are temporarily suppressed to minimize the confusion caused by simultaneous alarms.

If the primary speaker on the Narkomed GS fails, a backup speaker is activated. The backup speaker has a tinny sound to distinguish it from the primary speaker. Another indication of the failure of the primary speaker is the appearance of the Advisory message SPEAKER FAIL on the alarm display.

### Ventilation Alarms

When the system power switch is turned from STANDBY to ON, the volume and pressure apnea alarms default to Standby to allow machine setup without nuisance alarms. An interlock with the ventilator ensures that when the ventilator is turned on, the alarms are enabled. You can also enable the alarms individually using the keypad.

When the ventilator is turned off, the following events occur:

- If the pressure apnea threshold was greater than 15 cm H<sub>2</sub>O when the ventilator was turned off, the threshold setting is changed to 15 cm H<sub>2</sub>O. (If the pressure apnea threshold was less than 15 cm H<sub>2</sub>O when the ventilator was turned off, the threshold retains its setting.)
- The Cautions and Warnings associated with apnea alarms change from activation after 15 and 30 seconds of apnea to 30 and 60 seconds, respectively.

When the ventilator is turned back on, the pressure apnea threshold is restored to its previous set value and the apnea alarms revert to activation after 15 seconds (caution) and 30 seconds (warning) of apnea.

### **Manual Sphygmomanometer (optional)**

Noninvasive blood pressure can be measured with the manual sphygmomanometer. Several cuff sizes are available to accommodate varying patient requirements.

# 3

## Daily Checkout Procedure

*This section describes the daily checkout procedure that you are to perform on the Narkomed GS anesthesia machine.*

Daily Checkout Procedure ..... 3-2

## Daily Checkout Procedure

Before operating the Narkomed GS, the following checkout procedure must be performed to make sure the machine is ready for use. This is a recommended procedure. Follow your institution's policies for specific checkout procedures. If the anesthesia system fails any procedures identified by an asterisk (\*), do not use the machine. Contact a Draeger Medical qualified technical service representative for inspection of the unit.

**NOTE:** Do not insert any additional components into, or modify, the anesthesia system after the checkout procedure is started.

### Initial Setup and Verification

1. Enter the serial number located on the right rear leg into the anesthesia record.
2. Make sure there is a valid inspection sticker on the back of the machine indicating that the anesthesia machine was serviced and inspected by a Draeger Medical qualified technical service representative.
3. Verify that a cylinder wrench is tethered to the back of the machine next to one of the cylinders.
4. If the anesthesia machine is not already plugged in, connect the electrical power cable to an active AC outlet that accepts and properly grounds the power cable. **Do not** use “cheater” plugs. The term “cheater” plug implies any and all electrical plugs or other devices that can inhibit or prohibit the proper grounding of the anesthesia machine.

### System Software Diagnostics

5. \* Turn the SYSTEM POWER switch to the ON position. Wait for the machine to complete its diagnostic checks. Make sure the system is functional.

### Battery Power Verification

6. \* Check the reserve battery power. Remove the power plug from the outlet. Press the BATTERY TEST button on the main switch panel. The green indicator to the left of the test button must light. The yellow BATTERY LOW indicator must remain unlit. Plug the power cable back into the electrical outlet.

**NOTE:** This test assumes that the anesthesia machine has been plugged in for 12 hours. The battery charging system works only when the machine is connected to an active AC power source. The charging system takes about 12 hours to charge a fully discharged battery.

### Emergency Ventilation Equipment Verification

7. \* Verify that backup ventilation equipment is available and functional.

**High  
Pressure  
System  
Verification**

8. \* Check the oxygen cylinder supplies.
  - a. Disconnect all pipeline gas supply hoses and drain the system.
  - b. Close the oxygen cylinder valve and remove the cylinder from the yoke. Verify that there is one cylinder gasket and there are two index pins. Verify that the cylinder matches the yoke label. Place the cylinder back in its yoke.
  - c. Open an oxygen cylinder and check the cylinder pressure gauge. A full oxygen cylinder registers about 1900 psi. Replace any cylinder with pressure less than 1000 psi. To check for a high pressure leak, close the cylinder and observe the cylinder pressure gauge for a prominent decrease in the pressure.
  - d. If the machine is equipped with dual oxygen yokes, repeat these procedures for the other cylinder yoke.
9. \* Check the nitrous oxide cylinder supplies.
  - a. Close the nitrous oxide cylinder valve and remove the cylinder from the yoke. Verify that there is one cylinder gasket and there are two index pins. Verify that the cylinder matches the yoke label. Place the cylinder back in its yoke.
  - b. Open the nitrous oxide flow control valve until the nitrous oxide pipeline and cylinder pressure gauges indicate zero pressure. Open a nitrous oxide cylinder and check the cylinder pressure gauge. A full nitrous oxide cylinder registers about 745 psi. Replace any cylinder with a pressure less than 600 psi. To check for a high pressure leak, close the cylinder and observe the cylinder pressure gauge for a prominent decrease in the pressure.
  - c. If the machine is equipped with dual nitrous oxide cylinder yokes, repeat these procedures for the other cylinder yoke.
10. \* Check additional (optional) gas cylinder supplies.
  - a. With the cylinder closed, open the flow control valve of the associated gas until the cylinder and pipeline pressure gauges (air only) indicate zero pressure.
  - b. Close the cylinder valve and remove the cylinder from the yoke. Verify that there is one cylinder gasket and there are two index pins. Verify that the cylinder matches the associated yoke label. Place the cylinder back in its yoke.

- c. Open the associated flow control valve until the cylinder pressure gauges indicate zero pressure. Open the cylinder and check the cylinder pressure gauge. Replace the cylinder if its contents are insufficient for the intended procedure. To check for a high pressure leak, close the cylinder and observe the cylinder pressure gauge for a prominent decrease in the pressure.

**NOTE:** After testing all of the gas circuits, drain the oxygen circuit by closing the oxygen cylinder and actuating the oxygen flush button on the front of the anesthesia machine. Hold the button in until the pressure gauges indicate no pressure.

Table 3-1 shows the full and minimum pressures (E-size cylinders at 70°F, 21°C) for all gases available for the anesthesia machine.

**Table 3-1. Full and Minimum Cylinder Pressures**

<b>GAS</b>	<b>PSI - FULL*</b>	<b>PSI - MIN</b>
Air	1900	1000
Carbon Dioxide	838	600
Nitrous Oxide	745	600
Oxygen	1900	1000

\*typical full load

**Pipeline  
Supply  
System  
Verification**

11. \* Pipeline Supply Verification

- a. Inspect the supply hoses for cracks or wear.
- b. Connect the appropriate hospital pipeline supply hoses from the wall outlet fittings to the pipeline inlet connectors.
- c. Check for sufficient pipeline pressure readings for each gas on the pipeline pressure gauges located below the flow control valves. The pressure for each gas must be between 50–55 psi. Open the flow control valve for each gas to a moderate value. The pressure indicated at the pipeline pressure gauge must not decrease more than 5 psi.
- d. Verify that the correct gases are supplied to the anesthesia machine inlets.

**Low Pressure  
System  
Verification**

12. \* Vaporizer Verification

- a. Check for sufficient supply of liquid anesthetic in the vaporizer(s). The liquid level indicated in the vaporizer sight glass must be between the minimum and maximum markings.

- b. Make sure the fill and drain valves are completely closed.
- c. Check the vaporizer exclusion device, which prevents more than one vaporizer from being activated simultaneously. Make sure that when one vaporizer handwheel is turned to a setting greater than 0, the others remain locked in their 0 positions. Test all of the vaporizer positions. Then, turn all vaporizers to the 0 position.

**System Gas  
Circuit  
Verification**

13. \* Check the flowmeters. Adjust the flow control knob for each gas and verify the proper operation of the corresponding flowmeters. The float must move freely over the full range of each flowmeter.

**Oxygen  
Monitor  
Calibration**

14. \* Calibrate the oxygen monitor by exposing the sensor to ambient air and activate the calibration key. (See “Calibrating the Oxygen Sensor” on page 12-4 for more information.)
- a. Place the oxygen sensor securely in the sensor mount.
  - b. Verify that the correct gas concentrations are supplied to the anesthesia system from the supply cylinders.
  - c. Close the cylinder supplies and deplete the pressure from the system.

**OFPD  
Verification**

15. \* Check the oxygen failure protection device. With all gases available on the machine set to a flow of about 4 l/min, close the oxygen supply by disconnecting the oxygen pipeline supply hose and closing the oxygen cylinder(s). The flow of all other gases indicated by their flowmeters must decrease in proportion to the decrease in oxygen flow and eventually shut off.

**ORC  
Verification**

16. \* Check the function of the ORC. With the nitrous oxide flow control valve open to a flow of 10 l/min, vary the oxygen flow with the oxygen flow control valve. The nitrous oxide flow indicated on the nitrous oxide flowmeter must automatically vary in response to the adjustment of the oxygen flow control valve.

The ORC must maintain a fresh gas oxygen/nitrous oxide flow ratio of at least 25 ±4% oxygen.

**NOTE:** When the nitrous oxide flow control valve is open and oxygen is flowing at a minimum rate (150–200 ml/min), nitrous oxide flows at approximately 500 ml/min.

**Oxygen  
Flush  
Verification**

17. \* Check the oxygen flush:
- a. Press the oxygen flush button and listen for an audible gas flow sound, accompanied by a marked increase in oxygen concentration in the breathing system.

- b. Check the delivered oxygen concentration. Repeatedly flush the patient breathing system by pressing the oxygen flush button. Open the oxygen flow control valve to a flow of 8 l/min and close the other flow control valves. The oxygen measurement display area should indicate 97% to 100% oxygen concentration.

**Fresh Gas Verification**

- 18. \* Make sure all vaporizers are closed. Open the oxygen flow control valve to an 8 l/min flow and close all other flow control valves. Sniff the gas coming from the fresh gas common outlet. There should be no noticeable odor.

**Bain Circuit Adapter Verification**

- 19. \* Verify that the inner tube of the Bain circuit is intact and not occluded. First deliver a flow of oxygen to the Bain circuit through the fresh gas hose. Then occlude the inner tube of the Bain circuit. The oxygen flowmeter float should drop in response to the occlusion.

As an alternate test, press the oxygen flush button with the Bain circuit's patient port open to the atmosphere. The high flow of gas through the Bain circuit's inner tube will draw in gas from the outer tube. As a result, the breathing bag should deflate. If the breathing bag does not deflate or it inflates, the fresh gas hose or inner tube may be improperly connected.

**Absorber System Verification**

- 20. \* To check the absorber system:
  - a. Check the hose connections in the breathing system.
  - b. Make sure the fresh gas hose of the breathing system is securely connected to the fresh gas outlet.
  - c. Make sure a 22 mm patient breathing circuit is connected between the inspiratory valve and the expiratory hose terminal on the ultrasonic flow sensor.
  - d. Make sure a 22 mm breathing hose is connected between the ventilator hose terminal and the manual/automatic selector valve breathing hose terminal.
  - e. Make sure a breathing bag of proper capacity and appropriate construction is connected to the breathing bag terminal of the breathing system.
  - f. Make sure the breathing pressure pilot line is properly connected between the BREATHING PRESSURE interface and either the absorber quick-connect fitting or the appropriate fitting at or near the patient Y-piece.
  - g. Make sure the oxygen sensor and flow sensor are properly installed.



21. \* Make sure the absorber canisters are filled with CO<sub>2</sub> absorbent. Consult the absorbent manufacturer's literature for information on what signs to expect when the absorbent is exhausted. Replace the absorbent when it appears exhausted. Make sure that the color change represents the absorbent's true state of depletion and is not due to regeneration after a rest period. Flushing the anesthesia machine continuously with 100% oxygen for at least one minute before the first case of the day is recommended.

Remove accumulated absorbent dust and water from the absorber dust cup.

**WARNING:** Absorbent is caustic and is a strong eye, skin, and respiratory tract irritant. When emptying the absorber dust cup, take care not to spill its caustic contents.

**NOTE:** When changing the CO<sub>2</sub> absorbent, take care not to chip or crack the absorbent canister. Check the canister for signs of damage, especially along the rim, before reinstallation.

22. Close all vaporizers and flow control valves. Check for free gas passage in the patient breathing system. Wear a surgical mask to inhale and exhale through the breathing system (each limb individually, if possible). Verify the unidirectional flow in each limb and then reconnect the tubing.

#### APL Valve

23. \* Check the APL valve to be sure it can relieve excess gas from the breathing system into the scavenger system.

To check the APL valve's flow resistance:

- a. Set the manual/automatic selector valve to BAG.
- b. Remove the bag from the swivel arm bag mount.
- c. Interconnect the inspiratory valve and the expiratory hose terminal on the ultrasonic flow sensor with a 22 mm hose.
- d. Completely open the APL valve by turning the control knob fully counterclockwise to its stop position.
- e. Turn the SYSTEM POWER switch to ON.
- f. Open the oxygen flow control valve to a flow of 8 l/min.
- g. Occlude the bag mount opening and watch for a pressure increase on the breathing system pressure gauge. This pressure increase must not exceed 3 cm H<sub>2</sub>O.

#### Breathing System Leak Test

24. Perform a breathing and fresh gas delivery system pressure test. This test detects leaks from the patient breathing system and fresh gas delivery system.

To perform the test:

- a. Close all flow control valves on the anesthesia machine.
- b. Turn the SYSTEM POWER switch to the STANDBY position.
- c. Turn the vaporizers to 0% concentration.
- d. Interconnect the inspiratory valve and the expiratory hose terminal on the ultrasonic flow sensor with a 22 mm breathing hose.
- e. Set the manual/automatic selector valve to BAG.
- f. Close the APL valve by turning the knob fully clockwise to its stop position.
- g. Check that the breathing pressure gauge is on 0.
- h. Attach the supplied test terminal to the breathing bag mount.
- i. Connect a sphygmomanometer squeeze bulb (available from Draeger Medical) to the hose barb on the test terminal.
- j. Pump the squeeze bulb by hand until the breathing system pressure gauge indicates pressure of at least 50 cm H<sub>2</sub>O (not to exceed 80 cm H<sub>2</sub>O).
- k. Observe the pressure drop at the breathing system pressure gauge. When the pressure is at 50 cm H<sub>2</sub>O, begin counting seconds. The pressure must not drop more than 20 cm H<sub>2</sub>O in 30 seconds.

### Scavenger System

25. \* Verify the performance of the scavenger system.

To test the open reservoir scavenger system:

- a. Make sure a 19 mm scavenger hose is connected between the ventilator relief valve and the scavenger interface.
- b. Make sure a 19 mm scavenger hose is connected between the APL valve on the absorber and the scavenger interface.
- c. Check for moisture accumulation in the breathing and scavenger hoses. Remove any moisture found.
- d. Verify the safe performance of the open reservoir scavenging system. With the scavenging system properly installed and operating, test for positive and negative pressure relief.

To test for negative pressure relief:

- e. Connect a vacuum hose to the DISS threaded terminal on the left-hand side of the scavenger (or attach a wall suction hose onto the adapter's hose-barb fitting).
- f. Short-circuit the inspiratory valve and the expiratory hose terminal on the ultrasonic flow sensor with a 22 mm breathing hose.

- g. Set the absorber's manual/automatic selector valve to BAG.
- h. Turn the APL valve control knob fully counterclockwise.
- i. Verify that the suction waste gas disposal system is active.
- j. Adjust the scavenger needle valve to a flowmeter indication between the two white lines.
- k. Close all flow control valves on the anesthesia system.
- l. Occlude the absorber breathing bag terminal and observe the breathing pressure gauge on the absorber. The gauge should indicate only a negligible negative pressure (no lower than  $-0.5$  cm  $H_2O$ ).

To test for positive pressure relief:

- m. Perform steps a. through d.
- n. If the system is equipped with a PEEP valve, turn the PEEP valve control knob fully counterclockwise to its lowest setting.
- o. Adjust the scavenger needle valve to a completely closed position by turning it fully clockwise.
- p. Open the oxygen flow control valve to a flow of 10 l/min and occlude the absorber breathing bag terminal.
- q. The flow of oxygen must now exit through the relief ports located on top of the canister. The absorber system's breathing pressure gauge must indicate a pressure less than 5 cm  $H_2O$ .
- r. After the test, adjust the scavenger needle valve to a flowmeter indication halfway between the two white lines.

To test the scavenger interface for passive systems:

- a. Make sure a 19 mm scavenger hose is connected between the ventilator relief valve and the scavenger interface.
- b. Make sure a 19 mm scavenger hose is connected between the APL valve on the absorber and the scavenger interface.
- c. Check for moisture accumulation in the breathing and scavenger hoses. Remove any moisture found.
- d. Short-circuit the inspiratory valve and the expiratory hose terminal on the ultrasonic flow sensor with a 22 mm breathing hose.
- e. Set the absorber's manual/automatic selector valve to AUTO.
- f. If the system is equipped with a PEEP valve, turn the PEEP valve control knob fully counterclockwise to its lowest setting.
- g. Open the oxygen flow control valve to a flow of 10 l/min and occlude the 19 mm scavenger terminal labeled EXHAUST.

- h. After the ventilator bellows inflates, the flow of oxygen exits the system through the positive pressure safety relief valve. At this point, the absorber system's breathing pressure gauge must indicate a pressure of less than 10 cm H<sub>2</sub>O.

**Manual and Automatic Ventilation Systems**

26. \* Test the ventilator.

- a. Check for proper pressure and flow at the Y-piece during the inspiratory and expiratory phases. Turn the SYSTEM POWER switch and ventilator power switch to their ON positions. Place the manual/automatic selector valve in the AUTO position. Adjust the oxygen flow control valve to a 3 l/min flow. Set the ventilator frequency to 3 BPM, the I:E ratio to 1:2, and the tidal volume to about 1 liter. (If testing the Pediatric Bellows or Adult/Pediatric Bellows, adjust the tidal volume to 200 ml.)

Adjust the ventilator inspiratory flow control to the maximum of the "low" zone on the flow gauge. Occlude the patient side of the Y-piece. Fill the ventilator bellows by pressing the oxygen flush button. Observe the breathing system pressure gauge as the ventilator cycles.

The pressure gauge must indicate a pressure over 30 cm H<sub>2</sub>O when the bellows completes its downward travel. The pressure should not exceed 3 cm H<sub>2</sub>O at the end of the expiratory phase when the bellows completes its upward travel.

- b. If the system is equipped with a PEEP valve, verify the PEEP valve's performance. Attach a breathing bag to the patient Y-piece with an appropriate adapter such as an Draeger Medical combination mask elbow with a 22 mm male fitting for the breathing bag and 15 mm male fitting for the Y-piece. With the manual/automatic selector valve in the AUTO position, set the ventilator to the preferred frequency.

Set the PEEP bypass switch to the PEEP ON position. Then adjust the PEEP valve to different values and observe the breathing system pressure gauge to verify performance. Turn the PEEP valve control knob fully counterclockwise to its lowest setting after the test is completed. Set the PEEP bypass switch to the PEEP OFF position.

**Monitors**

- 27. Check the alarm limit settings. The monitor alarm limits are automatically set to a default configuration when the SYSTEM POWER switch is turned on. Check these settings and adjust them if necessary. Alarm limits can be adjusted at the beginning of or during a procedure. Also, make sure that any external monitors (if any) are connected properly.

28. \* Test the alarm functions for all monitors. Simulate alarm conditions and check for appropriate alarm signals.

**System Flush** 29. Flush the system with 100% oxygen by pressing the oxygen flush button.

**Fresh Gas Oxygen Sensor Adapter Option Verification** 30. If the optional fresh gas oxygen sensor adapter is installed, make sure the fresh gas hose connection is intact and not occluded. Verify that the oxygen analyzer is properly calibrated. (See “Calibrating the Oxygen Sensor” on page 12-4 for more information.) When removing the oxygen sensor during calibration, insert the oxygen sensor port plug into the fresh gas adapter port.

**Final Position** 31. When the daily checkout procedure is complete, verify that:

- a. all vaporizers are off (the handwheels are set to zero)
- b. the APL Valve is open (fully counterclockwise)
- c. the manual/automatic switch is set to BAG
- d. all flowmeters indicate 0 (or minimum)
- e. the patient suction is level adequate
- f. the breathing system is ready to use (the bag is in place and all hoses are connected properly)

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# 4

## Preuse Checkout

*This section describes the daily checkout procedure that you are to perform on the Narkomed GS anesthesia machine.*

Preuse Checkout Procedure ..... 4-2

## Preuse Checkout Procedure

Perform the following abbreviated checkout procedure when the Narkomed GS is used in successive cases. It may be performed only after the initial daily checkout procedure given in Section 3 was performed. This is a recommended procedure. Follow your institution's policies regarding specific checkout procedures. If the anesthesia system fails any procedures identified by an asterisk (\*), do not use the machine. Contact a Draeger Medical qualified technical service representative for inspection of the unit.

**NOTE:** Do not insert any additional components into or modify the anesthesia system after the checkout procedure is started.

### Reserve Power Verification

1. \* Check the reserve battery power. Make sure that the SYSTEM POWER switch is turned to the ON position. Remove the power plug from the outlet. Press the BATTERY TEST button on the main switch panel. The green indicator to the left of the test button must light. The yellow BATTERY LOW indicator must remain unlit. Plug the power cable back into the electrical outlet.

**NOTE:** This test assumes that the anesthesia machine has been plugged in for 12 hours. The battery charging system works only when the machine is connected to an active AC power source. The charging system takes about 12 hours to charge a fully discharged battery.

### Bain Circuit Adapter Verification

2. \* Verify that the inner tube of the Bain circuit is intact and not occluded. First deliver a flow of oxygen to the Bain circuit through the fresh gas hose. Then occlude the inner tube of the Bain circuit. The oxygen flowmeter float should drop in response to the occlusion.

As an alternate test, press the oxygen flush button with the Bain circuit's patient port open to the atmosphere. The high flow of gas through the Bain circuit's inner tube will draw in gas from the outer tube. As a result, the breathing bag should deflate. If the breathing bag does not deflate or it inflates, the fresh gas hose or inner tube may be improperly connected.

### Absorber System Verification

3. \* To check the absorber system:
  - a. Check the hose connections in the breathing system.
  - b. Make sure the fresh gas hose of the breathing system is securely connected to the fresh gas outlet.
  - c. Make sure a 22 mm patient breathing circuit is connected between the inspiratory valve and the expiratory hose terminal on the ultrasonic flow sensor.



- d. Make sure a 22 mm breathing hose is connected between the ventilator hose terminal and the manual/automatic selector valve breathing hose terminal.
  - e. Make sure a breathing bag of proper capacity and appropriate construction is connected to the breathing bag terminal of the breathing system.
  - f. Make sure the breathing pressure pilot line is properly connected between the BREATHING PRESSURE interface and either the absorber quick-connect fitting or the appropriate fitting at or near the patient Y-piece.
  - g. Make sure the oxygen sensor and flow sensor are properly installed.
4. \* Make sure the absorber canisters are filled with CO<sub>2</sub> absorbent. Consult the absorbent manufacturer's literature for information on what signs to expect when the absorbent is exhausted. Replace the absorbent when it appears exhausted. Make sure that the color change represents the absorbent's true state of depletion and is not due to regeneration after a rest period. Flushing the anesthesia machine continuously with 100% oxygen for at least one minute before the first case of the day is recommended.

Remove accumulated absorbent dust and water from the absorber dust cup.

**WARNING:** Absorbent is caustic and is a strong eye, skin, and respiratory tract irritant. When emptying the absorber dust cup, take care not to spill its caustic contents.

**NOTE:** When changing the CO<sub>2</sub> absorbent, take care not to chip or crack the absorbent canister. Check the canister for signs of damage, especially along the rim, before reinstallation.

5. Close all vaporizers and flow control valves. Check for free gas passage in the patient breathing system. Wear a surgical mask to inhale and exhale through the breathing system (each limb individually, if possible). Verify the unidirectional flow in each limb and then reconnect the tubing.

#### APL Valve

6. \* Check the APL valve to be sure it can relieve excess gas from the breathing system into the scavenger system.

To check the APL valve's flow resistance:

- a. Set the manual/automatic selector valve to BAG.
- b. Remove the bag from the swivel arm bag mount.

- c. Interconnect the inspiratory valve and the expiratory hose terminal on the ultrasonic flow sensor with a 22 mm hose.
- d. Completely open the APL valve by turning the control knob fully counterclockwise to its stop position.
- e. Turn the SYSTEM POWER switch to ON.
- f. Open the oxygen flow control valve to a flow of 8 l/min.
- g. Occlude the bag mount opening and watch for a pressure increase on the breathing system pressure gauge. This pressure increase must not exceed 3 cm H<sub>2</sub>O.

**Breathing  
System Leak  
Test**

7. Perform a breathing and fresh gas delivery system pressure test. This test detects leaks from the patient breathing system and fresh gas delivery system.

To perform the test:

- a. Close all flow control valves on the anesthesia machine.
- b. Turn the SYSTEM POWER switch to the STANDBY position.
- c. Turn the vaporizers to 0% concentration.
- d. Interconnect the inspiratory valve and the expiratory hose terminal on the ultrasonic flow sensor with a 22 mm breathing hose.
- e. Set the manual/automatic selector valve to BAG.
- f. Close the APL valve by turning the knob fully clockwise to its stop position.
- g. Check that the breathing pressure gauge is on 0.
- h. Attach the supplied test terminal to the breathing bag mount.
- i. Connect a sphygmomanometer squeeze bulb (available from Draeger Medical) to the hose barb on the test terminal.
- j. Pump the squeeze bulb by hand until the breathing system pressure gauge indicates pressure of at least 50 cm H<sub>2</sub>O (not to exceed 80 cm H<sub>2</sub>O).
- k. Observe the pressure drop at the breathing system pressure gauge. When the pressure is at 50 cm H<sub>2</sub>O, begin counting seconds. The pressure must not drop more than 20 cm H<sub>2</sub>O in 30 seconds.

**Scavenger  
System**

8. \* Verify the performance of the scavenger system.

To test the open reservoir scavenger system:

- a. Make sure a 19 mm scavenger hose is connected between the ventilator relief valve and the scavenger interface.

- b. Make sure a 19 mm scavenger hose is connected between the APL valve on the absorber and the scavenger interface.
- c. Check for moisture accumulation in the breathing and scavenger hoses. Remove any moisture found.
- d. Verify the safe performance of the open reservoir scavenging system. With the scavenging system properly installed and operating, test for positive and negative pressure relief.

To test for negative pressure relief:

- e. Connect a vacuum hose to the DISS threaded terminal on the left-hand side of the scavenger (or attach a wall suction hose onto the adapter's hose-barb fitting).
- f. Short-circuit the inspiratory valve and the expiratory hose terminal on the ultrasonic flow sensor with a 22 mm breathing hose.
- g. Set the absorber's manual/automatic selector valve to BAG.
- h. Turn the APL valve control knob fully counterclockwise.
- i. Verify that the suction waste gas disposal system is active.
- j. Adjust the scavenger needle valve to a flowmeter indication between the two white lines.
- k. Close all flow control valves on the anesthesia system.
- l. Occlude the absorber breathing bag terminal and observe the breathing pressure gauge on the absorber. The gauge should indicate only a negligible negative pressure (no lower than -0.5 cm H<sub>2</sub>O).

To test for positive pressure relief:

- m. Perform steps a. through d.
- n. If the system is equipped with a PEEP valve, turn the PEEP valve control knob fully counterclockwise to its lowest setting.
- o. Adjust the scavenger needle valve to a completely closed position by turning it fully clockwise.
- p. Open the oxygen flow control valve to a flow of 10 l/min and occlude the absorber breathing bag terminal.
- q. The flow of oxygen must now exit through the relief ports located on top of the canister. The absorber system's breathing pressure gauge must indicate a pressure less than 5 cm H<sub>2</sub>O.
- r. After the test, adjust the scavenger needle valve to a flowmeter indication halfway between the two white lines.

To test the scavenger interface for passive systems:

- a. Make sure a 19 mm scavenger hose is connected between the ventilator relief valve and the scavenger interface.
- b. Make sure a 19 mm scavenger hose is connected between the APL valve on the absorber and the scavenger interface.
- c. Check for moisture accumulation in the breathing and scavenger hoses. Remove any moisture found.
- d. Short circuit the inspiratory valve and the expiratory hose terminal on the ultrasonic flow sensor with a 22 mm breathing hose.
- e. Set the absorber's manual/automatic selector valve to AUTO.
- f. If the system is equipped with a PEEP valve, turn the PEEP valve control knob fully counterclockwise to its lowest setting.
- g. Open the oxygen flow control valve to a flow of 10 l/min and occlude the 19 mm scavenger terminal labeled EXHAUST.
- h. After the ventilator bellows inflates, the flow of oxygen exits the system through the positive pressure safety relief valve. At this point, the absorber system's breathing pressure gauge must indicate a pressure of less than 10 cm H<sub>2</sub>O.

**Manual and Automatic Ventilation Systems**

9. \* Test the ventilator.
  - a. Check for proper pressure and flow at the Y-piece during the inspiratory and expiratory phases. Turn the SYSTEM POWER switch and ventilator power switch to their ON positions. Place the manual/automatic selector valve in the AUTO position. Adjust the oxygen flow control valve to a 3 l/min flow. Set the ventilator frequency to 3 BPM, the I:E ratio to 1:2, and the tidal volume to about 1 liter. (If testing the Pediatric Bellows or Adult/Pediatric Bellows, adjust the tidal volume to 200 ml.)

Adjust the ventilator inspiratory flow control to the maximum of the "low" zone on the flow gauge. Occlude the patient side of the Y-piece. Fill the ventilator bellows by pressing the oxygen flush button. Observe the breathing system pressure gauge as the ventilator cycles.

The pressure gauge must indicate a pressure over 30 cm H<sub>2</sub>O when the bellows completes its downward travel. The pressure should not exceed 3 cm H<sub>2</sub>O at the end of the expiratory phase when the bellows completes its upward travel.

- b. If the system is equipped with a PEEP valve, verify the PEEP valve's performance. Attach a breathing bag to the patient Y-piece with an appropriate adapter such as an Draeger Medical combination mask elbow with a 22 mm male fitting for the breathing bag and 15 mm male fitting for the Y-piece. With the manual/automatic selector valve in the AUTO position, set the ventilator to the preferred frequency.

Set the PEEP bypass switch to the PEEP ON position. Then adjust the PEEP valve to different values and observe the breathing system pressure gauge to verify performance. Turn the PEEP valve control knob fully counterclockwise to its lowest setting after the test is completed. Set the PEEP bypass switch to the PEEP OFF position.

**Monitors**

10. Check the alarm limit settings. The monitor alarm limits are automatically set to a default configuration when the SYSTEM POWER switch is turned on. Check these settings and adjust them if necessary. Alarm limits can be adjusted at the beginning of or during a procedure. Also, make sure that any external monitors (if any) are connected properly.
11. \* Test the alarm functions for all monitors. Simulate alarm conditions and check for appropriate alarm signals.

**System Flush**

12. Flush the system with 100% oxygen by pressing the oxygen flush button.

**Fresh Gas  
Oxygen  
Sensor  
Adapter  
Option  
Verification**

13. If the optional fresh gas oxygen sensor adapter is installed, make sure the fresh gas hose connection is intact and not occluded. Verify that the oxygen analyzer is properly calibrated. (See "Calibrating the Oxygen Sensor" on page 12-4 for more information.) When removing the oxygen sensor during calibration, insert the oxygen sensor port plug into the fresh gas adapter port.

**Final Position**

- When the daily checkout procedure is complete, verify that:
- a. all vaporizers are off (the handwheels are set to zero)
  - b. the APL Valve is open (fully counterclockwise)
  - c. the manual/automatic switch is set to BAG
  - d. all flowmeters indicate 0 (or minimum)
  - e. the patient suction is level adequate
  - f. the breathing system is ready to use (the bag is in place and all hoses are connected properly)

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# 5

## Gas Delivery System

*This section describes the gas delivery system of the Narkomed GS anesthesia machine.*

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## Overview

The Narkomed GS is a continuous flow anesthesia system with pneumatic circuitry for mixing and delivering gases and anesthetic agent vapor. The pneumatic system can deliver up to four gases and one anesthetic agent simultaneously. Oxygen and nitrous oxide are standard on all machines; available optional gases include air and carbon dioxide. As many as two or three vaporizers can be mounted on the machine, depending on the model. Available vaporizers are for halothane, enflurane, isoflurane, sevoflurane, and desflurane.

## Connecting the Pipeline Gas Supply

Gas from the hospital pipelines enters the Narkomed GS through hoses connected to indexed inlets located on the side of the flowmeter housing. Depending on the country's standards and regulations, the available inlets are Diameter-Indexed Safety System (DISS) inlets (body or nut fitting), or National Institute for Standards and Technology (NIST) inlets. The available gas inlets are shown in Figure 5-1.

