



NUVAIR LP-LP 12 Nitrox Generator User Manual



NUVAIR LP-LP 12

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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 for information.

Table of Contents

Introduction

- 1.0 Introduction
- 2.0 Safety Warnings System Components
- 3.0 Safety and Operation Precautions
- 4.0 Legal Precautions
- 5.0 System Components and Overview
- 6.0 Theory Of Operation
- 7.0 Membrane System Flow Chart
- 8.0 System Drawing/Schematic

Setup, Operation, and Maintenance

- 9.0 Assembly Preparation
- 10.0 Set-Up and Assembly
 - 10.1 Power Connections
 - 10.2 Air Intake and Mixing Tube
 - 10.3 Oxygen Analyzer Mounting and Connections
- 11.0 Operation
- 12.0 Pumping Nitrox
- 13.0 Operation Notes
 - 13.1 Correlation of Input Pressure to Oxygen Content
- 14.0 Maintenance
 - 14.1 Routine Maintenance
 - 14.2 Compressor Lubricant
 - 14.3 LP Filtration
 - 14.4 Spare Parts List
 - 14.5 Service Record Log

Appendix

- Supply and Breathing Air Specifications
- Filter Element Life Factors
- Owner's Warranty Responsibilities
- Warranty

Separate Manuals Included:

- Nuvair Pro O₂ Oxygen Analyzer User Manual
- Pick O₂ Oxygen Analyzer User Manual
- Compressor User & Maintenance Instructions
- Gas Engine Manual

1.0 Introduction:

This manual will assist you in the proper set-up, operation and maintenance of the Nuvair LP-LP 12. 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:



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



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



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.



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

2.0 Safety Warnings

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



WARNING

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



WARNING

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



WARNING

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



DANGER

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



WARNING

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



WARNING

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

**WARNING**

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

**WARNING**

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

**WARNING**

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

**WARNING**

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

**CAUTION**

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

**WARNING**

Do not operate unit if any part on the system is not operating properly. Call the factory.

3.0 Safety And Operation Precautions

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

- 1) Read all instructions completely before operating any compressor or Nitrox System.
- 2) For installation, follow all local electrical and safety codes, as well as the National Electrical Code (NEC) and the Occupational Safety and Health Administration (OSHA) standards.
- 3) Electric motors must be securely and adequately grounded. This can be accomplished by wiring with a grounded, metal-clad raceway system to the compressor starter; by using a separate ground wire connected to the bare metal of the motor frame; or other suitable means.
- 4) Protect all power cables from coming in contact with sharp objects. Do not kink power cables and never allow the cables to come in contact with oil, grease, hot surfaces, or chemicals.
- 5) Make certain that power source conforms to the requirements of your equipment.
- 6) Pull main electrical disconnect switch and disconnect any separate control lines, if used, before attempting to work or perform maintenance. "Tag Out" or "Lock Out" all power sources.
- 7) Do not attempt to remove any parts without first relieving the entire system of pressure.
- 8) Do not attempt to service any part while System is in an operational mode.
- 9) Do not operate the System at pressures in excess of its rating.
- 10) Do not operate compressor at speeds in excess of its rating.
- 11) Periodically check all safety devices for proper operation. Do not change pressure setting or restrict operation in any way.
- 12) Be sure no tools, rags or loose parts are left on the Nitrox System.
- 13) Do not use flammable solvents for cleaning the Air Inlet Filters or elements and other parts.
- 14) Exercise cleanliness during maintenance and when making repairs. Keep dirt away from parts by covering parts and exposed openings with clean cloth or Kraft paper.
- 15) Do not operate the compressor without guards, shields, and screens in place.
- 16) Do not install a shut-off valve in the compressor discharge line, unless a pressure relief valve, of proper design and size, is installed in the line between the compressor unit and shut-off valve.
- 17) Do not operate in areas where there is a possibility of inhaling carbon monoxide, carbon dioxide, nitrogen, or flammable or toxic fumes.
- 18) Be careful when touching the exterior of a recently run electric, gasoline, or diesel motor - it may be hot enough to be painful or cause injury. With modern motors this condition is normal if operated at rated load - modern motors are built to operate at higher temperatures.
- 19) Inspect unit daily to observe and correct any unsafe operating conditions found.
- 20) Do not "play around" with compressed air, nor direct air stream at body, because this can cause injuries.
- 21) Compressed air from this machine absolutely must not be used for food processing or breathing air without adequate downstream filters, purifiers and controls and periodic air quality testing.
- 22) Always use an air pressure-regulating device at the point of use, and do not use air pressure greater than marked maximum pressure.
- 23) Check hoses for weak or worn conditions before each use and make certain that all connections are secure.

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

4.0 Legal Precautions

It is highly recommended that a Nitrox log be maintained when using Nitrox on a job site to document the following information. This log must be of permanent binding style with no loose pages.

- ◆ Date and time of day
- ◆ Job Name & Number
- ◆ Supplier's check of oxygen content (%O₂) plus signature and date
- ◆ User's check of oxygen content (%O₂) plus signature and date
- ◆ MOD (Maximum Operating Depth) in user's handwriting

Proper air/NITROX gas analysis tested on a quarterly basis and comprehensive maintenance is the best way to assure proper, safe, and economical Nitrox production.

5.0 System Components and Overview

The LP-LP 12 Nitrox package is designed to be portable yet rugged and open with good access to components, yet good moving part protection while it is running. This package is for use to supply Nitrox to a high or low pressure compressor that will pump the Nitrox to pressure. The operator should be able to produce Nitrox with a minimum of start-up hassles.

