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NARKOMED 2A

ANESTHESIA SYSTEM

SPECIFICATIONS AND EQUIPMENT

Part Number: 4106034 P (Instruction Manual)
4104036 A – 4104039 A (NM2A/USA)
4106536 A – 4106539 A (NM2A/Canada)

Revision: Rev. D

Date: December 21, 1987

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Instruction Manual

NARKOMED 2A
OPERATORS INSTRUCTION MANUAL

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NARKOMED 2A ANESTHESIA SYSTEM

INTRODUCTION

Classification

The NARKOMED 2A Anesthesia System is a continuous flow anesthesia machine incorporating the features described in this manual.

Serial Number Identification

All inquiries of referring to the NARKOMED 2A Anesthesia System should include the serial number of the machine; the serial number is located on the rear of the left leg of the machine.

Warranty

The warranty terms set forth in North American Dräger's Terms and Conditions (part number 4108055) apply.

Service and Repair

In case of malfunction of this device, contact your local North American Dräger authorized technical service center.

North American Dräger recommends that anesthesia machines be serviced at three month intervals. Yearly Preventive Maintenance contracts are available for most North American Dräger products. These agreements are available from the North American Dräger Technical Service Department, or from a North American Dräger Authorized Technical Service Center.

Repair of the NARKOMED 2A shall be performed only by a North American Dräger authorized technical service representative.

Restriction

CAUTION: Federal Law restricts this device to sale by or on the order of a physician.

Installation

Installation of the NARKOMED 2A Anesthesia System shall be by or under the direction of an authorized representative of North American Dräger.

Labeling and Color Coding

NARKOMED 2A Anesthesia Systems produced for sale in the United States and Canada are supplied with the following color coding.

<u>Gas</u>	<u>Label</u>	<u>USA</u>	<u>Canada</u>
Air	AIR	Yellow	Black and White checkered
Carbon Dioxide	CO ₂	Gray	Gray
Helium	He	Brown	Brown
Nitrogen	N ₂	Black	Black
Nitrous Oxide	N ₂ O	Blue	Blue
Oxygen	O ₂	Green	White

Electrical Specifications

Primary: 117 Volts AC, 60 Hz (100 V - Japan, 220 V - China).

Power Cord: Type SJT with Hospital grade plug.

Receptacles: (4) Hospital grade 117 Volts AC, 60 Hz (or appropriate national system).

Reserve Power Supply: 12 Volt rechargeable battery with built in charger.

Circuit Breaker 1: 1 AMP 2 pole, transformer primary.

Circuit Breaker 2: 10 AMP 2 pole, 117 Volts AC receptacles.

Circuit Breaker 3: 2 AMP 1 pole, battery.

Circuit Breaker 4: 1.5 AMP 1 pole, machine, ventilator and O₂MED.

Circuit Breaker 5: 2 AMP 1 pole, SPIROMED and CENTRALERT.

Dimension Specifications

Maximum height	68"	173 cm
Maximum width (extended)	40"	102 cm
Maximum depth	25"	63.5 cm
Table-top height	34"	86 cm
Table-top area	271 in. sq.	1,749 cm ²
Shelf area	200 in. sq.	1,290 cm ²
Drawer dimensions:		
Large drawer	14"x 21"x 7"	36 x 52 x 18 cm
Small drawer	14"x 17"x 3"	36 x 43 x 8 cm
Nominal weight	325 lb	147 kg

Electrical Conductivity

The NARKOMED 2A Anesthesia System is equipped with conductive casters. All anesthesia machines are tested for electrical conductivity between one caster as a measuring point and the table-top, shelf-top, and inspiratory valve, alternately, as the other measuring point. The maximum allowable resistance between any two points is 250,000 OHM.

This conductivity test should be performed monthly to assure continued conductivity of the machine.

1. STANDARD AND OPTIONAL EQUIPMENT

Gas Cylinder Yokes

The NARKOMED 2A is equipped with at least one oxygen and one nitrous oxide yoke to facilitate attachment of gas cylinders with flush-type valves. The Pin-Index System (ANSI B57.1 1965) is used to prevent connection of a cylinder of incorrect type.

Each NARKOMED 2A yoke contains a check valve to prevent transfer of gas from one cylinder to another, and to prevent leakage of gas to the atmosphere when the yoke is not holding a cylinder. The check valve will also prevent accidental backward leakages of gases that are assumed to be moving toward the patient, a condition that can occur when the flow control valve is open and there is no cylinder in the yoke. When there is no cylinder in a yoke we suggest that a yoke plug (Part 1100535) be inserted in the yoke for added security. Only (1) washer shall be used for sealing purposes in a cylinder yoke. The safety of the Pin-Index System can be compromised if more than one washer is used. When changing cylinders, special attentions should be given to check the existence of both index pins.

Additional Gas Circuits (Optional)

The NARKOMED 2A may be equipped with a maximum of two of the following additional gases: AIR, helium, nitrogen, and carbon dioxide. Flowmeters for additional gases will be located between the oxygen and nitrous oxide flowmeters. There will be a single flow tube for each additional gas. Additional gas(es) may be supplied to the anesthesia system by means of pin-indexed cylinders and yokes, by DISS pipeline connections (if applicable), or by both systems if so specified. Flow control valves will be located below the flowmeter for each gas. The cylinder yokes, if specified, are subject to the conditions described above for standard gas cylinder yokes.

Pressure Regulators

Each reserve cylinder gas circuit incorporates a pressure regulator that regulates the pressure of the gas being supplied by the reserve cylinders. These regulators are adjusted to a delivery pressure below the commonly used hospital pipeline pressure of 50 – 55 psi. Such settings ensure that gas will be supplied from the *pipeline* and not the cylinder *if both sources of supply are open*. * Overpressure relief valves, integral to the regulator, prevent excessive pressures in case of pressure regulator failure or excessive pipeline pressure and are set to open at 95 psi (75 psi for Canada).

* The cylinder supply system of the Canadian machine is equipped with a cutoff valve that prevents gas from flowing from the cylinder when the pipeline pressure exceeds 40–43 psi. The cutoff valve opens automatically if the pipeline pressure drops below 40–43 psi, allowing gas to flow from the cylinder.

Cylinder Pressure Gauges

Each yoke or group of interconnected yokes is provided with a Cylinder Pressure Gauge which indicates the pressure in the cylinder when the valve is open. Each gauge is calibrated in pounds per square inch (psi) and kilopascals (kPa) and is identified with the symbol for the specific gas it accommodates. The pressure gauges are located directly below the flow control valve and flowmeter with which they are associated.

The gauge pressure indicated is directly proportional to cylinder pressure in the case of non-liquefied gases (O₂, AIR). For liquefied gases (N₂O, CO₂) the gauge indicates the vapor pressure of vaporized liquid in the cylinder. This pressure remains approximately constant until all of the liquid in the cylinder has vaporized; the pressure then drops proportionately with further removal of gas from the cylinder. When two (2) cylinders of the same gas are open, the gauge will indicate the pressure in the cylinder having the higher pressure. The pressure gauge for CO₂ is located adjacent to the CO₂ cylinder yoke.

All pressure gauges are marked in psi in the English System and kilopascals in the metric system. Machines manufactured for export will be marked in the appropriate national system.

	Cylinder Fill Pressure Values (at 21° C/ 70° F)		Full Scale Gauge Pressure Values	
	<u>kPa</u>	<u>Lb. /in.²</u>	<u>kPa</u>	<u>Lb. /in.²</u>
	AIR	13,110	1,900	27,600
Nitrous Oxide	5,100	745	13,800	2,000
Oxygen	13,110	1,900	27,600	4,000
Carbon Dioxide	5,782	838	13,800	2,000
Nitrogen	13,110	1,900	27,600	4,000
Helium	11,040	1,600	27,600	4,000

The pressure of O₂ and N₂O (AIR optional) supplied from hospital pipelines at reduced pressure is indicated at an additional set of gauges located in the lower portion of the flowmeter housing.

