



Operation Manual

**Voyager II™**

Nitrox System

Rev 03.15

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If you lose this manual, you can download the latest version at [www.nuvair.com](http://www.nuvair.com).

## **Warning**

**This Operation Manual contains important safety information and should always be available to those personnel operating this equipment. Read, understand, and retain all instructions before operating this equipment to prevent injury or equipment damage.**

Every effort was made to ensure the accuracy of the information contained within. Nuvair, however, retains the right to modify its contents without notice. If you have problems or questions after reading the manual, stop and call Nuvair at 1-805-815-4044 for information.

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- Nuvair Pro O<sub>2</sub>™ Oxygen Analyzer Operation Manual
- Rotair RVK 8-20 Compressor Manual
- High Pressure Compressor Manual

## **1.0 Introduction**

Nuvair has taken extreme care in providing you with the information you will need to operate this system. However, it is up to you to carefully read this manual and make the appropriate decisions about system safety.

This manual will assist you in the proper set-up, operation and maintenance of the Nuvair Voyager IV™ Nitrox System. Be sure to read the entire manual.

Throughout this manual we will use certain words to call your attention to conditions, practices or techniques that may directly affect your safety. Pay particular attention to information introduced by the following signal words:

### **Danger**

**Indicates an imminently hazardous situation which, if not avoided, will result in serious personal injury or death.**

### **Warning**

**Indicates a potentially hazardous situation which, if not avoided, could result in serious personal injury or death.**

### **Caution**

**Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices.**

### **Notice**

**Notifies people of installation, operation or maintenance information which is important but not hazard-related.**

## 2.0 Safety Warnings

 **Warning**

This equipment is used to provide breathing gas for the purpose of underwater life support. Read this manual in its entirety. Failure to heed the warnings and cautions contained in this document may result in severe injury or death.

 **Warning**

The equipment you will be using to manufacture Nitrox (oxygen rich air) will expose you to both low and high-pressure gas. Gas, even under moderate pressures, can cause extreme bodily harm. Never allow any gas stream to be directed at any part of your body.

 **Warning**

Any pressurized hose can cause extreme harm if it comes loose or separates from its restraint (or termination) while under pressure and strikes any part of your body. Use appropriate care in making and handling all gas connections.

 **Danger**

Pure nitrogen is a colorless, odorless, tasteless gas that will not support life. Breathing gas mixtures containing more than 84% nitrogen at surface pressures will lead to unconsciousness and may cause death.

 **Warning**

The nitrogen discharge from the membrane system must be vented to the exterior of any closed building, boat, or similar enclosed space. Breathing gas mixtures containing more than 84% nitrogen at surface pressure will lead to unconsciousness and may cause death.

 **Warning**

Do not use any form of mineral oil or synthetic lubricant not rated for Nitrox in any compressor in this system. Use only the recommended Nitrox compressor lubricant. Never mix the Nitrox compressor lubricant with other lubricants.

Remove all existing lubricant and replace with the proper Nitrox compressor lubricant prior to installing the membrane system. The use of improper lubricants can lead to fire or explosions, which may cause serious personal injury or death.

 **Warning**

Do not use this system to produce Nitrox mixtures containing more than 40% oxygen. Pumping Nitrox mixtures with higher concentrations of oxygen may lead to fires or explosions, which can cause serious personal injury or death.

## Warning

The use of enriched air Nitrox does not eliminate the risk of decompression sickness (DCS) in diving. Decompression sickness can lead to permanent disability or death.



## Warning

Do not pump Nitrox mixtures at pressures above the H.P. compressor manufacturer's rating, and never above 3600 P.S.I. (250 bar). The system is not rated for pressures above 3600 P.S.I. (250 bar). Higher pressures may lead to explosions which may cause serious personal injury or death.

## Caution

Ambient room temperature should never exceed 100°F (38°C) during operation of the Nitrox System. Operation at higher temperatures may lead to system damage and malfunction. A damaged membrane will not produce the correct Nitrox mixture which can lead to severe personal injury if the gas is used for diving purposes without proper analysis.

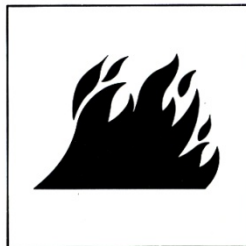
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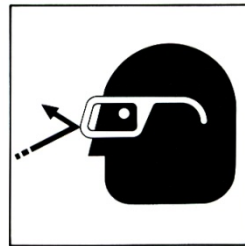
Moving belts



Electrocution



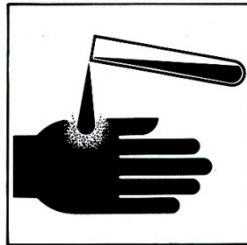
Fire



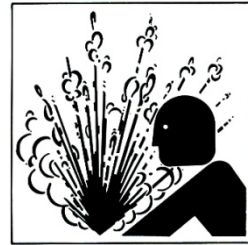
Eye protection



Gas inhalation



Skin damage



Explosion



Explosion



Electrocution



Machinery

### Abbreviations commonly used in this manual:

P.S.I. Pounds Per Square Inch  
H.P. High Pressure  
L.P. Low Pressure  
O<sub>2</sub> Oxygen  
CO Carbon Monoxide  
CO<sub>2</sub> Carbon Dioxide  
N Nitrogen

C.F.M. Cubic Feet Per Minute  
R.P.M. Rotations Per Minute  
P.P.M. Parts Per Million  
L/min Liters Per Minute  
O<sub>2</sub>% Oxygen Percentage of Gas  
B.P. Back Pressure

Cubic Feet Per Minute  
Rotations Per Minute  
Parts Per Million  
Liters Per Minute  
Oxygen Percentage of Gas  
Back Pressure

### **3.0 Safety and Operation Precautions**

Because a compressor is a piece of machinery with moving and rotating parts, the same precautions should be observed as with any piece of machinery of this type where carelessness in operations or maintenance is hazardous to personnel. In addition to the many obvious safety precautions, those listed below must also be observed:

- 1) Read all instructions completely before operating any compressor or Nitrox System.
- 2) For installation, follow all local electrical and safety codes, as well as the National Electrical Code (NEC) and the Occupational Safety and Health Administration (OSHA) standards.
- 3) Electric motors must be securely and adequately grounded. This can be accomplished by wiring with a grounded, metal-clad raceway system to the compressor starter; by using a separate ground wire connected to the bare metal of the motor frame; or other suitable means.
- 4) Protect all power cables from coming in contact with sharp objects. Do not kink power cables and never allow the cables to come in contact with oil, grease, hot surfaces, or chemicals.
- 5) Make certain that power source conforms to the requirements of your equipment.
- 6) Pull main electrical disconnect switch and disconnect any separate control lines, if used, before attempting to work or perform maintenance. "Tag Out" or "Lock Out" all power sources.
- 7) Do not attempt to remove any parts without first relieving the entire system of pressure.
- 8) Do not attempt to service any part while System is in an operational mode.
- 9) Do not operate the System at pressures in excess of its rating.
- 10) Do not operate compressor at speeds in excess of its rating.
- 11) Periodically check all safety devices for proper operation. Do not change pressure setting or restrict operation in any way.
- 12) Be sure no tools, rags or loose parts are left on the Nitrox System.
- 13) Do not use flammable solvents for cleaning the Air Inlet Filters or elements and other parts.
- 14) Exercise cleanliness during maintenance and when making repairs. Keep dirt away from parts by covering parts and exposed openings with clean cloth or Kraft paper.
- 15) Do not operate the compressor without guards, shields, and screens in place.
- 16) Do not install a shut-off valve in the compressor discharge line, unless a pressure relief valve, of proper design and size, is installed in the line between the compressor unit and shut-off valve.
- 17) Do not operate in areas where there is a possibility of inhaling carbon monoxide, carbon dioxide, nitrogen, or flammable or toxic fumes.
- 18) Be careful when touching the exterior of a recently run electric, gasoline, or diesel motor - it may be hot enough to be painful or cause injury. With modern motors this condition is normal if operated at rated load - modern motors are built to operate at higher temperatures.
- 19) Inspect unit daily to observe and correct any unsafe operating conditions found.
- 20) Do not "play around" with compressed air or direct air stream at body, this can cause injuries.
- 21) Compressed air from this machine absolutely must not be used for food processing or breathing air without adequate downstream filters, purifiers and controls and periodic air quality testing.
- 22) Always use an air pressure-regulating device at the point of use, and do not use air pressure greater than marked maximum pressure.
- 23) Check hoses for weak or worn conditions before each use and make certain that all connections are secure.

The user of any compressor or Nitrox System manufactured by Nuvair is hereby warned that failure to follow the preceding Safety and Operation Precautions can result in injuries or equipment damage. However, Nuvair does not state as fact or does not mean to imply that the preceding list of Safety and Operation Precautions is all-inclusive, and further that the observance of this list will prevent all injuries or equipment damage.

## **4.0 Legal Precautions**

It is highly recommended that a Nitrox fill log be maintained when filling Scuba cylinders to document the following information. This log must be of permanent binding style with no loose pages.

- ◆ Fill date and time of day
- ◆ Tank Number
- ◆ Supplier's check of oxygen content (%O<sub>2</sub>) plus signature and date
- ◆ User's check of oxygen content (%O<sub>2</sub>) plus signature and date
- ◆ Fill Pressure
- ◆ MOD (Maximum Operating Depth) in user's handwriting
- ◆ Nitrox certifying agency and card number

## **5.0 Theory of Operation**

The Voyager II™ Nitrox System is a turnkey package that produces oxygen-rich air (Nitrox) and then compresses it with a High Pressure (H.P.) Compressor to fill Scuba Tanks or storage cylinders. The package is designed to be fully automatic, with a quieted enclosure for noise reduction and protection from moving parts while it is running. Although it is described as the “Nitrox Compressor”, it can also be used to pump air.

The Nitrox System allows for efficient and cost effective Nitrox production using electric power, without the hazards or expense of blending with stored high-pressure oxygen (O<sub>2</sub>). Instead, the system uses a Semi-Permeable Membrane to produce Nitrox from air. A portion of the nitrogen in air is separated out, leaving an oxygen rich Nitrox mixture.

The Voyager II™ uses a Rotary Screw L.P. Compressor, Air/Oil Aftercooler, Refrigerated Air Dryer, and Filtration to provide the Membrane System with a source of clean, pressurized feed air for separation. The air is filtered to CGA Grade D or better air quality prior to entering the Membrane System so it will not damage or plug the Membrane fibers. Specifications for Grade D air are provided in the Appendix.

The Voyager II™'s Membrane System is rated for a maximum feed air pressure of 300 P.S.I. (21 bar) and has been configured to work well with the 175 P.S.I. (12 bar) maximum pressure delivered by the L.P. Compressor. A Back Pressure Regulator is used to adjust the amount of air the screw compressor produces to meet the appropriate levels for various %O<sub>2</sub> Nitrox production. The air is then heated to a temperature that provides stability over a wide range of ambient conditions, is optimal for Membrane permeation, and prevents moisture condensation.

The heated air enters the Membrane, which is made up of thousands of miniature hollow fibers. The walls of these fibers are semi-permeable and designed for different gases to move through them (or permeate) at different speeds. The resulting gas mixture is known as the “permeate”. As air flows through the hollow fibers, both oxygen and nitrogen permeate through the fiber walls. The oxygen permeates faster than the nitrogen, which produces permeate with oxygen content greater than air. The gas that reaches the end of the hollow fibers without permeating is almost entirely nitrogen and is discharged. The flow rate of this discharge is set by the factory via a fixed orifice, which controls the permeate to contain a constant 43-44% O<sub>2</sub> under normal operating conditions.

The permeate is a concentrated mixture that must be diluted with additional air prior to entering the H.P. Compressor. It exits the Membrane at ambient to slightly negative pressure and travels into the Mixing Tube, where it mixes homogeneously with filtered outside air. The amount of dilution, and thus final %O<sub>2</sub>, is obtained by adjusting the amount of air produced by the compressor and supplied to the membrane, with the Back Pressure Regulator. As air flow to the membrane is increased, permeate flow increases and a higher %O<sub>2</sub> Nitrox is produced. As air flow to the membrane is decreased, permeate flow decreases, compressor intake air increases, and a lower %O<sub>2</sub> Nitrox is produced.

This relationship between permeate flow and intake air flow exists because the total of these two flow rates will always equal the intake flow rate demanded by the H.P. Compressor. The resulting Nitrox mixture is analyzed for %O<sub>2</sub> before entering the H.P. Compressor for approximate content and again when pumping Nitrox for precise content. The H.P. Compressor pumps the Nitrox to a maximum pressure of 3600 psi (250 bar) to fill Scuba Tanks or storage cylinders.

A unique feature of Nuvair Nitrox Systems is that the feed air pressure that correlates to a specific Nitrox %O<sub>2</sub> is repeatable. For example, if your H.P. Compressor pumps 36% O<sub>2</sub> when the feed air pressure is at 125 P.S.I. (9 bar), then adjusting the Back Pressure Regulator to 125 P.S.I. (9 bar) during the next use will produce the same mixture.

