



Operation Manual

**LP 280**  
**Nitrox Generator™**

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## **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 for information.

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### Separate Manuals Included:

Nuvair Pro O2™ Oxygen Analyzer Operation Manual

Gardner Denver FX-Classic Rotary Screw Compressor Operation & Maintenance Instructions

## **1.0 Introduction**

This manual will assist you in the proper set-up, operation and maintenance of the Nuvair LP 280 Nitrox Generator™. 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**

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.



### **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 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.**



**WARNING**

**Some compressors are not suitable for compressing oxygen-rich air, i.e., nitrox. Use of an unsuitable compressor may lead to possible compressor damage and/or fires or explosion. This can lead to serious personal injury or death. If there is any doubt regarding the use of an existing compressor, contact Nuair or the compressor manufacturer before you connect your Membrane System to your machinery.**



**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.**

### **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, nor direct air stream at body, because 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 Membrane 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 LP 280 Nitrox Generator™ is a turnkey package that produces oxygen-rich air (Nitrox) for delivery to the intake of a separate High Pressure (HP) Compressor. This HP Compressor then compresses the Nitrox to fill Scuba Cylinders or Storage Tanks. Although it is described as the “Nitrox Compressor”, it is also used to pump air.

The Nitrox System allows for efficient and cost effective Nitrox production 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. This Nitrox mixture can be pumped up to a maximum pressure of 3600 P.S.I. (250 bar) when filling Scuba Cylinders or Storage Tank.

The Nitrox System uses an LP Rotary Screw Compressor, Air Aftercooler, Volume Tank, and Filtration to provide the Membrane System with a source of clean, pressurized air for separation. The air is filtered to CGA Grade D 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 LP280 Membrane System is rated for a maximum supply pressure of 300 P.S.I. (20 bar) and works well with the 190PSI (13 bar) maximum pressure from the Rotary Screw Compressor. An Input Pressure Regulator reduces these pressures to appropriate levels for 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 provides protection to the membrane from condensate.

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 an 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 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 Nitrox 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 Input Pressure Regulator. As pressure is increased, permeate flow increases, air flow decreases, and a higher %O<sub>2</sub> Nitrox is produced. As pressure is decreased, permeate flow decreases, air flow increases, and a lower %O<sub>2</sub> Nitrox is produced. This relationship between permeate flow and air flow exists because the total of these two flow rates will always equal the intake flow rate demanded by the Nitrox Compressor. The resulting Nitrox mixture is analyzed for %O<sub>2</sub> before entering the Nitrox Compressor for approximate content and again when pumping Nitrox for precise content.

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



## **6.0 Low Pressure Rotary Screw Compressor Technical Data**

### Capacity and Power Consumption:

- ◆ Normal working pressure – 175 P.S.I. (12 bar)
- ◆ Capacity at normal working pressure – 26 cfm (0.74 m<sup>3</sup>/min)
- ◆ Shaft power at normal working pressure – 10.2 hp (7.65 kW)
- ◆ Maximum working pressure – 190 P.S.I. (13 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)
- ◆ Compressed air temperature above cooling medium temperature – 50°F (10°C)
- ◆ Cooling air flow – 635 cfm (0.3 m<sup>3</sup>/s)
- ◆ Maximum cooling air pressure drop – 0.12 in H<sub>2</sub>O (30 Pa)
- ◆ Cooling air temperature rise – 64°F (18°C)
- ◆ Oil cooler heat rejection – 324 BTU/min (5.7 kW)
- ◆ Aftercooler heat rejection – 40 BTU/min (0.7 kW)

### Motor and Electrical Values:

- ◆ Motor - F class, IP55, 10hp (7.5 kW)
- ◆ Speed of rotation – 2920 rpm
- ◆ Fuse (max) – 25 A
- ◆ Compressor current – 16 A at 380 V / 50 Hz
- ◆ Control voltage – 230 V

### General Technical Data:

- ◆ Oil Quantity – 1.6 gal (6 liters)
- ◆ Oil Content – 3 mg/m<sup>3</sup>
- ◆ Noise level (Cagi Pneurop) - 71dB
- ◆ Compressor weight – 342 lb (155 kg)

## **7.0 System Components**

- Low Pressure Rotary Screw Compressor
- Nuvair 546™ Food Grade Rotary Screw Compressor Lubricant
- Low Pressure Volume Tank – 60 Gallon Vertical Mount standard, other configurations available
- On/Off Flow Valve
- Input Low Pressure>Low Pressure Regulator with Pressure Gauge:
  - ◆ Pressure Input to Regulator 165-189 P.S.I. (11-13 bar)
  - ◆ Output Pressure from Regulator 80-165 P.S.I. (4-11 bar) depending on HP Compressor size and Nitrox %O<sub>2</sub>
- Low Pressure Filtration, Grade D Breathing Air, including three stages:
  - ◆ Coalescing & Particle Removal to 1 micron, auto drain, differential pressure indicator
  - ◆ Water & Oil Vapor Removal to 0.01 micron, auto drain, differential pressure indicator
  - ◆ Oil Vapor Removal to 0.003 PPM, manual drain
- Heater including:
  - ◆ Thermostat Control
  - ◆ Digital Temperature Gauge
  - ◆ Pressure Switch
- Semi-Permeable Membrane – compatible with HP Compressors rated up to 10 cfm (283 L/min)
- Mixing Tube & Air Intake Filter
- Nuvair Pro O<sub>2</sub> Remote™ Panel Mount Inline Oxygen Analyzer
- Compressor Intake Hose for Nitrox Compressor
- Nitrogen Discharge Hose (optional)
- Nuvair Pro O<sub>2</sub>™ Fill Oxygen Analyzer, including:
  - ◆ High Pressure>Low Pressure Regulator
  - ◆ Flow Restrictor, 1 - 5 L/min
- Nitrox Compressor Lubricant:
  - ◆ Nuvair 455™ Food Grade Lubricant (standard)
  - ◆ Nuvair 751™ Diester Based Lubricant (optional)
- Air/Nitrox Quality Analysis Kit

