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# Portable Oxygen Systems

**It's the carry case, stupid. Nelson has the best and since the systems are functionally alike, they're our choice.**

by Douglas S. Ritter

The use of supplemental oxygen pilots is growing, perhaps fed by an increasing awareness of how dangerous hypoxia can be and the availability of inexpensive pulse oximeters that show just how oxygen deficient you can get, even at low altitudes.

Just as when we last examined these products six years ago, our evaluation shows that all the systems we looked at will provide a reliable source of oxygen.

The changes in equipment available today are relatively minor and the improvements and differences are in the details—details that make a difference in convenience, value, and in some instances, safety.

## Four Sources

There are still four players in this market, Aerox, Aircraft Industries (Sky Ox), Mountain High Equipment & Supply (MHE&S) and Precise Flight (Nelson). Precise Flight bought Nelson in 1998, making few changes in the product line.

Selecting a system can be confusing, since there are many similarities between the products and many share the same components.

Your first decision will be size. Two-person systems are a bit less expensive because a smaller cylinder is often used and there are fewer cannulas and masks to purchase.

MHE&S is unique in its wide choice of cylinders for the same price. However, except for Moun-

tain High's electronic EDS systems, the incremental cost of upgrading to a four-person system isn't much, while upgrading later can cost a good deal more, regardless of the system. Advice: If you think you'll ever need oxygen for four, buy it at the outset. You'll probably save money.

The second criteria is system management. Will one person manage it for everyone or do you want to allow individuals to manage their own oxygen? The standard Sky Ox system is designed around the former philosophy, the rest subscribe to the latter.

**Given similar performance, accessories such as cannulas, masks and cases set systems apart. Below, are systems from Mountain High (1), Aerox (2), Nelson (3) and Sky Ox (4). Aerox mask, right, is easy to use, comfortable and provides excellent mic quality.**

## Checklist



- All of the systems can deliver adequate oxygenation.

- Operability is a key concern and Nelson ranks highest, with easy-to-use flowmeters and, above all, a secure case. (The best.)

- For monitoring, consider buying a pulse oximeter. It's cheap insurance against hypoxia.



- Sky Ox makes an adequate system but its case doesn't measure up.

- Expensive MHE&S EDS system may be economical if filling your tank at an FBO. Use conserving cannulas for occasional pax.





**Cannula and mask choices, left photo, include oxygen conserving “mustache-style” cannula, pendant style and non-rebreather lightweight mask. Flowmeters, right photo left to right, include Sky Ox, Nelson dual-scale model and Aerox versions, also dual calibrated.**

Before deciding, understand that individual oxygen needs vary, thus a single oxygen flow setting may result in higher consumption than necessary for one person, too little for another.

With individual adjustment, each user can set the flow rate to what they require, which we think is the better solution, given individual differences.

Portability is an issue, too. Some “portable” systems are installed with brackets holding the cylinder to the floor or sidewall. It’s removed only for filling, maybe, and the case may or may not be used for transporting the cylinder.

### Commonalities

All the aluminum cylinders used by the suppliers are basically the same. The differences are in volume and dimensions. Volume is related to system size and duration required. Most two- and four-person systems use 22 to 24 cubic foot cylinders and we’d recommend that size as a minimum.

We suggest getting the largest cylinder you can afford, in cost, size and weight. Kevlar-wound aluminum cylinders are available for significantly more money and 50 percent weight savings may be worth it to some. Aerox, MHE&S

and Nelson’s Sportsman systems all use essentially the same piston style regulator, compact, simple and reliable. With the exception of the MHE&S EDS system, all provide Chad conserving cannulas. If you don’t like their standard style, they’ll give you the other style for no extra cost.

All use similar basic non-rebreather style soft plastic masks (bag attached) except for the MHE&S EDS mask, which dispenses with the bag. The masks are uncomfortable enough that many avoid their use, either limiting flight to 18,000 feet and below or using cannulas above that altitude, despite regulations to the contrary.

Aerox and Sky Ox provide only a single mask for the pilot as standard equipment. With Nelson and MH systems, everyone gets a mask.

