



# Operation Manual

## Voyager 315 Nitrox System



SKU 7037.6

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



### **WARNING**

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

Every effort was made to ensure the accuracy of the information contained within. Nuvair, however, retains the right to modify its contents without notice. If you have problems or questions after reading the manual, stop and call Nuvair at +1.805.815.4044 for information.

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### **Links to Additional Relevant Manuals**

Nuvair Pro O<sub>2</sub> [Oxygen] Analyzer User Manual · SKU 9462  
([https://nuvair.com/manuals/Pro\\_O2\\_Manual08.17.pdf](https://nuvair.com/manuals/Pro_O2_Manual08.17.pdf))

Nuvair Pro CO [Carbon Monoxide] Analyzer User Manual · SKU 9624  
([https://nuvair.com/manuals/ProCO\\_Manual\\_Rev\\_03.19.pdf](https://nuvair.com/manuals/ProCO_Manual_Rev_03.19.pdf))

Nuvair Pro CO<sub>2</sub> [Carbon Dioxide] Analyzer User Manual · SKU 9617  
([https://nuvair.com/manuals/Pro\\_CO2\\_Manual\\_Re%2003.18.pdf](https://nuvair.com/manuals/Pro_CO2_Manual_Re%2003.18.pdf))

Beko RAC35 Refrigerated Air Dryer User Manual · SKU F35-2  
([https://nuvair.com/manuals/DRYPOINT\\_user.pdf](https://nuvair.com/manuals/DRYPOINT_user.pdf))

EK76 Low Pressure Compressor User Manual · SKU 301KBA1095  
(<https://nuvair.com/manuals/EK76.pdf>)

Coltri MCH16/GP Tropical Plus + Oil Pump High Pressure Compressor Parts List · SKU SC000065  
([https://www.nuvair.com/manuals/MCH-13-16%20CATALOG\\_0217.pdf](https://www.nuvair.com/manuals/MCH-13-16%20CATALOG_0217.pdf))

### **Video Link**





Overview of Voyager 315 Operations  
([https://youtu.be/P9QYoroi\\_Og](https://youtu.be/P9QYoroi_Og))

## 1.0 Introduction

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

This manual will assist you in the proper set-up, operation and maintenance of the Nuvair Voyager 315 Nitrox System. Be sure to read the entire manual.

**This manual uses certain words and symbols to call your attention to conditions, practices or techniques that may directly affect your safety. Pay particular attention to information introduced by the following symbols or words:**

SYMBOL	MEANING	DESCRIPTION
	DANGER	Indicates an imminently hazardous situation, which if not avoided, will result in serious personal injury or death.
	CAUTION	Indicates a potentially hazardous situation, which if not avoided, could result in serious personal injury or death.
	WARNING	Indicates a potentially hazardous situation, which if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices.
	NOTICE	Notifies people of installation, operation or maintenance information which is important but not hazard-related.

## 2.0 Safety Warnings



### **WARNING**

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



### **WARNING**

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



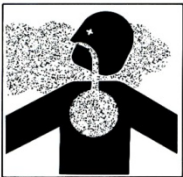
### **WARNING**

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



### **DANGER**

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



### **WARNING**

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



### **WARNING**

Do not use any form of mineral oil or synthetic lubricant not rated for Nitrox in any compressor in this system. Use only the recommended Nitrox compressor lubricant. Never mix the Nitrox compressor lubricant with other lubricants. Remove all existing lubricant and replace with the proper Nitrox compressor lubricant prior to installing the membrane system. The use of improper lubricants can lead to fire or explosions, which may cause serious personal injury or death.



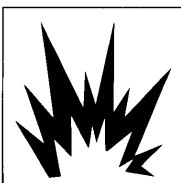
**WARNING**

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



**WARNING**

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



**WARNING**

Do not pump Nitrox mixtures at pressures above the HP compressor manufacturer's rating, and never above 3600 psi (250 bar). The system is not rated for pressures above 3600 psi (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.

Warnings Graphics Defined:



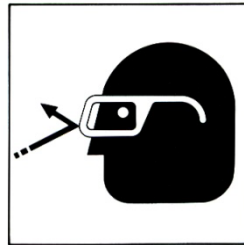
Moving belts



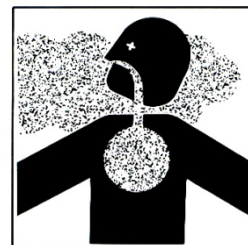
Electrocution



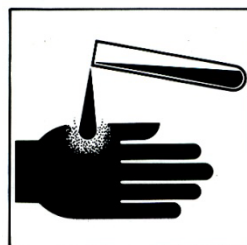
Fire



Eye protection



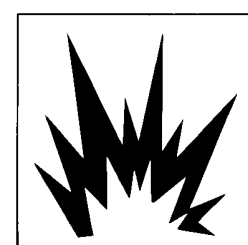
Gas inhalation



Skin damage



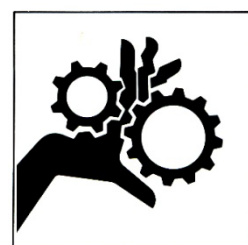
Explosion



Explosion



Electrocution



Machinery

### Abbreviations Used in This Manual:

psi	Pounds per Square Inch	CFM	Cubic Feet per Minute
HP	High Pressure	RPM	Rotations per Minute
LP	Low Pressure	PPM	Parts per Million
O <sub>2</sub>	Oxygen	L/min	Liters per Minute
CO	Carbon Monoxide	O <sub>2</sub> %	Oxygen Percentage of Gas
CO <sub>2</sub>	Carbon Dioxide	B.P.	Back Pressure
N	Nitrogen	A	Amperes (amp)



### **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 contact with sharp objects. Do not kink power cables and never allow the cables to contact with oil, grease, hot surfaces, or chemicals.
- 5) Make certain that power source conforms to the requirements of your equipment.
- 6) Pull main electrical disconnect switch and disconnect any separate control lines, if used, before attempting to work or perform maintenance. "Tag Out" or "Lock Out" all power sources.
- 7) Do not attempt to remove any parts without first relieving the entire system of pressure.
- 8) Do not attempt to service any part while system is in an operational mode.
- 9) Do not operate the system at pressures in excess of its rating.
- 10) Do not operate compressor at speeds in excess of its rating.
- 11) Periodically check all safety devices for proper operation. Do not change pressure setting or restrict operation in any way.
- 12) Be sure no tools, rags or loose parts are left on the Nitrox System.
- 13) Do not use flammable solvents for cleaning the Air Inlet Filters or elements and other parts.
- 14) Exercise cleanliness during maintenance and when making repairs. Keep dirt away from parts by covering parts and exposed openings with clean cloth or Kraft paper.
- 15) Do not operate the compressor without guards, shields, and screens in place.
- 16) Do not install a shut-off valve in the compressor discharge line, unless a pressure relief valve, of proper design and size, is installed in the line between the compressor unit and shut-off valve.
- 17) Do not operate in areas where there is a possibility of inhaling carbon monoxide, carbon dioxide, nitrogen, or flammable or toxic fumes.
- 18) Be careful when touching the exterior of a recently run electric, gasoline, or diesel motor - it may be hot enough to be painful or cause injury. With modern motors this condition is normal if operated at rated load - modern motors are built to operate at higher temperatures.

- 19) Inspect unit daily to observe and correct any unsafe operating conditions found.
- 20) Do not “play around” with compressed air or direct air stream at body, this can cause injuries.
- 21) Compressed air from this machine absolutely must not be used for food processing or breathing air without adequate downstream filters, purifiers and controls and periodic air quality testing.
- 22) Always use an air pressure-regulating device at the point of use, and do not use air pressure greater than marked maximum pressure.
- 23) Check hoses for weak or worn conditions before each use and make certain that all connections are secure.

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

### **4.0 Legal Precautions**

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

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

## **5.0 Theory of Operation**

The Voyager 315 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 315 uses a Rotary Screw LP Compressor, Air/Oil Aftercooler, Refrigerated Air Dryer, and Filtration to provide the Membrane System with a source of clean, pressurized feed air for separation. The air is filtered to CGA Grade D or better air quality prior to entering the Membrane System so it will not damage or plug the Membrane fibers. Specifications for Grade D air is provided in the Appendix.

The Voyager 315 Membrane System is rated for a maximum feed air pressure of 300 psi (21 bar) and has been configured to work well with the 175 psi (12 bar) maximum pressure delivered by the LP Compressor. A Back Pressure Regulator is used to adjust the amount of air the screw compressor produces to meet the appropriate levels for various %O<sub>2</sub> Nitrox production. The air is then heated to a temperature that provides stability over a wide range of ambient conditions, is optimal for Membrane permeation, and prevents moisture condensation.

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

The permeate is a concentrated mixture that must be diluted with additional air prior to entering the 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 amount of air produced by the compressor and supplied to the membrane, with the Back Pressure Regulator. As air flow to the membrane is increased, permeate flow increases and a higher %O<sub>2</sub> Nitrox is produced. As air flow to the membrane is decreased, permeate flow decreases, compressor intake air increases, and a lower %O<sub>2</sub> Nitrox is produced.