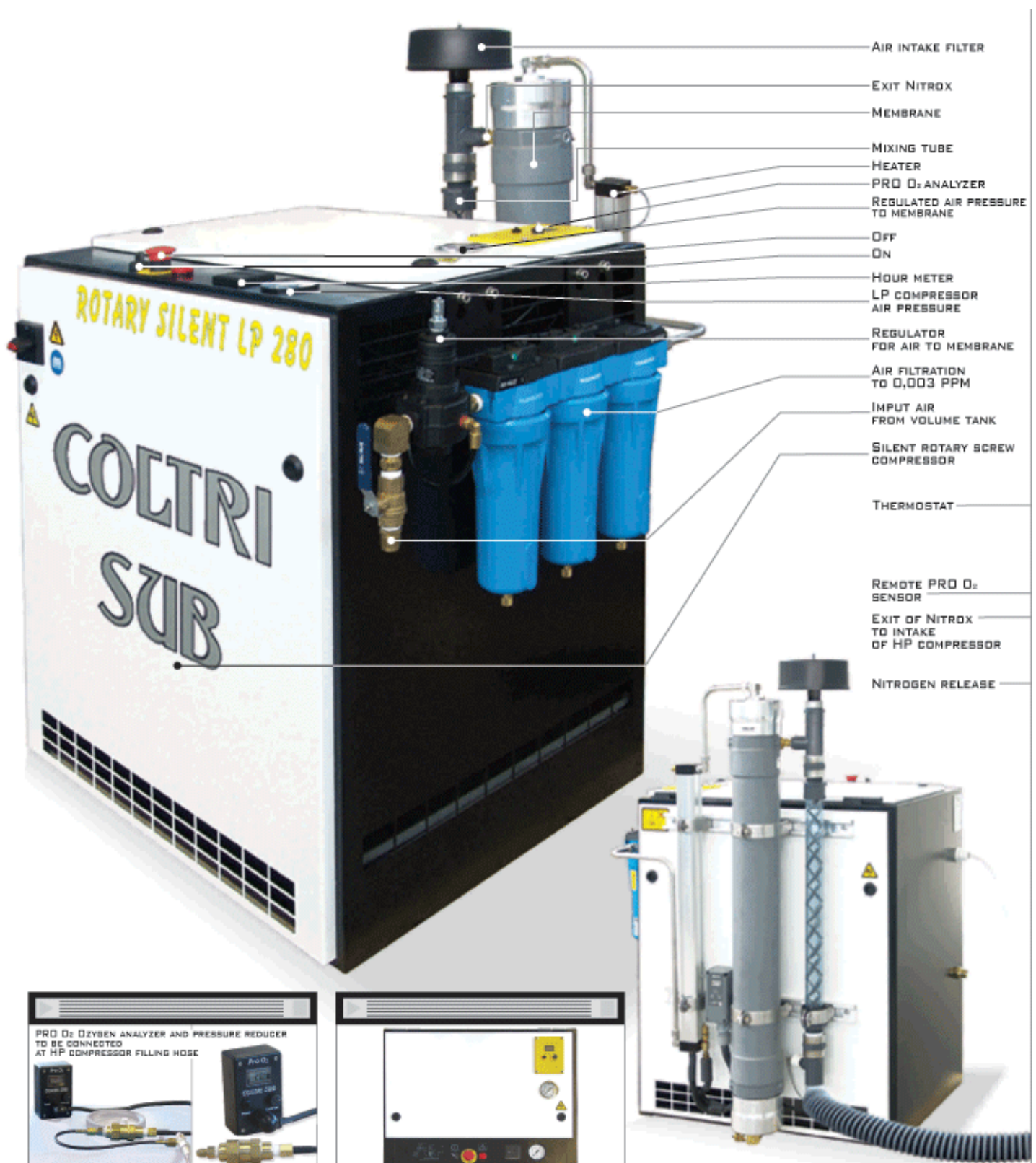
## 8.0 Nitrox System Specifications

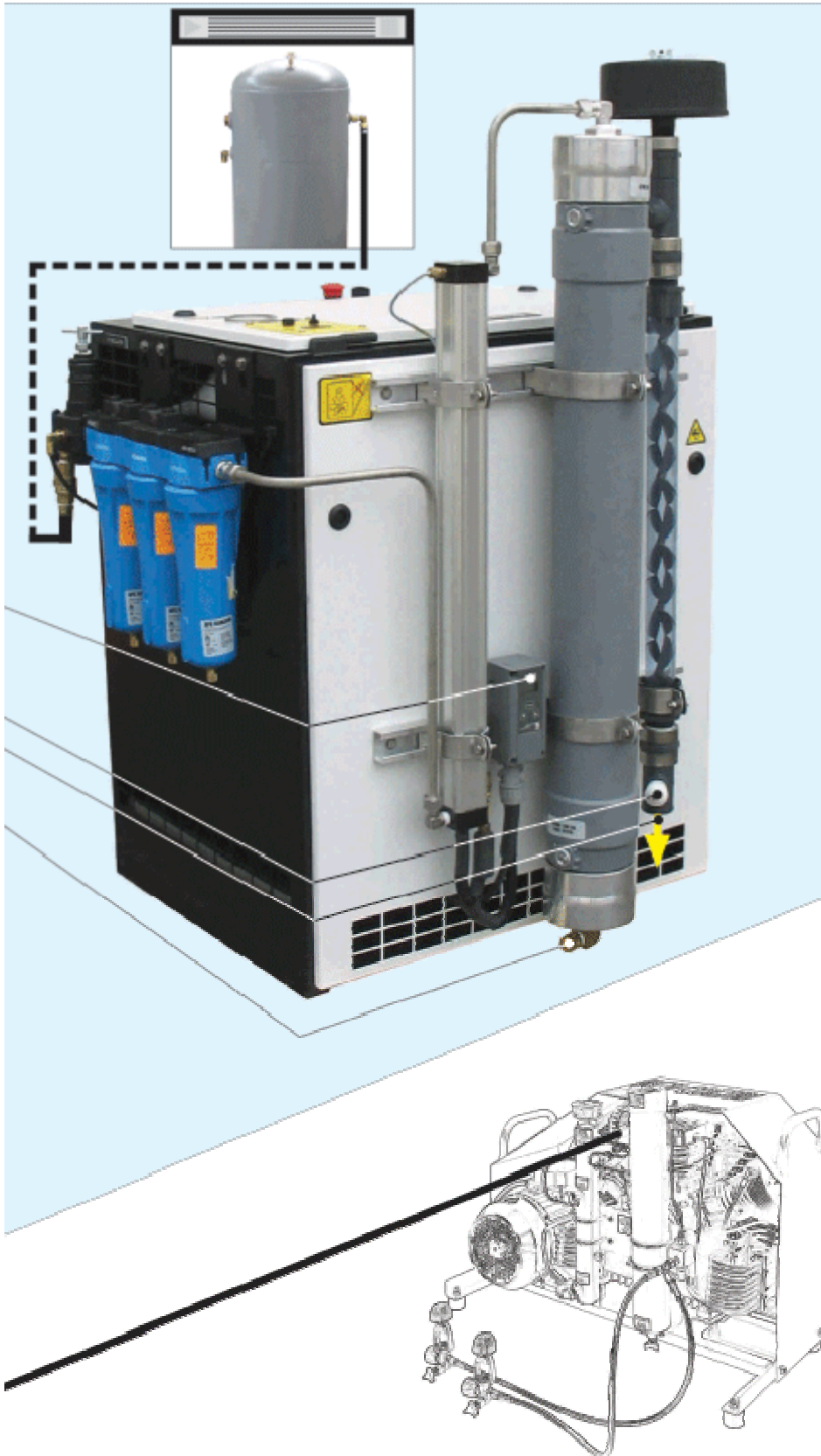
Nuvair Nitrox Generator Model		LP 280 50 Hz	LP 280 60 Hz
Physical Specifications	Height	47 in (1194 mm)	47 in (1194 mm)
	Width	34 in (833 mm)	34 in (833 mm)
	Depth	30.5 in (775 mm)	30.5 in (775 mm)
	Weight	530 lb (240 kg)	530 lb (240 kg)
Full Load Amps	Total Requirement for LP Compressor & Membrane Heater	21 A @ 380 VAC, 37 A @ 220 VAC, 50 Hz	37 A @ 220 VAC, 60 Hz
Membrane Input	Operating Pressure Range	90-165 psi (6-11 bar)	90-165 psi (6-11 bar)
	Maximum Input Pressure	300 psi (21 bar)	300 psi (21 bar)
	Supply Air Volume Range	8-26 scfm (212-736 L/min)	8-26 scfm (212-736 L/min)
	LP Supply Air Quality	Grade D	Grade D
	Optimum Temperature	110 +/- 5°F (43 +/- 3°C)	110 +/- 5°F (43 +/- 3°C)
	Nitrox %O <sub>2</sub> Range	24 - 40%	24 - 40%

