



# Get High

## Risks and advice

BY DR. RICH SUGDEN

As more and more members of the warbird community move into jets, it's time to review how high-altitude flight will introduce new risks to our flying . . . risks that are easily mitigated but must be dealt with appropriately.

The most popular ex-military turbine aircraft flying in the United States today is the L-39. Some 200 of these Czech-built trainer jets are registered here today, and I suspect most are flying regularly. These aircraft are fanjet powered and operate most efficiently at 25,000

to 29,000 feet, and with the cost of jet fuel continually rising, most owners will likely wish to operate their aircraft at those altitudes. The new reduced vertical separation minimum restrictions preclude operating between flight level (FL) 290 and 420 unless the aircraft has been modified with special air data equipment, autopilot, etc.—an expensive program!

Some warbird pilots are moving into higher-performance jets that have the capability of operating

above FL 430, and that introduces a whole new set of risks, as we'll see later.

The FAA requires the use of supplemental oxygen for passengers above 15,000 feet, for pilots above 12,500 after 30 minutes of flight, and at all times above 14,000 and recommends its use above 6,000 feet at night. The reason for the lower-altitude oxygen requirement at night is to preserve the function of the rods in the retina, which give you most of your night vision.



Hypoxia, or the lack of sufficient oxygen to provide for adequate cerebral (and later, other organ) function, is an insidious condition that may result in incapacitation if not recognized and treated. Modern oxygen equipment (and even not-so-modern!) is capable of delivering sufficient oxygen to prevent hypoxia if it is properly maintained, tested, and provided with an adequate supply of oxygen. No matter how good the regulator and mask, if the tank is empty or unavailable due to a misconfiguration of valves, there will be no oxygen flow. Remember the Payne Stewart disaster?

Almost all ex-military jets, and ex-military aircraft like the T-28 that are capable of regularly operating above 12,000 feet, have high-pressure (2,000 pound/square inch) oxygen tanks and diluter-demand regulators. This is in contrast to the usual general aviation oxygen systems that use constant-flow regulators, which supply oxygen at varying concentrations but with constant flow, usually with some sort of bag reservoir to

avoid wasting oxygen and make them more efficient. Constant-flow systems work fine up to about 18,000 feet but cannot deliver sufficient oxygen above that altitude. Diluter-demand regulators deliver varying concentrations of oxygen depending on altitude, and deliver that mixture with each breath. They are adequate up to 35,000 feet, where they are supplying 100 percent oxygen, and then are capable of supplying oxygen under increasing pressure up to about 50,000 feet. "Pressure breathing" is required at altitudes above 38,000 feet because the total atmospheric pressure is so low that 100 percent oxygen is under such low pressure that it cannot penetrate from the lung alveoli into the bloodstream in sufficient amounts to provide normal levels for brain function.

Let's talk about how to check your oxygen equipment prior to flight, then some discussion on hypoxia, and finally some peculiarities in the L-39 oxygen system.

The military uses the mnemonic PRICE for remembering the oxygen

system preflight items:

(P)ressure - oxygen bottle pressure, and system turned on

(R)egulator - function test the flow in both normal (diluter) and 100 percent oxygen

(I)ndicator - shows oxygen flow with inspiration (see discussion below)

(C)onnections - secure, no kinks in hoses, etc. . .

(E)mergency - check emergency function (high flow, pressure circuit)

Simply check that the oxygen valves are turned on, check the bottle pressure gauge, make sure all the fittings are secure, and then don the mask and check to see that there is free flow at both normal and 100 percent oxygen settings. Then activate the emergency setting, which should deliver a free flow of oxygen under modest pressure. All check okay? You're ready to fly.

Some pilots do not like to fly with helmets, and others do not like the confining feeling of a diluter demand face mask. In that case, consider a good constant-flow oxygen system



(Sky Ox, AirOx, Mountain High) with a bag reservoir, and limit your altitude to below 18,000 feet *and* do not forget to don your mask climbing through 10,000 feet. Personally, I enjoy the over-the-weather capability of the jet and the relative solitude of flight in the higher flight levels... not to mention the economy and extended range! Nasal cannula oxygen systems are marginal at 18,000 feet, and I would recommend

against them...though some manufacturers are promoting them for altitudes that high. Remember that you are going to have to have a mask with a microphone and proper wiring for its use with your headset. Consider getting a fitted, comfortable helmet and a properly sized diluter-demand mask...they are not that uncomfortable, especially for the shorter flight times you are going to have in the jet.

When we talk about hypoxia, we're looking at a condition that gradually renders a person unable to continue functioning. When the pilot can no longer perform simple tasks, like keeping the aircraft in level flight, we say that person has reached the end of "useful consciousness." The table below shows how long a person's period of useful consciousness is at various altitudes if breathing ambient air.

