

# ZERO AIR

## *Implementing Adsorption Technology To Produce Hydrocarbon Free Air*

Mixed gas diving is surfacing throughout the sport diver community and a fury of questions have been rising with it. Often, there are no pat answers for these curiosities and the craftsmen of the movement are just as bewildered for lack of defined instruction. Because of my involvement with purification products I am always being fielded with the “can we” questions at the air blending stage.

So, equipment and procedures aside, the focus here will be on the acceptance of enriching air (made by OIL LUBRICATED compressors which are already in place for standard diving air) with compressed oxygen. It is my opinion that this concept is viable, practical, and insurable yet there are precautions to be heeded. As you all know, petroleum products (A.K.A. Condensable hydrocarbons) will promote ignition or even explosion when encountering concentrated oxygen. In trace amounts, however, these hydrocarbon molecules pose an insignificant threat. The ACCUMULATION of these trace hydrocarbons in orifices along the air path do cause potential problems OVER THE COURSE OF TIME.

Reducing this potential seems to be a matter of effective Education on purification processes, installation of the Correct Equipment, careful monitoring of the results, constant Testing of the effectiveness, and meticulous Maintenance of the apparatus. The value of each of these subjects should not be underestimated.

Lets start with your education. An elementary beginning to the purification process might read like this, “The removal of contaminants from a compressed air (or gas) boils down to a means of squeezing it through a series of holes which are smaller than the selective contaminant”. There are many approaches and levels of effectiveness to this end. Among them are coalescing, micronic filtration, and the heart of the process which is

Adsorption.

### A) *Coalescing*

Is a mechanical means of separating heavy fluid droplets from the compressed air stream. Usually, a porous barrier is placed in the flow path where it can abruptly and turbulently change the air pattern. This causes the heavier particles to be “ thrown out” and impinge into the barrier. Effectively, this could remove 98% of the liquid substances including Condensable hydrocarbons. Coalescing is always the first stage of purifying air from an oil lubricated compressor.

### B) *Micronic Filtration*

It deals with the removal of particulate matter from the air stream. These particles originate from many sources including dusting from the filter media themselves. The objection to the passing of these contaminants is obviously more mechanical in nature than for health reasons. Guarding your air quality is accomplished by sifting it through Micronic Barriers placed throughout a well balanced system.

### C) *Adsorption*

It solves the balance of the contamination factor which only represents 2-10% and yet is the most critical. The adage applies, 80% of the effort goes to 20% of the problem.

Here, we get to the heart of this article. ADSORBENT MEDIA! You are familiar with this stuff, you’ve been using it for years, right? Charcoal, Alumina, and Desiccant. Simple stuff, right? WRONG. In light of the many strains, qualities, grades, sources, and specialty adsorbents available today we have to look to the experts for direction on their best usage. The best source of information I have found has come from the laboratory at Lawrence Factor™, Inc. whose ongoing research in this area is at the forefront of purification technology. Their testing has proven that adsorption techniques can get quite sophisticated and that it is also possible to produce

*See back for more -->*

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METICULOUS maintenance of your system are the key to success.

Counted among the recommended adsorbents are Molecular Sieves and Activated Carbon. These are most commonly used in hydrocarbon adsorption. Each, as noted earlier, is available in many grades and strains and when combined in various proportions and configurations will produce equally various results. In addition, the folks at Lawrence Factor™ claim that they have discovered some new adsorbents along with experimental approaches to their use. These products hold great promise in producing hydrocarbon free air.

Handling and implementation of adsorbents is an exacting science and requires sophisticated dispensing equipment as well as stringent quality controls. Without this knowledge and equipment, the media stands to become tainted with outside contaminants long before it ever reaches the purification system. This is a good reason

*“Any amount more than zero has the potential to accumulate over time into a literal ticking bomb“.*

to stick with professionally made and packaged cartridges. And, when it comes to hydrocarbon free air, it's an especially good reason to stick with professionally made cartridges.

The first requisite in installing a “Zero Air” system is to measure the average air quality produced by your existing compressor. This can be accomplished with the help of a competent lab. Again, the guys at Lawrence Factor™ have been instrumental in helping on this level since they maintain one of the most sophisticated labs of this nature in the country. Experience has proven that an astounding 95% of all breathing air contains some level of volatile hydrocarbons and oil droplets. And remember,

any amount more than zero has the potential to accumulate over time into a literal ticking bomb. These levels will show up in your air analysis. Given that these conditions remain consistent with some assurance and based on these results, a second stage “Zero Air” filter system is installed on a dedicated branch of your airline. This is the point at which you tap off a supply of hydrocarbon free air for use in your blending operation.