This relationship between permeate flow and intake air flow exists because the total of these two flow rates will always equal the intake flow rate demanded by the 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 psi (9 bar), then adjusting the Back Pressure Regulator to 125 psi (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 – 80-175 psi (5.5-12 bar)

Capacity at normal working pressure – 30 CFM (850 L/min)

Shaft power at normal working pressure – 10.2 hp (7.65 kW)

Maximum working pressure – 175 psi (12 bar)

Minimum working pressure – 44 psi (3 bar)

Idling shaft power consumption – 2.3 hp (1.7 kW)

Transmission – Belt drive

### **COOLING**

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

### **MOTOR AND ELECTRICAL VALUES**

Motor: F Class ODP, 10 horsepower (7.5 kW) three-phase or single-phase

### **3-PHASE MOTOR**

Motor - F class, IP55, 10 hp (7.5 kW)

Speed of rotation – 3480 rpm @ 60Hz | 2850 rpm @ 50Hz

FUSE (MAX)      25 A @ 380 V

45 A @ 230 V

### **GENERAL TECHNICAL DATA**

Oil Capacity 4 L

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



### **NOTICE**

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

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

### **CAPACITY AND POWER CONSUMPTION**

Normal working pressure – 3600 psi (250 bar)

FAD Flow 9.3 CFM (265 L/min)

Charging Rate – 10.8 SCFM (307 L/min)

Compressor speed of rotation – 1550 rpm

Maximum working pressure – 5000 psi (354 bar)

Transmission – Belt drive

### **COOLING**

Allowed ambient temperature – 32-105°F (0-40°C)

Air Cooled Interstage & Aftercooler

### **MOTOR AND ELECTRICAL VALUES**

Three-Phase 7.5 hp Motor

Speed of rotation – 3450 rpm @ 60Hz | 2850 rpm @ 50 Hz

### **GENERAL TECHNICAL DATA**

Number Of Stages – 3

Number Of Cylinders – 3

Lubrication – Splash Lubricated

Oil Quantity – 1.6 qt (1.5 L)

HP Filtration Rating – CGA Grade E, 60,000 cu ft @ 68°F (20°C)

Condensate Drains – Automatic & Manual Interstage & Final

Fill Pressure Stop – Automatic & Manual

Low Oil Level Shutdown

High Temperature Shutdown

Interstage Pressure Gauges

## **8.0 System Components**

### **LOW PRESSURE COMPRESSOR, INCLUDING**

Magnet Motor Starter

Hour Meter

External Lubricant Sight Gauge, Fill, and Drain

Nuvair 546 Food Grade Rotary Screw Compressor Lubricant

Large oil/air cooler with exhaust fan

### **BEKO DRYPOINT® RAC35 REFRIGERATED AIR DRYER**

Automatic Condensate Drain

### **BACK PRESSURE REGULATOR CONTROLLER OF LP COMPRESSOR FEED AIR SUPPLY**

Supply Air Pressure Gauge 90-165 psi (6-11 bar) depending on Nitrox %O<sub>2</sub>

### **LOW PRESSURE 3-STAGE GRADE D FEED AIR FILTRATION**

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

### **MEMBRANE HEATER**

Thermostat Control

Digital Temperature Gauge

Pressure Switch

200 psi (14 bar) ASME Over Pressure Relief

### **SEMI-PERMEABLE NITROX MEMBRANE SYSTEM**

Mixing Tube & Air Intake Filter

Nitrogen Discharge

### **(2) NUVAIR PRO O<sub>2</sub> FILL OXYGEN ANALYZERS FOR NITROX MIX ANALYSIS, INCLUDING:**

High Pressure>Low Pressure Regulator

Flow Restrictor, 1 - 5 L/min

SmartStart option installed – automatically powers-up analyzer when compressor turned on

**PRO CO ANALYZER**

SmartStart option installed – automatically powers-up analyzer when compressor turned on

**PRO CO<sub>2</sub> ANALYZER**

SmartStart option installed – automatically powers-up analyzer when compressor turned on

**CARBON DIOXIDE (CO<sub>2</sub>) SCRUBBER**

SmartStart option installed – automatically powers-up analyzer when compressor turned on

**HIGH PRESSURE COMPRESSOR, INCLUDING**

Magnet Motor Starter

Hour Meter

Automatic Condensate Drains

Automatic Fill Pressure Stop

External Lubricant Sight Gauge, Fill, and Drain

Nuvair 455 or Nuvair 751 Food Grade Compressor Lubricant

High Pressure Dual (2) CAN-35 Filtration, Grade E Breathing Air

**9.0 Voyager 315 Specifications**

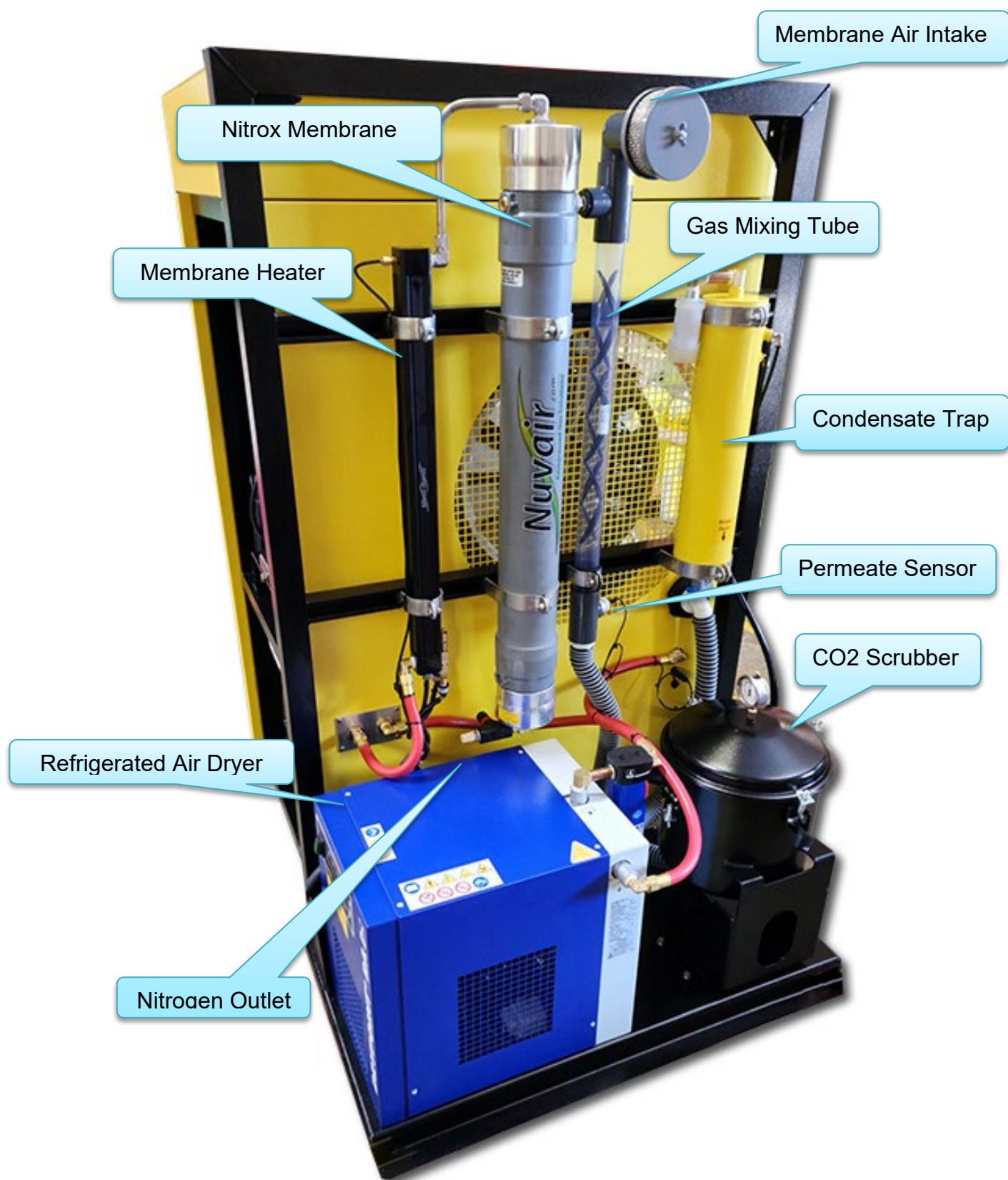
LP Compressor	Delivery @ 175 psi (12 bar)	30 CFM FAD (850 L/min)
	Horsepower – Electric	10 hp (7.4 kW)
Physical Specifications	Height	62 in (157 cm)
	Width	57 in (145 cm)
	Depth	32 in (81 cm)
	Weight	840 lb (382 kg)
Full Load Amps	400V / E3 / 50 Hz 208-230V / E3 / 60 Hz	30 A 54 A
Membrane Input	Operating Pressure Range	65-175 psi (4-12 bar)
	Maximum Input Pressure [Factory Set]	175 psi (12 bar)
	Feed Air Volume Range	8-33 SCFM (227-934 L/min)
	LP Feed Air Quality	Grade D
	Optimum Temperature	110 ± 5°F (43 ± 3°C)
Output	Nitrox %O <sub>2</sub> Range	22 – 40%
HP Compressor	Charging Rate	10.8 SCFM (305 L/min)
	Horsepower – Electric	7.5 hp (5.5 kW)



# 10.0 Nitrox System Component Identification



Figure 1. Voyager 315 front panel. All gauges are labeled.