**6.0 Low Pressure Compressor Technical Data**

**See separate manual for Rotair RVK10 L.P. compressor**

**Capacity and Power Consumption:**

Normal working pressure – 80-175 P.S.I. (5.5-12 bar)  
Capacity at normal working pressure – 30 cfm (850 l/min)  
Shaft power at normal working pressure – 10.2 hp (7.65 kW)  
Maximum working pressure – 175 P.S.I. (12 bar)  
Minimum working pressure – 44 P.S.I. (3 bar)  
Idling shaft power consumption – 2.3 hp (1.7 kW)  
Transmission – Belt drive

**Cooling:**

Allowed ambient temperature – 32-104°F (0-40°C)

**Motor and Electrical Values:**

- Motor: F class ODP, 10 horse power (7.5 kW) three phase or Single Phase

**3 phase Motor and Electrical Values:**

- Motor - F class, IP55, 10hp (7.5 kW)
- Speed of rotation – 3480 rpm @ 60Hz
- Compressor current :
  - 16 A at 380 V / 50Hz
  - 28 amps @ 230 volt / 60Hz
  - 14amps @ 440 volt /60Hz
- Fuse (max) –
  - 25 A @ 380v
  - 45 A @ 230v

**Single phase Motor and Electrical Values:**

- Motor - F class, IP55, 10hp (7.5 kW)
- Speed of rotation – 3480 rpm @ 60Hz
- Compressor current: 50 amps @ 230 volt 60Hz
- Fuse (max) – 60A @ 230v

Control voltage – 230 V

**General Technical Data:**

Oil Capacity 4 liters  
Maximum Oil Content in Air– 3 mg/m<sup>3</sup>

 **Notice**

Rotary screw compressors are continuous duty rated. They are not made to run for short intervals or sit without use for long periods of time. The rotary screw compressor must be run for a minimum of one continuous hour per week in tropical settings to insure moisture does not build up in the compressor. The oil filter and oil/air separator must be changed every 2000 hours or a minimum of once per year. In tropical conditions the oil should be checked every month for moisture by draining a small amount off the bottom of the compressor into a clear glass. If moisture is found it can be drained off and a visual inspection should be done on all filters checking for rust or corrosion.

## **7.0 High Pressure Compressor Technical Data**

### **Capacity and Power Consumption:**

- Normal working pressure – 3600 P.S.I. (250 bar)
- F.A.D. Flow 9.3cfm (265 l/m)
- Charging Rate – 10.8 SCFM (307 l/min)
- Compressor speed of rotation – 1550 rpm
- Maximum working pressure – 5000 P.S.I. (354 bar)
- Transmission – Belt drive

### **Cooling:**

- Allowed ambient temperature – 32-105°F (0-40°C)
- Air Cooled Interstage & Aftercooler

### **Motor and Electrical Values:**

- Motor - 7.5hp 3 phase or 7.5hp Single phase
- Speed of rotation – 3450 rpm
- Compressor current           230V-60 Hz/single phase – 40A  
  230V-50/60 Hz/three phase – 22A

### **General Technical Data:**

- Number Of Stages - 3
- Number Of Cylinders – 3
- Lubrication – Splash Lubricated
- Oil Quantity – 1.6 qt. (1.5 liters)
- H.P. Filtration Rating – CGA Grade E, 30,000 cu. ft. at 68°F (20°C)
- Condensate Drains – Automatic & Manual Interstage & Final
- Fill Pressure Stop – Automatic & Manual
- Low Oil Level Shutdown
- High Temperature Shutdown
- Interstage Pressure Gauges

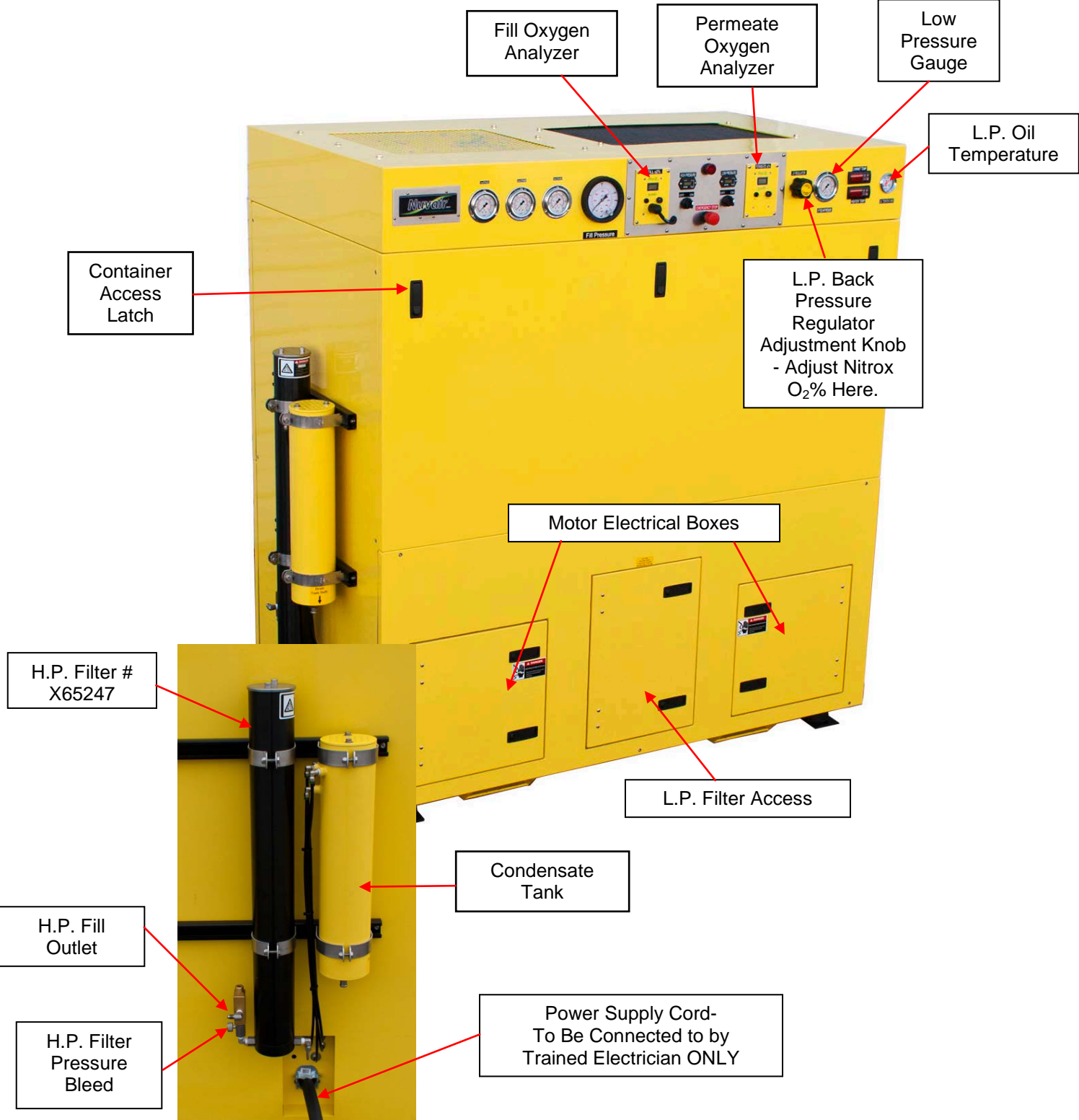
**8.0 System Components**

- Low Pressure Compressor, including:
  - ◆ Magnet Motor Starter
  - ◆ Hour Meter
  - ◆ External Lubricant Sight Gauge, Fill, and Drain
  - ◆ Nuvair 546™ Food Grade Rotary Screw Compressor Lubricant
  - ◆ Large oil/air cooler with exhaust fan
- Refrigerated Air Dryer
  - ◆ Automatic Condensate Drain
- Back Pressure Regulator that controls L.P. compressor feed air supply
  - ◆ Supply Air Pressure Gauge 90-165 P.S.I. (6-11 bar) depending on Nitrox %O<sub>2</sub>
- Low Pressure Feed Air Filtration, Grade D Breathing Air, including four stages:
  - ◆ Coalescing & Particle Removal to 1 micron, auto drain, liquid level indicator
  - ◆ Water & Oil Vapor Removal to 0.01 micron, auto drain, liquid level & service life indicators
  - ◆ Oil Vapor Removal to 0.003 PPM
- Heater including: (optional) not supplied with Nitrox Manager
  - ◆ Thermostat Control
  - ◆ Digital Temperature Gauge
  - ◆ Pressure Switch
  - ◆ 200 P.S.I. (14 bar) ASME Over Pressure Relief
- Semi-Permeable Membrane
- Mixing Tube & Air Intake Filter
- Nuvair Pro O<sub>2</sub> Remote™ Permeate Oxygen Analyzer
- Nitrogen Discharge
- Nuvair Pro O<sub>2</sub>™ Fill Oxygen Analyzer, including:
  - ◆ High Pressure>Low Pressure Regulator
  - ◆ Flow Restrictor, 1 - 5 L/min
- High Pressure Compressor, including
  - ◆ Magnet Motor Starter
  - ◆ Hour Meter
  - ◆ Automatic Condensate Drains
  - ◆ Automatic Fill Pressure Stop
  - ◆ External Lubricant Sight Gauge, Fill, and Drain
  - ◆ Nuvair 455™ Food Grade Compressor Lubricant
- High Pressure Filtration, Grade E Breathing Air
- Air/Nitrox Quality Analysis Kit

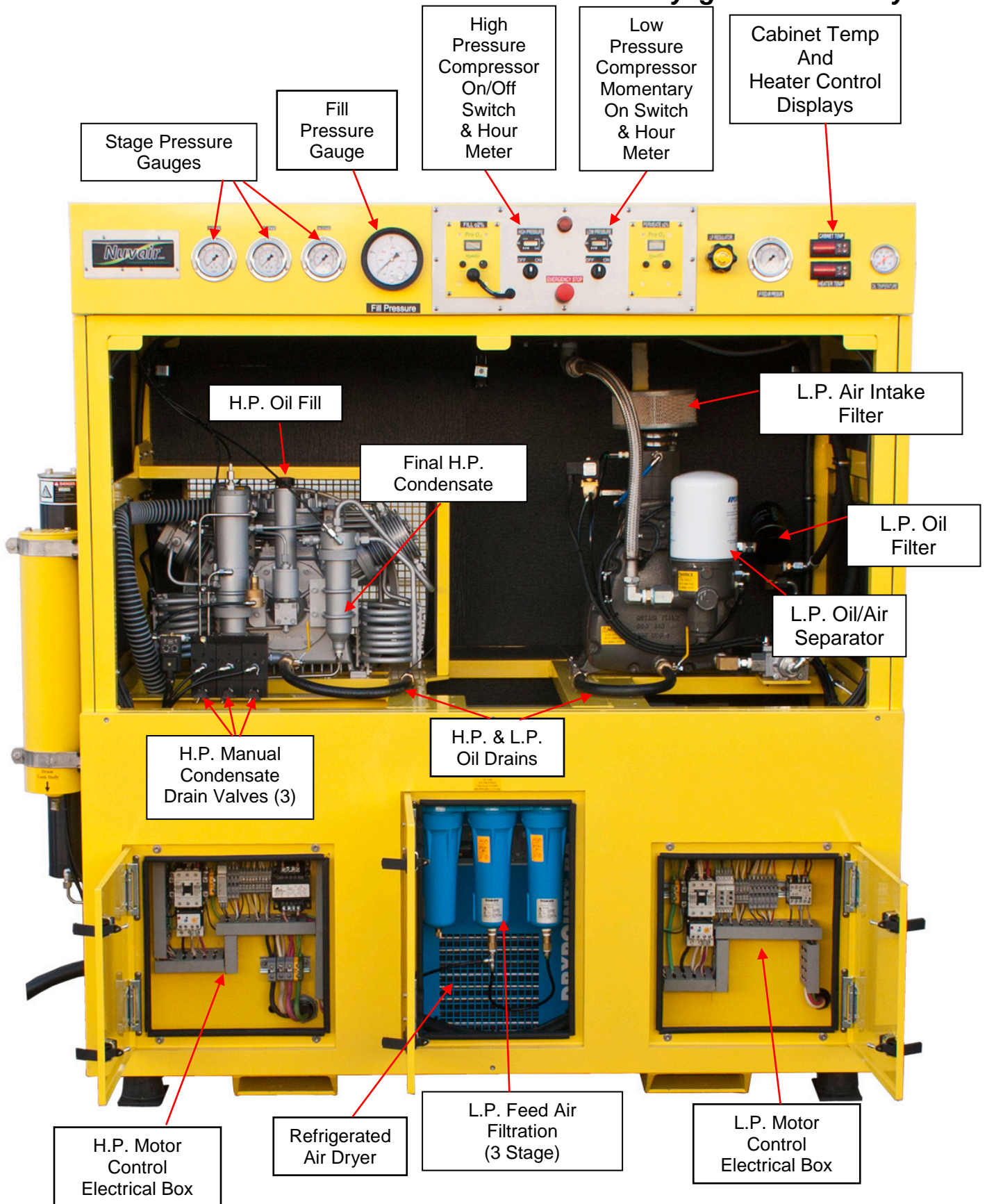
## 9.0 Nitrox System Specifications

<b>L.P. Compressor</b>	<b>Delivery @ 175 P.S.I. (12 bar)</b>	30 cfm FAD (850 L/min)
	<b>Horsepower – Electric</b>	7.5 hp (5.5 kW)
<b>Physical Specifications</b>	<b>Height</b>	62 in (157 cm)
	<b>Width</b>	57 in (145 cm)
	<b>Depth</b>	32 in (81 cm)
	<b>Weight</b>	840 lb (382 kg)
<b>Full Load Amps</b>	<b>230V/E1/60 Hz 230V/E3/50-60 Hz 415V/E3/50Hz 44V/E3/60Hz</b>	98A 56A 40A 31A
<b>Membrane Input</b>	<b>Operating Pressure Range</b>	90-185 psi (6-12 bar)
	<b>Maximum Input Pressure</b>	300 psi (21 bar)
	<b>Feed Air Volume Range</b>	8-33 scfm (227-934 L/min)
	<b>L.P. Feed Air Quality</b>	Grade D
	<b>Optimum Temperature</b>	110 +/- 5°F (43 +/- 3°C)
	<b>Nitrox %O<sub>2</sub> Range</b>	24 - 40%
<b>H.P. Compressor</b>	<b>Charging Rate</b>	10.8 SCFM (305 l/min)
	<b>Horsepower – Electric</b>	7.5 hp (5.5 kW)

