Operation Manual

MCH 36D

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 Nuvair at 1-805-815-4044 for information.

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Separate Manuals Included:

Nuvair Pro O_2 ™ Oxygen Analyzer Operation Manual
High Pressure Compressor Manual
Gas or Diesel Engine Manual (if equipped)

1.0 Introduction

This manual will assist you in the proper set-up, operation and maintenance of the Nuvair MCH36D Nitrox System. Be sure to read the entire manual.

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

⚠ Danger

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

⚠ Warning

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

⚠ Caution

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

⚠ Notice

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

2.0 Safety Warnings

⚠ Warning

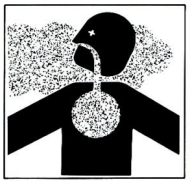
This equipment is used to provide breathing gas for the purpose of underwater life support. Read this manual in its entirety. Failure to heed the warnings and cautions contained in this document may result in severe injury or death.

⚠ Warning

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

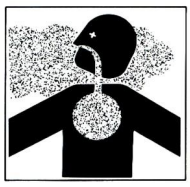
⚠ Warning

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



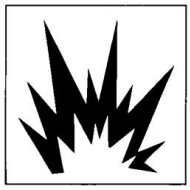
⚠ Danger

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



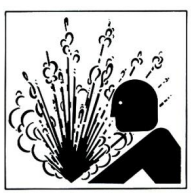
⚠ Warning

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



⚠ Warning

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



⚠ Warning

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

⚠ Warning

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

⚠ Warning

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

⚠ Caution

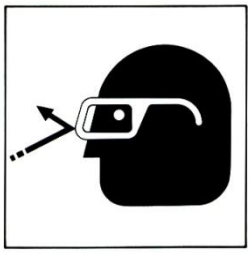
Ambient room temperature should never exceed 104° F (40° C) during operation of the nitrox system. Operation at higher temperatures may lead to system damage and malfunction. A damaged membrane will not produce the correct nitrox mixture which can lead to severe personal injury if the gas is used for diving purposes without proper analysis.

Warnings Graphics Defined:

Moving belts

Electrocution

Fire

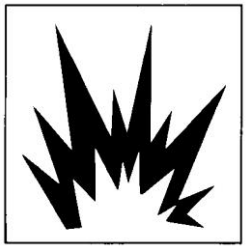


Eye protection

Gas inhalation

Skin damage

Explosion



Explosion

Electrocution

Machinery

Abbreviations commonly used in this manual:

P.S.I.	Pounds Per Square Inch	C.F.M.	Cubic Feet Per Minute
H.P.	High Pressure	R.P.M.	Rotations Per Minute
L.P.	Low Pressure	P.P.M	Parts Per Million
O_2	Oxygen	L/min	Liters Per Minute
CO	Carbon Monoxide	O_2%	Oxygen Percentage of Gas
CO2	Carbon Dioxide	B.P.	Back Pressure
N	Nitrogen		

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” **and** “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 this compressor in any location where there is a possibility of carbon monoxide (CO), carbon dioxide (CO_2), nitrogen (N), or any flammable or toxic fumes being sucked into the compressor intake.
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, 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 Storage & 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 ($\%O_2$) plus signature and date
- User's check of oxygen content ($\%O_2$) 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 MCH36D 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 portable, with an open aluminum frame for excellent access to components yet 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 diesel, gas, hydraulic or electric power, without the hazards or expense of blending with stored high-pressure oxygen (O_2). Instead, the system uses a Semi-Permeable membrane to produce Nitrox from air. A portion of the nitrogen in air is separated out, leaving an oxygen rich Nitrox mixture. This Nitrox mixture can be pumped up to a maximum pressure of 3600 P.S.I. (250 bar) when filling Scuba Cylinders or storage tanks.

The MCH36D Nitrox requires a source of clean, pressurized, and heated air for separation. The two most common sources are an LP compressor (LP Supply Option) or HP Air Storage Tanks (HP Supply Option).

The supply air must be properly filtered to CGA Grade D or E air quality prior to entering the Membrane System so it will not damage or plug the membrane fibers. Specifications for Grade D and E air are provided in the Appendix.

Standard systems are rated for maximum supply pressures of 300 P.S.I. (21 bar) for LP Supply and 5000 P.S.I. (345 bar) for HP Supply. An Input pressure regulator reduces the pressure to appropriate levels for various $\%O_2$ 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 44% O_2 under normal operating conditions.

The permeate is a concentrated mixture that must be diluted with additional air prior to entering the Nitrox Compressor. It exits the membrane at ambient to slightly negative pressure and travels into the mixing tube, where it mixes homogeneously with filtered outside air. The amount of dilution, and thus final $\%O_2$, is obtained by adjusting the Input pressure regulator. As pressure is increased, permeate flow increases, air flow decreases, and a higher $\%O_2$ Nitrox is produced. As pressure is decreased, permeate flow decreases, air flow increases, and a lower $\%O_2$ Nitrox is produced. This relationship between permeate flow and air flow exists because the total of these two flow rates will always equal the intake flow rate demanded by the Nitrox Compressor. The resulting Nitrox mixture is analyzed for $\%O_2$ before entering the Nitrox Compressor for approximate content and again when pumping Nitrox for precise content.

A unique feature of Nuvair Nitrox Systems is that the input pressure that correlates to a specific Nitrox $\%O_2$ is repeatable. For example, if your Nitrox Compressor pumps 36% O_2 when the input pressure is at 125 P.S.I. (9 bar), then adjusting the regulator to 125 P.S.I. (9 bar) during the next use will produce the same mixture.

6.0 High Pressure Compressor Technical Data

Capacity and Power Consumption:

- Normal working pressure Nitrox – 3600 P.S.I. (250 bar)
- Normal working pressure Air – 6000 PSI (413 bar)
- Free Air/Nitrox Delivery -22 CFM (622 L/min)
- Charging Rate - 26 SCFM (752 L/min)
- Compressor speed of rotation – 1250 rpm
- Maximum working pressure – 6000 P.S.I. (413 bar)
- Transmission – Belt drive

Cooling

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

Motor and Electrical Values:

- Motor – 20 hp (15 kW)
- Speed of rotation – 3450 rpm
- Circuit Breaker Size
  230V-50/60 Hz/three phase – 100A
- Compressor current
  230V-50/60 Hz/three phase – 53A

General Technical Data:

- Number Of Stages - 4
- Number Of Cylinders – 4
- Lubrication – Pressure Lubricated
- Oil Quantity – 5 Liters
- HP Filtration Rating – CGA Grade E, 60,000 cu. ft. at 68^{o}F (20^{o}C)
- Condensate Drain - Manual Interstage & Final
- Fill Pressure Stop – Automatic
- Low Oil Level Shutdown
- High Temperature Shutdown
- Interstage Pressure Gauges
- Solar Charger