Since this approach is heavily dependent on meticulous maintenance and constant monitoring a critical human error factor enters the picture. Reducing the chance of mishap could be improved by adding electronic alarms to the system. Some other suggestions include a program of system breakdown and cleansing, enrollment in an air quality analysis program with an accredited lab, and installation of proper equipment. One of the loudest warnings heard (even though it seems counter economy) is, “DO NOT ROTATE CARTRIDGES”. The explanation is that while the adsorbents effectively trap hydrocarbons they do have a higher affinity for other substances. So, if a partially contaminated cartridge is moved to a position further ahead in the air stream it stands to become overloaded and release hydrocarbons back into the airstream in favor of some other substance. Uh Oh!

This subject is much broader than my space allotment here. For details and advice on installing a “Zero Air” system I suggest contacting a professional organization who is involved in compressed gas purification. Several exist but I know that Lawrence Factor™ offers a complimentary Tech Line and has an eager staff willing to answer your questions. Contact them at: (305) 430-0550 or 4740 NW 157th Street, Miami Lakes, FL 33014

*Michael Casey II is an independent technical representative who has been active in the filed of compressed gas filtration. His expertise comes from many professional associations within this field.*



## OXYGEN COMPATIBLE AIR FROM OIL LUBRICATED COMPRESSORS AND ITS RECOMMENDED SAFETY FACTOR

FROM THE DESK OF  
Michael Casey, II

*Making oxygen compatible air from oil lubricated compressors can be done rather easily when your compressor is working properly and your system is relatively clean. To make and design a purification system which will produce oxygen compatible air under the above conditions is easy yet ABSOLUTELY WRONG, IRRESPONSIBLE AND POTENTIALLY DANGEROUS.*

With the production of CGA grade "E" air for sport diving purposes, should the air fall out of standards, it will most likely be for substances that pose no immediate problem. It will be found during your next scheduled air analysis. At which time corrective action can take place.

In the case of oxygen compatible air, the most critical substance in the standard is condensed hydrocarbons. To fall out of oxygen compatible air standards, in reference to condensed hydrocarbons or large particles of chemical media, can be extremely dangerous. It's these substances that can react as fuel, which might possibly be catastrophic in terms of ignition. Even in less severe conditions, the build up of contaminants might lead to future problems.

A properly designed oxygen compatible purification system MUST BE ABLE TO PRODUCE OXYGEN COMPATIBLE AIR FROM A FAILING COMPRESSOR. At any time a compressor may malfunction causing the excessive passing of condensed hydrocarbons. Without a properly designed system, the production of oxygen compatible air becomes a very volatile and potentially dangerous act.

To some people, a properly designed oxygen compatible purification system seems like overkill. Nothing can be farther from the truth. Purification experts consider this a necessary safety factor and is a must in a properly thought out and designed system. (One would never consider using a high pressure vessel or tank that was designed and built with no safety factor, and most are built with a 3:1 or 4:1 safety factor).

