



Operation Manual

**Voyager<sup>TM</sup>**

Nitrox System

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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 O<sub>2</sub>™ Oxygen Analyzer Operation Manual  
Champion R15 Compressor Manual  
High Pressure Compressor Manual

## **1.0 Introduction**

This manual will assist you in the proper set-up, operation and maintenance of the Nuvair Voyager™ 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

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 HP 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.**

### **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 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™ Nitrox System is a turnkey package that produces oxygen-rich air (Nitrox) and then compresses it with a High Pressure (HP) 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™ uses a Reciprocating Piston LP Compressor, Air Aftercooler, Volume Tank, 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™'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 LP Compressor. A Feed Air Pressure Regulator reduces the pressure to 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 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 HP 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 Feed Air 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 HP Compressor. The resulting Nitrox mixture is analyzed for %O<sub>2</sub> before entering the HP Compressor for approximate content and again when pumping Nitrox for precise content. The HP 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 HP Compressor pumps 36% O<sub>2</sub> when the feed air pressure is at 125 P.S.I. (9 bar), then adjusting the Feed Air 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

### Capacity and Power Consumption:

- Normal working pressure – 165-175 P.S.I. (11-12 bar)
- Capacity at normal working pressure – 23.5 cfm (666 L/min) Delivery
- 29.9 cfm (847 L/min) Displacement
- Compressor speed of rotation – 1035 rpm
- Maximum working pressure – 175 P.S.I. (12 bar)
- Transmission – Belt drive

### Cooling

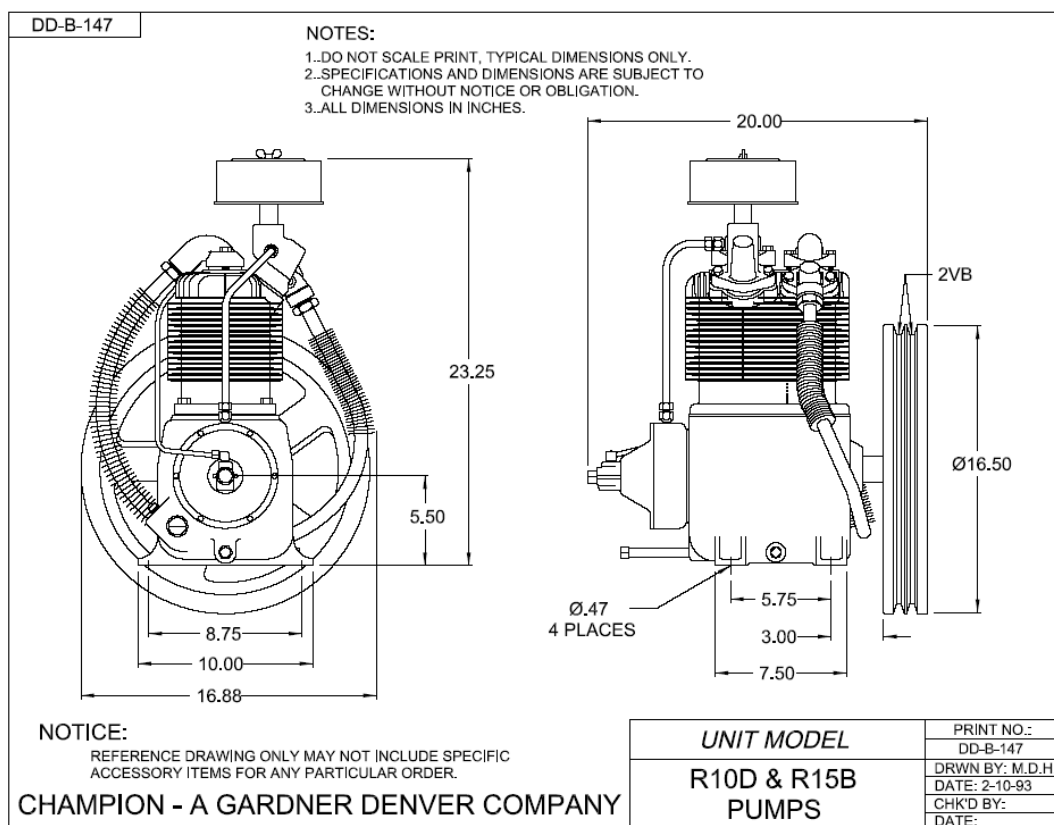
- Allowed ambient temperature – 32-100°F (0-38°C)
- Aftercooler heat rejection – outlet air temperature reduced to within 20°F (11°C ) of ambient

### Motor and Electrical Values:

- Motor - F class, IP55, 7.5hp 3 phase or 5.5hp Single phase
- Speed of rotation – 1725 rpm
- Compressor current
  - 230V-50/60 Hz/single phase – 24A
  - 230V-50/60 Hz/three phase – 20A

### General Technical Data:

- Oil Quantity – 2 qt. (1.9 liters)



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

### Capacity and Power Consumption:

- Normal working pressure – 3600 P.S.I. (250 bar)
- Charging Rate - 9 SCFM (255 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 5.5hp Single phase
- Speed of rotation – 3450 rpm
- Compressor current           230V-50/60 Hz/single phase – 24A  
  230V-50/60 Hz/three phase – 20A