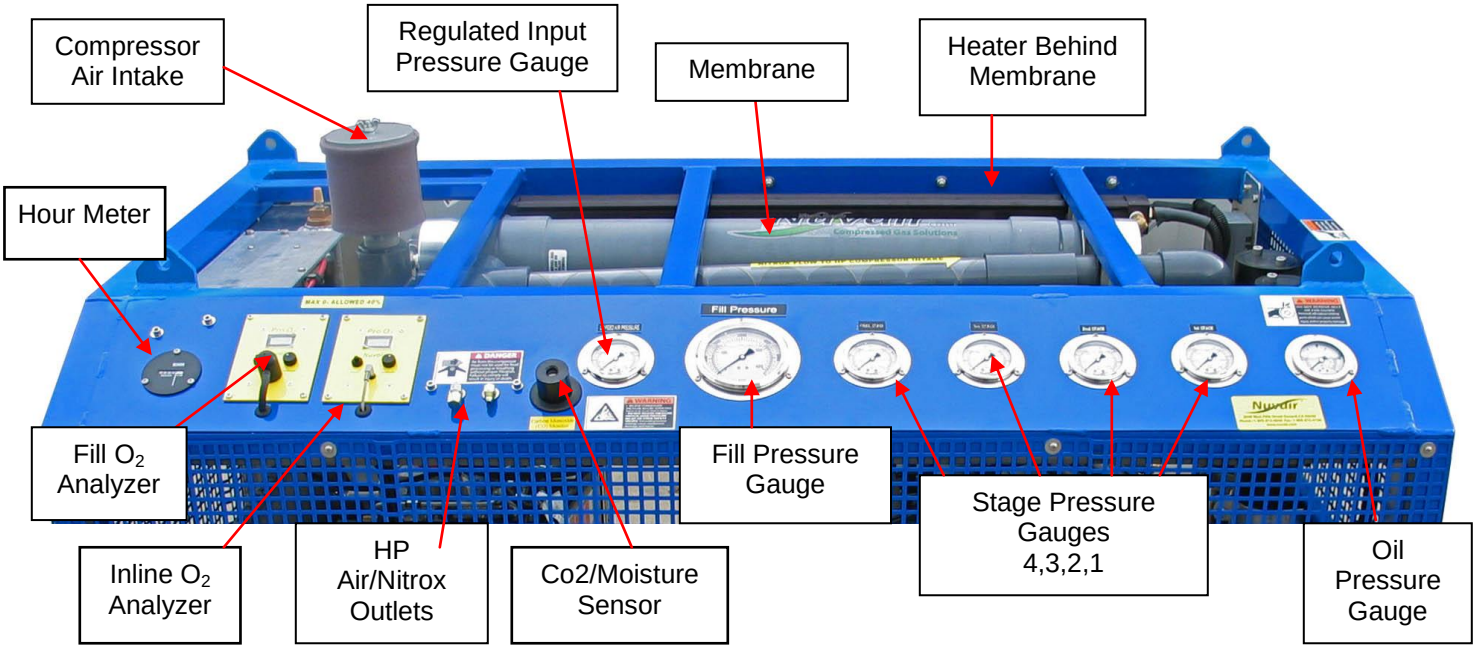
7.0 System Components

- High Pressure compressor:
- 20 hp (15kW) Electric Motor (28.5hp Diesel or Hydraulic Power available)
- Nitrox Compressor Lubricant:
  - Nuvair 455 ™ Food Grade Lubricant (standard)
  - Nuvair 751 ™ Diester Based Lubricant (optional)
- Powder Coated Steel Element Frame with lifting handles & dual isolation vibration mounts (Stainless Steel option available)
- Regulated Input Pressure Gauge
- Fill Pressure Gauge
- On/Off Flow Ball Valve
- Input pressure regulator with Pressure Gauge:
  - High Pressure>Low pressure regulator, Input Pressure 500-5000 P.S.I.(34-340Bar) (High Pressure Supply Option)
  - Low Pressure>Low pressure regulator, Input Pressure 165-300 P.S.I. (11-20 bar) (Low Pressure Supply Option)
  - Output Pressure 90-165 P.S.I. (6-11 bar) depending on Nitrox $\%O_2$
- High Pressure Inlet Filtration - Backup Oil Vapor Filter, 0.003 PPM (High Pressure Supply Option)
- Low Pressure Inlet Filtration, Grade D Breathing Air, including four stages: (Low Pressure Supply Option) Hankison Series 24
  - Particle Removal to 1 micron, auto drain, liquid level indicator
  - Coalescing, 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:
  - 110/220 Volt 7 Amp
  - 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_2 Remote ™ Inline Oxygen Analyzer
- Compressor Intake Hose
- Nitrogen Discharge Hose (optional)
- Nuvair Pro O_2 ™ Fill Oxygen Analyzer, including:
  - High Pressure>Low pressure regulator
  - Flow Restrictor, 1 - 5 L/min
- (2) Five Foot Fill Whips with International Yoke & Valve
- Hour Meter (Electric & Gas Powered only)
  - Air/Nitrox Quality Analysis Kit

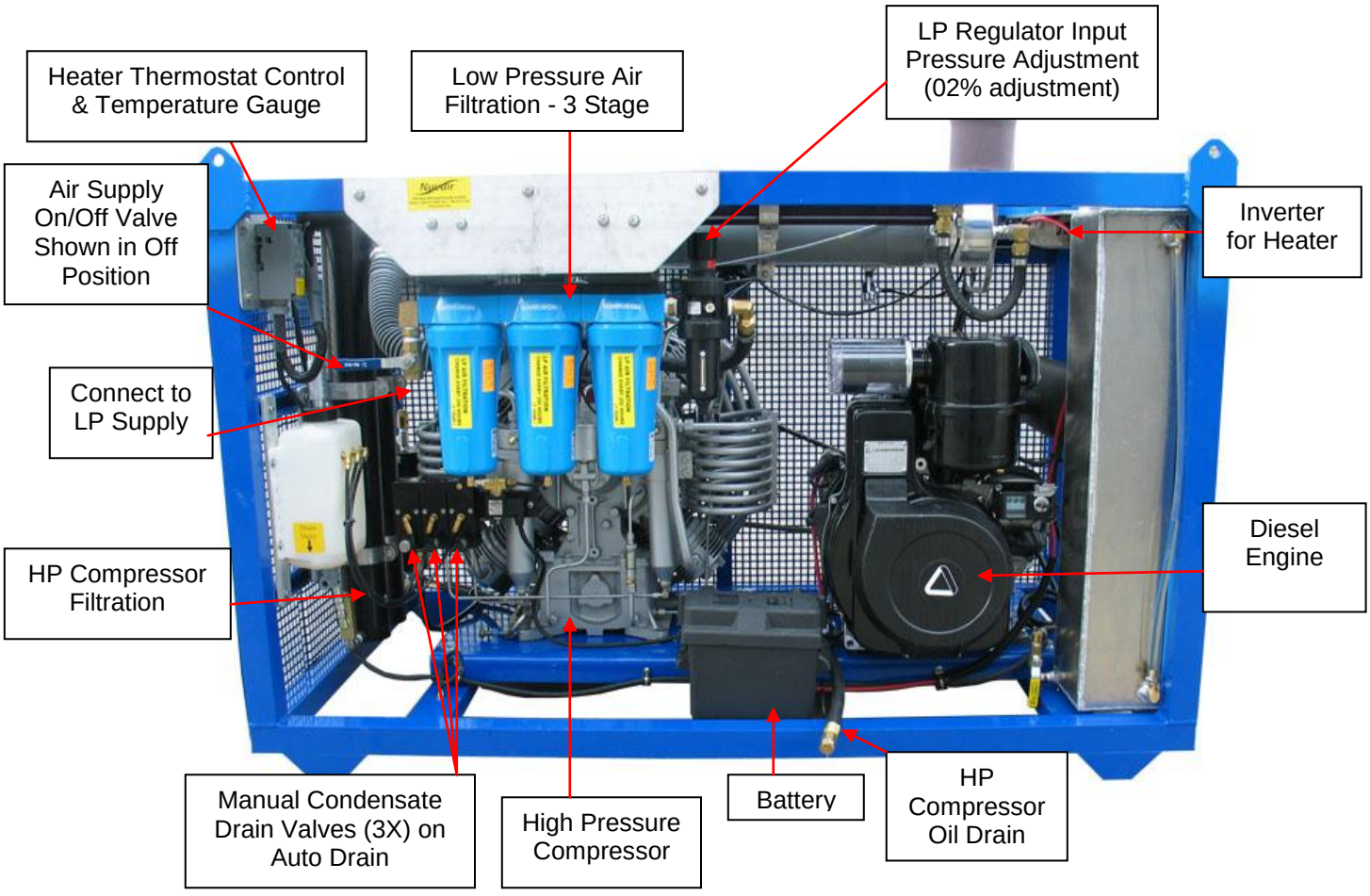
8.0 Nitrox System Specifications

Physical Specifications	Height	40 in (101 cm)
	Width	64 in (163 cm)
	Depth	36.5 in (93 cm)
	Weight diesel (motor dependent)	950 lb (432 kg)
Full Load Amps	230V/E3/60 Hz	53A
	460V/E3/60 Hz	26.5A
Membrane Input	Operating Pressure Range	90-195 psi (6-13 bar)
	Maximum Input Pressure	300 psi (21 bar)
	Supply Air Volume Range	90 scfm (2550 L/min)
	LP Supply Air Quality	Grade D
	Optimum Temperature	110 +/- 5°F (43 +/- 3°C)
	Nitrox $\%O_2$ Range	24 - 40%
HP Compressor	Fill Rate	22 CFM FAD (622 L/min)
	Horsepower – Electric	20hp (15 kW)
	Horsepower – Gas	N/A
	Horsepower – Diesel	28.5 hp

9.0 Nitrox System Component Identification



Front View – LP Supply Option Shown



Rear View – LP Supply Option Shown

Optional Equipment

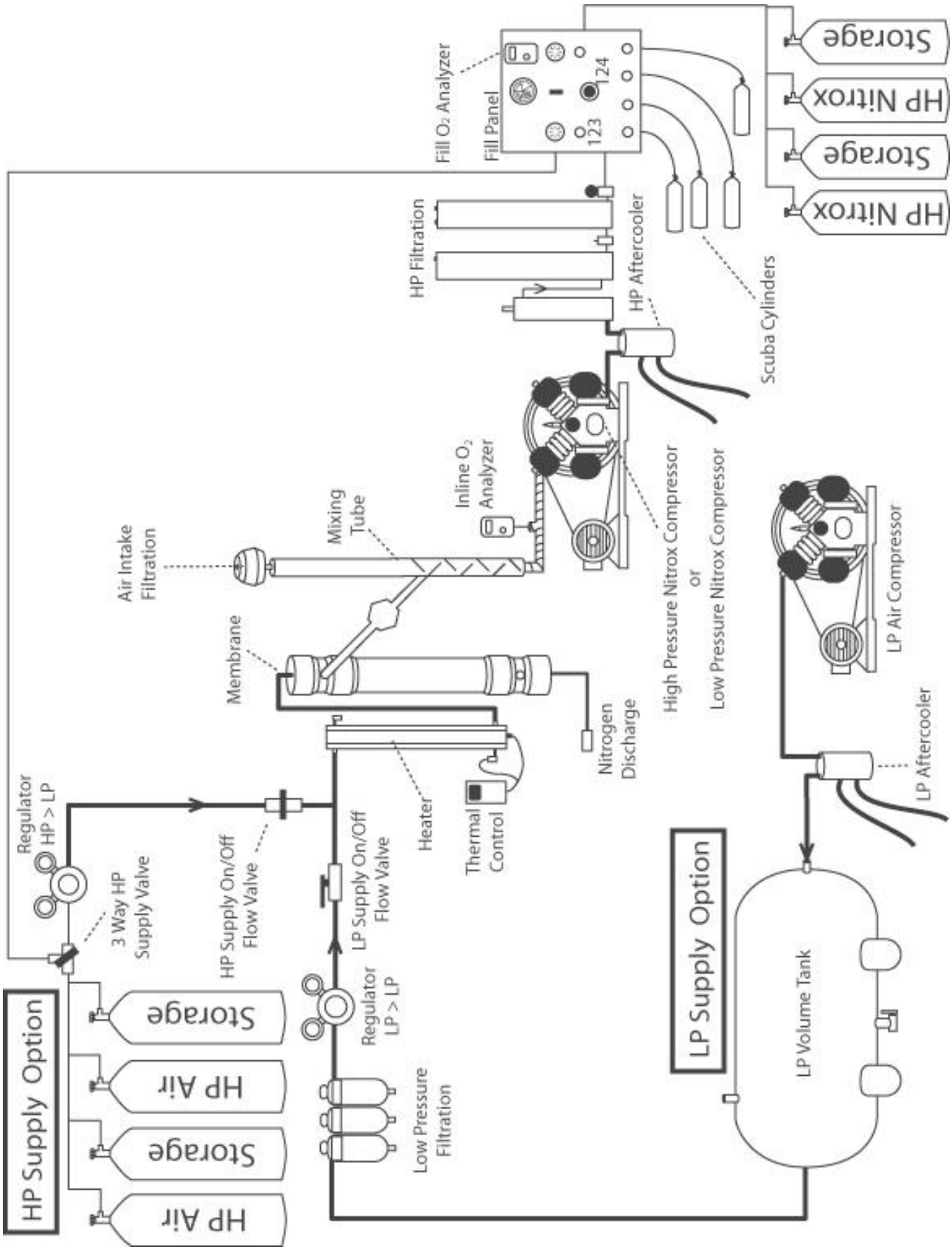
Automatic Fill Pressure Stop (Behind Panel)