### Nitrox Compressor Recommendations

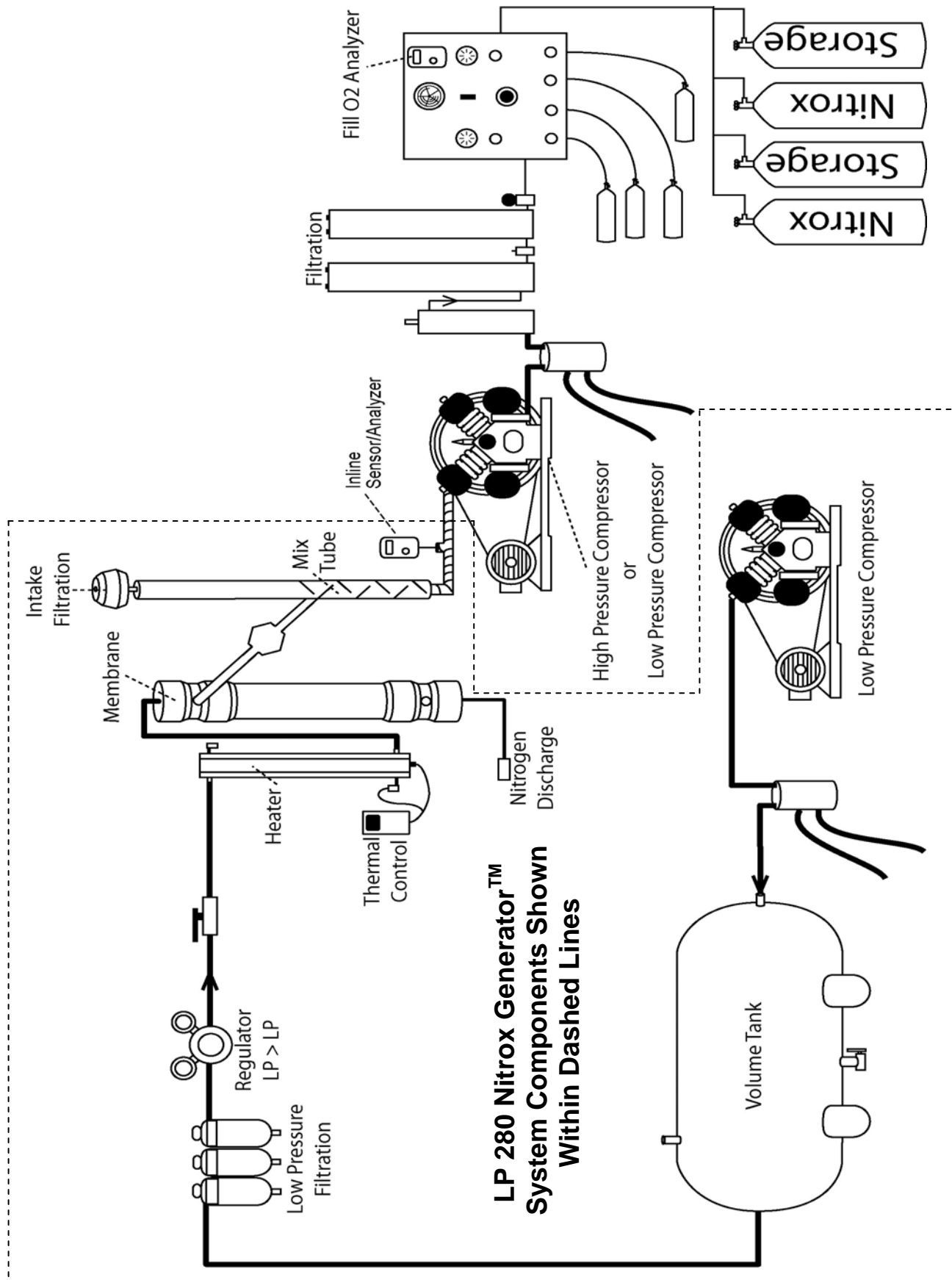
		To Pump Nitrox up to 40%O <sub>2</sub>	To Pump Nitrox up to 36%O <sub>2</sub>	To Pump Nitrox up to 32%O <sub>2</sub>
HP Nitrox Compressors	Charging Rate	6-10 scfm (170-280 L/min)	6-14 scfm (170-400 L/min)	6-18 scfm (170-510 L/min)
	Horsepower – Electric	5-7.5 hp (3.8-5.5 kW)	5-15 hp (3.8-7.5 kW)	5-20 hp (3.8-15 kW)
	Horsepower – Gas	6.5-11 hp (4.9-8.3 kW)	6.5-18 hp (4.9-14 kW)	6.5-24 hp (4.9-16 kW)
	Horsepower – Diesel	9-10 hp (6.8-7.5 kW)	9-18 hp (6.8-14 kW)	9-27 hp (6.8-20 kW)

## 9.0 Component Identification

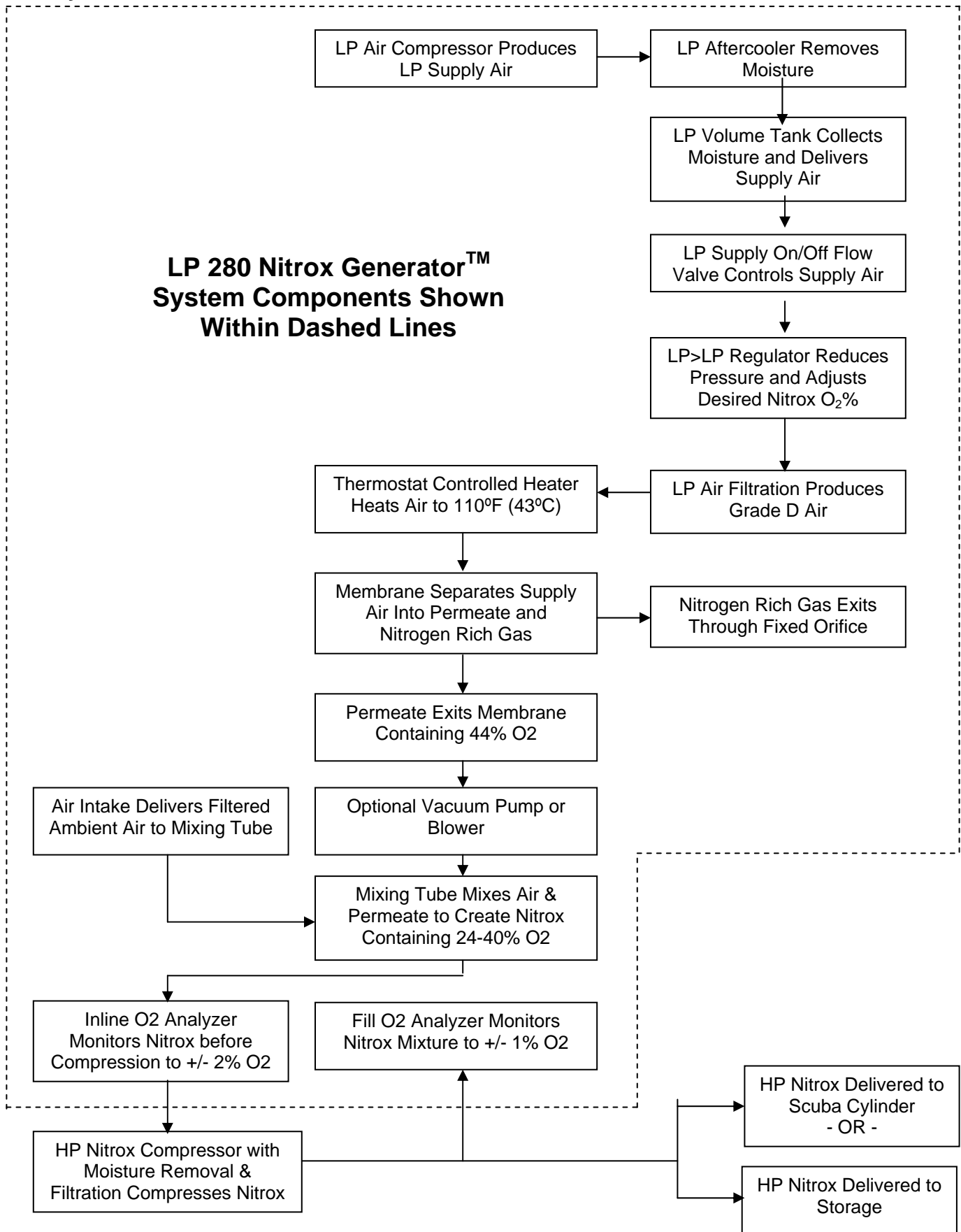




# 10.0 System Drawing / Schematic



## 11.0 System Flow Chart



## 12.0 Preparing Existing HP Compressors



### WARNING

Some compressors are not suitable for compressing oxygen-rich air, i.e., nitrox. Use of an unsuitable compressor may lead to possible compressor damage and/or fires or explosion. This can lead to serious personal injury or death. If there is any doubt regarding the use of an existing compressor, contact Nuvair or the compressor manufacturer before you connect your Nitrox System to your machinery.

### 12.1 Purification System

The purification system on the existing HP Compressor to which the Nitrox System will be installed must produce Grade E breathing air appropriate for diving use. This is the same standard applied to all breathing air compressors. Please make sure you place extra caution on timely replacement of the filters in the purification system to ensure these standards at all times. Specifications for Grade E air are provided in the Appendix.

A recent air quality test from your existing Compressor is highly recommended prior to installing the Nitrox System. After installation, test a Nitrox sample using the Air/Nitrox Quality Analysis Kit provided. Quarterly testing is mandatory once the System is operational.



### CAUTION

**Breathing air compressors must produce breathing air appropriate for diving use in accordance with the appropriate CGA Grade. Periodic air quality testing is mandatory to assure compliance.**

### 12.2 Replacement of Compressor Lubricant

For an existing Compressor to be used with the Membrane System, all traces of old Lubricant must be removed and replaced with Nitrox Compressor Lubricant. Nitrox Compressor Lubricant is compatible with both air and Nitrox.

- 1) Start Compressor and run for 10 minutes to warm Compressor Lubricant. Shut off Compressor, remove Lubricant, and replace Lubricant Filter if any.
- 2) Refill Compressor with the Nuvair Air/Nitrox Compressor Lubricant supplied. Do not overfill.
- 3) After 10 hours, repeat Steps 1 and 2.