### Aerox

The Aerox regulator has its small brass quick connectors protruding out of the top of the body. With the cylinder mounted on the seat back, these present a potential danger to a rearseat passenger, something that wouldn’t be a problem if the unit were semi-permanently installed on its side.

Aerox offers two flow adjustment

## O<sup>2</sup> SYSTEMS COMPARED

System	Price 2-person	Price 4-person	Cylinder Size/Type <sup>4</sup>	Cannula Style	Flow adjustment
Aerox	\$568	\$769	22 cu/ft aluminum	Oxysaver conserving	Individual at cylinder <sup>2</sup>
Mountain High XCP	\$450	\$550	24 cu/ft <sup>1</sup> aluminum	Oxymizer conserving	Individual Nelson Flowmeter <sup>3</sup>
Mountain High EDS	\$2400	+\$650/person	22 cu/ft Kevlar	Non-conserving	Individual electronic
Mountain High EDS	\$1700	+\$650/person	22 cu/ft aluminum	Non-conserving	Individual electronic
Nelson Sportsman	\$650	\$750	22 cu/ft aluminum	Oxymizer conserving	Individual Nelson Flowmeter <sup>3</sup>
Sky Ox	\$515	\$585	24 cu/ft aluminum	Pendant conserving	Adjustable regulator

Notes:

<sup>1</sup> Price includes choice of 3.3, 4.8, 6.8, 8, 13.4, 19, 22 or 24 cu/ft cylinders

<sup>2</sup> Combination inline flowmeter valve, add \$8 each

systems using the same brass needle valve. We like that brass valve for its inherent strength and resistance to damage and deterioration. In the standard system, the valve is located on the male quick connect fitting at the regulator.

A dual-range (cannula and mask) 22,000-foot flowmeter is located at the other end of the supply line and the cannula or mask attach to the outlet. With this design, there's no high pressure in the hose from the regulator to a remote valve, a good feature.

The Aerox case is constructed of lightweight nylon material laminated to 3/16 inch insubstantial foam with a lightweight "fuzzy" lining bonded to the foam. There's nothing to retain the cylinder in the case, so if the zipper is open, it could come out in transport or in turbulence.

Also, the harness straps made it difficult to operate the shutoff valve. The mounting harness is a poor knock-off of Nelson's, in our view, and attaching and removing it with a 22-cubic foot cylinder was awkward due to the webbing design. No storage for cannulas or masks is included. Aerox provided a sample of its Quick Donning Type, Double Seal Silicon Mask with electret microphone. This

same Aerox mask was also supplied by Nelson and Sky Ox. It proved comfortable and provided better sound quality than any other such mask we have tried.

Whether it's worth \$385 is questionable, although one volunteer tester purchased the unit he tested for his own use. A less expensive option is the same mask, sans microphone for \$120. It's equipped with a diaphragm that allows you to be heard through the mask and to use your mic. Sound quality suffers, but it's readable.

We got sound quality equivalent to these expensive masks by slipping a headset mic through cross slits cut in the side of the standard mask (with no noticeable reduction in oxygenation). Not elegant, but effective.

### Sky Ox

Upfront we'll mention this system's most significant failing: Its case, which we feel makes it unacceptable for portable use.



*To measure system effectiveness, we used pulse oximeters, above, which we'll review in a future issue.*

While Sky Ox claims the bag can be used to secure the system, it has only a shoulder strap, with no other means to fasten it securely.

The bag has a clear plastic window so you can check the cylinder pressure without opening it and a drawstring bag is included for cannulas and mask storage.

Sky Ox is the only manufacturer who supplies the pendant style conserving cannula as standard.

Flexible plastic loops go over the ears and we found them surprisingly comfortable for the most part. The pendant's nasal tubes are more comfortable without the reservoir and this allows you to drink without removing the cannula, important because oxygen dries you out.