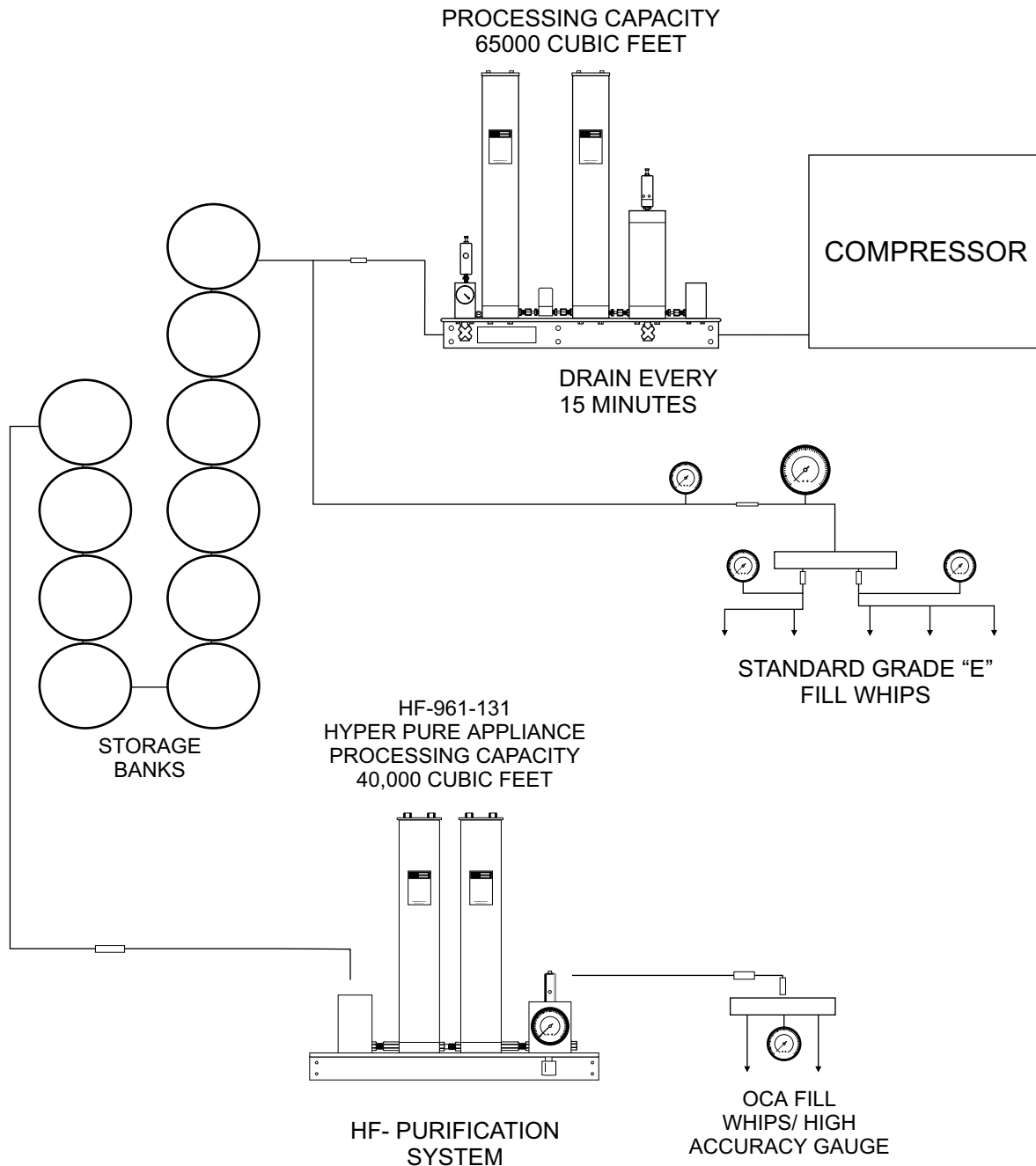
Furthermore, a properly designed system also needs to be set up, installed, maintained, and operated by trained personnel. Neglect any of these parameters and safety suffers.

For further information, contact us at: phone (305) 430-0550, fax (305) 430-0864, or e-mail: L-factor@ix.netcom.com.

OVER 600 FILTER TYPES AND STYLES: INTAKE FILTERS, COALESCOR ELEMENTS, CHECK VALVES, PRIORITY VALVES, RELIEF VALVES, FITTINGS, PURIFICATION APPLIANCES, NITROX APPLIANCES FOR OXYGEN COMPATIBLE AIR, FILTER HOUSINGS, COMPONENTS, COMPRESSOR OILS, COMPRESSOR PARTS (NEW PARTS™), PURIFICATION MEDIA, PARTICLE PADS, GREASE, L.F.W.™ REGULATOR CLEANER, CO-COP™, O-RINGS, INDICATOR KITS, SERVICE KITS, MICRONIC FILTERS, X-ZAM® BREATHING AIR ANALYSIS, AND MUCH MORE. CALL FOR PRODUCT INFORMATION AND PRICES.



# COMMON OCA SET-UP



**THIS IS THE CORRECT BASIC SET UP FOR AN OCA SYSTEM. THIS SYSTEM WILL AFFORD PLENTY OF SAFETY FACTOR WHEN DOING PARTIAL PRESSURE BLENDING IF OPERATED BY TRAINED PERSONNEL WITH REGULAR SCHEDULED MAINTENANCE.**

# PRODUCT SPECS

For Something A Lot More Precise  
Than Just Mixing a Highball . . .