Nuvair™ 455  
Food Grade Air &  
Nitrox Compressor  
Lubricant (Standard)



Nuvair™ 751  
Diester Based Air &  
Nitrox Compressor  
Lubricant (Optional)



### CAUTION

**After running the compressor, the lubricant will be very hot. Take care when removing the drain plug and draining the lubricant to avoid burns.**





## NOTICE

**Recommended Nitrox Compressor Lubricant change intervals after the 10-hour flush are at 25, 50, and 100 hours. After reaching 100 hrs, change lubricant in 100 hour cycles.**



## CAUTION

**Wear gloves when handling compressor lubricant. If contact with skin is made, wash the skin surface with soap and water.**



## CAUTION

**Always wear goggles when handling compressor lubricant. These materials can cause eye irritation. If you accidentally get lubricant into your eyes, flush with fresh water for 15 minutes and contact a physician if irritation develops.**



## CAUTION

**Compressor lubricant should be incinerated after use in a licensed facility in accordance with Federal, State, and local regulations.**

### 12.3 Installation of Fill Oxygen Analyzer

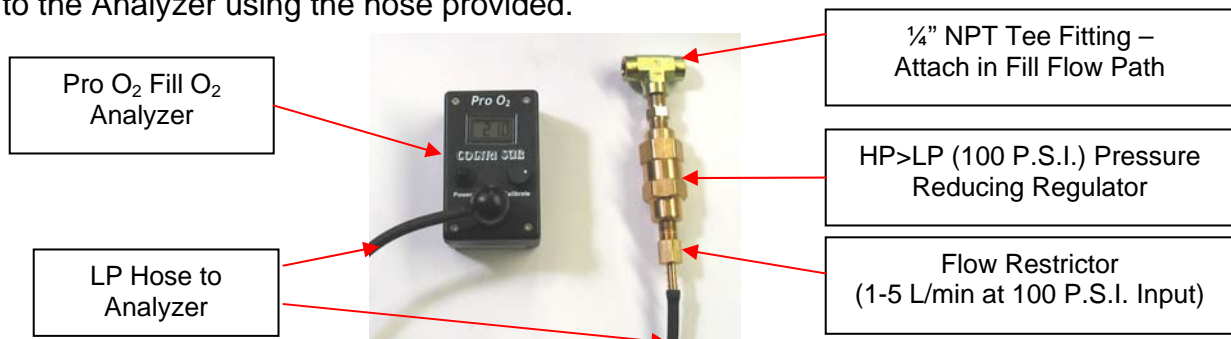
The Fill Oxygen Analyzer is installed at the final nitrox outlet (compressor fill whip, Fill Panel, etc.) to monitor oxygen content. A sample stream of nitrox is delivered to the analyzer to provide accurate results and prevent damage to the analyzer. A regulator and flow restrictor are used to control the pressure and flow of the sample stream. After installation, always use the Fill Oxygen Analyzer when pumping either nitrox or air to ensure proper oxygen content.



## WARNING

**Never expose the Oxygen Analyzer Sensor to pressure or you may cause damage and/or false readings. Damaged sensors will not provide accurate gas analysis. Inaccurate gas analysis can lead to serious personal injury or death.**

The Nitrox sample stream is obtained at the Fill Whip location on the Compressor or Fill Panel. Tap into the Fill Whip manifold or install a HP "T" fitting, then attach the inlet of the Regulator/Flow Restrictor Assembly using HP hose and fittings as required (hose and fittings not included). Mount the Fill Oxygen Analyzer in a secure location, then attach the outlet of the Regulator/Flow Restrictor Assembly to the Analyzer using the hose provided.



## 13.0 Installing the Nitrox System



### NOTICE

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



### CAUTION

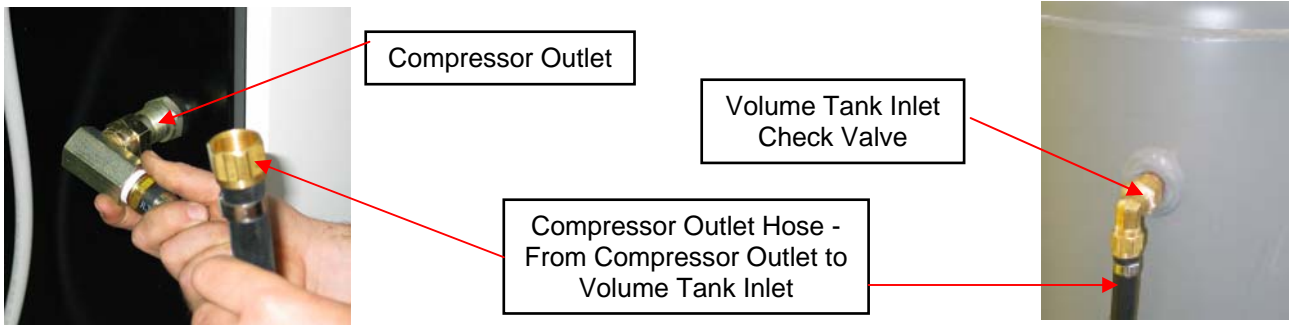
**Ambient room temperature should never exceed 100°F (38°C) during operation of the Nitrox System. Operation at higher temperatures may lead to system damage and malfunction. A damaged membrane will not produce the correct nitrox mixture which can lead to severe personal injury if the gas is used for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

### 13.1 Precautions

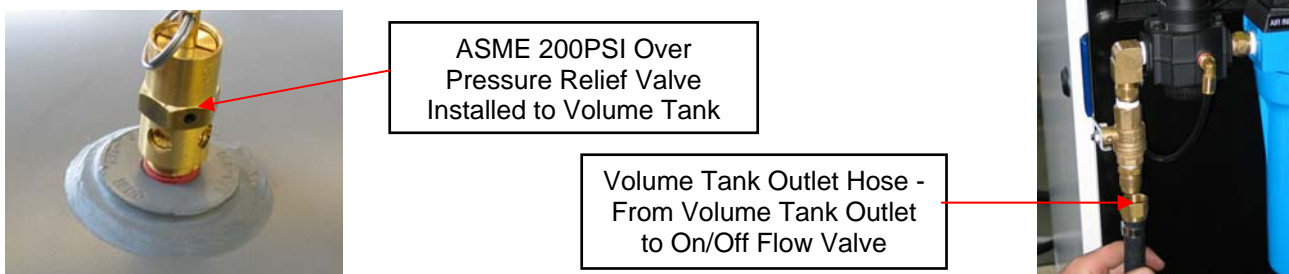
- 1) Please read all information supplied before physically installing the Nitrox System.
- 2) Unpack the system and remove from the pallet. Visually inspect the system to make sure there has been no damage during shipping. If damaged, please call Nuvair to file a damage report. Please take photos and supply detailed information about the damage.
- 3) Place the system in a permanent location near the existing HP Compressor. Allow 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.
- 5) A 13 foot corrugated Compressor Intake Hose has been provided to connect the Nitrox System to the HP Compressor intake. If a longer hose is required, the diameter must also be increased. Contact Nuvair for assistance.

### 13.2 Attaching the Air Supply

- 1) Attach Compressor Outlet Hose to the LP Compressor outlet and the LP Volume Tank inlet. The connection going into the Volume Tank has a one way check valve.



- 2) Attach Volume Tank Outlet Hose to Tank outlet and Membrane System On/Off Flow Valve.
- 3) Install the Volume Tank Over Pressure Relief Valve.



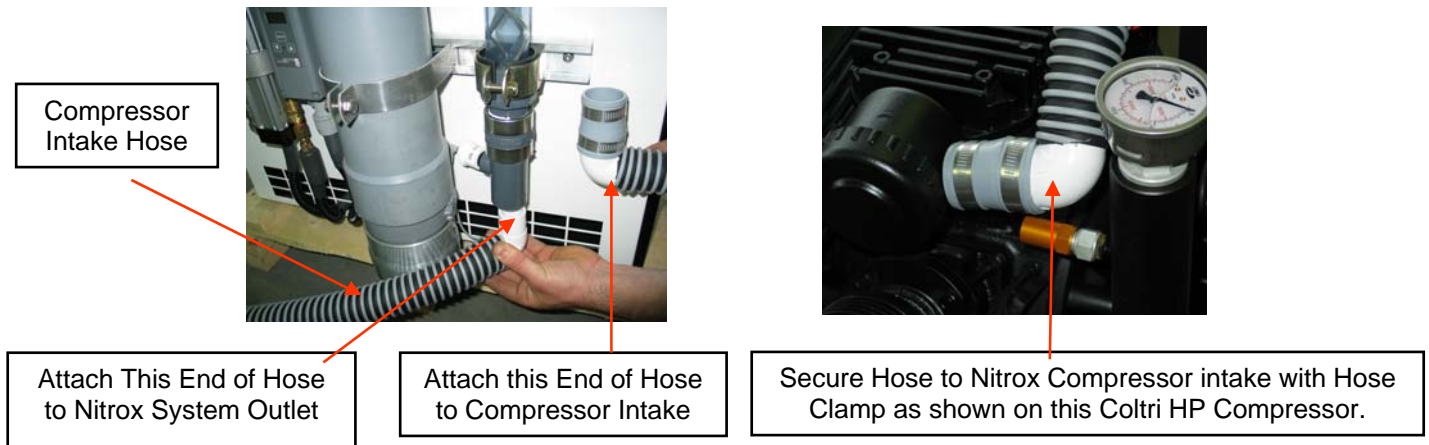
### 13.3 Attaching Compressor Intake Hose



#### WARNING

**Do not substitute a compressor intake hose of a smaller diameter or longer length than that supplied. This will increase the amount of suction the compressor must generate which can cause overheating and damage to the compressor. Damaged compressors can pump impurities into the diver's breathing gas. This may cause serious injury or death.**

- 1) Cut the Intake Hose to proper length to reach between the Nitrox System and HP Compressor. Reattach end fittings
- 2) Attach the Intake Hose to the Nitrox System outlet.
- 3) Attach the other end of the Intake Hose to the intake of the Nitrox Compressor and secure with the hose clamp provided.



