Supplemental Oxygen – General Aviation

1. FAA Requirements:

Sec. 91.211 Supplemental oxygen

(a) General No person may operate a civil aircraft of U.S. registry-

(1) At cabin pressure altitudes above 12,500 feet (MSL) up to and including 14,000 feet (MSL) unless the required minimum flight crew is provided with and uses supplemental oxygen for that part of the flight at those altitudes that is of more than 30 minutes duration;

(2) At cabin pressure altitudes above 14,000 feet (MSL) unless the required minimum flight crew is provided with and uses supplemental oxygen during the entire flight time at those altitudes; and

(3) At cabin pressure altitudes above 15,000 feet (MSL) unless each occupant of the aircraft is provided with supplemental oxygen.

Background comment on FAA Regulation:

Those regulations, originally developed in the 1950s, were based mostly on politics and economics and minimally on human physiology. Basically, the 12,500 and 14,000 MSL rules were instituted after the GA lobby convinced the FAA that anyone should be able to fly a GA airplane anywhere in the US without supplemental oxygen. Thus, this 12.5 for 30 minute rule made it possible for any pilot to fly across any mountain or mountain pass without the need for what was then, heavy, expensive oxygen equipment. What we now know is that some pilots need oxygen at 8,000 feet and some younger, healthy ones, who live at 6,000 feet, might not need oxygen till much higher.¹

Altitude Camber Training:

Everyone who flies high and certainly anyone who flies over 18,000 feet needs to undergo high altitude training in an altitude chamber. This is not for the commonly held reason that it teaches the pilot how to recognize hypoxia in their system. That is hog wash. The basic problem with early hypoxia is that it impairs cognitive thinking. No one who gets goofy is going to know when they are getting hypoxic and needs supplemental oxygen. The purpose in altitude training is to prove to pilots that they too can get goofy when hypoxic. The best chambers display this display of hypoxic effects on each participant so when back to normal oxygen levels, the pilot can see exactly how dumb they got. Convincing each and every pilot that they too will be affected is the important part of this training. There are many types of oxygen equipment but the bottom line is oxygen. Probably the most significant issue for pilots is the hassle of filling the oxygen, how big a tank to buy, and whether conserving equipment is necessary which is based on the prior two issues¹.

2. Types of Oxygen:

¹ Attributed to “Dr. Brent Blue”, Aeromedix  http://aeromedix.squarespace.com
There are generally four kinds of oxygen that are merchandised or sold to users; Aviation, Medical, Welding and Research. There are others such as Zero, Ultra High and Research grade. 

**Aviators** – The minimum purity required is 99.9% with less than 3 ppm water.

**Medical** – flight training manuals and the FAA tell pilots not to use medical oxygen because it contains more moisture add will freeze the oxygen equipment lines, or regulators. At one time this was true. The oxygen going to a hospital bed is plain oxygen that comes from liquid oxygen. At the bed location, there is a unit on the wall that adds moisture. At this moment we now have medical oxygen. Medical oxygen is dispensed and used under FDA protocols

**Research** - oxygen minimum purity required is 99.999% with no specified moisture content.

**Welders** – flight training manuals and the FAA tell pilots not to use welder’s oxygen because it contains impurities that may harm or kill you. Industrial/Technical (welders) oxygen minimum purity required is 99.9% with no specified moisture content.

**FAA** – Aviator’s oxygen must meet certain standards to ensure that it is safe to be taken to altitude. Only aviator’s – grade oxygen meets this specification. Neither medical grade nor industrial grade oxygen is safe to substitute because they do not meet the same stringent standards as ABO (Aviator’s Breathing Oxygen).

**Other views:**

Mountain High E & S Co. Aviation Oxygen Systems

Contrary to a common myth, there are no different grades of oxygen being produced or contained in cylinders maintained under DOT regulations. In addition, oxygen for medical use does not have any more moisture than oxygen for any other purposes. Furthermore, because of the chemical nature of oxygen it must be as pure and dry as possible if stored under pressure or else the cylinder and equipment may be damaged, or worse, personal injury or death may occur. By the very nature of the state-of-the-art process commonly used by compressed plants today, oxygen produced for any purpose will be better than 99.99% pure. In other words, it all originally comes from the same spout. What happens thereafter is why there is a set of hygiene protocols detailing the handling, inspection and transportation of oxygen to ensure purity at the destination. No doubt these protocols may be the cause of the oxygen grade misconception in the compressed gas industry. Oxygen holding the slightest amount of water moisture may cause the cylinder holding it to rust or corrode at an accelerated rate. The confusion may have stemmed from the fact that there are various grades of air mixtures. Some air mixture protocols may allow higher amounts of water moisture to be present. This also may have helped cause the misconception that there are different grades of oxygen.