Interstage Pressure Gauges

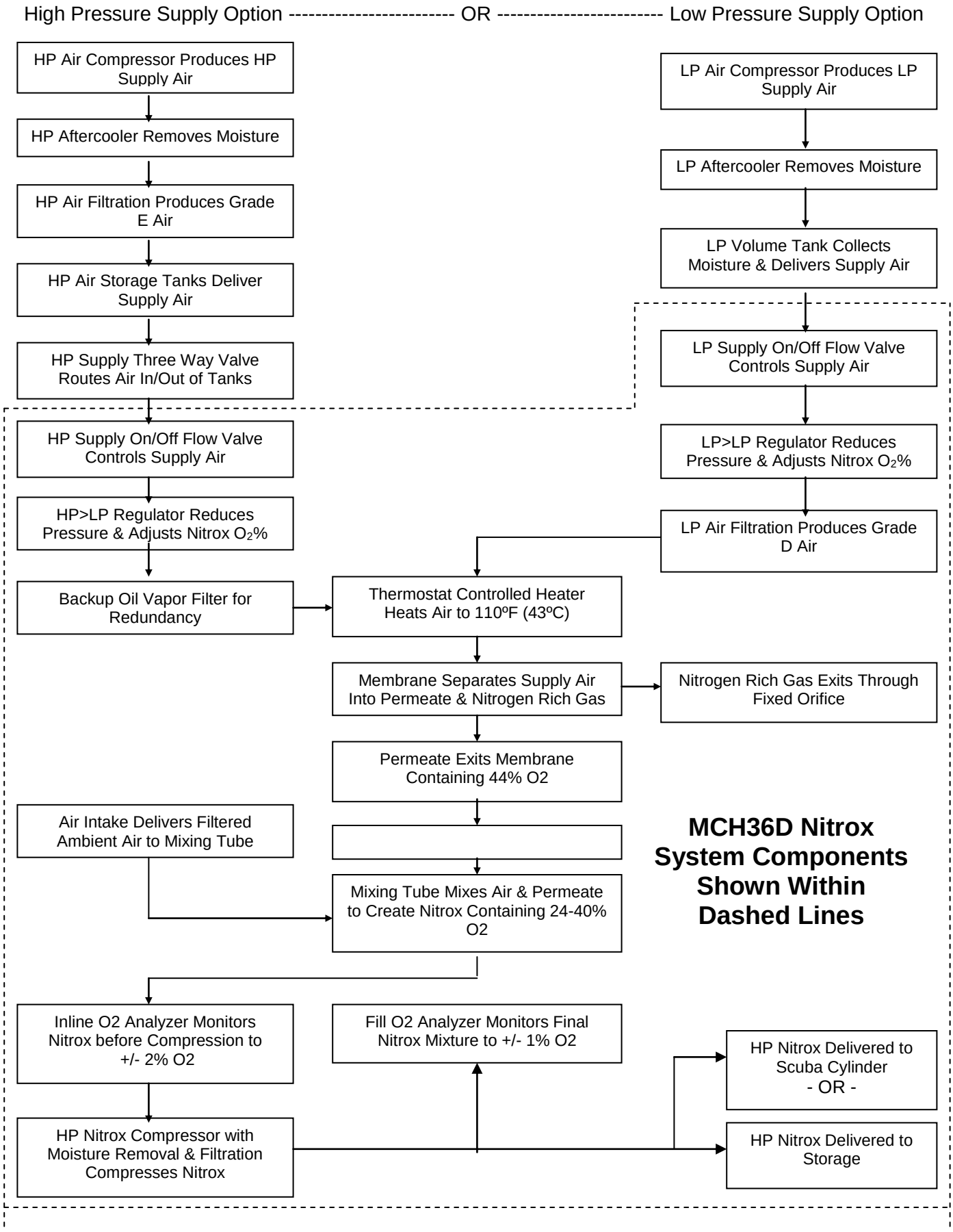
Auto Drains with Timer

Condensate Collection Container Attached to Auto Drains

10.0 System Drawing / Schematic



11.0 System Flow Chart



12.0 Installing the Nitrox System

⚠ Notice

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

⚠ Caution

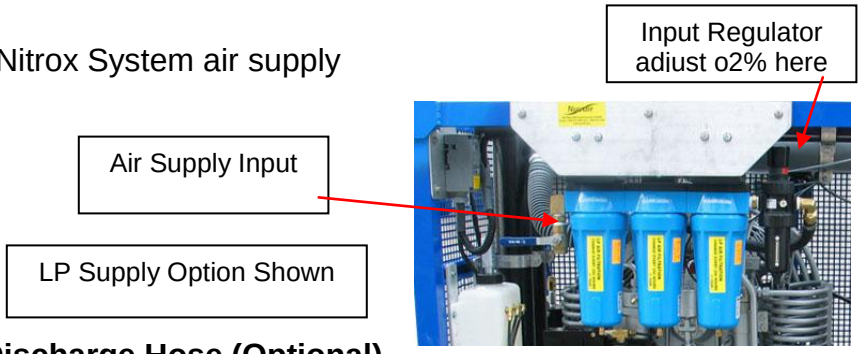
Ambient room temperature should never exceed 104° F (40° C) during operation of the nitrox system. Operation at higher temperatures may lead to system damage and malfunction. A damaged membrane will not produce the correct nitrox mixture which can lead to severe personal injury if the gas is used for diving purposes without proper analysis.

12.1 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 near the existing LP compressor. Allow a minimum spacing of 18" from adjacent walls for electric and 10' for diesel. Select a location where ambient temperature will never exceed 100°F (38°C).
4) The Heater Thermostat has been set in the factory. Do not adjust.

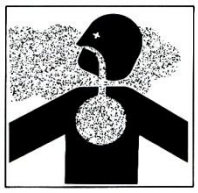
12.2 Attaching Air Supply

Secure the supply air source to the Nitrox System air supply input and verify that no leaks exist.



12.3 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 Nuvair for assistance.



⚠ Warning

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

⚠ Warning

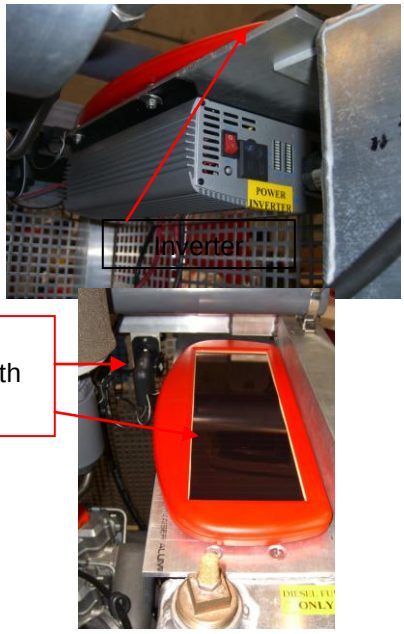
The nitrogen discharge from the membrane should be vented to a well-ventilated room or to open air with good circulation. Failure to isolate the discharge from the air intake of the membrane system or L.P. compressor could lead to incorrect nitrox mixtures, resulting in serious personal injury or death.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

12.4 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.



- Nitrox production may be limited in cold climates.
- Condensate Drain Valves will have to be operated manually.

<u>Amperage Load for System with Electric Motor</u>

- Approximately 53 A for 230 V three phase service
- Approximately 26.5 A for 460 V single phase service

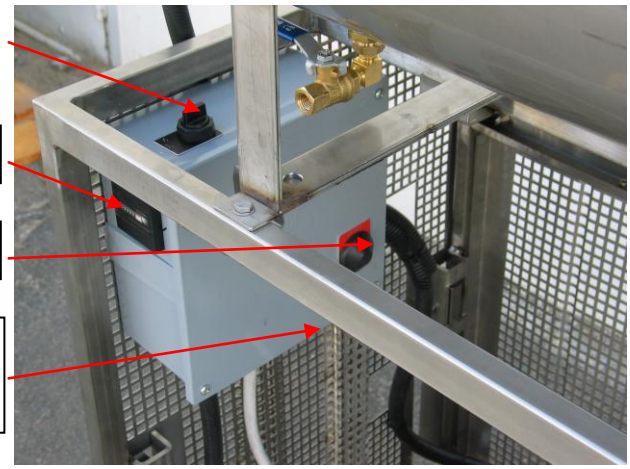
<u>HP Compressor Rotation Check</u>

<u>Always</u> turn on (bump) starter and run motor very briefly to check for proper direction of rotation of compressor (see arrow on frame).

⚠ Notice

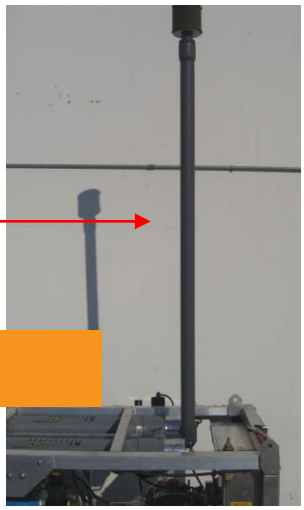
Operation in reverse direction for extended periods of time will cause a compressor to run hot and perform poorly and may cause permanent damage. Reverse rotation for a rotary screw compressor for even a short period of time will cause damage.