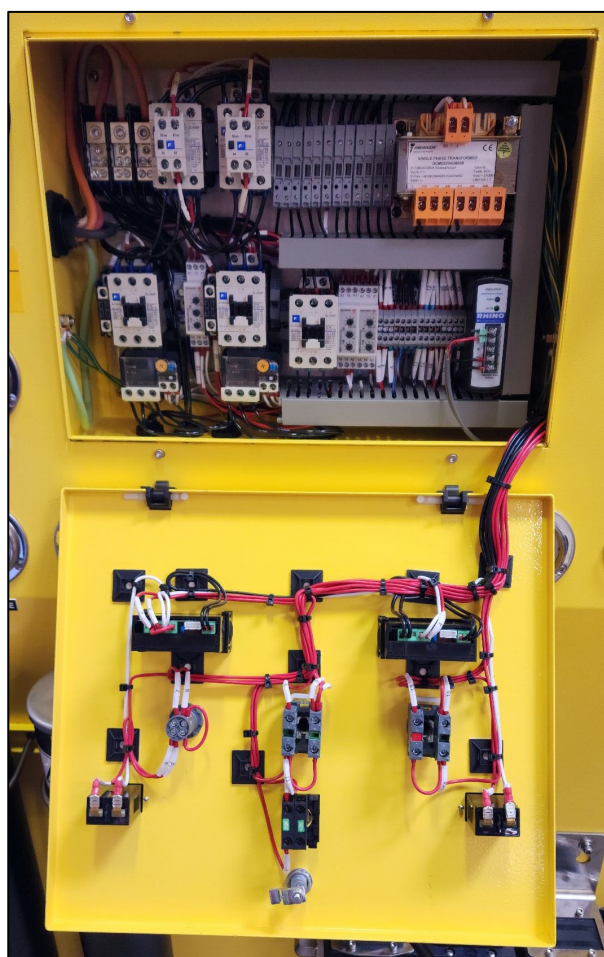


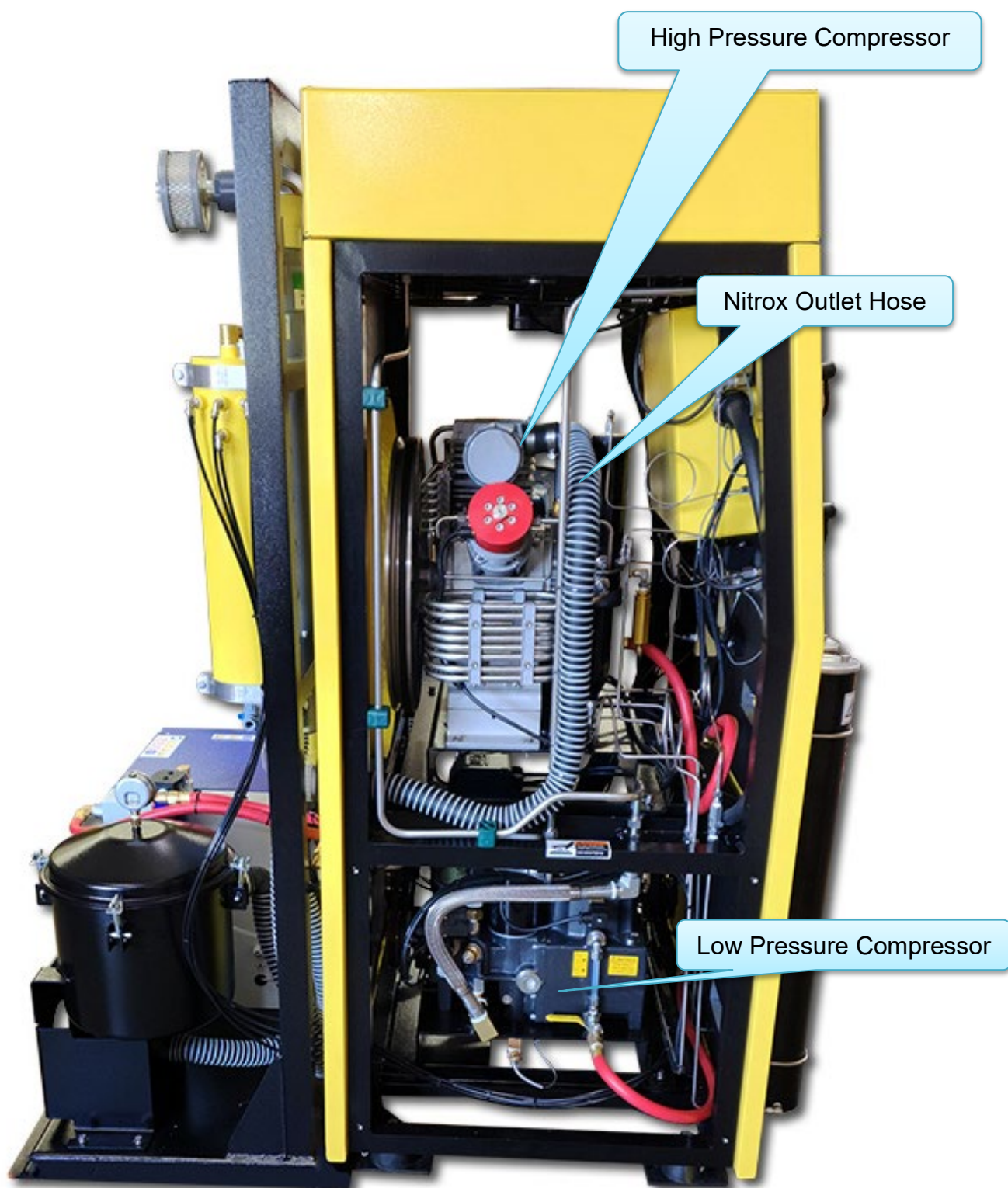
*Figure 2. Voyager 315 rear view featuring modular frame.*





Figure 3 and Figure 4. Voyager 315 control panel (above). Circuit panel open (below).