With the Sky Ox system, flow rate is set at the regulator for all users. The gauge is marked in both flow rates (liters per minute) and altitude. A instruction sheet provided explains LPM settings but reading closely reveals that the altitude markings are for mask use only, while cannula use isn't explicitly marked. We think it would be better to annotate the gauge for both cannula and mask and not rely upon a slip of paper that's sure to be lost.

### Mountain High

We tested two systems from Mountain High, a conventional system using Nelson A4 flowmeters and

Case/Harness	Case Rating	Comments
Full-Pack option, \$74	Fair	Compromised harness a negative; storage bags for each user a plus
Full-Pack standard	Fair	Save big with conventional cannulas for passengers
\$45 to \$50	Poor	Drawstring nylon bag holds four pendant cannulas

<sup>3</sup>Price includes choice of Nelson A3 or A4 Flowmeter  
<sup>4</sup>Comparable-sized cylinder on test system used for pricing comparison



***There's no denying that a portable oxygen system makes for a tangled mess of hoses, cannulas and masks, left, especially when testing systems. A good case keeps the bits in order but should also attach easily to the seat. Mountain High design, right, has a small pouch for accessories but mounting isn't as good as Nelson's design.***

conserving cannulas and their unique EDS Electronic Pulse-Demand Oxygen Delivery System.

As far as the conventional system goes, the only significant difference between MHE&S and Nelson is that MHE&S uses Delrin fittings instead of plated metal at the regulator.

Since we were testing to 24,000 feet, our system was equipped with A4 dual-scale flowmeters. A3 flowmeters are for use only with cannulas to 18,000 feet and are options.

Patrick McLaughlin, President of MHE&S, told us that they have designed new flowmeters that address the various failure modes of the Nelson units and these are supposed to be available this fall.

MHE&S supplied a Scott mask with electret microphone for use with its conventional system but we found it all but useless and uncomfortable. The head strap naturally falls over the ear, a poor design that's annoying to wear. The mic made for unintelligible sound quality.

The EDS D1 system is a second-generation unit using a digital rather than analog design and it's smaller and lighter than the original we tested a few years ago. In brief, it provides oxygen on demand at the beginning of each

inhalation, as opposed to a constant flow of oxygen in the conventional systems. By providing no more than is needed, oxygen duration is claimed to be extended as much as 30 to 60 percent over conserving cannulas.

The EDS D1 connects to the standard MHE&S regulator and runs for about 40 hours on a 9-volt battery but the battery will deplete quickly if not removed when the unit is idle. Alternatively, aircraft power can be used through a surge-protected power supply that sells for \$195. Oxygen from the cylinder is supplied to the inlet and the delivery device, a standard (not conserving) cannula or mask, is attached to the outlet. Each person requires his own EDS unit.

### **Automatic Oxygen**

The unit's solid-state temperature and baro sensors allow it to calculate pressure altitude to determine how much oxygen to supply. It senses the start of inhalation and delivers a pulse of oxygen, theoretically adequate for the pressure altitude.

There are four operational modes: The "N" setting ("Night" or "Now") provides oxygen at the rate of 1 LPM/10,000 feet; "D" ("Day" or "Delayed") mode delivers

oxygen upon reaching set pressure altitudes of 5000 and 10,000 feet, or ensuring you're legal at 12,000 feet. The "F" settings (Floor or Face Mask) increase oxygen delivery based on increasing pressure altitude.

Our experience suggests that the F-5 or F-10 setting is probably necessary to maintain oxygen levels in the low to mid-90 percent range using cannulas. Most users tell us they simply set it on one of those two settings and forget it, with confirmation via pulse oximeters.

Worth noting is that pulmonary efficiency declines as a function of numerous factors, with age being the most significant.

Younger persons may find the normal N and D settings adequate but anyone with compromised lungs may need to use higher settings.

Let's also note a few peculiarities: Some people breath shallow or more rapidly than the unit is calibrated to sense and will thus require a higher setting to maintain oxygen levels. We also discovered that by consciously breathing deeply and exhaling completely, we were able to raise our oxygenation levels by five percentage points easily, obviating the need for additional oxygen flow. Revert to normal breathing and you lose that advantage.