Pipeline Pressure Gauge Values

	<u>Nominal</u>		<u>Full Scale</u>	
	<u>kPa</u>	<u>Lb. /in.²</u>	<u>kPa</u>	<u>Lb. /in.²</u>
AIR	345	50	690	100
Nitrous Oxide	345	50	690	100
Oxygen	345	50	690	100

Pipeline Inlet Connections

The oxygen and nitrous oxide gas systems include low pressure inlets located at the right side of the flowmeter housing (AIR optional). These inlets include check valves which permit gas to enter when suitable hose connections are made, but prevent reverse flow of gas from the machine cylinder system to the pipeline or to atmosphere if no hose is connected. Each pipeline connection is equipped with a replaceable sintered bronze filter. The inlets are of the type known as Diameter Index Safety System (DISS), male. The purpose of the DISS system is to prevent misconnection of gases to the machine. Machines manufactured for export will be equipped with connectors conforming to the appropriate national standard.

AIR Pipeline Inlet Connections (Optional)

Machines equipped with an AIR circuit, in addition to the standard oxygen and nitrous oxide circuits, may also be supplied with a pipeline connection. Special AIR pipeline inlet connections will be of the DISS type, and will be equipped with a check valve and filter similar to that described for standard inlet connections.

OFPD - Oxygen Supply Pressure Failure Protection Device

To minimize hazards to the patient in the case of oxygen supply pressure failure, all gas dispensing systems of the NARKOMED 2A, with the exception of oxygen, are provided with an oxygen pressure failure protection device. This device consists of pneumatically operated valves which are located in the supply lines to the flow control valves of each gas other than oxygen. These valves are controlled by the pressure of the gas in the oxygen supply line delivering gas to the oxygen control valve. A failure, or reduction, of pressure in the oxygen supply line will proportionally reduce and eventually shut off the supply of all other gases. As an indication of the actuation system, the floats in the flowmeter will drop to zero.

Oxygen Flush

The NARKOMED 2A Anesthesia System is equipped with a manually operated oxygen flush valve of self-closing construction located at the left front of the frame. The valve, if actuated, delivers an unmeted oxygen flow of approximately 50 l/min directly to the common outlet of the machine. The oxygen flow of the flush bypasses the out-of-circuit vaporizers of the system. The connection of the fresh gas line and the oxygen flush line is designed to prevent the build-up of excessive pressure within certain limits of downstream resistance when the flush is actuated. The oxygen flush may be operated without the main switch being in the "ON" position.

Flowmeters

The NARKOMED 2A is equipped with both fine and coarse flow tubes for the oxygen and nitrous oxide circuits. In each case the fine tube is calibrated from 100 to 1,000ml/min and the coarse tube is calibrated from 1.0 to 10.0l/min. All flowtubes have the scale etched and printed directly onto the glass tubing. The accuracy of the flowtubes is certified to be within $\pm 3\%$ of full scale reading under test conditions. All flowtubes are calibrated at 20° C and 760 mm Hg barometric pressure. The center of the ball is the indication of flow. The indicator balls within the flowmeter tubes are one-half sphere chromeplated to indicate free movement of the ball through rotation. Lack of rotation may indicate malfunctioning of the tube and misindication of flow; an authorized North American Dräger service representative should be consulted.

The oxygen flowmeters and flow control valve are located on the right-hand side of the bank of flowmeters (when facing the machine). The nitrous oxide flowmeters and flow control valve are located on the left side of the bank of flowmeters.

Flowmeters (Optional)

Flowmeters for optional gases AIR, Carbon Dioxide (CO₂), Helium (He), and/or Nitrogen (N₂) are located between the oxygen and nitrous oxide flowtubes in the flowmeter bank. The "AIR" flowmeter tubes (fine and coarse) are calibrated as follows: the fine tube from 100 to 1000 ml/min and the coarse tube from 1.0 to 10.0 l/min. The "CO₂" flowmeter (single tube) is calibrated from 0.05 to 0.9 l/min. The "He" flowmeter (single tube) is calibrated from 0.2 to 5.0 l/min. The "N₂" flowmeter (single tube) is calibrated from 0.2 to 10.0 l/min.

Optional flowmeters are equipped with stainless steel or black glass floats and are certified to be within $\pm 5\%$ of full scale reading under test conditions. All flowtubes are calibrated at 20° C and 760 mm Hg barometric pressure. The center of the float is the indication of flow in all cases.

Auxiliary Oxygen Flowmeter (Optional)

For the delivery of a metered flow of pure oxygen (such as for the delivery of pure oxygen through a nasal cannula), the optional Auxiliary Oxygen Flowmeter can be mounted on the left-hand side of the flowmeter bank. It is calibrated from 0 to 10 L/min at an accuracy of $\pm 5\%$ of full scale. If adequate oxygen supply pressure is available (from either pipeline or reserve cylinders), oxygen is available at this flowmeter's flow control valve, regardless of the anesthesia machine System Power switch position.

NOTE: Since, the flow control valve for the Auxiliary Oxygen Flowmeter does not incorporate a zero stop, take care not to overtighten the valve control knob.

Flow Control Valves

Each gas line which dispenses metered gas to the patient breathing system incorporates one precision flow control valve. The flow control valve for each gas is located immediately below the flowmeter for the specific gas it controls, or below the low range tube where two flow tubes are used in tandem. The gas flow in all cases is increased by counter-clockwise motion of the valve knob, and decreases by clockwise motion of the knob.

The flow control valves are capable of adjusting the range of flow within the limits of the associated flowmeter or flowmeters where the delivery and supply pressures are within normal limits.

Excessive force should be avoided when shutting off the valve in order to prevent damage to the valve seat.

The oxygen control valve utilizes a touch-coded knob; the knob is deeply serrated. All other control knobs have minimal serrations. (Refer to page 2 on color-coding.)

In order to reduce possible damage to the delicate valve seats, the valve arrangement incorporates a zero flow stop; readjustment of this stop can be accomplished by authorized North American Dräger

Minimum Oxygen Flow

The oxygen dispensing system includes a minimum flow of 150 ± 25 ml/min; at nominal 50 psi pressure, which bypasses the flow control valve. (For exception see items 2.5 & 2.6 of OPERATOR ALERT TO SPECIAL FEATURES.)

Freshgas Common Outlet

The freshgas outlet is located in clear view of the operator and consists of a 15 mm female connector equipped with a safety locking device which prevents an inadvertent disconnection of the freshgas hose. Canadian machines are also equipped with a 22 mm male connector.

Vaporizers

The NARKOMED 2A Anesthesia System is equipped with vaporizers for the administration of liquid anesthetics. The vaporizers are located at the right side of the flowmeter housing. Operating instructions for the vaporizers will be found in separate manual(s).

Vaporizer Interlock System

The Vaporizer Interlock System consists of a mechanical interlock incorporated into the vaporizer mounting bracket, which limits the concentration adjustment to one vaporizer only. The interlock system requires all out-of-use vaporizers to be locked in the zero position. To change the administration of anesthetic from one vaporizer to another requires all vaporizers to be turned to the zero position.

Auxiliary Power Outlet

The machine is provided with an Auxiliary Power Outlet connection located behind the flowmeter housing. The outlet works in conjunction with the oxygen dispensing system. The pressure at the power outlet is equal to the delivery pressure of the O₂ regulator or the pipeline supply pressure, depending upon which oxygen supply source is in use.

Suction System (Optional)

The NARKOMED 2A Anesthesia Machine may be provided with a built-in suction system. The suction system control valve and reservoir bottle are located on the right front corner at table-top level. A DISS connector for vacuum, for the suction system, is located on the rear of the machine at table-top level.

Central Alarm Panel

The Central Alarm Panel, located to the left of the flowmeter housing, contains most of the alarm indicators and controls for the NARKOMED 2A (see Figure 1).

Electric Power Supply

The Electric Power Supply consists of 117 Volts AC (60 Hz) input with 10 Volts DC unregulated output. The 10 Volt output is further reduced to 5 Volts DC to provide power for the alarm circuit and the AV-E electronically controlled ventilator. There is a 10 Volt DC jack, to provide power for the SPIROMED, located on the bottom of the power supply module. The power supply module, including the back-up battery and battery charger, is located at the left rear of the machine below table-top level. The transformer secondary supplying the battery charging circuit operates at 17 Volts DC. The NARKOMED 2A shall always be used with the machine plugged into a 117 Volts AC outlet.

Battery Back-Up System

The NARKOMED 2A is equipped with a battery back-up system as a standard feature. The battery back-up system is designed to supply electric emergency power in the event that the prime electric power of the operating room fails or is temporarily interrupted.