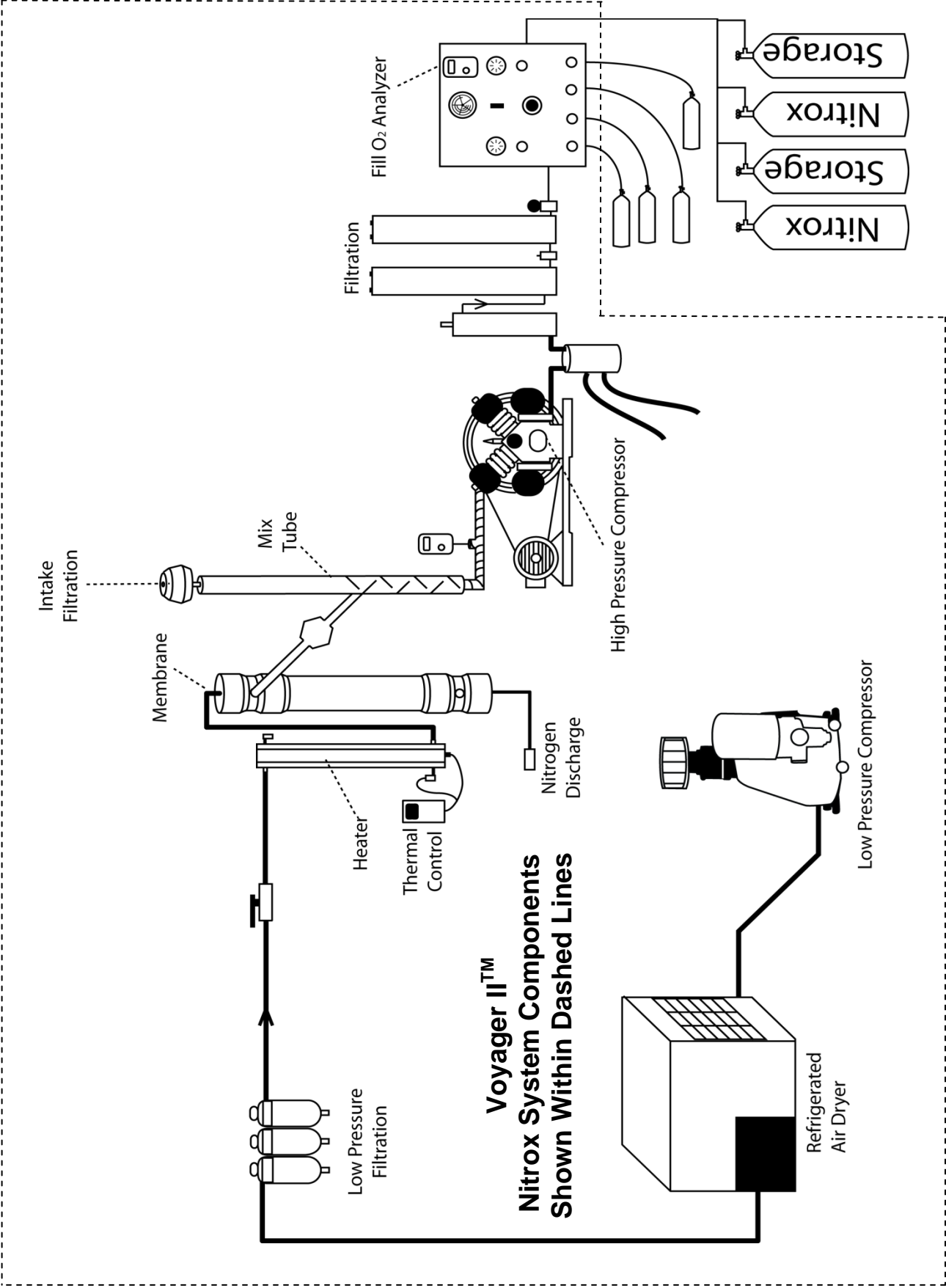
10.0 Nitrox System Component Identification



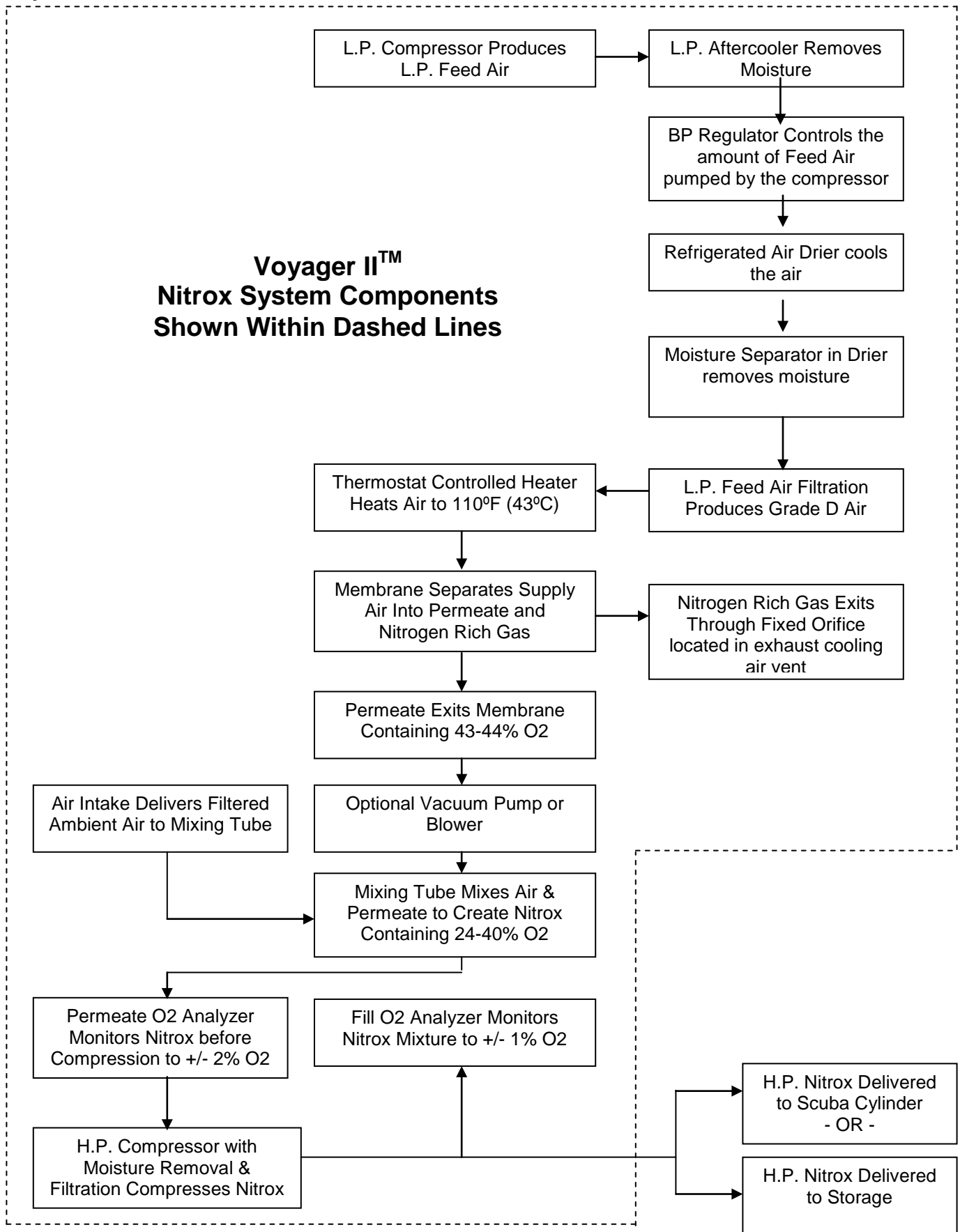
# Voyager II™ Nitrox System



11. System Drawing / Schematic



## 12. System Flow Chart



## 13.0 Installing the Nitrox System

### Notice

If any information in this manual conflicts with any of the other manuals, call Nuair before proceeding.

### Caution

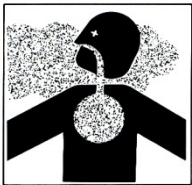
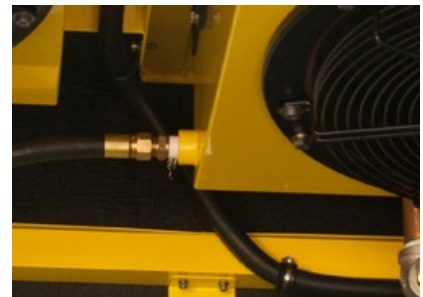
The Nuair Voyager II should never be operated in a facility where the room temperature exceeds 104° F (40° C) while the system is in use. Operation at higher temperatures may lead to system damage and malfunction. A damaged membrane will not produce the correct Nitrox mixture which can lead to severe personal injury if the gas is used for diving purposes without proper analysis.

#### 13.1 Precautions

- 1) Please read all information supplied before physically installing the Nitrox System.
- 2) Unpack the system and remove from the pallet. Visually inspect the system to make sure there has been no damage during shipping. If damaged, please call Nuair to file a damage report. Please take photos and supply detailed information about the damage.
- 3) Place the system in a location that allows a minimum spacing of 18" from adjacent walls. Select a location where ambient room temperature will never exceed 100°F (38°C).
- 4) The Heater Thermostat has been set in the factory. Do not adjust.

#### 13.2 Attaching Nitrogen Discharge Hose (Optional)

The nitrogen discharge from the Membrane on the Voyager II exits into the exhaust air fan. The fan pushes over 3000 cfm of exhaust air and as long as the fan is functioning there will be no need for an outside optional discharge.



### Warning

Pure nitrogen is a colorless, odorless, tasteless gas that will not support life. Breathing gas mixtures containing more than 84% nitrogen at surface pressures will lead to unconsciousness and may cause death.



### Warning

The nitrogen discharge from the membrane should be vented to a well-ventilated room or to open air with good circulation. Failure to isolate the discharge from the air intake of the membrane system or L.P. compressor could lead to incorrect Nitrox mixtures, resulting in serious personal injury or death. If you allow this pure nitrogen to accumulate in an enclosed space, anyone entering this space will quickly lose consciousness and will die if not immediately resuscitated.

### 13.3 Electrical Power Connection



#### Warning

Never use extension cords to provide power to your Nitrox system. The system must be properly wired according to national and local electrical codes by a qualified electrician. Improper wiring may lead to fires, which can cause serious personal injury or death.



#### Warning

The electrical power to the Nuvaire Voyager II must be off while wiring this system for service. Failure to ensure that the electrical power is off can lead to severe personal injury and death by electrocution.

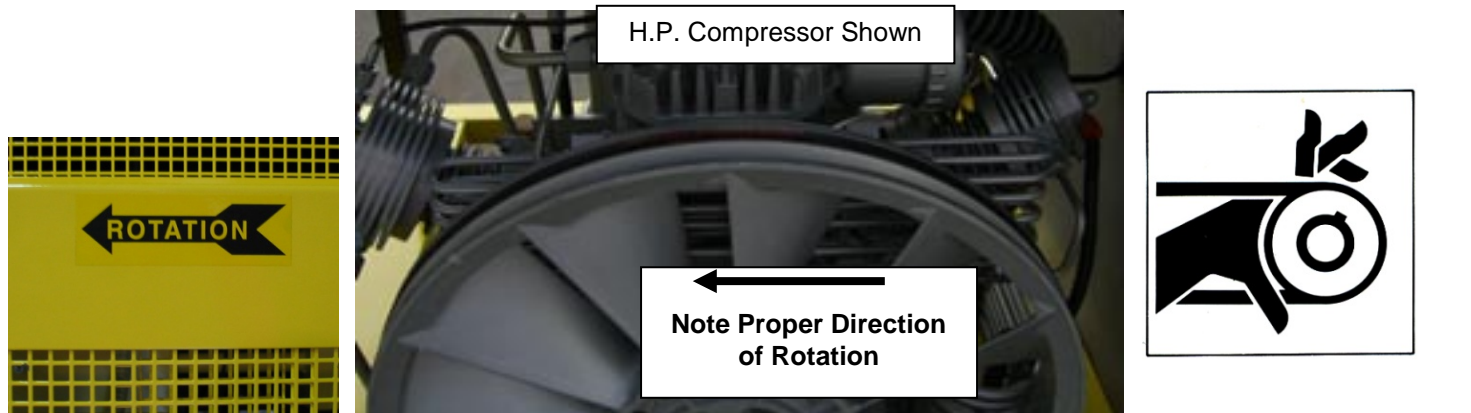
Prior to making the electrical power connection, check all system specifications provided in this manual. When working on the Nitrox System the main breaker at the power source must be “locked out” in the off position. The Nitrox System has electrical protection for the Compressor Motor and Membrane System Heater located inside the motor starter compartment.