The final EDS mode, "R/M" (Reserve/Manual), provides a fixed ½-second pulse regardless of altitude, the claimed equivalent of a 100 percent flow setting for a conventional system but still delivering significant conservation.

We were favorably impressed with the EDS unit. Once turned on, you can forget about adjustments and the standard cannulas are more comfortable.

At first, the pulsing is somewhat disconcerting, not for the flow itself but the hissing sound. But we adapted to this quickly and the lessened flow of oxygen should ease dry nose or throat problems that trouble many oxygen users.

Some nits: There's an audible and flashing LED alarm if the flow is stopped or if you don't take a breath for 45 seconds. Nice idea but the LED is so small as to be unnoticeable and the alarm is easily

missed with headsets on. A louder alarm would help.

Other than an oximeter, there's no way to know if the unit is functioning properly. Last, there's no easy way to bypass the electronics, as the original analog system had. Solution: Use a pulse oximeter and carry a spare line and mask to plug directly into the regulator, just in case.

Then there's the price. With cannula and mask but without cylinder and regulator, each EDS unit sells for \$650 each. While you can justify the expense in oxygen saved and convenience for one person, it may not make sense to equip every seat unless each is filled with a passenger breathing oxygen.

Most MH systems—two thirds of which are bought with the pricey Kevlar-wound cylinders—come with the Tuff-Pack case, a slimmed down mount and harness for the cylinder, saving about half the weight of the Full-Pack case, but providing little protection.

The MHE&S "Full-Pack" has some nice features, but also some shortcomings. The Cordura nylon exterior is tough, but the interior is fleeced lightweight foam, no different than that of Aerox. A pair of zippered pockets at the top provide storage of the harness and odds and ends. A zippered nylon pouch with handles is provided for each set of flowmeter or EDS unit and cannula and mask, a nice feature. But there's no easy way to secure them to the case for transport, leaving you with multiple bits to keep track of. The harness installation instructions were worse than useless, in our estimation. The illustrated installation was for a Cessna-style seat, hardly universal, and if installed as suggested, prevents the seat from folding forward, blocking access to and egress from the rear seat. We never did find a way to attach the case to the seat in a way that



## Back-Up Bottles

So what happens when Murphy shows up and the oxygen stops flowing? With useful consciousness at 24,000 feet of about three to four minutes, there's little time to dally.

The solution for many pilots who regularly fly at higher altitudes is an emergency oxygen supply, often called a "pony bottle," a small cylinder of oxygen that will last long enough to troubleshoot a problem or descend to a safe altitude. We evaluated two such

devices on the market; Mountain High's "Co-Pilot" and Aerox's Personal Rescue Oxygen System.

The Co-Pilot (\$150) includes three disposable cylinders,

a regulator and a mask, which attaches directly to the regulator, so you have to hold the entire thing up to your face. Alternatively, you can hook up a conserving cannula or regular mask.

The cylinder is punctured when you screw the regulator on, pressurizing the system and a built-in gauge shows charge status.

There's a rotary on/off control knob adjustable to a maximum setting of 2-liters per minute, which would result in nine minutes duration. (Watch that knob, though, it's too easy to turn and

could be bumped on accidentally.)

With a conserving cannula, the company claims about a 30-minute duration at 15,000 feet. Replacement cylinders cost \$18 each, \$45 for three.

Aerox originally developed its Pro2 or Personal Rescue Oxygen System (\$395) to serve as a replacement emergency oxygen system for pressurized aircraft. We tried a prototype of this system.

It's a conventional 2-cubic foot (56 liter) aluminum cylinder equipped with a regulator and gauge. A conventional oxygen mask is secured to the cylinder with its elastic strap. A wire cable is attached to the oxygen line to the mask and when extended it actuates the regulator, like the passenger oxygen system in an airliner.

At 2.5 LPM, there's approximately 22 minutes of oxygen. The cylinder is refillable and a protective nylon case will be provided.

Both systems worked as advertised and will serve adequately as an emergency oxygen source to provide time to descend. The Co-Pilot was awkward to use with its attached mask but is fine with a cannula or regular mask.