As mentioned previously, hypoxia is insidious in its symptoms...and everyone has different symptoms as their oxygen levels fall. Remember, we're not talking about *unconsciousness* as the symptom we're looking for. We're talking about *early* symptoms that will *warn* you that your oxygen level is falling, and something *must* be done to prevent any further degradation in your thought processes and motor function. The symptoms of hypoxia also vary with the rapidity of its onset...for example, slow climb to altitude without oxygen versus rapid decompression at high altitude. Here are some of the early symptoms of gradual hypoxia, in their **usual** order or progression:

ALTITUDE IN FEET	TIME OF USEFUL CONSCIOUSNESS
18,000	20 to 30 minutes
22,000	10 minutes
25,000	3 to 5 minutes
28,000	2.5 to 3 minutes
30,000	1 to 2 minutes
35,000	0.5 to 1 minute
40,000	15 to 20 seconds
43,000	9 to 12 seconds
50,000	9 to 12 seconds



- lightheadedness . . . feeling “fuzzy”

- difficulty concentrating
- headache (prolonged, mild hypoxia)
- tingling fingers and lips (hyperventilation symptoms)
- loss of peripheral vision, and color vision becoming “grayer”
- unusual sensation of well-being
- sensations of “impending doom” later
- slowing of motor function . . . for example, “slow motion” actions
- and, finally, unconsciousness

Anything that adversely affects your cerebral or cardiovascular function, or oxygen-carrying capacity of your blood, will aggravate the rapidity at which hypoxia develops in the individual aviator. Smoking is the worst offender. If you smoke one pack per day, the carbon monoxide in the cigarette smoke will partially block the transport of oxygen on your hemoglobin and you will be at an effective altitude of 5,000 feet above the non-smokers at your same altitude...that will put you at 15,000 feet when non-smokers are at

10,000 feet! Anemia, heart disease, and lung disease, like emphysema all put you at greater risk of hypoxia. Any significant chronic disease, that might make you more susceptible may require a “special issuance” of your medical, which is accompanied by frequent monitoring of your ongoing condition . . . in most cases to prevent you from being overly susceptible to hypoxia.

Fatigue, both physical and

emotional, makes your brain more susceptible to hypoxia. Drinking a “few too many” the night before renders your brain more susceptible to lack of oxygen.

The L-39 oxygen system is unique in a few respects. First, the oxygen regulator flowmeter, or “blinker,” registers only oxygen flow...not airflow through the system. Since the system is a *diluter*-demand system, oxygen will not start to flow until a





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cabin altitude of around 10,000 feet is reached. So, prior to takeoff, during the PRICE check, if the regulator is set to normal, will the blinker indicate any flow? Not unless you're taking off from Leadville. To see if the system is working, you have to go to 100 percent, and then the blinker will "wink" when you breathe. Interestingly, the Soviet oxygen regulator shows white when there is no flow, and goes to black during the flow of oxygen...opposite from U.S. regulators. If you set the regulator to emergency, there is a continuous flow of oxygen, and the blinker goes to black and stays there.

The oxygen filler, in the standard L-39 system, goes directly to the oxygen bottles, bypassing the blue oxygen valves in both cockpits. So, you do not need to have any of the oxygen valves turned on to fill the system.

There is a "connect" valve in the rear cockpit, which connects both the front-seat and rear-seat oxygen regulators together. It *does not* connect the front and rear oxygen cylinders together. There are check valves between the front and rear high-pressure bottles, to prevent leaks in one system from affecting the other. If the connect valve is open and one of the high-pressure bottles develops a leak, both cockpits will

receive oxygen from the other bottle. Also, the oxygen pressure gauges will both read the pressure in the highest system—front or rear.

For example, to illustrate the operation of the L-39 system, if the front cockpit oxygen valve is open, the rear oxygen valve is closed, and the connect valve is open, then the front system will supply oxygen to both cockpit regulators, and the pressure gauges in both cockpits will indicate the same pressure as in the front bottles.

Since both the front and rear high-pressure systems are protected with one-way valves, there really is no reason to fly with the connect valve closed, whether the rear cockpit is occupied or not.

Since the symptoms of hypoxia are insidious and variable from person to person, the only way you can become familiar with *your* symptoms is to experience them in an altitude chamber. Not only will you become able to recognize how hypoxia affects you, you will also see the remarkable resolution of those symptoms with the administration of oxygen. You will also have the opportunity of seeing what effect decreasing ambient pressure has on your ears, sinuses, and gastrointestinal tract. You will learn how to clear your ears during

a rapid descent and foods to avoid to decrease painful, embarrassing intestinal gas. Remember, no Mexican food the night before.

To schedule hypobaric-chamber training at an FAA, or military, altitude chamber, call the FAA Civil Aerospace Medical Institute in Oklahoma City at 405-954-4837. The FAA will be able to tell you what altitude chambers are near your home and their availability for training, as well as supply you with the forms that must be completed prior to your training. In the "old days," chamber flights were made at 35,000 feet, where aircrews experienced rapidly onset hypoxia and incapacitation, which generally offered little insight into early hypoxia symptoms and did not allow pilots time to feel the subtle changes that precede incapacitation. Now the altitude chamber is only taken to 25,000 feet, and pilots have several minutes to experience the onset of hypoxia and plenty of time

to recognize and remember how they feel as they become hypoxic. There is no substitute for experiencing hypoxia for yourself. Flight Safety has started a program of hypoxia training in its flight simulators, where it has pilots breathe decreasing concentrations of oxygen in nitrogen, which causes gradual hypoxia and deterioration of function...while you're flying the simulator. There is a minimal charge for the FAA altitude chamber ride, and I suspect the Flight Safety training is fairly expensive.

Hypoxia is insidious and lethal, but it's easily prevented by keeping your oxygen equipment in good condition and checking it prior to each flight. If you know what symptoms you will develop if you become hypoxic, you will be able to recognize a malfunction in your oxygen system early, and you will have time to take corrective action while you are still functional.

Fly safely . . . and often!



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