### General Technical Data:

- Number Of Stages - 3
- Number Of Cylinders – 3
- Lubrication – Splash Lubricated
- Oil Quantity – 1.6 qt. (1.5 liters)
- HP Filtration Rating – CGA Grade E, 13,000 cu. ft. at 68°F (20°C)
- Condensate Drains – Automatic & Manual Interstage & Final
- Fill Pressure Stop – Automatic & Manual
- Low Oil Level Shutdown – Optional
- High Temperature Shutdown – Optional
- Interstage Pressure Gauges – Optional

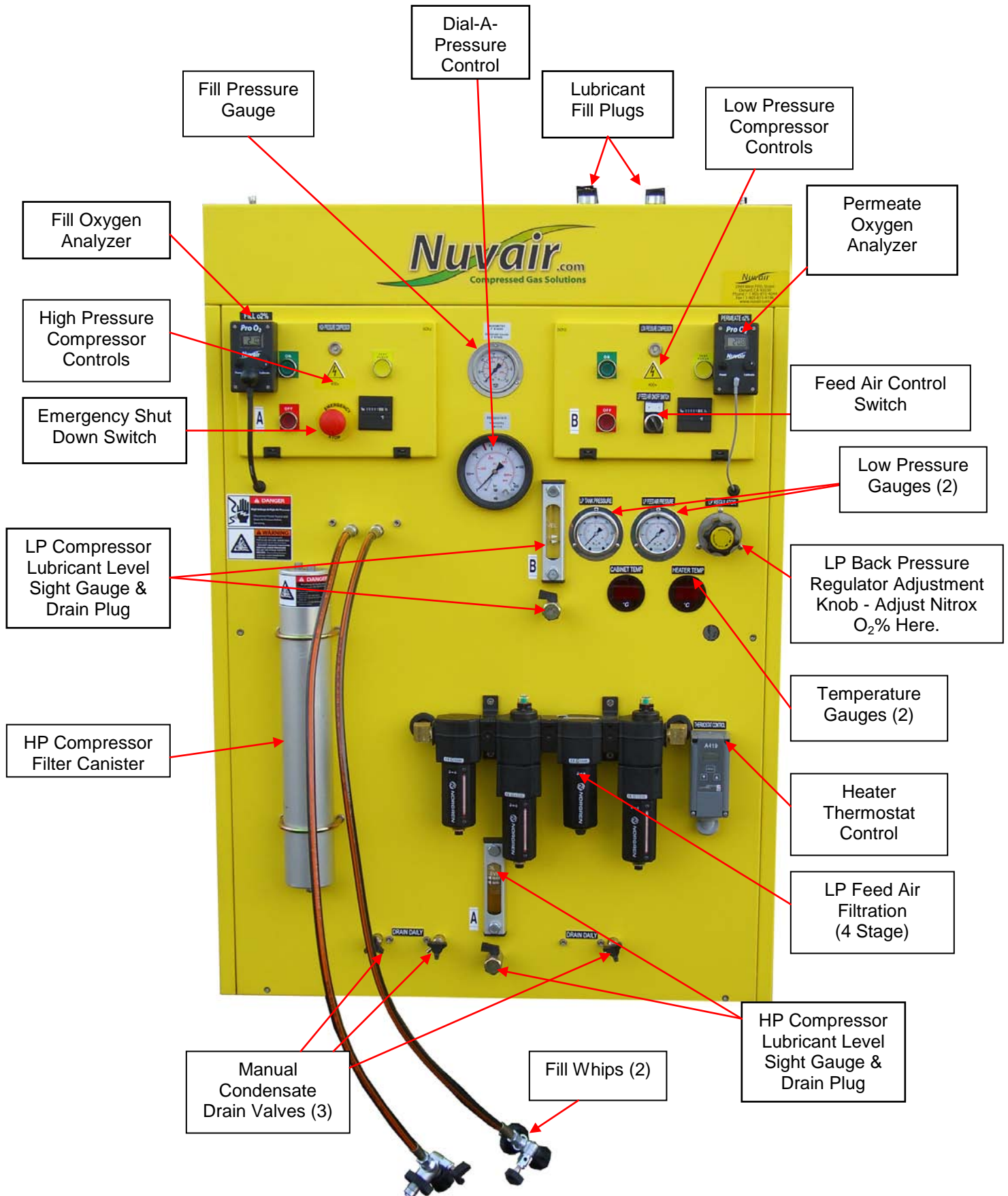
## 8.0 System Components

- Low Pressure Compressor, including:
  - ◆ Push Button Magnet Motor Starter
  - ◆ Hour Meter
  - ◆ External Lubricant Sight Gauge, Fill, and Drain
  - ◆ Nuvair 455™ Food Grade Compressor Lubricant
- Low Pressure Volume Tank:
  - ◆ 15 Gallon Vertical Mount standard, other remote configurations available
  - ◆ Automatic Condensate Drain
- Volume Tank Pressure Gauge
- Solenoid Powered Feed Air On/Off Valve
- Low Pressure>Low Pressure Feed Air Regulator with Pressure Gauge:
  - ◆ Pressure input to regulator 165-175 P.S.I. (11-12 bar)
  - ◆ Output Pressure from regulator 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
  - ◆ Final Stage Carbon Particle Removal, auto drain, liquid level & service life indicators
- Heater including:
  - ◆ 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 Hose (optional)
- 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
  - ◆ Push Button 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
- (2) Five Foot Fill Whips with International Yoke & Valve
- Air/Nitrox Quality Analysis Kit