LP>LP Nitrox:

- 1 x 230 Semi-permeable Membrane
- (2) O₂ Analyzers
- Air Supply and Regulated Air Input Gauges
- 110/220 volt Heater with Auto Thermostatic Control
- 700 Watt Inverter
- Air Intake Filter & Static Mixing Tube
- NUVAIR 455 FDA Approved Food Grade Compressor Lubricant
- Aluminum Frame with Stainless Steel Compressor Plate
- Vibration Isolation Mounts
- 2 x Low-pressure Two Stage Compressors
- 2 x 30 Gallon ASME LP Volume Tank with Drain & Gauges (Optional 2 x 60 gallon tanks)
- 2 x Air Cooler

Specifications:

- ◆ Produces 24%-40% Nitrox @ 20CFM
- ◆ Upgraded Purification
- ◆ LP To LP Regulator
- ◆ LP Filtration to .003 PPM Oil Vapor (optional 2nd set for divers)
- ◆ Mix Accurate To 1/10th Percent
- ◆ Gas Engine

Low Pressure Feed Air Compressor Technical Data:

- LP Compressor – 15 hp gas – 23 CFM @ 175 psi

Maximum Block Output Pressure:	175 psi
Maximum Block Rated Output @13KW	23 CFM
Final System Discharge Pressure:	155-175 psi
Dual Control Headunloaders	
Number of Stages:	2
Number of Cylinders:	4
Lubricant:	NUVAIR 455
Condensate Drain	Manual
Supplying Grade D Air to Membrane	

NUVAIR LP-LP 12

Final Low Pressure Nitrox/Air Compressor Technical Data:

- LP Compressor – 5 hp gas–12 CFM @ 175 psi
 - Maximum Block Output Pressure: 175 psi
 - Maximum Block Rated Output: 14 CFM
 - Final System Discharge Pressure: 155-175 psi
 - Dual Control Headunloaders
 - Number of Stages: 2
 - Number of Cylinders: 2
 - Package Free Air Delivered Max: 11.5 SCFM @ 36% O₂
 - Lubricant: NUVAIR 455 Manual
 - Condensate Drain

- ◆ Weight - 624 lbs.
- ◆ Dimensions (L x W x H): 53 x 22 x 57 in

Suggested Maintenance Intervals:

- Replace NUVAIR 455 Lubricant: 100 Hours
- LP Filtration Elements: 50-75 Hours

Typical Specification For Grade-D Air:

- O₂ Percentage: 20-22
- CO₂: 1000 PPM
- CO: 10 PPM
- Hydrocarbons: 25 PPM
- Odor: None

Membrane Technical Data:

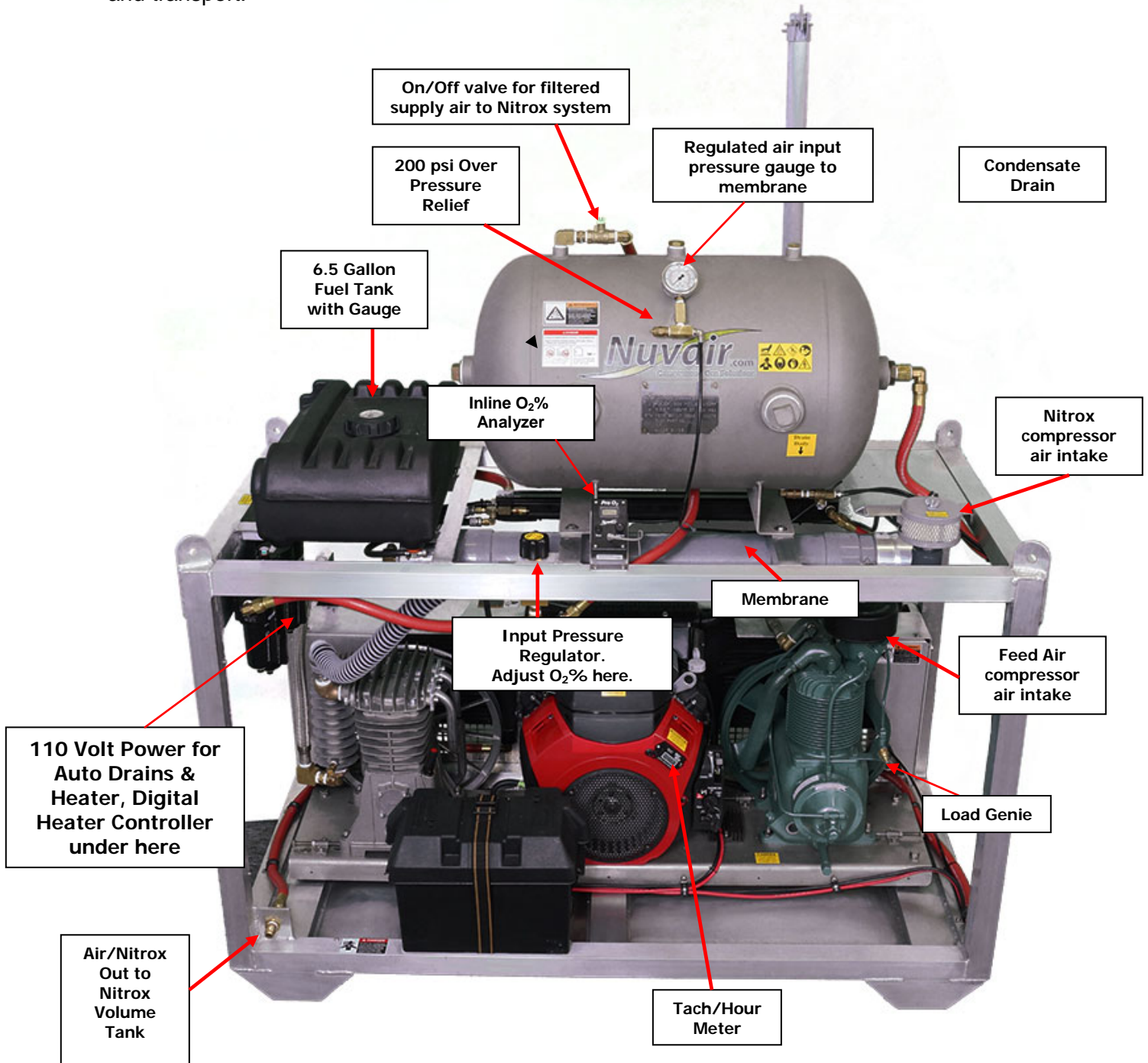
- ◆ Membrane Operating Temperature Range: 90-120 Fahrenheit
- ◆ Input Operating Pressure Range: 100 - 300 psi
- ◆ Input Gas Composition: Grade-D Air
- ◆ Input Gas Consumption: 10-34 SCFM
- ◆ Output Gas Delivery to Nitrox Compressor: Nitrox: 24% - 40%
- ◆ Power Requirements: 110-230 VAC Single Phase 5amps
- ◆ Lubricant: NUVAIR 455 ****