#### Amperage Load for System

- ♦ Approximately 58 A for 230 V three phase service
- ♦ Approximately 98 A for 230 V single phase service

#### Compressor Rotation Check

Always turn on (bump) starter for both L.P. and H.P. Compressors and run motor very briefly to check for proper direction of rotation (see arrow on belt guard and flywheel).



#### Notice

Operation in reverse direction for extended periods of time will cause a Reciprocating Compressor to run hot and perform poorly and may cause permanent damage. Reverse rotation for a rotary screw compressor for even a short period of time will cause damage.

## 13.4 Air/Nitrox Quality Testing

Before using your Nitrox System to pump Nitrox, test a sample of the Nitrox produced using the Air/Nitrox Quality Analysis Kit provided to verify compliance with CGA standards. Quarterly testing is mandatory once the System is operational.

## 14.0 Pre-Operation Instructions



### Warning

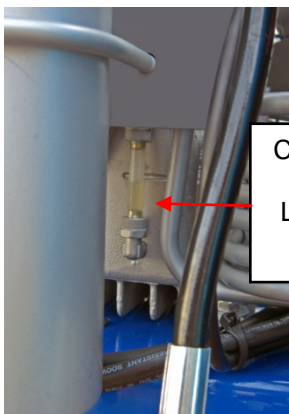
Do not allow Nitrox to be discharged into the air storage system. Nitrox introduced into the air storage system could cause a diver to suffer from oxygen poisoning at depth. Oxygen poisoning is extremely dangerous and can lead to death by drowning.

### Warning

Do not allow air to be discharged into the Nitrox storage system. Air introduced into the Nitrox storage system could cause a diver to suffer decompression sickness if the Nitrox mixture is not analyzed properly and is used underwater under the assumption it is a different mix.

## 14.1 Compressor Lubricant Levels

Check lubricant levels before starting the L.P. and H.P. Compressors, and add lubricant as required. Use only the lubricants specified.



Compressor Lubricant Level Sight Gauges

L.P. Oil Fill & Dip Stick



## 14.2 Membrane System Feed Air Regulator and Switch

A BP Regulator is used to adjust the amount of air that is pumped by the L.P. compressor. As the volume of air is increased the pressure to the Membrane System is increased to a typical range of 90 – 165 P.S.I. (6-11 bar). Prepare the Membrane System as follows:

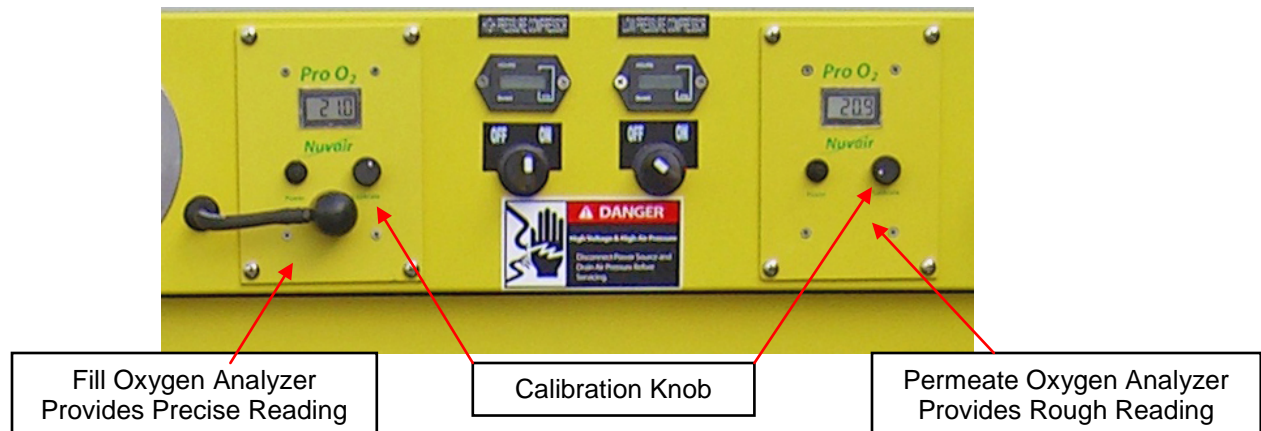
- 1) Reduce feed air pressure to minimum pressure setting by turning the regulator adjustment knob counter-clockwise (CCW).



L.P. Feed Air BP Regulator Adjustment Knob

### 14.3 Oxygen Analyzer Calibration

Gas production may be monitored with the Permeate Oxygen Analyzer before entering the H.P. Compressor to obtain a rough estimate of %O<sub>2</sub> (+/- 2%); however, do not rely on this reading as an indication of %O<sub>2</sub> at the H.P. Compressor outlet. Prior to pumping Nitrox into a Scuba cylinder or Surface Supply System, it must be monitored with the Fill Oxygen Analyzer to obtain a precise measurement of %O<sub>2</sub> (+/- 1%). **Both Oxygen Analyzers must be calibrated prior to each use.**



#### Warning

Oxygen Analyzers must be calibrated before each use. See Oxygen Analyzer manuals for correct calibration procedures. Improper calibration of the Fill Oxygen Analyzer may result in the use of incorrect Nitrox mixtures, which may cause serious injury or death to the diver using the gas mixture.

#### Warning

At altitudes above sea level, a correction factor must be used when calibrating the Fill Oxygen Analyzer may not be achievable. See Fill Oxygen Analyzer manual for correcting analyzer readings at various altitudes. Improper calibration of the Fill Oxygen Analyzer may result in the use of incorrect Nitrox mixtures, which may cause serious injury or death to the diver using the gas mixture.

#### Warning

The Permeate Oxygen Analyzer supplies oxygen readings that can vary +/- 2% O<sub>2</sub> due to heat, humidity, and pressure changes experienced in the Nitrox flow and therefore should only be used for rough estimates of %O<sub>2</sub>. The Fill Oxygen Analyzer supplies more accurate oxygen readings, within +/- 1% O<sub>2</sub>. For Scuba cylinder Nitrox fills, the user must always verify the final fill with a third independent Oxygen Analyzer.

**Calibrate Oxygen Analyzers as follows:**

- 1) Turn off L.P. compressor and return L.P. Feed Air BP Regulator to minimum pressure setting by turning adjustment knob CCW until it spins freely.

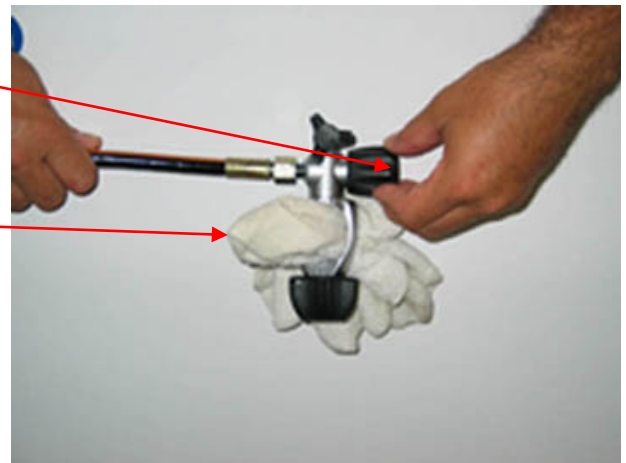


- 2) Slightly open fill whip valve on H.P. Compressor to relieve any residual pressure, and then, if desired, insert clean rag in yoke to act as sound muffler.

Adjust Fill Whip Valve to Maintain Pressure

Insert Clean Rag in Fill Whip Yoke

Optional Sound Muffler for H.P. Nitrox Compressor is available

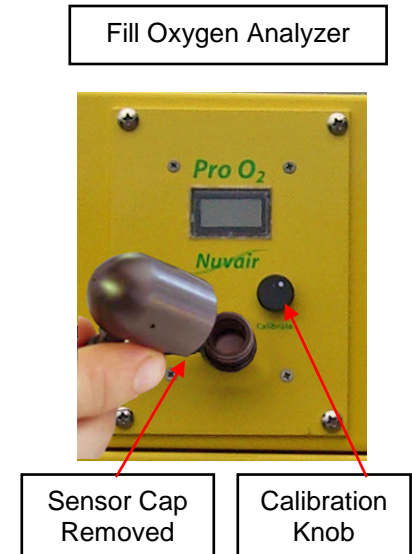


- 3) Adjust fill whip valve so the running H.P. Compressor maintains 1500-2000 P.S.I. (100-140 bar) outlet pressure. Air will now be flowing past both Oxygen Analyzers for calibration purposes.
- 4) Monitor all gauges for proper operating range and check all connections for leaks.
- 5) Calibrate Oxygen Analyzers while the H.P. Compressor is pumping air. Refer to the Oxygen Analyzer manual included with the Nitrox System for details. Note that special calibration procedures may be required when operating at altitudes above sea level.
  - ◆ Permeate Oxygen Analyzer - Calibrate analyzer so Display reads 20.9%.
  - ◆ Fill Oxygen Analyzer - Calibrate analyzer so Display reads 20.9% to correlate with the Grade E breathing air present at the Sensor. Different settings may be used depending on location, so verify your actual ambient conditions and refer to the Oxygen Analyzer manual for details.

## Fill Oxygen Analyzer - Alternate Calibration Method

The Fill Oxygen Analyzer can also be calibrated in ambient air as an alternative. This is especially useful during routine re-calibration while the system is operating. Different settings may be used depending on location, so verify your actual ambient conditions and refer to the Oxygen Analyzer manual for details.

- 1) Remove the Flow Adapter Cap covering the Sensor.
- 2) Expose the Sensor to ambient air for approximately 15 seconds.
- 3) Adjust Calibration Knob until Display reading stabilizes at 20.9%.
- 4) Reinstall the Flow Adapter Cap to the analyzer.
- 5) The Fill Oxygen Analyzer is now ready for use.



## 14.4 Attaching Scuba Cylinder

### Notice

**Only one fill whip is attached to a Scuba Cylinder at this point. The second whip will continue to be used to control H.P. Compressor outlet pressure.**

Attach one H.P. Compressor Fill Whip to a Scuba Cylinder. Leave Cylinder Valve closed.

Additional cylinders or storage tanks can be attached after the system is ready to pump Nitrox.



### Notice

**High-pressure cylinders that are filled quickly will become hot and due to the increased internal temperature the cylinder pressure will increase. This will leave a diver with less pressure inside the cylinder once cooling has occurred. This will decrease the amount of time the diver may spend underwater which may be critical during a deep dive. Customers must be warned of this possibility if cylinders are delivered for use while warm. Always fill all breathing gas cylinders slowly to avoid overheating.**

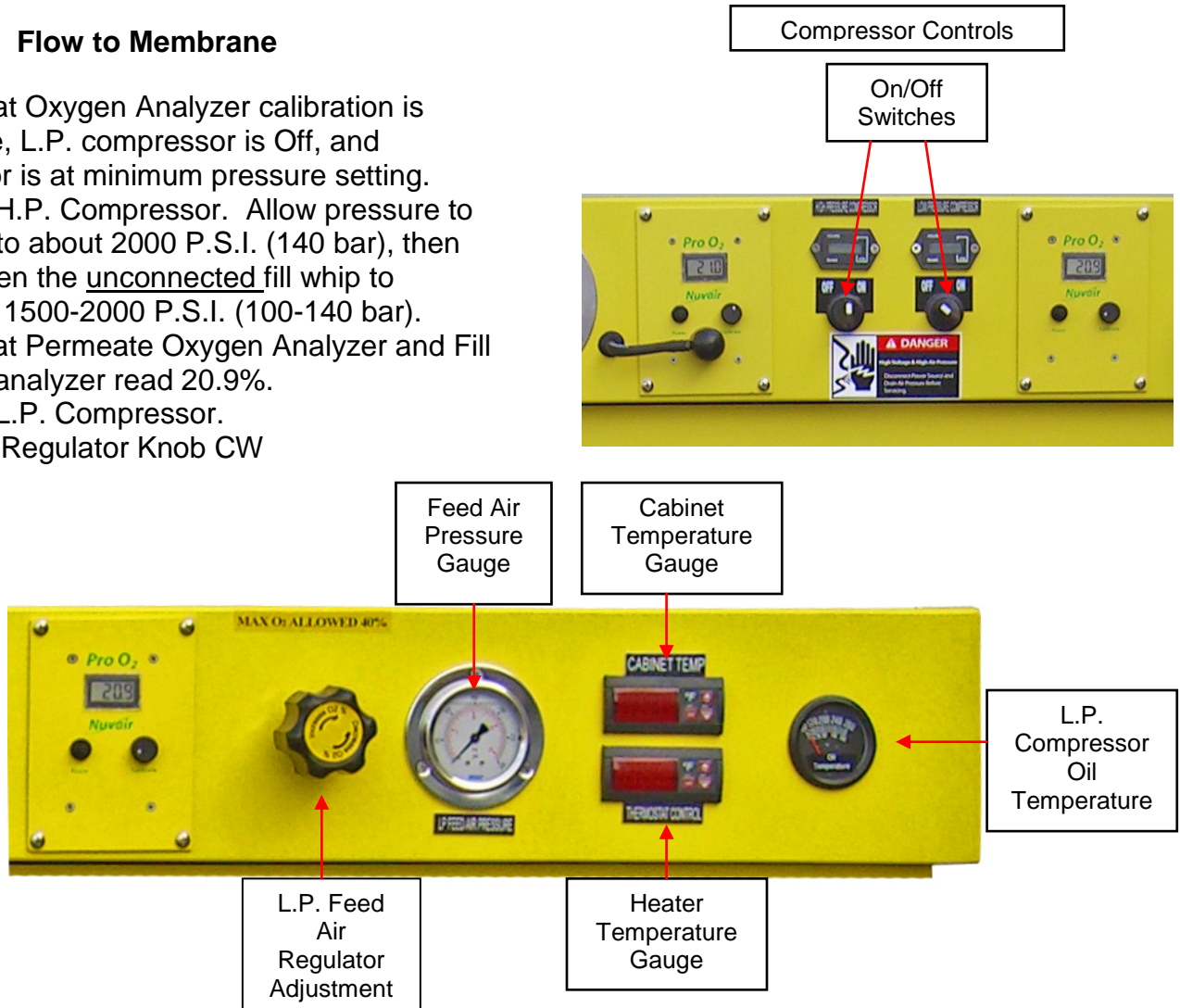
## 15.0 Producing Nitrox

### Warning

The equipment you will be using to manufacture Nitrox (oxygen rich air) will expose you to both low and high-pressure gas. Gas, even under moderate pressures, can cause extreme bodily harm. Never allow any gas stream to be directed at any part of your body.