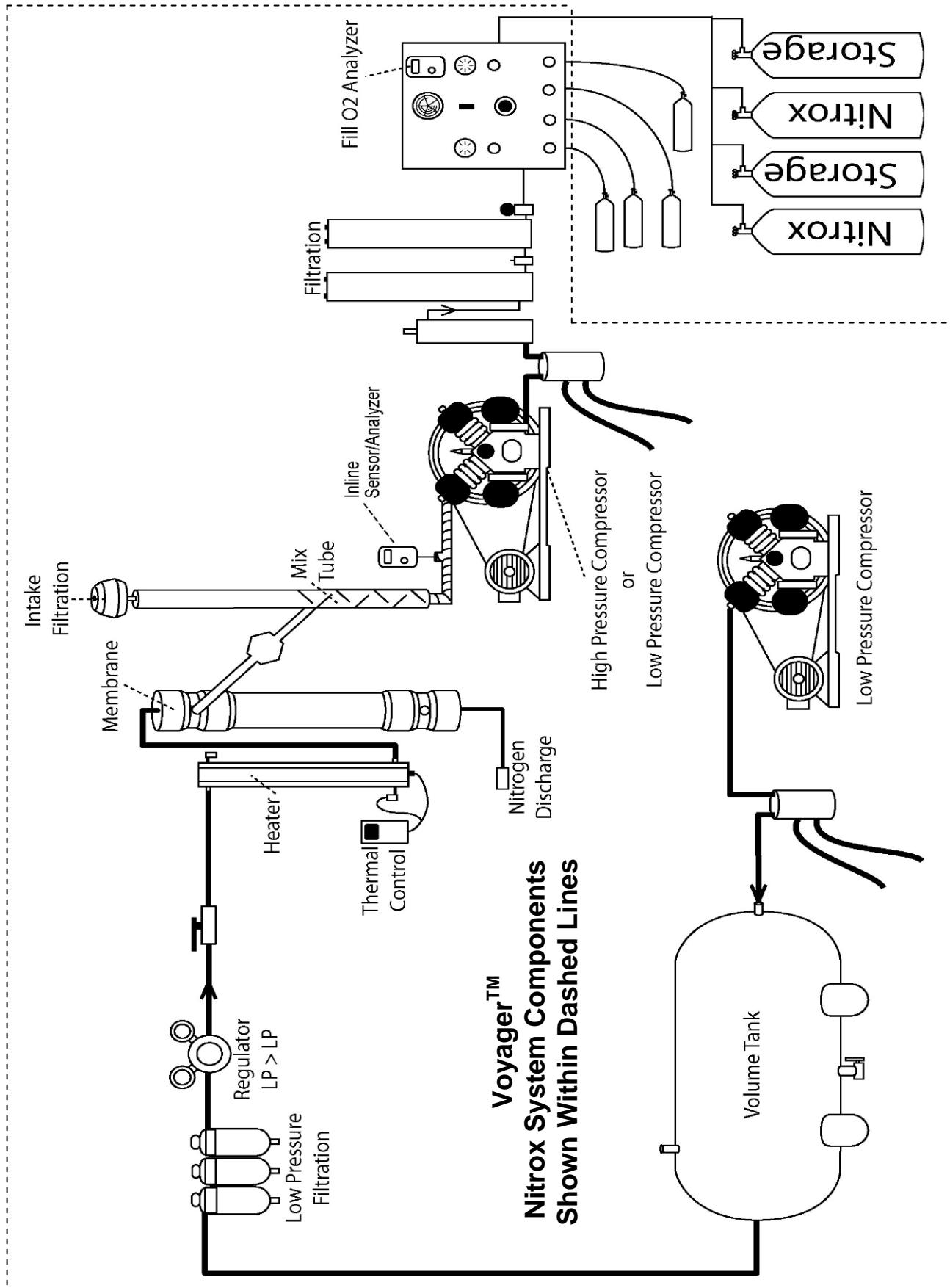
## 9.0 Nitrox System Specifications

LP Compressor	Delivery @ 175 P.S.I. (12 bar)	23.5 cfm FAD (666 L/min)
	Horsepower – Electric	7.5 hp (5.5 kW)
Physical Specifications	Height	52 in (132 cm)
	Width	38 in (97 cm)
	Depth	49 in (125 cm)
	Weight	840 lb (382 kg)
Full Load Amps	230V/E3/50-60 Hz	45A
	230V/E1/50-60 Hz	73A
Membrane Input	Operating Pressure Range	90-165 psi (6-11 bar)
	Maximum Input Pressure	300 psi (21 bar)
	Feed Air Volume Range	8-23.5 scfm (212-666 L/min)
	LP Feed Air Quality	Grade D
	Optimum Temperature	110 +/- 5°F (43 +/- 3°C)
	Nitrox %O <sub>2</sub> Range	24 - 40%
HP Compressor	Charging Rate	9 SCFM (255 L/min)
	Horsepower – Electric	7.5 hp (5.5 kW)