To connect a pipeline supply to the Narkomed GS:

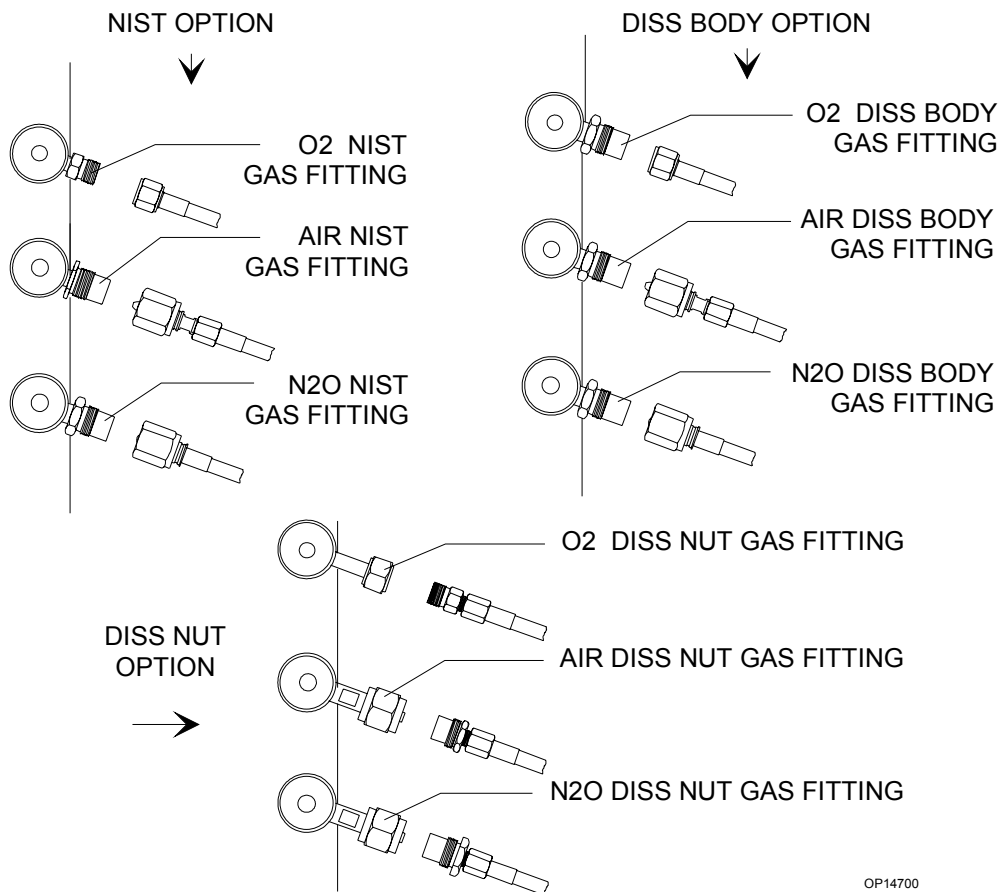
1. Connect the gas fitting on the supply hose to the corresponding gas fitting on the side of the flowmeter housing. Use a wrench to tighten the hex nut.

**WARNING:** Carefully check hoses each time you connect a machine to a wall or ceiling outlet to ensure that both ends of the hose are indexed for the same gas. Pipeline delivery hoses used between wall outlets and anesthesia machines have caused accidents when, during assembly, an oxygen fitting was placed on one end of the hose and a nitrous oxide fitting on the other end.

2. Connect the other end of the supply hose to the appropriate functioning hospital pipeline supplies.
3. Check the pipeline pressure gauge on the front of the Narkomed GS for sufficient pipeline pressure (50-55 psi).



Figure 5-1. Pipeline Gas Supply Connections



OP14700

## Connecting the Gas Cylinders

When attaching a cylinder, make sure that only one washer is installed between the cylinder and the yoke gas inlet. Using multiple washers may compromise the pin-indexed safety system. Be sure to verify the integrity of both index pins whenever you install a new cylinder. Refer to Figure 5-2.

To connect a gas cylinder to its yoke:

1. Place a new washer on the seat of the yoke gas inlet connection.

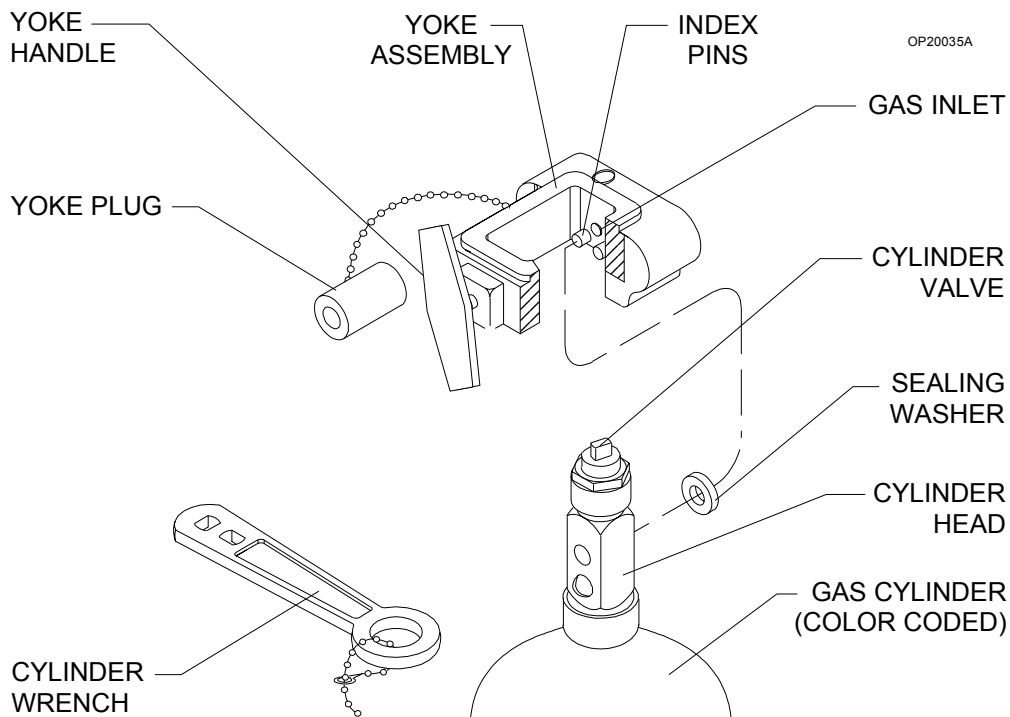
**WARNING:** Use only one cylinder washer per yoke. Using more than one washer could cause leakage of the cylinder gas and compromise the pin indexing system.

2. Verify the presence and integrity of the two index pins below the gas inlet.

**WARNING:** Check cylinder yokes for the presence of two index pins each time you attach a cylinder to the machine.

3. Insert the head of a gas cylinder with matching gas into the yoke from below, so that the gas outlet and indexing holes on the cylinder head are facing the gas inlet and indexing pins on the yoke assembly.
4. Engage the indexing holes with the index pins. Screw the yoke handle clockwise against the cylinder head, so that the point of the yoke handle bolt is aligned with the countersunk recess on the back of the cylinder head.
5. Verify that the sealing washer is in place, that the index pins are engaged, and that the cylinder hangs vertically. Tighten the handle securely.

Figure 5-2. Connecting the Gas Cylinders



## Connecting the Fresh Gas Hose

To connect the fresh gas hose, pull out the fresh gas locking bar located on the front of the Narkomed GS to its extended position. Insert the 15 mm male fitting on the fresh gas hose into the 15 mm female terminal. Release the spring-loaded locking bar over the fitting, allowing it to “lock” the fitting into place.

**WARNING:** Do not pinch or kink the fresh gas hose leading from the fresh gas outlet to the absorber.

## Adjusting the Gas Flow

To adjust the gas flow:

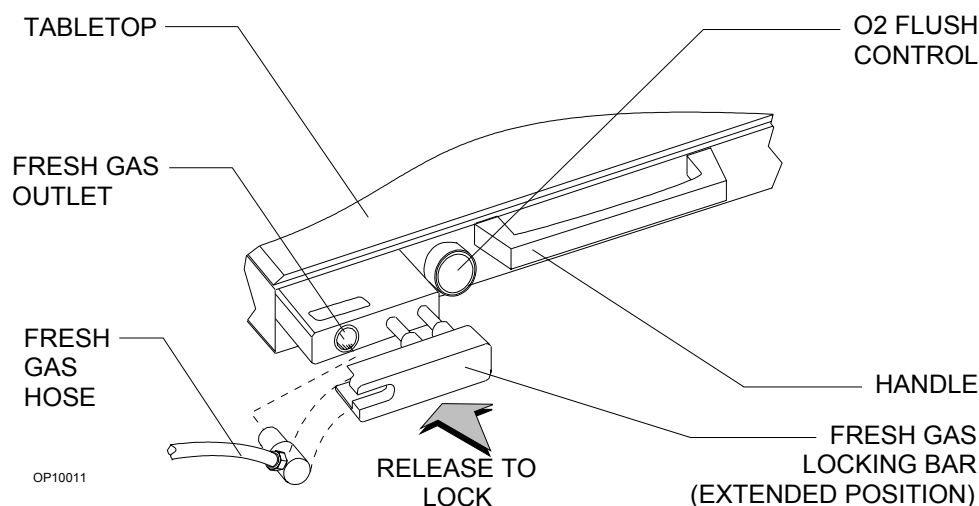
1. Turn the flow control knob located below the fine flowmeter tube for the gas you want to adjust. Turning the valve knob counterclockwise increases flow; turning the knob clockwise decreases flow.
2. As you adjust the flow control knob, observe the flow rate. Flow rate is indicated by the flowmeter scale reading at the center of the float.

**CAUTION:** The flow of oxygen cannot be completely shut off (see “Minimum Oxygen Flow” on page 2-7). Do not force the oxygen flow control knob past the zero stop in an effort to shut off the minimum flow; forcing the knob can damage the valve seat.

## Using the Oxygen Flush

To use the oxygen flush, press the oxygen flush button, located on the front of the Narkomed GS, for a few seconds. This introduces an unmetered flow of pure oxygen into the breathing circuit at a rate of about 55 l/min.

Figure 5-3. Oxygen Flush Control



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# 6

## Vaporizer

*This section describes the vaporizer of the Narkomed GS anesthesia machine.*

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## Overview

The Narkomed GS can be equipped with up to three fixed-mount vaporizers (Vapor 19.1) or up to two removable vaporizers (Vapor 19.3). These vaporizers add an anesthetic gas to the fresh gas stream by producing a precisely metered amount of the vapor of a particular liquid anesthetic. The vaporizer is installed in the fresh gas line upstream of the patient breathing system (semi-closed, semi-open system).

**WARNING:** The vaporizer must not be connected downstream of the fresh gas outlet of the anesthesia machine.

For low flow (fresh gas flows lower than 250 ml/min) or closed system anesthesia, breathing circuit concentrations may differ considerably from the vaporizer setting. When performing anesthesia with low flow or closed system techniques, it is essential to monitor inspiratory and expiratory anesthesia concentration, oxygen concentration, expiratory volume, and airway pressure in the circuit.

The carrier gases used must be dry and free of oil and dust. The limits for moisture are as follows:

- dew point of oxygen  $\leq 5^{\circ}$  C
- dew point of air  $\leq 5^{\circ}$  C
- water contents of nitrous oxide  $\leq 2$  mg/l

**NOTE:** For information on the Tec 6 desflurane vaporizer, refer to its instruction manual.

**NOTE:** For complete information on the Vapor 19.1 and 19.3 vaporizers, refer to the *Dräger Vapor 19.n Anaesthetic Vaporiser Instructions for Use*.

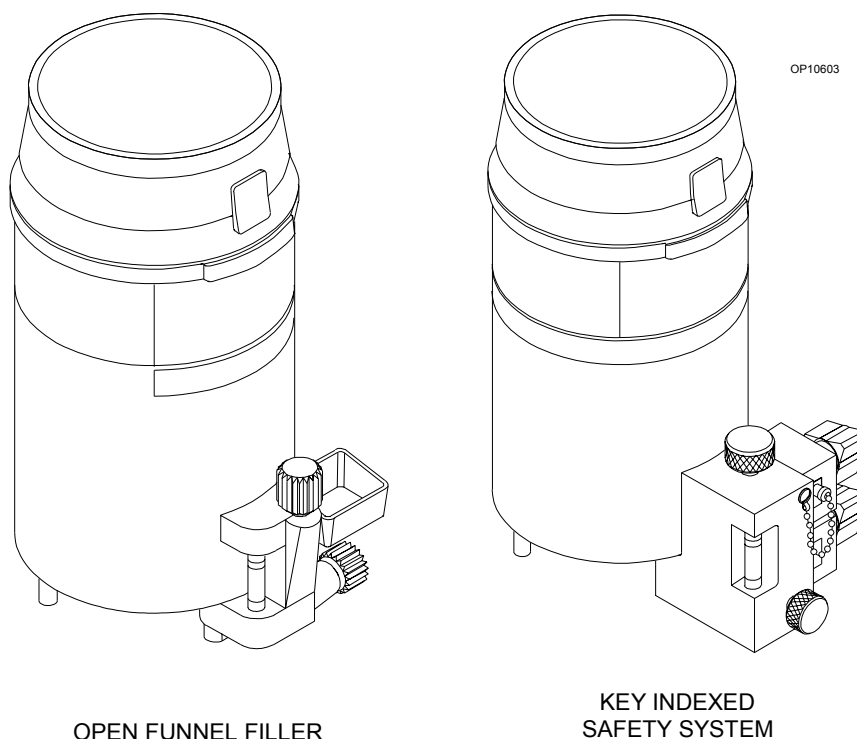
## Filling Systems

Two filling systems are available for the Vapor 19.1 and 19.3:

- Open funnel system
- Key indexed safety system

Figure 6-1 shows vaporizers with the two different types of available filling systems.

Figure 6-1. Vaporizer Filling Systems



## Exclusion Systems

The Narkomed GS is equipped with one of two vaporizer exclusion systems corresponding to the vaporizer model:

- fixed-mount vaporizer exclusion system (for the Vapor 19.1)
- removable vaporizer exclusion system (for the Vapor 19.3)

The purpose of the exclusion system is to prevent more than one vaporizer from being activated at a time. The exclusion system is incorporated into the vaporizer bank and requires all unused vaporizers to be locked in their zero percent positions.

**WARNING:** Only one vaporizer can be activated at a time. If the exclusion system permits simultaneous activation of two or more vaporizers, do not use the anesthesia machine; contact a Draeger Medical qualified technical service representative for adjustment.

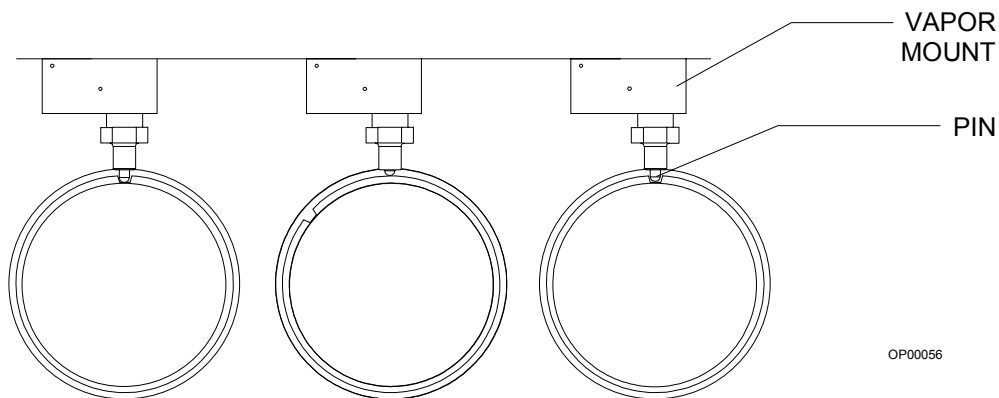
With the fixed-mount exclusion system, if the system permits simultaneous activation of multiple vaporizers and the anesthesia machine is turned on, the Caution message MULTI VAP SEL appears on the display screen. This does not apply to the removable vaporizer exclusion system.

**6** Vaporizer

**Fixed-Mount Exclusion System**

The fixed-mount exclusion system, shown in Figure 6-2, allows only one vaporizer to be turned on while locking the others in their zero positions.

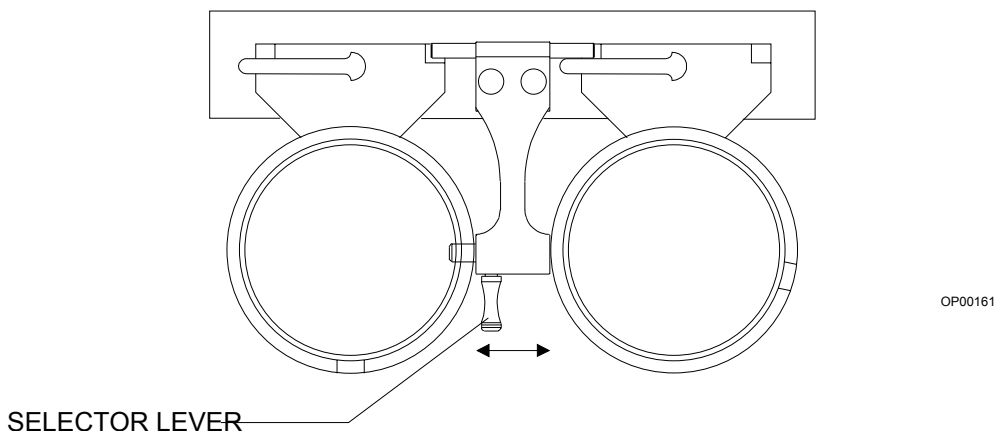
Figure 6-2. Fixed-Mount Exclusion System



**Removable Vaporizer Exclusion System**

The removable vaporizer exclusion system, shown in Figure 6-3, has a manual selector lever used to select which vaporizer is active. This selector lever provides an interlock function which ensures that only one vaporizer can be turned on at a time.

Figure 6-3. Removable Vaporizer Exclusion System





## Installing/Removing the Vapor 19.3 Vaporizer

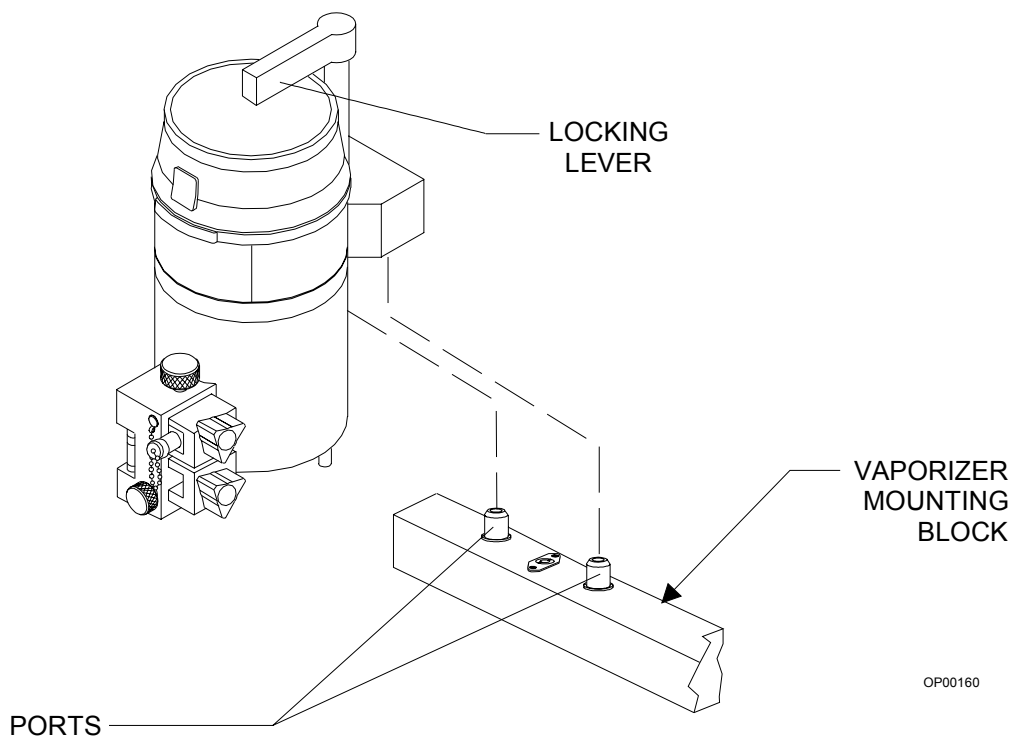
*To install the Vapor 19.3:*

1. Make sure the handwheel is set to “0” and that the button is engaged.
2. Make sure the locking lever is the open position (over the handwheel).
3. Make sure the two sealing rings on the ports on the vaporizer mounting block are present and undamaged.
4. Move the manual selector lever to the position opposite of the install position.
5. Lower the vaporizer onto the ports on the mounting block; turn the locking lever 90° clockwise until it engages to secure the vaporizer to the mounting block.

*To remove the Vapor 19.3:*

1. Turn the handwheel to “0” until it engages.
2. Move the locking lever 90° counterclockwise to the open position (over the handwheel).
3. Lift the vaporizer off the mounting block.

**Figure 6-4. Installing/Removing the Vapor 19.3 at the Mounting Block**



OP00160

## Selecting a Vapor 19.3 Vaporizer

Before a Vapor 19.3 vaporizer can be turned on, it must be selected using the selector lever:

- To select the right vaporizer, move the lever to the left position (this locks the left vaporizer in the “0” position).
- To select the left vaporizer, move the lever to the right position (this locks the right vaporizer in the “0” position).

There is also a center position available for the selector lever which locks both vaporizers in their “0” positions.

## Operating the Vaporizers

Before each case, check the following items.

1. Make sure the vaporizer contains a sufficient amount of anesthetic agent as indicated in the sight glass.
2. Make sure the filling and draining valves are closed. For vaporizers with the key indexed safety system, make sure the sealing plug is properly fitted and locking screw is tight.
3. Make sure the handwheel is set to “0” (zero-point interlock) and that the button is engaged.

**NOTE:** Machines equipped with fixed-mount vaporizers are configured internally with information about what types of vaporizers are located in the vaporizer positions (left, right, and if applicable, center). If a vaporizer is installed and the Narkomed's internal configuration is not set, the Advisory message VAP NOT CONFIG appears on the display screen. If this happens, contact a Draeger Medical qualified technical service representative to configure the system. This does not apply to removable vaporizers.

## Turning the Vaporizer On

To turn the vaporizer on:

1. Adjust the fresh gas flow.
2. Turn the vaporizer handwheel to the desired anesthetic concentration. Do not set the handwheel between 0 and 0.2% volume concentration (0.3% volume with Enflurane Vapor). This part of the handwheel actuates the on/off switch and cannot be calibrated.

**NOTE:** After you turn on the vaporizer, activate the scavenger system to collect and remove vented gas from the operating room.

### Turning the Vaporizer Off

To turn the vaporizer off, turn the vaporizer handwheel to “0” (zero-point interlock) and make sure the button engages. Do not interrupt the fresh gas flow until you have turned off the vaporizer.

**NOTE:** If you do not plan to use the vaporizer for more than a month, or if you remove it from the anesthesia machine, drain the anesthetic agent from the vaporizer.

### Filling the Vaporizer

Before filling a vaporizer, identify the filling system on the device as one of the following:

- Open funnel system
- Key indexed safety system

When you have identified the filling system, locate the appropriate procedure and read it entirely before filling the device.

**WARNING:** Do not inhale anesthetic vapors while filling the vaporizer. Uncontrolled inhalation of anesthetic vapors is injurious to health.

Before filling a vaporizer, note the expiration date of the anesthetic agent. Do not use anesthetics beyond the date of expiration.

**CAUTION:** Each vaporizer is specifically designed and calibrated for one particular anesthetic agent. Do not fill a vaporizer with any anesthetic other than the particular agent indicated on the vaporizer.

- The Isoflurane vaporizer must be filled with Isoflurane only (trade names: Forane, Forene, Aerrane).
- The Enflurane vaporizer must be filled with Enflurane only (trade names: Ethrane, Alyrane).
- The Halothane vaporizer must be filled with Halothane only (trade name: Fluothane).
- The Desflurane vaporizer must be filled with Desflurane only (trade name: Suprane).
- The Sevoflurane vaporizer must be filled with Sevoflurane only (trade name: Ultane).

Do not use a vaporizer that has been inadvertently filled with the wrong anesthetic. Drain the vaporizer and return the device to Draeger Medical's Technical Service Department.

## Filling the Vaporizer During a Case

If you must fill the vaporizer during a case, be extremely careful. While fresh gas is flowing and the vaporizer is turned on, the vaporizing chamber is pressurized. **DO NOT** open the inlet valve (or the screw of the safety filling device) under these circumstances—liquid anesthetic may gush out. To safely add anesthetic agent while the machine is in use, depressurize the vaporizer by setting the handwheel to “0” (zero-point interlock); make sure the button engages in the locked position. Allow at least 5 seconds for the vaporizing chamber to depressurize, then use the appropriate procedure to add the anesthetic agent.

**WARNING:** The vaporizer handwheel must be set to “0” (zero-point interlock) before the vaporizer can be filled.

### Filling Vaporizer With Open Funnel System

1. With the vaporizer in an upright position, turn the handwheel to “0” (zero-point interlock) and make sure the button engages in the locked position.
2. Make sure the filling spout is clean. To remove dust or other particles, use a clean, dry paper towel. Do not use water or other liquid cleaning solutions.
3. Make sure the drain valve is closed.
4. Open the inlet valve by turning it counterclockwise about three turns.

**CAUTION:** Be sure to fill the vaporizer in an upright position; filling the vaporizer in a tilted position may cause overfilling. Overfilling may cause the anesthetic concentration rate to be higher or lower than the handwheel setting.

5. Remove the cap from the anesthetic agent bottle. Check the sealing edge of the bottle for chipping or other damage. **DO NOT** use if damaged.
6. With the vaporizer in an upright position, pour the anesthetic agent into the funnel. As you pour the agent, observe the level through the sight glass. Fill the vaporizer to the MAX mark and close the inlet valve. Refer to Figure 6-5.

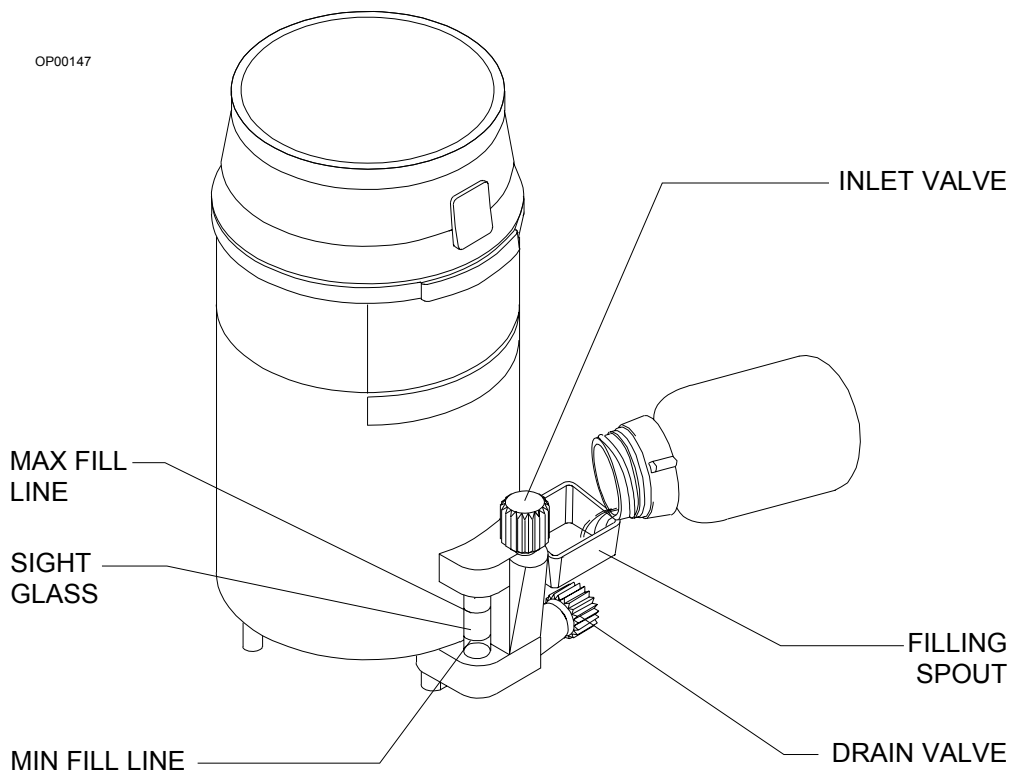
**NOTE:** The capacity of the vaporizer is approximately 140 cm<sup>3</sup> with wet wick, and approximately 200 cm<sup>3</sup> with dry wick.

7. After filling, check the level at the sight glass. When the vaporizer is in an upright position, the level must not exceed the MAX mark.

If the vaporizer is inadvertently overfilled (MAX mark exceeded), drain the excess anesthetic. For information on draining the vaporizer, refer to “Draining Vaporizer With Open Funnel Spout” on page 6-13 later in this section.

8. Place the cap back on the bottle.

Figure 6-5. Filling the Vaporizer (Open Funnel System)



**Filling Vaporizer With Key Indexed Safety System**

The key indexed safety system employs a matching assembly to prevent inadvertent use of the wrong agent in a Vapor 19.1 or 19.3 device. To fill a vaporizer with key indexed safety system, you must have the appropriate keyed bottle adapter for the anesthetic agent (see Figure 6-7 on page 6-12).

1. With the vaporizer in an upright position, turn the handwheel to “0” (zero-point interlock) and make sure the button engages in the locked position.
2. Remove the cap and seal from the anesthetic agent bottle. Check the sealing edge of bottle for chipping or other damage. DO NOT use if damaged.
3. Attach the keyed bottle adapter to the keyed collar on the bottle. Screw the parts together tightly to form an airtight seal.
4. Turn the filler port lock screw counterclockwise and remove the filler port plug from the filler port.
5. Insert the keyed adapter into the filler port of the vaporizer so that the two holes in the adapter face the Teflon seal surface of the filler port. Bend the filler tube so that the liquid level in the bottle is below the filler port. Adjust the plastic tubing to avoid kinks.

6. Turn the filler port lock screw clockwise to hold the adapter against the Teflon seal.
7. Open the filler valve by turning the knob counterclockwise two or three turns.

**CAUTION:** Be sure to fill the vaporizer in an upright position; filling the vaporizer in a tilted position may cause overfilling. Overfilling may cause the anesthetic concentration rate to be higher or lower than the handwheel setting.

8. Lift the bottle above the filler port level, avoiding kinks in the plastic tube. The liquid should begin flowing within 10 seconds after raising the bottle. If liquid does not begin to flow within 10 seconds, move the bottle below filler port level and raise it above the filler port again. (This allows any air trapped in the tubing to escape.) Repeat as necessary to start the flow. See Figure 6-6.
9. Watch the sight glass while the vaporizer is filling, and close the filler valve when the liquid level reaches the lower of the two marks at the upper end of the sight glass. The lower mark is the FULL mark; the upper mark is the OVERFLOW mark.

**NOTE:** The capacity of the vaporizer is approximately 140 cm<sup>3</sup> with wet wick, and approximately 200 cm<sup>3</sup> with dry wick.

10. Remove the adapter from the filler port.
11. Allow excess liquid to drain from the filler port.
12. Fully insert the filler port plug in the filler port and tighten the plug in place by turning the lock screw clockwise.
13. After filling, check the level at the sight glass. When the vaporizer is in an upright position, the level must not exceed the FULL mark.  
  
If the vaporizer is inadvertently overfilled (FULL mark exceeded), drain the excess anesthetic. For information on draining the vaporizer, refer to “Draining Vaporizer With Key Indexed Safety System” on page 6-13 later in this section.
14. Remove the adapter from the bottle.
15. Place the cap back on the bottle.