## HF-Series Appliances

Your Perfect Choice For Mixed Air and Inert Gases

**-Ideal for-  
OCA**  
(Oxygen-Compatible Air)

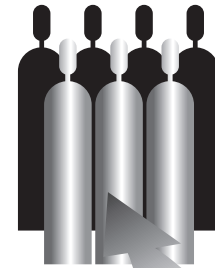
**Hyper-Pure Breathing Air  
Specialty Lab Uses  
Research Grades  
Technical Gases**

**-Each Appliance-  
Sanitized to  
O<sub>2</sub> Standards**  
(not for use with oxygens, however)

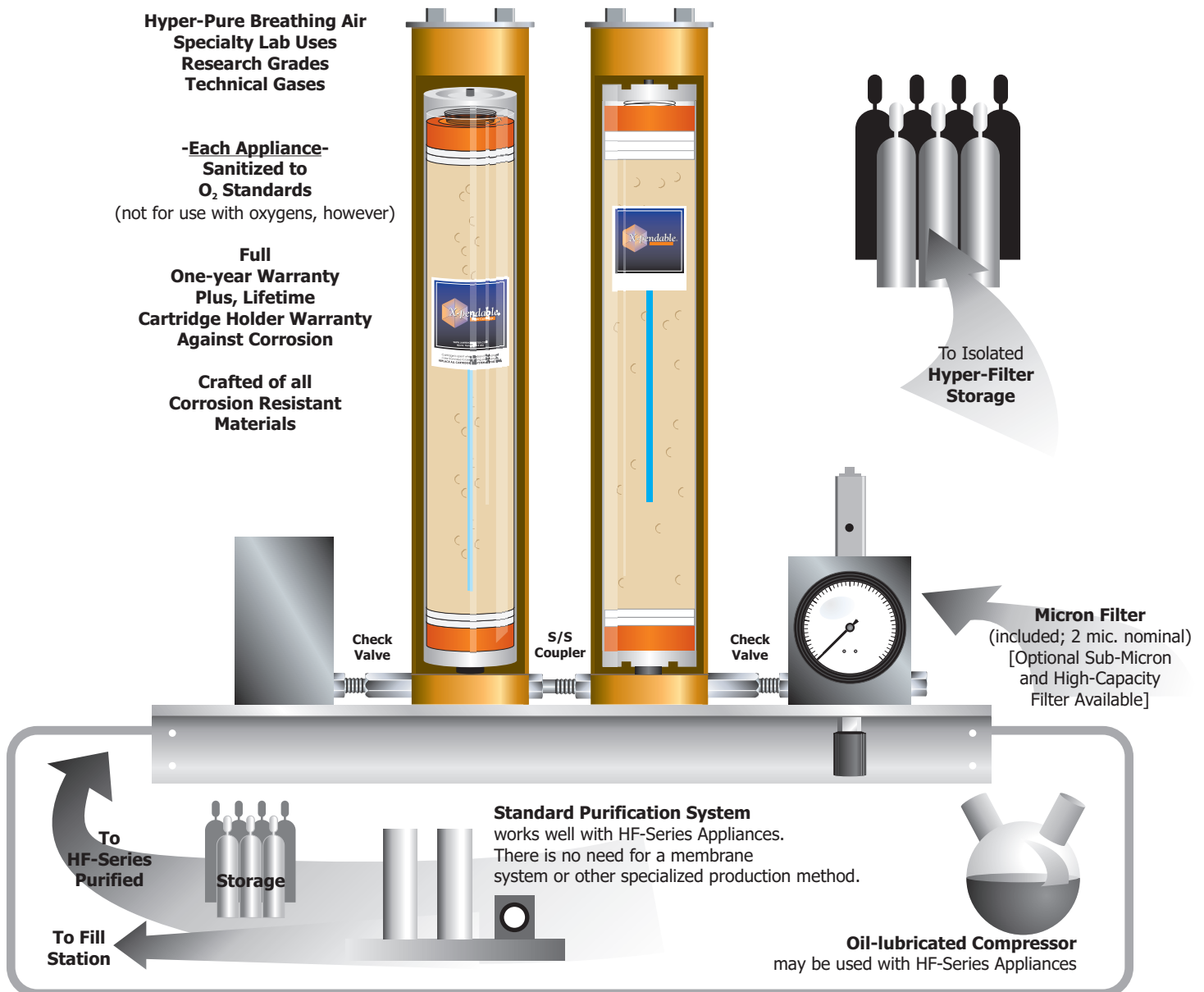
**Full  
One-year Warranty  
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**Crafted of all  
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(included; shown in housings)  
"polish" the air or gas to hyper-pure, standards  
for specialty lab, research, or technical use.