**** Proprietary high pressure FDA approved synthetic.

System Overview:

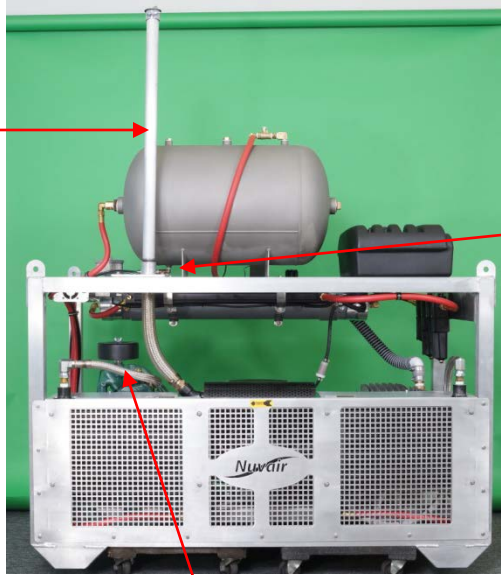
The LP-LP 12 Nitrox production system is a self-contained, portable, low pressure delivery package capable of supplying Nitrox in oxygen percentages between 24% and 36% to the intake of a second compressor.

The system utilizes two low pressure compressors that are mounted together with a gas engine and a permeable membrane in a rigid, aluminum frame. The system components include: (1) low to low pressure regulator, (2) low pressure air filtration, (3) gas stream temperature stabilizer (heater), (4) permeable membrane, (5) mixing tube, (6) air intake filter, (7) inline sensor/O₂ analyzer, (8) compressor intake porting and (9) two low-pressure compressors. All of the component assemblies and parts are mounted to facilitate easy set-up, operation, and transport.



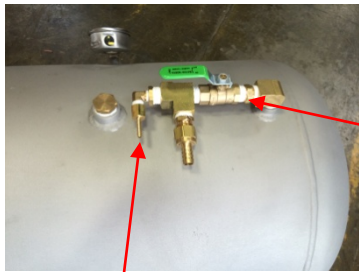
NUVAIR LP-LP 12

Engine Exhaust.
Keep exhaust away from compressor air intakes.
Increase height if necessary
CO in Exhaust Can Kill



Volume Tank Drain
Drain Daily

Compressor air intakes. Do not allow intakes to suck in exhaust from gas engine.
Run separate suction hoses away from compressor if necessary.



Manifold
On/Off Nitrox/air flow to divers

Flow Reducer to Test Final O₂% being delivered to divers.
Attach analyzer here.

Multistage Filtration – Monitor daily



Pilot Valve - Adjust LP Differential Pressure Here.
See Compressor Manual



Pressure of Nitrox/air being delivered to divers

ASME Rated
Air/Nitrox
Volume Tank

6.0 Theory Of Operation:

The LP-LP 12 is a turnkey package that produces oxygen-rich air (Nitrox) at low pressure of up to 175psi for surface supply use to divers.

The Nitrox System allows for efficient and cost effective Nitrox production without the hazards or expense of blending with stored high-pressure oxygen (O₂). 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 Nitrox System uses 2 x Low Pressure Reciprocating (piston) Compressors, 2 x Air Aftercoolers, 2 x Volume Tanks, and Filtration to provide the Membrane System with a source of clean, pressurized air for separation. The air is filtered to CGA Grade D air quality prior to entering the Membrane System so it will not damage or plug the Membrane fibers. Specifications for Grade D air are provided in the Appendix. It is then compressed for surface supply to divers.

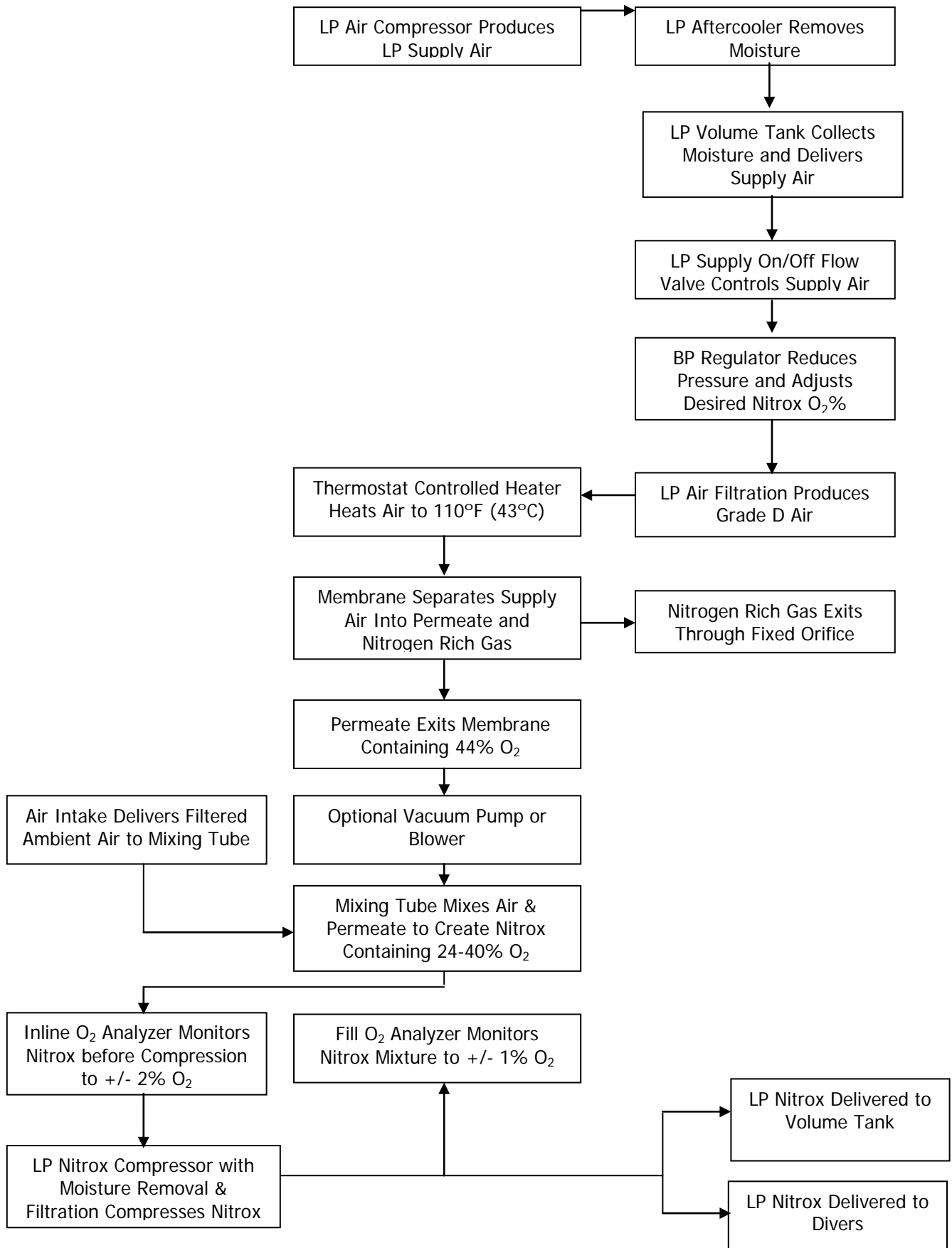
The Membrane System is rated for a maximum supply pressure of 300 P.S.I. (20 bar) and works well with the 175psi (12 bar) maximum pressure from the LP Supply Compressor. An Input Back Pressure Regulator reduces these pressures to appropriate levels for Nitrox production. Excess air being pumped by the Air Compressor will be vented to the atmosphere. The air is then heated to a temperature that provides stability over a wide range of ambient conditions, is optimal for membrane permeation and provides protection to the membrane from condensate.