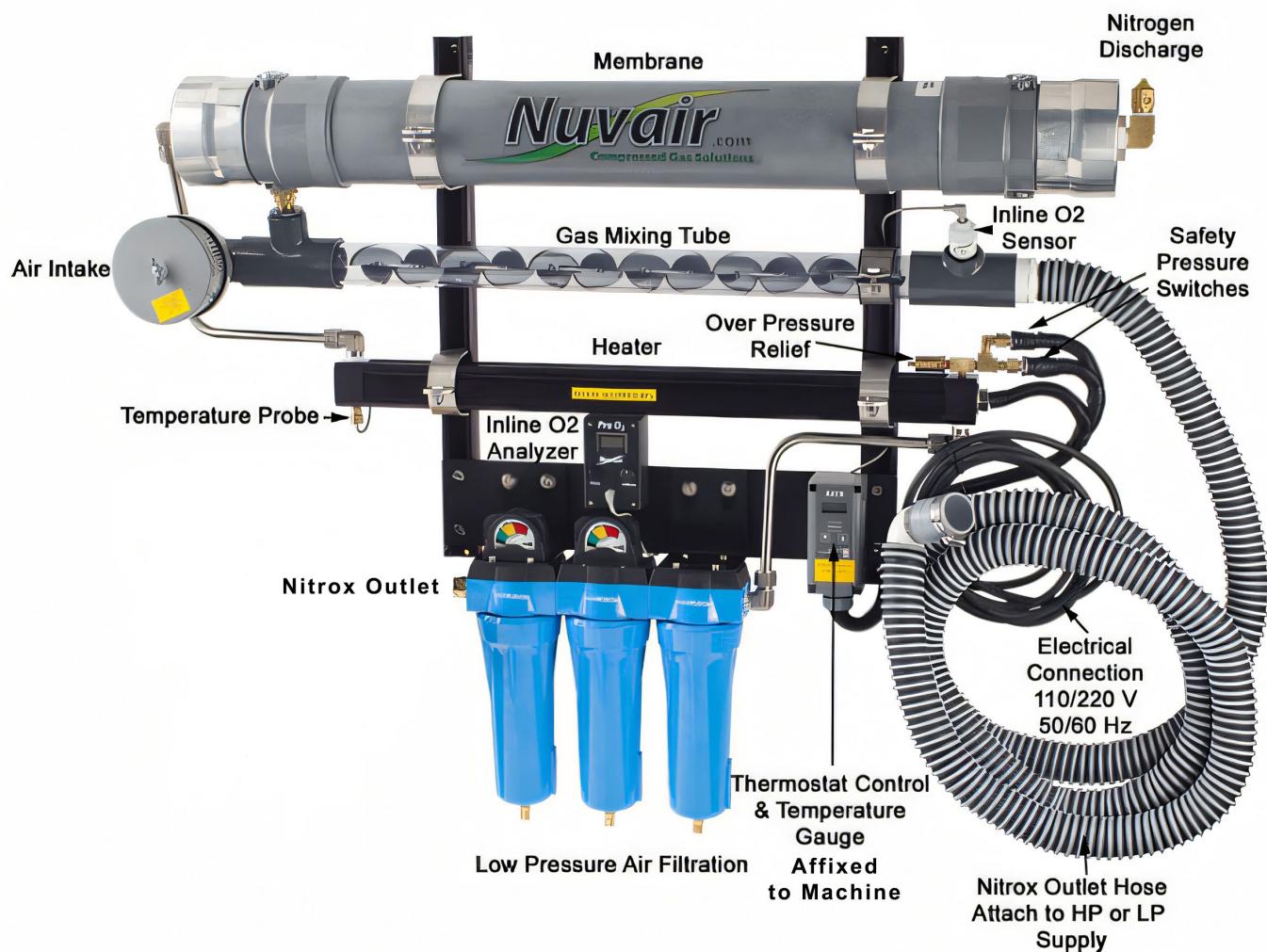




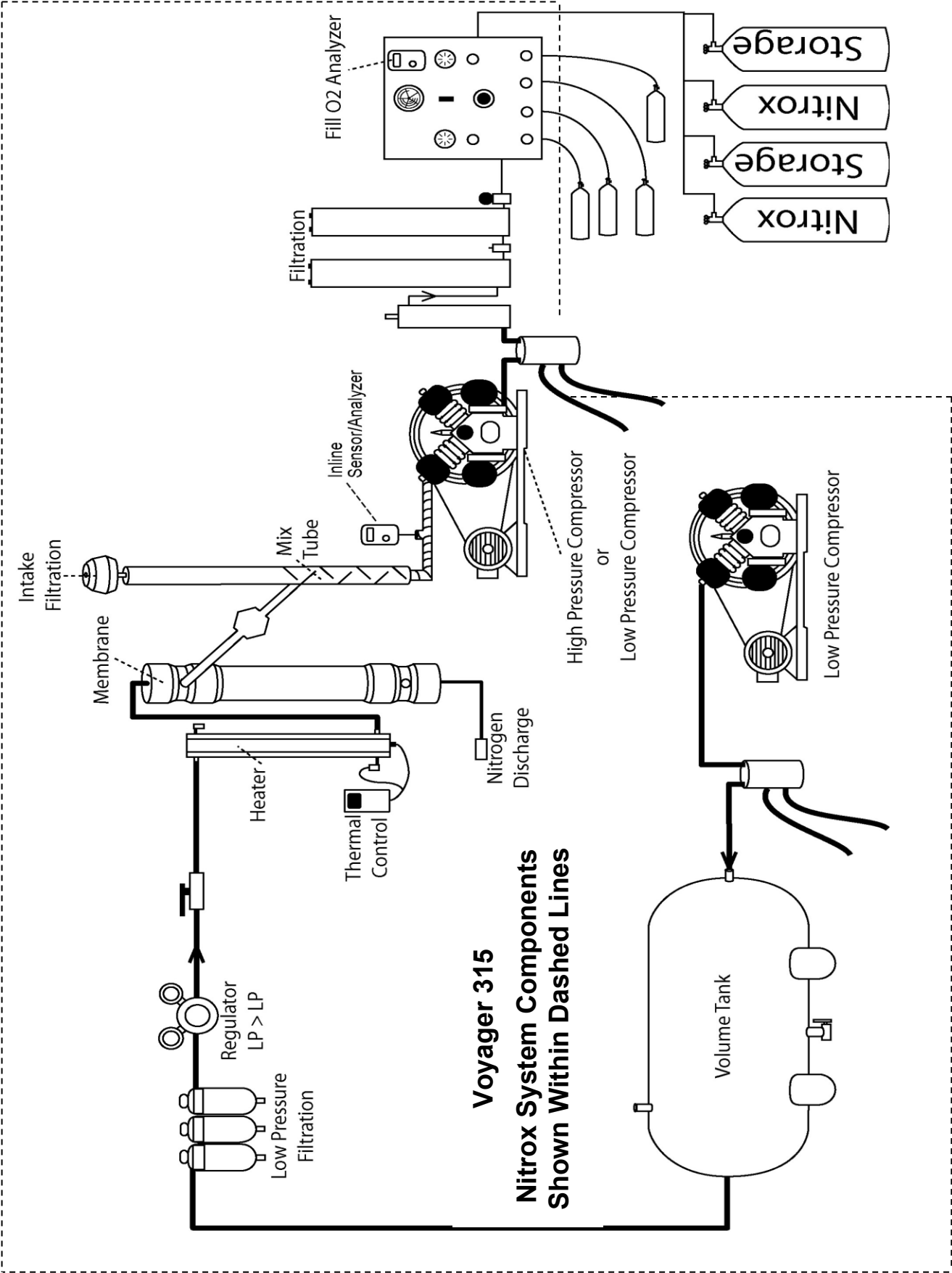
*Figure 5. Voyager 315 side view - panel doors removed.*



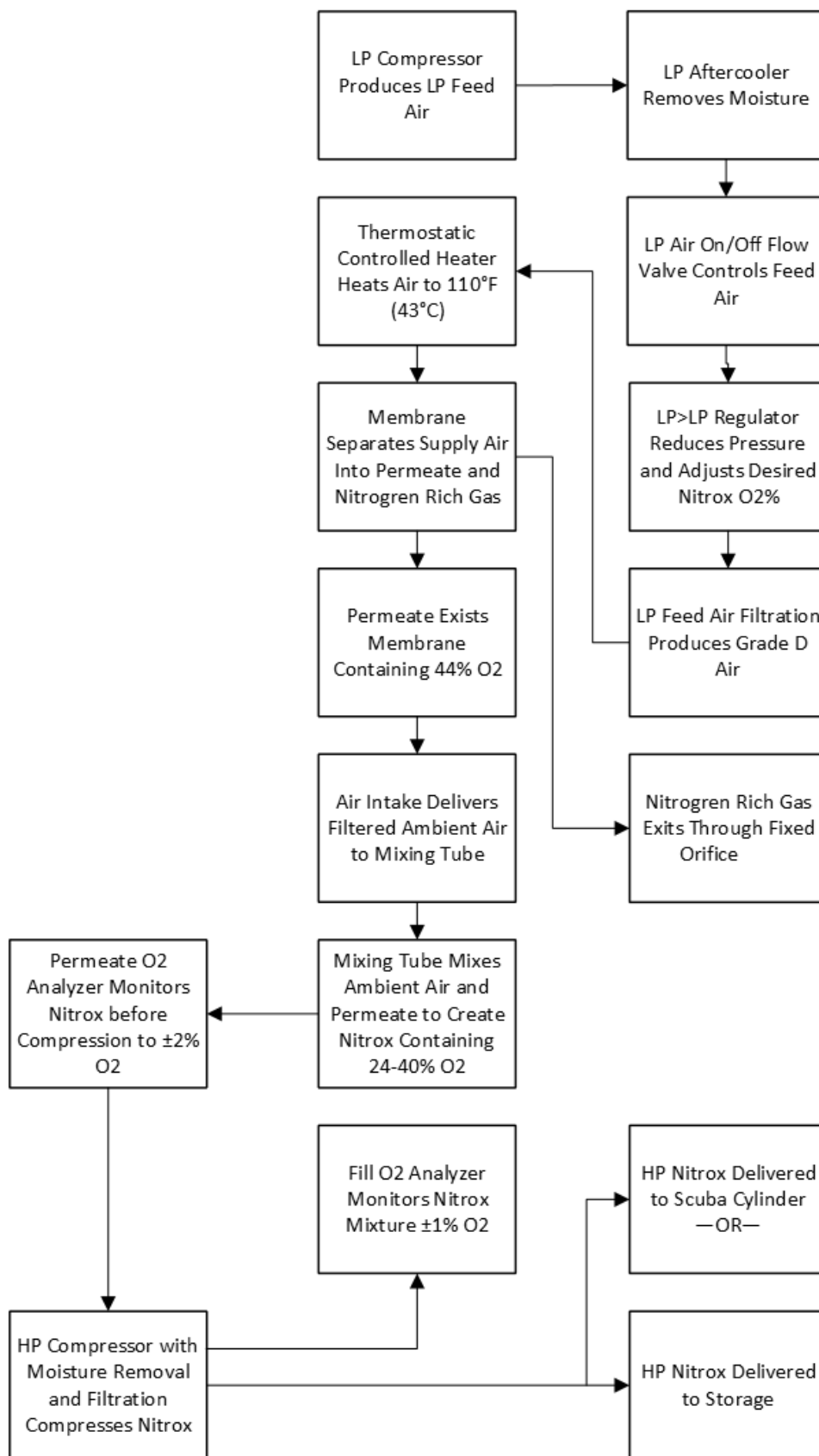
## LP Nitrox Membrane System



11.0 System Drawing / Schematic



## 12.0 Nitrox System Flow Chart



## 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**

The Nuvair Voyager 315 should never be operated in a facility where the room temperature exceeds 104°F (40°C) while the system is in use. Operation at higher temperatures may lead to system damage and malfunction. A damaged membrane will not produce the correct Nitrox mixture which can lead to severe personal injury if the gas is used for diving purposes without proper analysis.

## 13.1 Precautions

- 1) Please read all information supplied before physically installing the Nitrox System.
- 2) Unpack the system and remove from the pallet. Visually inspect the system to make sure there has been no damage during shipping. If damaged, please call Nuvair 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)

Excess nitrogen from the nitrox membrane on the Voyager 315 discharges from the base of the membrane tower. In unconfined spaces with sufficient air flow, the nitrogen expelled from the membrane should not be of concern, but in confined spaces with limited air flow, nitrogen buildup might be an issue.



Figure 7. Optional nitrogen discharge hose routing.

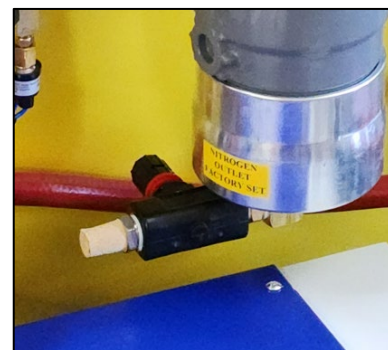


Figure 6. Nitrogen discharge port.

If confined spaces and limited air flow are a concern, users can attach a hose to the nitrogen discharge port and route the nitrogen flow closer to the compressor fan intake screen on the back of the compressor cabinet (see Figure 7 for example hose path, as indicated by arrow).

The compressor fan pulls air into the cabinet and cabinet air is then expelled upward and out of the cabinet by a second fan installed in the cabinet top.



Users can vent expelled cabinet exhaust by installing a ventilation hood that draws the cabinet exhaust from the confined space to a safe area (i.e., outdoors). Most HVAC (heating, ventilation and air conditioning) contractors can install such an exhaust system.

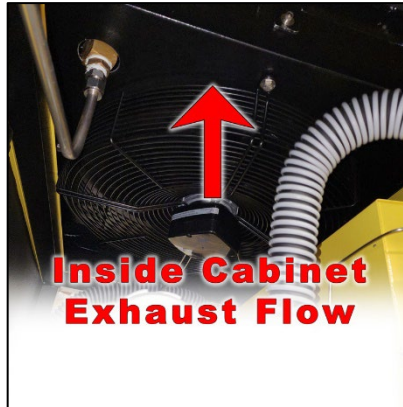


Figure 8. Internal and external view of cabinet top exhaust fan.