### 13.4 Attaching Nitrogen Discharge Hose (Optional)

The nitrogen discharge from the Membrane must be isolated from the air intakes of the Membrane System and LP Compressor. This requirement will be met if the Nitrox System is installed in a well-ventilated room that meets industry standards for Compressor installations. If the Nitrox System is installed in a closed building, boat, or similar enclosed space, the nitrogen discharge must be vented to the outside. An optional Nitrogen Discharge Hose may be needed. If your installation requires the use of a Nitrogen Discharge Hose, please contact Nuair for assistance.



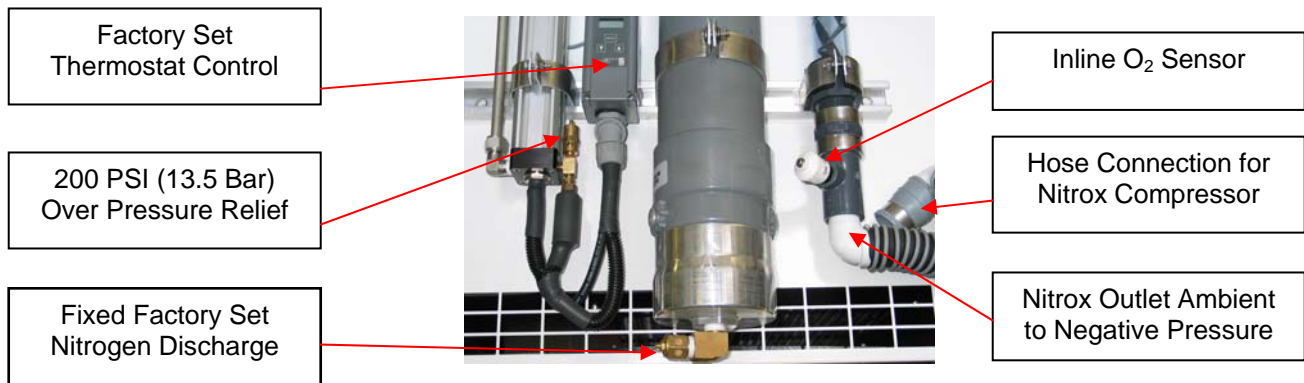
#### DANGER

**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 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 LP 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.**

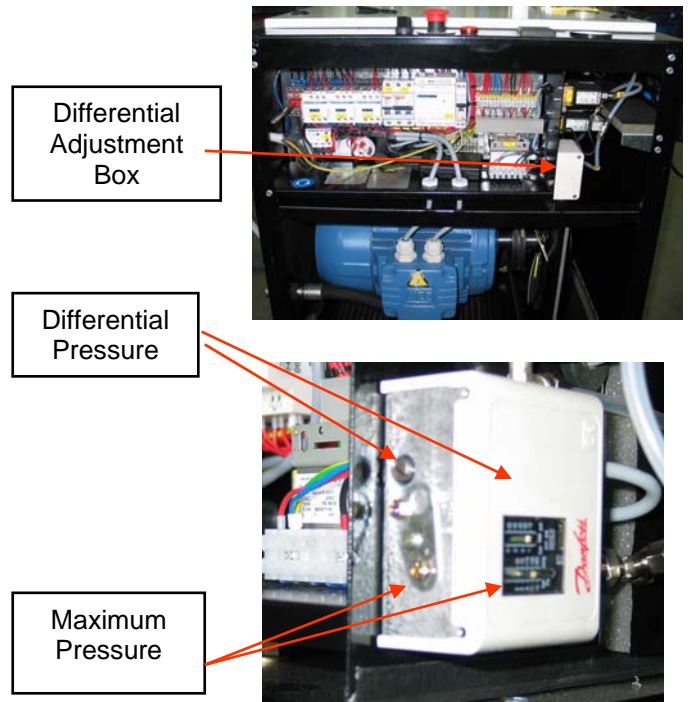


### 13.5 Output Pressure Adjustments

The LP Compressor pressure output has been factory set to pump up to 180 +/-5 P.S.I. (12.5 bar) and then go idle until the pressure drops down to a low pressure of approximately 165 P.S.I. (11 bar). This cycle is known as the compressor differential pressure.

This output setting allows the system to be used with a HP Compressor having a rated capacity up to 10 cfm (283 l/m). If your HP Compressor is smaller, the inlet pressures required for the Membrane System may be lower. It will then be beneficial to lower the compressor differential pressure accordingly. The low side pressure must always be at least 5 P.S.I. (0.3 bar) higher than the Membrane inlet pressure necessary to produce Nitrox with 40% O<sub>2</sub>.

Follow the directions in your LP Compressor manual to make this adjustment.



### 13.6 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.**

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.

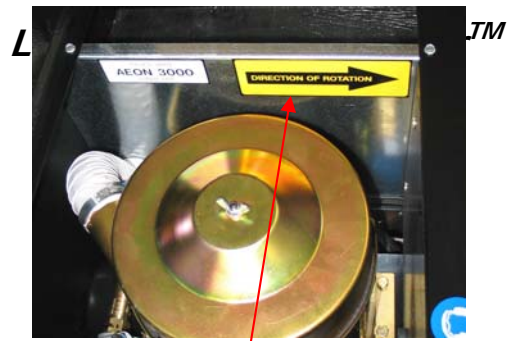


### Amperage Load for System

- ♦ Approximately 37 A for 220 V three phase service
- ♦ Approximately 21 A for 380 V three phase service

### LP Compressor Rotation Check

Always turn on (bump) starter and run motor very briefly to check for proper direction of rotation (see arrow above pulley).



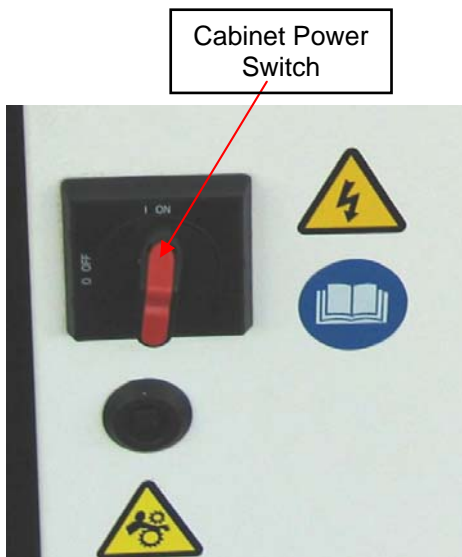
**CAUTION**

Note Proper  
Direction of Rotation

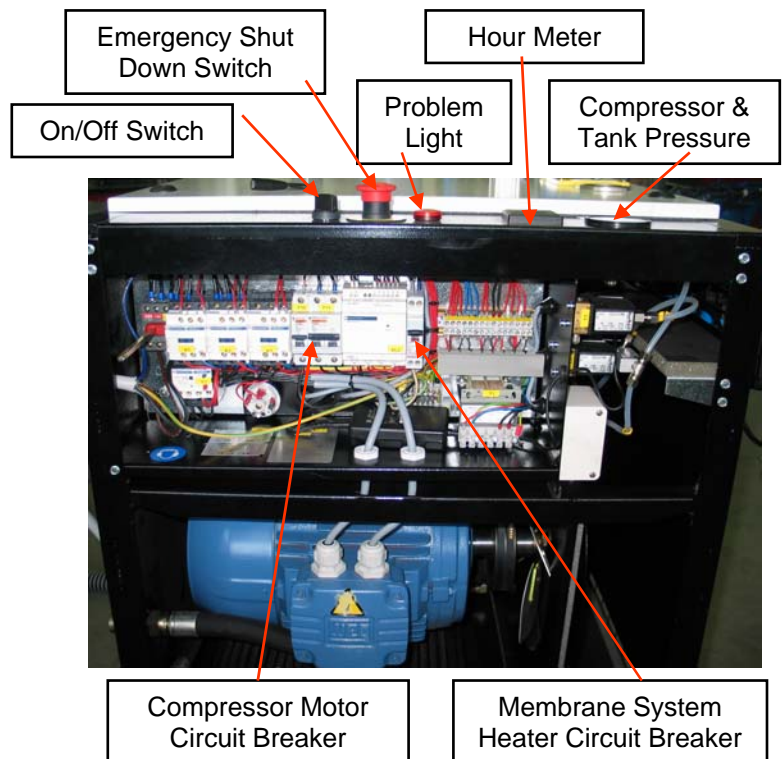
**Operation in reverse direction for even a short period of time will damage a Rotary Screw Compressor.**

The Cabinet Power Switch must be in the Off position to remove the front panel of the Compressor. This Switch terminates power to the Compressor and electrical panel. Store the compressor with this switch in the Off position. When working on the Compressor the main breaker at the power source must also be "locked out" in the Off position. The Nitrox System has circuit breaker protection for the Compressor Motor and Membrane System Heater located behind the front panel.