The heated air enters the Membrane, which is made up of thousands of miniature hollow fibers. The walls of these fibers are semi-permeable and designed for different gases to move through them (or permeate) at different speeds. The resulting gas mixture is known as the "permeate". As air flows through the hollow fibers, both oxygen and nitrogen permeate through the fiber walls. The oxygen permeates faster than the nitrogen, which produces permeate with an oxygen content greater than air. The gas that reaches the end of the hollow fibers without permeating is almost entirely nitrogen and is discharged. The flow rate of this discharge is set by the factory via a fixed orifice, which controls the permeate to contain a constant 44% O₂ under normal operating conditions.

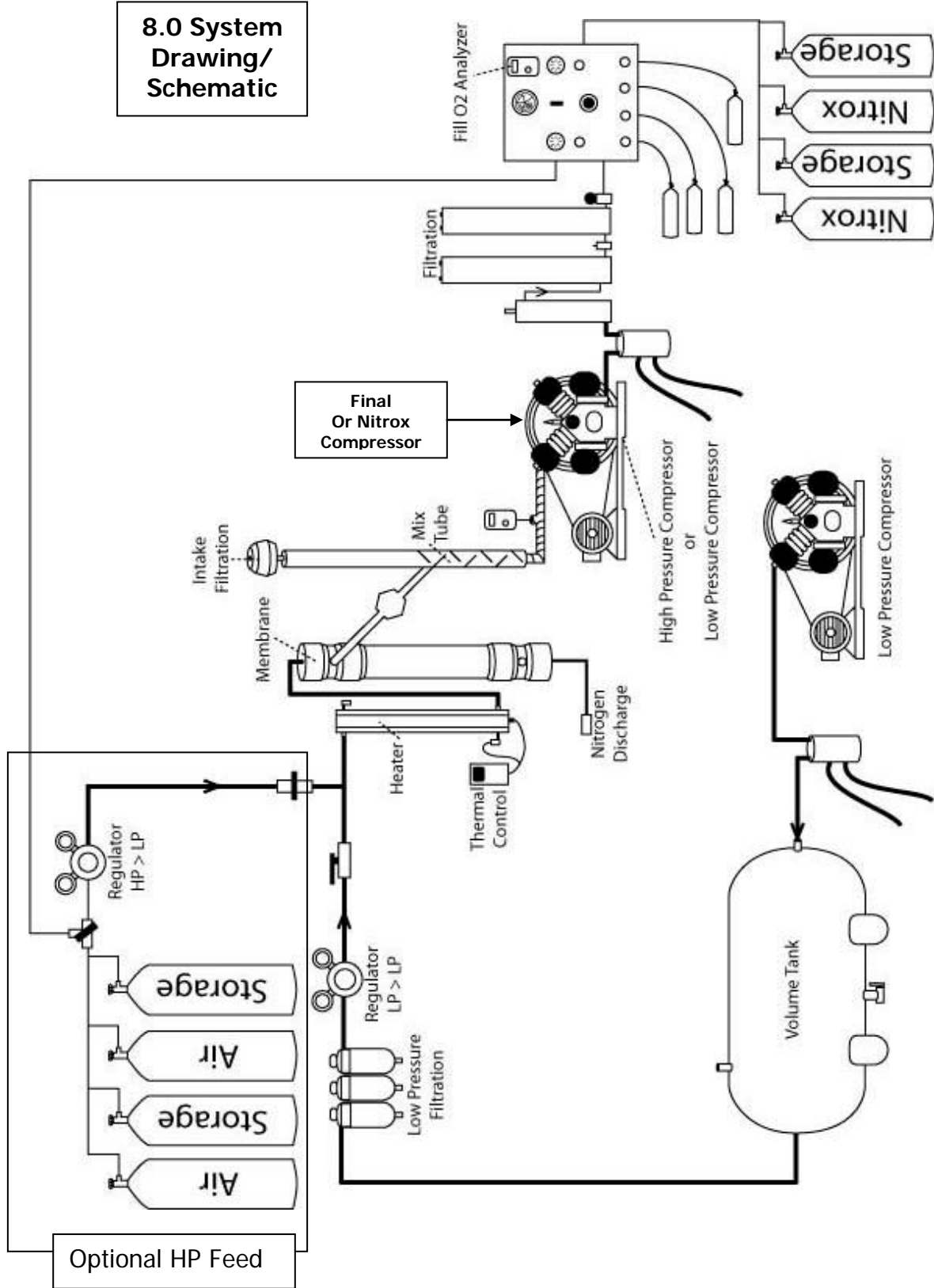
The permeate is a concentrated mixture that must be diluted with additional air prior to entering the Nitrox Compressor. It exits the Membrane at ambient to slightly negative pressure and travels into the Mixing Tube, where it mixes homogeneously with filtered outside air. The amount of dilution, and thus final %O₂, is obtained by adjusting the Input Pressure Regulator. As pressure is increased, permeate flow increases, air flow decreases, and a higher %O₂ Nitrox is produced. As pressure is decreased, permeate flow decreases, air flow increases, and a lower %O₂ 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 %O₂ before entering the Nitrox Compressor for approximate content and again when pumping Nitrox for precise content.