### 15.1 Flow to Membrane

- 1) Verify that Oxygen Analyzer calibration is complete, L.P. compressor is Off, and Regulator is at minimum pressure setting.
- 2) Turn on H.P. Compressor. Allow pressure to build up to about 2000 P.S.I. (140 bar), then crack open the unconnected fill whip to maintain 1500-2000 P.S.I. (100-140 bar).
- 3) Verify that Permeate Oxygen Analyzer and Fill Oxygen analyzer read 20.9%.
- 4) Turn on L.P. Compressor.
- 5) Turn BP Regulator Knob CW



- 6) Adjust feed air pressure to approximately 100 P.S.I (7 bar) to activate Heater Pressure Switch. Increase pressure by slowly turning the regulator Knob CW or decrease pressure by turning the Knob CCW. The heater will not turn on until Membrane System is pressurized.
- 7) Check the Heater Temperature Gauge to verify air temperature rises and is between 105-120 °F (40-49 °C).

## ! Notice

**Do not change the temperature setting on the Thermostat Control without contacting Nuvair. Changes in temperature settings may cause Membrane damage. A damaged membrane will not produce the correct Nitrox mixture which can lead to severe personal injury if the gas is used for diving purposes without proper analysis.**

### 15.2 Setting Proper Pressure

The Membrane System feed air pressure determines the %O<sub>2</sub> of the Nitrox mixture. As pressure is increased, a higher %O<sub>2</sub> Nitrox is pumped. As pressure is decreased, a lower %O<sub>2</sub> is pumped.

- 1) Increase pressure by slowly turning the regulator Knob CW while monitoring the L.P. Pressure Gauge and Permeate Oxygen Analyzer. As the pressure rises, watch the corresponding increase in the analyzer %O<sub>2</sub> reading.
- 2) Increase or decrease pressure slowly until the Permeate Oxygen Analyzer displays the %O<sub>2</sub> desired in the final Nitrox mixture.
- 3) Allow system pressure and temperature to stabilize (approximately 5-8 minutes).
  - ◆ Regulated Membrane System pressure range should be 90– 165 P.S.I (6-11 bar), depending on Nitrox %O<sub>2</sub> being produced.
  - ◆ Heater temperature range should be 105-120 °F (40-49 °C).



Permeate Oxygen Analyzer

### 15.3 Final Adjustments Before Pumping Nitrox

- 1) As the Nitrox initially makes its way through the running H.P. Compressor, the %O<sub>2</sub> reading on the Fill Oxygen Analyzer will slowly increase to read approximately the same %O<sub>2</sub> as the Permeate Oxygen Analyzer. This should happen within 3-5 minutes.
- 2) When the two analyzers read within +/- 1%, make any final adjustments to the Membrane System feed air pressure necessary to obtain the exact Nitrox %O<sub>2</sub> desired as indicated on the Fill Oxygen Analyzer.
- 3) The system is now ready to pump Nitrox.



Fill Oxygen Analyzer

## 15.4 Pumping Nitrox

 **Warning**

The use of enriched air Nitrox does not eliminate the risk of decompression sickness (DCS) in diving. Decompression sickness can lead to permanent disability or death.\

 **Warning**

The Permeate O<sub>2</sub> Analyzer supplies oxygen readings that can vary +/- 2% O<sub>2</sub> due to heat, humidity, and pressure changes in the Nitrox flow and should only be used for rough estimates of %O<sub>2</sub>. The Fill O<sub>2</sub> Analyzer supplies more accurate readings, within +/- 1% O<sub>2</sub>. For Scuba cylinder fills, the user must always verify the fill with a third independent O<sub>2</sub> analyzer.

 **Warning**

Do not use this system to produce Nitrox mixtures containing more than 40% oxygen. Pumping Nitrox mixtures with higher concentrations of oxygen may lead to fires or explosions, which can cause serious personal injury or death.

 **Warning**

Do not pump Nitrox mixtures at pressures above the H.P. compressor rating, and never above 3600 P.S.I. (250 bar). The system is not rated for pressures above 3600 P.S.I. (250 bar). Higher pressures may lead to explosions which may cause serious personal injury or death.

 **Notice**

No oxygen cleaning of standard cylinders or plumbing is mandatory when using the Nitrox System to produce Nitrox containing a maximum of 40% oxygen. When filling oxygen clean cylinders, hyper-purification of the Nitrox is required using an optional Oxygen Compatible Air purification system available from Nuair.

 **Warning**

This Nitrox system does not produce Nitrox mixtures acceptable for 100% oxygen service. Mixing Nitrox mixtures with 100% pure oxygen may lead to fires and / or explosions, which may cause serious personal injury or death.

 **Warning**

Never fill a cylinder that is marked, "For Oxygen Service," with Nitrox that has been produced by anything other than 100% oxygen clean system. Filling an oxygen clean cylinder with breathing gas containing hydrocarbons can lead to explosions if the cylinder is subsequently filled with gas mixtures containing gas mixtures containing greater than 40% oxygen. Explosions may cause serious injury or death.

 **Warning**

Only provide Scuba cylinder Nitrox fills to customers who have proof of Nitrox training and certification. Improper use of Nitrox can be fatal.



## **Danger**

This system is not cleaned for oxygen service and not all components are compatible with gas mixtures containing greater than 40% oxygen. Pumping gas mixtures containing greater than 40% oxygen will lead to explosions which may cause severe personal injury or death.

## **Warning**

Each Scuba cylinder belonging to a customer must be analyzed by that customer at the Nitrox filling facility, using an oxygen analyzer independent of those used with the Nitrox System. An employee must witness that the customer has properly analyzed the gas in each cylinder, noted the maximum operating depth for that mixture, and signed and dated the fill log. The time of day must also be included with the date, since some customers may fill the same cylinder more than once a day.

**Pump Nitrox as follows:**

- 1) When filling a Scuba cylinder, follow all industry standards. Do not exceed rated pressure of cylinder, and do not exceed 3600 P.S.I. (250 bar) under any condition.
- 2) With fill whip bleed valve open and Nitrox flowing, verify that Fill Oxygen Analyzer %O<sub>2</sub> reading equals the desired Nitrox %O<sub>2</sub>.
- 3) Close bleed valve, open cylinder valve, and fill cylinder. Monitor system for proper operation:
  - a) Monitor Oxygen Analyzers and recalibrate as required
  - b) Listen for proper operation of automatic condensate drains every 10-15 minutes.
  - c) Monitor all system gauges as shown in the table below.

## **Notice**

The Oxygen Analyzers may require re-calibration after 10-20 minutes of operation due to humidity and temperature change effects on the Sensor. To recalibrate, turn off the L.P. Feed Air Switch and follow calibration instructions.

## **Notice**

When the H.P. Compressor auto drain engages and dumps condensate, the Fill Oxygen Analyzer reading will decrease momentarily due to the pressure drop in the system. It will return to its previous reading within seconds after the auto drain sequence stops.

GAUGE	RECOMMENDED SETTING
Compressor Gauges	According to manufacturers recommendations
Heater Temperature	105-120° F (40-49° C)
Cabinet Temperature	Less than 100° F (38° C)
Volume Tank Pressure	165-175 PSI (11-12 bar)
Membrane Feed Air Pressure	90 - 165psi (6-11 bar) depending on Nitrox O2%
Fill Oxygen Analyzer	Showing the proper reading for intended fill
Nitrox Storage Pressure	<b>DO NOT</b> exceed rating of tank or 3600 P.S.I (250 bar)

- 4) After filling is complete, close cylinder valve, vent the bleed valve, and remove the cylinder.
- 5) Test the Nitrox %O<sub>2</sub> in the cylinder using an independent Oxygen Analyzer such as the Nuvair O<sub>2</sub> Quickstick™. Calibrate analyzer before use in accordance with manufacturer's instructions.
- 6) Repeat steps 1-5 until you have filled all Scuba cylinders.
- 7) Mark each tank with fill date, %O<sub>2</sub>, fill pressure, and MOD (Maximum Operating Depth).
- 8) Log every Nitrox fill to document the following information:
  - ◆ Fill date and time of day
  - ◆ Tank Number
  - ◆ Supplier's check of oxygen content (%O<sub>2</sub>) plus signature and date
  - ◆ User's check of oxygen content (%O<sub>2</sub>) plus signature and date
  - ◆ Fill Pressure
  - ◆ MOD (Maximum Operating Depth) in user's handwriting
  - ◆ Nitrox certifying agency and card number
- 9) When filling a H.P. Nitrox storage tank, verify that Fill Oxygen Analyzer %O<sub>2</sub> reading equals the desired Nitrox %O<sub>2</sub>. Open applicable line valves and tank valve, and fill with Nitrox. Do not exceed rated pressure of cylinder, and do not exceed 3600 P.S.I. (250 bar) under any condition. After filling is complete, close all valves and allow Nitrox System to shut down.



Use Independent Oxygen Analyzer for Verification

### 15.5 Pumping Air

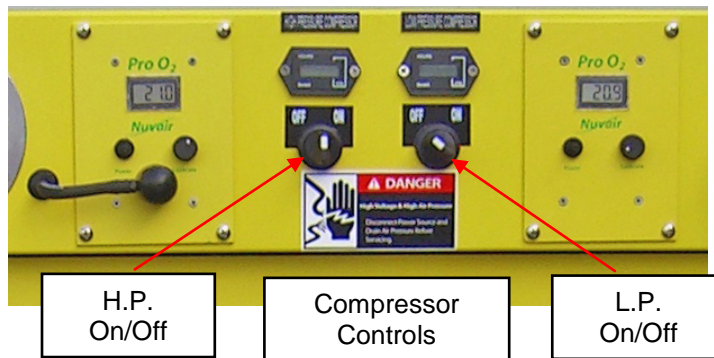
To use the System to pump air, simply turn off the L.P. Compressor. No Nitrox will be supplied to the H.P. Compressor, and it will pump air only. When the H.P. Compressor is pumping air, the Permeate Oxygen Analyzer and the Fill Oxygen Analyzer should both read 20.9% O<sub>2</sub>.

### Notice

**Always use Oxygen Analyzers to monitor oxygen content of any gas flowing through the System. Both air and Nitrox are subject to variations in oxygen content.**

## **15.6 Shutting Down**

- 1) When tank filling is complete and tank valves are closed, the Nitrox System will automatically shut down at the pressure set on the pressure switch (3600 psi).
- 2) Manually shut off the Membrane System by turning the Feed Air Regulator adjustment knob CCW to reduce pressure to minimum setting and then turn off the L.P. & H.P. compressors.
- 3) The system will automatically drain all Filter, Compressor, and Volume Tank condensate.



## **16.0 Nitrox Operation Notes**

### **16.1 Correlation of Feed air Pressure to Oxygen Content**

After the 10 hour break-in period for your Nitrox System, you will notice that specific Nitrox %O<sub>2</sub>'s always match specific feed air pressures once the System has warmed up. These pressures will be repeatable. If you find that the Fill Oxygen Analyzer reads 36% O<sub>2</sub> when the feed air pressure is at 125 P.S.I. (9 bar), record this pressure or make a mark on the feed air pressure gauge indicating the %O<sub>2</sub>. Do this for each %O<sub>2</sub> that you normally make, making sure System has warmed up first. The next time Nitrox with 36% O<sub>2</sub> is needed, adjust the regulator to 125 P.S.I. (9 bar) and wait for the Oxygen Analyzer reading to stabilize. You will find the analyzer reading to be very close to 36% O<sub>2</sub>, requiring only minor adjustments of the regulator to achieve the exact desired %O<sub>2</sub>.