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3 FAA OK-09-439, Oxygen Equipment Use in General Aviation Operations www.faa.gov/pilots/safety/pilotsafetybrochures/
This misconception is so wide-spread that some aircraft manuals and flight training manuals, tell pilots not to use 'MEDICAL' oxygen because the moisture will freeze the lines and/or equipment. Additionally, not to use welders oxygen because it contains impurities that may harm or kill you. This is FALSE!, unless the latter has been tampered with. Ask for AVO, or else the FDA may freeze your plans, and not from any moisture.4

Precise Flight, Inc. Nelson Oxygen Equipment

There are three kinds of oxygen that are merchandised or sold to users; Aviation, Medical, and Welding. There is an ongoing controversy whether or not there is any difference between the different types. Oxygen gas is produced from the boiling off of liquid oxygen. It would appear that the oxygen is therefore the same. Where we obtain oxygen, all the different types of oxygen are supplied from the same manifold system. Then someone says that medical oxygen has more moisture in it. That is partly true. The oxygen going to a hospital bed is plain oxygen that comes from liquid oxygen. At the bed location, there is a unit on the wall that adds moisture. At this moment we now have medical oxygen. If the oxygen is in a pressure vessel or in a manifold system (like inside a hospital) then it is regular oxygen. The cost of medical or welding oxygen is normally much less than the oxygen you get at an airport.

Also of interest, the suppliers of welding oxygen have told us, the purity level required for welding and cutting purposes is more critical than for breathing.

The bottom line about the different types of oxygen is in the insurance liability of the oxygen supplier. The gas is the same but the insurance liability is different. The welding gas company may or may not supply you with oxygen for your aircraft. Likewise the medical oxygen supplier may or may not supply you with oxygen for your aircraft. Some of our customers have told us that they can only get medical oxygen for aircraft use if they have a prescription from their family doctor.

We ask you to determine if the welding or medical oxygen is suitable for your use. We do not and cannot make any recommendation on the use of oxygen other than aviation oxygen.5

Aeromedix

There are many types of oxygen equipment but the bottom line is oxygen is oxygen. Probably the most significant issue for pilots is the hassle of filling the oxygen, how big a tank to buy, and whether conserving equipment is necessary which is based on the prior two issues.


Since the 1960s, all oxygen sources have been from liquid oxygen. There is no difference between aviator’s and medical oxygen. When oxygen was first used in hospitals, the gas was humidified in the tank which is a problem for aviation because water will freeze in oxygen


5 Precise Flight, Inc. Nelson Oxygen Equipment www.preciseflight.com
plumbing in cold, high altitude aircraft environments. Since medical oxygen is humidified after it leaves the tanks, this is no longer an issue. However, getting something taken off the FAA regulation books requires undue time and energy so everyone uses whatever oxygen they can find and no one apparently cares. If you truly get “aviation” oxygen, you will find the only difference is that it is tested for water and is more expensive.  

3. Cannula Breathing Devices:

   a. Standard Cannulas

   The medical cannula breathing device has been successfully adapted for use with aircraft. Doctors' Diamond and White of the Southern California area were instrumental in getting the FAA approval for its use. The cannulas are being used extensively with excellent results by thousands of pilots and their passengers.

   The cannula breathing device can be used satisfactorily up to 18,000 feet however; it should not be used above that altitude. One of the reasons for restricting its use above 18,000 feet is due to problems controlling the exhalation of carbon dioxide (CO2). Below 18,000 feet, the control or regulation of CO2 into the lungs is not too critical. At some point above 18,000 feet, it becomes critical. 18,000 feet may not be an exact point where the CO2 regulation is critical, but it is an easily remembered altitude (you are in positive controlled airspace above 18,000 feet) to change over to a face mask.

   The oxygen required for the standard cannula is the same as a face mask (1 liter per minute for every 10,000 feet). There are no savings of oxygen with the standard cannula. The advantages of the standard cannula are freedom to talk, eat, and drink. The cannula is much more comfortable than a face mask, especially for long durations.

   There are restrictions on the use of the cannula devices. Pilots should refer to FAR 23.1447 to see if any restrictions may apply for their use of cannula type breathing devices in the operation of their aircraft. What is or is not allowed is subject to discussion and legal determination. The ultimate decision to use the cannula must be made by the pilot in command of the aircraft.

   The FAA requires that there be a standby face mask on board for each cannula device that is being used.

   b. Oxygen Conserving Cannula

   The oxygen conserving cannula breathing device was introduced into the aviation field in 1987. The purpose of the device is to reduce home health care oxygen cost or consumption for those requiring oxygen on a daily basis. For example, Chad Therapeutics' Oxymizer® has been very successful for this purpose. Two versions are produced by Chad; one with a reservoir built into the face piece, the other
with a separate reservoir apart from the face piece. Both units perform equally well with the same specifications.