A unique feature of Nuvaire Nitrox Systems is that the input pressure that correlates to a specific Nitrox %O₂ is repeatable. For example, if your Nitrox Compressor pumps 36% O₂ 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.

7.0 Membrane System Flow Chart



8.0 System Drawing/
Schematic



NUVAIR LP-LP 12 Nitrox

Setup, Operation and Maintenance Step-by-Step

9.0 Assembly Preparation:

1. First familiarize yourself with the components of the system in the first section of the LP>LP Nitrox manual.
2. Please read and follow instructions in compressor manual.
3. Unpack the LP>LP Nitrox System and remove from the pallet.
4. Visually inspect the system to make sure there has been no damage during shipping.*
5. Follow the remaining step by step instructions for initial set up and operation.

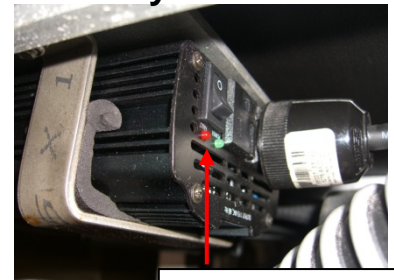
**Please contact NUVAIR to file a damage report if necessary.*

10.0 Set-up and Assembly

10.1 STEP 1: Power Connection

Requirement: 110/220 volt AC. Check voltage for proper connection. The Heater requires an alternate 110 VAC source. If the Nitrox System is used without an electric power source for the heater, there may be slow O₂% fluctuations due to temperature changes. This package is supplied with a 700 watt inverter to supply the 110 volt power. The package must be hooked up to 12 volt DC power for the gas engine electric start and inverter to function properly. **Red Is Positive!** Connecting the wrong leads may damage circuitry.

A. Engine Operation:
See engine user manual



Inverter ON/Off Switch

10.2 STEP 2: Air Intake and Mixing Tube:

- 1) The LP>LP membrane system is supplied with two air intake locations. They are all female pipe thread to allow for remote intake locations.
- 2) The Nitrox compressor air intake allows air to mix with the O₂ rich gas exiting the membrane permeate port.
- 3) The O₂ rich mix then passes by the inline sensor/analyzer where it is analyzed and an O₂% reading is supplied to the operator on the inline O₂ analyzer.
- 4) The gas then enters into the intake of the Nitrox low pressure compressor.
- 5) The O₂% is determined by adjusting the regulator. Increasing the input pressure by turning clockwise will increase the O₂%. Decreasing the pressure by turning CC will lower the O₂%. With no input pressure the compressor will be pumping air.



Regulator



WARNING

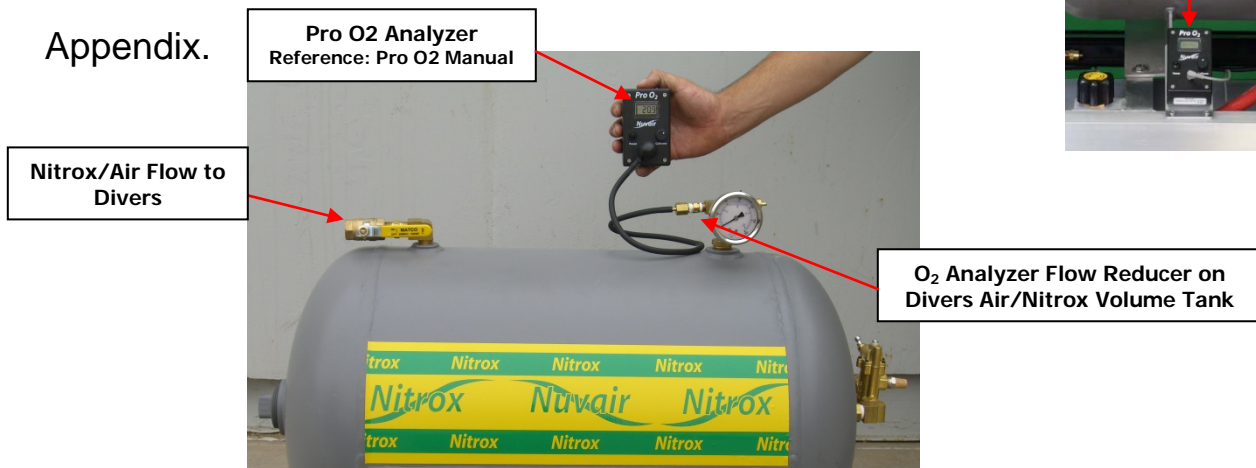
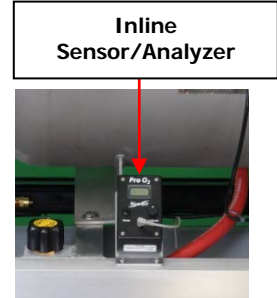
Never expose the Oxygen Analyzer Sensor to pressure or you may cause damage and/or false readings. Damaged sensors will not provide accurate gas analysis. Inaccurate gas analysis can lead to serious personal injury or death.