The Nitrox System has electrical protection for the compressor Motor and Membrane System Heater located inside the motor starter.



12.5 Membrane System Air Intake

The Nitrox System is supplied with an extended Air Intake Tube that stores in a slot on the top of the frame. Install the Tube into its fitting before operating the system.



⚠ Warning

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

12.6 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.

12.7 Gas and Diesel Engines

If your Nitrox System is powered by a gas or diesel engine, some engine preparation may be required. Consult the owner's manual provided for details.

13.0 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.

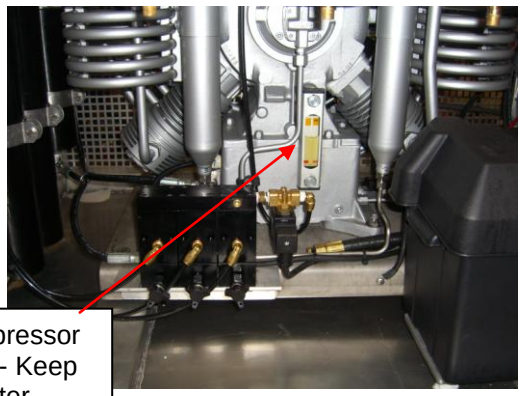
⚠ Warning

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.

13.1 Compressor Lubricant Levels

<u>Compressors</u>

Check lubricant levels before starting the LP Air compressor (LP Supply Option) and the HP compressor, and add lubricant as required. Use only the lubricants specified.



Check HP Compressor Lubricant Level - Keep Level in Center.

<u>Gas or Diesel Engine (If Equipped)</u>

Check lubricant levels before starting the gas or diesel engine, and add lubricant as required. Use only the lubricants specified.

13.2 Membrane System Regulator and Flow Valve

A regulator is used to reduce supply pressure to the Membrane System to a typical range of 90 – 195 P.S.I. (6-13 bar). An On/Off Flow Valve is used to control the flow of supply air into the Membrane System. Prepare the Membrane System as follows:

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

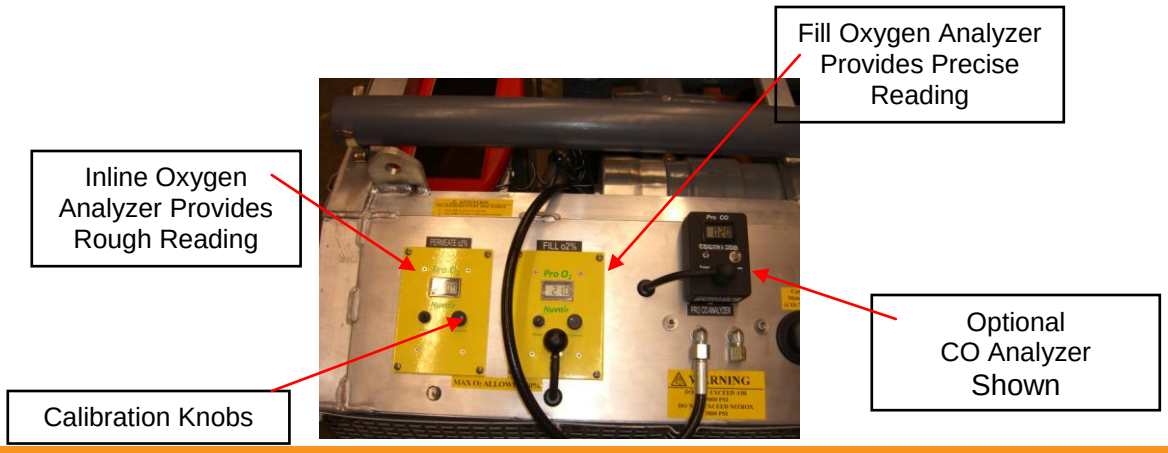
On/Off Flow Valve Handle in Off Position

Regulator Adjustment Knob

LP Supply Option Shown

13.3 Oxygen Analyzer Calibration

Gas production may be monitored with the Inline Oxygen Analyzer before entering the Nitrox compressor to obtain a rough estimate of $\%O_2$ (+/- 2%); however, this reading is just an indication of $\%O_2$ at the Nitrox Compressor outlet. Prior to pumping Nitrox into a Scuba cylinder or Surface Supply System, it must be monitored with the Fill Oxygen Analyzer to obtain a precise measurement of $\%O_2$ (+/- 1%). Both Oxygen Analyzers must be calibrated prior to each use.



⚠ Warning

Oxygen analyzers must be calibrated before each use. See oxygen analyzer manuals for correct calibration procedures. Improper calibration of the fill oxygen analyzer may result in the use of incorrect nitrox mixtures, which may cause serious injury or death to the diver using the gas mixture.

⚠ Warning

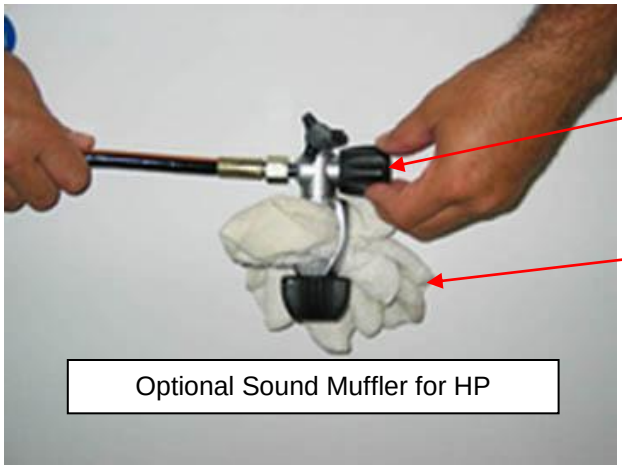
At altitudes above sea level, a correction factor must be used when calibrating the fill oxygen analyzer. It may not be possible to achieve all desired mixtures at altitude. See fill oxygen analyzer manual for correcting analyzer readings at various altitudes. Improper calibration of the fill oxygen 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 (in-line) oxygen analyzer supplies oxygen readings that can vary +/- 2% O_2 due to heat, humidity, and pressure changes experienced in the nitrox flow and therefore should only be used for rough estimates of oxygen percentage. The fill oxygen analyzer supplies more accurate oxygen readings, within +/- 1% O_2. For cylinder nitrox fills, the user must always verify with a third independent Oxygen Analyzer.

Calibrate Oxygen Analyzers as follows:

1) Close Membrane System On/Off Flow Valve and return regulator to minimum pressure setting by turning adjustment knob counter-clockwise 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.



⚠ Caution

Hearing protection is recommended whenever you are working around a compressor system that is running, or when you are venting breathing gas from a high-pressure or low-pressure hose. Failure to wear proper hearing protection may lead to hearing loss.

3) Turn on HP compressor.
4) Adjust fill whip valve so the running 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.
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.

- Inline Oxygen Analyzer - Calibrate analyzer so Display reads 20.9%.
- Fill Oxygen Analyzer - Calibrate analyzer so Display reads 20.9% to correlate with the Grade E breathing air present at the Sensor. Different settings may be used depending on location, so verify your actual ambient conditions and refer to the Oxygen Analyzer manual for details.

<u>Fill Oxygen Analyzer - Alternate Calibration Method</u>

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.

13.4 Attaching Scuba Tank or Storage 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.

14.0 Producing Nitrox

Before using your nitrox generator to pump nitrox, test a sample of the nitrox produced using the air/nitrox quality analysis kit provided to verify compliance with CGA standards or applicable standards for intended use. Quarterly testing is mandatory once the system is operational.

⚠ Warning

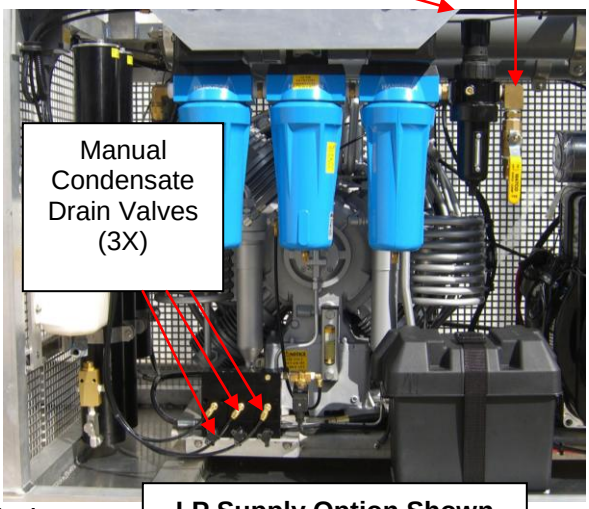
The equipment you will be using to manufacture nitrox (oxygen rich air) will expose you to both low and high-pressure gas. Gas, even under moderate pressures, can cause extreme bodily harm. Never allow any gas stream to be directed at any part of your body.

⚠ 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.

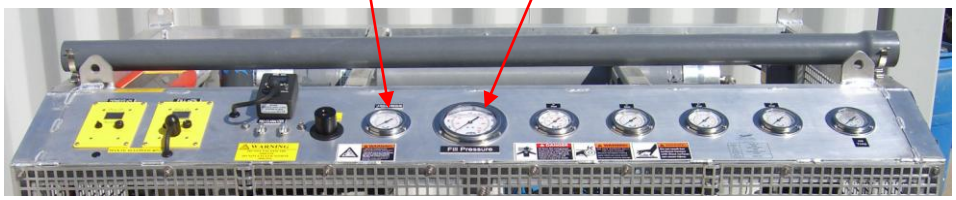
14.1 Flow to Membrane

1) Verify that Oxygen Analyzer calibration is complete, Membrane System On/Off Flow Valve is in Off position, and regulator is at minimum pressure setting.
2) Manually bleed Condensate Drain Valves to remove moisture and pressure from the HP compressor.
3) Turn on air supply source for Nitrox System:
   - ♦ LP Supply Option - Turn on LP Air compressor and allow Volume Tank to come up to full pressure.
   - ♦ HP Supply Option – Turn on HP Air Storage.
4) Turn on HP compressor. Allow outlet pressure to build up to approximately 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 Inline Oxygen Analyzer reads 20.9%.