Figure 6-6. Filling the Vaporizer (Key Indexed Safety System)

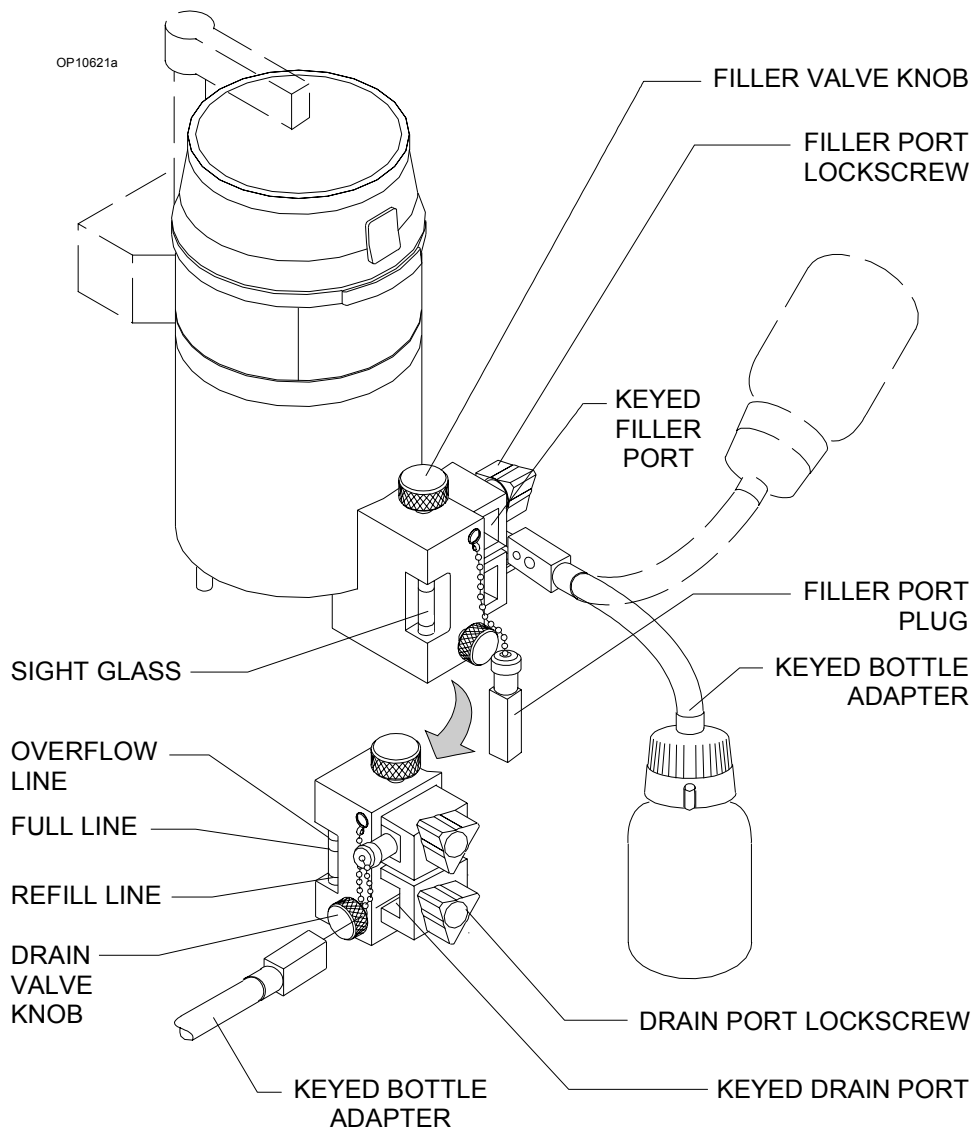
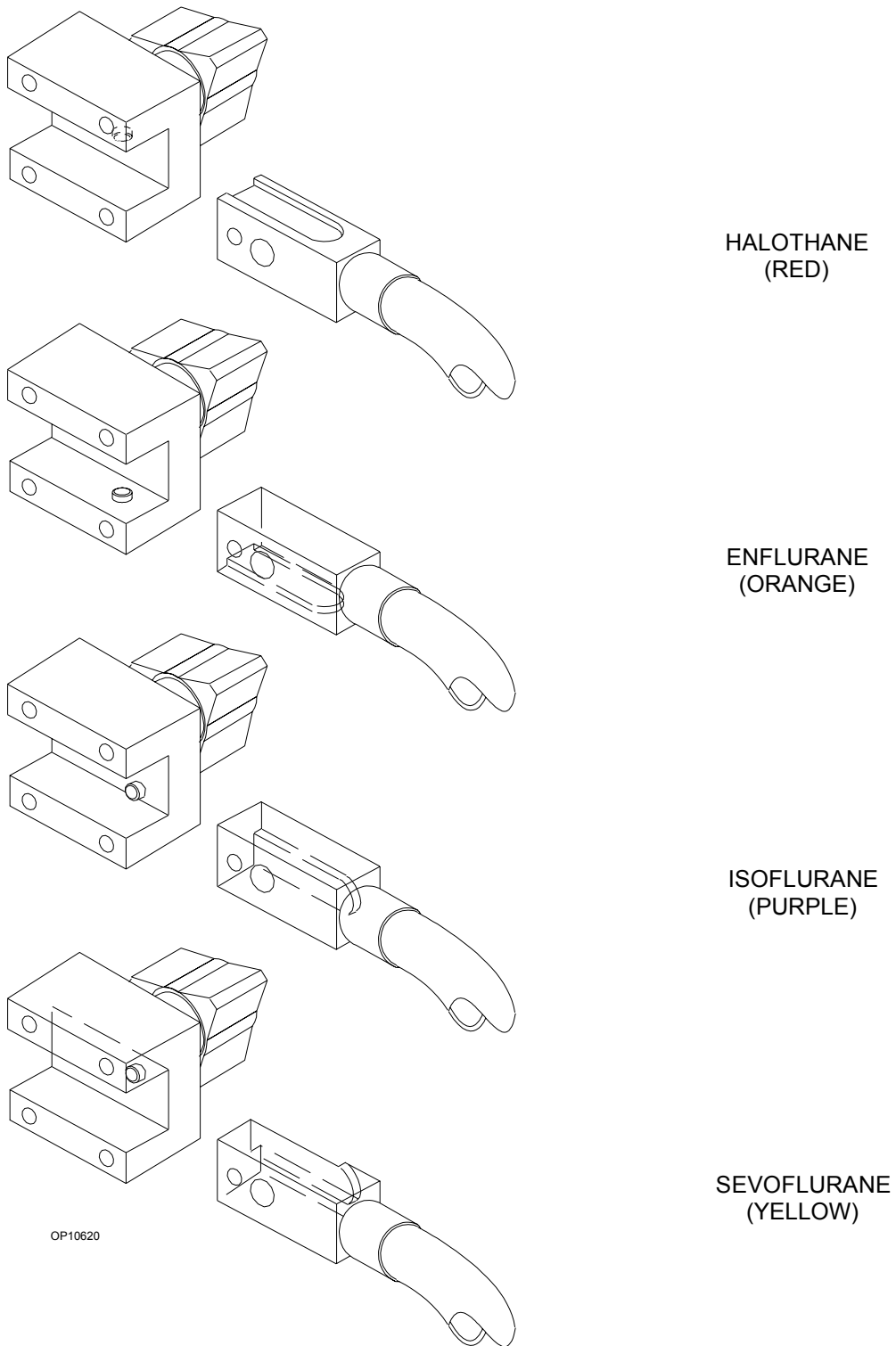


Figure 6-7. Keyed Bottle Adapters





## Draining the Vaporizer

Before draining a vaporizer, identify the filling system on the device as one of the following:

- Open funnel system
- Key indexed safety system

When you have identified the filling system, locate the appropriate procedure and read it entirely before draining the device.

**WARNING:** Do not inhale anesthetic vapors while draining the vaporizer. Uncontrolled inhalation of anesthetic vapors is injurious to health.

### Draining Vaporizer With Open Funnel Spout

1. With the vaporizer in an upright position, turn the handwheel to “0” (zero-point interlock) and make sure the button engages in the locked position.
2. Place an empty anesthetic-specific bottle under the drain hole of the filling spout. Mark the bottle to indicate that it contains a previously used anesthetic agent.

**WARNING:** The vaporizer handwheel must be set to “0” (zero-point interlock) before the vaporizer can be drained.

3. Open the drain valve by turning it counterclockwise about three turns. Do not unscrew the valve completely.
4. Close the drain valve.

**WARNING:** Do not re-use drained agent.

5. Place the cap back on the bottle and dispose of the bottle in accordance with approved hospital procedures.

### Draining Vaporizer With Key Indexed Safety System

The key indexed safety system employs a matching pin-and-socket assembly to prevent inadvertent use of the wrong agent in a Vapor 19.1 or 19.3 device. To drain a vaporizer with key indexed safety system valves, you must have the appropriate keyed bottle adapter for the anesthetic agent.

1. With the vaporizer in an upright position, turn the handwheel to “0” (zero-point interlock) and make sure the button engages in the locked position.
2. Attach the keyed bottle adapter to the appropriate empty bottle. Tighten to assure airtight seal. Mark the bottle to indicate that it contains a previously used anesthetic.
3. Insert the bottle adapter fitting into the drain port of the vaporizer. The two holes in the adapter fitting must face the Teflon seal surface in the drain port.

4. Turn drain port lock screw clockwise to hold the adapter against the Teflon seal.

**WARNING:** The vaporizer handwheel must be set to “0” (zero-point interlock) before the vaporizer can be drained.

5. Hold the bottle below drain port level, and avoid kinking the plastic tube. Open the drain valve by rotating the knob counterclockwise. Allow the liquid to drain into the bottle until the vaporizer is empty. The vaporizer is empty when no anesthetic flows from the drain.

6. Close the drain valve and remove the adapter from the drain port.

**WARNING:** Do not re-use drained agent.

7. Place the cap back on the bottle and dispose of the bottle in accordance with approved hospital procedures.

# 7

## Open Reservoir Scavenger

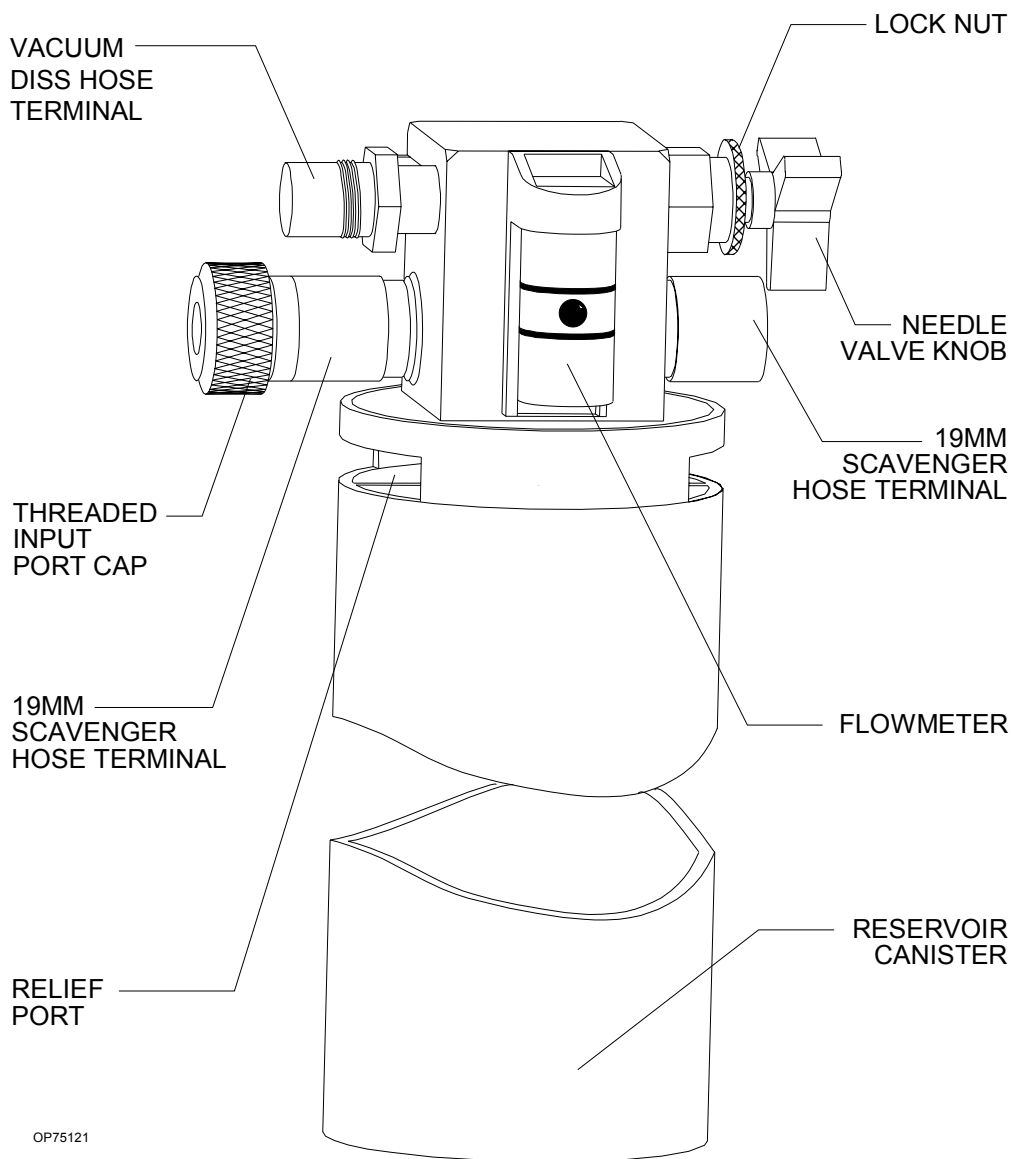
*This section describes the open reservoir scavenger of the Narkomed GS anesthesia machine.*

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Operating the Open Reservoir Scavenger System .....	7-4

### Overview

The open reservoir scavenger is intended for use with suction (vacuum) waste gas disposal systems. This scavenging approach applies a continuous suction to transfer waste gas from the scavenger to the disposal system. The open reservoir scavenger is an “open” system, which uses continually open relief ports to provide positive and negative pressure relief. The open reservoir scavenger is shown in Figure 7-1.

Figure 7-1. Open Reservoir Scavenger



## Connecting the Open Reservoir Scavenger System

The open reservoir scavenger system is installed on the Narkomed GS before shipping. The only thing you need to do before operating the scavenger is to make the hose connections. Refer to Figure 7-2 on page 7-4.

**CAUTION:** Take special care not to accidentally force 19 mm scavenger hoses over 22 mm breathing hose terminals. Carefully follow the hose connection instructions for installing the scavenger and the absorber.

To connect the scavenger hoses:

1. Attach a 19 mm scavenger hose between the 19 mm terminal (marked SCAVENGER HOSE) on the rear of the APL valve and the 19 mm terminal (marked SCAVENGER HOSE) on the right side of the scavenger.

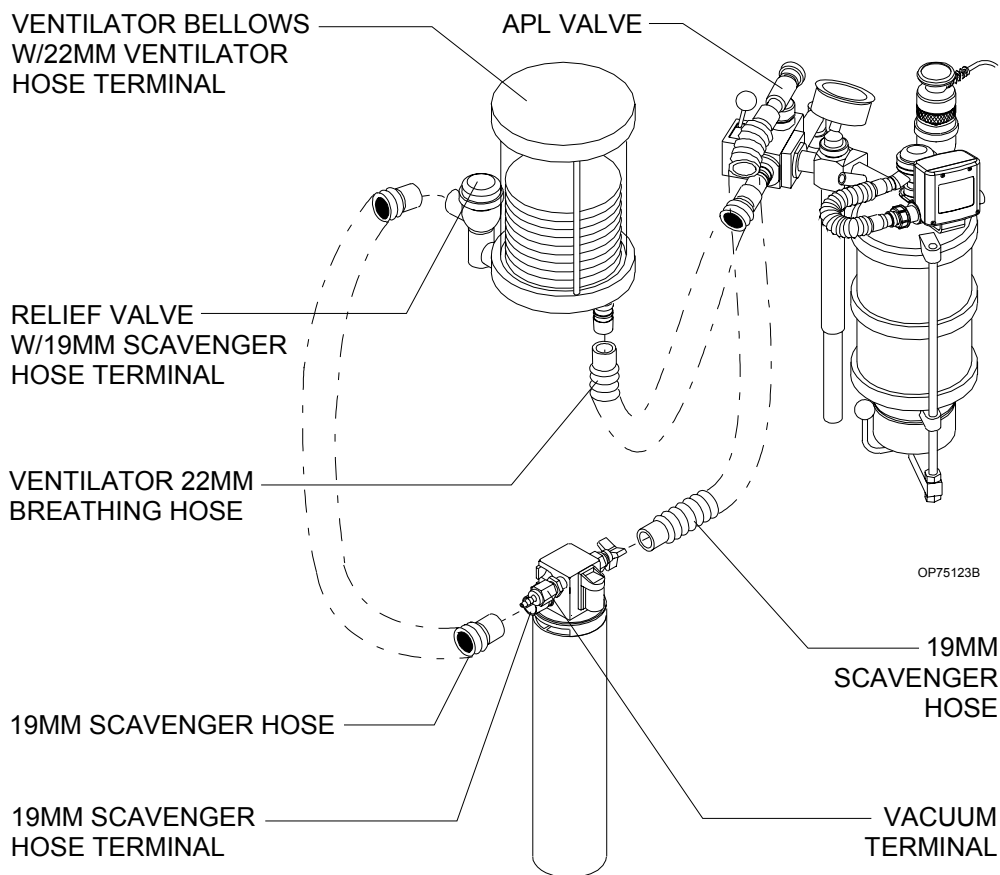
**WARNING:** Make sure the 19 mm scavenger hose leading from the absorber is not pinched, kinked, or blocked in any manner.

2. Attach another 19 mm scavenger hose between the 19 mm terminal (marked SCAVENGER HOSE) on the ventilator relief valve and the 19 mm terminal (marked SCAVENGER HOSE) on the left-hand side of the scavenger.

**WARNING:** Make sure the 19 mm scavenger hose leading from the ventilator relief valve is not pinched, kinked, or blocked in any manner.

3. Attach a wall suction hose between the wall suction outlet and the suction terminal (DISS or hose barb with adapter) on the scavenger.
4. Verify the proper functioning of the scavenger system.

Figure 7-2. Connecting the Open Reservoir Scavenger System



### Operating the Open Reservoir Scavenger System

Because the open reservoir scavenger's reservoir canister is open to the atmosphere, it does not require spring-loaded relief valves. If the waste gas flow rate from the patient breathing system exceeds the disposal system's suction flow rate, the canister initially accommodates excess waste gas. After excess waste gas fills the canister, waste gas then exits through the relief ports around the top of the canister. Thus, positive pressure does not build up within the patient breathing system.

**CAUTION:** Waste gas vented from the relief ports may contaminate the operating room. To prevent such contamination, be sure to adjust the needle valve properly.

If the disposal system's flow rate (suction) exceeds the waste gas flow rate from the patient breathing system, the disposal system draws room air through the relief ports. Thus, the disposal system does not apply a negative pressure to the patient breathing system.

### **Adjusting the Needle Valve**

You must properly adjust the waste gas flow rate to prevent waste gas contamination of the operating room. The needle valve wing nut regulates the waste gas exhaust flow.

To adjust the needle valve:

1. Attach all appropriate hoses and verify that the waste gas disposal system is active.
2. Turn the needle valve wing nut until the flowmeter indicates a flow halfway between the two white lines etched on the scavenger's flowmeter. This setting corresponds to a suction flow rate of about 25 l/min.

Depending on the fresh gas flow rate, the needle valve setting may have to be increased or decreased to settings either above or below the lines on the flowmeter. If the suction flow rate is set too low, waste gas will exit the canister through the relief ports around the top of the canister and contaminate the operating room. If the suction flow rate is too high, the waste gas disposal system's suction capacity will be needlessly depleted and the system will be noisy.

You may have to readjust the needle valve setting during a case. For example, a shared suction disposal system may provide a varying suction flow rate, depending on the number of users at any given time.

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# 8

## Scavenger Interface for Passive Systems

*This section describes the scavenger interface for passive systems of the Narkomed GS anesthesia machine.*

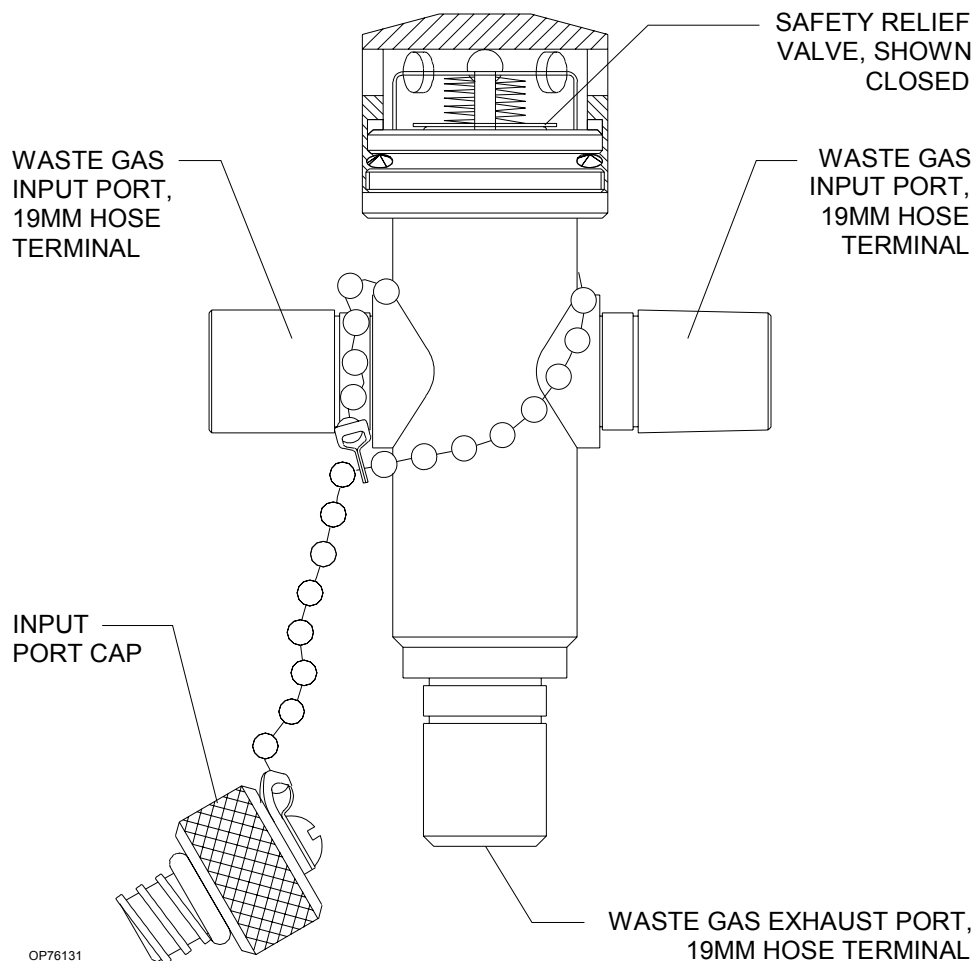
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Operating the Scavenger Interface for Passive Systems .....	8-3

### Overview

The Scavenger Interface for Passive Systems is intended for use with non-recirculating HVAC systems (also called exhaust systems). This scavenging approach relies on the pressure of the waste gas itself to transfer the gas from the scavenger to the disposal system. The scavenger interface is a “closed” system, which uses a spring-loaded valve for positive pressure relief. The scavenger interface is shown in Figure 8-1.

**WARNING:** Do not use this device with a waste gas disposal system capable of applying a negative pressure to the scavenger interface (a suction or vacuum waste gas disposal system).

Figure 8-1. Scavenger Interface for Passive Systems

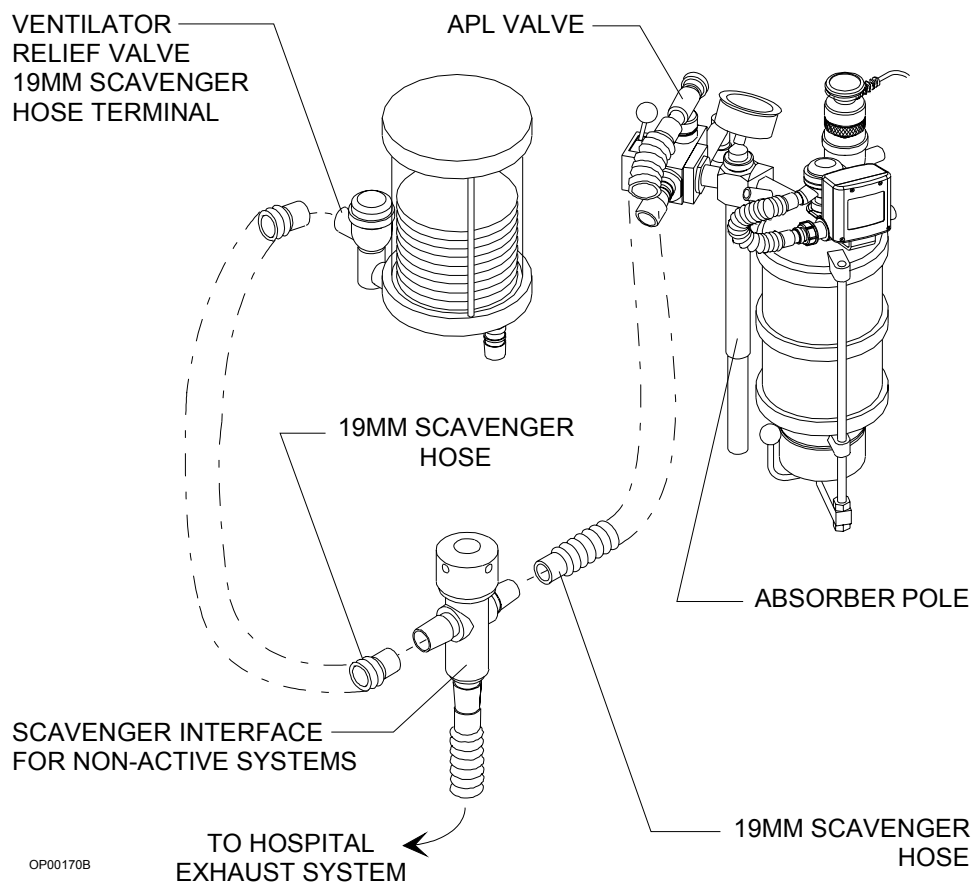


## Operating the Scavenger Interface for Passive Systems

In a typical anesthesia circle system, waste gas exits from the breathing system APL or ventilator relief valves and passes through the scavenger to the exhaust system. If the hospital exhaust system stopped functioning (or if the path between the scavenger and the exhaust system becomes blocked), positive pressure would build up within the scavenging and breathing systems. To prevent such a harmful pressure build-up, the scavenger's positive pressure relief valve is set to open at a pressure of 5 cm H<sub>2</sub>O. Waste gas then exits through the holes in the relief valve housing. Therefore, you do not have to adjust this scavenger. You must, however, make sure that hoses are properly connected and that the positive pressure safety relief valve is functioning. Hose connections are shown in Figure 8-2.

**WARNING:** The positive pressure relief valve must be inspected and cleaned (if necessary) at six month intervals.

Figure 8-2. Scavenger Interface for Passive Systems Hose Connections



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# 9

## Main Switch Panel

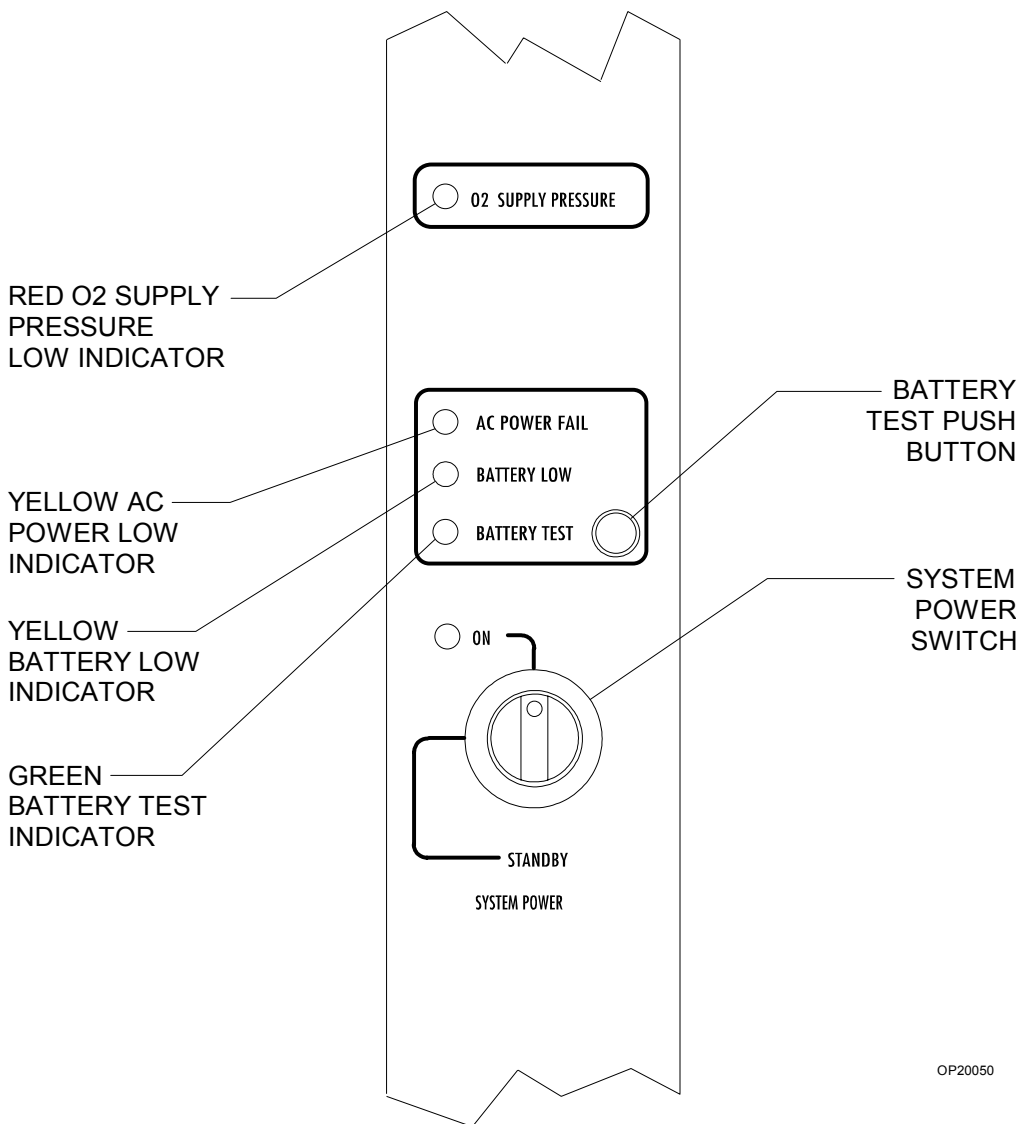
*This section describes the main switch panel of the Narkomed GS anesthesia machine.*

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### Overview

The main switch panel, located between the ventilator bellows and flowmeter bank, incorporates the SYSTEM POWER switch and indicator lights for low O<sub>2</sub> supply pressure, AC power failure, and battery low alarms. These alarms are annunciated and displayed on the monitor screen's alarm window.

Figure 9-1. Main Switch Panel



## System Power Switch

The SYSTEM POWER switch on the Narkomed GS has two positions: ON and STANDBY. In the ON position the gas (pneumatic) and electric power circuits are activated and the green LED indicator adjacent to the switch is illuminated. In the STANDBY position the gas supplies, the monitoring system, and all electrical power to the machine except the convenience receptacles and battery charging circuit are deactivated.

**NOTE:** The battery charging circuit and convenience receptacles are active whenever the power cable is attached to an active wall receptacle, regardless of the switch setting.

## Testing the Battery

The backup battery system shall be tested daily. To test the battery:

1. Turn the SYSTEM POWER switch ON, and wait until the power-on diagnostic screen is no longer displayed.
2. Remove the machine's power plug from the electrical outlet.
3. Press and hold the BATTERY TEST button.
4. If the battery is sufficiently charged, the green BATTERY TEST light illuminates after a short delay.

Usually, a fully charged battery can power the electrical components of the anesthesia machine for at least 30 minutes in the event of a power failure.

**NOTE:** During an AC power loss, the BATTERY LOW indicator is illuminated when the battery reserve approaches depletion. However, do not rely solely on this indicator for an assessment of battery capacity. If the backup battery becomes completely depleted and the machine does not have AC power, the BATTERY LOW indicator light has no source of power and does not function. Therefore, always remember to perform the pre-use battery test.

To prevent premature battery failure, use backup battery power only during interruption of primary AC power. Do not start an anesthetic procedure on the anesthesia machine if the AC POWER FAIL indicator light or the BATTERY LOW indicator light is illuminated.

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# 10

## AV2+ Anesthesia Ventilator

*This section describes the AV2+ anesthesia ventilator of the Narkomed GS anesthesia machine.*

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## Overview

The AV2+ anesthesia ventilator is a volume preset, time cycled, pressure limited ventilator with electronic timing, pneumatic circuitry and independent controls for frequency, inspiratory to expiratory (I:E) ratio, inspiratory flow rate, tidal volume, and inspiratory pressure limit.

Pneumatic power (bellows drive gas) to the ventilator is supplied through the hospital pipeline supply or through reserve cylinders on the anesthesia machine. The pressure of the supply gas must be between 40 and 60 psi. The ventilator will not function if this pressure drops below 32 psi. Electrical power is supplied by the Narkomed GS's AC power source, or, in event of AC power failure, by the backup battery. A fully charged battery can power the ventilator for approximately 20 minutes.

The anesthesia ventilator is designed for use with a Draeger Medical absorber system, which incorporates a manual/automatic selector valve. This valve allows you to select either the breathing bag and adjustable pressure limiter (APL) valve for manual ventilation, or the ventilator bellows for automatic ventilation.

During automatic ventilation, the manual/automatic selector valve isolates the absorber's APL valve from the breathing system. To compensate for the continuous introduction of fresh gas into the breathing system, the ventilator incorporates a relief valve mounted behind the bellows chamber.

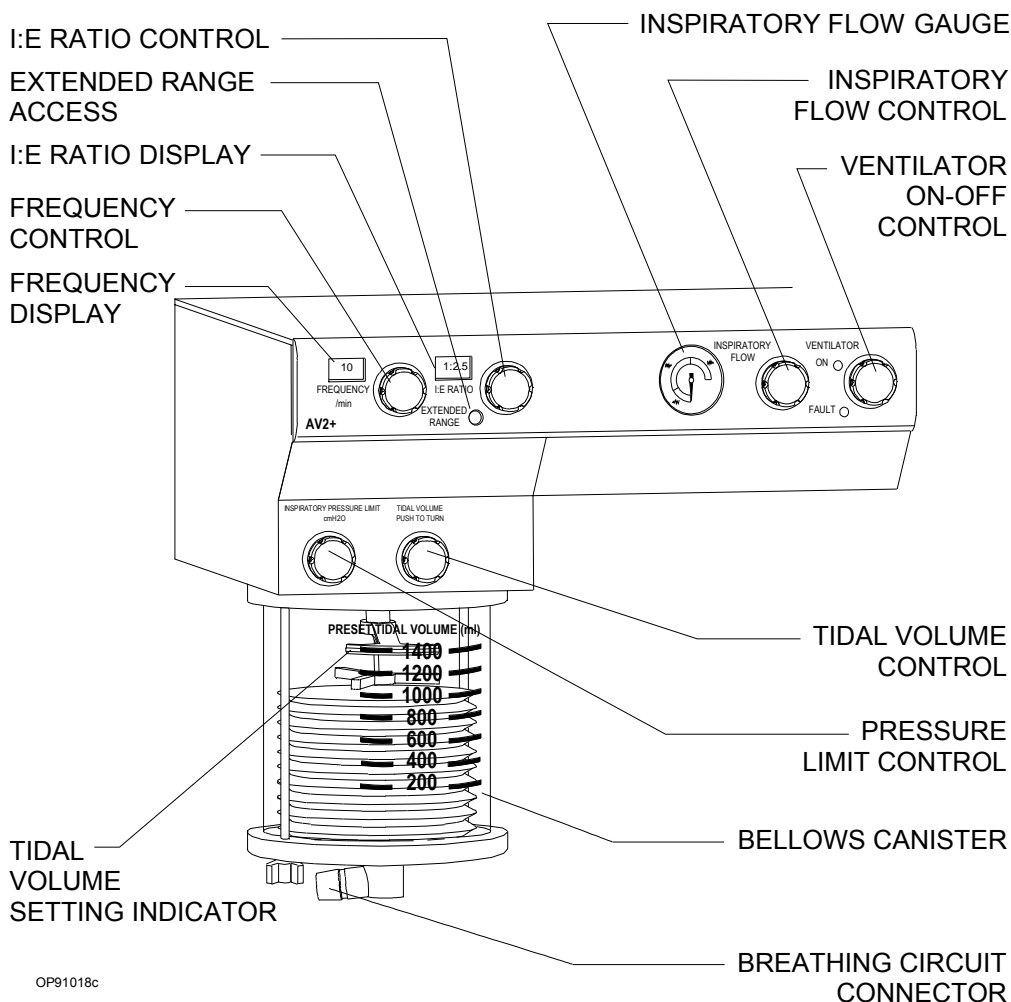
When the bellows is completely filled, any excess gas in the system is released to the scavenging system through the ventilator relief valve. As in any ascending bellows, the force needed to overcome gravity acting on the bellows causes a positive end-expiratory pressure (PEEP) within the breathing system. For the Narkomed GS, the PEEP is approximately 2 cm H<sub>2</sub>O.