The Pro2 is a more elegant solution but whether it's worth nearly three times more, an extra \$245, is questionable. The Co-Pilot strikes us as the better value.

pleased us.

### Nelson

Nelson originated the integrated flowmeter and valve concept, eventually supplying flowmeters for other manufacturers. There are some known weak points in this design. We've seen a number of these with the inlet or outlet barbs broken off and with valve failures, so it's a good idea to carry a spare.

Nelson's regulator is virtually

identical to MHE&S, except for its plated brass fittings. The cylinder pressure gauge has no markings, just numbers. Nelson also offers its original Oxypack style diaphragm regulator as an option (\$50), which we tested last time around. It's bulkier and heavier and less reliable, according to user reports so we can't see a reason to choose it.

What sets Nelson apart from the rest is the case and mounting harness. Nelson's "Oxypack" case

is constructed of Cordura with resilient ¼-inch close cell foam padding and a sturdy nylon interior lining. The foam is substantial enough to offer protection to the tank and regulator—and passengers.

A zipper extends down one side and over the top and part way down the other side, but there's a sewn-in stop to prevent the zipper from opening all the way down the full side. A Velcro restraining strap fits around the tank neck, securing it in place.

A commodious zippered storage compartment is attached to the side of the case and the nylon web handle is padded and quite comfortable.

The harness was straightforward to install and the instructions were clear. Once installed, it isn't going anywhere and is easy on the upholstery. It was easily the best secured of the bunch and it requires only seconds to remove or replace the tank. All in all, a superior design.

While Mountain High and Aerox

offer limited lifetime warranties, Nelson offers a two-year limited warranty. Sky Ox has but a one-year warranty. Our experience, and that of users we've interviewed, is that the systems are trouble-free for the most part and all the companies have a reputation for good support.

However, Nelson, under the new ownership, confirms that there is now a \$20 replacement charge for out-of-warranty flowmeters. In days of yore, Nelson almost always replaced these for free.

## Our Choices

When we were contacting the companies to arrange for evaluation units, one purveyor gave us an earful about our previous test, complaining that it seemed that we had focused solely on the case to determine the winner. While that wasn't the entire story, we do think the cases are important.

All other things being substantially equal, the case can easily become a deciding factor. To quote one volunteer struggling to mount one of the cases, "you've got to wonder if the designers ever actually use this stuff."

The overall winner in the conventional category is Nelson, even though you'll pay a slight premium for the vastly superior case and harness. We also suggest you carry a spare flowmeter with any system using the Nelson flowmeters, since we've seen too many failures. Too bad they no longer replace these for free, although MHE&S does for its customers, eating the losses. We commend them for great customer service.

Aerox charges a premium for its systems and the reliability advantages of the brass needle valves may be worth it. (You don't need to carry a spare, reducing the price differential.)

The lifetime warranty and the company's reputation are pluses. We do think it's more practical to have the adjustment at the flowmeter than at the regulator, so we'd choose Aerox's optional integrated flowmeters, increasing the price slightly. The Aerox case rates only a fair.

Mountain High's XCP system

will save a few bucks and provide a virtually identical oxygen system to the Nelson, but with an inferior case. We like Mountain High's lifetime warranty and excellent reputation for customer service and if they'd just improve that case, they'd move to the top of the pack, no question.

Given the competition, we just can't get excited about the Sky Ox systems. Any cost savings don't cover its inadequacies, in our opinion, especially the case and adjustable regulator with its inadequately marked gauge. The cost savings don't offset these shortcomings, in our view.

For those who do a good deal of flying at altitudes where oxygen is necessary, Mountain High's EDS system is the answer. If you're paying FBO prices to fill your cylinder, the payback will come quickly; less so if you decide to fill your own.

If weight isn't a concern, we'd skip the expensive Kevlar cylinder and the skimpy Tuff-Pack case. In most cases, we think a sensible buy is a one- or two-unit EDS system, with conventional flowmeters and conserving cannulas and masks for occasional use by passengers.

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