LP Supply Option Shown

6) Turn on Membrane System by slowly opening the On/Off Flow Valve.
7) Adjust input pressure to approximately 100 P.S.I (7 bar) to activate Heater Pressure Switch. Increase pressure by slowly turning the regulator Knob clockwise or decrease pressure by turning the Knob counter-clockwise. Heater will not turn on until Membrane System is pressurized.
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 ºF (40-49 ºC). At any time that that temperature exceeds 120 ºF, .green indicator light should be off.



⚠ Caution

The on/off flow valve on the nitrox membrane system must be opened slowly. A sudden rush of gas can damage the Membrane and other system components.

⚠ Notice

The heater thermostat control green indicator light will stay on until operating temperature is reached.

⚠ 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.

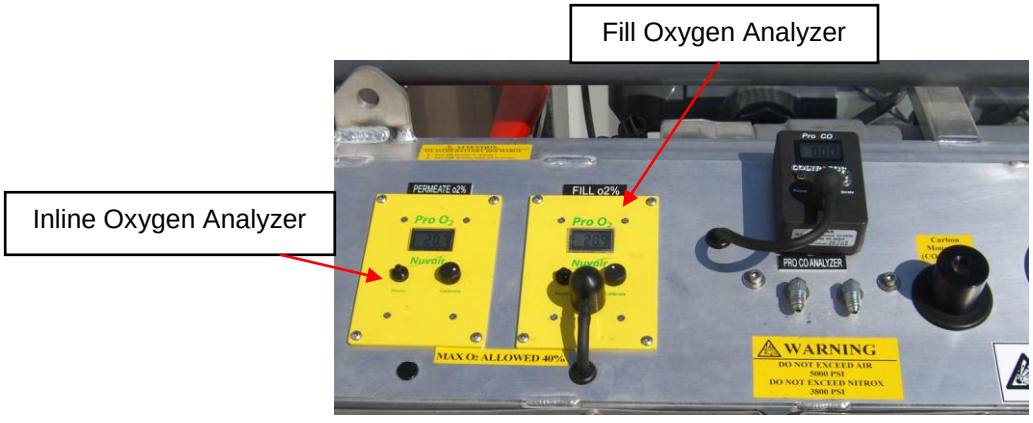
14.2 Setting Proper Pressure

The Membrane System input pressure determines $\%O_2$ of the Nitrox mixture produced. As pressure is increased, a higher $\%O_2$ Nitrox is pumped. As pressure is decreased, a lower $\%O_2$ is pumped.

1) Increase input pressure by <u>slowly</u> turning the regulator Knob CW while monitoring the Pressure Gauges and Inline Oxygen Analyzer. As the pressure rises, watch the corresponding increase in the analyzer $\%O_2$ reading.
2) Increase or decrease pressure slowly until the Inline Oxygen Analyzer displays the $\%O_2$ desired in the final Nitrox mixture.
3) Allow system pressure and temperature to stabilize (approximately 5-8 minutes).
   - ♦ Volume Tank pressure range should be 170-195 P.S.I. (12-13 bar).
   - ♦ Regulated Membrane System pressure range should be 90– 165 P.S.I (6-11 bar), depending on Nitrox $\%O_2$ being produced.
   - ♦ Heater temperature range should be 105-120 ºF (40-49 ºC).

⚠ Notice

Regulator pressure will never be higher than Volume Tank pressure.



14.3 Adjustments Before Pumping Nitrox

1) As the Nitrox initially makes its way through the running Nitrox Compressor, the $\%O_2$ reading on the Fill Oxygen Analyzer will slowly increase to read approximately the same $\%O_2$ as the Inline Oxygen Analyzer. This should happen within 3-5 minutes.
2) When the two analyzers read within +/- 1%, make any final adjustments to the Membrane System input pressure necessary to obtain the exact Nitrox $\%O_2$ desired as indicated on the Fill Oxygen Analyzer.
3) The system is now ready to pump Nitrox.

14.4 Pump 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_2 analyzer supplies oxygen readings that can vary +/- 2% O_2 due to heat, humidity, and pressure changes in the nitrox flow and should only be used for rough estimates of O_2%. The fill O_2 analyzer supplies more accurate readings, within +/- 1% O_2. For scuba cylinder fills, the user must always verify the fill with a third independent O_2 analyzer.

⚠ Warning

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

⚠ Warning

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

⚠ Notice

No oxygen cleaning of standard cylinders or plumbing is mandatory when using the nitrox system to produce nitrox containing a maximum of 40% oxygen. When filling oxygen clean cylinders, hyper-purification of the nitrox is required using an optional oxygen compatible air purification system available from Nuvair.

⚠ Warning

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

⚠ Warning

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

⚠ Warning

Only provide scuba cylinder nitrox fills to customers who have proof of nitrox training and certification. Improper use of nitrox can cause severe personal injury or death.

⚠ 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.

⚠ 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.

14.4 –continued Pump Nitrox as follows:

1) When filling a Scuba tank or storage 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 $\%O_2$ reading equals the desired Nitrox $\%O_2$.
3) Close bleed valve, open cylinder valve, and fill cylinder. Monitor system for proper operation:
   a) Monitor Oxygen Analyzers and recalibrate as required
   b) Manually drain all compressor condensate every 10-15 minutes or listen for proper operation of auto-drains if equipped.
   c) Monitor all system gauges as shown below.

⚠ Notice

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

⚠ Notice

When the H.P. compressor auto drain engages and dumps condensate, the fill oxygen analyzer reading will decrease momentarily due to the pressure drop in the system. It will return to its previous reading within seconds after the auto drain sequence stops.

GAUGE	*RECOMMENDED SETTING*
Compressor gauges	According to manufacturers recommendations
Heater Temperature	104-120° F (40-49° C)
Cabinet Temperature	Less than 104 Degrees F (40 °C)
Membrane Feed Air Pressure	90 - 175psi (6-12bar) Depending on the Nitrox O2%
Fill Oxygen Analyzer	Showing the proper reading for intended fill
Nitrox Storage Pressure	**DO NOT** exceed rating of tank or 3600 P.S.I. (250Bar)

4) After filling is complete, close cylinder valve, vent the bleed valve, and remove the cylinder.
5) Test the Nitrox $\%O_2$ in the cylinder using an independent Oxygen Analyzer such as the Nuvair O_2 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, $\%O_2$, 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 ($\%O_2$) plus signature and date
   - User's check of oxygen content ($\%O_2$) plus signature and date
   - Fill Pressure
   - MOD (Maximum Operating Depth) in user's handwriting
   - Nitrox certifying agency and card number

Use Independent Oxygen Analyzer for Verification

9) When filling a HP Nitrox storage tank, verify that Fill Oxygen Analyzer %O_2 reading equals the desired Nitrox %O_2. Open applicable line valves and tank valve, and fill with Nitrox. Do not exceed rated pressure of cylinder, and do not exceed 3600 P.S.I. (250 bar) under any condition. After filling is complete, close all valves and turn off compressor or relieve pressure.

⚠ Notice

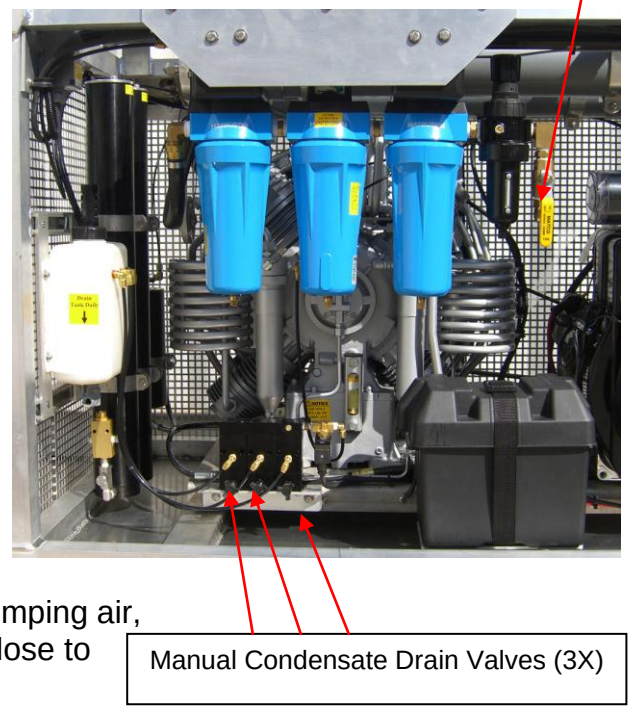
High-pressure cylinders that are filled quickly will become hot and due to the increased internal temperature the cylinder pressure will increase. This will leave a diver with less pressure inside the cylinder once cooling has occurred. This will decrease the amount of time the diver may spend underwater 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.

14.5 Pumping Air

⚠ Notice

Always use oxygen analyzers to monitor oxygen content of any gas flowing through the system. Both air and nitrox are subject to variations in oxygen content.

To use the system to pump air, simply move the On/Off Flow Valve to the Off position. No Nitrox will be supplied to the compressor, and it will pump air only. Both the Inline Oxygen Analyzer and Fill Oxygen Analyzer should read 20.9% O_2 when the compressor is pumping air.



14.6 Shutting Down

1) Shut off the Membrane System by turning the regulator adjustment knob counter-clockwise to reduce input pressure to minimum setting and then closing the On/Off Flow Valve.
2) Manually drain all Condensate Drain Valves.
3) Turn off air supply source for Nitrox System.
4) Turn off HP compressor when it has returned to pumping air, as determined by a Fill Oxygen Analyzer reading close to 20.9% O_2.