CAUTION: THE EMERGENCY BACK-UP POWER OF THE NARKOMED 2A SHALL NOT BE USED AS A PRIME SOURCE FOR OPERATING THE ANESTHESIA MACHINE AND THE NARKOMED 2A SHALL ONLY BE USED WITH THE POWER CORD PLACED IN A LIVE RECEPTACLE SUPPLYING ELECTRIC POWER. NO ANESTHETIC PROCEDURE SHALL BE STARTED UTILIZING A NARKOMED 2A ANESTHESIA MACHINE IF THE RESERVE POWER ACTIVE CAUTION LIGHT OR THE RESERVE POWER LOW WARNING LIGHT IS LIT.

Indicators and Alarms: The activation of the battery back-up system is accompanied by certain warnings and alarms described in the following.

In the event that the electric service to the operating room fails, the battery back-up system will automatically be actuated, supplying battery power to the electronic ventilator as well as the internal alarm system of the anesthesia machine. When the battery back-up system becomes active, the yellow RESERVE POWER ACTIVE caution light located on the alarm panel of the anesthesia machine will light up and inform the operator that the prime power supply to the machine has failed and the anesthesia machine is operating with emergency battery power. This occurrence is accompanied by a short warning sound every one minute. If the emergency power supply is activated for a longer period of time (depending upon the number of components provided with emergency power), the capacity of the battery may near exhaustion and the voltage will decrease, to a point where the yellow RESERVE POWER LOW warning light on the panel is lit. This is accompanied by a continued warning sound which alerts the operator that emergency power is only available for an additional limited amount of time and appropriate measures must be taken. With further decrease of the back-up voltage an internal safety mechanism which protects the battery from deep discharge will shut off the emergency power. At that point the ventilator as well as all alarms and monitor will cease to operate.

Operation without Electric Power: The operation of the gas supply systems in the anesthesia machine do not require electrical power. The anesthesia machine can be used under emergency conditions if the AC power to the operating room has failed and the battery back-up system is exhausted, however, under these conditions the electronic ventilator is inoperative and manual ventilation by bag-squeezing must be performed. There will be no alarm functions or monitoring displays during such a period.

Charging the Battery Back-Up System: After prime electrical power to the receptacles in the operating room is restored and the power line of the NARKOMED 2A is attached to a live receptacle, the NARKOMED 2A switches automatically back to AC power and the exhausted battery is recharged.

Battery Test: Sufficient battery power of the back-up system of the NARKOMED 2A shall be tested daily by pressing the battery test button on the alarm panel of the anesthesia machine. A green light indicates that power to operate the electrical components of the anesthesia machine is available but does not indicate the period of time for which this power will be provided. This depends on the period of time the battery was used and for what period of time it was charged.

Circuit Breakers

The NARKOMED 2A electrical system includes five (5) circuit breakers to protect various functions. The purpose of the various circuit breakers is described in the Specifications section of this manual. Circuit breakers are located on the Electrical Power Supply at the left rear of the anesthesia machine.

The cause of an open breaker must be investigated. Equipment that caused the breaker to open shall be repaired or replaced before returning the anesthesia system to service.

System Power Switch

The System Power Switch is located on the Central Alarm Panel at the left side of the flowmeter housing, FIGURE 1, #18. The System Power Switch has two positions; "STANDBY" (9 o'clock position) and "ON" (12 o'clock position). With the "ON" position, the System Power Switch actuates all gas supplied to respective control valves and electric power supply to all alarm systems with the exception of the ventilation pressure monitor which is actuated by the ventilator switch. In order to prevent inadvertent disengagement of the System Power Switch, it is necessary to push and turn the control knob when changing positions. A green LED adjacent to the System Power Switch is actuated any time that the switch is "ON" and supplying power to the machine. With the System Power Switch in "STANDBY", the alarm system and the gas supplies are shut off. The battery charging circuit, the 117 Volt AC receptacles, and the SPIROMED receptacle are powered when the power cord is attached to an active receptacle regardless of the setting of the System Power Switch. To prevent drainage of the back-up battery, the System Power Switch shall be turned to the "STANDBY" position whenever the machine is not in use.

Indicators and controls on the Central Alarm Panel are listed below. The numbers below correspond to the numbers on FIGURE 1.

1. Audible alarm.
2. Thirty (30) second audible alarm "DELAY" pushbutton.
3. Thirty (30) second audible alarm "DELAY" indicator, yellow LED.
4. Audible alarm "DISABLE" pushbutton.
5. Audible alarm "DISABLE" indicator, yellow LED.
6. Breathing system high pressure alarm indicator, single red LED.
7. Breathing system sub-atmospheric pressure indicator, single red LED.
8. Breathing system continuing pressure alarm indicator, two (2) alternating red LED's.
9. Breathing system minimum ventilation pressure alarm indicators, two (2) alternating red LED's.
10. Breathing system minimum ventilation alarm pressure selector switch.
11. Oxygen Ratio Monitor (ORM) alarm indicators, two (2) alternating red LED's.
12. Oxygen supply pressure alarm indicators, two (2) alternating red LED's.
13. Reserve power battery test pushbutton.
14. Reserve power battery "TEST", indicator, green LED.
15. Reserve power battery "LOW", indicator, yellow LED.
16. Reserve power battery "ACT", indicator, yellow LED.
17. System power "ON" indicator, green LED.
18. System Power switch, Standby-On.
19. Breathing system pressure alarm connector port.
20. Flowmeter lights On-Off toggle switch (Optional).

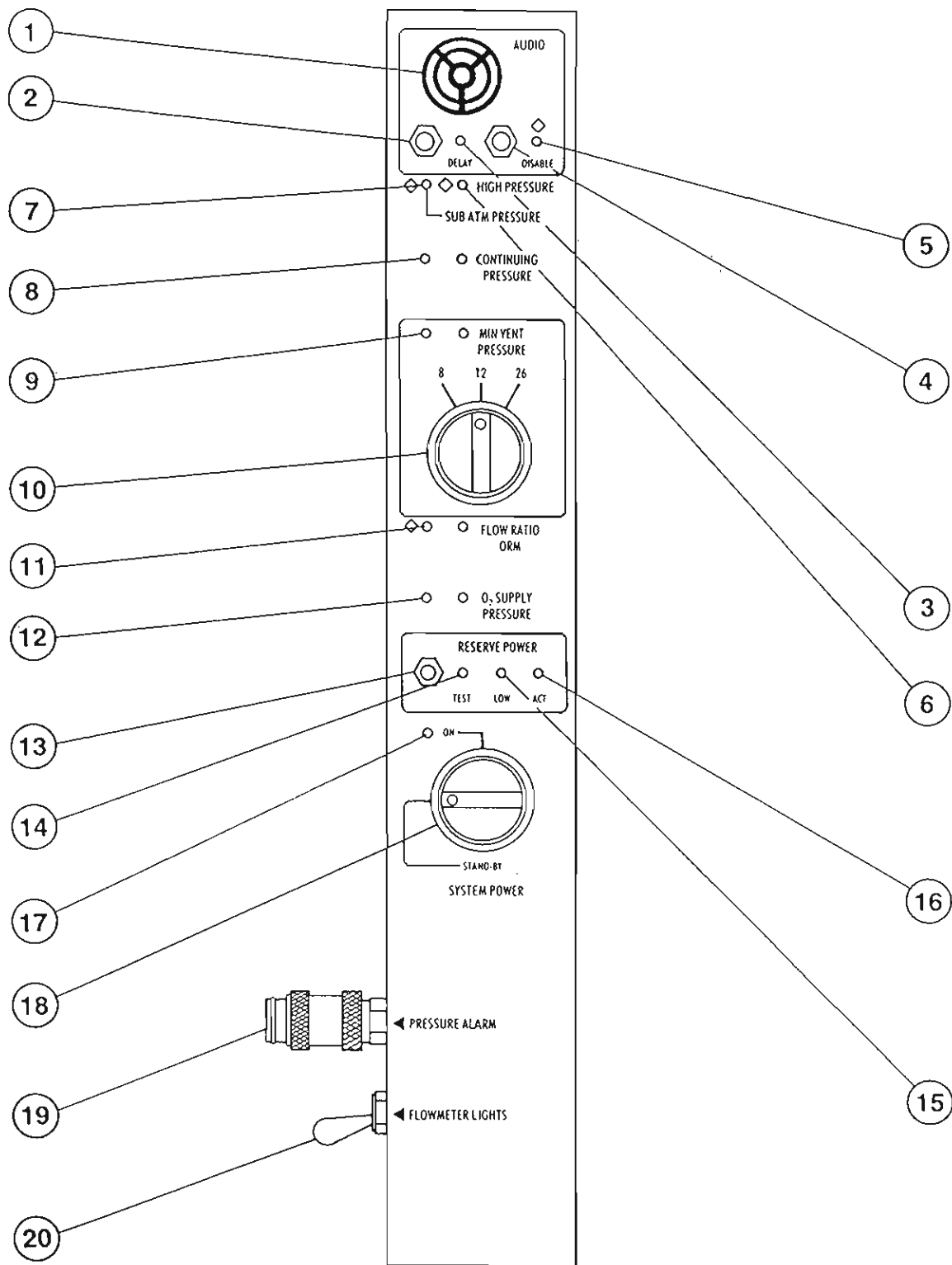


FIGURE 1: CENTRAL ALARM PANEL

Reserve Power Test Assembly

The Reserve Power Test Assembly is located on the alarm channel at the lower left of the flowmeter housing. The assembly consists of a battery test pushbutton, a green LED and two (2) yellow LED's.