### 50 Hz Model Shown



Cabinet Power  
Switch



Emergency Shut  
Down Switch

Hour Meter

On/Off Switch

Problem  
Light

Compressor &  
Tank Pressure

Compressor Motor  
Circuit Breaker

Membrane System  
Heater Circuit Breaker

## 13.7 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.

Air/Nitrox Quality  
Analysis Kit



## 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 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 from 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 LP and HP Compressors, and add lubricant as required. Use only the lubricants specified.

50 Hz Model Shown

Check LP  
Compressor  
Oil Level



### 14.2 Membrane System Regulator and Flow Valve

A LP>LP Regulator is used to reduce supply pressure to the Membrane System to a typical range of 90 – 165 P.S.I. (6-11 bar) An On/Off Flow Valve is used to control the flow of LP supply air into the Membrane System. Prepare the Membrane System as follows:

- 1) Reduce input pressure to minimum pressure setting by turning the Regulator adjustment knob counter-clockwise (CCW) until it spins freely.
- 2) Turn Regulator knob clockwise (CW) until you first feel resistance, which means that the spring is starting to compress.
- 3) Make sure the LP Supply Air On/Off Flow Valve is in the Off position.

LP>LP Regulator  
Adjustment Knob

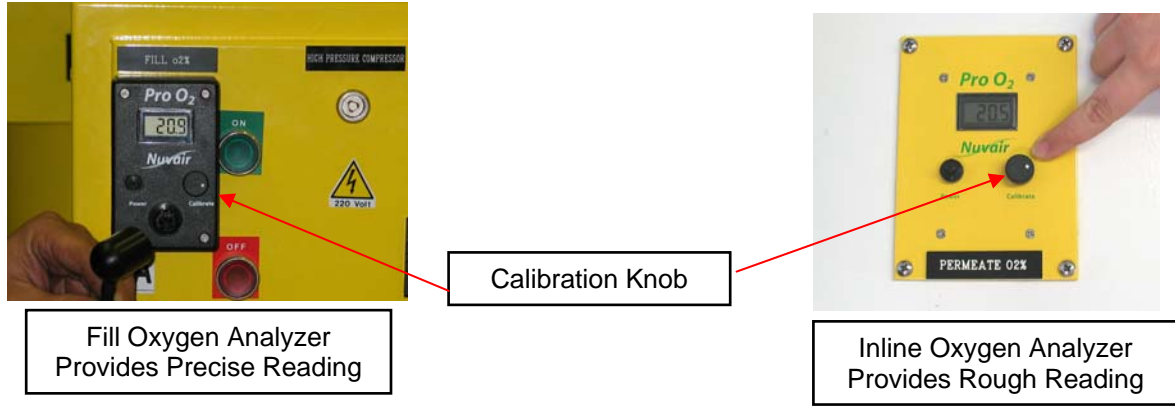


On/Off Flow Valve  
Handle in Off Position



### 14.3 Oxygen Analyzer Calibration

Gas production may be monitored with the Inline Oxygen Analyzer before entering the Nitrox 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 Nitrox 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.

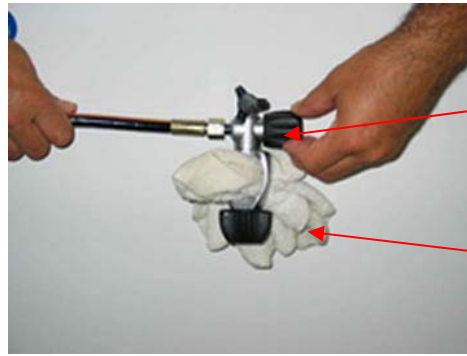


#### WARNING

The Inline 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) Close Membrane System On/Off Flow Valve and return LP>LP Regulator to minimum pressure setting by turning adjustment knob CCW until it spins freely.
- 2) Slightly open fill whip valve on HP Nitrox Compressor to relieve any residual pressure, and then, if desired, insert clean rag in yoke to act as sound muffler.
- 3) Turn on HP Nitrox Compressor according to manufacturer's instructions.
- 4) Adjust fill whip valve so the running Compressor maintains 1500-2000 P.S.I. outlet pressure. Air will now be flowing past both Oxygen Analyzers for calibration purposes.



Adjust Fill Whip Valve to Maintain Pressure

Insert Clean Rag in Fill Whip Yoke

Optional Sound Muffler for HP Nitrox Compressor

- 5) Monitor all gauges for proper operating range and check all connections for leaks.
  - 6) Calibrate Oxygen Analyzers while the Nitrox 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.
- ◆ Inline 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.



Sensor Cap Removed

Calibration Knob

## 14.4 Attaching Scuba Cylinder



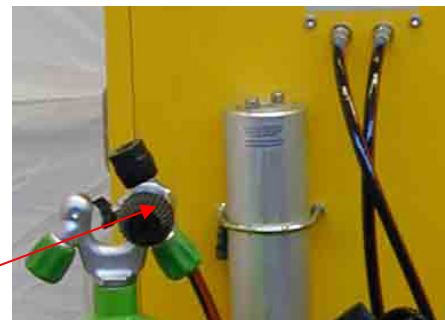
### NOTICE

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

Attach one HP 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.

Fill Whip Attached to Scuba Cylinder





## 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.
- 2) Turn on LP Compressor using On/Off Switch and allow Volume Tank to come up to full pressure of approximately 180 +/-5 P.S.I. The Compressor rpm will then increase, indicating that the Compressor is unloading.
- 3) Turn on your HP Compressor. Allow outlet pressure to build up to approximately 2300 P.S.I., then crack open the unconnected fill whip to maintain 1500-2300 P.S.I.
- 4) Verify that Inline Oxygen Analyzer reads 20.9%.
- 5) Turn on Membrane System by slowly opening the Flow Valve.
- 6) Adjust input pressure to approximately 100 P.S.I to activate Heater Pressure Switch. Increase pressure by slowly turning the Regulator Knob CW or decrease pressure by turning the Knob CCW.
- 7) Verify that Heater Thermostat Control green indicator light is on. The light will remain on until operating temperature is reached and will then cycle on and off. When light turns off, check Heater Temperature Gauge to verify air temperature is between 105-120 °F (40-49 °C). Temperature is preset at the factory and changes to the Thermostat Control should not be required.



Heater Temperature Gauge

Heater Thermostat Control



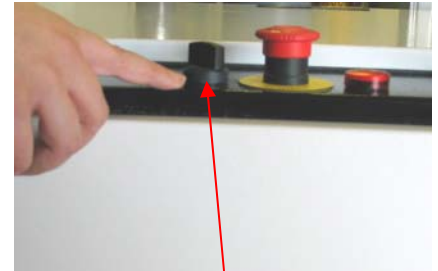
### CAUTION

The On/Off Flow Valve on the Membrane System must be opened slowly. A sudden rush of gas can damage the Membrane and other system components. 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.

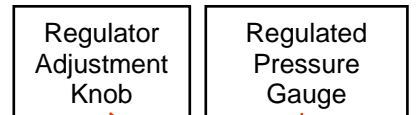


### NOTICE

The Heater Thermostat Control green indicator light will stay on until operating temperature is reached.