15 Nitrox Operational Notes

- **Ensure all personnel who operate the system are properly trained in its use.**
- **Keep a log with details of each cylinder filled with nitrox, including the time and date, name of operator of system, name and certification number of diver, gas analysis, MOD, and cylinder pressure.**

15.1 Correlation of Input Pressure to Oxygen Content

After the 10 hour break-in period for your Nitrox System, you will notice that specific Nitrox $\%O_2$'s always match specific input pressures once the system has warmed up. These pressures will be repeatable. If you find that the Fill Oxygen Analyzer reads 36% O_2 when the input pressure is at 125 P.S.I. (9 bar), record this pressure or make a mark on the input pressure gauge indicating the $\%O_2$. Do this for each $\%O_2$ that you normally make, making sure system has warmed up first. The next time Nitrox with 36% O_2 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_2, requiring only minor adjustments of the regulator to achieve the exact desired $\%O_2$.

⚠ 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.

15.2 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 appropriate valves.
2) Record the Membrane System input pressure reading
3) Slightly open Fill Whip Valve on the HP compressor, and adjust so the running compressor maintains 1500-2000 P.S.I. (100-140 bar) outlet pressure.
4) Adjust the input regulator to the pressure corresponding to the desired Nitrox $\%O_2$ for the Scuba Cylinder fill.
5) Allow the Fill Oxygen Analyzer reading to stabilize, make any minor adjustments necessary to achieve the desired $\%O_2$, 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 $\%O_2$, and then resume filling storage tanks.

16.0 Maintenance

16.1 Forward

To obtain the best possible performance from the compressor and ensure a long working life for all its parts it is essential that personnel follow the use and maintenance instructions with extreme diligence. It is thus advisable to read the information below and consult the manual every time an inconvenience arises. For further information please contact Nuvair

Nuvair
Phone: 805-815-4044
Email: Info@nuvair.com

Address:
2949 West 5th St.
Oxnard, California 93030, USA

16.2 General

- Proper preservation of the compressor requires thorough cleaning.
- This type of refill station, designed and built according to the most advanced technological criteria, requires only minimum preventive and routine maintenance.
- Before carrying out any maintenance tasks, run checks and/or controls on the compressor, switch off the compressor, remove the plug from the mains socket.
- The residual pressure present in the compressor and all lines must be released.
- During disassembly and re-assembly of the compressor, always use suitable wrenches/tools so as not to damage the relevant components.
- Loosen stiff parts with a copper or plastic mallet.
- When refitting parts make sure they are clean and lubricated sufficiently.
- Compressor maintenance tasks must only be carried out by authorized personnel and recorded on page 31 Maintenance Log of this manual.

16.3 Unscheduled Work

Involves repairs and/or replacement of the mechanical parts of one or more compressor components, this work normally needs to be done after some years of use. If substantial modifications are made, the manufacturer cannot be held liable for any dangers that might arise. This work must be carried out by a “Nuvair” qualified mechanic.

16.4 Scheduled Maintenance Table

Maintenance	Every 5 hours	Every Day	Every Year	250 (hours)	500 (hours)	1000 (hours)	3000 (hours)
Lubricating Oil Check		○					
Automatic Shutdown Check		○					
Condensate Container discharge	○	○					
Belt wear and tension			○		●		
Air intake filter			●	●			
Fitting / hose leak check			○		○		
Oil Filter and Oil change			●	●*			
Separator filter element cleaning			○			○	
1st – 2nd – 3rd stage Valve replacement					○	●	
4th stage valve replacement					●		
Water & HP oil separator replacement							●
HP filter body replacement							●

○ Checking and cleaning ● Change

* Oil Change every 100 hours when used with Nitrox

16.5 Troubleshooting

Problem	Cause	Solution
-Rotation speed and flow rate decrease	•Motor power too low •The belt slips	•Check the motor and the line
-The flow rate diminishes without rpm decreasing	•Valves not working •4th stage piston worn •Fittings loose / leaking seals •Intake filter clogged •Intake extension kinked •Piston or piston rings worn	•Check fuses or condenser •Contact technical support •Check for leaks with soapy water and eliminate them •Replace filter •Straighten, use stiffer pipe •Contact technical support
-Air smells of oil	•Cartridge filter exhausted •Piston rings worn	•Replace filter •Contact technical assistance
-Compressor overheats	•Direction of rotation wrong •Cooling tubes dirty •Incomplete valve closure (causing overload of another stage)	•Check direction of rotation •Contact technical support •Contact technical support

16.6 Checking and changing the lubricating oil and filter

During the compressors initial break-in period the original oil filter and lubricating oil must be changed at the 25 hour mark. After the initial change of lubricants and filter the oil and oil filter must be changed every 100 hours of use or annually, whichever comes first.

HP Compressor Lubricant: Only use lubricants rated for use with Nitrox, such as Nuvair 455 ™ Synthetic Food Grade Lubricant or Nuvair 751 ™. **Never mix Compressor Lubricants.** Nuvair Compressors are shipped with Nuvair 455 Synthetic Food Grade Lubricant or Nuvair 751 ™ in the compressor. Coltri OIL CE750 and Anderol 755 may also be used, but not mixed with Nuvair oil.

⚠ 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.

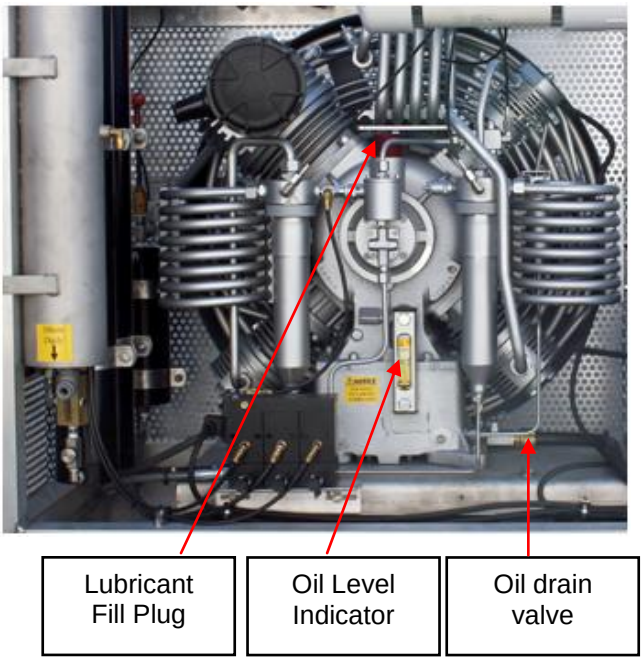
⚠ Danger

Do not carry out these tasks if the compressor has only just shut down; wait for the compressor to cool. Pressure must be drained before opening LP Fill Plug.
Any oil spilt during the oil/filter change could cause personnel to slip; wear protective garments and anti-slip footwear and remove traces of oil immediately.
Both oil and filter are classified as special wastes and must therefore be disposed of in compliance with the anti-pollution laws in force.
All maintenance work must be carried out with the compressor OFF and the power supply lead unplugged from the main socket.

⚠ Notice

The compressor must be placed on a solid surface with a tilt of no more than 6°.

16.7 Checking the Oil Level



The oil level must be checked every 5 working hours of the compressor.
The oil level must be between the minimum and the maximum shown on the oil level indicator.
(See close-up picture bottom of next page)
If the oil level is above the maximum level:

- Position a recipient under the drain hose so that the oil flows into the exhausted oil recipient.
- Open the drain valve and let the oil flow out until the oil level returns within the max. and min. limits
- Close the drain valve.

If the oil level is below the minimum level:

- Open the top fill plug
- Top off with oil until the level returns within the max. and min. limits
- Close the fill plug.

⚠ Caution

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

⚠ Notice

Recommended Nitrox Compressor Lubricant is changed when the first 25 hours of use is reached, then change lubricant in 100 hour cycles or annually.

⚠ Caution

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

⚠ Caution

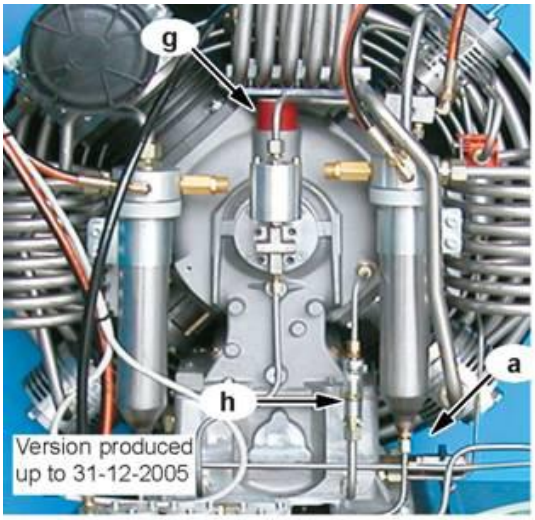
Always wear goggles when handling compressor lubricant. These materials can cause eye irritation. If you accidentally get lubricant into your eyes, flush with fresh water for 15 minutes and contact a physician if irritation develops.

