



Federal Aviation
Administration

Oxygen Equipment

Use in General
Aviation Operations



Oxygen Equipment Use in General Aviation Operations

A basic knowledge of oxygen equipment can be critical whether you are flying a commercial, commuter, or a general aviation aircraft. This equipment is the first line of defense against the potentially lethal effects of hypoxia and carbon monoxide poisoning. It is the responsibility of the pilot that all aboard the aircraft—crewmembers and passengers—know how to use this life-saving equipment safely and efficiently.

General Precautions

This pamphlet describes operational precautions to use with all types of oxygen systems. The basic principles and practices include:

- Keep your equipment clean. The interaction of oil-based products and oxygen creates a fire hazard. Additionally, oil attracts dirt particles, and these dirt particles can contaminate storage containers, regulators, masks, and valves. For cleaning instructions, check with the manufacturer's guide.
- Protect your oxygen mask from direct sunlight and dust. Store in proper containers.
- Inspect oxygen storage containers. Make sure that they are securely fastened in the aircraft, as turbulence or abrupt changes in attitude can cause them to come loose. Proper inspections are important, so your oxygen equipment should be inspected regularly at an authorized Federal Aviation Administration inspection station.
- No smoking! Oxygen is highly flammable. Do not allow anyone to smoke around oxygen equipment that is being used. Likewise, no one should smoke around oxygen equipment that is being recharged. Ensure that the aircraft is properly grounded before loading oxygen.
- Mix and match components with caution. When inter-changing oxygen systems components, ensure compatibility of the components- storage containers, regulators, and masks.

Basic Components

There are three components on most oxygen systems, whether they are portable or installed systems.

- A storage system (containers)
- A delivery system
- Mask or nasal cannula

Storage Systems

Oxygen can be stored in the aircraft as a gas, liquid, or a solid.

Gaseous aviator's breathing oxygen (ABO).

Storing oxygen as a gas has the major advantage of being more economical. It can be stored in high-pressure (1800-2200 psi) containers



or low-pressure (400-450 psi) containers. The major disadvantage is the weight and bulk of the storage containers, which may become an issue in smaller aircraft. Aviator's oxygen must meet certain standards to ensure that it is safe to be taken to altitude. Only aviator's-grade breathing 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.

Liquid aviators breathing oxygen (LOX). Oxygen can be serviced to the aircraft in a liquid state. The advantage of LOX is that it has a 900 to 1 expansion ratio. In other words, one liter of LOX will expand into 900 gaseous liters of ABO. This will afford a 3 to 1 space and a 5 to 1 weight savings over gaseous ABO. The major disadvantages are that LOX is stored at its critical temperature of minus 197° F and its volatile nature when it come in contact with petroleum products. If LOX comes in contact with exposed skin, **severe frostbite** may occur.

Sodium chlorate candles (solid-state oxygen). Sodium chlorate is a chemical that, when heated to 350° F, will thermally decompose and release oxygen. Sodium chlorate candles have the advantage of saving weight and space over ABO because it provides a 600 to 1 expansion ratio.



The major disadvantage is that once the chemical reaction (the candle is activated) has started, it can't be easily stopped. Additionally, the candle produces a great deal of heat, and precautions must be taken to avoid a fire hazard.

Molecular sieve oxygen generators (MSOG). The air that we breathe contains basically 21% oxygen, and the remainder is inert gases that play no major physiological role in the body. MSOGs take ambient air and separates oxygen from inert gases, using that to supply oxygen to the aircraft. The military has used this system for many years, as well as medical patients who need a portable oxygen system. Civil aviation hasn't embraced MSOG, but it may be more in vogue in future aircraft.

Oxygen Delivery Systems

Continuous flow. This system delivers a continuous flow of oxygen from the storage container. It is a very economical system in that it doesn't need complicated masks or regulators to function. But it is also very wasteful—the flow of oxygen is constant whether you're inhaling, exhaling, or pausing in between breaths. This system is typically used at 28,000 feet and lower.