The green LED (TEST) will light when the pushbutton is depressed and the battery is charged to normal operating potential. The yellow LED (LOW) lights when the battery potential drops below the normal operating threshold, the LED will be extinguished when the battery is completely depleted. The yellow LED (ACT) will light when the battery is supplying power to the alarm circuit or the electronic ventilator, this is an indication of AC power interruption.

Electric Power Outlets

The NARKOMED 2A includes four (4) 117 Volt AC (60 cycle) electric power outlet receptacles. The hospital grade receptacles are mounted on the rear of the machine in the power pack assembly.

Audible Alarm Delay

The alarm system includes an Audible Alarm Delay circuit which will, upon actuation, silence the audible portion of the alarm for a maximum of thirty (30) seconds. The delay circuit pushbutton is located on the upper portion of the alarm panel, below the Sonalert Alarm. A yellow light-emitting diode, located adjacent to the pushbutton will be illuminated during the period of alarm delay. The delay circuit functions automatically for the first thirty (30) seconds, after the System Power switch of the anesthesia machine is turned "ON".

Audible Alarm Disable Switch

The Audible Alarm System includes a pushbutton switch which can be used to disable certain alarm functions.

This switch is located adjacent to the Audible Alarm Delay pushbutton, it will disable the audio portion of those alarms on the control panel which are marked with a white diamond adjacent to the alarm LED.

In the disabled condition the audible portion of the affected alarms are silenced, the visual (LED) portion of the alarms will continue to function if an alarm condition should occur. Re-actuating the pushbutton restores the audible alarms. If the machine is equipped with a CENTRALERT, visual indication of disabled alarms is also suppressed.

Oxygen Supply Pressure Alarm

The Oxygen Supply Pressure Alarm, marked O₂ SUPPLY PRESSURE, is located in the central alarm panel at the left side of the flowmeter housing and displays alternating red warning lights. The audible alarm may be silenced if desired. It is actuated if the oxygen supply pressure in the system decreases to below 30 psi.

Oxygen Flow Ratio Alarm Monitor (ORM)

The Oxygen Flow Ratio Alarm, labeled FLOW RATIO ORM, is located in the central alarm panel at the left side of the flowmeter housing and displays alternating red warning lights. The audible alarm may be silenced, if desired. It is actuated if the ratio of nitrous oxide flow to oxygen flow decreases below a factory pre-set level. The Oxygen Flow Ratio Monitor is factory adjusted to give a warning when the oxygen flow decreases to below 30%, \pm 5%, of the combined oxygen and nitrous oxide flow at an oxygen flow greater than 1 L/min. At oxygen flows less than 1 L/min, the alarm point is adjusted at a higher oxygen concentration to assure an adequate supply of oxygen to the rebreathing system when rebreathing systems are used. On machines equipped with an ORMC (see below) the alarm operates in conjunction with the ORMC control function.

ORMC

The ORMC extends the function of the ORM by providing an active control system which permits independent control of the gases on an anesthesia machine within predetermined safety limits of oxygen flow. The alarm functions of the ORM apply, as well, to the ORMC.

The ORMC, by use of common flow control valves and flowmeters, maintains the oxygen to controlled gas(es) ratio within pre-determined safety limits (25% oxygen or higher). In order to guarantee delivery of safe oxygen concentration at low flows, the oxygen safety limit increases inversely with the flow at oxygen flows lower than 1 L/min.

The ORMC will actively lower the flow of nitrous oxide in proportion to the oxygen flow in the event that the oxygen flow is decreased and the safety limit is reached.

Minimum Ventilation Pressure Alarm

The Minimum Ventilation Pressure Alarm, marked MIN VENT PRESSURE, is located in the central alarm panel at the left side of the flowmeter housing and consists of a minimum ventilation pressure selector switch and two alternating red warning lights. The audible alarm cannot be turned off. The selector switch has three alternate positions: 8, 12 and 26cm H₂O. The alarm consists of a breathing system pressure monitor which will actuate the audio and visual signal when the maximum pressure amplitude in the system is less than the monitored pressure set at the selector switch or if the frequency of artificial ventilation is less than four times per minute. A decrease of maximum pressure below the monitor setting and the actuation of the warning signal may be the result of a disconnect of the patient, an excessive leak in the system, or failure of the ventilator in the expiratory phase. To operate, set pressure selector switch to next lower pressure setting below maximum pressure indicated at system pressure gauge.

Example: For system peak pressure higher than 30cm H₂O, set monitoring pressure selector to 26cm H₂O.

For system peak pressure between 15 and 29cm H₂O, set monitoring pressure selector to 12cm H₂O.

For system peak pressure between 8 and 14cm H₂O, set monitoring pressure selector to 8cm H₂O.

Note: Anesthesia systems equipped with a Dräger AV-E Ventilator include a circuit to increase alarm delay to sixty (60) seconds during low frequency and/or high I:E ratio operation.* This circuit may be manually actuated to silence the audible alarm when the ventilator is operated with frequency and inspiration to expiration phase time ratio settings which result in expiratory phase time greater than fifteen (15) seconds.

Continuing System Pressure Alarm

The Continuing System Pressure Alarm, labeled CONTINUING PRESSURE, is located in the central alarm panel at the left side of the flowmeter housing above the minimum ventilation pressure selector switch and consists of two alternating red warning lights. The audible alarm cannot be silenced. The alarm is actuated in the event that a positive pressure of more than 18cm H₂O is monitored for longer than ten seconds in the system. Such continuing pressure in the system may be caused by inadvertent closing or misadjustment of the APL valve, a blockage of the APL valve, blockage of the ventilator relief valve, blockage of gas passages leading to or from these valves, blockage or other failure of the gas scavenging system, or a failure of the automatic ventilator during the inspiratory phase, thus keeping the bellows contracted and the ventilator relief valve closed.

* For details see AV-E Ventilator Manual.

* Sub-Atmospheric Alarm

The Sub-Atmospheric Alarm, marked SUB ATM PRESSURE, is located in the central alarm panel at the left side of the flowmeter housing and displays one red, continually-lighted LED. The audible alarm can be silenced. The alarm is actuated if the pressure in the system decreases below 10cm H₂O sub-atmospheric pressure exists. A condition like this may be caused by the malfunctioning of a suction scavenging system or by a blocked anesthesia breathing system where the patient creates the sub-atmospheric pressure by inhaling from a dead-ended system, or by lack of freshgas supplied into the breathing system.

* High Pressure Alarm -

The High Pressure Alarm, marked HIGH PRESSURE, is located in the central alarm panel at the left side of the flowmeter housing and displays one red, continually-lighted LED. The audible alarm can be silenced. It is actuated if the system pressure exceeds 60cm H₂O; the alarm is actuated for the period of time the pressure is in excess of the threshold pressure. A condition like this may be caused by drastically increased airway resistance or an otherwise blocked inspiratory, expiratory or waste gas elimination path.

Checklist

The pre-operative and intra-operative checklist is located on the panel between the oxygen and nitrous oxide flowmeters on two-gas machines. Machines equipped for three or four gases will have the checklist in the top drawer of the machine. The checklist is intended to serve as a reminder to perform certain tests prior to and during each use of the machine. Test procedures are described in Section 5 of this manual.