### **WARNING**

Pure nitrogen is a colorless, odorless,

tasteless gas that will not support life. Breathing gas mixtures

containing more than 84% nitrogen at surface pressures will lead to unconsciousness and may cause death.



### **WARNING**

The nitrogen discharge from the membrane should be vented to a well-ventilated room or to open air with good circulation. Failure to isolate the discharge from the air intake of the membrane system or 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.



### **WARNING**

The electrical power to the Nuvair Voyager 315 must be off while wiring this system for service. Failure to ensure that the electrical power is off can lead to severe personal injury and death by electrocution.

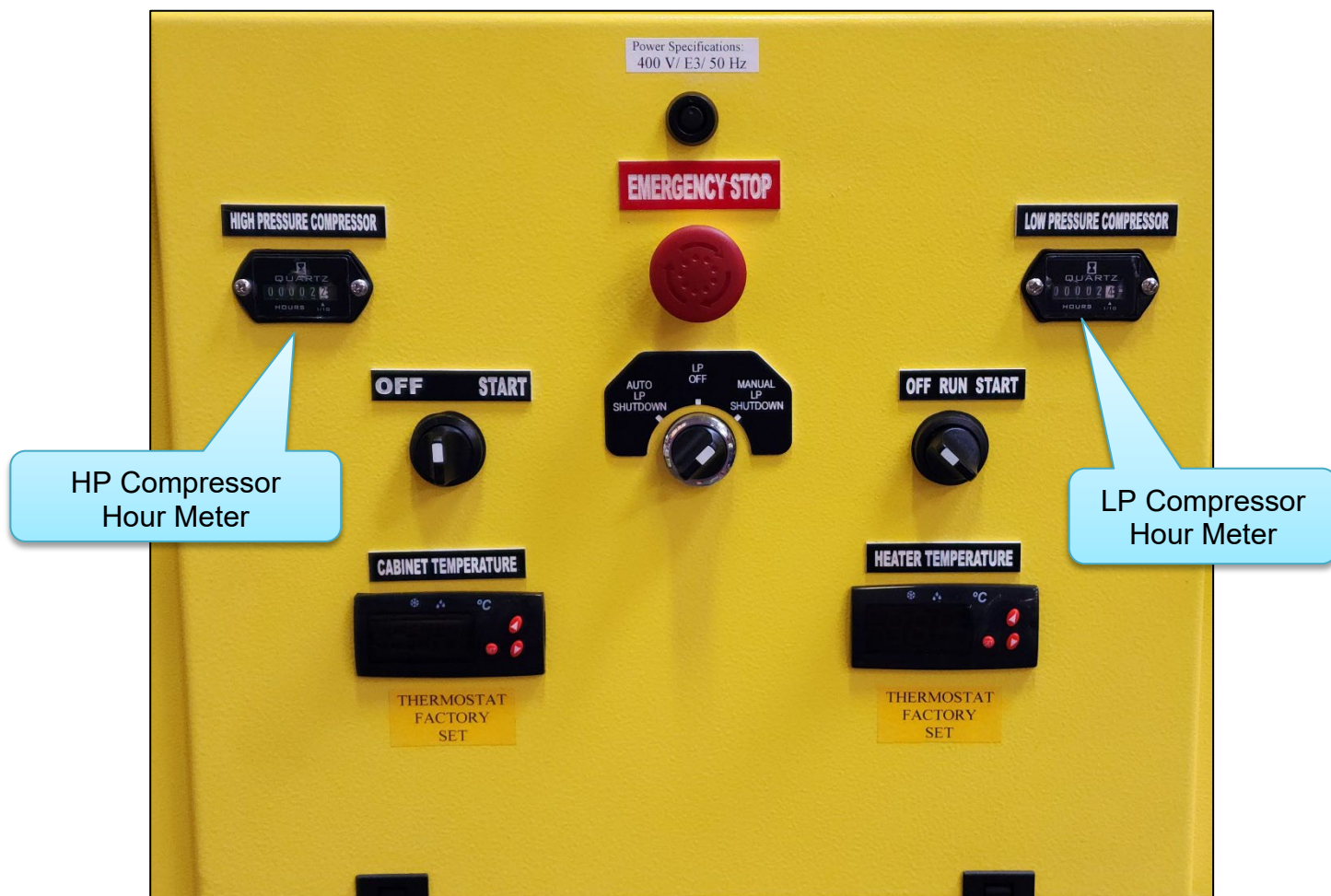


Figure 9. Compressor hour meters.

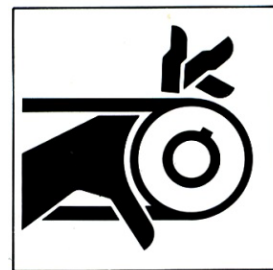
Prior to making the electrical power connection, check all system specifications provided in this manual. When working on the Nitrox System the main breaker at the power source must be “locked out” in the off position. The Nitrox System has electrical protection for the Compressor Motor and Membrane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

## Amperage Load for System

- ◆ Approximately 30A for 400V three-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**).



To bump start the rotary low pressure compressor, switch on the press emergency stop button.



### **NOTICE**

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

## 13.4 Air/Nitrox Quality Testing

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

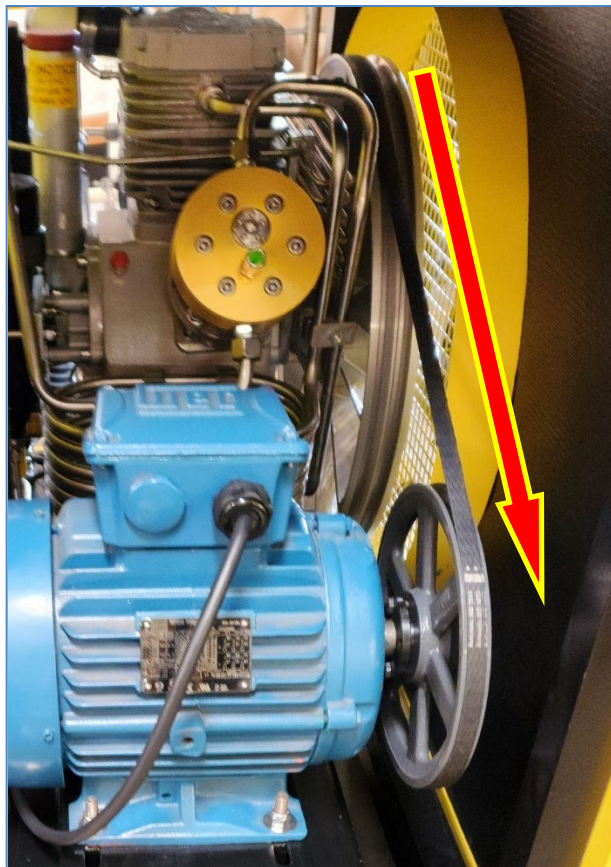
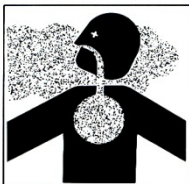


Figure 10. Rotation direction of fan belt.



## 14.0 Pre-Operation Instructions



### **WARNING**

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



### **WARNING**

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

## 14.1 Compressor Lubricant Levels

Check lubricant levels before starting the LP and HP Compressors, and add lubricant as required. Use only the lubricants specified. For additional information on how to check and change oil in the EK76 low pressure compressor, see this [YouTube video](https://youtu.be/kjYuaQ2l_nQ) ([https://youtu.be/kjYuaQ2l\\_nQ](https://youtu.be/kjYuaQ2l_nQ)).