Diluter demand. The diluter demand system is designed to compensate for the short-comings of the continuous-flow system. It gives the user oxygen on-demand (during inhalation) and stops the flow when the demand ceases (during exhalation). This helps conserve oxygen. Additionally, the incoming oxygen is diluted with cabin air and provides the



proper percentage of oxygen, depending on the altitude. This system is typically used at altitudes up to 40,000 feet.

Pressure demand. This system provides oxygen under positive pressure. Positive pressure is a forceful oxygen flow that is intended to slightly over-inflate the lungs. This will, in a sense, pressurize the lungs to a lower altitude, thus allowing you to fly at altitudes above 40,000 feet, where 100% oxygen without positive pressure will not suffice.



Oxygen Masks and Cannulas

When considering an oxygen mask, you must ensure that the mask you are using is compatible with the delivery system you are using.

Nasal cannulas. These are continuous-flow devices and offer the advantage of personal comfort. They are restricted by federal aviation regulations to 18,000 feet service altitude because of the risk of reducing oxygen-blood saturation levels if one breathes through the mouth or talks too much.



Oral-nasal re-breather. This type is the most common and least expensive. It is also the simplest in operation; it has an external plastic bag that inflates every time you exhale. The purpose of the bag is to store exhaled air, so it may be mixed with 100% oxygen from the system. These masks supply adequate oxygen to keep the user physiologically safe up to 25,000 feet.



Quick-don mask. These masks must demonstrate the ability to be donned with one hand in 5 seconds or less, while accommodating prescription glasses. Quick-don masks are typically suspended or stored to permit quick and unimpeded access by cockpit crew. These masks are typically rated to altitudes up to 40,000 feet.



Airline drop-down units (Dixie cup). The phase-sequential continuous-flow mask looks similar to a general aviation re-breather. However, both masks function differently, and the phase sequential mask allows the user to go to higher altitudes. This mask uses a series of one-way ports that allow a mixture of 100% oxygen and cabin air into the mask. Exhalation is vented to the atmosphere; as a result, the bag does not inflate. This mask can be safely used at emergency altitudes up to 40,000 feet.

The PRICE Check

Prior to every flight, the pilot should perform the “PRICE” check on the oxygen equipment. The acronym PRICE is a checklist memory-jogger that helps pilots and crewmembers inspect oxygen equipment.

- **PRESSURE** - ensure that there is enough oxygen pressure and quantity to complete the flight.
- **REGULATOR** - inspect the oxygen regulator for proper function. If you are using a continuous-flow system, make sure the outlet assembly and plug-in coupling are compatible.
- **INDICATOR** - most oxygen delivery systems indicate oxygen flow by use of flow indicators. Flow indicators may be located on the regulator or within the oxygen delivery tube. Don the mask and check the flow indicator to assure a steady flow of oxygen.
- **CONNECTIONS** - ensure that all connections are secured. This includes oxygen lines, plug-in coupling, and the mask.
- **EMERGENCY** - have oxygen equipment in the aircraft ready to use for those emergencies that call for oxygen (hypoxia, decompression sickness, smoke and fumes, and rapid decompressions.) This step should include briefing passengers on the location of oxygen and its proper use.



Training

To get first-hand experience using oxygen equipment, it is highly recommend that all pilots, especially those operating their aircraft at altitudes where oxygen is required, get additional training in an altitude chamber. The Federal Aviation Administration offers several of these valuable training programs through the U.S. Air Force and Army. If interested, use the contact information at the end of this brochure.

Be Aware

From a safety-of-flight standpoint, oxygen equipment is an issue that should concern all pilots. Know the equipment you have on board, know when to use it, and most importantly, know its limitations. It's your key to a safe and enjoyable flight.