Oxygen Pressure Whistle Alarm

(Optional on USA machines, Standard on Canadian machines)

The NARKOMED 2A may be equipped with an oxygen powered whistle to indicate oxygen pressure failure. This alarm, if included, will sound a high pitch signal of approximately ten seconds duration any time the oxygen pressure falls below 30-35 psi. This alarm will also be activated when the oxygen pressure is deliberately shut off such as shutdown of the machine on completion of an operating procedure.

DRÄGER AV-E Anesthesia Ventilator

The DRÄGER AV-E Anesthesia Ventilator is a volume preset, time-cycled ventilator that features solid state timing, pneumatic circuitry, independent controls, and ease of operation and cleaning. The unit acts as a controller of respiratory rate. The Inspiratory/Expiratory phase time ratio is variable, in steps from 1:1 to 1:4.5.

Frequency (BPM) is variable from 1 to 99 in one (1) BPM increments. For details refer to the DRÄGER AV-E Instruction Manual.

* Actuation of the high pressure and sub-atmospheric LED's simultaneously is an indication of a system failure detected by the alarm logic circuit. This condition must be investigated immediately.

O₂MED Oxygen Analyzer (Optional)

The O₂MED is an oxygen concentration monitor (oxygen analyzer) specifically designed for North American Dräger anesthesia systems. It utilizes a dual galvanic cell sensor to measure oxygen concentration in the patient circuit. The oxygen concentration is displayed as "% OXYGEN" and is continuously compared to preset alarm limits. Should an alarm condition occur, both visible and audible indications are produced. In addition to these basic functions, the O₂MED contains an automatic calibration procedure, a digital communications interface, and many self-diagnostic and patient-protection features.

A detailed description and operating instructions can be found in the O₂MED Operator's Instruction Manual.

SPIROMED Respiratory Volume Monitor (Optional)

The SPIROMED is an electronic respiratory monitor specifically designed for North American Dräger anesthesia systems. The SPIROMED sensor consists of a positive-displacement rotating-lobe impeller that generates electronic pulses in response to the patient's expiratory flow. The monitor converts these pulse patterns into meaningful readings for Tidal Volume, Minute Volume, and Respiratory Rate displays.

Alarms are provided for a variety of respiration related alarm conditions.

A detailed description and operating instructions can be found in the SPIROMED Operator's Instruction Manual.

CENTRALERT Central Alarm Unit (Optional)

The CENTRALERT is a central alarm unit which is used to collect, prioritize, display, and annunciate alarm signals which are generated by other devices in a North American Dräger anesthesia monitoring system. The CENTRALERT provides the means for the implementation of a uniform and structured alarm strategy which is aimed toward reducing the confusion caused by the increasing proliferation of alarm signals in the operating room environment.

A detailed description and operating instructions can be found in the CENTRALERT Operator's Instruction Manual.

N.A.D. Sphygmomanometer(Optional)

The Sphygmomanometer is located on the left side of the flowmeter head. Connection to the gauge is by means of a female luer fitting mounted on the front of the machine. The connector block is labeled BLOOD PRESSURE. The gauge features a "floating zero" position. The reset forces of the pointer are minimal when no pressure is applied. A "zero" position of the pointer deviating from the exact 6 o'clock position but within the horizontal arc is no indication of any inaccuracy of the gauge. If the pointer is outside of the horizontal arc, tap the gauge lightly with a forefinger. Tapping may cause the pointer to move. If the pointer remains outside of the arc, check the gauge with a master gauge. Your service representative will help you with this test.

Flowmeter Channel Lights (Optional)

The NARKOMED 2A Anesthesia System may include light-emitting diodes (LED's) for flowmeter illumination.

The On-Off toggle switch, marked FLOWMETER LIGHTS is located on the lower left side of the Central Alarm Panel (see FIGURE 1).

Drawers (Optional)

The NARKOMED 2A is equipped with one, two, three or four drawers. They are of heavy gauge steel construction. The two, three and four drawer assemblies are equipped with ball bearing slides for easy movement and full extension.

Stainless Steel Table-Top

The Stainless Steel Table-Top on the NARKOMED 2A presents a smooth uncluttered work area for the operator. Stainless steel construction assures ease of cleaning.

2. OPERATOR ALERT TO SPECIAL FEATURES OF THE NARKOMED 2A
- 2.1 The System Power switch must be turned ON to operate unit.
- 2.2 The ON/OFF switch of the AV-E Ventilator features two (2) ON positions. The upper ON position shall be used under conditions of normal operation. The lower ON position is to be used when the ventilator is operated at extremely low frequency and high I:E phase time ratio which results in expiratory phase time in excess of fifteen (15) seconds. The lower ON position actuates the sixty (60) second disconnect alarm delay.
- 2.3 The NARKOMED 2A reserve power supply system incorporates a maintenance free sealed lead-acid rechargeable battery. To prevent premature failure of the battery, the reserve power should only be used during emergency situations when primary service is interrupted. The System Power switch shall be turned to the Standby position when the machine is not in use. The machine shall never be used while not plugged into a 117 Volt AC service outlet and it shall never be stored with the System Power switch in the ON position. Failure to comply with these procedures may result in damage to the reserve power supply system.
- 2.4 During automatic ventilation, the APL valve (pop-off valve) is excluded from the breathing system by the manual/automatic selector valve. A closing of the APL valve during automatic artificial ventilation is not necessary.
- 2.5 Special consideration of low flow operation.
- 2.5.1 At low oxygen flow (less than 0.5 L/min) the oxygen (O₂) concentration in the patient breathing system cannot be guaranteed by measurement of the oxygen concentration of the freshgas flow. This is due to the undetermined amount of rebreathing which occurs at low oxygen flow. For the reason stated above, the safety protection of the ORMC is limited at low oxygen flow. Under conditions of low oxygen flow the oxygen concentration must be measured by using an oxygen monitor having its sensor located within the patient breathing system.
- 2.5.2 The ORMC alarm may actuate momentarily at oxygen flows between 0 and 0.5 L/min when the oxygen is turned on and the nitrous oxide is not flowing. This momentary alarm should be ignored; it is a function of pressurizing the system and not a hazard-related condition.
- 2.5.3 Anesthesia systems designed for very low flow operation (less than 300mL/min O₂) do not include minimum oxygen flow. The alarm function of the ORM is eliminated for all N₂O flow less than 750mL/min on these systems.

2.6 Additional Gas Selector Switch.

2.6.1 The Additional Gas Selector Switch allows the operator to select a freshgas mixture of oxygen and nitrous oxide or a freshgas mixture of oxygen, nitrous oxide, and an additional gas (or two additional gases in four-gas machines).

2.6.1.1 The "ALL GASES" switch position permits a freshgas mixture of all gases and automatically disables the ORMC audible alarms.

2.6.1.2 The "O₂ & N₂O" switch position permits a freshgas mixture of oxygen and nitrous oxide and automatically enables the ORMC audible alarm.

2.6.2 In machines equipped to deliver air as an additional gas, the "ALL GASES" position automatically disables the minimum oxygen flow feature. This allows the operator to dispense only air if desired. However, the oxygen flow control valve continues to function normally in either selector switch position.

2.6.3 Machines equipped with carbon dioxide (CO₂) as an optional third gas do not have a gas selector switch. Carbon dioxide is always available at its flow control valve.

2.7 Carbon Dioxide Circuit Operation

2.7.1 Anesthesia systems which incorporate a carbon dioxide (CO₂) dispensing circuit DO NOT include safety devices to protect the patient in the event that CO₂ flow is set at a level which is higher than the clinically safe O₂/CO₂ ratio. Such patient safety is dependent upon constant observation and control by the operator.

2.8 Disconnect Alarm, Auxiliary Ventilator

2.8.1 Anesthesia systems equipped to use a ventilator other than the DRÄGER AV-E include a ventilator on-off switch. This switch is located on the left front of the machine above the flowmeter housing. The switch will, when actuated, supply driving gas to the ventilator and will supply power to the minimum ventilation alarm system.

The switch has two ON positions. The upper ON position activates the 15 second minimum ventilation alarm delay. The lower ON position activates the 60 second minimum ventilation alarm delay.

2.9 Reserve Power Supply System

2.9.1 The Reserve Power Supply System provides emergency back-up power for the NARKOMED 2A, the DRÄGER AV-E Ventilator, and for the O₂MED monitor integrated into the machine. It does not provide back-up power for accessories or monitors which are plugged directly into the electrical power supply assembly.