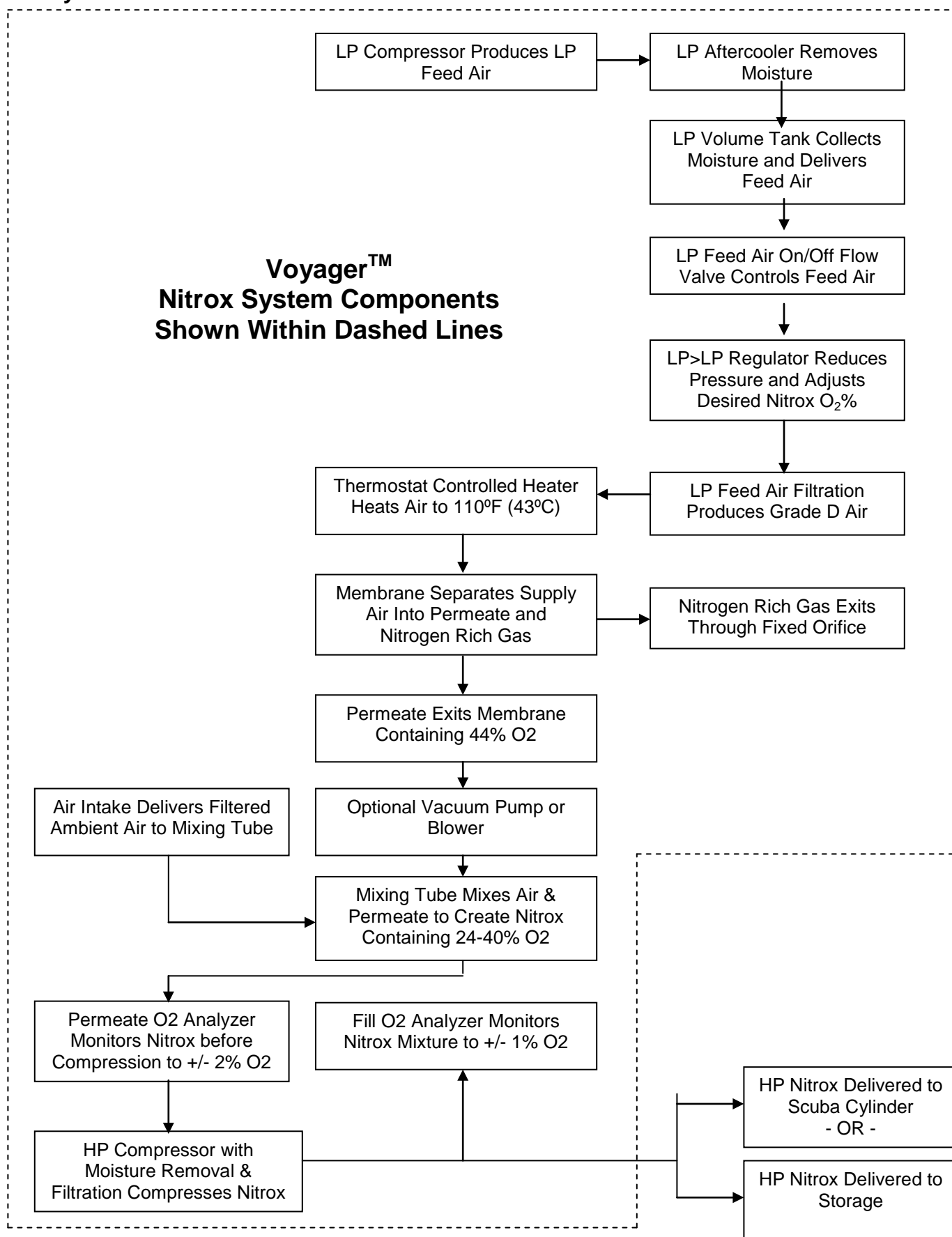
## 10.0 Nitrox System Component Identification



# 11.0 System Drawing / Schematic



## 12.0 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

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 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 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.

[new picture](#)



Fixed Factory Set  
Nitrogen Discharge



### 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.

### 13.3 Electrical Power Connection



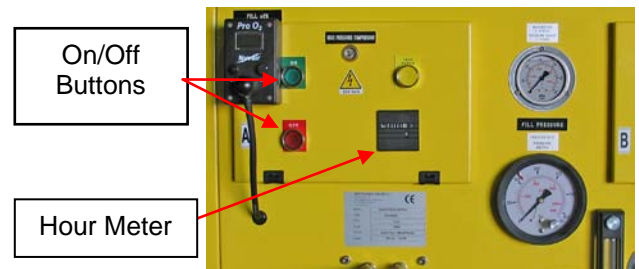
#### WARNING

**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.**

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 45 A for 230 V three phase service
- ◆ Approximately 73 A for 230 V single phase service