The standard cannulas waste oxygen. The conserving device accumulates the continuous flow of oxygen that is normally wasted during exhalation. This accumulated oxygen is then available as a bonus at the very beginning of the next inhalation when it is taken deep into the lungs for maximum efficiency. This permits drastic reductions in the oxygen flow rates while maintaining proper oxygenation of the blood. As a result, the contents of a portable oxygen system last much longer. This can increase oxygen availability as much as 75%.

The use of the conserving device easily doubles the normal duration of oxygen use at 18,000 ft. and triples the use at 10,000 ft. The basic principle of the conserving device is to accumulate wasted oxygen while the user is exhaling. Oxygen is only needed when we inhale. We inhale only about 25% of our breathing process and exhale the remaining 75%. However, the oxygen is flowing all the time. Therefore, we are wasting 75% of the oxygen. Instead of wasting oxygen, we divert this oxygen into a small reservoir (conserving device).

See attachment I for how to use the oxygen conserving cannula

4. Oxygen System for CAP 403

The oxygen system for most California Wing aircraft consists of a portable O₂ cylinder (22 cu. ft., charged to 2000 psi), carrying case and is attached to the back of the right front seat with straps.

To use the system the carrying case is opened and plastic thread protector removed and the oxygen regulator (Nelson Aircraft Model 300M) screwed on to the cylinder. The oxygen regulator, flow regulator and tubing are stored in the side pocket on the carrying case.
There are four ports around the regulator that accept oxygen tubing with a metal CPC male connector. The connector is pressed into the port and snaps in place. There is a release button on the bottom of the port that is pressed so the connector can be removed. Note there is an "O" ring on the connector, if the "O" ring is defective or missing oxygen will leak past the connector.

The various websites offering aviation oxygen equipment do not specify the type of O-ring or offer replacement O-rings. A bit of research and experimentation found that AS568-008 (AS568 Standard O-Ring Sizes) with an ID 3/16" OD 5/16" Wall or Dia. of 1/16" works with the CPC connector. The O-ring is not in the flow path of the oxygen, it simply seals the connection. Neoprene, EP Rubber, Silicon Rubber, and Flurocarbon Rubber (Viton®) have excellent compatibility for “cold” oxygen (i.e. oxygen temperatures at which we can breathe the oxygen). Buna-n (Nitrile Rubber) is considered to have good compatibility.

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6 American standard for O-rings. AS-568 is the Aerospace Standard (AS) as well as the SAE standard and is used for military and industrial manufacturing in North America.

Once the oxygen tubing and flow meter is connected to the O2 regulator, an oxygen conserving cannula is attached downstream of the flow meter by means of a standard oxygen connector. The connector is barbed plastic splice that is commonly used with home portable medical oxygen equipment.

Once the oxygen tubing is connected to the regulator, a standard oxygen connector is used to connect the tubing from the regulator/cylinder to the tubing on the cannula.

Other types of aviation oxygen tubing connectors are available. Various quick disconnect types, military, those supplied by various aircraft manufacturers, etc. are also available. The standard connector shown is inexpensive, compact and provides a universal solution to connecting the cannula to the oxygen tubing.
a. Flow Meter

Once the cannula is connected, the flow meter is adjusted to the altitude at which you are flying. The flow is adjusted via the knob on the bottom of the flow meter. The flow meter must be in a vertical position for the adjustment, but can in any position once adjusted. If the altitude is changed, readjust the flow meter to the new altitude.

Note: each crew member has a flow meter and after initial adjustment should check for correct flow three or four times an hour.

The flow meter is a Model A3 which is calibrated for the oxygen conserving cannula. **It is not appropriate for the standard medical style cannula which does not conserve oxygen** and may not receive sufficient oxygen flow.

Note: the photograph of the flow meter, it is adjusted for approximately 15,000 feet and one can see the Model No. at the bottom and the statement about “For Oxymizer® Cannula Only” at the top. The Oxymizer® is a specific brand name for an oxygen conserving cannula.

b. Oxygen Duration

The duration of the oxygen cylinder is can be estimated for flight planning purposes using the Cylinder Duration Chart from Mountain High E&S Co. The KF-022 Cylinder is similar to CAP (Nelson) cylinder; it has the same capacity of 22 cu. ft. but at a lower pressure of 1850 psi. The CAP cylinder is 22 cu. ft. but charged to 2000 psi instead of the maximum working pressure of 2200 psi.