3. WARNINGS AND RESTRICTIONS

- 3.1 The NARKOMED 2A is designed for use with non-flammable anesthetic agents. Flammable anesthetic agents shall not be used with this equipment.
- 3.2 Oil and grease may combine explosively with oxygen or nitrous oxide. For this reason, oil and grease shall never be allowed to come in contact with cylinders, cylinder valves, gauges, fittings, etc., which conduct oxygen or nitrous oxide on the machine. For further information regarding medical gases, consult CGA Pamphlets P-2, G-4, and G-4.3; and NFPA Standards 53M, 56B, and 56F.
- 3.3 The safety potential of oxygen supply pressure failure protection devices is widely overstated. The following causes are known to actuate the system:
 - 3.3.1 Depletion of pressure in the oxygen pipeline.
 - 3.3.2 Closed oxygen cylinder valve.
 - 3.3.3 Improper connection of oxygen supply hose.
 - 3.3.4 Blockage of the oxygen dispensing system upstream of the pneumatically operating valve of the protection device.
 - 3.3.5 Excessive leakage in the oxygen dispensing system upstream of the pneumatically operating valve of the protection device.
- 3.4 Delivery hoses used between wall outlets and machine have been the cause of accidents when during assembly, an oxygen fitting was placed on one end of the hose and a nitrous oxide fitting on the other end. Hoses must be carefully checked each time a machine is connected to a wall or ceiling outlet to ensure that both ends of the hose are intended for the same gas.
- 3.5 Check cylinder yokes for presence of two index pins each time a cylinder is attached to the machine.
- 3.6 Check pressure gauges for adequate supply of gases.
- 3.7 Check oxygen analyzer sensor calibration, see section 5 of this manual for instructions.
- 3.8 To ensure that the backup battery is in a continuously ready state, a successful Battery Test (i.e., "RESERVE POWER TEST" green indicator illuminates) should be performed prior to each anesthesia procedure.
- 3.9 Check function of flowmeters over full range.
- 3.10 Assure that oxygen delivery system supplies oxygen by using oxygen analyzer at common outlet.
- 3.11 If the machine has vaporizers with safety interlock adjustment knobs, any replacement vaporizer must have an identical interlock.
- 3.12 Check tightness of vaporizer filler caps.
- 3.13 Check proper connection of the freshgas delivery hoses; machine side and patient system.
- 3.14 Check status of absorbent in absorber.
- 3.15 Check function of patient system relief valve (APL valve) and unidirectional valves.

- 3.16 The manual/automatic selector valve must be in the "BAG" position for spontaneous breathing or manually assisted ventilation; in the "AUTO" position for automatic ventilation.
- 3.17 For spontaneous breathing the APL valve control knob must be turned fully counterclockwise (lowest resistance).
- 3.18 For manually assisted or manually controlled ventilation, adjust the APL valve to desired resistance by clockwise rotation of the control knob.
- 3.19 Observe breathing system pressure gauge frequently.
- 3.20 Check proper connection of endotracheal tube frequently.
- 3.21 Observe patient chest movement frequently to assure adequate ventilation.
- 3.22 Positive confirmation of proper function of the alarm system should be determined, prior to each use of the machine, by the deliberate creation of alarm conditions and subsequent actuation of the applicable alarms.
- 3.23 Unless otherwise noted, all pressures listed in this manual are nominal values.

4. SETUP AND OPERATION

4.1 Initial Setup

Initial setup of a NARKOMED 2A Anesthesia Machine shall be by or under the direct supervision of an authorized North American Dräger representative. The North American Dräger representative will have information required for correct installation of the anesthesia machine and its auxiliary equipment (breathing systems, vaporizers, scavenger interface, etc.).

4.2 Gas Supply Attachment and Checkout Procedure

Close all flow control valves and have the System Power switch in the stand-by position before beginning this procedure.

4.2.1 Reserve Cylinder Attachment

This procedure applies to each yoke for all gases supplied to the anesthesia machine by reserve cylinder.

4.2.1.1 Check each cylinder yoke to assure presence of two (2) yoke index pins. DO NOT USE a yoke having less than 2 pins, call your authorized N.A.D. service representative for assistance.

4.2.1.2 Remove old inlet gasket (if applicable) and place new gasket on yoke inlet. DO NOT USE more than one gasket per yoke, additional gasket will defeat the purpose of the pin index system.

4.2.1.3 Turn yoke T-handle counterclockwise sufficiently to allow E-cylinder valve to be inserted in yoke. Carefully insert cylinder valve over index pins and inlet port of yoke. Turn T-handle clockwise to hold cylinder valve securely in yoke.

4.2.2 Pipeline Supply Attachment

This procedure applies to each gas service supplied to the anesthesia machine by hospital pipeline.

4.2.2.1 Attach appropriate hose fittings DISS to each pipeline gas inlet on the rear of the anesthesia machine. Check each pipeline supply hose to assure that the gas inlet on the machine is connected to the correct pipeline outlet of the hospital piping system.

4.3 Gas Supply Test Procedure

Pipeline supply must be shut off when performing cylinder test.

4.3.1 Reserve Cylinder Supply Test

4.3.1.1 Slowly open valve on one oxygen cylinder to allow gradual build-up of pressure within piping system of machine.

Carefully open valve on one nitrous oxide cylinder and one AIR cylinder (if applicable).

- 4.3.1.2 Set Additional Gas Selector switch (if applicable) on ventilator panel to the "ALL GASES" position. Turn on the System Power switch of the machine.
- 4.3.1.3 Place sensor of calibrated oxygen analyzer at freshgas outlet of machine. Open oxygen flow control valve and set oxygen flow to 4 L/min. Oxygen analyzer shall indicate $100 \pm 3\%$ oxygen within 30 seconds of start of flow.
- 4.3.1.4 Reduce oxygen flow to 2 L/min and set nitrous oxide flow to 2 L/min. Oxygen analyzer shall indicate $50 \pm 3\%$ oxygen within 30 seconds. Close oxygen and nitrous oxide flow control valves.
- 4.3.1.5 With oxygen analyzer sensor held at freshgas outlet of machine. Open AIR flow control valve and set AIR flow to 4 L/min. Oxygen analyzer shall indicate $21 \pm 3\%$ oxygen within 30 seconds of start of AIR flow.
- 4.3.1.6 Shut off AIR flow control valve and all cylinder valves.

NOTE: Repeat above procedure for additional yokes if machine is equipped with more than one yoke per gas service.

4.3.2 Pipeline Supply Test Procedure

- 4.3.2.1 Open valves controlling supply of gases from hospital pipeline to anesthesia machine.
- 4.3.2.2 Set Additional Gas Selector switch (if applicable) to "ALL GASES" position.
- 4.3.2.3 Place oxygen analyzer sensor at freshgas outlet of machine. Open oxygen flow control valve and set oxygen flow to 4 L/min. Oxygen analyzer shall indicate $100 \pm 3\%$ oxygen within 30 seconds of start of flow.
- 4.3.2.4 Reduce oxygen flow to 2 L/min and set nitrous oxide flow to 2 L/min. Oxygen analyzer shall indicate $50 \pm 3\%$ oxygen within 30 seconds. Close oxygen and nitrous oxide flow control valves.
- 4.3.2.5 With oxygen analyzer sensor held at freshgas outlet, open AIR flow control valve and set flow to 4 L/min. Oxygen analyzer shall indicate $21 \pm 3\%$ oxygen within 30 seconds.

NOTE: Contact your authorized N.A.D. service representative for assistance if the above tests cannot be performed satisfactorily.

5. DAILY SETUP AND TEST PROCEDURES

Instructions for the setup and testing of the NARKOMED 2A Anesthesia System are outlined below. Specific descriptions of the various auxiliary system and equipment are contained in manuals for each type of equipment.

Waste gases generated during the course of testing should be directed to an appropriate waste gas disposal system.

The North American Dräger NARKOMED 2A Anesthesia Machine with anesthesia breathing systems as well as alarm and monitoring devices represent an integral system and shall be tested as such.

5.1 High Pressure Test

Test to be performed with each gas independently.