### **Notice**

**Use the Fill Oxygen Analyzer to verify the Nitrox oxygen percentage prior to pumping. When using the feed air pressure reading to obtain specific oxygen percentage, minor adjustments of the feed air pressure regulator may be required to obtain the exact percentage desired.**

### **16.2 Hot Fills**

While in the process of filling H.P. Nitrox Storage Tanks, you may have a need to supply a walk-in customer with a Scuba Cylinder fill of a different Nitrox mix. You can change mixes as follows:

- 1) With the Nitrox System operating, isolate the H.P. Nitrox Storage Tanks from the H.P. Compressor by closing the appropriate valves.
- 2) Record the Membrane System feed air pressure reading.
- 3) Slightly open fill whip valve on the H.P. Compressor, and adjust so the running Compressor maintains 1500-2000 P.S.I. (100-140 bar) outlet pressure.
- 4) Adjust the feed air regulator to the pressure corresponding to the desired Nitrox %O<sub>2</sub> for the Scuba Cylinder fill.
- 5) Allow the Fill Oxygen Analyzer reading to stabilize, make any minor adjustments necessary to achieve the desired %O<sub>2</sub>, and then fill cylinder in normal manner.
- 6) When finished return regulator to previous setting, and allow the Fill Oxygen Analyzer reading to stabilize. Make any minor adjustments necessary to achieve the desired %O<sub>2</sub>, and then resume filling Storage Tanks.

## 17.0 Maintenance

The following list of daily and routine maintenance items is intended as a guide. Refer to L.P. and H.P. Compressor manuals for complete maintenance requirements.

### 17.1 Daily Maintenance

#### Caution

**Be sure to check Compressor Lubricant levels prior to each day of operation. Failure to ensure the proper lubricant level will lead to system damage.**

- 1) Check lubricant levels of both L.P. and H.P. Compressors and add proper lubricants as required. See Section 17.3 and Compressor manuals for details.
- 2) Slightly open each H.P. and L.P. Manual Condensate Drain Valve to verify that no condensate is present.
- 3) Check L.P. Air Filtration for condensate and proper operation of condensate drains.

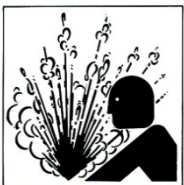
Filter Pressure  
Drain

Condensate  
Tank



#### Warning

**Use only the specified Nuvair lubricants in this system. The use of incompatible lubricants presents a risk of fire and/or explosion, and may result in system damage. This can lead to severe personal injury and death.**



#### Warning

**Be sure that all pressure has been relieved from the system prior to opening any filtration canister. Failure to vent pressure from the system prior to opening the canister can lead to serious personal injury or death.**

#### Caution

**If system is located in an area where there is high humidity and high heat, the life of all Filtration Elements may be as little as 35% of rated operating capacity. Check the Compressor manual and Appendix for details on Filter Element Life Factors.**

## 17.2 Routine Maintenance

- 1) L.P. Compressor Lubricant: Change Compressor Lubricant every 500 hours. Only use lubricants rated for use with Nitrox, such as Nuvair 546™. Never mix Compressor Lubricants. See Section 17.3 and L.P. Compressor manual for details.
- 2) H.P. Compressor Lubricant: Change Compressor Lubricant every 100 hours or annually, whichever comes first. Only use lubricants rated for use with Nitrox, such as Nuvair 455™. Never mix Compressor Lubricants. See Section 17.4 and H.P. Compressor manual for details.
- 3) L.P. Air Filtration Inspection: On a weekly basis, inspect each Filter Bowl for the presence of moisture and each Element for any unusual degradation or wetness. See Section 17.5 for details.
- 4) L.P. Air Filtration Elements: Change L.P. Filter Elements every 250 hours to maintain CGA Grade D air standards. Visual liquid level and service life indicators assist with monitoring replacement intervals. See Section 17.5 for details. If the Nitrox System is operated in high humidity and/or high temperature, Filter Elements must be changed more often. See Appendix for details on Filter Element Life Factors.
- 5) H.P. Compressor Filtration Element: Change H.P. Filter Element every 60,000 cubic feet of air or Nitrox processing to maintain CGA Grade E air standards. See Section 17.6 for details. If the Nitrox System is operated in high humidity and/or high temperature the Filter Element must be changed more often. See Appendix for details on Filter Element Life Factors.
- 6) Condensate Drain Container: Check level and drain weekly or as needed.
- 7) Semi-Permeable Membrane: No maintenance required. Service life exceeds 20 years if L.P. Air Filtration is properly serviced to maintain Grade D standards.
- 8) Membrane System Air Intake Filter: Inspect filter element every 3 months for visible particles. Change every 12 months or sooner if particles are visible.
- 9) Oxygen Analyzers: Replace Oxygen Sensor and Battery as required. See manual included with Nitrox System.
- 10) Air/Nitrox Quality Analysis: Take breathing air/Nitrox samples quarterly for analysis to assure compliance with CGA Grade E breathing air standards.



Condensate Drain Container  
Check & Drain Daily

### **Danger**

**Do not swallow (ingest) either the electrolyte from the Oxygen Sensor or the Sensor itself. The Potassium Hydroxide chemical contained in the Sensor can cause severe injury or death. If electrolyte or the Sensor is swallowed, seek medical attention immediately.**



### **Danger**

**If after handling the oxygen analyzer or sensor, you find that your fingers or other parts of your body feel “slippery” or the skin or eyes sting, immediately flush affected area with clean, fresh water for at least 15 minutes. The stinging or slippery sensation is an indication of a leaking Sensor. The Potassium**

**Hydroxide chemical contained in the sensor can cause severe injury or death. Seek immediate medical attention if eye contact is made or skin stinging persists.**

### 17.3 Compressor Lubricant (see page 40 - 42 for Material Safety Data Sheets)

- The L.P. compressor in your Nitrox system comes standard with Nuvair 546™ synthetic food grade compressor lubricant for rotary screw compressors. Customers may specify different lubricants, check lubricant page at the back of manual for accepted lubricants.
- The H.P. compressor comes with the Nuvair 455™ synthetic food grade lubricant. Customers may specify different lubricants, check lubricant page at the back of manual for accepted lubricants.
- Check lubricant levels at each sight gauge and add lubricant as required through the appropriate lubricant fill plug.
- Lubricant is removed through the drain plugs. See L.P. and H.P. compressor manuals for details on servicing lubricant

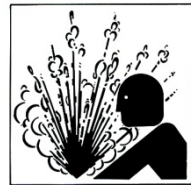
#### **Warning**

**Never mix different lubricants together because equipment damage may occur when machinery is operated with improper lubricant.**



#### **Warning**

**Do not carry out any maintenance tasks if the compressor has just shut down. Wait for the compressor to cool to avoid skin burns.**



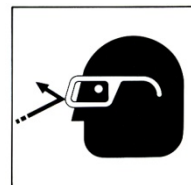
#### **Warning**

**Pressure must be properly drained from the system before opening the L.P. fill plug. Failure to drain pressure may result in severe personal injury.**



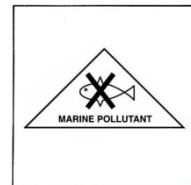
#### **Warning**

**Any oil spilled during the oil and oil filter change could cause personnel to slip and fall. Wear anti-slip footwear. Remove any traces of spilled oil immediately. Slips and falls may cause severe personal injury or death.**



#### **Caution**

**Wear eye protection, gloves, and skin protection when performing oil changes. Although the oil is not classified as a dangerous substance, the oil can be irritating to your eyes and skin.**



#### **Caution**

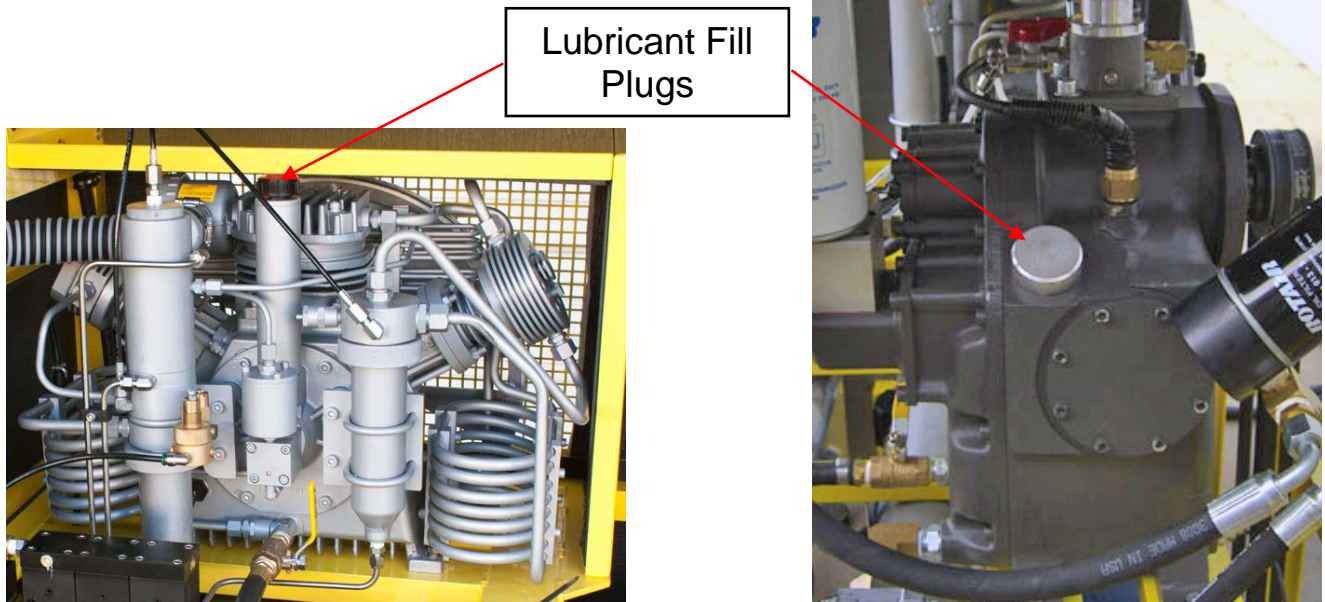
**Both oil and oil filter are classified as “special wastes” and must be disposed of properly according to applicable national and local laws. Failure to dispose of these wastes properly can lead to death of wildlife as well as government fines and penalties.**



## Warning

All maintenance work must be carried out with the compressor off and the power supply lead unplugged from the main socket. Appropriate steps must be taken to tag out and lock out the electrical power. Failure to isolate this equipment from the power source while performing maintenance may result in severe personal injury or death.

Lubricant fill ports shown below for each compressor installed in the Voyager II



- The L.P. compressor in your Nitrox system comes standard with Nuvair 546™ synthetic food grade compressor lubricant for rotary screw compressors.
- The H.P. compressor comes with the Nuvair 455™ synthetic food grade lubricant.
- Check lubricant levels at each sight gauge and add lubricant as required through the appropriate lubricant fill plug.
- Lubricant is removed through the drain plugs. See L.P. and H.P. compressor manuals for details on servicing lubricant

17.4 L.P. Feed Air Filtration

**Caution**

Special attention needs to be given to the arrangement of the three LP Feed Air Filtration Elements and Bowls. Properly reinstall each Element and Bowl to the correct Housing. Improper sequence can cause damage to downstream components

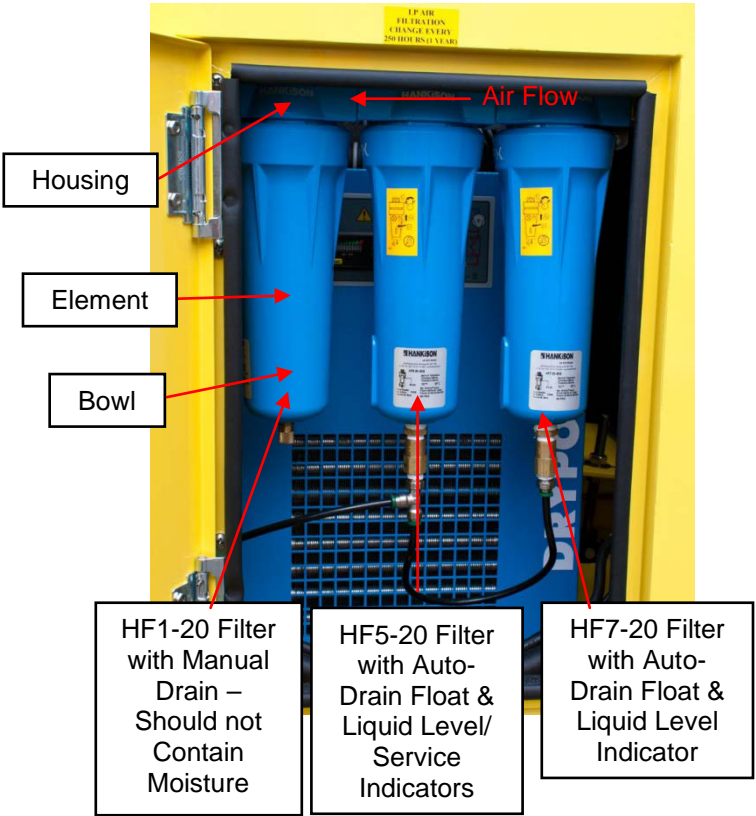
The use of Grade D or better feed air is critical to prevent the passing of any residual oil vapor into the Membrane System. Three stages of Hankison L.P. filtration are used to produce Grade D air:

- 1) Coalescing & Water/Oil Vapor Removal to 1 micron (HF7-20)
- 2) Coalescing & Water/Oil Vapor Removal to 0.01 micron (HF5-20)
- 3) Final Stage - Oil Vapor Removal to 0.003 PPM (HF1-20)

**L.P. Filtration Inspection**

Open each Filter and inspect as follows:

- 1) Inspect Bowl for the presence of moisture. A high level of moisture build-up in the HF7-20 Filter indicates improper operation of auto-drain floats. Evidence of any moisture in the HF1=20 Filter indicates air is not cooling properly and moisture is not properly being removed. Excess moisture will prevent the final filter from operating properly and can lead to damage of the membrane.