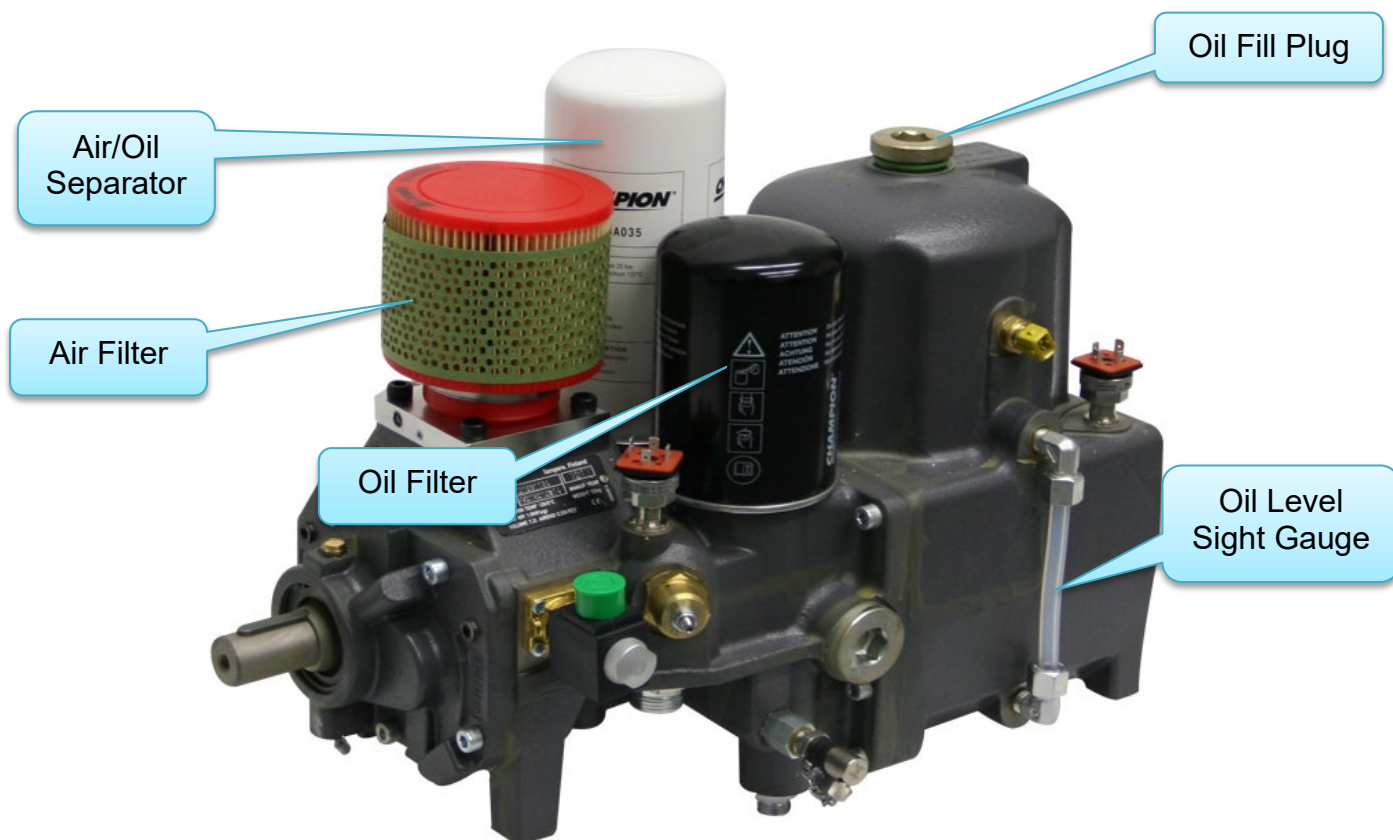


Figure 11. EK76 Low Pressure Compressor.

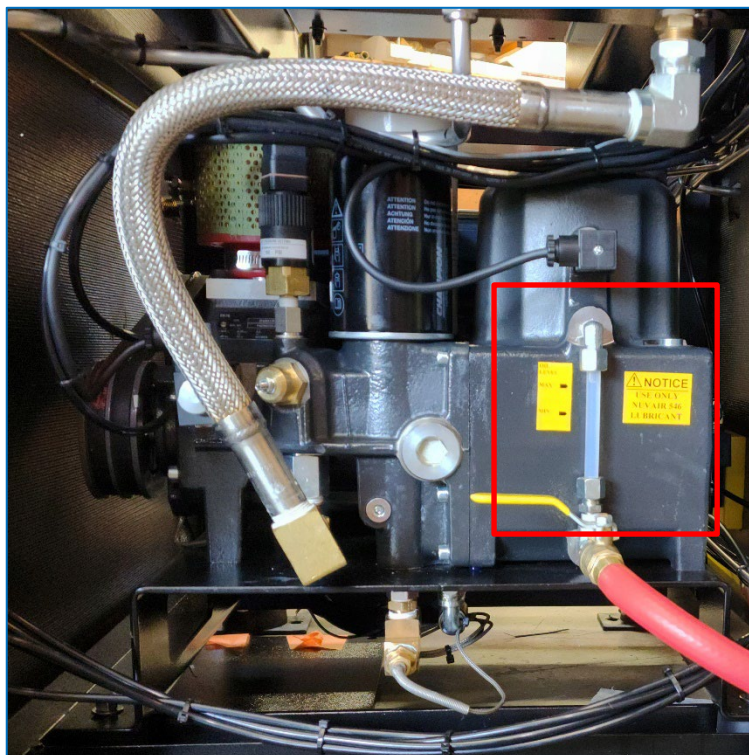


Figure 12. Voyager 315 EK76 oil level sight gauge and high/low indicator decal.

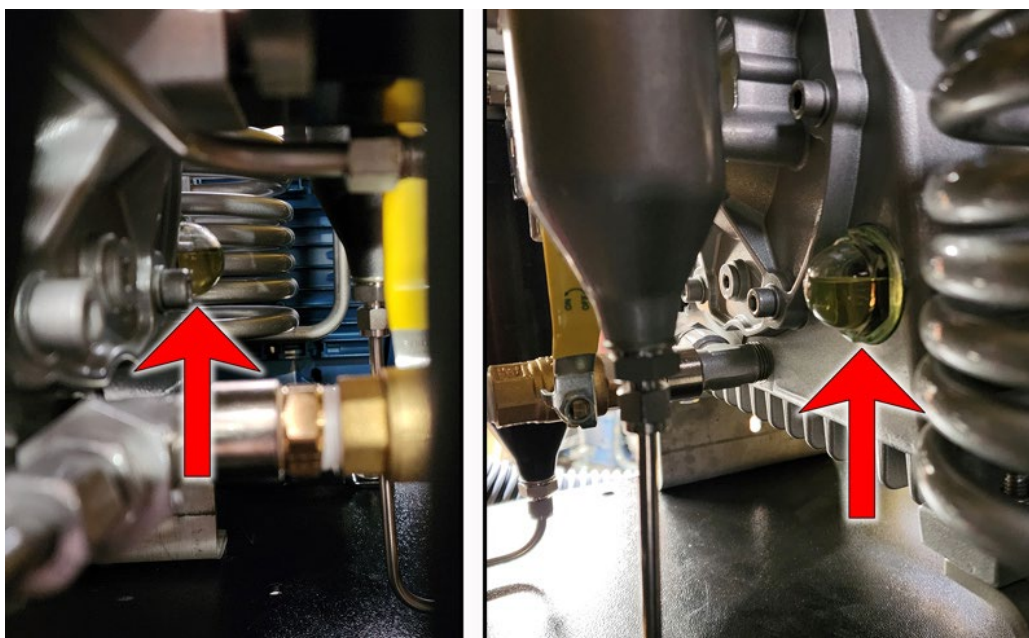


Figure 13. Two views of high pressure compressor oil level sight glass from both sides of cabinet.

## 14.1 Start Refrigerated Air Dryer

Power up the refrigerated air dryer 30 minutes before operating the Voyager 315. The refrigerated dryer extends the life of the nitrox membrane low pressure filters by 100 or more hours.

## 14.2 Membrane System Feed Air Regulator and Switch

A back pressure (BP) Regulator is used to adjust the amount of air that is pumped by the LP compressor. As the volume of air increases, the pressure to the Membrane System is increased to a typical range of 90–165 psi (6–11 bar). Prepare the Membrane System as follows:

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

## 14.3 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> ( $\pm 2\%$ ); 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> ( $\pm 1\%$ ). **Both Oxygen Analyzers must be calibrated prior to each use.**

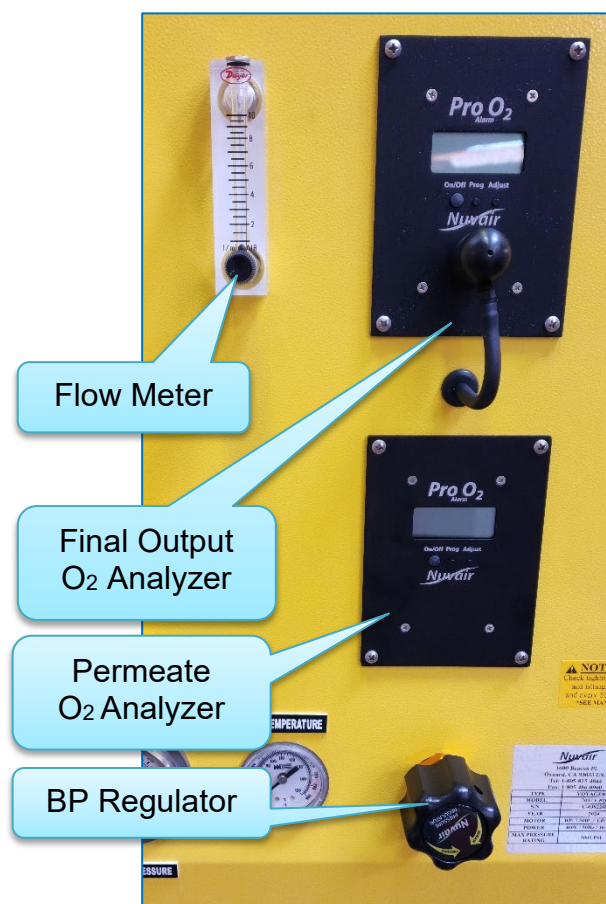


Figure 14. Membrane system components.



### **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  $\pm 2\%$  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  $\pm 1\%$  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 compressor and return LP Feed Air BP Regulator to minimum pressure setting by turning adjustment knob CCW until it spins freely.
- 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.
- 3) Adjust fill whip valve so the running HP Compressor maintains 1500-2000 psi (100-140 bar) outlet pressure. Air will now be flowing past both Oxygen Analyzers for calibration purposes.
- 4) Monitor all gauges for proper operating range and check all connections for leaks.
- 5) Calibrate Oxygen Analyzers while the 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.



*Figure 15. Clean rag acts as sound muffler.*

### **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.

Flow Adapter Cap



### 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.**



#### **NOTICE**

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





## **15.0 Producing Nitrox**



### **WARNING**

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

### **15.1 Flow to Membrane and Setting Proper Pressure**

- 1) Verify that Oxygen Analyzer calibration is complete, LP compressor is Off, and Regulator is at minimum pressure setting.
- 2) Turn on HP Compressor. Allow pressure to build up to about 2000 psi (140 bar), then crack open the unconnected fill whip to maintain 1500–2000 psi (100–140 bar).
- 3) Verify that Permeate Oxygen Analyzer and Fill Oxygen analyzer read 20.9%.
- 4) Turn on LP Compressor.
- 5) Turn BP Regulator Knob CW
- 6) Adjust feed air pressure to approximately 100 psi (7 bar) to activate Heater Pressure Switch. Increase pressure by slowly turning the regulator Knob CW or decrease pressure by turning the Knob CCW. The heater will not turn on until Membrane System is pressurized.
- 7) Check the Heater Temperature Gauge to verify air temperature rises and is between 105–120°F (40–49°C).