- 5.1.1 Attach appropriate E-cylinder to each yoke supply position.
- 5.1.2 Turn System Power switch to Standby.
- 5.1.3 Close flow control valve by clockwise motion.
- 5.1.4 Open cylinder valve until indicated pressure at cylinder pressure gauge stabilizes.
- 5.1.5 Close cylinder valve.
- 5.1.6 Remove cylinder from yoke.

The decrease of pressure indicated at the pressure gauge during the following two (2) minutes shall not be more than 50 psi.

5.2 Sphygmomanometer Leak Test

- 5.2.1 Insert male luer fitting of a sphygmomanometer squeeze bulb/hose assembly into the female luer fitting adjacent to the BLOOD PRESSURE label on the machine.
- 5.2.2 Hand pump squeeze bulb until pressure of 200 mm Hg is indicated on the sphygmomanometer gauge on the machine. Pinch hose closed adjacent to the luer fitting to assure that the hose-bulb assembly is not the source of any leak indicated.

The decrease of pressure indicated at the sphygmomanometer gauge during the following 30 seconds shall not exceed 10 mm Hg.

5.3 Anesthesia Breathing System and Freshgas Delivery System Test

The below test specifications apply to an anesthesia breathing system without accessories, e.g., respiratory meter, filters, concentration measurement device, and other adapters. Test limits described below will be exceeded when accessory items are included in the test. The supplier of the accessory should be contacted for leak specifications.

- 5.3.1 Close all flow control valves.
- 5.3.2 Turn System Power switch to Standby.
- 5.3.3 Turn vaporizer(s) to zero (0) concentration.
- 5.3.4 Short circuit inspiratory and expiratory valves with 22mm hose.

- 5.3.5 Set manual/automatic selector valve to "BAG" position.
- 5.3.6 Close APL valve (pop-off valve); knob must be turned fully clockwise to stop position.
- 5.3.7 Attach test terminal to bag mount.
- 5.3.8 Connect sphygmomanometer squeeze bulb to hose barb on test terminal.
- 5.3.9 Hand pump squeeze bulb until pressure at breathing system pressure gauge indicates pressure higher than 50cm H₂O.
- 5.3.10 Observe pressure drop at gauge.
Thirty (30) seconds, or longer, shall be required for a pressure decrease from 50 to 40cm H₂O.

5.4 VAPOR Exclusion System Test

- 5.4.1 Set control knob on each VAPOR to "0" position.
- 5.4.2 Adjust control knob on Halothane VAPOR to any setting above "0" concentration %.
- 5.4.3 With Halothane VAPOR set as above it shall not be possible to set either the Enflurane or Isoflurane VAPOR (if applicable) to any position other than "0".
- 5.4.4 Set Halothane VAPOR control knob to "0" position and repeat steps 5.4.2 and 5.4.3 successively with Enflurane and Isoflurane VAPOR. Under these conditions it shall not be possible to adjust any VAPOR if another is already set higher than 0%.
NOTE: On VAPOR 19.1 it is necessary to depress the white "0" button when setting the control knob.
- 5.4.5 Re-adjust all VAPORS to "0" position.

5.5 APL Valve (Pop-Off Valve) Flow Test

The below test specifications apply only to absorber systems incorporating a manual/automatic selector valve. The absorber freshgas connector must be attached to the common outlet of the anesthesia machine.

- 5.5.1 Set manual/automatic selector valve to "BAG" position.
- 5.5.2 Short-circuit inspiratory and expiratory valves with 22mm hose.
- 5.5.3 Open APL valve; knob must be turned fully counterclockwise to stop position.
- 5.5.4 Open O₂ flow control valve and set flow to 8 L/min.
- 5.5.5 Occlude bag mount opening.
- 5.5.6 Observe breathing system pressure gauge.
Breathing system pressure gauge shall not exceed 3cm H₂O.

5.6 Flowmeter Test

Turn on gas supply pressure (Pipeline or E-cylinder) and adjust flow for each gas over the full range of its associated flowmeter(s). With an anesthesia machine supply pressure within the nominal range, it shall be possible to adjust the flow over the full range of the flowmeter(s). The float within the flowmeter(s) shall freely rotate at all positions.

5.7 Ventilation Pressure Monitor Test

The below test specifications apply to ventilation pressure monitors incorporated into the NARKOMED 2A; the oxygen cylinder must be closed and the oxygen pipeline supply disconnected. The oxygen low pressure alarm will be actuated and lamps will function during the test after the System Power switch has been turned ON.

- 5.7.1 Short-circuit inspiratory and expiratory valves with 22mm hose.
- 5.7.2 Set manual/automatic selector valve to "BAG" position.
- 5.7.3 Close APL valve.
- 5.7.4 Attach test terminal to bag mount.
- 5.7.5 Connect sphygmomanometer squeeze bulb to hose barb on test terminal.
- 5.7.6 Turn OFF audible alarm.
- 5.7.7 Turn ON System Power switch of anesthesia machine.
- 5.7.8 Turn ON ventilator switch.
Following this step, the ventilation pressure monitor alarm shall be actuated; audible and visual alarms cannot be silenced.
- 5.7.9 Adjust pressure selector switch to lowest setting (8cm H₂O).
- 5.7.10 Hand pump squeeze bulb until breathing pressure gauge indicates 10cm H₂O; alarm shall be silenced.
- 5.7.11 Open relief valve at squeeze bulb to allow system pressure to decrease to zero (0).
The alarm will be reactivated 18 seconds (\pm 3.5 sec.) after the system pressure has decreased below the pressure set at the selector switch.
- 5.7.12 Adjust pressure selector switch to 12cm H₂O.
- 5.7.13 Repeat steps 5.7.10 and 5.7.11. Pressurize to 15cm H₂O.
- 5.7.14 Adjust pressure selector switch to 26cm H₂O.
- 5.7.15 Repeat steps 5.7.10 and 5.7.11. Pressurize to 30cm H₂O.

5.8 Continuing Pressure Monitor Alarm Test

- 5.8.1 Test set-up is as described under 5.7 Ventilation Pressure Monitor Test.
- 5.8.2 Hand pump squeeze bulb until breathing pressure gauge indicates 20cm H₂O. Maintaining this pressure, the alarm shall be actuated after a period of 10 seconds (\pm 3 sec.).

5.9 High Pressure Monitor Alarm Test

- 5.9.1 Test set-up is as described under 5.7 Ventilation Pressure Monitor Test.
- 5.9.2 Hand pump squeeze bulb until breathing pressure gauge indicates 70 to 75cm H₂O; the high pressure alarm shall be actuated.
During this test the Continuing Pressure Monitor Alarm may be actuated if a pressure higher than 18cm H₂O is maintained in the system for a period longer than 10 seconds.

5.10 Sub-Atmospheric Pressure Monitor Alarm Test

5.10.1 Test set-up is as described under 5.7 Ventilation Pressure Monitor Test, however, the squeeze bulb is connected directly to the test terminal, eliminating spiral hose and bleed valve at bulb.

5.10.2 Open APL valve.

5.10.3 Hand squeeze bulb, engage in squeezed condition.

5.10.4 Occlude intake port of bulb with thumb.

5.10.5 Release bulb quickly.

The pressure in the system shall drop below minus 12 cm H₂O for an instant and actuate the sub-atmospheric alarm; if this result is impossible to obtain, other means shall be applied, e.g., using a large syringe.

5.11 Ventilator Test

5.11.1 Pressure Test

5.11.1.1 Attach 22mm hose from bellows outlet to absorber VENT inlet.

5.11.1.2 Open APL valve.

5.11.1.3 Turn System Power switch ON.

5.11.1.4 Turn ventilator switch ON.

5.11.1.5 Adjust O₂ flow to 3 L/min.

5.11.1.6 Adjust frequency to 10 BPM (1:E ratio 1:2 on AV-E ventilator).

5.11.1.7 Adjust tidal volume to approximately one (1) Liter.

5.11.1.8 Adjust flow to maximum of low zone on ventilator FLOW gauge.

5.11.1.9 Switch manual/automatic selector valve to AUTO position.

5.11.1.10 Close 15 mm outlet at Y-piece with thumb.

The breathing system pressure gauge shall indicate a pressure in excess of 30cm H₂O when the bellows stops its inspiratory motion (NOTE: the bellows will not fully deflate). During the expiratory phase, the pressure in the breathing system indicated at the pressure gauge shall decrease to approximately 2cm H₂O pressure when the bellows reaches its resting position. On ventilators utilizing a hanging bellows the pressure in the breathing system may drop below zero (0) momentarily before reaching its final condition, this condition will not occur with a standing bellows.