<b>HF1-20</b> Oil Vapor Removal	<b>HF5-20</b> Coalescing &Water/Oil Vapor Removal	<b>HF7-20</b> Particle & Moisture Removal
<b>Replacement Element Part Number</b>		
E1-20	E5-20	E7-20

## Changing L.P. Filtration Elements

Change Filter Elements every 250 hours. If the Nitrox System is operated in high humidity and/or high temperature, Filter Elements must be changed more often. See Appendix for details on Filter Element Life Factors. Visual service indicators on the HF series filters assist with monitoring replacement intervals.

- 1) Push up on Filter Bowl, rotate counter-clockwise, and lower to remove.
- 2) Gently unscrew Filter Element and pull down off mounting post.
- 3) Replace Element and reassemble in reverse order.



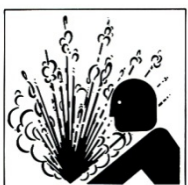
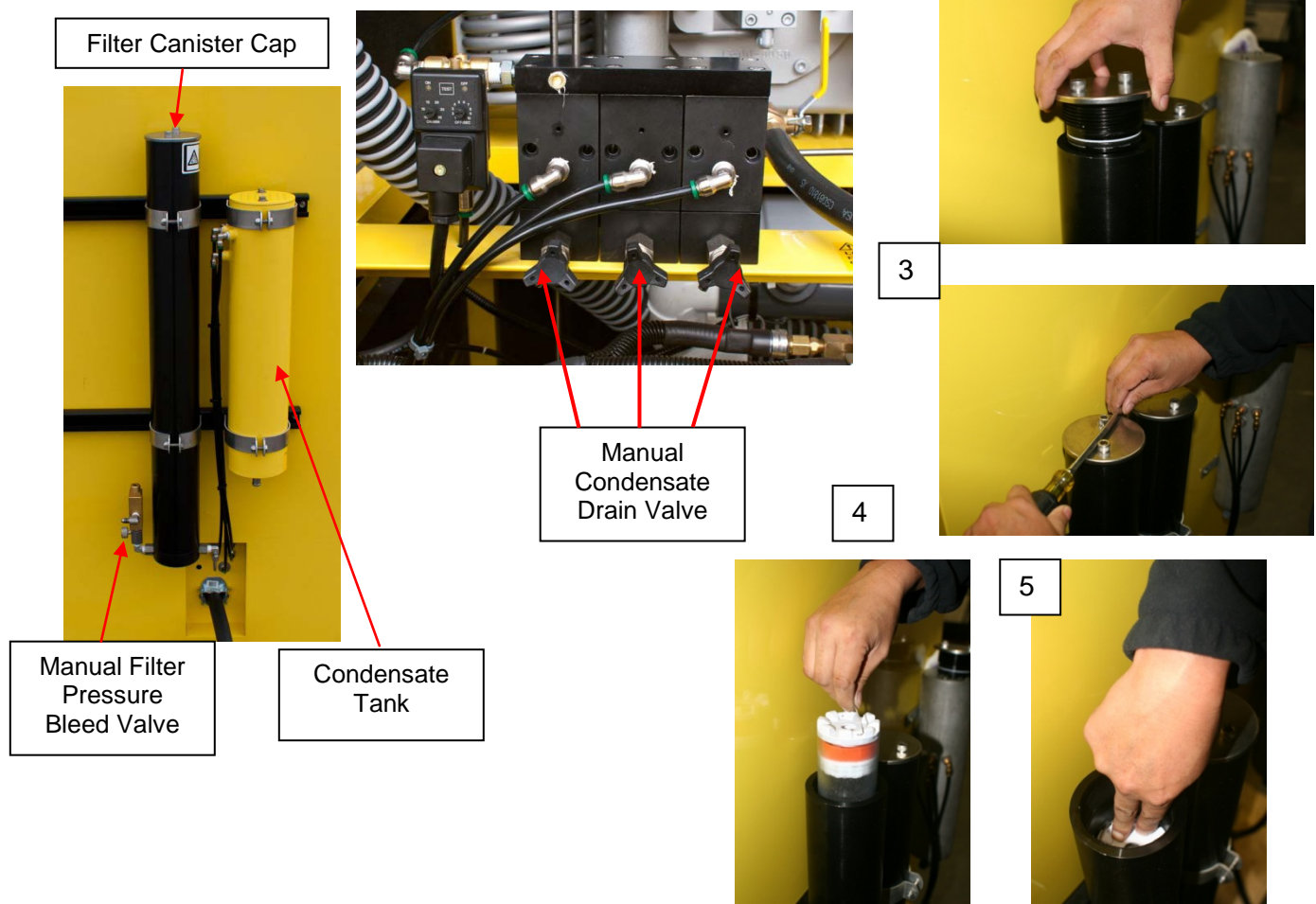
## Notice

The interior of the Filter Bowls can be cleaned with a diluted solution of Simple Green™ and flushed thoroughly with clean water. This will assist to prolong the life of the element, bowl, and auto drain.

## 17.5 H.P. Compressor Filtration

The H.P. Compressor comes standard with Triplex filtration, utilizing a single Filter Element. Do **NOT** use any substitute. Change Filter Element every 60,000 cubic feet of air or Nitrox processing. If the Nitrox System is operated in high humidity and/or high temperature, Filter Element must be changed more often. See Appendix for details on Filter Element Life Factors.

- 1) Shut down the Nitrox System
- 2) Open Manual Condensate Valves and Filter Pressure Bleed Valve to drain pressure. Leave Valves open.
- 3) Unscrew the Filter Canister Cap per the H.P. Compressor manual.
- 4) Remove expended Element from Filter Canister.
- 5) Slide new Element into Canister (**DO NOT drop in**) and reinstall Canister Cap.
- 6) Close Manual Condensate Valves and Filter Pressure Bleed Valve.



### Warning

Be sure that all pressure has been relieved from the system prior to opening any filtration canister. Failure to vent pressure from the system prior to opening the canister can lead to serious personal injury or death.

## 17.6 Spare Parts List

See L.P. and H.P. Compressor manuals for Compressor parts lists. Other Nitrox System components and related items are listed below.

<b><u>Nitrox System Components</u></b>	<b><u>Type</u></b>	<b><u>Part Number</u></b>
<b>L.P. Compressor Consumables</b>		
<b>Rotary Screw Compressor Lubricant, Food Grade, Nitrox Compatible</b>	<b>Nuvair 546, 1 Gal</b>	<b>9409</b>
<b>L.P. Filtration Element</b>	<b>Hankison HF7-20</b>	<b>E7-20</b>
	<b>Hankison HF5-20</b>	<b>E5-20</b>
	<b>Hankison HF1-20</b>	<b>E1-20</b>
<b>Oil Filter</b>	<b>Rotair</b>	<b>099-013-S</b>
<b>Air/Oil Separator</b>	<b>Rotair</b>	<b>157-170-S</b>
<b>Air Intake Filter</b>	<b>Rotair</b>	<b>162-578-S</b>
<b>H.P. Compressor Consumables</b>		
<b>H.P. Compressor Lubricant, Food Grade, Nitrox Compatible</b>	<b>Nuvair 455, 1 Gal</b>	<b>9406</b>
<b>H.P. Compressor Filtration Element</b>	<b>Breathing Air, Grade E</b>	<b>X65247</b>
<b>Optional Filter</b>	<b>Breathing Air, Grade E</b>	<b>X65677</b>
<b>Heater Assembly</b>	<b>1200 Watt, 28" Length</b>	<b>H1200.1</b>
<b>Heater Thermostat Control</b>	<b>110V/220V</b>	<b>TS-13021</b>
<b>Heater Pressure Switch</b>	<b>2pcs (redundant)</b>	<b>B16-947</b>
<b>Membrane</b>	<b>230 Series</b>	<b>PPA-230</b>
<b>Air Intake Filter Element</b>	<b>10 CFM</b>	<b>14</b>
<b>Analyzers</b>		
<b>Pro O<sub>2</sub></b>	<b>Analyzer</b>	<b>9460</b>
	<b>Replacement Sensor</b>	<b>9505</b>
<b>Pro O<sub>2</sub> Remote</b>	<b>Analyzer</b>	<b>9462</b>
	<b>Replacement Sensor</b>	<b>9506</b>
<b>Related Components</b>		
<b>Air/Nitrox Quality Analysis Kit</b>	<b>CGA Grade Required</b>	<b>Specify: (1) Single Use or (2) Program Use</b>

## 17.7 Service Record Log

[illegible]

## Appendix

### Supply and Breathing Air Specifications

All supply and breathing air must meet the following requirements of CGA G-7.1-1997. Supply air delivered to the Membrane System must be purified to meet Grade D or E quality, and periodic air quality testing to assure compliance is recommended. All breathing air for diving produced by the downstream Compressor must be purified to meet Grade E quality, and periodic air quality testing to assure compliance is mandatory.

Item	Grade D	Grade E
Oxygen	19.5-23.5%	20-22%
Carbon Dioxide (maximum)	1000 PPM	1000 PPM
Carbon Monoxide (maximum)	10 PPM	10 PPM
Hydrocarbons (maximum)	Not specified	25 PPM
Water Vapor (maximum)	Not specified	Not specified
Dew Point (maximum) (1)	Not specified	Not specified
Oil & Particles (maximum) (2)	5 mg/m3	5 mg/m3
Odor	None	None

Notes: (1) Dew Point of supply air must be >10°F (6°C) colder than coldest ambient air expected

(2) Supply air delivered to the Membrane System must contain <0.003 PPM Oil Vapor

All breathing Nitrox produced for diving must be purified to meet these same requirements, except for oxygen content. Nitrox oxygen content must measure within +/- 1% O<sub>2</sub> of the specified value of the mixture using a properly calibrated Oxygen Analyzer (i.e. Nitrox produced with a target content of 32% O<sub>2</sub> must measure in the range of 31-33% O<sub>2</sub>). Periodic air quality testing to assure compliance is mandatory.

### Filter Element Life Factors

Breathing air filter element life is typically rated by manufacturer based on an air temperature of 80°F at the filter inlet. Under normal operation this temperature is 12°F (5°C) warmer than the ambient air, resulting in an equivalent ambient temperature rating at 68°F (20°C).

To determine element life at a different ambient temperature, multiply the rated life by the life factor listed below:

Filter Temperature	Ambient Temperature	Filter Element Life Factor
53°F (12°C)	41°F (5°C)	2.6 x Life
62°F (17°C)	50°F (10°C)	1.8 x Life
71°F (23°C)	59°F (16°C)	1.35 x Life
<b>80°F (27°C)</b>	<b>68°F (20°C)</b>	<b>1 x Life</b>
89°F (32°C)	77°F (25°C)	0.8 x Life
96°F (36°C)	84°F (29°C)	0.55 x Life
105°F (41°C)	93°F (34°C)	0.45 x Life
114°F (46°C)	102°F (39°C)	0.35 x Life

**Material Safety Data Sheets**

**Nuvair™ 455 Premium Synthetic Food Grade Air/Nitrox Compressor Lubricant**

Effective Date: 03/19/2010

**I. Product Identification:**

Trade Name: ..... Nuvair 455  
 Chemical Name: ..... Polyalphaolefin  
 Chemical Family: ..... Synthetic hydrocarbons/Esters

**II. Components & Hazard Statement:**

**This product is non-hazardous.** This material is not considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

**III. Physical Data:**

Viscosity: ..... 100 cst. @40°C  
 Specific Gravity (Water = 1.0): ..... 0.85  
 Boiling Point: ..... N/A  
 Vapor Pressure: ..... Negligible  
 Appearance & Odor: ..... Clear – with Mild odor  
 Solubility in Water: ..... Negligible

**IV. Fire & Explosion Hazard Data:**

Flash point: ..... 464°F / 24°C/ COC  
 Autoignition Temperature: ..... Not Established  
 Flammability Limits: ..... Not Established  
 Extinguishing Media: ..... Dry Chemical; CO2 Foam; Water Spray  
 Special Fire Fighting Procedure: ..... Burning may produce irritating/noxious fumes. Firefighters should use NIOSH/MNSA approved self-contained breathing apparatus. Use water to cool fire-exposed containers to prevent pressure build-up.

**V. Reactivity Data:**

Stability: ..... This product is stable and will not react with water.  
 Materials to Avoid: ..... Avoid strong oxidizers  
 Hazardous Decomposition Products: ..... Carbon monoxide, Carbon dioxide

**VI. Health Information:**

Eye Contact: ..... Flush eyes with water for 15 minutes. Call physician if irritation develops.  
 Skin Contact: ..... Wash skin with soap and water.  
 Inhalation: ..... Remove to fresh air.  
 Ingestion: ..... First aid not normally required. If uncomfortable, call physician.

**VII. Health Hazard Data:**

Exposure Limit: ..... Not Applicable  
 Effects of Overexposure: ..... Low oral and dermal toxicity. Prolonged or repeated exposure may cause irritation, nausea, and vomiting.

**VIII. Employee Protection:**

For general personal hygiene, wash hands thoroughly after handling material. Avoid contact with skin and eyes. Chemical impervious gloves are not required, but may be recommended for prolonged exposure. Use in a well ventilated area.

**IX. Storage, Spill, & Disposal Procedures:**

Storage: ..... Store in clean, dry area.  
 Spills: ..... Use absorbent materials to soak up fluid.  
 Disposal: ..... Incinerate this product and all associated wastes in a licensed facility in accordance with Federal, state, and local regulations.