### **NOTICE**

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

The Membrane System feed air pressure determines the %O<sub>2</sub> of the Nitrox mixture. As pressure increases, 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 LP Pressure Gauge and Permeate Oxygen Analyzer. As the pressure rises, watch the corresponding increase in the analyzer %O<sub>2</sub> reading.
- 2) Increase or decrease pressure slowly until the Permeate Oxygen Analyzer displays the %O<sub>2</sub> desired in the final Nitrox mixture.

- 3) Allow system pressure and temperature to stabilize (approximately 5-8 minutes).
  - ◆ Regulated Membrane System pressure range should be 90–165 psi (6–11 bar), depending on Nitrox %O<sub>2</sub> being produced.
  - ◆ Heater temperature range should be 105-120°F (40-49°C).



Figure 16. Power control switches.

### 15.2 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  $\pm 1\%$ , 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.
- 4) Now you're ready to close Bleed Valve and open Storage System.

### 15.3 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.



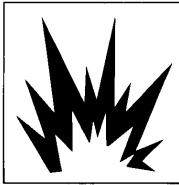
#### **WARNING**

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.



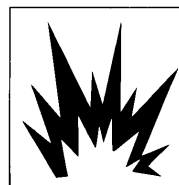
#### **WARNING**

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



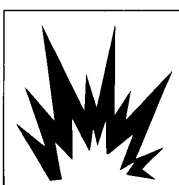
#### **NOTICE**

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. Mixing Nitrox mixtures with 100% pure oxygen may lead to fires and / or explosions, which may cause serious personal injury or death.



#### **DANGER**

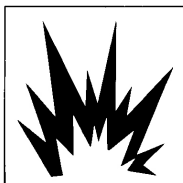
Never fill a cylinder that is marked, "For Oxygen Service," with Nitrox that has been produced by anything other than 100% oxygen clean system. Filling an oxygen clean cylinder with breathing gas containing

hydrocarbons can lead to explosions if the cylinder is subsequently filled with gas mixtures containing gas mixtures containing greater than 40% oxygen. Explosions may cause serious injury or death.



### **WARNING**

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



### **DANGER**

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



### **WARNING**

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

Pump Nitrox as follows:

- 1) When filling a Scuba cylinder, follow all industry standards. Do not exceed rated pressure of cylinder, and do not exceed 3600 psi (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.

DEVICE	RECOMMENDED SETTING
Flow Meter	3 L/min maximum
Compressor Gauges	According to manufacturer's recommendations
Heater Temperature	105–102°F (40–49°C)
Cabinet Temperature	Less than 100°F (38°C)
Membrane Feed Air Pressure	90–165 psi (6–11 bar) depending on nitrox O <sub>2</sub> %
Fill Oxygen Analyzer	Showing the proper reading for intended fill
Nitrox Storage Pressure	DO NOT exceed rating of tank or 3600 psi (250 bar)

4) After filling is complete, close cylinder valve, vent the bleed valve, and remove the cylinder.

5) Test the Nitrox %O<sub>2</sub> in the cylinder using an independent Oxygen Analyzer such as the Nuvair O<sub>2</sub> Quickstick. Calibrate analyzer before use in accordance with manufacturer's instructions.

6) Repeat steps 1–5 until you have filled all scuba cylinders.

7) Mark each tank with fill date, percentage nitrox, fill pressure, and MOD (Maximum Operating Depth).

8) Log every Nitrox fill to document the following information:

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

9) When filling a 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 psi (250 bar) under any condition. After filling is complete, close all valves and allow Nitrox System to shut down.



Figure 17. Independent oxygen analysis.



## 15.4 Pumping Air

To use the System to pump air, simply turn off the LP Compressor. 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.**

## 15.5 Automatic Compressor Shutdown

The Voyager 315 uses automatic controls to shut down the system when set pressure is reached. The Dial-a-Pressure Switch indicates the system's fill pressure. Turn the gauge knob to dial-in the desired shutdown pressure. The red hand in the pressure dial indicates the approximate shutdown pressure. The compressor will shut down when that pressure is reached.

The LP Shutdown Switch (shown in Figure 16) allows users to determine how the LP compressor will shut down:

- When set to "Auto LP Shutdown" the LP compressor will turn off in conjunction with the HP compressor shuts down when set pressure is reached.
- When set to "Manual LP Shutdown" the LP compressor will need to be turned off manually.
- When set to "LP Off," this function is disabled.

## 15.6 Shutting Down

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



Figure 18. Dial-a-Pressure switch.

## **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 percentages 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 psi (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 psi (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 psi (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.

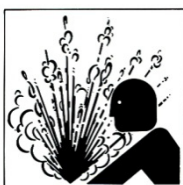
### 17.1 Daily Maintenance



#### **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) 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.
- 4) Users can attach a hose to the condensate trap discharge valve and use a 5-gallon bucket to collect condensate. Make sure to properly dispose of collected condensate appropriately and at regular intervals to avoid overflowing collection container.

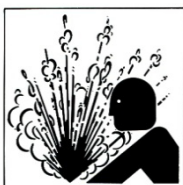


#### **WARNING**

**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.**



Figure 19. Condensate trap discharge valve.



#### **WARNING**

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





**CAUTION**

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

**17.2 Routine Maintenance**

- 1) LP Compressor Lubricant: Change Compressor Lubricant every 500 hours. Only use lubricants rated for use with Nitrox, such as Nuvair 546. Never mix Compressor Lubricants. See Section 17.3 and 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 <sup>TM</sup>. 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 250 hours to maintain CGA Grade D air standards. Visual liquid level and service life indicators assist with monitoring replacement intervals. See Section 17.5 for details. If the Nitrox System is operated in high humidity and/or high temperature, Filter Elements must be changed more often. See Appendix for details on Filter Element Life Factors.
- 5) HP Compressor Filtration Element: Change HP Filter Element every 60,000 cubic feet of air or Nitrox processing to maintain CGA Grade E air standards. See Section 17.6 for details. If the Nitrox System is operated in high humidity and/or high temperature the Filter Element must be changed more often. See Appendix for details on Filter Element Life Factors.
- 6) Condensate Drain Container: Check level and drain weekly or as needed.
- 7) Semi-Permeable Membrane: No maintenance required. Service life exceeds 20 years if 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.
- 10) Air/Nitrox Quality Analysis: Take breathing air/Nitrox samples quarterly for analysis to assure compliance with CGA Grade E breathing air standards.



**DANGER**

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



**DANGER**

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

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

### **17.3 Compressor Lubricant**

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



**WARNING**

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



**WARNING**

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



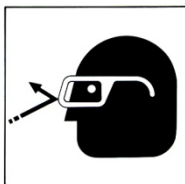
**WARNING**

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



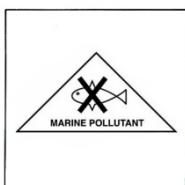
### **WARNING**

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



### **CAUTION**

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



### **CAUTION**

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



### **WARNING**

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

Lubricant fill ports shown below for each compressor installed in the Voyager 315.

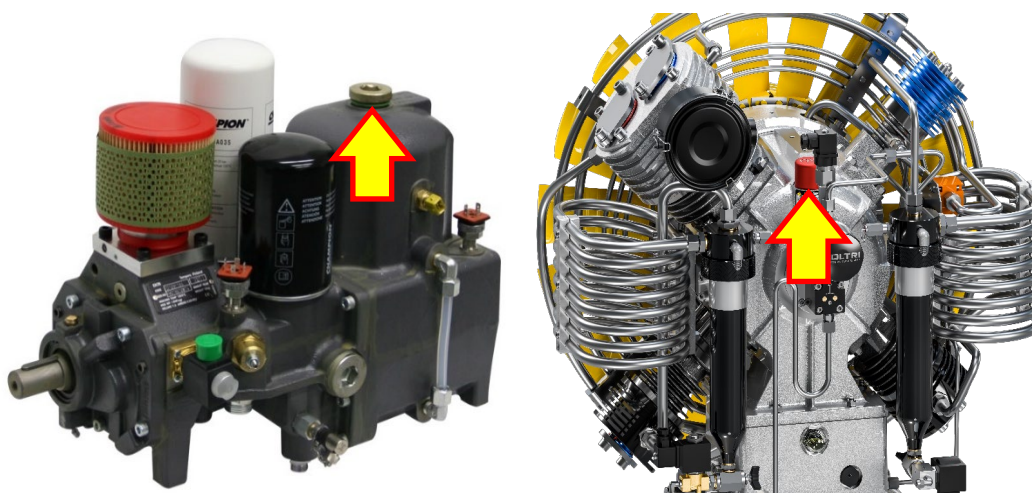


Figure 20. Lubrication fill plugs for each compressor. (Representative image of HP compressor)

- The LP compressor in your Nitrox system comes standard with Nuvair 546 synthetic food grade compressor lubricant for rotary screw compressors.
- The HP compressor comes with the Nuvair 455 synthetic food grade lubricant.
- Check lubricant levels at each sight gauge and add lubricant as required through the appropriate lubricant fill plug.
- Lubricant is removed through the drain plugs. See 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 three LP Feed Air Filtration Elements and Bowls. Properly reinstall each Element and Bowl to the correct Housing. Improper sequence can cause damage to downstream components**

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

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

### **17.5 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 HF7-20 Filter indicates improper operation of auto-drain floats. Evidence of any moisture in the HF1-20 Filter indicates air is not cooling properly and moisture is not properly being removed. Excess moisture will prevent the final filter from operating properly and can lead to damage of the membrane.