5.11.2 Inspiratory-Expiratory Ratio Test

5.11.2.1 With ventilator operating as described in 5.11.1.1 through 5.11.1.9, time the inspiratory phase of the respiratory cycle (start of bellows upward movement to start of bellows downward movement). Record inspiratory phase time.

5.11.2.2 Time expiratory phase of the respiratory cycle (start of the bellows downward movement to start of bellows upward movement). Record expiratory phase time.

5.11.2.3 Inspiratory to expiratory phase time shall be 1:2 ± 15%; e.g., at 10 BPM the inspiratory time shall be 1.8 to 2.2 seconds, the expiratory time shall be 3.6 to 4.4 seconds.

- 5.11.3 Frequency (BPM) Test
5.11.3.1 With ventilator operating as described in 5.11.2.1, measure time required for one respiratory cycle (start of upward bellows movement to start of next upward bellows movement). Lapsed time shall be within $\pm 10\%$ of calculated time; e.g., at 10 BPM calculated time equals 6 seconds, tolerance range is 5.4 seconds to 6.6 seconds.

5.12 Flow Direction Test

- 5.12.1 This test specification applies to systems incorporating a ventilator and a breathing system with a manual/automatic selector valve.
- 5.12.1.1 Set manual/automatic selector valve to "BAG" position.
- 5.12.1.2 Attach bag to bag connector.
- 5.12.1.3 Connect ventilator hose at Y-piece.
- 5.12.1.4 Open APL valve.
- 5.12.1.5 Open O₂ flow control valve and adjust flow to 3L/min.
- 5.12.1.6 Turn ventilator ON.
- 5.12.1.7 Set BPM to 16.
- 5.12.1.8 Set tidal volume to 700 ml.
- 5.12.1.9 Adjust ventilator inspiratory flow so that tidal volume is fully delivered within inspiratory phase time.
- 5.12.1.10 The pressure on the breathing system pressure gauge shall neither exceed +2 cm H₂O during the expiratory phase nor go below -2 cm H₂O during the inspiratory phase.
- 5.12.2 As an alternate to use of the ventilator, as described above, flow direction may be checked by use of a manually operated bellows. Connect the bellows to the patient breathing system Y-piece and pump bellows to simulate patient breathing. Test results described above in 5.12.1.10 apply as well to the manual bellows test.

5.13 NAD Oxygen Monitor Sensor Calibration

- 5.13.1 Expose the oxygen sensor to ambient air and perform a calibration. (See the O₂MED Operator's Instruction Manual for details.)

5.14 Oxygen Concentration Test

- 5.14.1 This test specification applies to breathing systems with the oxygen sensor mounted into the inspiratory valve; the hose terminal at the inspiratory valve must be open to atmosphere.
- 5.14.1.1 Close APL valve.
- 5.14.1.2 Turn System Power Switch ON.
- 5.14.1.3 Adjust O₂ flow to 8 L/min.
Oxygen meter shall indicate an O₂ concentration of approximately 100% ($\pm 3\%$).

5.15 Oxygen Ratio Monitor Alarm Test

- 5.15.1 Turn System Power switch to ON.
- 5.15.2 Set oxygen flow to 1 L/min.
- 5.15.3 Open nitrous oxide flow control knob and increase N₂O flow until ORM alarm is actuated. ORM alarm shall actuate at N₂O flow between 2 and 2.6 L/min.
- 5.15.4 Increase O₂ flow to 2 L/min.
- 5.15.5 Increase N₂O flow until alarm is actuated, alarm shall actuate at N₂O flow between 4 and 5.2 L/min.
- 5.15.6 In steps 5.15.3 and 5.15.5 above, reduction of the N₂O flow below the minimum actuation flow shall shut off the alarm.

5.16 ORMC Test

- 5.16.1 Open pipeline supply valves for oxygen and nitrous oxide.
- 5.16.2 Attach oxygen monitor sensor to adapter on inspiratory valve; attach 22 mm breathing hose to inspiratory valve port.
- 5.16.3 Set manual/automatic selector valve to "BAG" position.
- 5.16.4 Close APL (pop-off) valve.
- 5.16.5 Turn System Power switch ON.
- 5.16.6 Open oxygen flow control valve; set flow to 0.8 L/min.
- 5.16.7 Open nitrous oxide flow control fully to stop position (don't force flow control valve at full-open position. Damage to control may result).
- 5.16.8 The oxygen monitor shall indicate 25 (± 3%) oxygen.
- 5.16.9 Repeat steps 5.16.6 and 5.16.7 with oxygen flow set at 1.5 L/min and 3.5 L/min, respectively. Oxygen monitor reading shall continue as described in 5.16.8.
- 5.16.10 Decrease oxygen flow to 0.8 L/min, nitrous oxide flow shall decrease accordingly maintaining the 25 (± 3%) reading indicated in 5.16.8.
NOTE: The alarm function of the ORMC will be actuated at any time that the ORMC is actively controlling flow rates.

5.17 Oxygen Flush

Actuate the oxygen flush by pressing the O₂ FLUSH button on the left front edge of the table-top. The oxygen flush delivers an unmeasured flow of approximately 50 L/min of oxygen direct to the common outlet. Releasing the O₂ FLUSH button must immediately shut off this flow.

5.18 Oxygen Supply Pressure Failure Protection Device

- 5.18.1 Set oxygen flow to 1 L/min.
- 5.18.2 Set nitrous oxide flow to 1 L/min.
- 5.18.3 Shut off oxygen cylinder valve if E-cylinder is source of pressure, or pipeline valve if pipeline is source of oxygen pressure.
- 5.18.4 Nitrous oxide flow must cease when the flow of oxygen has stopped.
- 5.18.5 Repeat test (Steps 5.18.1–5.18.4) for additional gas circuit(s) (optional) on the machine.
- 5.18.6 Following Step 5.18.4, shutting off the oxygen shall actuate the O₂ Supply Alarm, when oxygen pressure drops below approximately 30 psi.

5.19 Alarm Circuit Delay Test

- 5.19.1 Turn ON System Power switch of machine. Immediately upon turning on the System Power switch, the audible alarm delay function will start; it will continue for thirty (± 3) seconds. The yellow LED, adjacent to the Sonalert Alarm on the alarm panel of the machine, will be actuated during the thirty (± 3) seconds delay cycle.
- 5.19.2 Upon completion of the automatic delay described in 5.19.1, test the function of the manually actuated delay. Manual delay is operated by actuating the push-button located adjacent to the yellow LED on the alarm panel. The manual delay is also thirty (± 3) seconds in duration and includes the LED function described in 5.19.1.

- NOTES: 1. Alarm functions that occur during the course of the delay operation are indicated by red LED's on the alarm panel. These LED's will continue to operate at any time that an alarm condition exists regardless of the delay. The yellow LED remaining ON after thirty (± 3) seconds of delay is an indication of malfunction of the delay circuit in the "delay on" mode and must be investigated.
2. Actuation of the high pressure and sub-atmospheric LED's simultaneously, is an indication of a system failure detected by the alarm logic circuit. This condition must be investigated immediately.

6. MAINTENANCE AND CLEANING PROCEDURE

- 6.1 Painted, plated and plastic surfaces of the NARKOMED 2A, including flowmeter covers and gauge windows, may be cleaned using a soft cloth moistened with TOR Germicidal Cleaner. (TOR is a product of Huntington Laboratories Inc., P.O. Box 710, Huntington, IN 46750.)

Mix TOR Germicidal Cleaner in accordance with instructions provided by the Huntington Laboratories. Use a moist wiping cloth only, do not allow liquid to enter the cabinet or housing of the NARKOMED 2A. DO NOT use solvent cleaners or abrasive cleaning agents on any surfaces of the NARKOMED 2A. DO NOT use anesthetic agents for cleaning purposes. Frequency of cleaning should be based on established policies and procedures.

6.2 Ventilator Bellows Cleaning

Cleaning and sterilization procedures for the ventilator bellows dome assembly are described in the Ventilator Manual.

6.3 Breathing System Cleaning Procedures

Cleaning and sterilization procedures for NAD Absorber System will be found in the Absorber Manual.

Call or write for technical assistance with design or application problems,
or for the name of the authorized distributor in your area.

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