10.3 STEP 3: Oxygen Analyzer Mounting And Connections:

Two oxygen analyzers have been provided with your system. The analyzers are used to determine the oxygen percentages that you are producing.

For more information see Pro O₂ Manual in

Appendix.



A. Calibrate the Inline Sensor/Analyzer while both compressors are running, pumping air and pulling fresh air across the sensor, with the Feed Air On/Off Ball Valve is Closed. Push the calibrate button.

B. The Final Fill O₂ Analyzer should be installed to supply a reading off the divers air/Nitrox manifold. It has been supplied with a flow restrictor or optional flow meter that has a ¼” NPT fitting.

C. Calibrate the fill or divers air/Nitrox (final) analyzer to 20.9% as follows:

Remove the fitting covering the sensor.

- Expose the sensor to ambient air for approximately (15) seconds.
- Adjust the potentiometer until the reading stabilizes to 20.9%.
- Re-connect the sensor fitting to the analyzer.
- The Final Analyzer Supplies the **IMPORTANT READING**.



**WARNING**

Oxygen Analyzers must be calibrated before each use. See Oxygen Analyzer manuals for correct calibration procedures. Improper calibration of the Divers Supply (Final) 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. See Fill Oxygen Analyzer manual for correcting analyzer readings at various altitudes. Improper calibration of the Fill Oxygen Analyzer may result in the use of incorrect Nitrox mixtures, which may cause serious injury or death to the diver using the gas mixture.

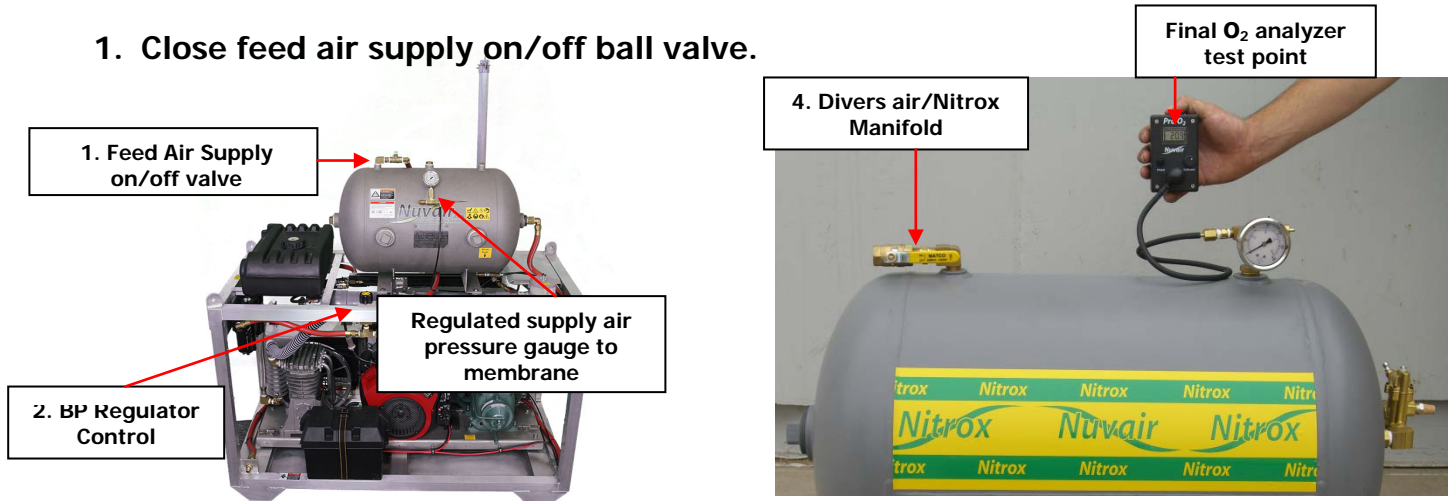
**WARNING**

The Inline Oxygen Analyzer supplies oxygen readings that can vary +/- 2% O₂ due to heat, humidity, and pressure changes experienced in the Nitrox flow and therefore should only be used for rough estimates of %O₂. The inline O₂ analyzer could read 43% O₂ +/-2 when the Nitrox compressor is unloading and not pumping Nitrox. The Divers Supply (Final) Oxygen Analyzer supplies more accurate oxygen readings, within +/- 1% O₂.

11.0 Operation

Once you have read through this manual, the compressor manuals, the gas engine manual, the Nuvaire Pro O₂ Analyzer manual, made the necessary set-up connections, and you understand how the system functions; follow the steps below to operate the system:

1. Close feed air supply on/off ball valve.



2. Release spring pressure on BP regulator by turning knob counter clockwise.

3. Turn on power to the inverter.

4. Start both compressors.

5. Slightly open the ball valve on the diver air/Nitrox manifold, maintaining a pressure of 125 psi or more in the divers air/Nitrox volume tank and venting the remainder to the atmosphere.(shown in open position above)

6. While the Nitrox compressor is pumping air through the manifold valve, calibrate both O₂ analyzers as per instructions in the Pro O₂ manual and on page 20.

7. Slowly open the feed air supply ball valve to membrane.



CAUTION

The On/Off Flow Valve on the Membrane System must be opened slowly. A sudden rush of gas can damage the Membrane and other system components. A damaged membrane will not produce the correct Nitrox mixture which can lead to severe personal injury if the gas is used for diving purposes without proper analysis.



NOTICE

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



CAUTION

Do not change the temperature setting on the Thermostat Control without contacting Nuair. 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.

8. Slowly turn the BP regulator control handle clockwise to increase input pressure. Watch the Inline sensor/O₂ analyzer (page 20). Increase pressure until the analyzer reads the O₂% desired. The regulated input air pressure must be over 80 psi initially for the heater to operate.

9. Check the A419 Thermostat Control to see if it is operating

10. The Nitrox will slowly make its way through the compressor and filtration. It will take 3-8 minutes for the O₂% to stabilize as air in the Nitrox Volume Tank is slowly be replaced with Nitrox.