#### Compressor Rotation Check

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

Note Proper  
Direction of Rotation



HP Compressor Shown



#### 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.**

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



Lubricant  
Fill Plugs

Compressor  
Lubricant  
Level Sight  
Gauges

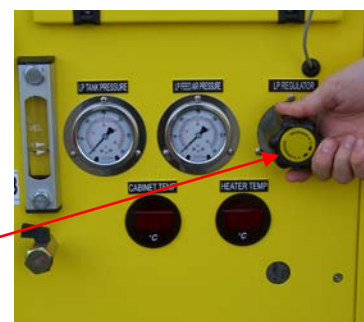


### 14.2 Membrane System Feed Air Regulator and Switch

An LP>LP Feed Air Regulator is used to reduce feed air pressure to the Membrane System to a typical range of 90 – 165 P.S.I. (6-11 bar). An LP Feed Air Switch is used to control the flow of air into the Membrane System. Prepare the Membrane System as follows:

- 1) Reduce feed air 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 Feed Air Switch is in the Off position.

LP Feed Air  
Regulator  
Adjustment Knob



LP Feed Air  
Switch



## Oxygen Analyzer Calibration

Gas production may be monitored with the Permeate Oxygen Analyzer before entering the HP 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 HP 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.



Permeate Oxygen Analyzer  
Provides Rough Reading



Fill Oxygen Analyzer  
Provides Precise Reading



### 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

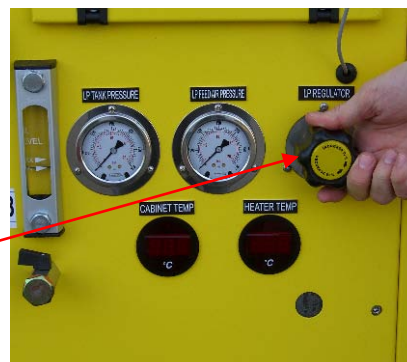
The Permeate Oxygen Analyzer supplies oxygen readings that can vary +/- 2% O<sub>2</sub> due to heat, humidity, and pressure changes experienced in the Nitrox flow and therefore should only be used for rough estimates of %O<sub>2</sub>. The Fill Oxygen Analyzer supplies more accurate oxygen readings, 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 LP Feed Air Switch and return LP Feed Air Regulator to minimum pressure setting by turning adjustment knob CCW until it spins freely.



LP Feed Air Switch

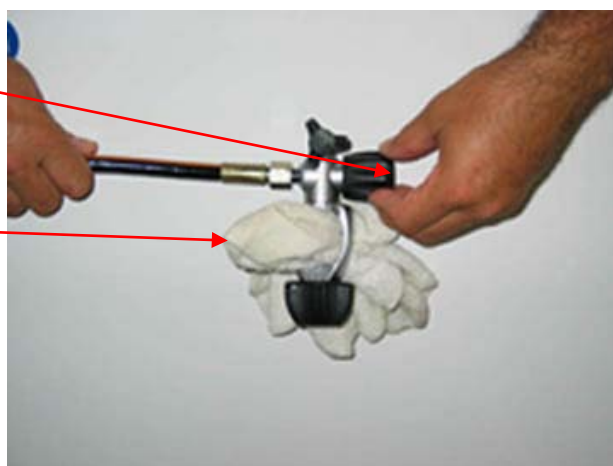


LP Feed Air Regulator Adjustment Knob

- 2) Slightly open fill whip valve on HP 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 HP Nitrox Compressor

- 3) Turn on HP Compressor and drain condensate.

HP Compressor On Button

Dial-A-Pressure Control



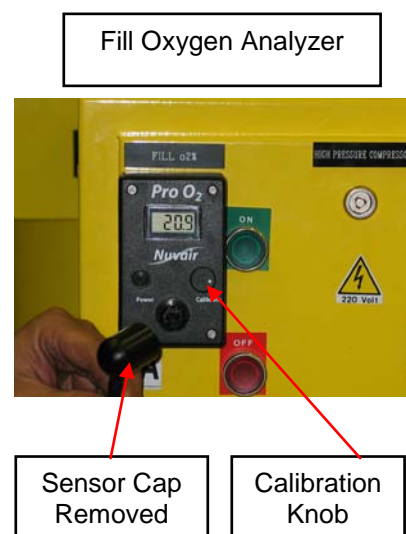
- 4) Set Dial-A-Pressure Gauge for desired fill pressure. Adjust fill whip valve so the running HP Compressor maintains 1500-2000 P.S.I. (100-140 bar) outlet pressure. Air will now be flowing past both Oxygen Analyzers for calibration purposes.
- 5) Monitor all gauges for proper operating range and check all connections for leaks.
- 6) Calibrate Oxygen Analyzers while the HP 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.