Federal Aviation Regulations and Oxygen Use

(Title 14 of the Code of Federal Regulations)

PART 135

OPERATING REQUIREMENTS:

Commuter and On Demand Operations and Rules
Governing Persons On Board Such Aircraft

Sec. 135.89 Pilot requirements: Use of Oxygen.

(a) Unpressurized aircraft. Each pilot of an unpressurized aircraft shall use oxygen continuously when flying—

(1) At altitudes above 10,000 feet through 12,000 feet MSL for that part of the flight at those altitudes that is of more than 30 minutes duration; and

(2) Above 12,000 feet MSL.

(b) Pressurized aircraft. (1) Whenever a pressurized aircraft is operated with the cabin pressure altitude more than 10,000 feet MSL, each pilot shall comply with paragraph (a) of this section.

(2) Whenever a pressurized aircraft is operated at altitudes above 25,000 feet through 35,000 feet MSL, unless each pilot has an approved quick-donning type oxygen mask—

(i) At least one pilot at the controls shall wear, secured and sealed, an oxygen mask that either supplies oxygen at all times or automatically supplies oxygen whenever the cabin pressure altitude exceeds 12,000 feet MSL; and

(ii) During that flight, each other pilot on flight deck duty shall have an oxygen mask, connected to an oxygen supply, located so as to allow immediate placing of the mask on the pilot's face sealed and secured for use.

(3) Whenever a pressurized aircraft is operated at altitudes above 35,000 feet MSL, at least one pilot at the controls shall wear, secured and sealed, an oxygen mask required by paragraph(b)(2)(i) of this section.

(4) If one pilot leaves a pilot duty station of an aircraft when operating at altitudes above 25,000 feet MSL, the remaining pilot at the controls shall put on and use an approved oxygen mask until the other pilot returns to the pilot duty station of the aircraft.

PART 91
GENERAL OPERATING AND FLIGHT RULES

§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.

(b) Pressurized cabin aircraft. (1) No person may operate a civil aircraft of U.S. registry with a pressurized cabin—

(i) At flight altitudes above flight level 250 unless at least a 10-minute supply of supplemental oxygen, in addition to any oxygen required to satisfy paragraph (a) of this section, is available for each occupant of the aircraft for use in the event that a descent is necessitated by loss of cabin pressurization; and

(ii) At flight altitudes above flight level 350 unless one pilot at the controls of the airplane is wearing and using an oxygen mask that is secured and sealed and that either supplies oxygen at all times or automatically supplies oxygen whenever the cabin pressure altitude of the airplane exceeds 14,000 feet (MSL), except that the one pilot need not wear and use an oxygen mask while at or below flight level 410 if there are two pilots at the controls and each pilot has a quick-donning type of oxygen mask that can be placed on the face with one hand from the ready position within 5 seconds, supplying oxygen and properly secured and sealed.

(2) Notwithstanding paragraph (b)(1)(ii) of this section, if for any reason at any time it is necessary for one pilot to leave the controls of the aircraft when operating at flight altitudes above flight level 350, the remaining pilot at the controls shall put on and use an oxygen mask until the other pilot has returned to that crewmember's station.

MEDICAL FACTS FOR PILOTS

Publication OK-08-639

Written by: J.R. Brown, A. Salamanca, MD

Prepared by:

Federal Aviation Administration

Civil Aerospace Medical Institute

Aerospace Medical Education Division

P.O. Box 25082

Oklahoma City, OK 73125

To order copies of this brochure,
write to the above address.

Physiological Training Classes for Pilots

If you are interested in taking a one-day aviation physiological training course with altitude chamber and vertigo demonstrations or a one-day survival course, learn about how to sign up for these courses that are offered at various locations across the U.S. by visiting this FAA Web site:

www.faa.gov/pilots/training/airman_education/aerospace_physiology/index.cfm

For more pilot and traveler safety
information, see:

www.faa.gov/pilots/safety/pilotsafetybrochures/