The monitoring system's breathing pressure and expiratory flow waveform displays can be used as an aid in adjusting the ventilator and establishing alarm criteria.

**WARNING:** Regardless of the indications of any alarm or monitoring device, patient chest movement shall be the primary indication of a securely connected, properly ventilated patient.

A front view of the AV2+ anesthesia ventilator is shown in Figure 10-1.

Figure 10-1. AV2+ Anesthesia Ventilator (Front View)

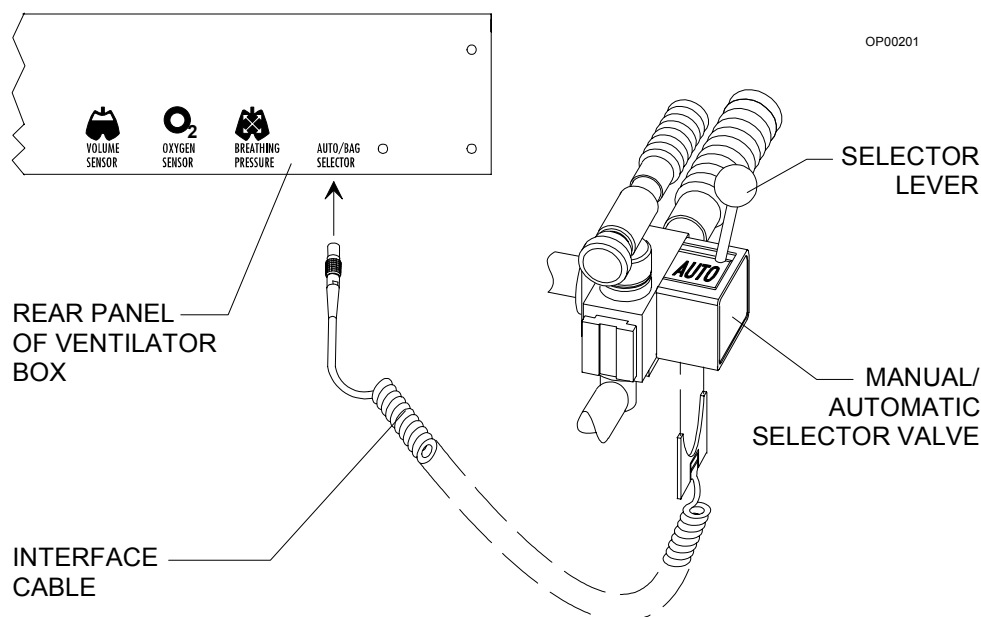


## Activating the Ventilator

The ventilator can be activated by using the ventilator on/off control, or, optionally, by using the lever on the manual/automatic selector valve. The anesthesia machine's SYSTEM POWER switch must be set to ON in order for the ventilator to function.

**NOTE:** The selector valve lever can activate the ventilator only when the interface cable is connected between the manual/automatic selector valve housing and the AUTO/BAG SELECTOR interface, as shown in Figure 10-2. When the interface cable is disconnected, the position of the selector lever has no effect on the ventilator.

Figure 10-2. Auto/Bag Selector Interface Cable Connection



When the ventilator is activated, both pneumatic and electric power to the ventilator are turned on, and the monitoring system's volume and pressure alarms are automatically enabled. When the ventilator is turned off, the FREQUENCY and I:E RATIO displays remain lighted, but the ventilator will not function.

### Using the Ventilator On/Off Control

The ventilator on/off control is a momentary switch that returns to its center position after being turned in either direction.

- To activate the ventilator, turn the switch clockwise; the green ON indicator is then turned on and the switch returns to its center position.

**NOTE:** The ventilator can only be activated when the manual/automatic selector valve is in the AUTO position (with the interface cable between the selector valve housing and AUTO/BAG SELECTOR interface connected). If you attempt to activate the ventilator with the selector lever in the BAG position, the yellow FAULT indicator on the ventilator bezel will be turned on, indicating a fault condition.

- To shut down the ventilator, turn the switch counterclockwise; the green ON indicator is then turned off and the switch returns to its center position.

### Using the Manual/Automatic Selector Valve Lever

The ventilator can be turned on and off with the selector lever on the manual/automatic selector valve (with the interface cable between the selector valve housing and AUTO/BAG SELECTOR interface properly connected).

**NOTE:** When you operate the lever, let it snap into position. Do not hold back on the lever; preventing its free movement could damage the ventilator's sensors.

- To activate the ventilator, move the manual/automatic selector valve lever to the **AUTO** position; the green **ON** indicator on the ventilator bezel is then turned on.
- To shut down the ventilator, move the manual/automatic selector valve lever to the **BAG** position; the green **ON** indicator on the ventilator bezel is then turned off.

### Adjusting the Tidal Volume

The tidal volume is adjusted using a self-locking knob, located above the bellows assembly. The control knob positions a stop within the bellows canister which limits the upward travel of the bellows and thus sets the maximum tidal volume of gas delivered to the patient. To adjust the tidal volume, press the self-locking knob so that it can turn, then set the desired tidal volume as shown by the setting indicator on the bellows chamber scale (marked 200–1400 ml). The tidal volume can be adjusted to achieve volumes between 20 and 1500 ml.

Smaller tidal volumes can be adjusted by setting the pointer below the 200 ml marking on the bellows chamber; larger tidal volumes can be selected by setting the pointer above the 1400 ml calibration.

As in any volume-preset anesthesia ventilator, the actual tidal volume delivered to the patient's lungs may differ from the preset volume at the bellows due to the compliance of the breathing system and fresh gas flow. To accurately set the tidal volume, refer to the tidal and minute volume measurements.

The position of the tidal volume indicator can be calibrated for a specific combination of fresh gas flow and equipment compliance by a Draeger Medical qualified technical service representative.

### Setting the Respiratory Frequency

Use the frequency control knob to set the respiratory frequency from 1 to 99 breaths per minute (BPM) in 1 BPM increments.

Clockwise rotation of the control knob increases the frequency setting, while counterclockwise rotation decreases the frequency setting.

## Setting the Inspiratory/Expiratory (I:E) Phase Time Ratio

Use the I:E ratio control knob to set the inspiratory/expiratory (I:E) phase time ratio. The standard range of ratios is from 1:1 through 1:4.5, adjustable in increments of 0.5.

An extended range of ratios is also available which allows the setting of inverse I:E ratios. The specific extended range settings are: 4:1, 3:1, and 2:1. The extended range settings are accessible by pressing the EXTENDED RANGE switch while rotating the I:E ratio control knob.

Clockwise rotation of the control knob increases the I:E ratio setting, while counterclockwise rotation decreases the I:E ratio setting.

**WARNING:** The use of inverse I:E ratios will introduce auto-PEEP.

## Setting the Inspiratory Flow Rate

Use the inspiratory flow control knob to set the inspiratory flow in the range of 10 l/min to 100 l/min. This setting controls the flow rate of gas into the bellows canister, and thus the flow rate of gas delivered to the patient.

Because of patient circuit variables such as lung compliance, fresh gas flow, airway resistance and equipment compliance, the flow gauge is labeled with nominal zones of LOW, MEDIUM, and HIGH.

You should adjust the flow setting to a point where the ventilator bellows is fully compressed (but not deformed) at the end of the inspiratory phase of the breathing cycle.

You can also use the inspiratory flow control to create an inspiratory plateau at the end of the inspiratory cycle and to affect the potential peak inspiratory pressure within the patient breathing system. Always check the pressure indicated by the breathing system pressure gauge and waveform when adjusting the inspiratory flow control.

## Setting the Inspiratory Pressure Limit

The pressure limit control, located above the bellows canister, is used to adjust the pressure limit. Nominal pressure zones are indicated by the label. This control determines the maximum pressure that can be delivered by the ventilator during the inspiratory phase of the respiratory cycle. Because of patient circuit variables, the scale on the label is only a reference; the pressure should be read from the breathing system pressure gauge or the anesthesia machine's pressure monitoring system.

When the pressure limit control is turned fully counterclockwise, the peak inspiratory pressure will be less than or equal to 15 cm H<sub>2</sub>O. When the control is turned fully clockwise, the peak inspiratory pressure will be less than or equal to 120 cm H<sub>2</sub>O.

## Problem Resolution

Table 10-1. Problem Resolution

PROBLEM	POSSIBLE CAUSE	REMEDY
Excessive PEEP	Improperly adjusted ventilator relief valve	Contact Draeger Medical qualified technical service representative.
	Insufficient suction scavenger flow setting	Increase suction scavenger flow valve.
	PEEP valve active	Decrease PEEP valve setting.
	Inverse I:E ratios	Reset ratios.
Excessive NEEP	Excessive suction scavenger flow	Reduce suction scavenger flow rate.
Bellows won't reach tidal volume stop setting during expiration	Frequency too high for selected tidal volume	Decrease frequency.
		Increase expiratory phase time.
	Improperly adjusted ventilator relief valve	Contact Draeger Medical qualified technical service representative.
	Breathing system leak	Repair leak.
Ventilator won't cycle	Low oxygen supply pressure	Provide sufficient oxygen supply pressure.
Moving manual/automatic selector valve lever to AUTO position does not activate ventilator.	SYSTEM POWER switch is in STANDBY position	Turn SYSTEM POWER switch to ON.
	Interface cable is not connected	Connect interface cable.
Ventilator does not operate; yellow FAULT LED on ventilator lights	Selector switch on the absorber is in the BAG position	Turn the selector switch on the absorber to the AUTO position

PROBLEM	POSSIBLE CAUSE	REMEDY
Bellows won't compress during inspiration	Absorber manual/automatic selector valve in BAG position	Place selector valve in AUTO position.
	Inspiratory flow control setting on ventilator too low	Increase inspiratory flow control setting.
	Frequency too high	Decrease frequency.
	Inspiratory pressure limit setting on ventilator too low	Increase inspiratory pressure limit setting.



# 11

## Monitoring System

*This section describes the monitoring system of the Narkomed GS anesthesia machine.*

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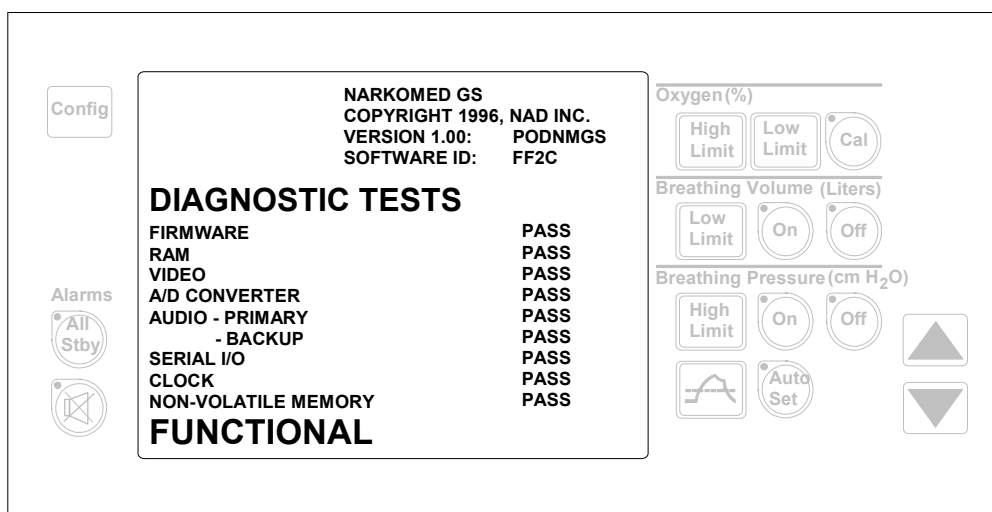
## Overview

In addition to monitoring clinical parameters, the Narkomed GS performs diagnostic self-tests every time the machine is turned on. After the initial power-on screen appears, the Monitor screen is displayed. This section of the manual describes these screens, and explains how to establish general monitoring settings.

## Power-On Screen

When you turn the SYSTEM POWER switch to the ON position, the Narkomed GS performs extensive self-tests on its internal hardware. As these diagnostics are performed, each test and its result appear on the screen. The result, PASS or FAIL, indicates the status of the tested component. See Figure 11-1.

Figure 11-1. Power-On Screen



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At the end of the self-diagnostics, one of three possible conclusions to the self-tests is posted on the screen:

**FUNCTIONAL** Every component of the monitoring system is in satisfactory operational order. After a brief delay, the Monitor screen appears.

**CONDITIONALLY FUNCTIONAL** A noncritical fault was detected, such as a speaker failure. The Narkomed GS may be used, but a Draeger Medical qualified technical service representative should be notified to correct the problem.

When you are ready to resume operation, press any key on the keypad.

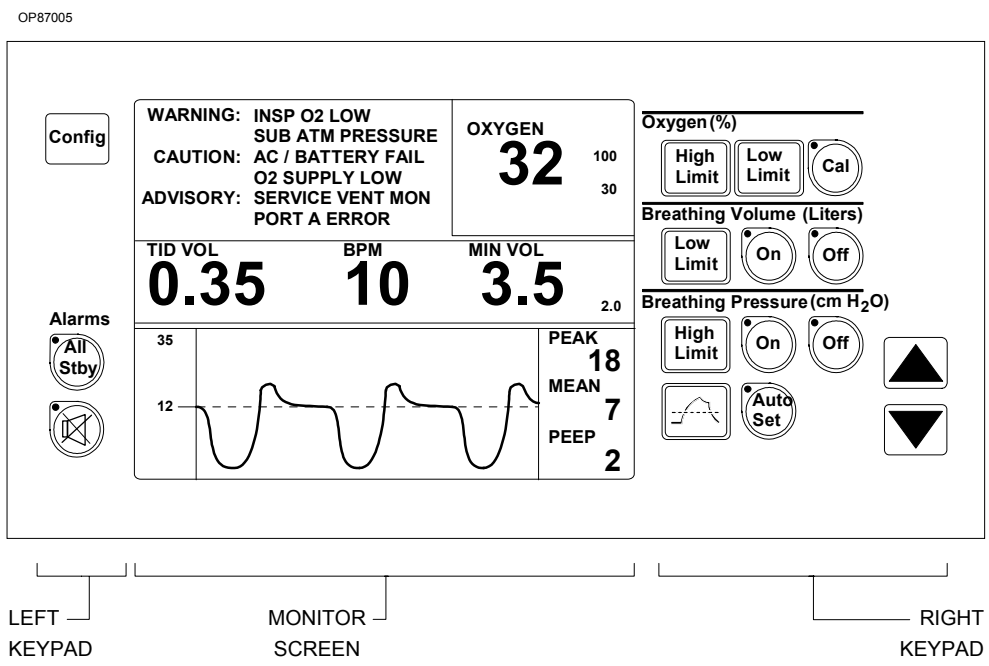
**NON-FUNCTIONAL**

A serious fault was detected and operation of the monitor is inhibited. Do not use the machine. Immediately notify a Draeger Medical qualified technical service representative to correct the problem.

**Monitor Screen and Controls**

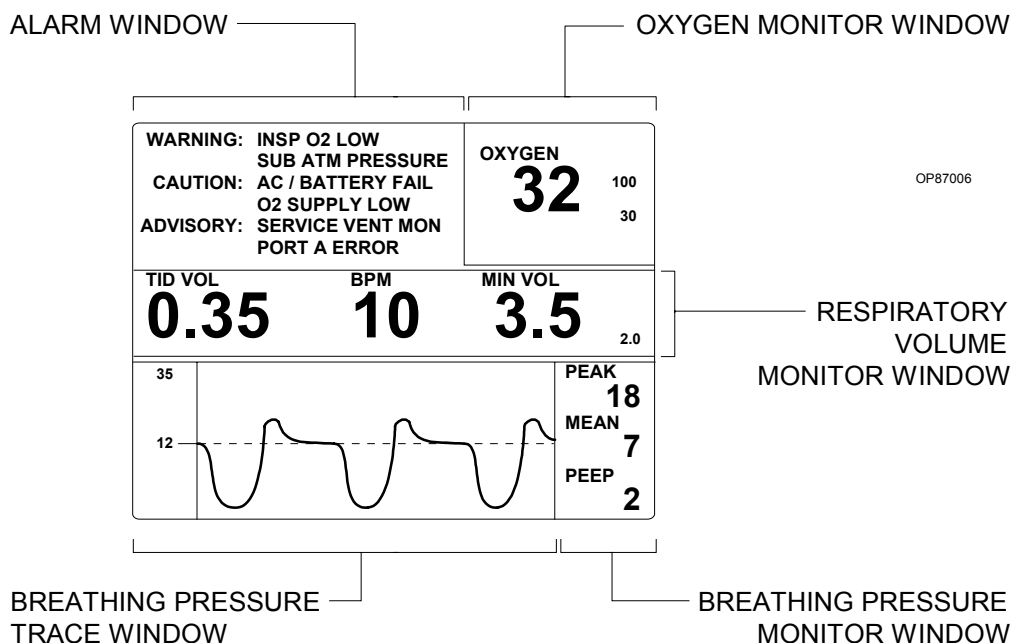
Following a successful power-up, monitoring information is displayed on the Monitor screen. The control keys to the left and right of this screen allow you to establish monitoring settings. See Figure 11-2.

Figure 11-2. Monitor Screen and System Controls



**Monitor Screen** The Monitor screen displays information in five separate windows, as shown in Figure 11-3.

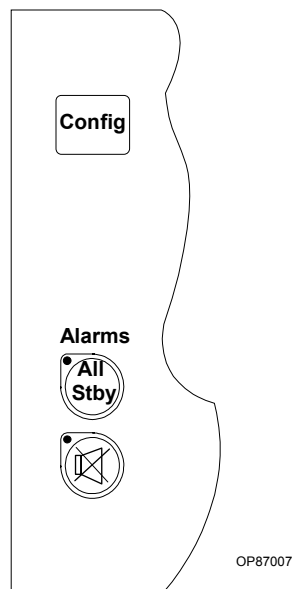
Figure 11-3. Monitor Screen





- **Alarm Window**—Displays up to six of the highest priority alarms.
- **Oxygen Monitor Window**—Displays the patient's oxygen concentration and the anesthesia machine's oxygen alarm limits.
- **Respiratory Volume Monitor Window**—Displays the patient's tidal volume, respiratory rate (breaths per minute), and minute volume, as well as the anesthesia machine's minute volume low alarm limit.
- **Breathing Pressure Monitor Window**—Displays the patient's peak airway pressure, mean airway pressure, and positive end expiratory pressure (PEEP).
- **Breathing Pressure Trace Window**—Displays a trace, or waveform, of the patient's breathing pressure, and the anesthesia machine's breathing pressure alarm limits (to the left of the waveform).


**Left Keypad** You use the left keypad to initiate system-wide monitoring functions.

Figure 11-4. Left Keypad



**All Standby**  When the ventilator is off, turns off audible tones and message displays associated with the breathing pressure alarm and respiratory volume alarms, until a valid breath is detected.  
If the ventilator is on, only the respiratory volume alarms are affected.

**Silence Alarms**  Silences all audible alarm tones for 2 minutes.

**Configure**  Displays the Configure screen, where you can set system parameters, such as the time, date, and alarm volume. You also enter the Alarm Log by way of the Configure screen.

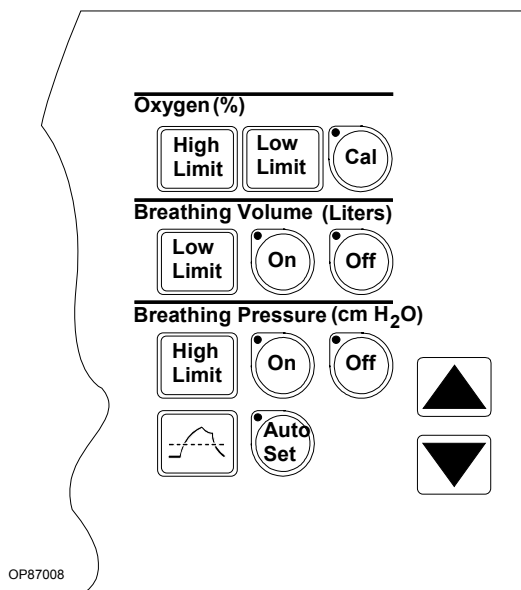
These functions are described in detail later in this section.

**11** | Monitoring System

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**Right Keypad** You use the right keypad to perform functions associated with a specific monitor. These functions are described in the following sections: Section 12, "Oxygen Monitoring", Section 13, "Respiratory Volume Monitoring", and Section 14, "Breathing Pressure Monitoring".

**Figure 11-5. Right Keypad**



## Configuring the Anesthesia Machine

You can configure the following parameters on the Narkomed GS:

- **Trace Speed**—Speed of the breathing pressure waveform trace: either FAST or SLOW
- **Alarm Volume**—Volume of annunciated alarms
- **Current Time**—The current hour and minute in 24-hour format (*hour:minute*)
- **Current Date**—The current day, month, and year
- **Display Alarms**—On/Off status of the anesthesia machine's Alarm window

The Display Alarms parameter is configurable only when the anesthesia machine is connected to another Narkomed product that can display the anesthesia machine's alarms on a central alarm display. An On status indicates that the anesthesia machine's Alarm window will continue to display alarms as usual. An Off status indicates that the anesthesia machine's Alarm window will not display alarms; instead, alarms will be displayed on the other product's central alarm display.

When you start the anesthesia machine, it uses the values that were established the last time the machine was configured. You can view or change these values on the Configure screen.

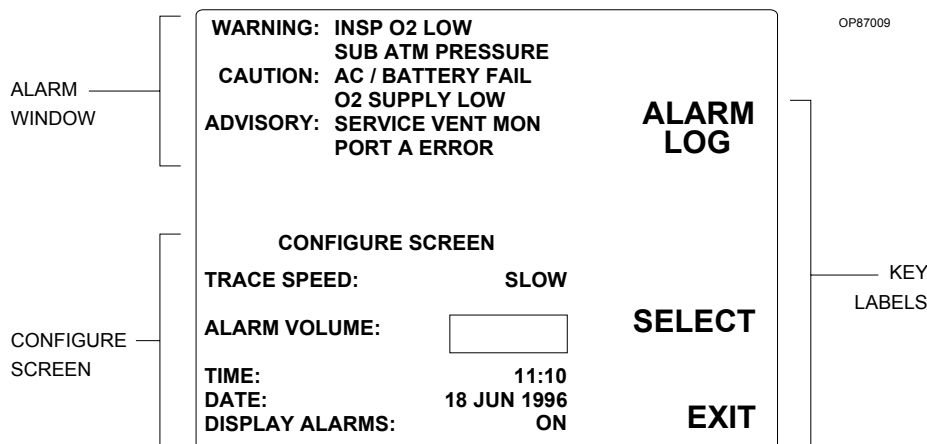
### Displaying the Configure Screen

To display the Configure screen, press the Config key, which is located on the left keypad.






The Configure screen replaces the standard Monitor screen. You must begin configuration within 1 minute, or the Monitor screen will replace the Configure screen.

Figure 11-6. Configure Screen



**Understanding the Keys** When the Configure screen is displayed, the system control keys function according to the labels on the screen as explained in Table 11-1.

**Table 11-1. Control Key Functions in the Configure Screen**

Key	Label	Function
	ALARM LOG	Displays the Alarm Log, a separate screen that lists cautions and warnings that have occurred
	SELECT	Selects a parameter by highlighting it with a box
	EXIT	Exits the Configure screen and returns to the Monitor screen

**Changing Parameter Values**



Follow this procedure for each parameter you want to change.

1. Press the SELECT key until the variable you want to change is highlighted with a box.
2. Press the up or down arrow key to increase or decrease the value of the highlighted variable.

**Exiting the Configure Screen**



To exit the Configure screen immediately, press the EXIT key.

**NOTE:** The monitoring system automatically exits the Configure screen if a minute passes and no keys are pressed.

When you exit the Configure screen, the values displayed on the screen are saved. The monitoring system uses these values until they are changed.

**Using the Alarm Log**

If you miss a warning or caution message in the Alarm window, you can look for it in the Alarm Log. It contains up to 100 of the most recent warning and caution messages. When there are more than 100 warnings and cautions, the oldest message is deleted to make room for the newest.

**Displaying the Alarm Log**



Follow this procedure to display the Alarm Log.

1. From the Monitor screen, press the Config key.  
The Configure screen is displayed.



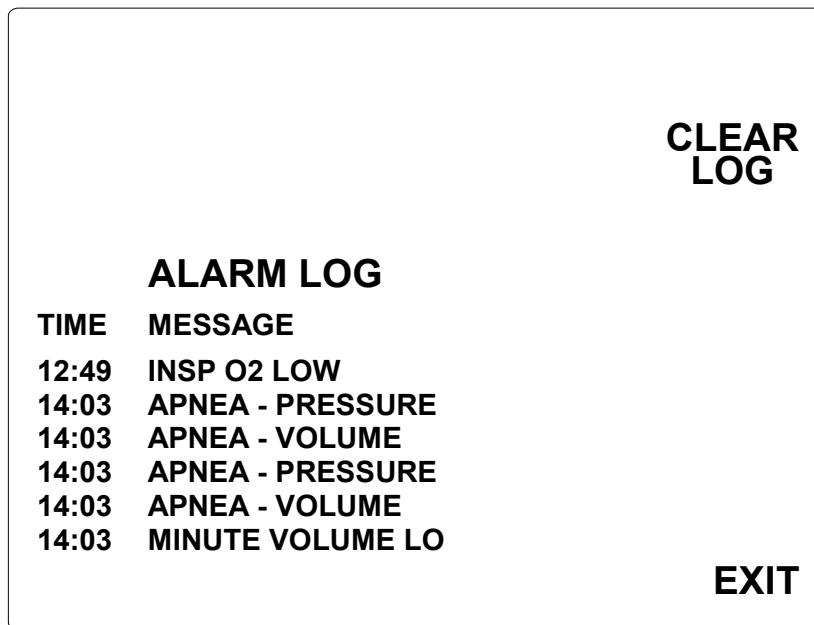


2. From the Configure screen, press the ALARM LOG key.

The Alarm Log appears, with the first warning or caution that occurred at the top of the list.

3. If the list extends beyond the page, scroll forward by pressing the down arrow key, and scroll backward by pressing the up arrow key.

Figure 11-7. Alarm Log



Clearing the Alarm Log

To delete all of the messages from the Alarm Log, press the CLEAR LOG key.



The messages are permanently deleted from the Log.

Exiting the Alarm Log

To exit the Alarm Log immediately, press the EXIT key.

**NOTE:** The monitoring system automatically exits the Alarm Log if a minute passes and no keys are pressed.



When you exit the Alarm Log, you are returned to the Monitor screen.

## Setting Alarms to Standby



When the ventilator is off, you can use the All Stby key to turn off audible tones and message displays associated with the breathing pressure alarm and respiratory volume alarms. The alarms remain in this standby condition until the monitor detects a valid breath.

**NOTE:** When the ventilator is on, pressing the All Stby key places the volume alarm in Standby until the next breath is detected. It has no effect on the pressure alarm. The pressure alarm cannot be turned off when the ventilator is on.

To set alarms to standby, press the All Stby key.

The LED next to the All Stby key lights to indicate the standby condition.

## Silencing Alarms



You can silence all audible alarm tones for 2 minutes while retaining the alarm message display on the monitor.

To silence alarm tones for 2 minutes, press the Silence Alarms key.

The LED next to the Silence Alarms key lights and remains lit for the duration of the silence period. Pressing the Silence Alarms key while the LED is lit restarts the 2-minute silence period.

If a new alarm condition occurs during the silence period, a single tone pattern sounds corresponding to the priority of the alarm.

After the silence period, one of the following occurs:

- If no alarm conditions are active, audio annunciation reverts to normal.
- If any Warning or Caution conditions are active, the tone associated with the highest existing alarm condition sounds. The alarm continues to sound once every minute, for up to 3 minutes, or until alarm conditions have been cleared for 10 seconds.

**NOTE:** All continuous audible alarms are automatically silenced for 2 minutes following power-up. During this period, the occurrence of a new alarm produces a non-repeating tone pattern appropriate for that alarm's level of urgency.

# 12

## Oxygen Monitoring

*This section describes the oxygen monitoring of the Narkomed GS anesthesia machine.*

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## Overview

Inspiratory oxygen concentration is measured with a dual galvanic cell sensor, which is attached to the inspiratory valve dome. The sensor contains two independent electrochemical cells, or sensor halves. When the sensor takes in oxygen, an electrochemical reaction occurs within each cell. The oxygen monitor reads the voltage produced in each cell, computes an average for the two cells, and translates the average into an oxygen concentration measurement.

**CAUTION:** Never remove an oxygen sensor from its housing, except to replace it. If a sensor is removed from its housing, you must do the following before continuing normal operations:

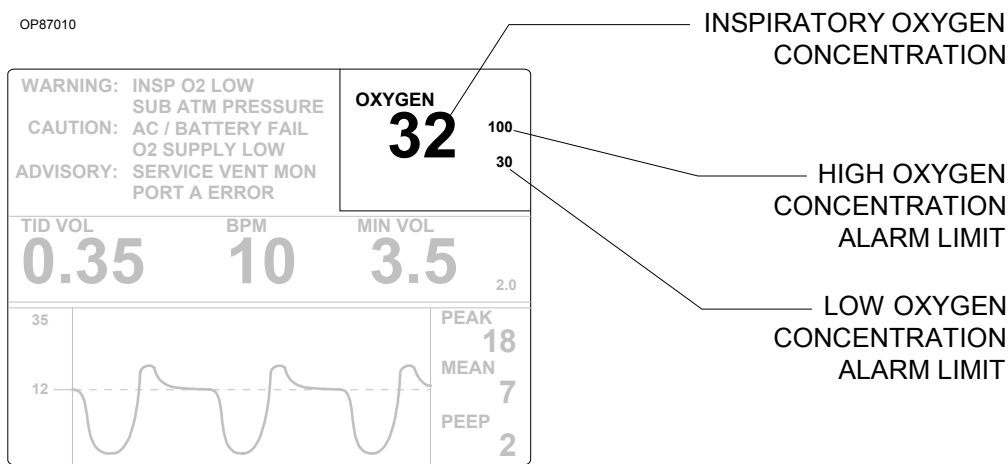
- Reinstall the sensor in the housing.
- Wait for a period equal to the time that the sensor spent outside the housing.
- Calibrate the sensor.

**NOTE:** When the machine is not in use, remove the oxygen sensor assembly from the inspiratory valve dome, and insert the inspiratory valve dome plug into the inspiratory valve dome.

## Monitor Display

Information about the oxygen analysis is presented in the Oxygen Monitor window at the top right of the monitor display as shown in Figure 12-1. The numerical value for inspiratory oxygen concentration is shown in large type. To the right of this figure, in small type, are the high and low oxygen concentration alarm limits.

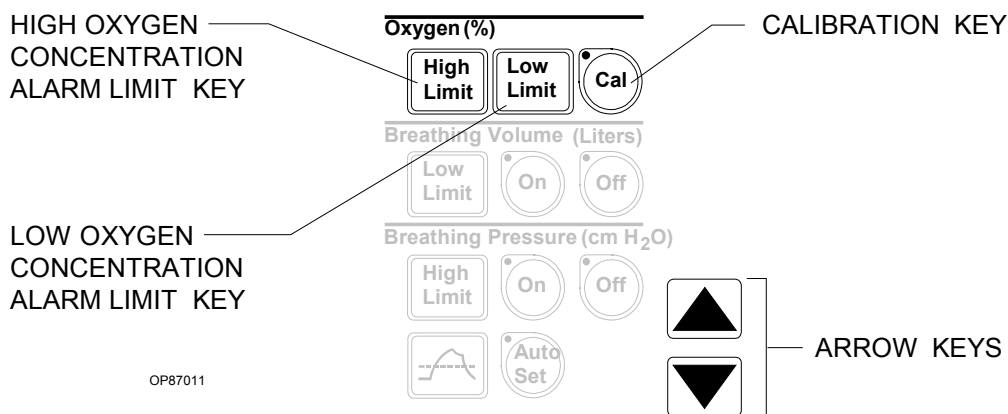
Figure 12-1. Monitor Display



## Monitor Controls

You use the oxygen monitor control keys and the arrow keys on the right keypad to set oxygen concentration alarm limits and calibrate the oxygen sensor. The oxygen monitor control keys are located next to the Oxygen Monitor window. See Figure 12-2.

Figure 12-2. Monitor Controls



## Setting Alarm Limits



At power-up, the oxygen high and low alarm limits are automatically set to their system defaults. You can adjust these limits within specified ranges. Valid settings for the alarm limits, and their system defaults, are shown in Table 12-1.

Table 12-1. Alarm Limits

Alarm Limit	Default	Valid Settings
High	100%	19%–100%; must be greater than low alarm limit
Low	30%	18%–99%; must be less than high alarm limit

Follow these steps to change the high or low alarm limit:

1. Press the oxygen High Limit or Low Limit key, depending on which alarm limit you want to change.  
A box is drawn around the selected alarm limit.
2. Press the up arrow or down arrow key to increase or decrease the highlighted alarm limit.
3. To save the new value, stop pressing arrow keys until the highlighting box disappears (5 seconds), or press a different alarm limit key.

The new value is saved as the alarm limit.