## 14.3 Attaching Scuba Cylinder



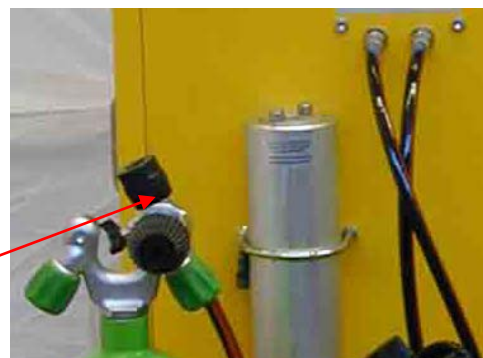
### NOTICE

**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.

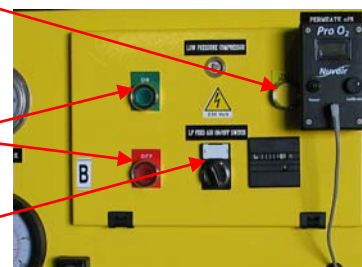
### 15.1 Flow to Membrane

- 1) Verify that Oxygen Analyzer calibration is complete, LP Feed Air Switch is in Off position, and Regulator is at minimum pressure setting.
- 2) Press LP and HP Compressor Purge buttons briefly to remove condensate and bleed pressure.
- 3) Turn on LP Compressor and allow Volume Tank to come up to full pressure of approximately 175 P.S.I. (12 bar). The sound will change and the rpm will increase slightly, indicating that the Compressor is unloading.
- 4) Turn on HP Compressor. Set Dial-A-Pressure Gauge for desired fill pressure. 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).
- 5) Verify that Permeate Oxygen Analyzer reads 20.9%.
- 6) Turn on Membrane System by turning LP Feed Air Switch on.

Test Purge Button

On/Off Buttons

LP Feed Air Switch



LP Compressor Controls

Volume Tank Pressure Gauge

Feed Air Pressure Gauge

LP Feed Air Regulator Adjustment Knob



Heater Temperature Gauge

Cabinet Temperature Gauge

Test Purge Button

On/Off Buttons

Dial-A-Pressure Control



HP Compressor Controls

- 7) 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. Heater will not turn on until Membrane System is pressurized.



LP Feed Air  
Regulator  
Adjustment  
Knob

- 8) 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). At any time that temperature exceeds 120 °F, green indicator light should be off.



## NOTICE

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



## 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.**

- 9) Check Permeate Pressure Gauge to verify that it reads near 0 P.S.I. A negative or positive pressure reading could indicate blockage.



## 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 Pressure Gauges 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).
  - ◆ Volume Tank pressure range should be 165-175 P.S.I. (11-12 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).



Permeate Oxygen Analyzer



### NOTICE

**Feed air pressure will never be higher than Volume Tank pressure.**

## 15.3 Final Adjustments Before Pumping Nitrox

- 1) As the Nitrox initially makes its way through the running HP 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 HP 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 Nuvair.

**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.

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 LP Feed Air Switch 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	165-175 PSI (11-12 bar)
Membrane Feed Air Pressure	90 - 165psi (6-11 bar) depending on Nitrox O <sub>2</sub> %
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 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).

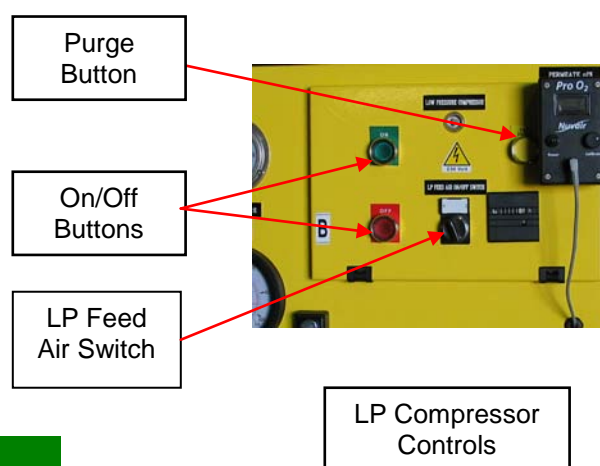


Use Independent Oxygen Analyzer for Verification

- 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 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 allow Nitrox System to shut down.

### 15.5 Pumping Air

To use the System to pump air, simply turn off the LP Compressor and LP Feed Air Switch. No Nitrox will be supplied to the HP Compressor, and it will pump air only. When the HP 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 Dial-A-Pressure Gauge.
- 2) Manually shut off the Membrane System by turning the Feed Air Regulator adjustment knob CCW to reduce pressure to minimum setting and then turning off LP Feed Air Switch.
- 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 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 operating, isolate the HP Nitrox Storage Tanks from the HP Compressor by closing the appropriate valves.
- 2) Record the Membrane System feed air 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 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 LP and HP Compressor manuals for complete maintenance requirements.

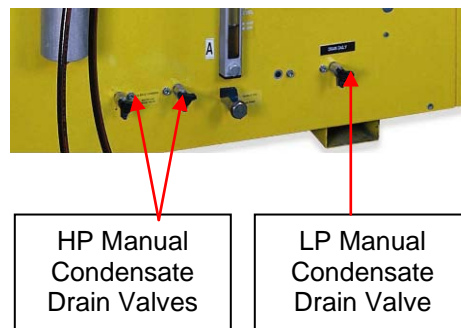
### 17.1 Daily Maintenance



#### 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 LP and HP Compressors and add proper lubricants as required. See Section 17.3 and Compressor manuals for details.
- 2) Operate LP and HP Purge Buttons to verify proper operation of automatic condensate drain valves, then slightly open each HP and LP Manual Condensate Drain Valve to verify that no condensate is present.
- 3) Check LP Air Filtration for condensate and proper operation of condensate drains.