To Isolated  
**Hyper-Filter  
Storage**



# HF-Series 5000 PSI Appliances for Mixed Air and Inert Gases

Shown are Lawrence Factor's™ most popular models. Additional models available.

Lawrence Factor™: the people known worldwide as *The Air and Gas Purification X-perts™*. Our HF-Series Appliances, developed for polishing air and inert gases to hyper-pure standards, are the ideal choice for OCA, technical, research, specialty lab, or hyper-pure breathing air production.

## Excellence . . .

Lawrence Factor™ HF-Series Appliances are crafted of highly rugged and corrosion resistant materials. Each appliance is subject to rigorous testing and sanitizing, including comprehensive analysis by X-zam™ Laboratories.

## Easy and Convenient . . .

Lawrence Factor™ HF-Series Appliances can be used with the equipment you already own. No special set-up - such as a membrane system, specialty compressor, or other production method - is needed.

## Economical . . .

Lawrence Factor™ HF-Series Appliances represent a lower capital investment than comparable systems. And, because they can be used with the equipment you now own, expensive upgrades are unnecessary.

## Effective . . .

A Lawrence Factor™ HF-Series Appliance, when used with X-pendable® and X-tractor™ filters, can be used to "designed" air and inert gases to your precise specifications.

## General Specifications

Minimum WP: 2000 PSI  
 Maximum WP: 5000 PSI  
 Max. Operating Temp.: 100°F  
 Tensile Strength: 83000  
 Cylinder Mat.: Aluminum  
 Couplings: Stainless Steel  
 Safety Factor: 4:1ASME  
 Re-Pressure Cycle Life: 40000

## Minimum Inlet Condition

Depends upon your application. Please consult your Lawrence Factor™ representative for guidance.

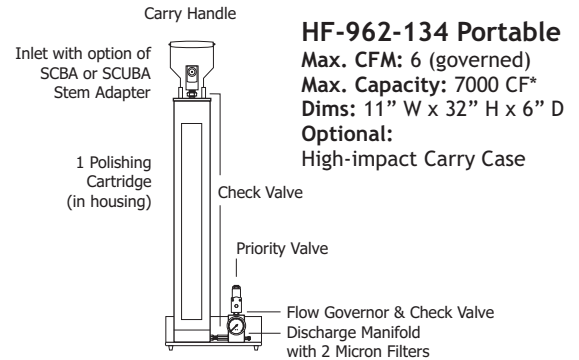
## Included

Lawrence Factor™  
 X-pendable® Cartridge Set  
 Instruction Manual  
 Full 1-year Warranty  
 Lifetime Cartridge Holder  
 Corrosion Warranty

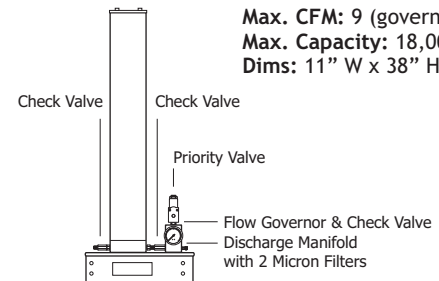
## Optional Accessories and Supplies

Electronic Cartridge  
 Change Monitor  
 Electronic Dewpoint Monitor  
 Cryomon Contaminant Monitor  
 Gas Sampling Connection  
 Freestanding Chassis  
 Spanner Wrench  
 OxyLube™  
 Non-hydrocarbon Grease  
 Seal Kit  
 Specialty Valves  
 Leak-X™ Leak-finding Aerosol  
 Viton O-rings  
 OCA Air Analysis (by X-zam Labs)  
 X-pendable Polishing Cartridges  
 X-tractor Particle and  
 Micron Filters