## Calibrating the Oxygen Sensor

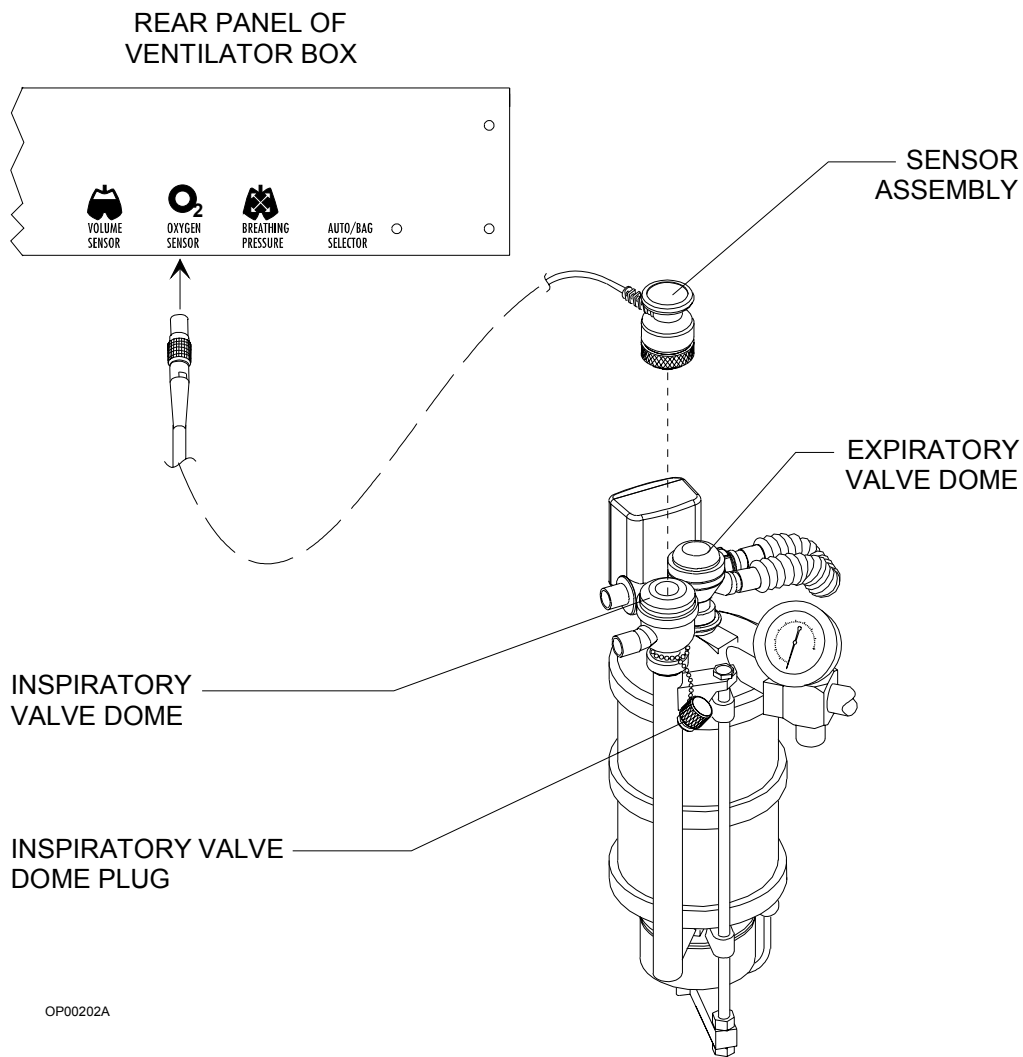
To calibrate the oxygen sensor correctly, make sure it is exposed only to room air during the entire calibration period. You should calibrate the oxygen sensor as part of the daily preoperative setup of the anesthesia equipment. Refer to Figure 12-3.

1. Remove the sensor assembly from the inspiratory valve dome and close off the dome with the inspiratory valve dome plug. (Do not disassemble the sensor assembly further.)
2. Expose the sensor to ambient air only (21% oxygen concentration) and allow it to stabilize for several minutes. To ensure an ambient air exposure, hold the sensor away from any open part of the breathing system.
3. With the sensor exposed only to room air, press the Cal key.  
Calibration begins.
4. View the monitor screens to track progress of the 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. (If the calibration was not successful, the Oxygen Monitor window is blank. See “Unsuccessful Calibration” on page 12-6 for further information.)

Typically, calibration lasts less than 30 seconds. However, the time may vary depending on the amount of oxygen the sensor was exposed to before calibration.

<u>Oxygen Exposure</u>	<u>Typical Calibration Time</u>
21%	10 seconds
> 21%	up to 50 seconds

Figure 12-3. Calibrating the Oxygen Sensor



5. When the Narkomed GS successfully completes the calibration, pull the inspiratory valve dome plug and reinsert the sensor assembly.

## Unsuccessful Calibration

If, at the end of the calibration period, the Oxygen Monitor window is blank, the calibration was not successful. (This condition is also indicated by the CAL O2 SENSOR Advisory message in the Alarm window.)

An unsuccessful calibration can be caused by several conditions as described in Table 12-2.

**Table 12-2. Unsuccessful Calibration - Causes and Solutions**

Cause	Solution
Sensor was exposed to an excessively lean or excessively rich oxygen calibration mixture.	Make sure that the sensor is exposed to room air only for the entire calibration period.
Sensor was exposed to a constantly changing calibration mixture.	Make sure that the sensor is exposed to room air only for the entire calibration period.
Sensor did not receive the proper waiting period.	If the sensor capsule was removed from the sensor assembly, a waiting period equal to the time that the capsule spent outside the sensor assembly (up to one week) is necessary prior to calibration. New sensors require a 15-minute waiting period.
Sensor is exhausted.	If the oxygen sensor has decayed beyond its useful service life (see the "Specifications" section of the manual), replace the decayed sensor with a new sensor and allow the proper waiting period.
Sensor is defective.	If there is too great a difference between the outputs of the two sensor halves, replace the defective sensor with a new sensor, and allow the proper waiting period prior to calibration.
Sensor is disconnected.	When the sensor is disconnected, the display area is blank, and the message O2 SENSOR DISC appears in the Alarm window. If this happens, reconnect the sensor cord to the OXYGEN SENSOR interface beneath the rear panel of the ventilator box and try to calibrate the oxygen sensor again.

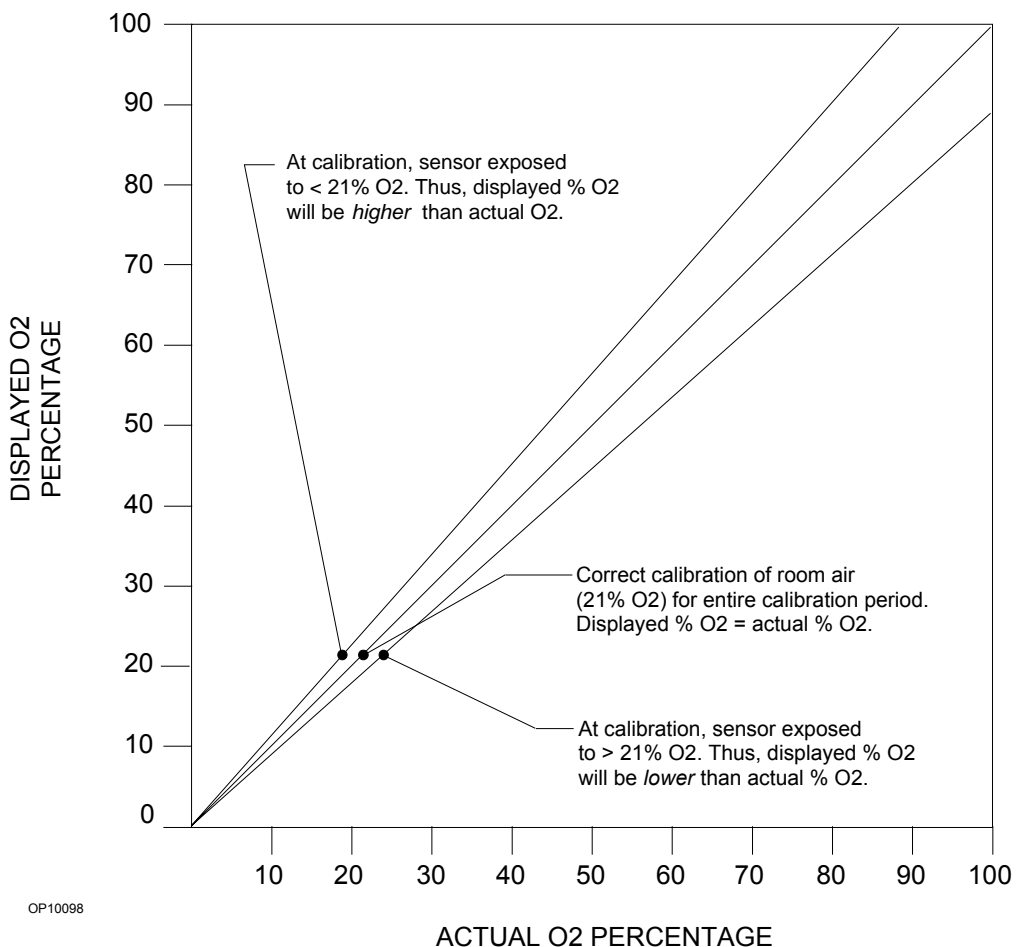


**Consequences**

If the oxygen sensor is improperly calibrated, it can cause inaccurate measurements. When a calibration gas mixture is excessively rich or lean in oxygen, the Narkomed GS will not complete an attempted calibration; however, if the calibration gas is rich or lean but is within certain limits, the Narkomed GS will complete the calibration. As a result, when displaying sensor measurements, the Narkomed GS displays an oxygen percentage either greater or less than the actual oxygen percentage. Therefore, make sure that the sensor is exposed only to room air during the entire calibration period.

Figure 12-4 illustrates the relationship between the calibration mixture and the accuracy of oxygen measurement.

**Figure 12-4. Measurement Error Due to Incorrect Calibration**



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## Oxygen Alarm Messages

The following list contains all warning, caution, and advisory alarms associated with oxygen monitoring.

### **INSP O2 LOW (Warning)**

The Narkomed GS continuously compares the current inspiratory oxygen percentage with the preset low oxygen alarm limit. If the measured oxygen concentration falls below the low alarm limit, the Warning message INSP O2 LOW appears in the Alarm window, and a continuous audible alarm sounds.

### **INSP O2 HIGH (Advisory)**

If the measured inspiratory oxygen concentration exceeds the preset high alarm limit, the Advisory message INSP O2 HIGH appears in the Alarm window, and a single-tone audible alarm sounds.

### **O2 SENSOR DISC (Advisory)**

If the oxygen sensor cord becomes disconnected (or is damaged enough to cause an open circuit), the Advisory message O2 SENSOR DISC appears in the Alarm window, and a single-tone audible alarm sounds.

### **REPLACE O2 CELL (Advisory)**

During oxygen sensor calibration and monitoring, the Narkomed GS checks for a difference between the outputs of the two sensor channels. If the difference exceeds a predetermined percentage, the Advisory message REPLACE O2 CELL appears in the Alarm window.

During oxygen sensor calibration, the Narkomed GS also checks the sensor's output against a range of acceptable output voltages. There are three possible causes for deviation from within this range.

- *Exhausted sensor.* If the sensor's capacity is exhausted, its output voltage will not meet the required minimum.
- *Incorrect calibration environment.* If the sensor is exposed to an excessive oxygen during calibration, the sensor's output will be above or below the acceptable output range.
- *Improper waiting.* If the proper waiting period is not allowed for a new sensor or for a sensor removed from the sensor housing, the sensor's output may be above or below the acceptable output range.

If a sensor error condition is detected during monitoring, the Advisory message REPLACE O2 CELL appears in the Alarm window and operation continues. Try to recalibrate the sensor; if the message remains, replace the sensor cell.

**CAL O2  
SENSOR  
(Advisory)**

The Advisory message CAL O2 SENSOR appears in the Alarm window in the following instances:

- the oxygen sensor enters a non-calibrated state
- the Narkomed GS is unable to calibrate the oxygen sensor
- more than 18 hours have elapsed since the last calibration

**SERVICE  
VENT MON  
(Advisory)**

If the Narkomed GS detects an internal electronic failure that would prevent proper operation, the Advisory message SERVICE VENT MON appears in the Alarm window. If this happens, contact a Draeger Medical qualified technical service representative.

**Low Oxygen Supply Whistle**

If the Narkomed GS is configured to do so, it sounds a 7-second whistle when the oxygen supply drops too low to properly pressurize the fresh gas circuit (below about 37 psi). If this alarm sounds, it cannot be silenced.

**Problem Resolution**

Table 12-3. Oxygen Monitoring Problem Resolution

PROBLEM	POSSIBLE CAUSE	REMEDY
Display area remains blank when a reading is expected. CAL O2 SENSOR message in Alarm window.	Needs calibration	Perform proper calibration. Remove sensor assembly from breathing circuit. Make sure sensor is exposed to room air only. Then press the Cal key.
O <sub>2</sub> analyzer fails to retain calibration. Alarm message CAL O2 SENSOR appears in Alarm window.	Backup memory power not available	Check battery circuit breaker.  Allow backup battery to recharge, and recalibrate the analyzer.
	Hardware malfunction	Contact Draeger Medical qualified technical service representative.

<b>PROBLEM</b>	<b>POSSIBLE CAUSE</b>	<b>REMEDY</b>
Pressing Cal does not initiate calibration.	Sensor is disconnected	Insert sensor cord connector into OXYGEN SENSOR interface underneath rear panel of ventilator box.
	Sensor cord is damaged	Replace housing/cord assembly.
Pressing Cal initiates calibration, but Oxygen Monitor window is blank at end of calibration period.	Sensor is exposed to incorrect oxygen concentration.	Expose sensor to room air for 21% calibration.
	Sensor exposed to constantly changing calibration mixture.	
	Sensor capsule was removed from housing for a prolonged period.	Allow a waiting period equal to duration of capsule removal.
	New capsule not given proper waiting period.	Allow 15 minute waiting period.
	Exhausted or defective sensor capsule.	Replace housing/cable assembly.
O2 SENSOR DISC message appears in alarm window during monitoring.	Defective sensor housing and cable.	Replace housing/cable assembly.
	Sensor cord is disconnected.	Insert sensor cord connector into OXYGEN SENSOR interface underneath rear panel of ventilator box.

# 13

## Respiratory Volume Monitoring

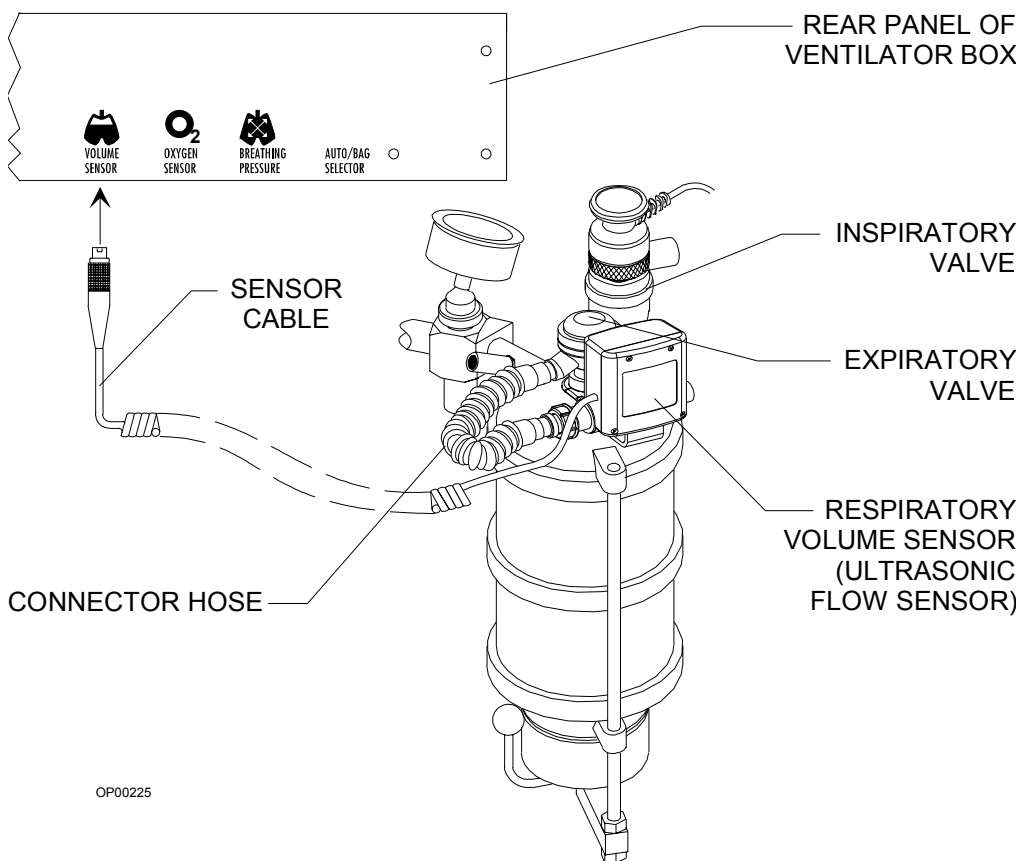
*This section describes the respiratory volume monitoring of the Narkomed GS anesthesia machine.*

Overview .....	13-2
Monitor Display .....	13-3
Monitor Controls .....	13-4
Setting the Minute Volume Low Alarm Limit .....	13-5
Turning Respiratory Volume Alarms Off .....	13-5
Turning Respiratory Volume Alarms On .....	13-5
Respiratory Volume Alarm Messages .....	13-6
Problem Resolution .....	13-8

## Overview

Respiratory volume is measured using an ultrasonic flow sensor which is attached to the expiratory valve and mounted to the top of the absorber assembly as shown in Figure 13-1. The ultrasonic flow sensor has two transducers that measure the time of flight of ultrasonic pulses transmitted upstream and downstream in the respiratory flow path. The difference in time of flight is used to determine the velocity and the flow rate of gas through the patient circuit. The flow sensor output is converted into meaningful readings for minute volume, tidal volume, and respiratory rate displays.

Figure 13-1. Respiratory Volume System



**WARNING:** The ultrasonic flow sensor can be used with all normal anesthetic gases except oxygen-helium (heliox). Incorrect flow measurements will result if heliox is used.

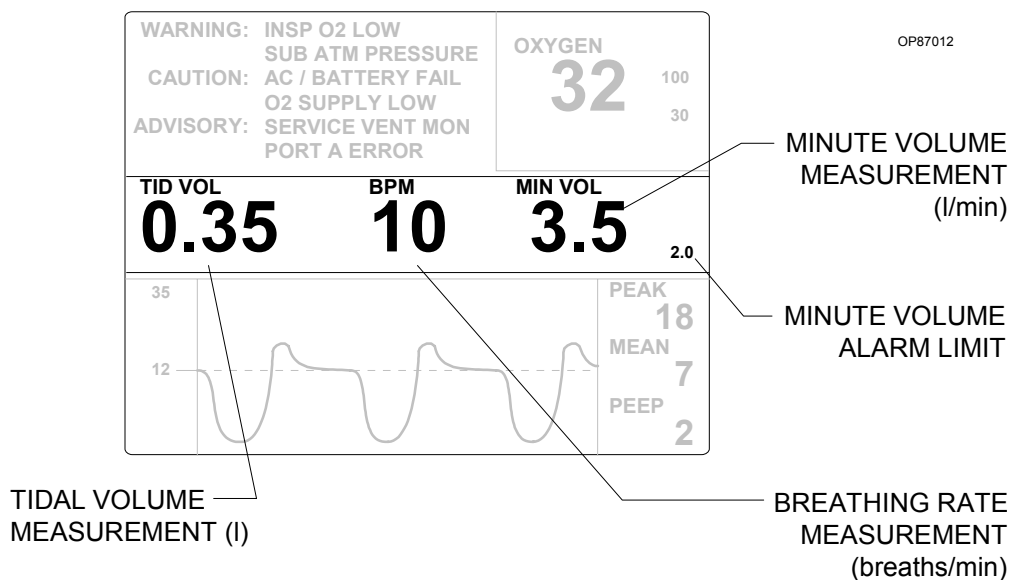
**CAUTION:** Although the Narkomed GS is designed to minimize the effects of ambient radio-frequency interference, the functioning of the respiratory volume monitor may be adversely affected by the operation of electrosurgical equipment or short wave or microwave diathermy equipment in the vicinity.

**NOTE:** Sudden, irregular expiratory flow may cause erratic tidal volume and respiratory rate displays. To avoid such erroneous measurements, defer reading the display until a full minute has elapsed after the irregular flow has stopped.

## Monitor Display

Information about the patient's respiratory volume is presented in the Respiratory Volume Monitor window in the middle of the monitor display as shown in Figure 13-2. From left to right, numerical values are shown in large type for tidal volume, respiratory rate, and minute volume. At the extreme right, in small type, is the minute volume low alarm limit.

Figure 13-2. Monitor Display



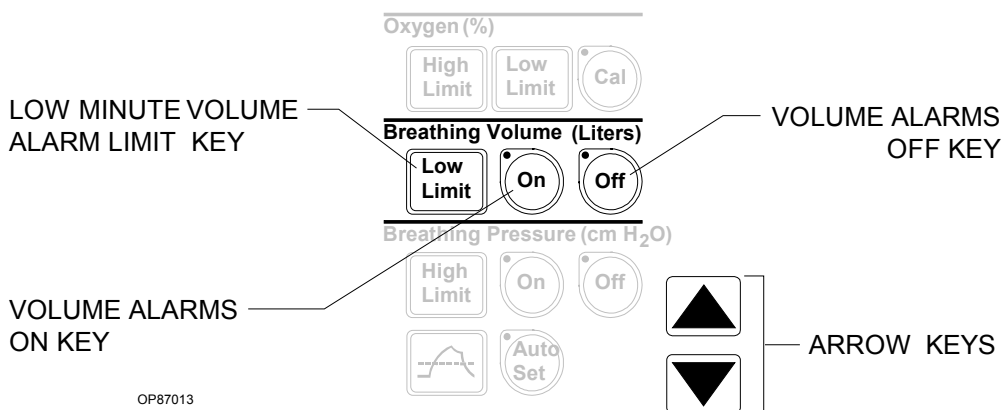
- **Tidal Volume Measurement (TID VOL)**—Displays the volume for each breath. If the monitor does not detect a valid breath within 30 seconds, the display area goes blank.
- **Breathing Rate Measurement (BPM)**—Shows the number of breaths during the previous minute of respiration. If the BPM display is blank, a full minute of respiration has not occurred.

- **Minute Volume Measurement (MIN VOL)**— Continuously displays the volume of exhaled gas accumulated during the previous minute of respiration. A blank MIN VOL display area indicates that a full one-minute history of exhaled volume is not available.
- **Minute Volume Alarm Limit**—Indicates the volume below which an alarm condition occurs.

## Monitor Controls

You use the respiratory volume monitor control keys and the arrow keys on the right keypad to set the minute volume low alarm limit and to turn the volume alarms on and off. The respiratory volume monitor control keys are located next to the Respiratory Volume Monitor window. See Figure 13-3.

Figure 13-3. Monitor Controls



Fixed alarms are provided for low tidal volume (apnea-volume), low minute volume, and reverse flow through the sensor. While the ventilator is on, apnea volume alarms are generated at 15 seconds (Caution) and 30 seconds (Warning) if the respiratory volume monitor does not sense a valid breath. While the ventilator is off, these alarms are generated at 30 seconds (Caution) and 60 seconds (Warning).

The Narkomed GS's volume alarms are automatically enabled when the ventilator power switch is turned to the ON position. A disconnected or damaged sensor causes a sensor failure alarm.



## Setting the Minute Volume Low Alarm Limit

If the low minute volume falls below the minute volume low alarm limit, an alarm condition occurs. The alarm limit is automatically set to a default of 1.0 liter/min. at power-up. You can change the default to a value within the range of 0.2 liters/min. to 10.0 liters/min.

Follow these steps to adjust the minute volume low alarm limit:

1. Press the Breathing Volume Low Limit key.  
A box is drawn around the minute volume low alarm limit.
2. Press the up arrow or down arrow key to increase or decrease the highlighted alarm limit.
3. To save the new value, stop pressing arrow keys until the highlighting box disappears (5 seconds), or press a different alarm Limit key.  
The new value is saved as the alarm limit.

## Turning Respiratory Volume Alarms Off

To turn off the respiratory volume alarms, press the Breathing Volume Off key.

The alarms stop sounding and their messages are erased from the display. In addition, the LED next to the Breathing Volume Off key lights to indicate the Off condition.

## Turning Respiratory Volume Alarms On

To turn on the respiratory volume alarms, press the Breathing Volume On key.

The LED next to the Breathing Volume On key lights to indicate that the volume alarms are enabled.

**NOTE:** After power-up, the volume alarms are in standby.

## Respiratory Volume Alarm Messages

The following list contains all warning, caution, and advisory alarms associated with respiratory volume monitoring.

### **APNEA- VOLUME (Warning/ Caution)**

The Narkomed GS continuously monitors the expiratory flow in the patient breathing system. By processing the expiratory flow pattern, the monitor can determine whether a “valid” breath has occurred. A “valid” breath has a tidal volume of 20 ml or greater.

#### **When the ventilator is on:**

- If 15 seconds pass and a valid breath is not detected, the Caution message APNEA-VOLUME appears in the Alarm window, and an intermittent audible alarm sounds.
- If an additional 15 seconds pass (30 seconds total) and a valid breath is not detected, the Caution message APNEA-VOLUME is upgraded to a Warning in the Alarm window, and a continuously repeating audible alarm sounds.

#### **When the ventilator is off:**

- The Caution condition does not occur until 30 seconds have elapsed.
- The Warning condition does not occur until 60 seconds have elapsed.

During apneic conditions, the respiratory volume measurements disappear after 30 seconds. When a valid breath is detected, alarm annunciation ceases and a tidal volume measurement appears in the display window. However, a full minute of respiratory activity must be registered before the minute volume and respiratory rate appear.

**NOTE:** You can disable volume-related alarms by pressing the Breathing Volume Off key.

**NOTE:** During some breathing system disconnects when the ventilator is in use, the ventilator's dynamics may cause a small volume of gas to be drawn through the expiratory valve and the ultrasonic flow sensor. Because of the enhanced sensitivity of the flow sensor, this volume may be detected as a valid breath. However, the disconnect will still be detected by the airway pressure monitor which is always on and can not be turned off when the ventilator is in use.

### **MINUTE VOLUME LOW (Caution)**

Whenever the Narkomed GS measures a minute volume less than the low minute volume alarm limit, the Caution message MINUTE VOLUME LOW appears in the Alarm window, and an intermittent audible alarm sounds.

**REVERSE  
FLOW  
(Advisory)**

If a reverse flow in excess of 20 ml is detected, the Advisory message REVERSE FLOW appears in the Alarm window, and a single-tone audible alarm sounds.

A forward flow greater than 20 ml clears the alarm condition. The REVERSE FLOW alarm message remains on the screen for 5 seconds after the resumption of forward flow to allow for recognition of an intermittent reverse flow condition.

**VOL SENSOR  
DISC  
(Advisory)**

The VOL SENSOR DISC advisory message appears in the Alarm window if the sensor cable is not properly connected to the interface panel, if there is an internal sensor fault, or if the electronics housing is not properly seated on the flow housing/transducer assembly.

**VOL ALARMS  
STBY  
(Advisory)**

When the volume alarms have been set to Standby, the Advisory message VOL ALARMS STBY appears in the Alarm window.

**SERVICE  
VENT MON  
(Advisory)**

If the Narkomed GS detects an internal electronic failure that would prevent proper operation, the Advisory message SERVICE VENT MON appears in the Alarm window. If this happens, contact a Draeger Medical qualified technical service representative.

## Problem Resolution

Table 13-1. Respiratory Volume Monitoring Problem Resolution

PROBLEM	POSSIBLE CAUSE	REMEDY
Blank display area	One full minute has not elapsed (for minute volume and respiratory rate) since respiration began	Wait one full minute to read display.
	Apnea condition	Correct apnea condition. Ensure sensor is properly connected to the expiratory valve.
Blank display area, VOL SENSOR DISC alarm message in Alarm window	Sensor cable disconnected	Reconnect sensor cable to interface panel on anesthesia machine.
	Sensor fault	Replace sensor assembly.
	Electronics housing is not properly seated on flow housing/transducer assembly	Reseat electronics housing on the flow housing/transducer assembly and ensure it is locked in place.
REVERSE FLOW alarm message in Alarm window	Expiratory valve not closing completely during inspiration	Check expiratory valve disc and pins. Clean, repair, or replace expiratory valve.
	Defective sensor	Replace sensor assembly.

# 14

## Breathing Pressure Monitoring

*This section describes the breathing pressure monitoring of the Narkomed GS anesthesia machine.*

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## Overview

Breathing pressure is measured with a solid-state pressure transducer that can sense pressure at either the absorber or patient Y-piece, depending on which pilot line is used.

## Choice of Breathing Pressure Monitoring Location

Draeger Medical has no control over the type of breathing hoses and Y-pieces that are ultimately used with Draeger Medical absorber systems and pressure monitors—specifically, whether such user-supplied components include a terminal for pressure monitoring at or near the Y-piece. In order to ensure that some form of pressure monitoring is always used, provisions have been made for pressure monitoring at the absorber (the quick-connect fitting on the absorber gas pipe). However, do not construe this provision for monitoring at the absorber as a recommendation from Draeger Medical for this pressure monitoring location.

In fact, arguments can be made for pressure monitoring at either the Y-piece or at the absorber. Advocates of Y-piece pressure monitoring first claim that it more accurately reflects the pressure developed in the patient's lungs. They also claim that a blocked breathing system can be more easily detected with this method when compared with pressure monitoring at the absorber.

For example, if the inspiratory breathing hose became kinked or blocked during automatic ventilation, the ventilator bellows would continue to cycle against the blocked hose. A pressure monitor connected at the Y-piece (downstream of the occlusion) could sense either an absence of pressure fluctuation and alarm, or could sense a reduced pressure fluctuation (below the threshold pressure alarm limit) and alarm. In contrast, a pressure monitor connected at the absorber (upstream of the occlusion) could sense a pressure fluctuation above the threshold pressure alarm limit, and thus would not alarm. (Both of these scenarios assume that the occlusion does not cause a peak pressure high enough to activate the peak pressure alarm, which is meant to detect pressures likely to cause barotrauma.)

However, Draeger Medical disagrees with the idea of relying on pressure monitoring to detect a blocked breathing circuit. Carbon dioxide monitoring and respiratory flow monitoring provide superior detection of blocked breathing paths when compared to pressure monitoring, which detects such conditions only in some instances. Draeger Medical pressure monitors are therefore not promoted for detection of blocked breathing paths.

Further, Y-piece pressure monitoring has several disadvantages that could collectively cause the operator to neglect connecting the pressure monitoring pilot line. Examples include increased contamination of the pilot line due to its proximity to secretions, buildup of condensation within the pilot line, and the introduction of additional disconnection points (if the pilot line connects to a 15 mm adapter).

In conclusion, the responsibility for the selection of pressure monitoring at either the absorber or the Y-piece rests with you, the operator. Your clinical considerations, over which Draeger Medical has no control, must be included in this decision. Draeger Medical is available to discuss with you in detail the positive and negative aspects of each pressure monitoring approach.

## Installing the Breathing Pressure Pilot Line

Draeger Medical anesthesia systems are supplied with two breathing pressure pilot lines:

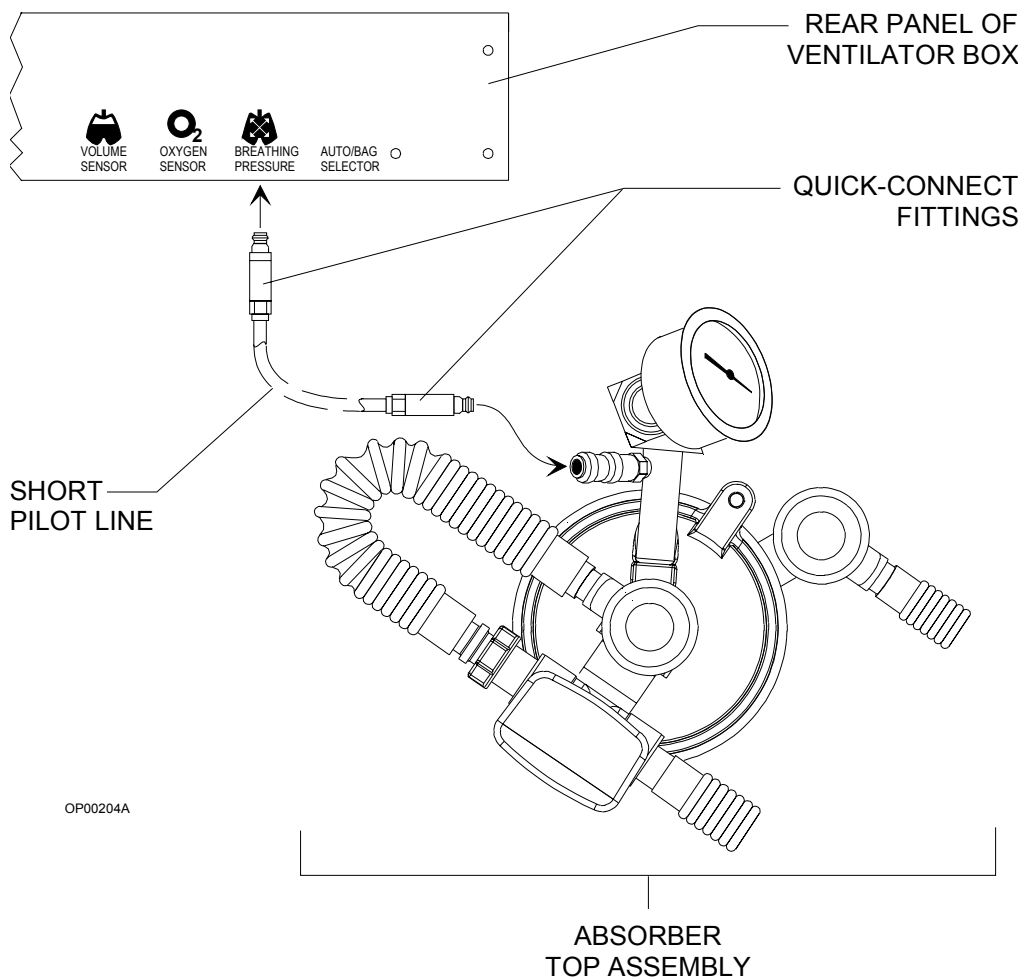
- A short line for breathing pressure monitoring at the absorber
- A long line for breathing pressure monitoring at the Y-piece

### For Absorber Monitoring

For breathing pressure monitoring at the absorber, install the short pilot line (which has quick-connect fittings on both ends) as follows (refer to Figure 14-1):

1. Connect one end of the pilot line to the fitting mounted on the rear of the pipe extending from the absorber top assembly.
2. Connect the other end of the pilot line to the BREATHING PRESSURE interface underneath the rear panel of the ventilator box.