### 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.**



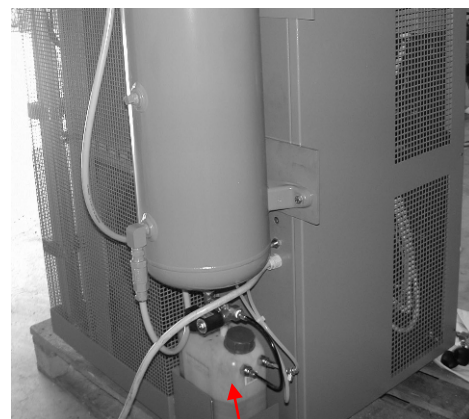
#### CAUTION

**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 Compressor Lubricant every 200 hours. Only use lubricants rated for use with Nitrox, such as Nuvair 455™. Never mix Compressor Lubricants. See Section 17.3 and LP Compressor manual for details.
- 2) HP 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 HP Compressor manual for details.



- 3) LP 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) LP Air Filtration Elements: Change LP Filter Elements every 100 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) HP Compressor Filtration Element: Change HP Filter Element every 13,000 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 LP 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.



Condensate Drain Container.  
Check & Drain Weekly.



**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.**



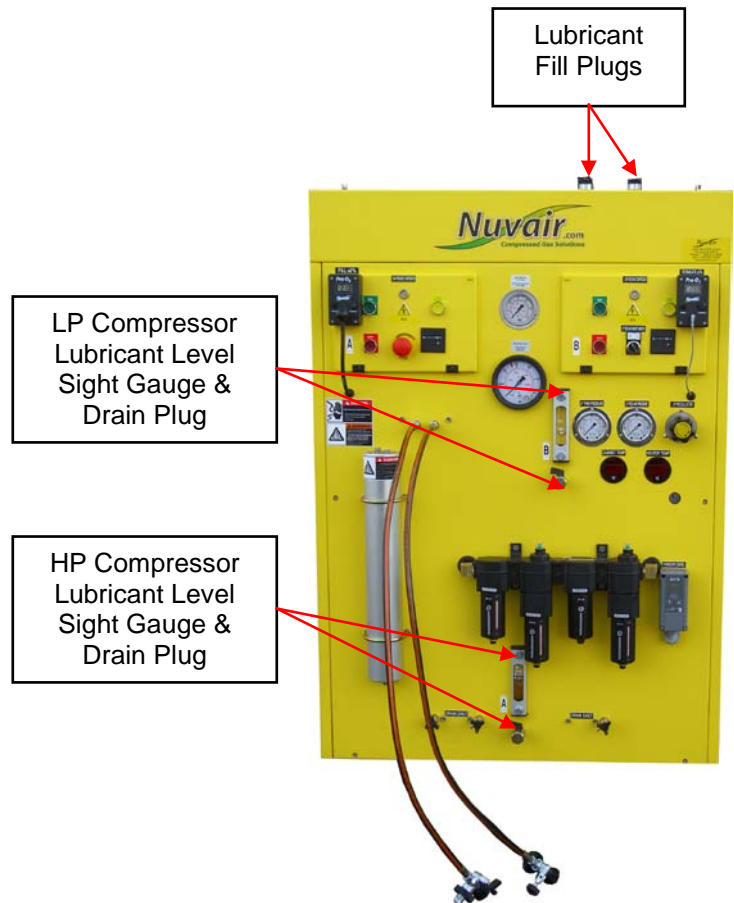
**DANGER**

**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.**

- 10) 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 and HP Compressors in your Nitrox System comes standard with Nuvair 455™ Synthetic Food Grade Compressor Lubricant. Check lubricant levels at each Sight Gauge and add lubricant as required through the appropriate Fill Plug. Lubricant is removed through the Drain Plugs. See LP and HP Compressor manuals for details on servicing Lubricant.





## 17.4 LP Feed Air Filtration



### CAUTION

**Special attention needs to be given to the arrangement of the four 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**

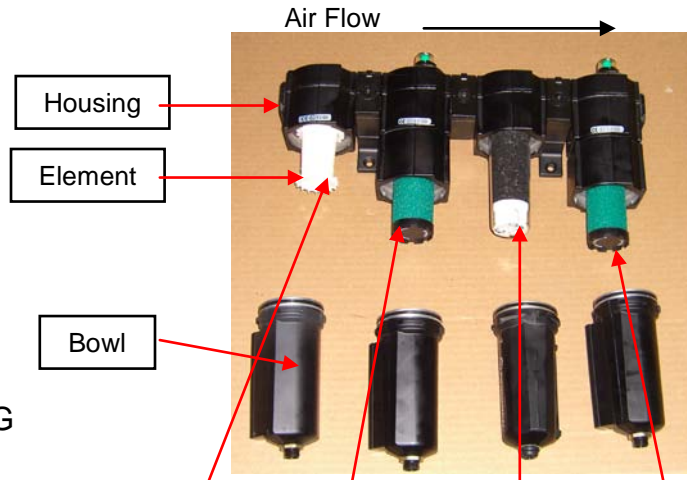
The use of Grade D or better feed air is critical to prevent the passing of any residual oil vapor into the Membrane System. Four stages of Norgren LP filtration are used to produce Grade D air:

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

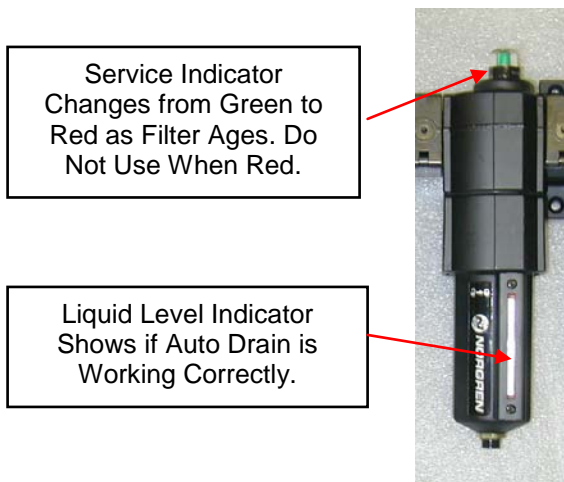

### LP Filtration Inspection

Open each Filter and inspect as follows:

- 1) Inspect Bowl for the presence of moisture. A high level of moisture build-up in the B74G or F74H Filter indicates improper operation of auto-drain floats. Evidence of moisture in the F74V Filter indicates 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 Nuair for assistance.



F74G	F74H	F74V	F74H
Particle Removal	Coalescing & Water/Oil Vapor Removal	Oil Vapor Removal	Carbon Particle Removal & Coalescing
Replacement Element Part Number			
4338	4344	4341	4344

F74G Filter with Auto-Drain Float & Liquid Level Indicator	F74H Filters with Auto-Drain Float & Liquid Level/Service Indicators	F74V Filter with Manual Drain – Should not Contain Moisture
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## Changing LP 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 service indicators on the F74H 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.



Changing LP  
Filtration Element



## 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 HP Compressor Filtration

The HP Compressor comes standard with Triplex filtration, utilizing a single Filter Element. Do **NOT** use any substitute. Change Filter Element every 13,000 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.

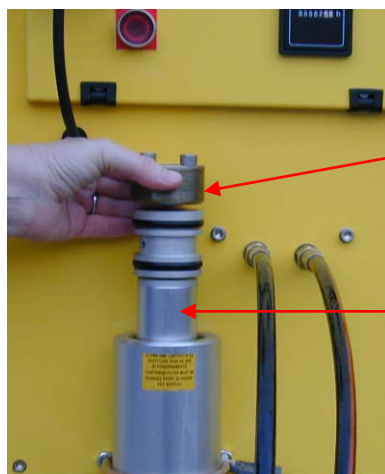
- 1) Shut down the Nitrox System
- 2) Open Manual Condensate Valves to drain pressure. Leave Valves open.
- 3) Unscrew the Filter Canister Cap per the HP Compressor manual.
- 4) Remove expended Element from Filter Canister and unscrew from Canister Cap.
- 5) Install new Element to Canister Cap and reinstall Cap to Canister.
- 6) Close Manual Condensate Valves.



Manual Condensate  
Drain Valves

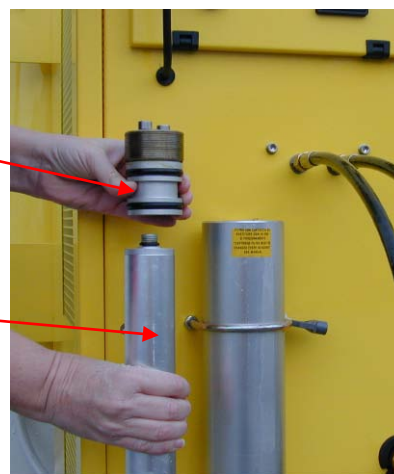
Filter Canister Cap

HP Compressor  
Filter Canister



Filter Canister Cap

Filter Element



## 17.6 Spare Parts List

See LP and HP Compressor manuals for Compressor parts lists. Other Nitrox System components and related items are listed below.

Nitrox System Components	Type	Part Number
Reciprocating Compressor Lubricant, Food Grade, Nitrox Compatible	Nuvair 455, 1 Gal (Other Sizes Available)	9406
LP Filtration Element	Norgren B74G	4338-04
	Norgren F74H	4344-02
	Norgren F74V	4341-01
HP Compressor Filtration Element	Breathing Air, Grade E	X302414
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	10-16 CFM	16CP
Mixing Tube Assembly	1.5 inch diameter, specify length	
Oxygen Analyzer	Pro O <sub>2</sub>	9450
	Pro O <sub>2</sub> Remote	9452
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	

## 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/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

# 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.



**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 or LP Compressor for compressing Nitrox, contact Nuair or the Compressor manufacturer before you connect your Nitrox System.
- If an existing HP or LP 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 HP or LP 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 HP 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 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. 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.



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