11. When both O₂ analyzers are within 1% of each other.

12. Close the manifold valve and dive.



Factory Set
Nitrogen
Relief Valve

A419
Thermostat
Control

**WARNING**

OSHA Regulations require an emergency back up source of breathing gas for the diver in case of an emergency or compressor malfunction.

- 13.** Monitor compressor operation at all times. Note tank pressure on the first compressor, feed air input pressure on air going to the membrane, divers air/Nitrox tank pressure and O₂%.
- 14.** During the dive, monitor both analyzers to ensure they stay within 1% of each other. Lightly fine tune the input pressure to get the exact desire O₂% on the final analyzer. The Final analyzer indicates the O₂% going to the diver. This is the important reading. During the operation the analyzer sensor may warm slightly and require recalibration. Remove the cap and recalibrate as per the manual. The inline sensor will also warm and start to supply a reading that is higher than the actual O₂%. This sensor can only be recalibrated by turning off the air flow to the membrane while the compressor is running. This should never be done while divers are breathing the Nitrox. During this period rely on the final O₂ analyzer reading. A third analyzer can be used to check the final analyzer's accuracy at any time by removing the cap from the final analyzer and attaching it to another analyzer.
- 15.** After completion, close feed air ball valve.
- 16.** Shut off the Feed Air Valve and Divers Nitrox Valve. Turn the regulator control knob counter clockwise to the unloaded position. Turn the engine off.
- 17.** Turn off the inverter.

12.0 Pumping Nitrox



WARNING

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



WARNING

The Inline O₂ Analyzer supplies oxygen readings that can vary +/- 2% O₂ due to heat, humidity, and pressure changes in the Nitrox flow and should only be used for rough estimates of %O₂. **The Fill O₂ Analyzer supplies the accurate reading, within +/- 1% O₂.** Use an additional o₂ analyzer at the divers manifold.



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.



NOTICE

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



WARNING

Only provide Nitrox to divers 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 may lead to explosions which may cause severe personal injury or death.



NOTICE

The Oxygen Analyzers may require re-calibration after 10-20 minutes of operation due to humidity and temperature change effects on the Sensor. To recalibrate, turn off the Membrane System On/Off Flow Valve and follow calibration instructions.

<i>GAUGE</i>	<i>RECOMMENDED SETTING</i>
Compressor Gauges	According to manufacturers recommendations
Heater Temperature	105-120° F (40-49° C)
Ambient Temperature	Less than 105 ° F (40 °C)
Volume Tank Pressure	160-175 PSI (11-13 Bar)
Regulated Pressure to Membrane	90 – 160 PSI (6-10.5bar) depending on Nitrox O ₂ %.
Fill Oxygen Analyzers	Showing the proper reading for intended fill
Nitrox Delivery Pressure	<u>DO NOT</u> exceed rating of tank or 175 psi

13.0 Operation Notes:

- ◆ Utilizes standard Hankison filtration
Do NOT use any substitute.
- ◆ Bleed condensate drain on the volume tanks daily.
- ◆ Do NOT use this system to produce greater than 40% oxygen concentration.
- ◆ Use only NUVAIR 455 compressor lubricant in this system, do NOT substitute.

- ◆ Final discharge pressure is factory set. Do NOT alter setting. 13.1

Correlation of Input Pressure to Oxygen Content

After the 10 hour break-in period for your Nitrox System, you will notice that specific Nitrox O₂ percentages 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% O₂ 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 %O₂. Do this for each %O₂ that you normally make, making sure System has warmed up first. The next time Nitrox with 36% O₂ 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% O₂, requiring only minor adjustments of the regulator to achieve the exact desired %O₂.

**NOTICE**

Use the Diver Supply (Final) Oxygen Analyzer to verify the Nitrox oxygen percentage prior to delivery to divers. When using the input pressure reading to obtain specific oxygen percentage, minor adjustments of the input pressure regulator may be required to obtain the exact percentage desired.

14. Maintenance

14.1 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 as little as 35% of rated operating capacity. Check the compressor manual and Appendix for details on Filter Element Life Factors.

- 1) LP Compressor Lubricant: Change Compressor Lubricant after the first 100 hour break in period and every 200 hours thereafter. Only use Lubricants rated for use with breathing air/Nitrox systems such as NUVAIR455™. Never mix Compressor Lubricants. See LP Compressor manual for details.
- 2) LP Filtration Inspection: On a weekly basis, inspect each Filter Bowl for the presence of moisture and each Element for any unusual degradation or wetness.
- 3) LP Filtration Elements: Change LP Filter Elements every 50-75 hours to maintain CGA Grade D air standards. Visual differential pressure (DP) indicators on the coalescing filters assist with monitoring replacement intervals. See Section 14.3 for details. If the Nitrox System is operated in high humidity and/or high temperature, Filter Elements must be changed more often. See Appendix for details on Filter Element Life Factors.
- 4) Semi-Permeable Membrane: No maintenance required. Service life exceeds 20 years if LP Filtration is properly serviced to maintain Grade D standards.
- 5) Membrane System Air Intake Filter: Inspect filter element every 3 months for visible particles. Change every 12 months or sooner if particles are visible.
- 6) Oxygen Analyzers: Replace Oxygen Sensor and Battery as required. See manual included with Nitrox System.



DANGER

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



DANGER

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

14.2 Compressor Lubricant:

Change with NUVAIR 455 Nitrox rated lubricant every 100 hours or minimum once per year. Do not mix brands.

Refer to gas engine manual for proper oil and maintenance.

- 1) Check oil and gas levels before operation.
- 2) Drain Volume tank daily.
- 3) Start and warm to operating temperature before Nitrox preparation.