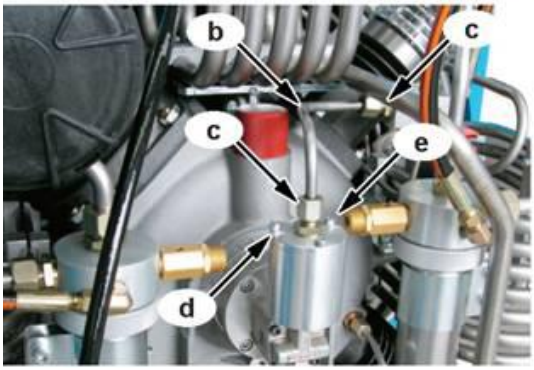
⚠ Caution

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

16.8 Changing the lubricating oil and filter

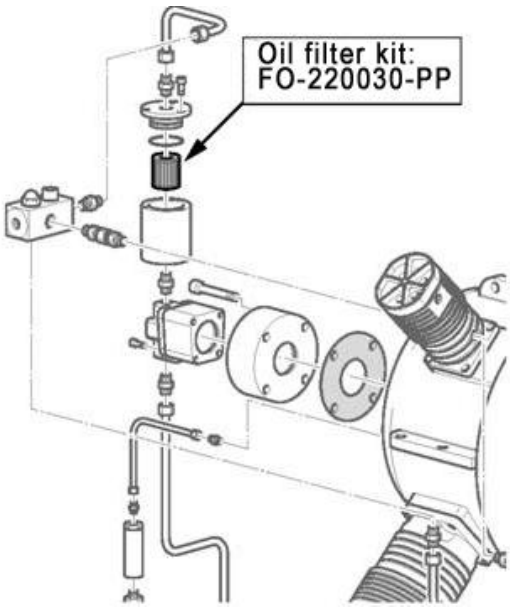
The lubricating oil must be changed every 250 working hours or annually. Every time the lubricating oil is changed the oil filter must be changed too. To change the oil continue as described:

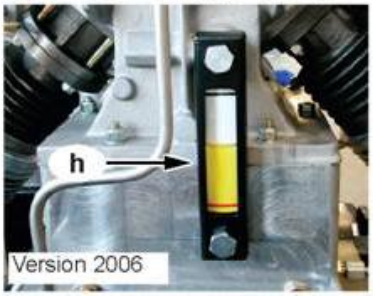




- position a recipient under the drain tap (**a**) so that the oil flows into the exhausted oil recipient (recipient capacity of at least 1.3 gallons or 5 liters required).
- open the oil fill plug (**g**).
- open the plug (**a**) and let all the oil flow out.
- unscrew the fittings (**c**) and remove the pipe (**b**).
- remove the fixing screws (**e**) and the cover (**d**).
- replace the filter (**f**) with a new one.
- re-close the plug (**d**) with the screws (**e**).
- put the pipe (**b**) back and tighten the fittings (**c**).
- close the drain tap (**a**). -remove the fill plug (**g**).
- fill the oil sump with 1.3 gallons or 5 liters of oil from top oil plug
- close the oil fill plug (**g**).
- switch on the compressor and run it depressurized for 30 seconds.
- switch off the compressor and remove the plug from the mains socket.
- check the oil level (**h**); if it is not between the min. and max. lines proceed with the tasks described in paragraph “11.7 Checking the oil level”.

(h) Version 2007 to present



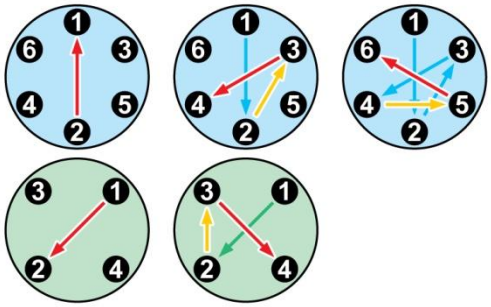


16.9 Tightening Torque Values – Should be done at 25 hour maintenance

The table below shows tightening torques for bolts or hexagonal-head screws or socket screws lubricated with grease, except for specific cases indicated in the manual. Pipe connections (swivel nuts) should be finger tight
plus an additional 1/2 turn.

Tightening Torque Values	
Thread	**Maximum Torque**
M6 - 1/4”	**10**Nm (**7**ft-lbs)
M8 - 5/16”	**25**Nm (**18**ft-lbs)
M10 - 3/8”	**45**Nm (**32**ft-lbs)
M12 - 1/2”	**75**Nm (**53**ft-lbs)
M14 - 9/16”	**120**Nm (**85**ft-lbs)
M16 - 5/8”	**200**Nm (**141**ft-lbs)

6 bolt and 4 bolt torque sequence



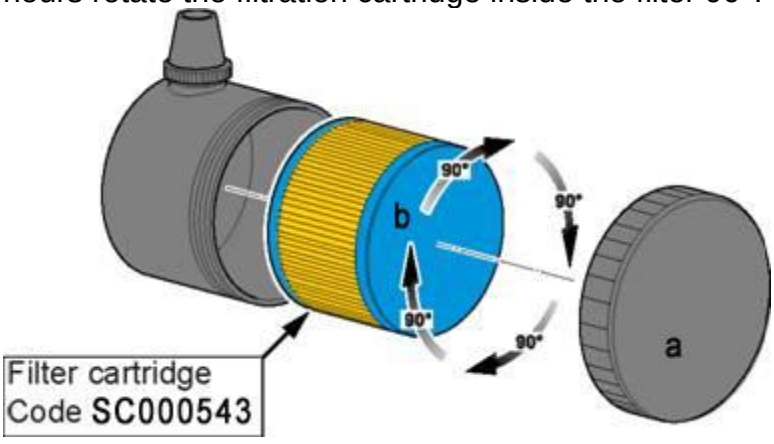
16.10 CO Moisture Indicator

This element contains a CO indicating button and a humidity element in the form of a strip about 1/4in. wide and 3/4in. long. These items need to be installed per the manufacturer’s instructions provided in the sealed foil packaging. When doing routine maintenance it is highly recommended these indicators are checked for damage and functionality or be replaced.

CO Moisture (option)

16.11 Changing the Air intake filter

After putting the compressor into service the intake filter must be changed after the first 50 working hours. The air filter must then be changed every 250 working hours or annually. Every 50 working hours rotate the filtration cartridge inside the filter 90°.



The air intake filter must be changed every 250 working hours or annually. If the compressor is used in a dusty environment the filter change interval should be reduced to every 100 hours.
Change the Air filter as follows:

- unscrew the air filter cover (**a**) by rotating it counter clockwise
- remove the air filter cartridge (**b**)
- replace the cartridge with a new one
- re-close the cover (**a**): screw it back on

⚠ Danger

Do not carry out these tasks if the compressor has only just shut down and is hot; wait for the compressor to cool down. All maintenance work must be carried out with the compressor OFF and the power supply lead unplugged from the wall socket.

⚠ Notice

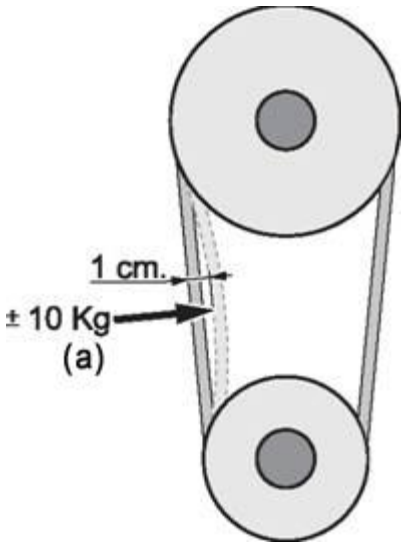
If the compressor is used in a dusty environment the filter change interval should be reduced to every 100 hours.

17.0 Tension Belt

Belt tension must be checked monthly. The tension belts must be replaced every 500 working hours of the compressor.

17.1 Checking the Tension Belt

To check for proper tension belt tension (**a**) exert a pressure of approximately 10 Kg on the belts; check that the belts do not flex by more than 1 cm with respect to their original position. Should they flex more than this the belts must be replaced.



18.0 Daily Maintenance

⚠ Caution

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

1) Check lubricant levels of both LP and HP compressors and add proper lubricants as required. See Section 16.3 and compressor manuals for details.
2) Check HP compressor Filtration for condensate and proper operation of Condensate Drains. Refer to HP compressor manual for details.
3) If using LP Supply Option, drain condensate from LP Volume Tank by opening drain valve and draining all moisture.
4) Check Supply Air Filtration for condensate and proper operation of Condensate Drains.

18.1 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 less than 35% of rated operating capacity. Check the compressor manual and Appendix for details on Filter Element Life Factors.

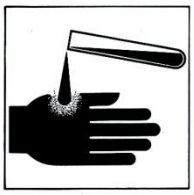
1) HP compressor lubricant: Change compressor lubricant every 100 hours or annually, whichever comes first. Only use lubricants rated for use with Nitrox, such as Nuvair 455 ™. Never mix compressor lubricants. See Section 16.3 and compressor manual for details.
2) HP compressor Filtration Element: Change HP Filter Element every 60,000 cubic feet of air or Nitrox processing to maintain CGA Grade E air standards. See Section 16.4 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.
3) Supply 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 16.5 for details.
4) Supply Air Filtration Elements:
   - ♦ LP Supply Option - Change LP Filter Elements every 100 hours. Visual liquid level and service life indicators assist with monitoring replacement intervals. See Section 16.5 for details.
   - ♦ HP Supply Option – Change Backup Vapor Filter Element every 200 hours. See Section 16.5 for details.
5) Semi-Permeable Membrane: No maintenance required. Service life exceeds 20 years if Supply Air Filtration is properly serviced to maintain Grade D or E standards.
6) Membrane System Air Intake Filter: Inspect filter element every 3 months for visible particles. Change every 12 months or sooner if particles are visible.
7) Oxygen Analyzers: Replace Oxygen Sensor and Battery as required. See manual included with Nitrox System.

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

Liquid Level Indicator Shows if Auto Drain is Working Correctly.

⚠ Danger

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



⚠ Danger

If after handling the oxygen analyzer or sensor, you find that your fingers or other parts of your body feel "slippery" or the skin or eyes sting, immediately flush affected area with clean, fresh water for at least 15 minutes. The stinging or slippery sensation is an indication of a leaking Sensor. The Potassium Hydroxide chemical contained in the sensor can cause severe injury or death. Seek immediate medical attention if eye contact is made or skin stinging persists.

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

1) LP compressor lubricant: Change LP compressor lubricant every 200 hours of operation in accordance with manufacturer's guidelines. Only use lubricants rated for use with Nitrox, such as Nuvair 455 ™ for reciprocating compressors or Nuvair 546 ™ for rotary screw compressors. Never mix compressor lubricants. Refer to LP compressor manual for details.
2) Air/Nitrox Quality Analysis: Take breathing air/Nitrox samples quarterly for analysis to assure compliance with CGA Grade D or E breathing air standards.