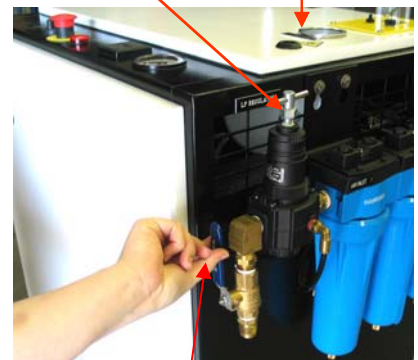


LP Compressor On/Off Switch



Regulator Adjustment Knob

Regulated Pressure Gauge



On/Off Flow Valve Handle in Open Position



## CAUTION

**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

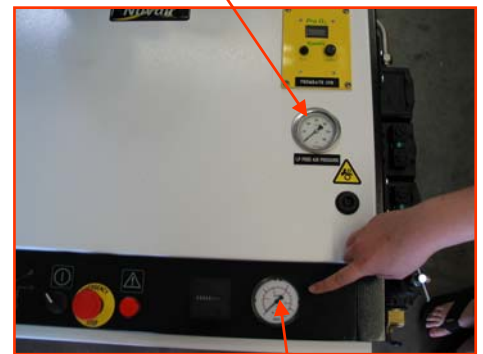
The input pressure to the Membrane System determines the %O<sub>2</sub> of the Nitrox mixture produced. As input pressure is increased, a higher %O<sub>2</sub> Nitrox is pumped. As pressure is decreased, a lower %O<sub>2</sub> Nitrox is pumped.

- 1) Increase input pressure by slowly turning the Regulator knob CW while monitoring the Pressure Gauges and Inline 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 Inline 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).
  - ◆ Volume Tank pressure range should be 165-185 P.S.I. (11-13 bar).
  - ◆ 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).



Inline Oxygen Analyzer

Regulated Pressure



Volume Tank Pressure

**Regulator pressure will never be higher than Volume Tank pressure.**



## NOTICE

### 15.3 Final Adjustments Before Pumping Nitrox

- 1) As the Nitrox initially makes its way through the running Nitrox 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 Inline 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 input 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 Inline 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 nitrox 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 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 Nuvaair.

**DANGER**

This Nitrox System does not produce nitrox mixtures acceptable for 100% oxygen service.

**DANGER**

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.

**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.

Fill Scuba Cylinders or HP Storage tanks 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. 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. While filling, monitor system for proper operation:
  - a) Monitor Oxygen Analyzers and recalibrate as required
  - b) Manually drain all Compressor condensate periodically or listen for proper operation of auto-drains if equipped.
  - 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 Membrane System On/Off Flow Valve and follow calibration instructions.



## NOTICE

When the HP 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	165-189 PSI (11-13 Bar)
Regulated Pressure to Membrane	90 – 165 PSI (6-11bar) depending on Nitrox O <sub>2</sub> % .
Fill Oxygen Analyzers	Showing the proper reading for intended fill
Nitrox Storage Pressure	<b>DO NOT</b> exceed rating of tank or 3600PSI (250Bar)

- 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 Nuair 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
- ◆ When filling a HP 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 turn off compressor or relieve pressure.



Use Independent Oxygen Analyzer for Verification

## 15.5 Pumping Air

To use the System to pump air, simply move the On/Off Flow Valve to the Off position. No Nitrox will be supplied to the HP Compressor, and it will pump air only. Both the Inline Oxygen Analyzer and Fill Oxygen Analyzer should read 20.9% when the HP Compressor is pumping air.



### 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.**



On/Off Flow Valve Handle in Off Position

## 15.6 Shutting Down

- 1) Shut off the Membrane System by turning the Regulator adjustment knob CCW to reduce input pressure to minimum setting and then closing the On/Off Flow Valve.
- 2) Manually drain all filter, Compressor, and Volume Tank condensate drains.
- 3) Turn off LP Compressor On/Off Switch. The Compressor will go into shut down mode.
- 4) Turn off HP Compressor when it has returned to pumping air, as determined by a Fill Oxygen Analyzer reading close to 20.9% O<sub>2</sub>.



## **16.0 Nitrox Operation Notes**

### **16.1 Correlation of Input 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 input 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 input pressure is at 125 P.S.I. (9 bar), record this pressure or make a mark on the input 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 input pressure reading to obtain specific oxygen percentage, minor adjustments of the input pressure regulator may be required to obtain the exact percentage desired.**

### **16.2 Hot Fills**

While in the process of filling HP 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 and HP compressor operating, isolate the HP Nitrox Storage Tanks from the HP compressor by closing appropriate valves.
- 2) Record the Membrane System input pressure reading
- 3) Slightly open fill whip valve on the HP compressor, and adjust so the running compressor maintains 1500-2000 P.S.I. (100-140 bar) outlet pressure.
- 4) Adjust the input 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 LP and HP Compressor manuals for complete maintenance requirements.

### 17.1 Daily Maintenance



#### CAUTION

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

- 1) Check Lubricant levels of both LP and HP Compressors and add proper Lubricants as required. See Section 17.3 and Compressor manuals for details.
- 2) Check HP Compressor Filtration for condensate and proper operation of condensate drains. Refer to HP Compressor manual for details.
- 3) Drain condensate from LP Volume Tank by opening drain valve and draining all moisture.
- 4) Check LP Filtration for condensate and proper operation of condensate drains.



LP Volume Tank  
Condensate Drain Valve

### 17.2 Routine Maintenance



#### 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.**

- 1) LP Compressor Lubricant: Change Rotary Screw Compressor Lubricant and Lubricant Filter after the first 100 hour break in period and every 1500 hours thereafter. Only use Lubricants rated for use with Rotary Screw Compressors, such as Nuvair 546™. Never mix Compressor Lubricants. See Section 15.3 and LP Compressor manual for details.
- 2) LP 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 15.4 for details.
- 3) LP Filtration Elements: Change LP Filter Elements every 100 hours to maintain CGA Grade D air standards. Visual differential pressure (DP) indicators on the HF7 and HF5 filters assist with monitoring replacement intervals. See Section 15.4 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.

- 4) Semi-Permeable Membrane: No maintenance required. Service life exceeds 20 years if LP Filtration is properly serviced to maintain Grade D standards.
- 5) Membrane System Air Intake Filter: Inspect filter element every 3 months for visible particles. Change every 12 months or sooner if particles are visible.
- 6) Oxygen Analyzers: Replace Oxygen Sensor and Battery as required. See manual included with Nitrox System.



**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.**

The following items are not integral parts of the Nitrox System, but proper maintenance is required to assure optimum performance.

- 1) HP Compressor Lubricant: Change HP Compressor Lubricant every 100 hours of operation in accordance with manufacturer’s guidelines. Only use Lubricants rated for use with Nitrox, such as Nuvair 455™ or 751™. Never mix Compressor Lubricants. Refer to HP Compressor manual for details.
- 2) Breathing Air Filters: Change HP Compressor Filter Elements in accordance with manufacturer’s guidelines to maintain CGA Grade E breathing air standards.
- 3) Air/Nitrox Quality Analysis: Take breathing air/Nitrox samples quarterly for analysis to assure compliance with CGA Grade E breathing air standards.



### 17.3 Compressor Lubricant

The LP Rotary Screw Compressor in your Nitrox System uses Nuvair 546™ Food Grade Synthetic Rotary Screw Compressor Lubricant. This lubricant is thinner than the lubricants that are used in reciprocating HP Compressors and should not be mixed with other Compressor Lubricants.

For access to the Lubricant Level Sight Gauge, Filter, and Drain, the back panel of the cabinet must be opened as shown. Turn off all electrical power to Nitrox System before opening cabinet. See LP Compressor manual for details on servicing Lubricant and Filter.



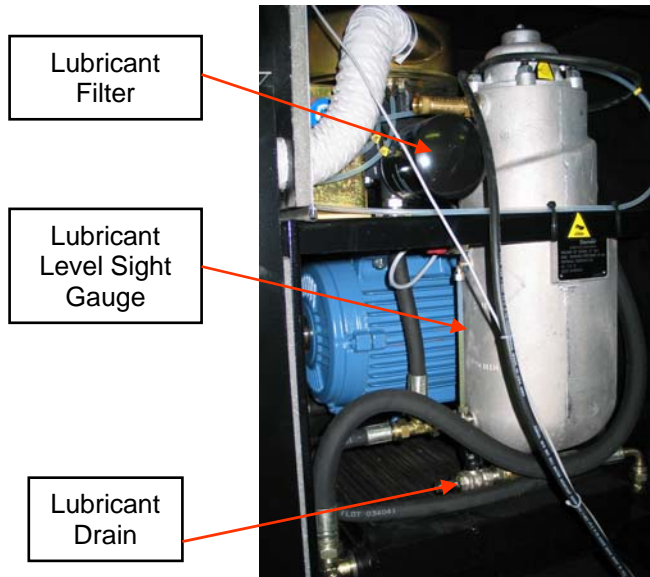
Step 1 - Undo the filtration tubing nut and pull tube away.



