



Federal Aviation  
Administration

# HYPOXIA

## The Higher You Fly... The Less Air In The Sky

**B**reathing is one of the most automatic things we do — over 20,000 times a day. Each breath does two things for our body. It expels carbon dioxide when we exhale, and takes in oxygen when we inhale. It's a delicate balance.



Exercise or stress increases the production of carbon dioxide, so we breathe faster to eliminate it and take in more oxygen at a greater rate.

Because of the effects of gravity, the amount of air containing oxygen is greater at sea level. For example, the pressure at sea level is twice that found at 18,000 feet MSL.

Although the percentage of oxygen contained in air at 18,000 feet is identical to that at sea level (a little over 20%), the amount of air our lungs take in with each breath contains half the oxygen found at sea level. Breathing faster or more deeply doesn't help. In fact, because you're consciously over-riding a system that is normally automatic, you'll be compounding the problem by exhaling too much carbon dioxide.

### Supplemental oxygen

The solution is simple, familiar to most pilots, and required by FAR 91.211: supplemental oxygen. This regulation specifies a 30-minute limit before oxygen is required on flights between 12,500 and 14,000 feet MSL,

and immediately upon exposure to cabin pressures above 14,000 feet MSL. For best protection, you are encouraged to use supplemental oxygen above 10,000 feet MSL.

At night, because vision is particularly sensitive to diminished oxygen, a prudent rule is to use supplemental oxygen when flying above 6,000 feet MSL.

So, when you fly at high altitudes, supplemental oxygen is the *only* solution. That's because supplemental oxygen satisfies the twin demands of having enough oxygen to meet your body's demands and a breathing rate that excretes the right amount of carbon dioxide.

### Hypoxia

Unfortunately, our body doesn't give us reliable signals at the onset of hypoxia — oxygen starvation — unless we have received special training to recognize the symptoms. In fact, it's quite the contrary. The brain is the first part of the body to reflect a diminished oxygen supply, and the evidence of that is usually a loss of judgment.

### Hypoxia tests

Altitude chamber tests, in which high altitude flight conditions are duplicated, have shown that some people in an oxygen deficient environment actually experience a sense of euphoria — a feeling of increased well-being. These subjects can't write their name intelligibly, or even sort a deck of cards by suits...yet, they think they're doing just fine!



Such is the insidious nature of oxygen deprivation. It sneaks up on the unwary and steals the first line of sensory protection — the sense that something is wrong — dreadfully wrong.

### The higher you go

Bear in mind, the progressive reduction of oxygen per breath will continue the higher you go. Flying above a layer of clouds that doesn't look too high, or flying in the mountains on a clear day — are the very environments that have caused many good "flat-land" pilots to get into trouble.

## Symptoms

Everyone's response to hypoxia varies. Unless, as we've stated, you've had special training to recognize its symptoms, hypoxia doesn't give you much warning. It steals up on you, giving your body subtle clues. The order of symptoms varies among individuals: increased breathing rate, headache, lightheadedness, dizziness, tingling or warm sensations, sweating, poor coordination, impaired judgment, tunnel vision, and euphoria. Unless detected early and dealt with, hypoxia can be a real killer.

## Caution and safety

So, don't decide you'll try to fly over that range of mountains, thinking you'll turn back if you start to feel badly. You may feel great...until it's too late! Use supplemental oxygen.

## Smoking and altitude

A Western state pilot lived to tell about this one. Cruising at 13,500 feet MSL over mountainous terrain in his light single, he took a deep drag on his cigarette and next remembered being in a screaming dive with just enough altitude left in which to pull out! That deep drag replaced precious oxygen in his brain with carbon monoxide...and he passed out.

## Briefly...

- ▶ When you breathe, you inhale oxygen and exhale carbon dioxide.
- ▶ With each normal breath, you inhale about one-half liter of air, 20% of which is oxygen.
- ▶ At 18,000' MSL, you have **half** the sea level air pressure; hence, only **half** the oxygen.
- ▶ Oxygen starvation first affects the brain; judgment is impaired, so you may not know you are in trouble.
- ▶ We all react differently to the effects of hypoxia. Only physiological training can safely "break the code" for you.

## Physiological training for pilots

The effects of hypoxia can be safely experienced under professional supervision at the Civil Aeromedical Institute's altitude chamber in Oklahoma City and at 14 cooperating military installations throughout the U.S. If you would like to attend a one-day physiological training course, ask your FAA Accident Prevention Specialist for AC Form 3150-7.

You'll learn to recognize *your* symptoms of hypoxia. It could mean the difference between life and death.

## Medical Facts for Pilots

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To request copies of this brochure and others listed below, contact

FAA Civil Aerospace Medical Institute

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## Other Pilot Safety Brochures Available

Number	Title
AM-400-94/2	Alcohol and Flying: A Deadly Combination
AM-400-95/2	Altitude Decompression Sickness
OK05-0270	Carbon Monoxide: A Deadly Threat
AM-400-03/2	Deep Vein Thrombosis and Travel
AM-400-98/3	Hearing and Noise in Aviation
AM-400-97/1	Introduction to Human Factors in Aviation
OK05-0005	Medications and Flying
AM-400-01/1	Physiological Training Courses for Civil Aviation Pilots
AM-400-98/2	Pilot Vision
AM-400-91/2	Seat Belts and Shoulder Harnesses
AM-400-95/1	Smoke!
AM-400-00/1	Spatial Disorientation: Visual Illusions
AM-400-03/1	Spatial Disorientation: Why You Shouldn't Fly By the Seat of Your Pants
AM-400-05/1	Sunglasses for Pilots: Beyond the Image

To view these pilot and passenger safety brochures, visit the Federal Aviation Administration's Web Site

[www.faa.gov/pilots/safety/pilotsafetybrochures/](http://www.faa.gov/pilots/safety/pilotsafetybrochures/)

## 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 14 locations across the U.S. by visiting this FAA Web site:

[www.faa.gov/pilots/training/airman\\_education/aerospace\\_physiology/index.cfm](http://www.faa.gov/pilots/training/airman_education/aerospace_physiology/index.cfm)