Figure 14-1. Absorber Monitoring





**For Y-piece Monitoring**

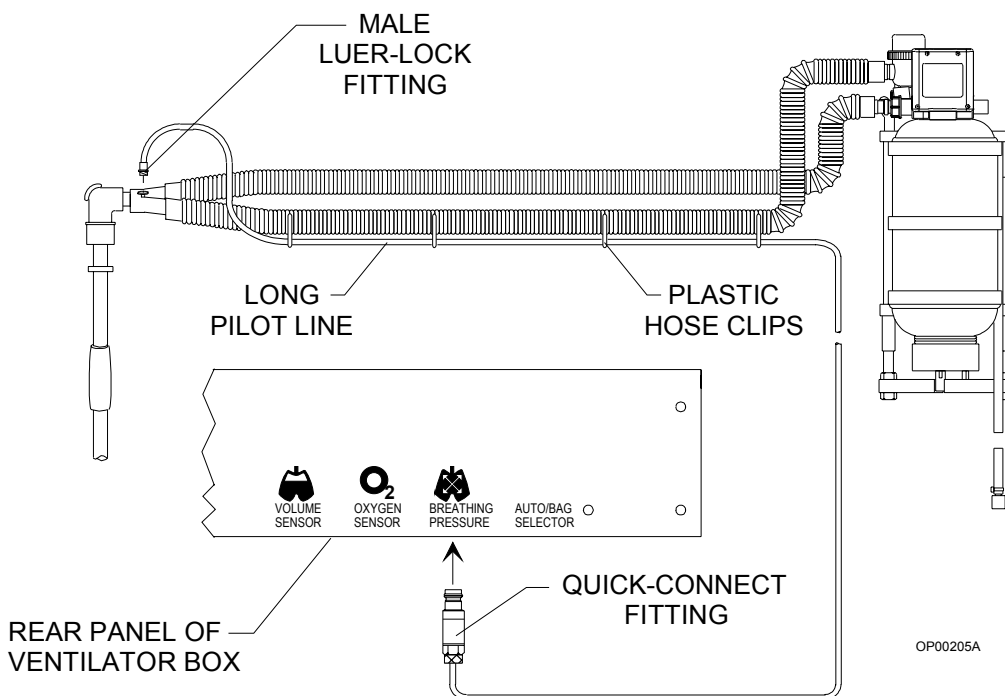
For breathing pressure monitoring at the patient Y-piece, install the long pilot line (which has a quick-connect fitting on one end and a Luer type fitting on the other end) as follows (refer to Figure 14-2):

1. Connect the quick-connect fitting on the pilot line to the BREATHING PRESSURE interface underneath the rear panel of the ventilator box.

**NOTE:** The quick-connect fitting on the absorber is self-closing. You can leave it unused when installing the long pilot line for Y-piece monitoring.

2. Connect the Luer fitting on the other end of the pilot line to a Luer fitting on either the patient Y-piece or a 15 mm adapter on the patient side of the Y-piece.
3. Using the four plastic hose clips attached to the pilot line, mount the pilot line on either of the breathing hoses leading to the Y-piece.

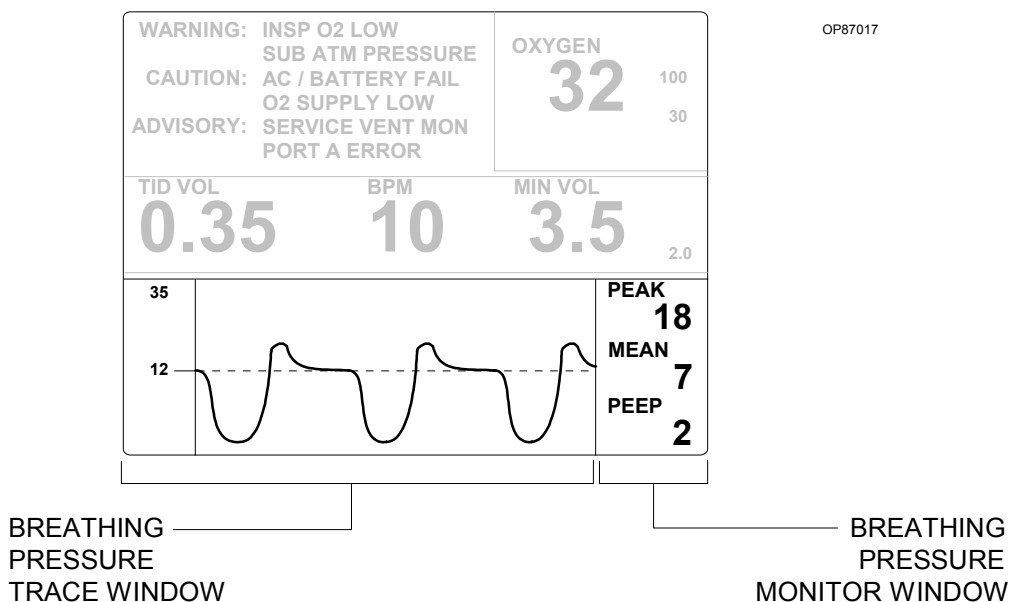
Figure 14-2. Y-piece Monitoring



## Monitor Displays

Information about the patient's breathing pressure is presented in two windows at the bottom of the monitor display as shown in Figure 14-3.

Figure 14-3. Monitor Displays

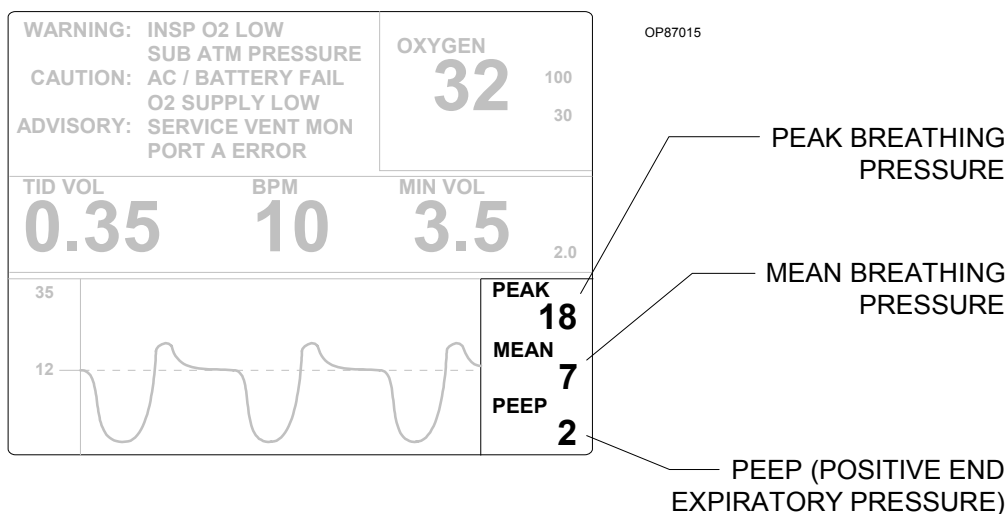


- **Breathing Pressure Trace Window**—This large window on the left displays a breathing pressure trace, or waveform. To the left of the waveform, in small type, are the pressure high and threshold pressure alarm limits.
- **Breathing Pressure Monitor Window**—This small window on the right contains numerical breathing pressure measurements.

**Breathing Pressure Monitor Window**

The Breathing Pressure Monitor window, shown in Figure 14-4, contains breathing pressure measurements expressed in units of cm H<sub>2</sub>O.

Figure 14-4. Breathing Pressure Monitor Window



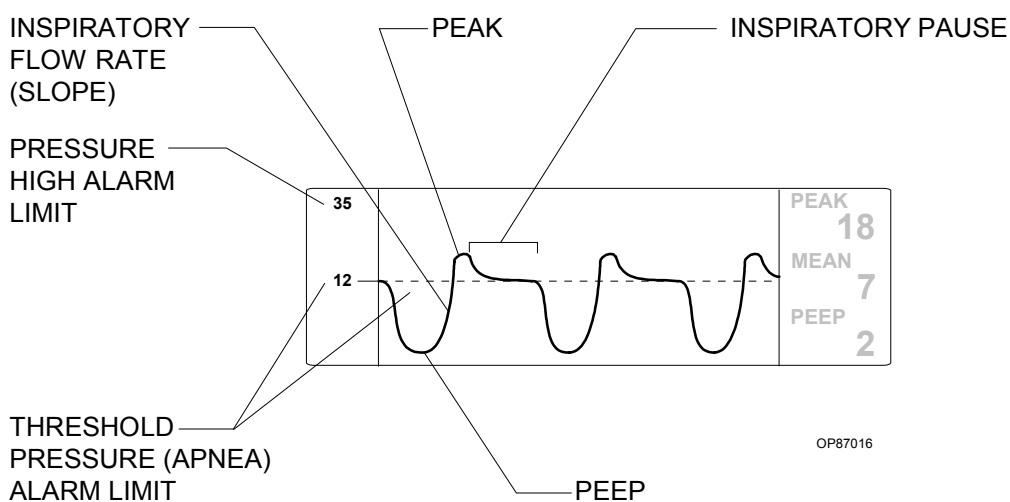
- **PEAK Breathing Pressure**—The highest instantaneous pressure value for each breath
- **MEAN Breathing Pressure**—The average of all the instantaneous pressure values recorded during each breath
- **PEEP (Positive End Expiratory Pressure)**—The breathing pressure at the end of exhalation

During apneic conditions, the pressure monitor displays numeric information as long as it detects a peak pressure at least 10 cm H<sub>2</sub>O greater than PEEP pressure. When this pressure difference drops below 10 cm H<sub>2</sub>O, the numeric information remains 1 minute longer and then disappears.

**Breathing Pressure Trace Window**

The Breathing Pressure Trace window displays the breathing pressure waveform, and the pressure high and threshold pressure alarm limits. Pressure measurements are displayed in units of cm H<sub>2</sub>O and are automatically scaled from 0–20, 0–50, or 0–100 cm H<sub>2</sub>O. If the scale changes, the positions of the waveform and alarm limits also change relative to the new scale. The window shown below in Figure 14-5 has a scale of 0–20 cm H<sub>2</sub>O.

Figure 14-5. Breathing Pressure Trace Window

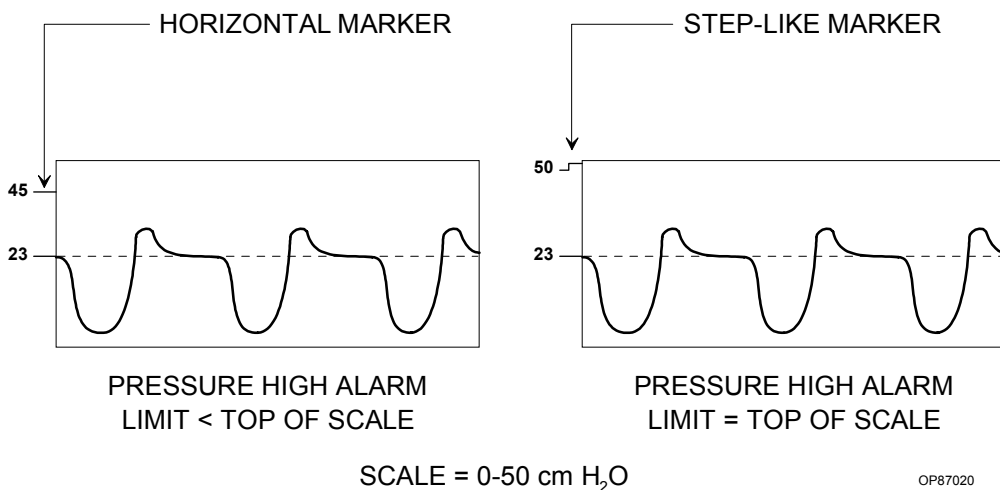


- The peak of the waveform corresponds to the peak pressure.
- The slope of the trace as it rises toward the peak pressure is correlated with the inspiratory flow rate; the steeper the slope, the higher the flow rate.
- The amount of pressure that the baseline is raised from zero corresponds to the patient's positive end expiratory pressure (PEEP).
- The length of the plateau from peak pressure to the decrease in pressure corresponding to expiration is equivalent to the length of the inspiratory pause (if present).

- The horizontal dotted line on the waveform and the adjacent marker on the Y-axis both represent the threshold pressure (apnea) alarm limit. The horizontal dotted line is always displayed, but the marker on the Y-axis appears only when the threshold pressure alarm limit is less than or equal to the top of the scale set by the system. There is a marker in the illustration above, because the threshold pressure alarm limit (12 cm H<sub>2</sub>O) is less than the top of the scale (20 cm H<sub>2</sub>O).
- The pressure high alarm limit is denoted by a marker on the Y-axis only when it is less than or equal to the top of the scale set by the system. In Figure 14-5, the pressure high alarm limit (35 cm H<sub>2</sub>O) is greater than the top of the scale (20 cm H<sub>2</sub>O).

When a high alarm limit marker is displayed, its appearance depends on whether the pressure high alarm limit is less than or equal to the top of the scale. Figure 14-6 illustrates the difference in appearance. (Note that a threshold pressure alarm limit marker is also displayed in these examples.)

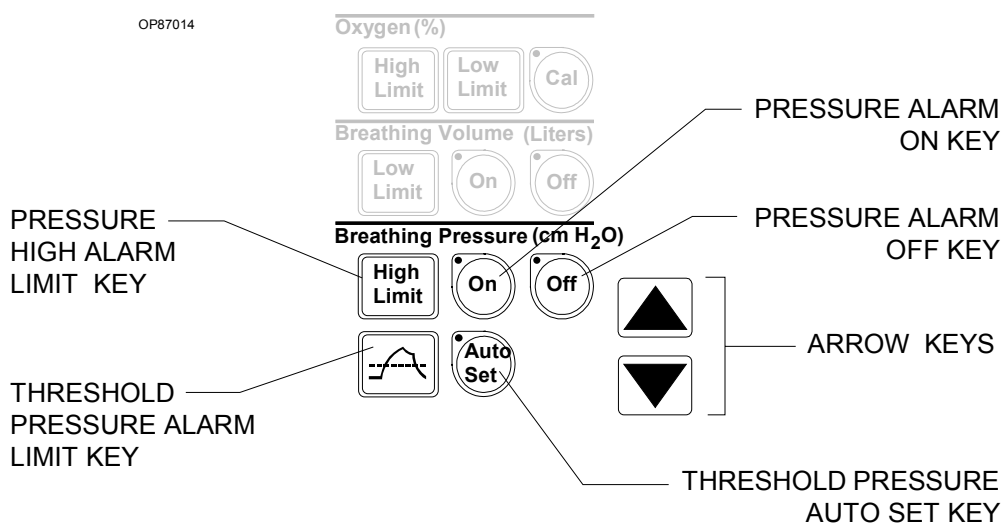
Figure 14-6. Breathing Pressure Trace Window with Examples of High Alarm Limit Markers



## Monitor Controls

You use the breathing pressure monitor control keys to set breathing pressure alarm limits, turn the apnea (threshold pressure) alarm off or on, and automatically set the threshold pressure. The breathing pressure monitor control keys are located next to the Breathing Pressure Monitor window. See Figure 14-7.

Figure 14-7. Monitor Controls



## Setting the Pressure High Alarm Limit

The pressure high alarm limit is automatically set to 50 cm H<sub>2</sub>O at power-up. You can change this limit to any value from 30–120 cm H<sub>2</sub>O, as long as it is greater than the threshold pressure alarm limit.



To adjust the pressure high alarm limit, follow these steps:

1. Press the Breathing Pressure High Limit key.  
A box is drawn around the pressure high alarm limit.
2. Press the up arrow or down arrow key to increase or decrease the pressure high alarm limit.
3. To save the new value, stop pressing arrow keys until the highlighting box disappears (5 seconds), or press a different Alarm Limit key.

The new value is saved and displayed as the pressure high alarm limit. If the alarm limit is on or below the upper limit of the scale, a marker appears next to the alarm limit.

## Setting the Threshold Pressure Alarm Limit

The threshold pressure alarm limit defines the level below which an apneic alarm condition exists. When the patient's breathing pressure falls below the threshold limit, a message appears in the Alarm window and an audible alarm sounds.

The threshold pressure alarm limit is automatically set to 12 cm H<sub>2</sub>O at power-up. The setting can be changed to any value from 5–30 cm H<sub>2</sub>O, as long as it is less than the pressure high alarm limit. You can change the alarm limit manually to a value you select or have the system set it automatically to an optimum value based on the current peak pressure.

**WARNING:** The threshold pressure alarm limit should be as close as possible to the sensed peak pressure without exceeding it. For details, see “Threshold Limit Guidelines” and “Sample Threshold Limit Settings” in this section.

### Manually Setting the Threshold Limit



To set the threshold pressure alarm limit manually, follow these steps. Remember that the value must be within the range of 5–30 cm H<sub>2</sub>O and less than the pressure high alarm limit.

1. Press the Breathing Pressure Threshold key.  
A box is drawn around the threshold pressure alarm limit.
2. Press the up arrow or down arrow key to increase or decrease the threshold pressure alarm limit.
3. To save the new value, stop pressing arrow keys until the highlighting box disappears (5 seconds), or press a different Alarm Limit key.

The new value is saved and displayed as the threshold pressure alarm limit. If the alarm limit is on or below the upper limit of the scale, a marker appears next to the alarm limit, and a dotted line extends from the alarm limit horizontally across the scale.

### Automatically Setting the Threshold Limit



You can have the monitoring system automatically set the threshold pressure alarm limit to an optimum value based on the current peak pressure.

To automatically set the threshold pressure alarm limit, press and then release the Breathing Pressure Auto Set key.

The LED next to the Breathing Pressure Auto Set key lights briefly when you press it.

The threshold pressure limit is automatically set 4 cm H<sub>2</sub>O below the current peak pressure measurement, to a minimum of 5 cm H<sub>2</sub>O and a maximum of 30 cm H<sub>2</sub>O.

If the alarm limit is on or below the upper limit of the scale, a marker appears next to the alarm limit, and a dotted line extends from the alarm limit horizontally across the scale.

**Threshold  
Limit  
Guidelines**

If a breathing system leak or partial disconnection occurs when the threshold pressure alarm limit is set significantly lower than the peak pressure, continued positive pressure ventilation can produce a pressure fluctuation great enough to exceed the threshold (and thereby satisfy the alarm), yet not great enough to provide adequate ventilation.

To address the problem, the Advisory message THRESHOLD LOW appears in the Alarm window when either of the following conditions occurs:

- The sensed peak pressure exceeds the set threshold by more than 6 cm H<sub>2</sub>O at threshold pressure alarm limit settings of 5–20 cm H<sub>2</sub>O.
- The sensed peak pressure exceeds the set threshold by more than 8 cm H<sub>2</sub>O at threshold pressure alarm limit settings of 21–29 cm H<sub>2</sub>O.

**NOTE:** The threshold setting may be affected when the ventilator is turned on or off. If you turn the ventilator off while the threshold is set to a value greater than 15 cm H<sub>2</sub>O, the setting is changed to 15 cm H<sub>2</sub>O. (If the threshold is set lower than 15 cm H<sub>2</sub>O when the ventilator is turned off, the threshold retains its setting.) When the ventilator is turned back on, the threshold is restored to its previous set value.

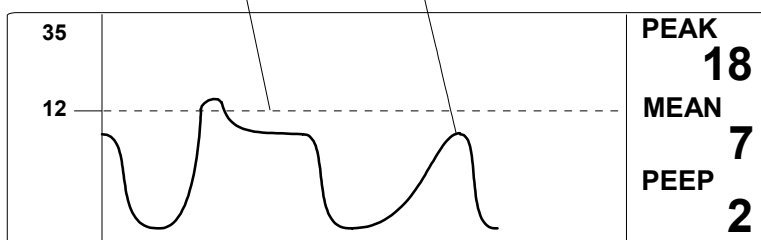


Sample  
Threshold  
Limit Settings

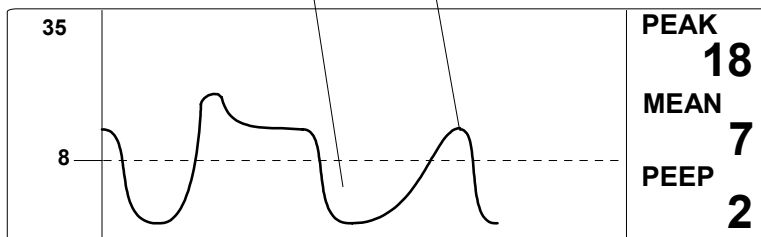
Figure 14-8 illustrates the effects of correct and incorrect settings of the threshold pressure alarm limit.

Figure 14-8. Sample Threshold Limit Settings

- 1. Threshold pressure alarm limit correctly set to within 6 cm H<sub>2</sub>O of peak pressure (for alarm limit settings of 5 through 20 cm H<sub>2</sub>O).
- 2. Thus, after partial breathing system disconnection or leak, small pressure fluctuation does not cross threshold pressure alarm limit. Operator is warned of apnea condition.



- 1. Threshold pressure alarm limit incorrectly set > 6 cm H<sub>2</sub>O below peak pressure.
- 2. Thus, after partial breathing system disconnection or leak, small pressure fluctuation in system satisfies incorrectly set threshold pressure alarm limit. Operator is not alerted of apnea condition.



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## Turning the Apnea Pressure Alarm Off

You can turn the apnea pressure alarm off only when the ventilator is off. When the ventilator is on, the alarm is automatically forced on to ensure notification of problem conditions.



To turn off the apnea pressure alarm, press the Breathing Pressure Off key. Audio annunciation of the alarm is disabled and pressure alarm messages are erased from the display. The LED next to the Breathing Pressure Off key lights to indicate that the apnea pressure alarm is disabled.

## Turning the Apnea Pressure Alarm On

To turn on the apnea pressure alarm, press the Breathing Pressure On key.



The LED next to the Breathing Pressure On key lights to indicate that the apnea pressure alarm is enabled.

**NOTE:** After power-up, the pressure alarms are in the standby state.

## Breathing Pressure Alarm Messages

The following list contains all warning, caution and advisory alarms associated with breathing pressure monitoring.

### APNEA- PRESSURE (Warning/ Caution)

#### When the ventilator is on:

If the measured breathing pressure remains below the threshold pressure alarm limit for more than 15 seconds, the Caution message APNEA-PRESSURE appears in the Alarm window and an intermittent audible alarm sounds.

If the breathing pressure remains below the threshold pressure for an additional 15 seconds (30 seconds total), the Caution message APNEA-PRESSURE is upgraded to a Warning in the Alarm window, and a continuously repeating audible alarm sounds. During the Warning condition, numeric data remains on the display as long as the monitor detects a peak pressure at least 10 cm H<sub>2</sub>O greater than PEEP pressure. When this pressure difference drops and remains below 10 cm H<sub>2</sub>O for more than 60 seconds, the numeric data is cleared.

#### When the ventilator is off:

The Caution condition does not occur until 30 seconds have elapsed; the Warning condition does not occur until 60 seconds have elapsed.

**VENT  
PRESSURE  
HI (Warning)**

If the measured breathing pressure exceeds the high pressure limit, the Warning message VENT PRESSURE HI appears in the Alarm window and a continuously repeating audible alarm sounds.

This alarm condition is cleared when the measured breathing pressure drops below the high pressure alarm limit. However, the alarm message is extended for 5 seconds to allow for a momentary high pressure condition.

**SUB ATM  
PRESSURE  
(Warning)**

If the measured breathing pressure falls below -10 cm H<sub>2</sub>O, the Warning message SUB ATM PRESSURE appears in the Alarm window and a continuously repeating audible alarm sounds.

This alarm condition is cleared when the sensed pressure rises above -10 cm H<sub>2</sub>O. However, the alarm message is extended for 5 seconds to allow the recognition of a momentary subatmospheric pressure condition.

**CONTIN-  
UOUS PRES  
(Warning)**

If the measured breathing pressure remains above the threshold pressure alarm limit for more than 15 seconds, the breathing pressure display area is cleared, the Warning message CONTINUOUS PRES appears in the Alarm window, and an intermittent audible alarm sounds.

When the measured breathing pressure drops below the threshold pressure alarm limit, alarm annunciation ceases.

**PEEP > 25  
(Caution)**

Any time that the monitor measures a PEEP of 26 cm H<sub>2</sub>O or greater, the Caution message PEEP > 25 appears in the Alarm window and an intermittent audible alarm sounds.

Alarm annunciation ceases when the measured PEEP drops below 26 cm H<sub>2</sub>O. Also, an APNEA or CONTINUOUS PRES alarm condition will clear this alarm condition.

**THRESHOLD  
LOW  
(Advisory)**

The Advisory message THRESHOLD LOW appears in the Alarm window any time the sensed peak pressure exceeds the threshold pressure alarm limit by more than 6 cm H<sub>2</sub>O at threshold pressure alarm limit settings of 5–20 cm H<sub>2</sub>O, or by more than 8 cm H<sub>2</sub>O at threshold pressure alarm limit settings of 21–29 cm H<sub>2</sub>O. Setting the threshold pressure alarm limit at 30 cm H<sub>2</sub>O disables the THRESHOLD LOW advisory.

**PEEP > 4  
(Advisory)**

Any time the monitor measures a PEEP of 5 cm H<sub>2</sub>O or greater, the Advisory message PEEP > 4 appears in the Alarm window.

When the measured PEEP drops below 5 cm H<sub>2</sub>O, the Advisory message is cleared from the display.

**APNEA-P  
ALM STBY  
(Advisory)**

Any time that the apnea pressure alarm (threshold pressure alarm limit) has been set to Standby, the Advisory message APNEA-P ALM STBY appears in the Alarm window.

**14** Breathing Pressure Monitoring

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**SERVICE  
 VENT MON  
 (Advisory)**

If the Narkomed GS detects an internal electronic failure that would prevent proper operation, the Advisory message SERVICE VENT MON appears in the Alarm window. If this happens, contact a Draeger Medical qualified technical service representative.

**Problem Resolution**

**Table 14-1. Breathing Pressure Monitoring Problem Resolution**

<b>PROBLEM</b>	<b>POSSIBLE CAUSE</b>	<b>REMEDY</b>
No pressure readout in display area during ventilation	Pilot line not connected	Make sure pilot line is properly connected.
	Pilot line blocked or kinked	Make sure that lumen of pilot line is free of obstructions.
Erratic readings	Condensation accumulation in pilot line	Drain and reconnect pilot line.

# 15

## Manual Sphygmomanometer

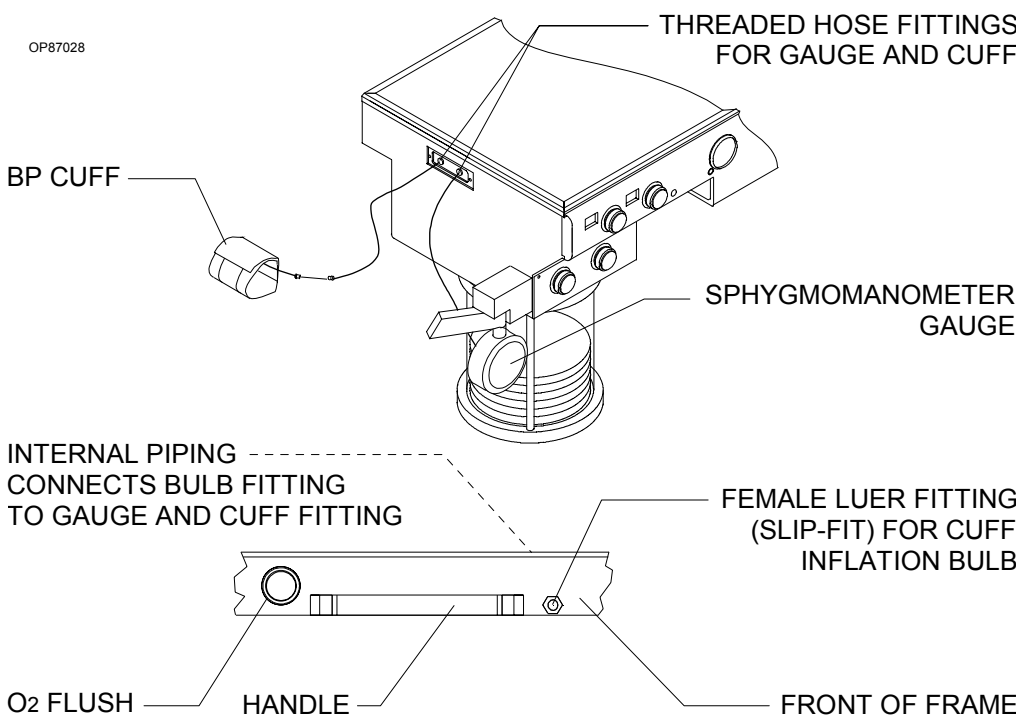
*This section describes the sphygmomanometer of the Narkomed GS anesthesia machine.*

Overview .....	15-2
Selecting a Blood Pressure Cuff .....	15-3
Connecting the Cuff .....	15-3
Placing the Cuff .....	15-4

### Overview

An aneroid manual sphygmomanometer can be mounted on the Narkomed GS. The sphygmomanometer gauge is positioned on the left side of the anesthesia machine, next to the ventilator bellows. The cuff inflation bulb is located to the right of the oxygen flush button on the front of the machine. See Figure 15-1.

Figure 15-1. Manual Sphygmomanometer



## Selecting a Blood Pressure Cuff

When preparing for a case that includes noninvasive blood pressure monitoring, be sure to choose the correct cuff size and to place the cuff correctly. Use Table 15-1 below to select the appropriate cuff size. If you don't have a tape measure, use the INDEX and RANGE lines marked on the cuff as described in "Placing the Cuff" on page 15-4.

**Table 15-1. Selecting a Blood Pressure Cuff**

	Cir. (cm)	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	25	30	35	40	45	50	55	60	65	70								
Disposable Cuff	Neonatal#10	3-6cm																																			
	Neonatal#11				6-9.5cm																																
	Neonatal#12							8-12cm																													
	Neonatal#13										9-14cm																										
Nondisposable Cuff	Newborn				6-11cm																																
	Infant							10-19cm																													
	Pediatric										18-26cm																										
	Adult													25-35cm																							
	Large Adult																33-47cm																				
	Thigh																			46-66cm																	

OP30031A

## Connecting the Cuff

To connect the cuff:

1. Connect the cuff hose (attached to the cuff) to the extension hose (with a threaded fitting on one end and a Luer lock fitting on the other end). Insert the Luer lock fitting on the cuff hose into the Luer lock fitting on the extension hose, and twist until they lock together.
2. Attach the other end of the extension hose to the fitting on the patient interface panel labeled BP CUFF. Hand-tighten the threaded hose fitting onto the threaded fitting of the interface panel.
3. Make sure that none of the hoses are pinched or kinked.

After connecting the manual sphygmomanometer, check the gauge's pressure indication. With zero pressure applied to the gauge and cuff, the gauge pointer should remain within the band marked on the face plate.

## Placing the Cuff

When fitting the cuff, place the center of the cuff inflation bag over the artery (for the brachial artery, place over the inside of the arm above the elbow). Make sure that the cuff fits securely on the limb and that the INDEX line falls between the two RANGE lines. If the INDEX line does not fall between the RANGE lines, select a smaller or larger cuff. Refer to Figure 15-2.

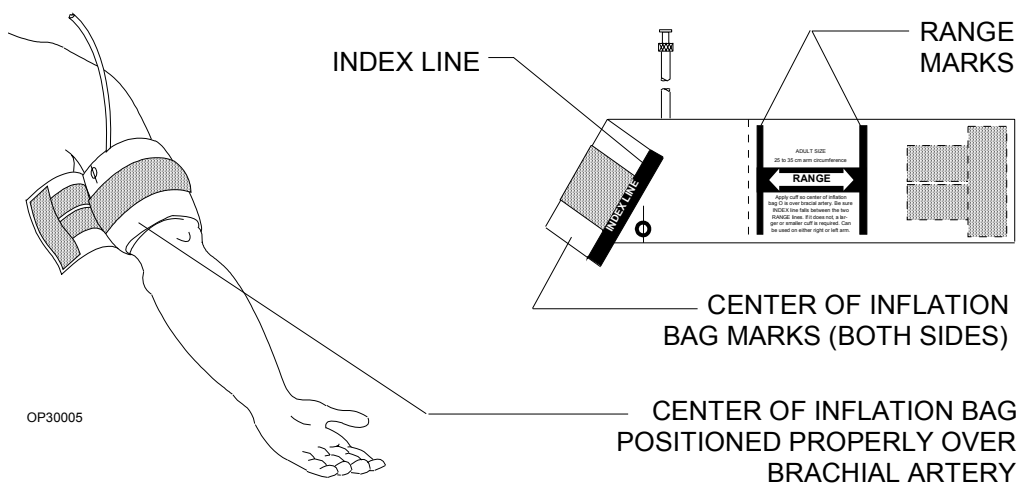
The cuff can be used on either the right or left extremity, but the left is usually preferred.