Figure 21. Low pressure filtration and drain valves.

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

## 17.6 Changing LP Filtration Elements

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

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



Figure 22. Replacement low pressure filter elements.





## **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.

### **17.7 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 60,000 cubic feet of air or Nitrox processing. If the Nitrox System is operated in high humidity and/or high temperature, Filter Element must be changed more often. See Appendix for details on Filter Element Life Factors.

- Shut down the compressor system.
- Open and leave open the drain valve/s (Figure 21) to vent all pressure from the circuit.
- Use the wrench (a, Figure 25) to apply leverage on the screw heads (b) of the plug (c) and rotate counterclockwise. If a filter wrench (SKU TL-033) is not available, a large screwdriver can be used to unscrew the filter plug (1, Figure 24).



Figure 23. Voyager 315 HP filter cannisters.

- Remove the filter plug (2, Figure 24).
- Remove the first cartridge (3, Figure 24) and the second cartridge; replace both with new cartridge elements. Place pressure on each cartridge (4, Figure 24) to seat the element fully into the canister.
- Replace the O-ring (e, Figure 25) on the plug (c) every time the filter is changed.
- Reinstall cap to canister by rotating clockwise and tightening with screwdriver or cap wrench.
- There are sealing O-rings (e-f, Figure 25) on the plug and the filter cartridge. If these O-rings deteriorate, the air is released via the venting hole (g).
- If you notice any venting from this hole replace the O-rings. When replacing the O-rings observe the precautions described at the start of the section.
- Close the drain valve/s.



Figure 24. Changing air filter cartridge.



## **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.**

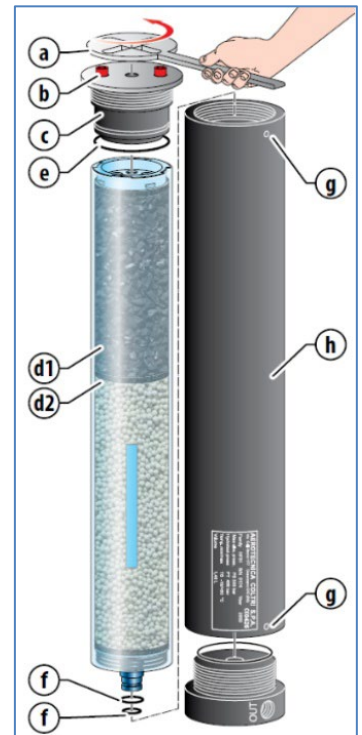
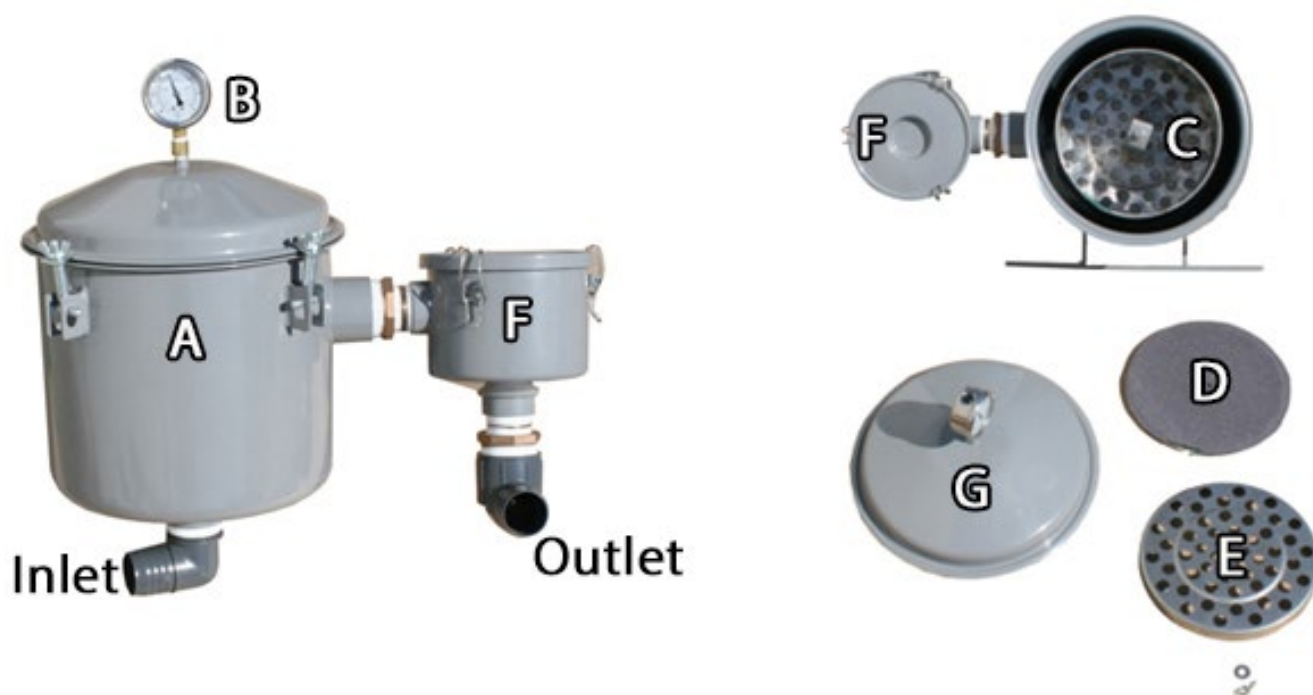


Figure 25. Filter cartridge and cartridge parts.

## 17.8 CO<sub>2</sub> Scrubber Maintenance

The CO<sub>2</sub> Scrubber (SKU 6070.5) is equipped with:

- A. Outer Scrubber Housing
- B. Scrubber Housing Vacuum Gauge
- C. Inner Media Containment Housing
- D. Dust Containment Mat
- E. Perforated Media Containment Housing Lid
- F. After Filter
- G. Outer Housing Lid



*Figure 26. Carbon Dioxide (CO<sub>2</sub>) Scrubber parts.*

The media should be changed any time a significant rise in CO<sub>2</sub> level is indicated by calibrated analyzer. When filling the media containment housing, take care not to spill media between it and the outer scrubber housing. When reinstalling the outer scrubber housing lid, ensure that the large O-ring is properly seated.



When reassembling the inner media containment housing after initial fill or media change, ensure that the dust containment mat is in place under the Perforated Lid.

If a rise in vacuum in the scrubber housing is indicated, the media has been compromised or a blockage has occurred prior to the scrubber housing.

When the media is changed, the after filter element should be inspected for cleanliness and water saturation. If there is an excess of media dust or water present, the filter element is compromised and should be changed.

### **Recommended Divesorb® Pro CO<sub>2</sub> Absorbent Media**

Capacity: 3 gallons (11.3 L) or 25 lb (11.3 kg)

SKU DIVESORB37

### **After Filter Element**

Intake Filter Element for SCL-848-150HC

SKU 848



*Figure 27. Assembled scrubber inner housing.*

## 18.0 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	SKU Number
<b>LP Compressor Consumables</b>		
Food Grade Lubricant, Nitrox Compatible	Nuvair 546, 1 Gallon	9409
LP Filtration Element	Hankison HF7-20	E7-20
	Hankison HF5-20	E5-20
	Hankison HF1-20	E1-20
Oil Filter	EK76	A11207674
Air/Oil Separator	EK76	300KBA035
Air Intake Filter	EK76	300KBA1446
<b>HP Compressor Consumables</b>		
Food Grade Lubricant, Nitrox Compatible	Nuvair 455 or Nuvair 751, 1 Gal	9406 or 9403
HP Compressor Filtration Element	Breathing Air, Grade E	X65247
Optional Filter	Breathing Air, Grade E	X65677
Heater Assembly	1200 Watt, 28" Length	H1200.1
Heater Thermostat Control	110V/220V	TS-13021
Heater Pressure Switch	2pcs (redundant)	B16-947
Membrane	230 Series	PPA-230
Air Intake Filter Element	10 CFM	14
<b>Analyzers</b>		
Pro O2 Alarm	Analyzer Panel Mount	9612
	Replacement Sensor	9507M
Pro O <sub>2</sub> Remote	Analyzer Panel Mount	9462
	Replacement Sensor	9506
Pro CO Remote	Analyzer Panel Mount	9624
	Replacement Sensor	9501
Pro CO <sub>2</sub> Remote	Analyzer Panel Mount	9617
	Replacement Sensor	9616-SEN
<b>Related Components</b>		
Air/Nitrox Quality Analysis Kit	See <a href="https://nuvair.com/products/parts-accessories/test-kits">https://nuvair.com/products/parts-accessories/test-kits</a>	
Divesorb® Pro CO <sub>2</sub> Absorbent	CO <sub>2</sub> Media Scrubber	DIVESORB37
After CO <sub>2</sub> Scrubber Filter Element	CO <sub>2</sub> Scrubber After Filter Element	848

## 19.0 Service Record Log

[illegible]

## 20.0 Appendix

### 20.1 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) <sup>1</sup>	Not specified	Not specified
Oil & Particles (maximum) <sup>2</sup>	5 mg/m <sup>3</sup>	5 mg/m <sup>3</sup>
Odor	None	None

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

<sup>2</sup> 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.

### 20.2 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:

## ***Voyager 315 Nitrox System***

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



### **21.0 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 User 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 an HP or LP Compressor for compressing Nitrox, contact Nuvair 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 Nuvair.
- 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 Nuvair for assistance.
- Compressors must be provided with 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 psi (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 Nuvair for assistance.

#### **Maintenance:**

## ***Voyager 315 Nitrox System***

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

**22.0 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 unwarrantable 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.

## 23.0 Additional Record of Changes

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

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

Change Date	Description of Change



## NOTES

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