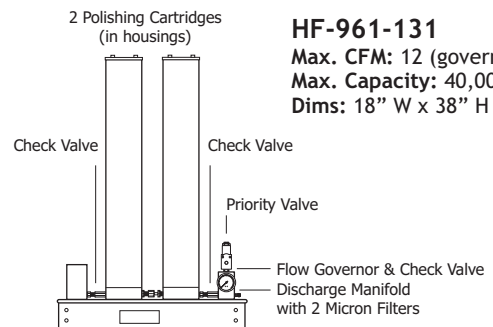
*\*Capacities are calculated for gas at CGA level E and entering the Appliance at 80°F and 5000 PSI. Capacities can be affected by temperature, pressure, and gas flow.*



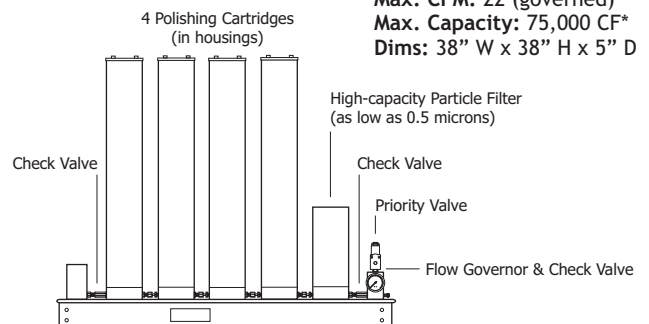
**HF-962-134 Portable**  
**Max. CFM: 6 (governed)**  
**Max. Capacity: 7000 CF\***  
**Dims: 11" W x 32" H x 6" D**  
**Optional:**  
 High-impact Carry Case



**HF-961-111**  
**Max. CFM: 9 (governed)**  
**Max. Capacity: 18,000 CF\***  
**Dims: 11" W x 38" H x 5" D**



**HF-961-131**  
**Max. CFM: 12 (governed)**  
**Max. Capacity: 40,000 CF\***  
**Dims: 18" W x 38" H x 5" D**



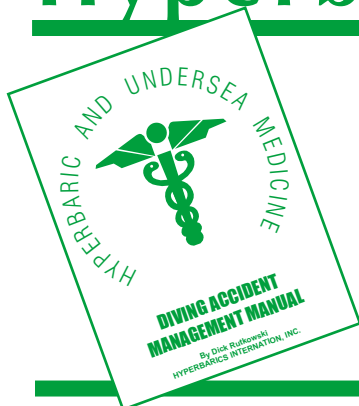
**HF-961-114**  
**Max. CFM: 22 (governed)**  
**Max. Capacity: 75,000 CF\***  
**Dims: 38" W x 38" H x 5" D**



# DIVING MANUALS

by  
**Hyperbarics International, Inc.**

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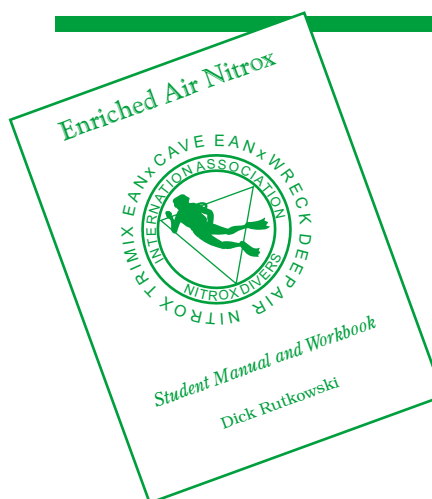
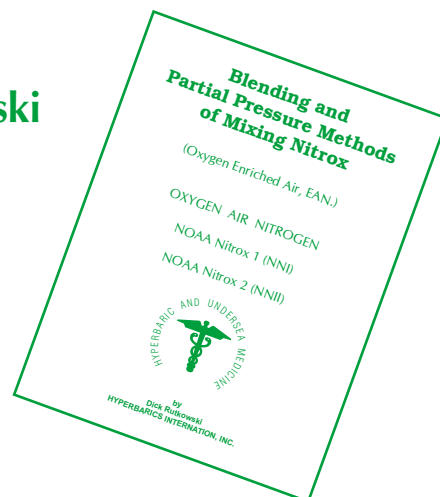
## **Diving Accident Manual** by Dick Rutkowski

This manual is a simplified version of how to recognize a diving accident victim, recognition of signs and symptoms, stabilization, first aid and evacuation procedures. First edition 1978, revised many times since. \$5.00