**NOTE:** Do not place the cuff on a limb being used for infusion.

For accurate blood pressure measurements, position the cuff at the same level as the patient's heart. Placing the cuff above the heart causes the reading to be falsely low; placing the cuff below the heart causes the reading to be falsely high. In instances where you cannot place the cuff at the same level as the heart, use the following general rule.

- For every inch of elevation above the heart, add 1.8 mm Hg to the reading.
- For every inch of elevation below the heart, subtract 1.8 mm Hg from the reading.

Figure 15-2. Placing the Cuff





# 16

## Routine Maintenance and Cleaning

*This section describes the routine cleaning and maintenance required for the Narkomed GS anesthesia machine.*

Overview .....	16-2
Routine Maintenance .....	16-2
Scavenger Interface for Passive Systems Maintenance ..	16-8
Removing Parts for Cleaning and Disinfection .....	16-10
Disassembling Parts for Cleaning and Disinfection .....	16-13
General Guidelines for Cleaning and Disinfection .....	16-15
Reassembly Instructions .....	16-22

## Overview

This section outlines procedures for maintaining and cleaning the Narkomed GS.

## Routine Maintenance

Routine maintenance must be performed regularly to ensure safe and effective operation. Regularly check the condition of the absorbent and the overall condition of the machine, power cord, hoses, and breathing bag.

### Replacing the Absorbent

When the carbon dioxide absorbent in the absorber system is exhausted, it must be replaced. Refer to the manufacturer's instructions for the signs to expect when the absorbent is exhausted.

If the machine has been out of use or in storage, replace the absorbent before using the machine. Draeger Medical recommends establishing a routine schedule with a sufficient safety margin for replacing absorbent.

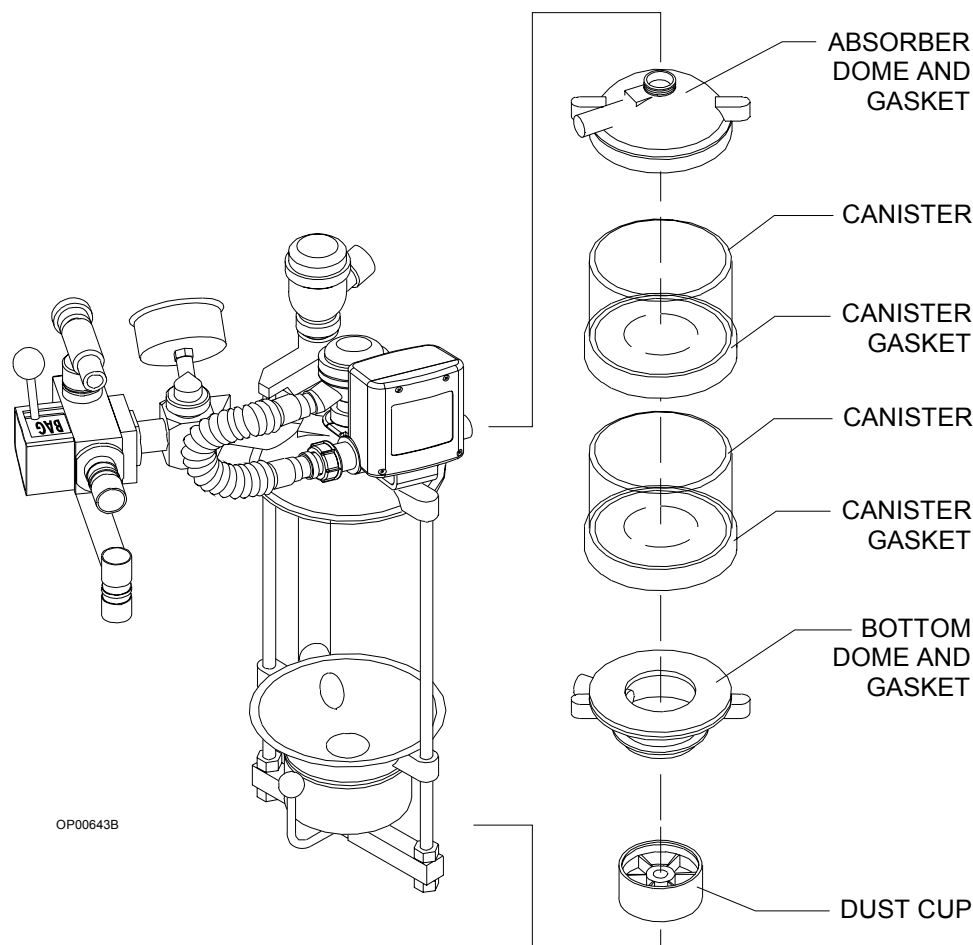
When using loose absorbent, do not fill above the maximum fill level line located about a quarter-inch from the top of the canister. The clearance and the ratio of canister diameter to screen opening minimize the potential for channeling. In channeling, gas flows through the canister along the path of least resistance. The gas depletes the efficiency of the absorbent along this route, bypassing absorbent in the other areas of the absorber.

**WARNING:** Absorbent is caustic and is a strong irritant to the eyes, skin, and respiratory tract. When replacing the absorbent, take care not to spill its caustic contents.

To replace the absorbent, follow the procedures below (refer to Figure 16-1):

1. Pull the canister release lever down.
2. Remove the canisters from the absorber system.
3. Empty the contents of the canisters into an appropriate refuse container.
4. Check the canisters to make sure they are not chipped or cracked.

Figure 16-1. Replacing the Absorbent



5. Taking care not to chip or crack the canisters, add new absorbent to each one.
  - When using absorbent prepacks, remove all packaging materials (some have clear plastic wrappers) and place a prepack into each canister.
  - When using loose absorbent, fill the canister to the fill line. Do not overfill.
6. Stack one canister on top of the other and center the stack on the gasket of the bottom dome.
7. Raise the bottom dome, remove and empty the dust cup if loose absorbent is present, and replace the dust cup.

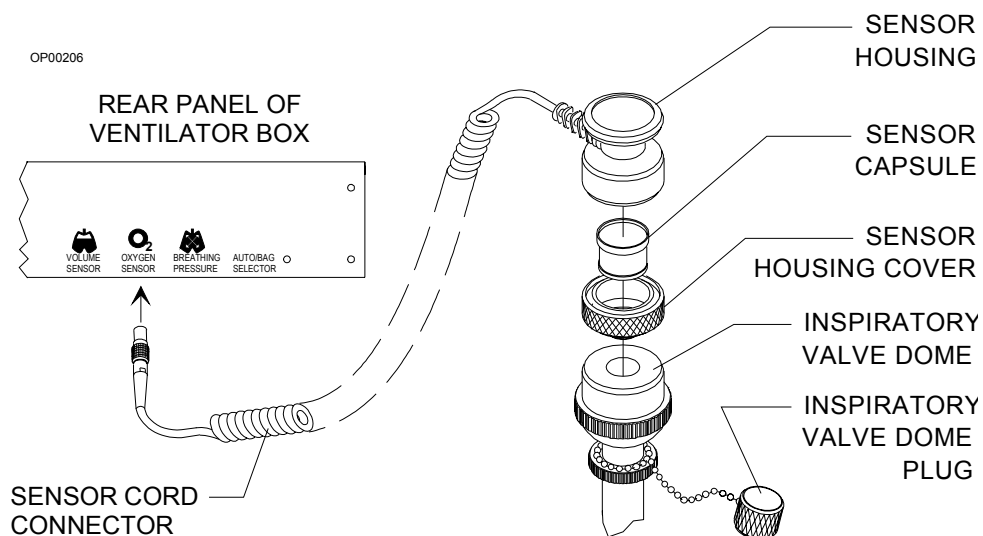
8. Pull the canister release lever up to close the absorber system.
9. Perform the absorber portion of the daily checkout procedure provided in Section 3, "Daily Checkout Procedure" to verify proper reassembly.

### Replacing the Oxygen Sensor

Replace the oxygen sensor capsule when its sensor is depleted, because a depleted sensor cannot correctly analyze oxygen concentrations. Refer to Figure 16-2.

1. Turn the SYSTEM POWER switch to STANDBY.
2. Remove the oxygen sensor housing from the inspiratory valve dome. (It is a press fit.)
3. Unscrew the cover from the sensor housing and remove the sensor capsule.
4. Install the replacement sensor in the housing. Verify that the copper rings on the capsule mate with the electrical contacts in the sensor housing.
5. Wait 15 minutes to let the sensor capsule stabilize to ambient air.  
If you do not wait, calibration (the next step) will not be successful.
6. Restore power to the machine and calibrate the oxygen sensor, as described in "Calibrating the Oxygen Sensor" on page 12-4.

Figure 16-2. Replacing the Oxygen Sensor



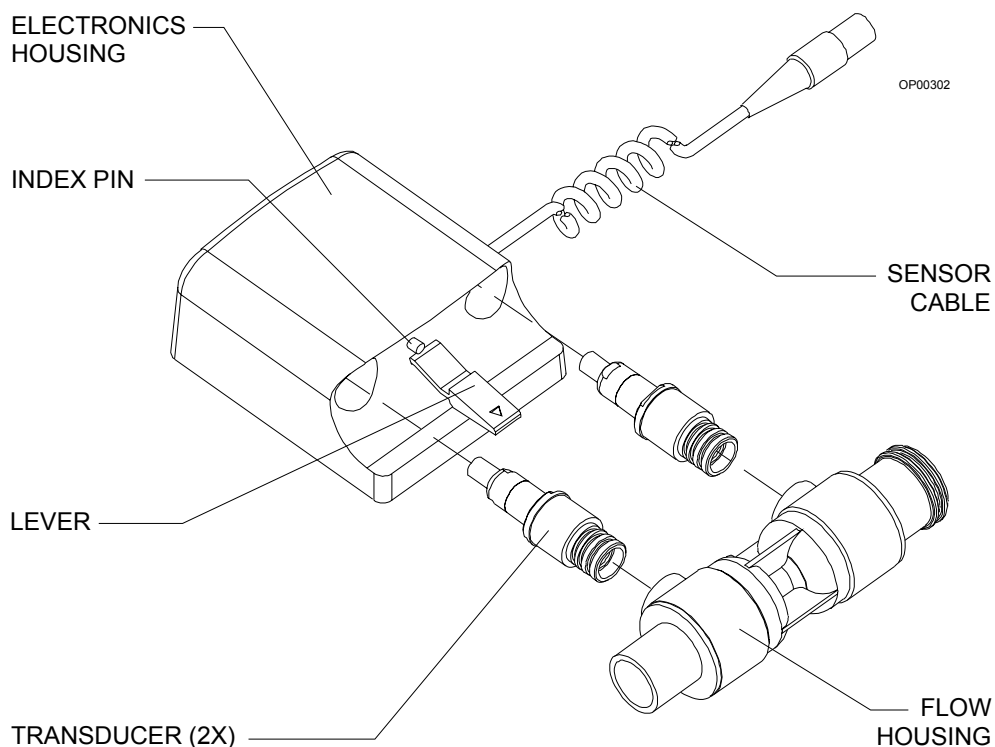
### Clearing Condensation in the Ultrasonic Flow Sensor

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.

Figure 16-3. Clearing Condensation in the Ultrasonic Flow Sensor



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.

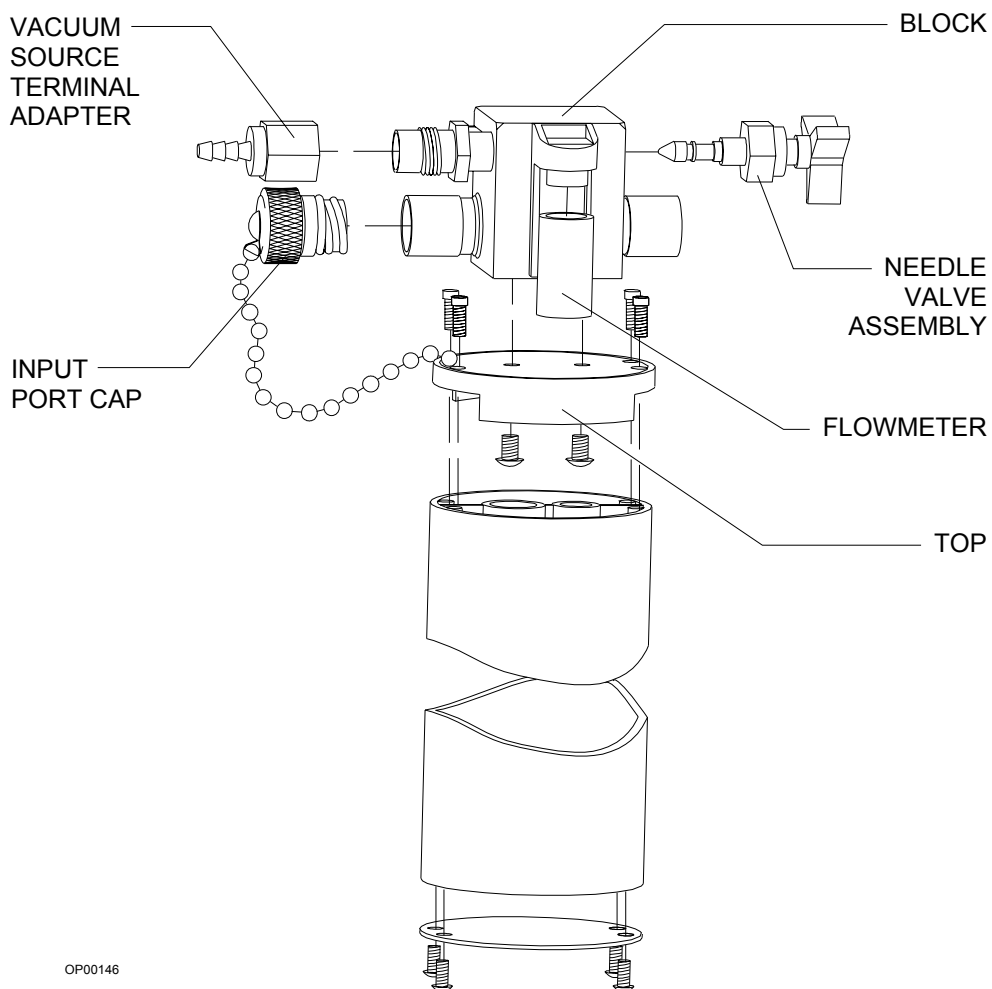
9. Press the transducers back into their ports in the flow housing.
10. Slide the electronics housing over the flow housing/transducer assembly. Be sure that it clicks into place.  
**NOTE:** If the flow housing/transducer assembly does not fit easily into the electronics housing, make sure the flow 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.

**Open Reservoir Scavenger Maintenance**

The scavenger should be cleaned at least once every six months.

1. Clean the outer surface of the scavenger with a soft cloth moistened with mild detergent and water.
2. Remove and inspect all scavenger hoses for signs of deterioration. Replace any worn hoses.
3. If applicable, unscrew the wing nut until the needle valve assembly can be removed from its seat. Remove the nut and disassemble the valve. Inspect the needle valve and seat for lint or dust accumulation. Clean with compressed air, if necessary.

**Figure 16-4. Open Reservoir Scavenger Maintenance**



4. The flowmeter has a small port, located on its underside, that is open to the atmosphere. For the flowmeter to work properly, this port must remain open. Remove the flowmeter from the block and inspect this port. If it is blocked, clean it with compressed air.
5. Remove the reservoir canister from the scavenger body by unscrewing the four socket head cap screws located at the top of the canister.
6. Replace the cleaned needle valve assembly and reservoir canister. Verify that all parts are completely dry before reassembly.
7. Perform the open reservoir scavenger portion of the daily checkout procedure provided in Section 3, "Daily Checkout Procedure".

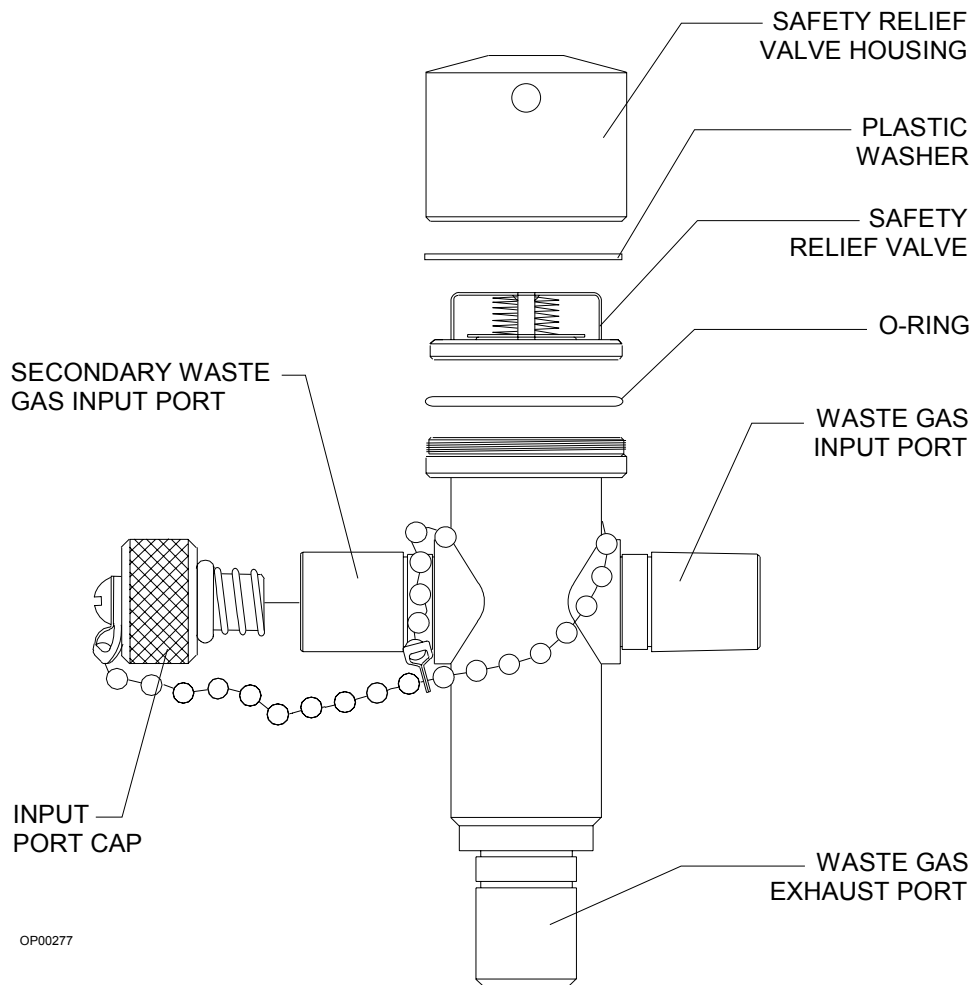
**Scavenger  
Interface for  
Passive  
Systems  
Maintenance**

The scavenger should be cleaned at least once every six months. Refer to Figure 16-5.

1. Clean the scavenger body with a moist cloth.
2. Inspect all scavenger hoses for deterioration. Replace any worn hoses.
3. Remove the relief valve housing by unscrewing it counterclockwise.
4. Inspect the rubber O-ring. If it is worn, replace it.
5. Remove the relief valve by twisting it counterclockwise out of the housing. You can use the tips of a needle-nose pliers to turn the valve, but take care not to damage the relief valve's fragile valve disk.
6. Brush any accumulated lint or dust off the valve with a soft brush. The valve can be further cleaned with a low flow of clean air or oxygen.
7. 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.
8. Verify 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.
9. Perform the scavenger interface for passive systems portion of the daily checkout procedure provided in Section 3, "Daily Checkout Procedure".



Figure 16-5. Scavenger Interface for Passive Systems Maintenance



**Manual Sphygmomanometer Maintenance**

Under typical conditions, the only cleaning the manual sphygmomanometer requires is a wiping down with a liquid disinfection agent. However, if further disinfection is required, remove the sphygmomanometer gauge assembly, hoses, and blood pressure cuff from the anesthesia machine and sterilize them with ethylene oxide gas (cold cycle), followed by appropriate aeration according to the sterilizer manufacturer's instructions.

**NOTE:** Do not autoclave the gauge assembly; it cannot withstand the heat of autoclaving.

## Removing Parts for Cleaning and Disinfection

1. Turn the SYSTEM POWER switch to STANDBY.
2. Disconnect the 22 mm breathing circuit hoses between the ventilator and the absorber and from the inspiratory valve and the expiratory hose terminal on the ultrasonic flow sensor. Remove the Y-piece, mask, and mask elbow from the hoses.
3. Disconnect the 19 mm scavenger hoses connecting the scavenger to the APL valve and the ventilator relief valve.

**NOTE:** The scavenger interface generally does not need disinfection. However, if your facility requires a disinfection process for the scavenger interface and hoses, remove the scavenger and all 19 mm hoses. Refer back to the cleaning instructions under “Open Reservoir Scavenger Maintenance” or “Scavenger Interface for Passive Systems Maintenance” for disassembly instructions.

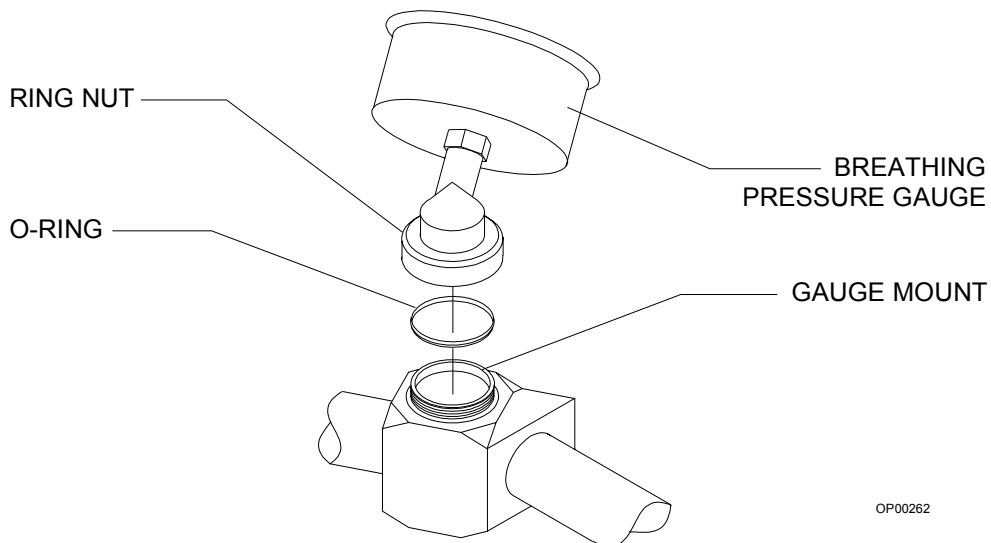
4. Remove the oxygen sensor assembly from the inspiratory valve, and disconnect the sensor cord from the system interface panel.
5. Disconnect the flow sensor cable from the system interface panel.
6. Remove the connector hose assembly between the flow sensor and the expiratory valve by turning the ring nut counterclockwise.
7. Lift the flow sensor off the bracket.
8. Disconnect the fresh gas hose from the fresh gas outlet.
9. Disconnect the breathing pressure pilot line from the absorber and the system interface panel.
10. Remove the absorbent canisters and dust cup. Discard the absorbent. Refer back to “Replacing the Absorbent” for instructions.

**WARNING:** Absorbent is caustic and a strong irritant to the eyes, skin, and respiratory tract. When removing the absorbent, take care not to spill its caustic contents.

11. Remove the inspiratory and expiratory valves by turning their ring nuts counterclockwise until the valves are free of the system.

12. Remove the pressure gauge by turning the knurled ring nut that connects the pressure gauge to the gauge mount counterclockwise. Lift the pressure gauge assembly off the gauge mount. Do not misplace the O-ring. See Figure 16-6.

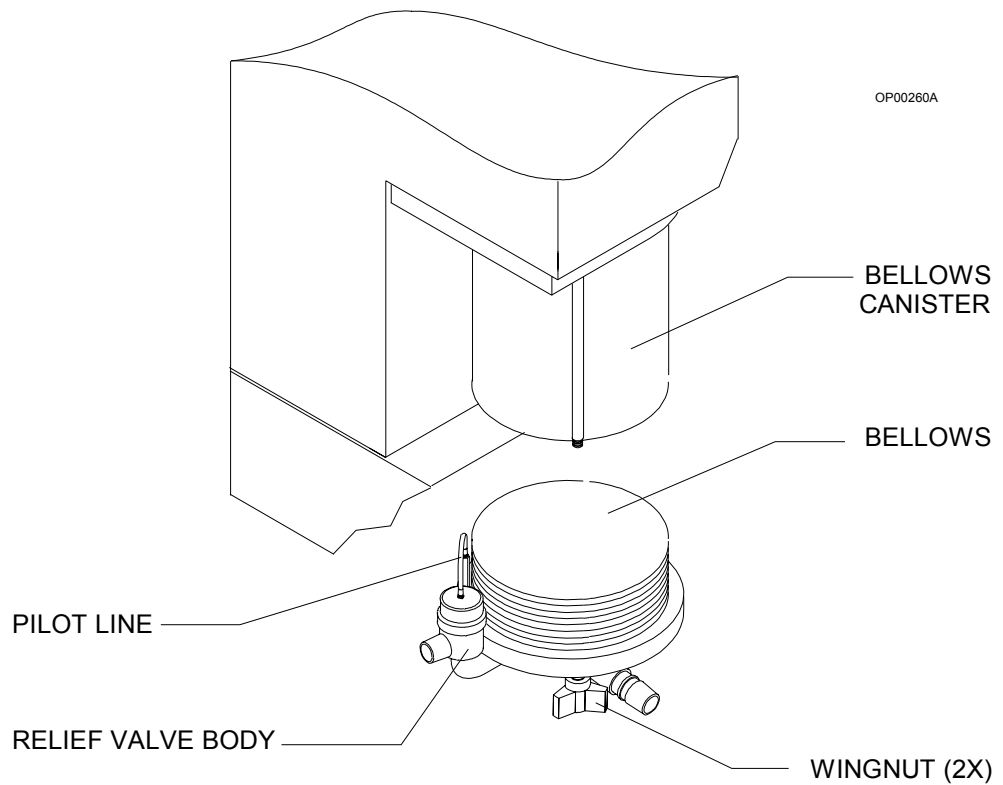
**Figure 16-6. Removing the Pressure Gauge**



13. Remove the absorber using a 3/16-inch hex screwdriver to loosen the hex screw securing the absorber assembly to the absorber pole. Do not remove the screw. Lift the absorber off the absorber pole.

14. Remove the bellows assembly by loosening the two wing nuts on the bottom of the assembly until the assembly releases from the canister. See Figure 16-7.

Figure 16-7. Removing the Bellows Assembly



## Disassembling Parts for Cleaning and Disinfection

The following parts must be further disassembled for thorough cleaning and disinfection:

- oxygen sensor assembly
- respiratory sensor flow housing/transducer assembly
- ventilator bellows assembly
- inspiratory/expiratory valves

### Disassembling the Oxygen Sensor Assembly

Unscrew the cover from the sensor housing and remove the sensor capsule. Take care not to drop the sensor housed inside. The sensor is not connected to the housing.

### Disassembling the Flow Housing/Transducer Assembly

1. Press down on the lever under the flow housing and pull the flow housing/transducer assembly out of the electronics housing.
2. Pull both transducers out of the flow housing.

### Disassembling the Ventilator Bellows Assembly

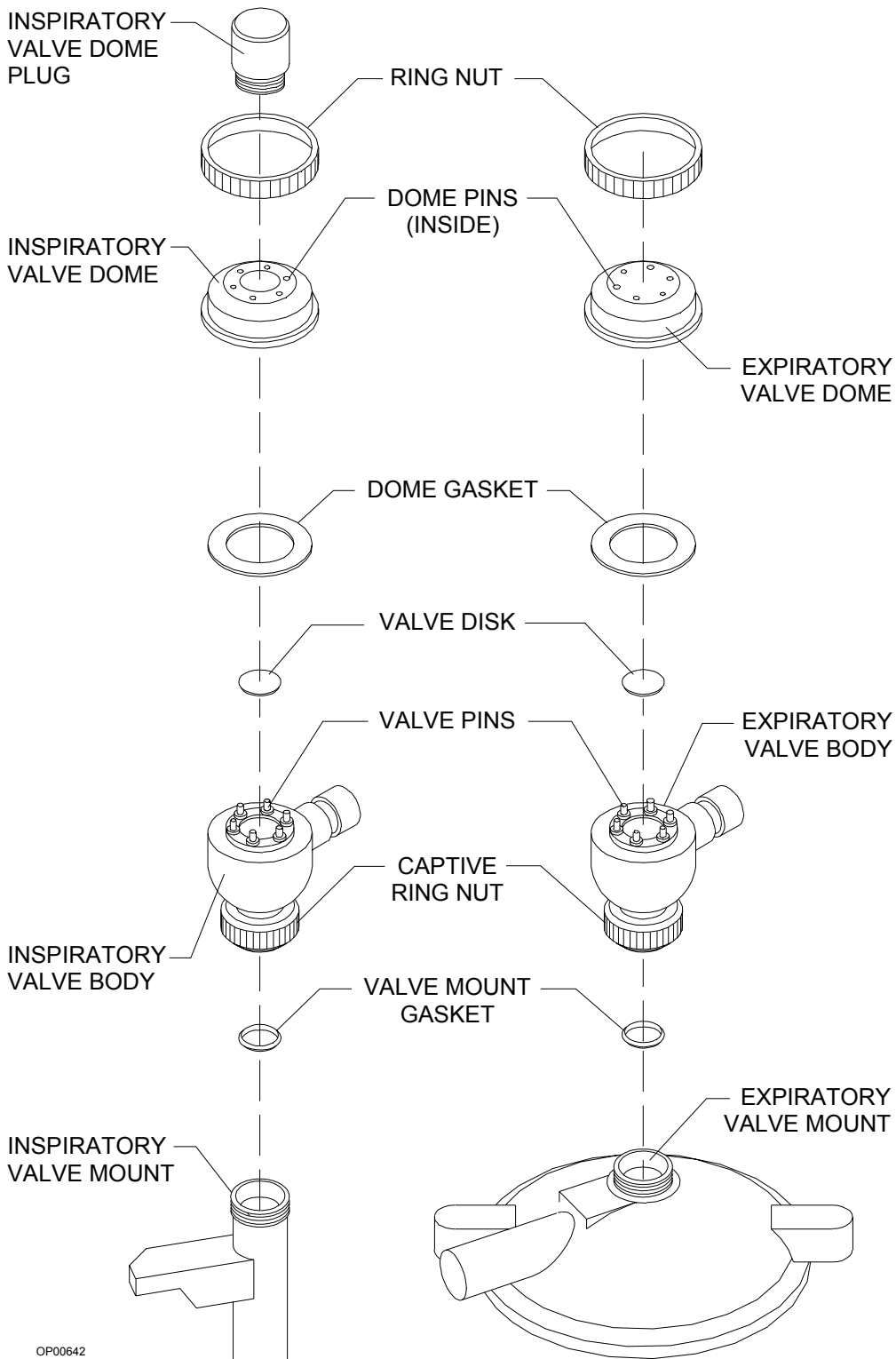
1. Remove the bellows from the ventilator bottom assembly by unscrewing it in a counterclockwise direction until it is released.
2. Unscrew the knurled ring nut around the ventilator relief valve and pull the relief valve dome and pilot line away from the relief valve body.

**CAUTION:** Take special care not to change the position of the adjustment lock ring on the ventilator relief valve dome. Do not attempt to loosen the knurled relief valve ring nut by twisting the pilot line hose barb.

### Disassembling the Inspiratory and Expiratory Valves

1. Unscrew and remove the ring nut around the plastic valve dome.
2. Separate the plastic dome, dome gasket, and valve disk from the valve body. See Figure 16-8.

Figure 16-8. Disassembling the Inspiratory and Expiratory Valves



## General Guidelines for Cleaning and Disinfection

The frequency, level, and need for disinfection of the Narkomed GS is determined by the user facility based on the conditions of use and hospital infection control policy. Draeger Medical recommends using disposable patient breathing circuits that can be replaced after single use.

If disinfection is required, first clean, dry, and then disinfect the Narkomed GS and its parts according to the guidelines provided in this chapter. Determining the need and frequency of cleaning or disinfecting any particular component is the responsibility of the user institution. These procedures should be performed according to procedures established by the user institution, following the specific instructions provided by the manufacturer of the equipment or agent used.

For additional information about infection control practice, refer to the *APIC Guideline for Selection and Use of Disinfectants*. This guideline was developed by the Association for Professionals in Infection Control and Epidemiology, Inc. and published in *AJIC* Vol. 24, No. 4 pp. 313-342, August 1996. Table 16-1 listing recommended disinfection methods for the Narkomed GS was adapted from the *APIC Guideline for Selection and Use of Disinfectants*.