Oil Level Dipstick and Fill Port – We recommend using an oil evacuator through this hole to remove the majority of oil during oil changes as the drain hole at the bottom of the block is quite small and oil flows from it very slowly

Oil Level Sight Gauge

Oil Drain

Oil Fill Plug

14.3 LP Filtration



CAUTION

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

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

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



REPLACEMENT ELEMENT PN:

E7-16

E5-16

E1-16

Filtration Inspection

Open each Filter and inspect as follows:

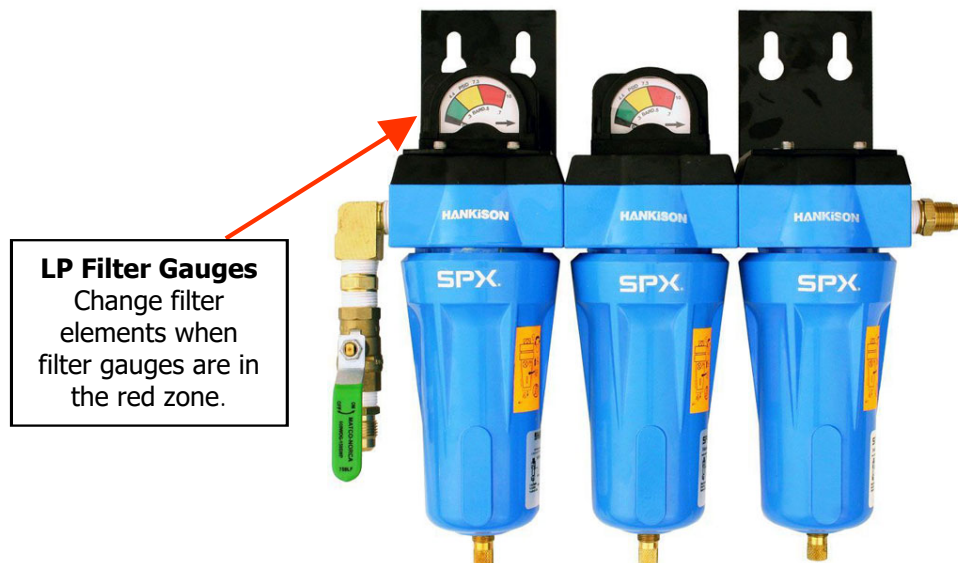
1. Inspect Bowl for the presence of moisture. There should be no moisture build-up in the Oil Vapor filter element. Any evidence of moisture in the Oil Vapor Filter indicates the air is not cooling properly and moisture is not properly being removed by the Coalescing filters or the filter elements are due to be changed. Excess moisture will prevent the Oil Vapor filter from operating properly.

2. Inspect Elements for any unusual degradation or wetness. Element degradation can indicate more serious problems. Contact Nuair for assistance.

Changing Filtration Elements

Change Filter Elements every 50-75 hours. If the Nitrox System is operated in high humidity and/or high temperature, Filter Elements must be changed more often. See Appendix for details on Filter Element Life Factors. Visual DP indicators on the coalescing filters assist with monitoring replacement intervals.

- 1) Push up on the Bowl, rotate CCW, and lower to remove.
- 2) Gently unscrew the filter element.
- 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. Ensure the filter bowls are completely clean before reassembly. This will assist to prolong the life of the element, bowl, and auto drain.

14.4 Spare Parts List

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

Nitrox System Components	Type	Part Number
Compressor Lubricant, Food Grade	Nuvair 455, 1 Gal (Other Sizes Available)	9406
LP Filtration Elements	Hankison HF 16 (6063.1)	E1-16 E5-16 E7-16
Heater Assembly	1200 Watt, 28" Length	H1200
Heater Thermostat Control	110V/220V	A419
Heater Pressure Switch		3100-052
Membrane	230 Series	NUV250
Air Intake Filter Element	1"	16CP
Oxygen Analyzer	Pro O ₂	9450
	Pro O ₂ Remote Panel Mount	9460
Oxygen Sensor	See Analyzer Owners Manual	
Related Equipment Components		
Air/Nitrox Quality Analysis Kit	Specify: (1) CGA Grade Required (2) Single Use or Program Use	

14.5 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 Nitrox Membrane System must be purified to meet Grade D or E quality, and periodic air quality testing to assure compliance is recommended. All breathing air for diving produced by the downstream Compressor must be purified to meet Grade E quality, and periodic air quality testing to assure compliance is mandatory.

Item	Grade D	Grade E
Oxygen	19.5-23.5%	20-22%
Carbon Dioxide (maximum)	1000 PPM	1000 PPM
Carbon Monoxide (maximum)	10 PPM	10 PPM
Hydrocarbons (maximum)	Not specified	25 PPM
Water Vapor (maximum)	Not specified	Not specified
Dew Point (maximum) (1)	Not specified	Not specified
Oil & Particles (maximum) (2)	5 mg/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% O₂ of the specified value of the mixture using a properly calibrated Oxygen Analyzer (i.e. Nitrox produced with a target content of 32% O₂ must measure in the range of 31-33% O₂). Periodic air quality testing to assure compliance is mandatory.

Filter Element Life Factors

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

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

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

OWNER'S WARRANTY RESPONSIBILITIES

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

Installation:

- All set up requirements and procedures provided in the Nitrox System Operation Manual must be followed in their entirety including supply air cleanliness, Compressor preparation, and installation of the Nitrox System.
- Supply air to the Membrane must be properly filtered to CGA Grade D air quality or better to prevent damage to the Membrane. Air quality testing of the supply air should be performed periodically and documented to assure compliance.
- If there is any doubt regarding the suitability of a HP Compressor for compressing Nitrox, contact Nuvair or the Compressor manufacturer before you connect your Nitrox System.
- 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.

Operation:

- Do not use the Nitrox System to supply a HP Compressor with Nitrox mixtures containing more than 40% oxygen. Compressing higher concentrations of oxygen may cause severe Compressor damage.
- Do not pump Nitrox mixtures at pressures above the compressor manufacturer's rating, and never above 3600 P.S.I. Compressing Nitrox at higher pressures may cause severe HP Compressor damage.
- To prevent Membrane damage, drain all low pressure filter and volume tank condensate on a daily basis.
- Do not use system if there is any broken or poorly functioning part. Contact the factory.

Maintenance:

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

Pro-Rated Terms:

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

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

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

Maintenance Items:

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

Return Policy:

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

Limitation of Warranty and Liability:

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



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