Step 2 - Unlock the two cabinet fasteners.



Step 3 - Tilt open back panel, then lift and move to the side. Be careful to clear electrical wiring from any obstructions.



## 17.4 LP Filtration

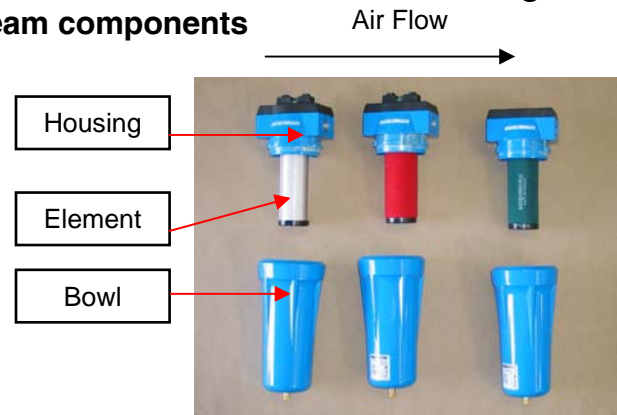


### CAUTION

**Special attention needs to be given to the arrangement of the four LP Supply 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 supply air is critical to prevent the passing of any residual oil vapor into the Membrane System. Three stages of Hankison LP filtration are used to produce Grade D air:

- 1) Particle Removal to 1 micron
- 2) Coalescing & Water/Oil Vapor Removal to 0.01 micron
- 3) Oil Vapor Removal to 0.003 PPM



### 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 or HF5 Filter indicates improper operation of auto-drain floats. Any evidence of moisture in the HF1 Filter indicates the air is not cooling properly and moisture is not properly being removed. Excess moisture will prevent the final filter from operating properly.
2. Inspect Elements for any unusual degradation or wetness. Element degradation can indicate more serious problems. Contact Nuvair for assistance,

### Changing Filtration Elements

Change Filter Elements every 100 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 DP indicators on the HF7 and HF5 filters assist with monitoring replacement intervals.

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

HF7-20 Particle Removal	HF5-20 Coalescing & Water/ Oil Vapor Removal	HF1-20 Oil Vapor Removal
-------------------------------	--	--------------------------------

HF7 & HF5  
Filters with Auto-  
Drain Floats &  
DP Indicators.

HF1 Filter with  
Manual Drain –  
Should not  
Contain Moisture



DP Indicator  
Changes from  
Green to Red as  
Filter Ages. Do  
Not Use When  
Red.



### 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 Spare Parts List

See Rotary Screw Compressor manual for LP Compressor parts list. Other Nitrox System components and related items are listed below.

<b>Nitrox System Components</b>	<b>Type</b>	<b>Part Number</b>
Rotary Screw Compressor Lubricant, Food Grade	Nuvair 546, 1 Gal (Other Sizes Available)	9409
LP Filtration Element	Hankison HF 7-20	E7-20
	Hankison HF 5-20	E5-20
	Hankison HF 1-20	E1-20
Heater Assembly	1200 Watt, 28" Length	H1200
Heater Thermostat Control	110V/220V	A419
Heater Pressure Switch		3100-052
Membrane	230 Series	NUV230
Air Intake Filter Element	LP280	16CP
Mixing Tube Assembly	1.5 inch diameter, specify length	
Oxygen Analyzer	Pro O2	9450
	Pro O2 Remote Panel Mount	9460
Oxygen Sensor	See Analyzer Owners Manual	
Compressor Hose Coupler	1-1/4"-1-1/2" to 1-1/4"-1-1/2"	PTC-150
	1-1/4"-1-1/2" to 1-1/2"	RDTC40X32
<b>Related Equipment Components</b>		
Air/Nitrox Quality Analysis Kit	Specify: (1) CGA Grade Required	
	(2) Single Use or Program Use	
Air/Nitrox Compressor Lubricant		
Reciprocating Compressor, Food Grade	Nuvair 455, 1 Gal	9406
Reciprocating Compressor, Diester Based	Nuvair 751, 1 Gal	9403
	(Other Sizes Available)	

## 17.6 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 Nitrox 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/m <sup>3</sup>	♦ 5 mg/m <sup>3</sup>
♦ 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

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Oxnard, CA 93030 USA  
Ph: 1-805-815-4044  
Fax: 1-805-815-4196

## Material Safety Data Sheet

Nuvair™ 546

EFFECTIVE DATE: 9/3/03

SUPERCEDES: 2/1/02

### I. PRODUCT IDENTIFICATION:

**Trade Name:** Nuvair™ 546

Chemical Name: Polyalphaolefin

Chemical Family: Synthetic Hydrocarbon

### II. COMPONENTS & HAZARD STATEMENT:

This product is non-hazardous. The product contains no known carcinogens. No special warning labels are required under OSHA 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:	Liquid, colorless, odorless
Solubility in Water:	Negligible
Other Data:	Non-Toxic USDA H-1 Approved

### IV. FIRE & EXPLOSION HAZARD DATA:

Flash Point:	475 °F
Autoignition Temperature:	Not Determined
Flammability Limits:	Not Established
Extinguishing Media:	Dry Chemical; CO <sub>2</sub> 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 a 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.

EFFECTIVE DATE: 9/3/03	SUPERCEDES: 2/1/02
PRODUCT: Nuvair™ 546	

VII. HEALTH HAZARD DATA:	
Exposure Limits:	Not applicable
Effects of Overexposure:	Low oral and dermal toxicity. Prolonged or repeated exposure may cause irritation, nausea, and vomiting.

VII. EMPLOYEE PROTECTION:	
For general personal hygiene, wash hands thoroughly after handling material. Avoid contact with skin and eyes.	
Chemical impervious gloves are recommended for prolonged exposure.	
Use in a well ventilated area	

VIII. 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.

IX. HAZARD RATING INFORMATION:			
	NFPA	KEY	
Health:	1	4=Severe	0=Minimal
Flammability:	1	3=Serious	
Reactivity:	O	2=Moderate	B=Gloves,Goggles
Personal Protection:	B	1=Slight	

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.	
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For Additional Information:
Nuvair
2949 West 5 <sup>th</sup> St.
Oxnard, CA 93030 USA
Ph: 1-805-815-4044
Fax: 1-805-815-4196
Website: <a href="http://www.nuvair.com">www.nuvair.com</a>
E-mail: <a href="mailto:info@nuvair.com">info@nuvair.com</a>

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

Effective Date: 7/8/2003

**I. Product Identification:**

Trade Name: ..... Nuvair 455  
Chemical Name: ..... Polyalphaolefin  
Chemical Family: ..... Synthetic hydrocarbon mix

**II. Components & Hazard Statement:**

**This product is non-hazardous.** The product contains no known carcinogens. No special warning labels are required under OSHA CFR 1910.1200. This product complies with FDA 21 CFR 178.3570 regarding lubricants for incidental food contact.

**III. Physical Data:**

Viscosity: ..... 70 cst. @40°C  
Specific Gravity (Water = 1.0): ..... 0.83 – 0.85  
Boiling Point: ..... N.A.  
Vapor Pressure: ..... Negligible  
Appearance & Odor: ..... Clear – with little odor  
Solubility in Water: ..... Negligible

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

Flash point: ..... 490°F 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: ..... 1  
             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.



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

Effective Date: 2/1/2000

Supersedes: 9/1/1998

**I. Product Identification:**

Trade Name: ..... Nuvair 751  
Chemical Name: ..... Diester/organic compound blend  
Chemical Family: ..... Ester

**II. Components & Hazard Statement:**

**This product is non-hazardous.** The product contains no known carcinogens. No special warning labels are required under OSHA CFR 1910.1200, SARA TITLE 111 SECTION 313 (40 CFR PART 372): This product is not regulated under Section 313 and 40 CFR Part 372.

**III. Physical Data:**

Viscosity: ..... 143 cst. @40°C  
Specific Gravity (Water = 1.0): ..... 0.96  
Boiling Point: ..... Not determined  
Vapor Pressure: ..... Negligible  
Appearance & Odor: ..... Straw color – bland odor  
Solubility in Water: ..... Negligible  
Other Data: ..... Non-toxic USDA H-2 approved

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

Flash point: ..... 520°F 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: ..... 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: ..... 1  
             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 HP Compressor for compressing Nitrox, contact Nuair or the Compressor manufacturer before you connect your Nitrox System.
- If an existing HP 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.

**Operation:**

- Do not use the Nitrox System to supply a HP 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. Compressing Nitrox at higher pressures may cause severe HP Compressor damage.
- To prevent Membrane damage, drain all low pressure filter and volume tank condensate on a daily basis.

**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 showing 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.

**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.



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