The Cylinder Duration Chart lists a MH3 and MH4 flow meters. The MH3 is equivalent to the A3 flow meter, i.e. **both are calibrated for an oxygen conserving cannula**.

Using the MH3 @ 10,000 ft the chart suggests 25.9 man hours of oxygen can be expected. If there are two crew members on the flight, the estimated cylinder duration will be almost 13 hours. If one plans for a flight to use oxygen for four hours, the cylinder should have adequate capacity for three flights prior to refilling the cylinder. Of course this is an estimate and must be monitored during flight. A second duration table from Aerox is also present which is a bit more conservative in estimated duration time.

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A similar estimate can be made for altitude of 15,000 ft. and/or three crew members.
5. **Issues and Warnings with Oxygen Use**

Oxygen is an oxidizer and in pure or concentrated form will cause combustion or fire in situations that are not obvious. For example, Oxygen containers, valves, regulators, hose and other oxygen apparatus should be kept free from oil or grease and shall not be handled with oily hands, oily gloves or with greasy equipment.

In addition, one is warned against the excessive use of lipstick and Chapstick® type material on lips when using oxygen. You should not eat peanuts during the use of oxygen. In both cases, the excess oil along with the potential of ignition by a static electricity charge could cause a reaction with oxygen. How does the phrase “fiery lips” strike you? This is a problem generally associated with an oxygen mask, but never-the-less one must use caution around oxygen.

Compressed oxygen containers should not be subjected to atmospheric temperatures above 130°F.
The Oxyimizer® oxygen-conserving nasal cannula

Featured with our XCP, XCR and A34 systems

The Oxyimizer’s® unique oxygen-conserving reservoir design accumulates (saves) the continuous flow of oxygen normally wasted during exhalation. The saved oxygen is available as a bonus at the very beginning of each inhalation cycle where oxygen is taken deeper into the lungs, allowing a much greater absorption efficiency. Thus, a smaller flow rate is required over conventional cannulas saving your precious oxygen. The Oxyimizer’s unique design closely emulates the function of much more complicated and expensive diluter demand regulators. Tests have shown pilots using the Oxyimizer® need only 0.750 liter/minute at 18,000 feet to obtain more than 95% of saturated oxygen in the blood. A standard cannula or facemask will require about 2 liters/min. at 18,000 ft. The Oxyimizer® will properly oxygenate the blood using only 1/3 the oxygen needed by standard cannulas resulting in up to 66% of saved oxygen. The Oxyimizer® type "M" is standard issue with our XCR, XCP and A34 systems and with almost any adjustable constant flow oxygen regulator.

- Oxyimizer® connects directly to an MH3, MHA flowmeter, or an A34 and most other systems.
- Oxyimizer® will increase oxygen savings by as much as 3 times.
- Greatly reduces nasal irritation and dryness.
- Approved for aviation use.

DIRECTIONS
Your doctor or healthcare professional has prescribed the OXYMIZER oxygen-conserving device for you. Used properly, this device will provide you with the oxygen you need, as well as these added benefits:

- It will take a lower flow rate to get the same amount of oxygen into your body, which can be as much as 75% less (depending on the flow rate) than a standard nasal cannula.
- If you use a portable oxygen system, it will last longer and allow you to be away from your main oxygen source for a longer period of time; or, you may be able to use a smaller, lighter weight portable system.

It is important that you follow your physician’s instructions carefully concerning:

- How often and how long you receive oxygen from the system.
- The flow rate to use. (Note: The flow rate indicated for use with the OXYMIZER device may be 1/4 - 1/2 of the amount prescribed with a non-oxygen-conserving cannula.)
- When to replace your OXYMIZER device.

HOW TO WEAR THE OXYMIZER DEVICE

1. Slide the loop adjustment collar (bola) down to enlarge the size of the loop.

2. With the back of the facepiece toward you, pick up the OXYMIZER with one of the small flexible plastic tubes in each hand, as if putting on a pair of eyeglasses.

3. Place the flexible plastic tubing over your ears (as shown in diagram below) and under your chin or pass the tubing over your ears and around the back of your head.

4. The facepiece should rest on your upper lip under your nose with the oxygen-delivering prongs extending well into and pointing towards the back of your nose.

5. Slide the bola up toward your chin so that the cannula fits snugly and comfortably against your face.

6. Connect the female connector to your oxygen source.

7. Turn on the oxygen and set the flow rate as prescribed by your doctor or healthcare professional. (Note: The flow rate prescribed for use with this device may be 1/4 - 1/2 of the amount prescribed with a non-oxygen-conserving cannula.)
Web links for Information or finding equipment:

The information provided in does not convey any endorsement for a company or product and is offered simply for information. One is encouraged to search for better or updated information before using acting on any of this information.

Information Articles