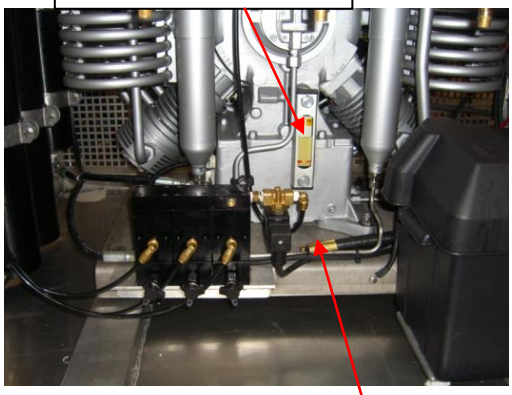
18.2 HP Compressor Lubricant

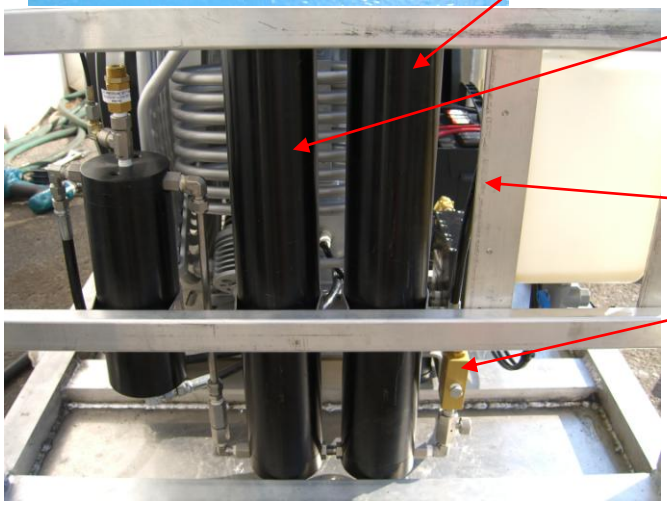
H.P. Compressor Lubricant: Change H.P. compressor lubricant every 100 hours of operation in accordance with manufacturer's guidelines. Only use lubricants rated for use with nitrox, such as Nuvair 455 ™ or 751 ™. Never mix compressor lubricants. Refer to H.P. compressor manual for details.

18.3 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 and drain pressure.
2) Remove the Filter Canister Cap per the HP compressor manual.
3) Remove and replace the expended Element.
4) Replace the Filter Canister Cap.

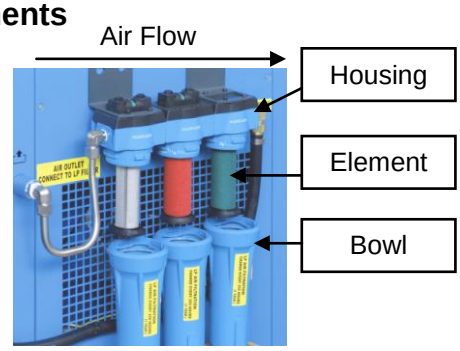




18.4 L.P. Supply Air Filtration

⚠ Caution

Special attention needs to be given to the arrangement of the four L.P. 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 supply air is critical to prevent the passing of any residual oil vapor into the membrane system. Three stages of Hankison L.P. filtration are used to produce Grade D air:

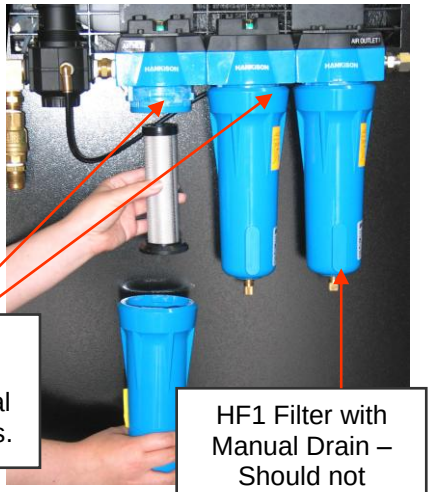
1) Particle Removal to 1 micron (Model No. HF7-20)
2) Coalescing & Water/Oil Vapor Removal to 0.01 micron (Model No. HF5-20)
3) Oil Vapor Removal to 0.003 PPM (Model No. HF1-20)

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

Filtration Inspection

Open each Filter and inspect as follows:

1. Inspect bowl for the presence of moisture. A high level of moisture build-up in the HF7 or HF5 filter indicates improper operation of auto-drain floats. Any evidence of moisture in the HF1 Filter indicates the air is not cooling properly and moisture is not properly being removed. Excess moisture will prevent the final filter from operating properly.
2. Inspect Elements for any unusual degradation or wetness. Element degradation can indicate more serious problems. Contact Nuvair for assistance.

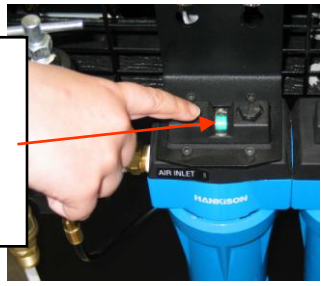


HF7 & HF5 Filters with Auto-Drain Floats & Differential Pressure Indicators.

HF1 Filter with Manual Drain – Should not Contain Moisture

Changing Filtration Elements

Change Filter Elements every 250 hours if operated with the refrigerated air drier. If the nitrox generator is operated in high humidity and/or high temperature or without the drier, filter elements must be changed more often. See Appendix for details on Filter Element Life Factors. Visual differential pressure indicators on the HF7 and HF5 filters assist with monitoring replacement intervals.



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

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

⚠ 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.

HP Supply Option

For HP Supply, a Backup Vapor Filter is used to assure Grade E air. This is a redundant filter since the supply air must already be rated grade E.

Backup Vapor Filter

Change the Backup Vapor Filter Element every 200 hours:

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

19.0 Spare Parts List

See HP compressor manual for HP compressor parts list. Other Nitrox System components and related items are listed below.

Nitrox System Components	Type	Part Number
HP Compressor Lubricant, Food Grade	Nuvair 455, 1 Gal (Other Sizes Available)	9406
LP Filtration Element	Hankison HF 7-24	E7-24
	Hankison HF 5-24	E5-24
	Hankison HF 1-24	E1-24
Heater Assembly	1200 Watt, 28" Length	H1200
Heater Thermostat Control	110V/220V	A419
Heater Pressure Switch		3100-052
Membrane	2 x 230 Series	NUV230
Air Intake Filter Element	20CP	20CP
Mixing Tube Assembly	2” inch diameter, specify length	
Oxygen Analyzer	Pro O2	9450
	Pro O2 Remote	9452
Oxygen Sensor	See Analyzer Owners Manual	
Compressor Hose Coupler		PTC-150
		RDTC40X32
Related Equipment Components		
Air/Nitrox Quality Analysis Kit	Specify: (1) CGA Grade Required	
	(2) Single Use or Program Use	
Air/Nitrox Compressor Lubricant		
Reciprocating Compressor, Food Grade	Nuvair 455, 1 Gal	9406
Reciprocating Compressor, Diester Based	Nuvair 751, 1 Gal	9403
LP Screw Compressor		
Oil Filter (Remote)	Donaldson	P170306
Oil Filter (on compressor)		099-012-S
Air/Oil separator		157-170-S
Air Intake Filter		162-578-S
Fuel Filter		2175-045

20.0 Service Record Log

Date	Technician Name	Service Performed

Appendix

Supply and Breathing Air Specifications

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

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

Notes: (1) Dew Point of supply air must be >10°F (6°C) colder than coldest ambient air expected
(2) Supply air delivered to the Membrane System must contain <0.003 PPM Oil Vapor

All breathing Nitrox produced for diving must be purified to meet these same requirements, except for oxygen content. Nitrox oxygen content must measure within +/- 1% O_2 of the specified value of the mixture using a properly calibrated Oxygen Analyzer (i.e. Nitrox produced with a target content of 32% O_2 must measure in the range of 31-33% O_2). 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 80ºF at the filter inlet. Under normal operation this temperature is 12ºF (5ºC) warmer than the ambient air, resulting in an equivalent ambient temperature rating at 68ºF (20ºC).

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
53ºF (12ºC)	41ºF (5ºC)	2.6 x Life
62ºF (17ºC)	50ºF (10ºC)	1.8 x Life
71ºF (23ºC)	59ºF (16ºC)	1.35 x Life
80ºF (27ºC)	**68ºF (20ºC)**	**1 x Life**
89ºF (32ºC)	77ºF (25ºC)	0.8 x Life
96ºF (36ºC)	84ºF (29ºC)	0.55 x Life
105ºF (41ºC)	93ºF (34ºC)	0.45 x Life
114ºF (46ºC)	102ºF (39ºC)	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 OHSA 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°0C/ 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
Supercedes:

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 OHSA 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 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 are air-cooled devices and therefore must be provided adequate ventilation to operate properly and prevent heat damage. This requires an ambient temperature below 100ºF (40ºC), 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 Nuvair for assistance.

Maintenance:

- Change filter elements for membrane air supply and HP breathing air purification on a schedule determined by filter capacity and ambient temperature and humidity. Contact Nuvair 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 it's discretion and according to the terms as set forth within, replace or repair any materials which fail under normal use and service and do not exhibit any signs of improper maintenance, misuse, accident, alteration, weather damage, tampering, or use for any other than the intended purpose. Determination of failure is the responsibility of NUVAIR, which will work together with the customer to adequately address warranty issues. When any materials are repaired or replaced during the warranty period, they are warranted only for the remainder of the original warranty period. This warranty shall be void and NUVAIR shall have no responsibility to repair or replace damaged materials resulting directly or indirectly from the use of repair or replacement parts not approved by NUVAIR.

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

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

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

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

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

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

Additional Record of Changes

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

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

Change Date	Description of Change
08.01.2012	**Compressor maintenance schedule updated and new warnings added**

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