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## **Blending & Partial Pressure Methods of Mixing Nitrox/Trimix, by Dick Rutkowski**

This manual is intended to be a guide to those persons without detailed technical training. It is intended to help explain the standards, properties, equipment, oxygen safety, handling and cleaning procedures for mixing or blending diving gases other than air, such as Nitrox (EANx) or Trimix. Unqualified persons are often confused as to what standard to use for mixing oxygen, air and helium because they do not understand the differences between physiology and mixing or how the two are differentiated. This manual should help eliminate this confusion. \$35.00



## **Enriched Air Nitrox Student Manual and Workbook, by Dick Rutkowski**

An instructor/student guide for the use of nitrogen-oxygen mixtures as a divers' breathing gas. Designed as a simplified version of how to use and handle nitrox (N<sub>2</sub>/O<sub>2</sub>), this manual includes physics, physiology, and pathophysiology of nitrox use, oxygen safety, analysis of nitrox mixtures, operational implications, decompression tables for nitrox mixtures, and training for mixers/users. This book is the official manual for the International Association of Nitrox Divers. \$30.00

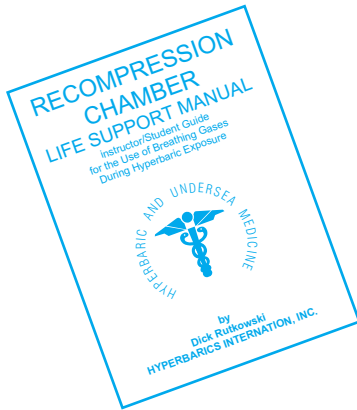
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**Hyperbarics International, Inc.**

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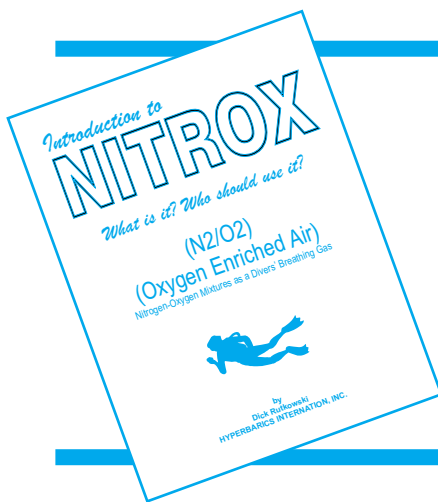
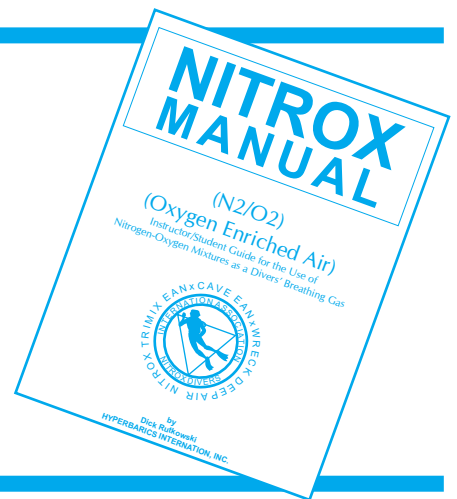


## Recompression Chamber Life Support Manual, by Dick Rutkowski

An instructor/student guide explaining the correct physics, physiology, and pathophysiology of breathing gases during hyperbaric exposure in recompression chambers, habitats, and diving bells. Open circuit free flow, demand, and closed circuit systems for both field and hospital based chambers are covered, teaching the skills and knowledge necessary to correct time, gas, and pressure physiology for encapsulating patients and tenders in a hyperbaric environment. A must for every chamber operator. \$30.00.

## Nitrox Manual, by Dick Rutkowski

A guide and workbook for the use of nitrogen-oxygen mixtures as a divers' breathing gas. Designed as a simplified version of how to use and handle nitrox (N<sub>2</sub>/O<sub>2</sub>), this manual includes physics, physiology and pathophysiology of nitrox use, oxygen safety, analysis of nitrox mixtures, operational implications, decompression tables for nitrox mixtures, and training for mixers/users. \$30.00.



## Introduction to Nitrox Diving, by Dick Rutkowski

This manual is intended to introduce divers to oxygen enriched air. It covers the history, users, pros and cons of its use, and the myths and misconceptions of nitrox. A welcome addition to every divers' library. \$20.00.

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