**Table 16-1. Recommended Disinfection Methods**

Part	A	B	C	D	E	F
Exterior Painted, Plated, and Plastic Surfaces					x	x
Corrugated Breathing Hoses, Mask Elbow, and Breathing Bag	x	x	x	x		
Y-Piece and Mask		x	x	x		
Ventilator Bellows		x	x	x		
Ventilator Bellows Bottom Assembly		x				
Oxygen Sensor Capsule		x				
Oxygen Sensor Housing					x	x
Oxygen Sensor Housing Cover		x	x	x		
Inspiratory/Expiratory Valves	x	x	x	x		
Ultrasonic Flow Sensor Housing and Transducers	x					
Ultrasonic Flow Sensor Electronics Housing and Cable					x	x
Breathing Pressure Pilot Line		x				
Breathing System Pressure Gauge		x				
Absorber Canisters, Gaskets, and Dust Cup	x	x	x	x		
Vaporizer Exterior					x	x
Corrugated Scavenger Hoses (do not normally need disinfection)	x	x	x	x		
Open Reservoir Scavenger (does not normally need disinfection)		x			x	x
Passive Scavenger Interface (does not normally need disinfection)		x			x	x

- A Heat sterilization (autoclaving), including steam or hot air (use manufacturer's recommendations)
- B Ethylene oxide gas (use manufacturer's recommendations)
- C Glutaraldehyde-based formulations (2%)
- D Wet pasteurization at 70° C for 30 minutes after detergent cleaning
- E Sodium hypochlorite (5.2% household bleach) 1:500 dilution (100 ppm free chlorine)
- F Ethyl or isopropyl alcohol (70% to 90%)



**CAUTION:** To avoid damaging the Narkomed GS:

- Do not use Betadine®, Povodine®, Sagrotan®, Mucocit®, acetone, ketone, xylene, or anesthetic agents for cleaning.
- Dilute cleaning agents before use by strictly following the manufacturer's instructions.
- Do not use abrasives such as steel wool, liquid abrasives, or powder abrasives on the machine.
- Do not let any liquid enter the interior of the machine.
- Do not submerge any part of the system, unless specifically instructed to do so in this manual.
- Do not pour or spray liquid directly on the machine during cleaning. Always moisten a soft-lint free cloth with the appropriate cleanser before applying it to the machine.
- Wipe any spills and cleanser off the equipment surfaces immediately.

**Cleaning and  
Disinfecting  
Exterior  
Surfaces**

Clean painted, plated, and plastic surfaces with a soft lint-free cloth moistened with mild detergent and water. Follow up with a 70% to 90% diluted solution of ethyl or isopropyl alcohol or sodium hypochlorite (5.2% household bleach) at 1:500 dilution (100 ppm chlorine).

**NOTE:** Draeger Medical makes no claims about the efficacy of these agents or this method of cleaning for infection control. Consult your hospital's infection control officer or epidemiologist.

**Cleaning and  
Disinfecting  
Corrugated  
Breathing  
Hoses, Mask  
Elbow, and  
Bag**

Contact with oxygen, ether, mineral or vegetable oils, phenols, cresols, terpenes, hydrocarbon solvents, chlorinated hydrocarbons, esters, or oxidizing acids hastens the deterioration process for rubber goods.

Check the hoses, mask elbow, and breathing bag often for signs of deterioration, including swelling, tackiness, or cracking. Replace the affected parts when any of these conditions are evident.

Thoroughly clean rubber goods with mild alkali detergent and water before disinfecting them. Then, thoroughly rinse them with water to remove all detergent. To prevent water spots, use distilled or demineralized water. Avoid using hard-bristle brushes.

Manufacturers of rubber goods recommend that reusable rubber goods be soaked in a liquid disinfection agent. Always follow the agent manufacturer's instructions for use.

**CAUTION:** Disinfectants containing phenol or phenyl compounds destroy rubber goods. Latex and rubber goods treated with disinfectants having a quaternary ammonium base will be damaged if subsequently autoclaved.

Use 2% glutaraldehyde-based formulations for more than 20 minutes or wet pasteurization at 70° C for 30 minutes after detergent cleaning.

Thoroughly rinse the corrugated hoses, mask elbow, and breathing bag after contact with chemicals. Use sterilized water to prevent contamination by tap water organisms. Thoroughly dry rubber goods before returning them to service.

The corrugated hoses, mask elbow, and breathing bag can be autoclaved at 121° C. However, such temperatures accelerate the natural aging of rubber goods. Autoclaved rubber goods can also harden over time as a result of the loss of softeners. Exposure to ozone or ultraviolet light also accelerates the natural aging of rubber goods. Reusable rubber goods can also be gas sterilized with ethylene oxide. After EtO sterilization, properly aerate rubber goods before returning them to service. Always follow manufacturer's instructions for these procedures.

**CAUTION:** Do not autoclave face masks. Autoclaving causes rapid deterioration of face mask cushions.

**Cleaning and Disinfecting the Y-Piece and Mask**

The Y-piece and mask can be disinfected by wiping or immersion with glutaraldehyde-based formulations. EtO and wet pasteurization processes can also be used.

**Cleaning and Disinfecting the Ventilator Bellows**

The ventilator bellows and its bottom assembly are the only ventilator components that come in contact with the patient's breath. Refer back to "Cleaning and Disinfecting Exterior Surfaces" on page 16-17 for instructions on cleaning and disinfecting the surface of the ventilator bellows assembly.

Clean the bellows with a soft lint-free cloth moistened with mild alkali detergent and water, followed by a distilled water rinse. Let the bellows drip dry.

After cleaning, use wet pasteurization at 70°C for 30 minutes, a glutaraldehyde-based solution, or an EtO process to disinfect the ventilator bellows. Follow manufacturer's guidelines for these procedures.

**Cleaning and Disinfecting the Ventilator Bellows Bottom Assembly**

Clean the ventilator bellows bottom assembly with a soft lint-free cloth moistened with mild detergent and water, followed by a distilled water rinse. Allow the assembly to drip dry.

After cleaning, use an EtO process for disinfection. Follow manufacturer's guidelines.

**Cleaning and Disinfecting the Oxygen Sensor Capsule**

Wipe the oxygen sensor capsule with a soft lint-free cloth moistened with mild detergent and water. Make sure the capsule is dry before replacing it.

**CAUTION:** Do not immerse or autoclave the oxygen sensor capsule.

After cleaning the capsule, perform an EtO process at a temperature not exceeding 50°C. Aerate the sensor according to the manufacturer's instructions.

**Cleaning and Disinfecting the Oxygen Sensor Housing**

The oxygen sensor housing can be immersed for cleaning and disinfection. Use mild detergent and water for cleaning. For disinfection, follow up with either sodium hypochlorite (5.2% household bleach) 1:500 dilution (100 ppm free chlorine) or 70% to 90% ethyl or isopropyl alcohol.

**Cleaning and Disinfecting the Oxygen Sensor Housing Cover**

The oxygen sensor housing cover can be immersed or wiped during cleaning and disinfection. Use mild detergent and water for cleaning. For disinfection, follow up with a 2% glutaraldehyde-based formulation, wet pasteurization at 70°C for 30 minutes, or an EtO process.

**Cleaning and Disinfecting the Inspiratory and Expiratory Valves**

The inspiratory and expiratory valves come into contact with the patient's breath. Clean these parts with soft lint-free cloth moistened with mild alkali detergent and water. Dry the parts before reassembling.

The valve assemblies can be immersed in a 2% glutaraldehyde-based solution, wet pasteurized, gas sterilized, or autoclaved at a temperature not exceeding 121° C. The valve disks can also be autoclaved in certain instances, but should not be autoclaved routinely.

Be careful while handling the valve disks. Improper handling can damage them. After cleaning or disinfecting the inspiratory or expiratory valve assembly, verify that the valve disk and all internal pins are undamaged and that the valve disks are correctly reinstalled.

**Cleaning and Disinfecting the Ultrasonic Flow Sensor Housing and Transducers**

Wash the flow housing and transducers with mild detergent and water. Follow with a distilled water rinse. These components can be immersed.

The flow housing and transducers can be autoclaved at a temperature not exceeding 121°C. Follow the manufacturer's instructions for the process. Allow the transducers to normalize for 30 minutes under room ambient conditions before using them.

**Cleaning and Disinfecting the Ultrasonic Flow Sensor Electronics Housing and Cable**

Wipe the electronics housing and sensor cable with a clean, soft cloth moistened with mild detergent and water. Take care not to allow any fluid to access the interior of the electronics housing.

The electronics housing and sensor cable can be wiped with a clean, soft, lint-free cloth moistened with a 70% to 90% diluted solution of ethyl or isopropyl alcohol or sodium hypochlorite (5.2% household bleach) at 1:500 dilution (100 ppm chlorine).

**NOTE:** Draeger Medical makes no claims about the efficacy of these agents or this method of cleaning for infection control. Consult your hospital's infection control officer or epidemiologist.

**Cleaning and Disinfecting the Breathing System Pressure Gauge**

Wipe the pressure gauge assembly with a soft lint-free cloth moistened with mild detergent and water. Dry the assembly before reinstalling.

The gauge can be disinfected with ethylene oxide gas, followed by appropriate aeration. Follow the manufacturer's instructions.

**CAUTION:** The breathing system pressure gauge cannot withstand immersion or the heat and pressure of autoclaving.

**Cleaning and Disinfecting the Absorber Canister Assemblies and Dust Cup**

Refer to "Replacing the Absorbent" on page 16-2 for instructions on removing the absorbent canister assemblies from the absorber.

Clean the canisters frequently. Remove used absorbent and clean absorbent residues for the canister and gasket surfaces. Check the dust cup periodically. Empty and clean it when necessary.

**WARNING:** Absorbent is caustic. Avoid contact with the skin and eyes.

After removing the canister assemblies and dust cup from the absorber system, wash these parts with mild alkali detergent and water. The canister assemblies and dust cup can be immersed or wiped with a soft lint-free cloth. Allow the parts to dry.

Several methods can be used for disinfection. Wet pasteurization, autoclaving, EtO, and immersion or wiping with 2% glutaraldehyde-based solution are all acceptable. If an EtO process is used, make sure the parts are properly aerated before returning them to service.

**Cleaning and Disinfecting the Absorber Assembly**

Turn the APL valve control knob fully counterclockwise before cleaning or disinfecting the absorber system.

After cleaning, an EtO procedure can be used. Follow manufacturer's guidelines.

**CAUTION:** Do not autoclave the absorber assembly.

### **Cleaning and Disinfecting the Vaporizer Exterior**

Clean the vaporizer with a soft lint-free cloth moistened with mild detergent and water. Follow up with a 70% to 90% diluted solution of ethyl or isopropyl alcohol or sodium hypochlorite (5.2% household bleach) at 1:500 dilution (100 ppm chlorine). Do not sterilize the vaporizer.

**WARNING:** Water and other liquids (with the exception of the appropriate anesthetic) that enter the vaporizer chamber can cause injury to the patient or form corrosive products that affect the function of the vaporizer.

**CAUTION:** Do not immerse the vaporizer or allow water or any other liquid to enter the fill or drain ports or fresh gas inlet or outlet ports. Any vaporizer suspected of contamination with water or any other liquid must be returned to Draeger Medical's Technical Service Department for a complete overhaul.

Additional care must be taken with halothane vaporizers. Halothane contains a stabilization additive called thymol, which evaporates more slowly than halothane, and collects in the vaporizer. Over time, thymol may decompose into compounds that affect the wick material and turn the halothane yellow.

If you see particles in the sight glass of a halothane vaporizer, or if the halothane turns yellow, rinse the vaporizer chamber with fresh halothane as follows:

1. Drain the discolored halothane from the vaporizer.
2. Fill the vaporizer with fresh halothane up to the maximum level, then drain completely.
3. Dispose of the drained halothane in accordance with standard practices at your facility.

For information about filling and draining the vaporizer, see Section 6, "Vaporizer".

### **Cleaning and Disinfecting the Open Reservoir Scavenger**

The scavenger interface does not normally need to be disinfected. However, if the user facility requires disinfection, an EtO process can be used after cleaning. Refer back to the cleaning instructions provided in "Open Reservoir Scavenger Maintenance" on page 16-7.

**CAUTION:** Do not autoclave the open reservoir scavenger. The scavenger's flowmeter cannot withstand the heat of autoclaving.

### **Cleaning and Disinfecting the Passive Scavenger Interface**

The scavenger interface does not normally need to be disinfected. However, if the user facility requires disinfection, an EtO process can be used after cleaning. Refer back to the cleaning instructions provided in “Scavenger Interface for Passive Systems Maintenance” on page 16-8.

**CAUTION:** Do not autoclave the scavenger interface for passive systems. The scavenger's relief valves cannot withstand the heat of autoclaving.

### **Disinfecting the Scavenger Hoses**

The scavenger hoses are not part of the breathing circuit, so they do not require disinfection. If the user facility requires disinfection, refer back to the instructions provided in “Cleaning and Disinfecting Corrugated Breathing Hoses, Mask Elbow, and Bag” on page 16-17 to select a compatible process.

Check the hoses frequently for signs of deterioration, including swelling tackiness, or cracking. Replace the affected parts when any of these conditions are evident.

## **Reassembly Instructions**

Make sure all parts are complete dry and adequately aerated before reassembling the machine after cleaning and disinfection procedures.

1. Reassemble the ventilator bellows assembly. Fit the relief valve dome onto the relief valve body, and tighten the knurled ring nut. Place the ventilator bellows on bellows bottom assembly and turn it clockwise until it is secure.
2. Replace the bellows assembly. Fit the bellows assembly into the ventilator bellows canister and tighten the two wing nuts.
3. Replace the absorber. Fit the absorber assembly on the absorber pole. Use a 3/16-inch hex screwdriver to tighten the hex screw securing the absorber system assembly to the absorber pole.
4. Replace the pressure gauge. Place the pressure gauge assembly on the gauge mount, making sure that the O-ring is in place between the pressure gauge assembly and the gauge mount. Slide the knurled ring nut over the threads on the gauge mount. Turn the knurled ring nut clockwise until it is secure. Check the gauge needle's zero position and adjust it if necessary.
5. Replace the canisters and dust cup, making sure the gaskets and O-ring are in place. Pull the canister lever up until it clicks in place.
6. Reassemble the inspiratory and expiratory valves. Place the valve disk and dome gasket in the valve body, then replace the dome and ring nut. Turn the ring nut clockwise to tighten.

7. Replace the inspiratory valve assembly and gasket on the valve mount. Turn the valve assembly clockwise to secure it to the valve mount.
8. Replace the expiratory valve assembly and gasket on the absorber. Turn the valve assembly clockwise to secure it to the absorber dome.
9. Reassemble the ultrasonic flow sensor. Press the transducers into their ports on the flow housing. Ensure that the three O-rings on each transducer are not damaged and are properly seated. Slide the flow housing/transducer assembly into the electronics housing. 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.

10. Slide the flow sensor onto the bracket.
11. Connect the patient hose to the expiratory hose terminal on the flow sensor.
12. Install the connector hose assembly between the flow sensor and the expiratory valve, and secure it by turning the ring nut clockwise.
13. Connect the sensor cable to the volume sensor receptacle on the system interface panel.
14. Replace the oxygen sensor in the inspiratory valve port. Connect the sensor cord to the system interface panel.
15. Connect the fresh gas hose to the fresh gas outlet on the machine.

**WARNING:** Do not pinch or kink the fresh gas hose leading from the fresh gas outlet to the absorber.

16. Reconnect the breathing pressure pilot line to the absorber and the system interface panel.
17. Replace the 22 mm hoses and other breathing circuit accessories.
18. Replace the 19 mm hoses that connect the scavenger to the APL valve and the ventilator relief valve as illustrated in Figure 16-9 and Figure 16-10. If the scavenger hoses were removed from the scavenger, replace the scavenger hoses as illustrated on the following pages.
19. Turn the SYSTEM POWER switch to ON.
20. Perform the daily checkout procedure provided in this manual before operating the machine.

Figure 16-9. Open Reservoir Scavenger Connections

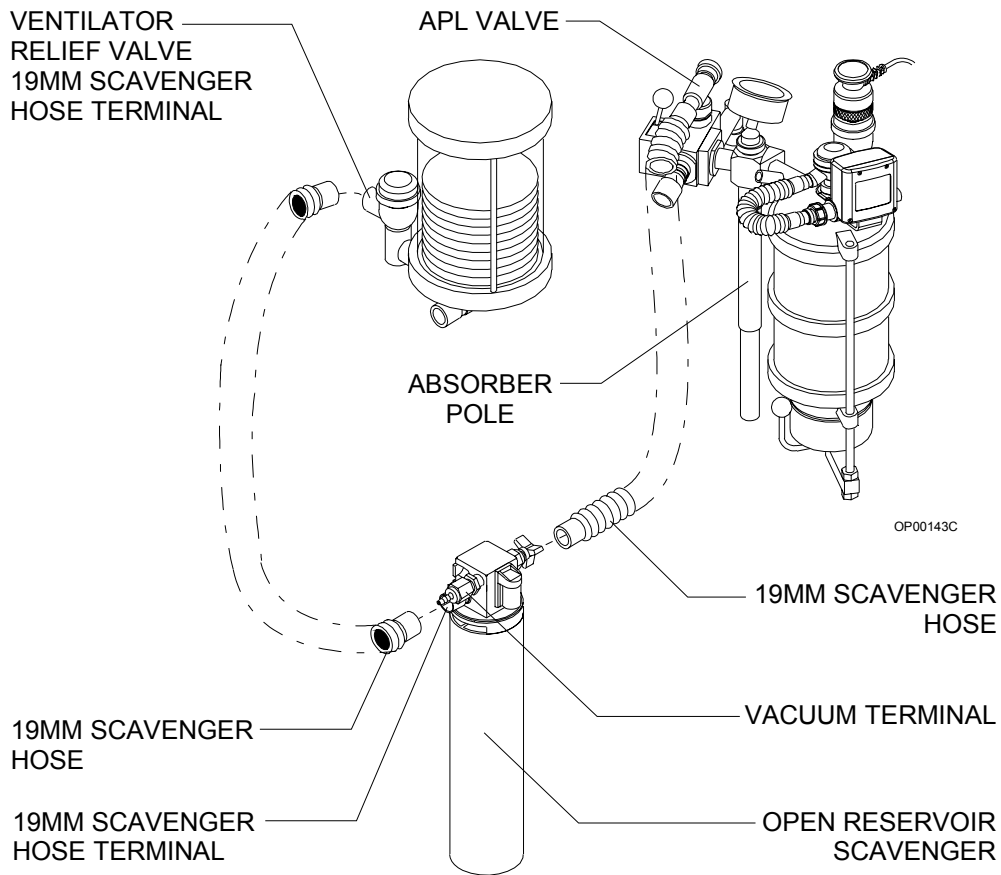
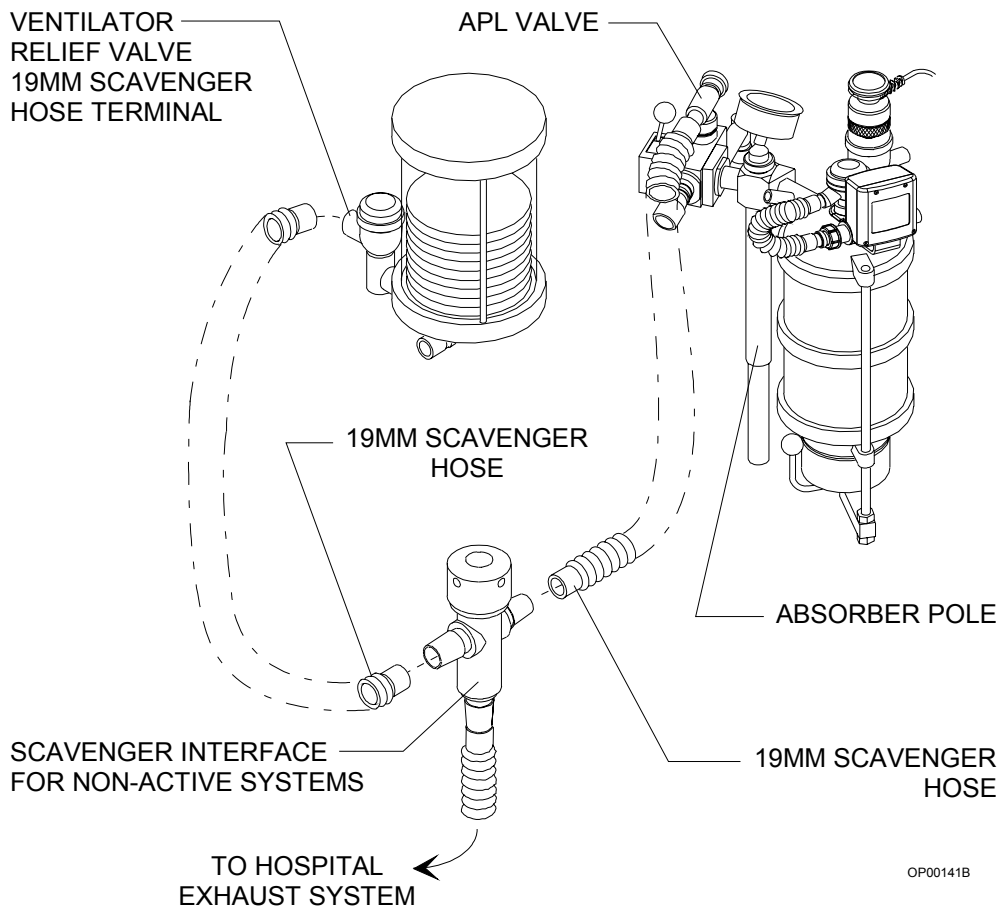




Figure 16-10. Passive System Scavenger Connections



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## Specifications

*This section describes the specifications of the Narkomed GS anesthesia machine.*

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**General**

Dimensions (approximate)

Two-vaporizer configuration (W x H x D) . . . . .36 x 53 1/2 x 27 inches

Three-vaporizer configuration (W x H x D) . . . . .40 x 53 1/2 x 27 inches

Weight (approximate) . . . . .375 lbs

**Environmental**

**Storage**

Temperature . . . . .-10–60°C

Humidity . . . . .10–90% relative humidity (noncondensing)

**Operating**

Temperature . . . . . 10–40°C

Humidity . . . . .30–70% relative humidity (noncondensing)

**Electrical**

Equipment class . . . . .IEC 601 Class 1, Type B,  
 continuous operation, IPX0

Leakage current . . . . . ≤ 300 microamps (per UL 544)

Ground impedance . . . . . ≤ 0.1 ohm (60 Hz source)

Dielectric withstand . . . . . ≥ 1500 VAC (per UL 544)

Chassis resistance (between any metallic point  
 and ground pin on power cord) . . . . . ≤ 0.1 ohm

**120 Volt  
 Power Supply**

Primary input voltage (acceptable range) . . . . .100–120 VAC @ 50/60 Hz

Primary input current . . . . . ≤ 10 amps (RMS total)  
 ≤ 3 amps (machine)  
 ≤ 7 amps (receptacles)

**220/240 Volt  
 Power Supply**

Primary input voltage (acceptable range) . . . . .200–240 VAC @ 50/60 Hz

Primary input current . . . . . ≤ 6.5 amp (RMS total)  
 ≤ 1.5 amps (machine)  
 ≤ 5 amps (receptacles)

**Backup  
 Battery**

Charging time . . . . . ≤ 12 hours

Reserve power time (from full charge) . . . . . ≥ 30 min

## Gas Delivery System

	Pipeline inlet connections. . . . .	DISS/male Nut with nipple (Canada)
	Pipeline inlet pressure . . . . .	50–55 psi (345–380 kPa) (O <sub>2</sub> , N <sub>2</sub> O, Air)
	Pipeline gauge accuracy . . . . .	±3 psi (0–25 psi) ±2 psi (26–75 psi) ±3 psi (76–100 psi)
	Cylinder connections. . . . .	Pin-indexed hanger yokes (CGA V-1-1994)
	Regulator safety relief valve. . . . .	95 psi (655 kPa)
	Regulator safety relief valve (Canada) . . . . .	75 psi (520 kPa) (CSA Standard Z168.3-M84)
	Fresh gas common outlet . . . . .	15 mm female (Canada: 15 mm female, 22 mm male)
	Fresh gas oxygen concentration (ORC) . . . . .	25 ±4%
	Oxygen flush flow rate . . . . .	55 (±10) l/min
	Minimum oxygen flow (at 50 psi pipeline pressure). . . . .	150 ±50 ml/min
	Low oxygen supply pressure alarm . . . . .	34–40 psi
	Cylinder gauge accuracy. . . . .	±90 psi (0–750 psi) ±60 psi (751–2250 psi) ±90 psi (2251–3000 psi)
<b>Cylinder Gas Pressures (typical full loads at 70°F, 21°C)</b>	Oxygen, Air . . . . .	1900 psi (13100 kPa)
	Nitrous oxide . . . . .	745 psi (5130 kPa)
	Carbon dioxide . . . . .	838 psi (5770 kPa)
<b>Flowmeter Accuracy (at 20°C and 760 mmHg)</b>	Oxygen, Nitrous Oxide, Air (Fine) . . . . .	100–1000 ml/min ±2.5% FS
	Oxygen, Nitrous Oxide, Air (Coarse) . . . . .	1–10 l/min ±2.5% FS
	Air (Dual Tapered) . . . . .	0.2–1 l/min ± 50 ml/min of reading 2–10 l/min ±5% FS
	Carbon Dioxide . . . . .	0.05–1.0 l/min ±5% FS
	Oxygen, Nitrous Oxide (Fine) (Optional, Low-Flow) . . . . .	20–500 ml/min ±2.5% FS
	Oxygen, Nitrous Oxide (Coarse) (Optional, Low-Flow) . . . . .	0.6-10 l/min ±2.5% FS @ >1 l/min ± 15% of reading @ <1 l/min
	Oxygen (Auxiliary Oxygen) . . . . .	1–10 l/min ±5% FS

### Vaporizers (Vapor 19.1 and 19.3)

Temperature Range	+15–35°C (at normal atmospheric pressure of 760 mmHg)
Flow Range	0.25–15 l/min
Maximum Pressure Load	150 mmHg (above atmospheric)
Maximum Angle of Inclination	45°
Weight	approximately 7.5 kg

The following values refer to individual concentration settings when operated with a continuous flow of air in the range 0.25–15 l/m, temperature at 22°C, and normal atmospheric pressure (760 mmHg).

<b>Halothane</b>	Adjustment range	0.2–5 vol%
	Accuracy	± 0.15% concentration (volume) <b>or</b> ± 15% (whichever is higher)

<b>Enflurane</b>	Adjustment range	0.3–7 vol%
	Accuracy	± 0.2% concentration (volume) <b>or</b> ± 20% (whichever is higher) <b>or</b> + 20%/- 30% with flow settings 6.0–15 l/min and handwheel settings higher than 5.0% volume concentration

<b>Isoflurane</b>	Adjustment range	0.2–5 vol%
	Accuracy	± 0.15% concentration (volume) <b>or</b> ± 15% (whichever is higher)

<b>Sevoflurane</b>	Adjustment range	0.3–8 vol%
	Accuracy	± 0.2% concentration (volume) <b>or</b> ± 20% (whichever is higher)

### Ventilator

Frequency	1–99, ±1 BPM (in 1 BPM increments)
I:E ratio	<i>Standard range:</i> 1:1–1:4.5, ±0.1 (in increments of 0.5); <i>Extended range:</i> 4:1, 3:1, 2:1
Inspiratory flow	10–100 l/min (uncalibrated)
Tidal volume	20–1500 ml, ±100 ml
Pressure limit control adjustment range	15–120 cm H <sub>2</sub> O

## Absorber System

<b>Inspiratory Valve</b>	Mounting ring nut size . . . . .	M35 x 1	
	Hose terminal . . . . .	22 mm male	
<b>Expiratory Valve</b>	Mounting ring nut size . . . . .	M33 x 1	
	Hose terminal . . . . .	22 mm male	
<b>PEEP Valve (optional)</b>	Range . . . . .	approx. 2–15 cm H <sub>2</sub> O (continuously adjustable)	
<b>Breathing System Pressure Gauge</b>	Range . . . . .	-20 to +80 cm H <sub>2</sub> O	
	Smallest scale division . . . . .	2 cm H <sub>2</sub> O	
	Nominal accuracy . . . . .	-20 to +5 cm H <sub>2</sub> O:	3% FS
		+5 to +55 cm H <sub>2</sub> O:	2% FS
		+55 to +80 cm H <sub>2</sub> O:	3% FS
Mounting ring nut size . . . . .	1 1/8 x 18		
<b>APL Valve</b>	Nominal low flow resistance . . . . .	2 cm H <sub>2</sub> O at 8 l/min	
	Hose terminal . . . . .	19 mm male	
<b>Breathing Bag Terminal</b>	Bag terminal . . . . .	22 mm male	

## Oxygen Monitoring

Range . . . . .	10–100 vol % O <sub>2</sub>
Resolution . . . . .	1 vol % O <sub>2</sub>
Accuracy . . . . .	±3 vol % O <sub>2</sub>
	(When calibrated within 18 hours, and constant temperature and pressure)
Response time . . . . .	≤ 25 sec (T90)
Zero drift . . . . .	≤ 0.1 vol % O <sub>2</sub> /month
Span drift . . . . .	≤ 1 vol % O <sub>2</sub> /8 hours
Temperature error . . . . .	≤ ± 3% of reading (15° to 40°C)
Sensor service life . . . . .	≥ 8 months at 25°C, 50% relative humidity, 50% O <sub>2</sub> gas mixture (or ≥5000% hour CO <sub>2</sub> )

### Breathing Pressure Monitoring

Numeric display range . . . . .	-10–125 cm H <sub>2</sub> O
Resolution . . . . .	1 cm H <sub>2</sub> O
Accuracy . . . . .	±3 cm H <sub>2</sub> O or ±10% of reading, whichever is greater
Waveform display range - full . . . . .	0–100 cm H <sub>2</sub> O
Waveform resolution . . . . .	1 cm H <sub>2</sub> O
Waveform accuracy . . . . .	±3 cm H <sub>2</sub> O or ±10% of reading, whichever is greater
Waveform display scales . . . . .	0–20, 0–50, 0–100 cm H <sub>2</sub> O

### Respiratory Volume Monitoring

<b>Minute Volume</b>	Display Range . . . . .	0.1–50.0 l
	Resolution . . . . .	0.1 l
	Accuracy . . . . .	10% of reading or 0.01 l x breath rate, whichever is greater*
<b>Tidal Volume</b>	Display Range . . . . .	0.01–2.0 l
		(Note: the standard bellows will deliver up to 1.5 l)
	Resolution . . . . .	0.01 l
	Accuracy . . . . .	10% of reading or 0.015 l, whichever is greater*
	Volume Apnea Threshold . . . . .	0.02 l
<b>Respiratory Rate</b>	Numeric display range . . . . .	2–99 bpm
	Resolution . . . . .	1 bpm
	Accuracy . . . . .	±10% of reading or 1 bpm, whichever is greater

\*exclusive of hose compliance effects

### Serial Interface

<b>Serial Port</b>	Type . . . . .	RS-232/422
	Baud Rate . . . . .	300-38400, 4800, 9600, 19.2K, 38.4K
	Parity . . . . .	Odd, Even, None
	Data Bits . . . . .	7 or 8
	Stop Bits . . . . .	1 or 2
	Protocols . . . . .	Vitalink





## Appendix - Spare and Replacement Parts

---

*This section describes the spare and replacement parts for the Narkomed GS anesthesia machine along with their part numbers.*

	<b>Description</b>	<b>Part Number</b>
<b>Manuals</b>		
	Narkomed GS Operator's Instruction Manual . . . . .	4113853
	Narkomed GS Technical Service Manual . . . . .	4112817-010
<b>Absorber System</b>		
	Gasket - Canister Top . . . . .	4105848
	Gasket - Canister Bottom . . . . .	4105849
	Gasket - Absorber Bottom . . . . .	1101001
	Screen - Canister . . . . .	1100022
	Canister . . . . .	4105852
	Breathing Pressure Gauge Assembly . . . . .	4105853
	PEEP Bypass . . . . .	4110300
	Dome - Inspiratory/Expiratory Valve (without port) . . . . .	2109230
	Dome - Inspiratory Valve (with sensor port) . . . . .	4108329
	Plug Assembly - (for inspiratory valve dome with sensor port) . . . . .	4106837
	Valve Assembly - Inspiratory (with ported dome assembly and plug assembly) . . . . .	4107649
	Valve Assembly - Expiratory . . . . .	4107650
	Ring Nut (inspiratory or expiratory valve upper ring nut) . . . . .	2109228
	Gasket (flat washer, inspiratory or expiratory valve mount) . . . . .	1101690
	Dust Cup . . . . .	4106874
	Spring Clip (absorber rod) . . . . .	1100097
	Hose Assembly (patient pressure/Luer) . . . . .	4108528
	O-ring #237, Silicone (dust cup fitting) . . . . .	4102940
<b>Breathing System Accessories</b>	Breathing Hose, 22 mm x 23" long . . . . .	9995123
	Breathing Hose, 22 mm x 32" long . . . . .	9995132
	Breathing Hose, 22 mm x 40" long . . . . .	9995140
	Rubber Good Set (includes Y-Piece, Mask Elbow, 2 Liter Breathing Bag, and 2 each 32" Breathing Hoses) . . . . .	1101071
<b>Gas Evacuation Accessories</b>	Hose, 19 mm x 20" long . . . . .	9995220
	Hose, 19 mm x 30" long . . . . .	9995230
	Hose, 19 mm x 48" long . . . . .	9995248

	Description	Part Number
<b>Breathing Bags</b>	2.0 liter .....	9995320
	5.0 liter .....	9995350
 <b>Vaporizers (19.1)</b>		
	Mounting screws (4 x 30 metric) .....	HW01072
	O-rings .....	2121929
	Cover assembly vapor block (short circuit block) .....	4104530
 <b>Bellows</b>		
	Adult Latex-Free Bellows (replacement bellows) .....	4106930-001
	Pediatric Bellows .....	4109700
 <b>Oxygen Monitoring Accessories</b>		
	Oxygen Sensor Capsule .....	6850645
	Sensor Housing & Cable Assembly .....	4106363
	Inspiratory Valve Dome .....	4108329
	Inspiratory Valve Dome Plug .....	4106387
 <b>Breathing Pressure Monitoring Accessories</b>		
	Breathing Pressure Pilot Line (to absorber) .....	4109368
	Breathing Pressure Pilot Line (with Luer to Y-piece) .....	4108528
 <b>Respiratory Volume Monitoring Accessories</b>		
	Flow Sensor Assembly .....	4115754
	Connector Hose Assembly .....	4114912
	Flow Housing .....	4114444
	Transducer Set .....	4114445
	O-ring Set .....	4115147

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Web: [www.draegermedical.com](http://www.draegermedical.com)  
Printed in the U.S.A.