**X. Hazard Rating Information:**

NFPA      Health: ..... 0  
             Flammability: ..... 1  
             Reactivity: ..... 0  
             Personal Protection: ..... B

**This information contained herein is based on the data available to us and is believed to be true and accurate. Nuvair makes no warranty, expressed or implied, regarding the accuracy of this data or the results to be obtained from the use thereof. Nuvair assumes no responsibility for injury from the use of this product.**

# **Material Safety Data Sheet**

Nuvair™ 751 Premium Synthetic Diester Based Air/Nitrox Compressor Lubricant

Effective Date: 3/10/2010

Supersedes:

## **I. Product Identification:**

Trade Name: ..... Nuvair 751  
Chemical Name: ..... Diester  
Chemical Family: ..... Diester

## **II. Components & Hazard Statement:**

**This product is non-hazardous.** This material is not considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

## **III. Physical Data:**

Viscosity: ..... 146 cst. @40°C  
Specific Gravity (Water = 1.0): ..... 0.94  
Boiling Point: ..... Not determined  
Vapor Pressure: ..... Negligible  
Appearance & Odor: ..... Amber / Mild odor  
Solubility in Water: ..... Negligible  
Other Data: ..... Non-toxic USDA H-2 approved

## **IV. Fire & Explosion Hazard Data:**

Flash point: ..... 520°F / 271°C COC ASTM D-92  
Autoignition Temperature: ..... 765°F ASTM D-2155  
Flammability Limits: ..... Not Established  
Extinguishing Media: ..... Dry Chemical; CO2 Foam; Water Spray  
Special Fire Fighting Procedure: ..... Burning may produce irritating/noxious fumes. Firefighters should use NIOSH/MNSA approved self-contained breathing apparatus. Use water to cool fire-exposed containers to prevent pressure build-up.

## **V. Reactivity Data:**

Stability: ..... Stable under normal conditions.  
Materials to Avoid: ..... Incompatible with oxidizing agents.  
Hazardous Decomposition Products: ..... Carbon monoxide, Carbon dioxide

## **VI. Health Information:**

Eye Contact: ..... Flush eyes with water for 15 minutes. Call physician if irritation develops.  
Skin Contact: ..... Wash skin with soap and water.  
Inhalation: ..... Remove to fresh air.  
Ingestion: ..... First aid not normally required. If uncomfortable, call physician.

## **VII. Health Hazard Data:**

Exposure Limit: ..... Not Applicable  
Effects of Overexposure: ..... Low oral and dermal toxicity. Prolonged or repeated exposure may cause irritation, nausea, and vomiting.

## **VIII. Employee Protection:**

For general personal hygiene, wash hands thoroughly after handling material. Avoid contact with skin and eyes. Chemical impervious gloves are not required, but may be recommended for prolonged exposure. Use in a well ventilated area.

## **IX. Storage, Spill, & Disposal Procedures:**

Storage: ..... Store in clean, dry area.  
Spills: ..... Use absorbent materials to soak up fluid.  
Disposal: ..... Incinerate this product and all associated wastes in a licensed facility in accordance with Federal, state, and local regulations.

## **X. Hazard Rating Information:**

NFPA Health: ..... 0  
Flammability: ..... 1  
Reactivity: ..... 0  
Personal Protection: ..... B

This information contained herein is based on the data available to us and is believed to be true and accurate. Nuvair makes no warranty, expressed or implied, regarding the accuracy of this data or the results to be obtained from the use thereof. Nuvair assumes no responsibility for injury from the use of this product.

**Material Safety Data Sheet**

Nuvair™ 546 Premium Synthetic Food Grade Air/Nitrox Compressor Lubricant

Effective Date: 03/19/2010

Supersedes:

**I. Product Identification:**

Trade Name: ..... Nuvair 546  
 Chemical Name: ..... Polyalphaolefin  
 Chemical Family: ..... Synthetic hydrocarbon

**II. Components & Hazard Statement:**

**This product is non-hazardous.** This material is not considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200)

**III. Physical Data:**

Viscosity: ..... 46 cSt. @ 40°C  
 Specific Gravity (Water = 1.0): ..... 0.84  
 Boiling Point: ..... Not Determined  
 Vapor Pressure: ..... Negligible  
 Appearance & Odor: ..... Clear & odor Mild  
 Solubility in Water: ..... Negligible  
 Other Data: ..... Non-Toxic USDA H-1 Approved

**IV. Fire & Explosion Hazard Data:**

Flash point: ..... 500°F / 260°C  
 Autoignition Temperature: ..... Not Determined  
 Flammability Limits: ..... Not Determined  
 Extinguishing Media: ..... Dry Chemical; CO2 Foam; Water Spray  
 Special Fire Fighting Procedure: ..... Burning may produce irritating/noxious fumes. Firefighters should use NIOSH/MNSA approved self-contained breathing apparatus. Use water to cool fire-exposed containers to prevent pressure build-up.

**V. Reactivity Data:**

Stability: ..... Stable under normal conditions.  
 Materials to Avoid: ..... Incompatible with oxidizing agents.  
 Hazardous Decomposition Products: ..... Carbon monoxide, Carbon dioxide

**VI. Health Information:**

Eye Contact: ..... Flush eyes with water for 15 minutes. Call physician if irritation develops.  
 Skin Contact: ..... Wash skin with soap and water.  
 Inhalation: ..... Remove to fresh air.  
 Ingestion: ..... First aid not normally required. If uncomfortable, call physician.

**VII. Health Hazard Data:**

Exposure Limit: ..... Not Applicable  
 Effects of Overexposure: ..... Low oral and dermal toxicity. Prolonged or repeated exposure may cause irritation, nausea, and vomiting.

**VIII. Employee Protection:**

For general personal hygiene, wash hands thoroughly after handling material. Avoid contact with skin and eyes.  
 Chemical impervious gloves are not required, but may be recommended for prolonged exposure.  
 Use in a well ventilated area.

**IX. Storage, Spill, & Disposal Procedures:**

Storage: ..... Store in clean, dry area.  
 Spills: ..... Use absorbent materials to soak up fluid.  
 Disposal: ..... Incinerate this product and all associated wastes in a licensed facility in accordance with Federal, state, and local regulations.

**X. Hazard Rating Information:**

NFPA Health: ..... 0  
 Flammability: ..... 1  
 Reactivity: ..... 0  
 Personal Protection: ..... B

This information contained herein is based on the data available to us and is believed to be true and accurate. Nuvair makes no warranty, expressed or implied, regarding the accuracy of this data or the results to be obtained from the use thereof. Nuvair assumes no responsibility for injury from the use of this product.

**OWNER'S WARRANTY RESPONSIBILITIES**

Failure of the owner to prevent equipment damage by complying with the procedures outlined below and in the Operation Manual will void the Nitrox System warranty.

**Installation:**

- All set up requirements and procedures provided in the Nitrox System Operation Manual must be followed in their entirety including supply air cleanliness, Compressor preparation, and installation of the Nitrox System.
- Supply air to the Membrane must be properly filtered to CGA Grade D air quality or better to prevent damage to the Membrane. Air quality testing of the supply air should be performed periodically and documented to assure compliance.
- If there is any doubt regarding the suitability of a H.P. or L.P. Compressor for compressing Nitrox, contact Nuair or the Compressor manufacturer before you connect your Nitrox system.
- If an existing H.P. or L.P. Compressor is to be used for compressing Nitrox, all traces of the old lubricant must be removed and replaced with a Nitrox Compressor Lubricant approved by Nuair.
- Electrical wiring and connections should be made by a qualified electrician in accordance with all national and local electrical codes.
- Do not change the temperature setting on the Heater Thermostat Control. Changes in temperature settings may cause Membrane damage.
- To prevent Compressor damage, only use the Compressor Intake Hose provided. If a longer hose is required, contact Nuair for assistance.
- Compressors must be provided adequate ventilation to operate properly and prevent heat damage. This requires an ambient temperature below 100 °F (38 °C), sufficient clearance from adjacent walls, and proper rotation direction.

**Operation:**

- Do not use the Nitrox System to supply a H.P. or L.P. Compressor with Nitrox mixtures containing more than 40% oxygen. Compressing higher concentrations of oxygen may cause severe Compressor damage.
- Do not pump Nitrox mixtures at pressures above the Compressor manufacturer's rating, and never above 3600 P.S.I. (250 bar). Compressing Nitrox at higher pressures may cause severe H.P. Compressor damage.
- To prevent Membrane damage, drain all low pressure filter and volume tank condensate on a daily basis.
- If you become aware of an operational fault, stop using the equipment immediately and contact Nuair for assistance.

**Maintenance:**

- Change low pressure filter elements on a schedule determined by filter capacity and ambient temperature and humidity. Contact Nuair if you need assistance establishing a schedule for your equipment and location.
- Replace Membrane System Air Intake Filter on a regular basis to prevent flow obstruction.
- Keep all nuts, bolts, fittings, connectors, and clamps tight.
- Keep a service record book to show that regular maintenance work has been carried out. If a warranty claim becomes necessary, it will aid in demonstrating that damage has not been caused by insufficient maintenance. Proof of maintenance may be required prior to determining the validity of a warranty request.

**NUVAIR NITROX SYSTEM WARRANTY**

NUVAIR extends a limited warranty, which warrants the Nitrox System to be free from defects in materials and workmanship under normal use and service for a limited period. The specific Membrane Component of the Nitrox System is warranted according to the pro-rated terms as set forth below. All other Original Equipment Manufacturer (OEM) components used in the system are warranted only to the extent of the OEM's warranty to NUVAIR. NUVAIR makes no warranty with respect to these OEM components, and only warrants the workmanship that NUVAIR has employed in the installation or use of any OEM component. This warranty is not transferable.

NUVAIR will, at its discretion and according to the terms as set forth within, replace or repair any materials which fail under normal use and service and do not exhibit any signs of improper maintenance, misuse, accident, alteration, weather damage, tampering, or use for any other than the intended purpose. Determination of failure is the responsibility of NUVAIR, which will work together with the customer to adequately address warranty issues. When any materials are repaired or replaced during the warranty period, they are warranted only for the remainder of the original warranty period. This warranty shall be void and NUVAIR shall have no responsibility to repair or replace damaged materials resulting directly or indirectly from the use of repair or replacement parts not approved by NUVAIR.

**Pro-Rated Terms:**

NUVAIR warrants the Membrane Component of the Nitrox System to be free from defects in material and workmanship for a period of thirty-six (36) months from date of installation or forty-two (42) months from date of shipment by NUVAIR, whichever may occur first. The warranty covers parts only and is prorated as follows:

- First Year      Repair or replacement free of charge
- Second Year    Warranty allowance of 70% of the current Membrane Component list price
- Third Year      Warranty allowance of 40% of the current Membrane Component list price

A warranty registration card, supplied with system documentation, must be filled out and submitted to NUVAIR for the warranty to be in full effect. If the warranty registration card is not received within thirty (30) days of installation, the thirty-six (36) month warranty will begin with the date of shipment from NUVAIR. For warranty service to be considered, customer's account must be current or paid in full.

**Maintenance Items:**

Any materials which are consumed, or otherwise rendered not warrantable due to processes applied to them, are considered expendable and are not covered under the terms of this policy. This includes maintenance and consumable items listed as part of a suggested maintenance program included with system documentation.

**Return Policy:**

Application for warranty service can be made by contacting NUVAIR during regular business hours and requesting a Return Material Authorization number. Materials that are found to be defective must be shipped, freight pre-paid, to the NUVAIR office in Oxnard, California. Upon inspection and determination of failure, NUVAIR shall exercise its options under the terms of this policy. Warranty serviced materials will be returned to the customer via NUVAIR's preferred shipping method, at NUVAIR's expense. Any expedited return shipping arrangements to be made at customer's expense must be specified in advance.

**Limitation of Warranty and Liability:**

Repair, replacement or refund in the manner and within the time provided shall constitute NUVAIR'S sole liability and the Purchaser's exclusive remedy resulting from any nonconformity or defect. NUVAIR shall not in any event be liable for any damages, whether based on contract, warranty, negligence, strict liability or otherwise, including without limitation any consequential, incidental or special damages, arising with respect to the equipment or its failure to operate, even if NUVAIR has been advised of the possibility thereof. NUVAIR makes no other warranty or representation of any kind, except that of title, and all other warranties, express or implied, including warranties of merchantability and fitness for a particular purpose, are hereby expressly disclaimed. No salesman or other representative of NUVAIR has authority to make any warranties.

**Additional Record of Changes**

It is the responsibility of the owner of this product to register their ownership with Nuvair by sending the warranty card provided to Nuvair. This card is to establish registration for any necessary warranty work and as a means of communication that allows Nuvair to contact the user regarding this product.

The user must notify Nuvair of any change of address by the user or sale of the product. All changes or revisions to this manual must be recorded in this document to ensure that the manual is up to date.

<b>Change Date</b>	<b>Description of Change</b>
<b>04/2013</b>	<b>New pictures from new design in cabinet inserted in this manual</b>
<b>04/2013</b>	<b>Updated warnings and cautions throughout manual</b>
<b>07/2013</b>	<b>Updated Full Load Amp data</b>
<b>03/2014</b>	<b>Update Contact Info</b>
<b>3/2015</b>	<b>Update Spare Parts</b>

**NOTES:**



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*Revision 03.15*