LIGHTSPEED®

# CO and Aviation

## A Deadly Mix

eBook

# About Lightspeed Aviation

## *On a mission to save lives*

Lightspeed Aviation is a leading manufacturer of premium aviation headsets and helmet products. Since the first product was introduced in 1996 at AirVenture in Oshkosh, WI., the company has established a reputation for leading innovation in the aviation headset marketplace with a number of "first to market" advances, technologies, and features.

In 2022, the company launched a new category of aviation products called "Safety Wearables". Layering life-saving technologies on top of their award-winning audio and ANR platform, Lightspeed ushered in a new era of aviation safety. With this, the company continues to live its mission of "creating products that protect and save lives".

Additionally, Lightspeed is a passionate supporter of initiatives to encourage the next generation of pilots through its support of programs like Young Eagles and Ray Scholars. The company is proud to have participated in helping countless young people experience everything from a discovery flight to getting a Pilot Certificate.

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# Introduction

The average adult probably knows that carbon monoxide (CO) can be dangerous. Even if they don't know its chemical name, people are aware that you shouldn't close your garage door while your car engine is running. They may have ridden in a car or vehicle where there was an exhaust smell that caused a headache, without ever realizing that they were experiencing a mild form of carbon monoxide poisoning.

The average adult doesn't know that CO poisoning is a constant and common risk in aviation. Even the average pilot may not know when they're experiencing CO poisoning, because everyone reacts differently. And, unlike a driver, a pilot cannot simply pull over and get out of the vehicle. In aviation, CO poisoning kills. We typically can't even pinpoint how often it causes crashes because by the time investigators arrive, all traces of the gas are gone from the aircraft. Only if the investigators decide to measure the CO in the individual's blood can there be some certainty.

This eBook explains the causes and effects of CO poisoning, the steps you can take to prevent it, and what to do if you suspect it. We've also included some stories from pilots who've experienced CO poisoning, to show the different ways it can appear. We hope you'll find this information useful and share it with other pilots, because awareness can save lives.

## CHAPTER ONE

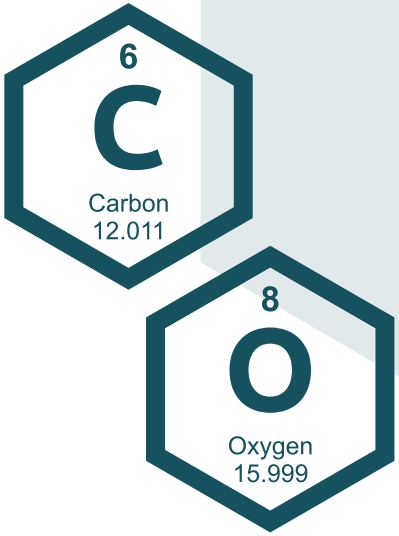
# What Causes CO Poisoning?

**Carbon monoxide is a colorless, odorless, tasteless gas.** It occurs in small amounts in nature, the result of volcanic emissions, brush and forest fires, natural gases escaping from mines, and even lightning strikes. The vast majority of CO in the environment is human-produced, a by-product of the incomplete combustion of carbon-based materials such as aviation fuel.

CO is highly poisonous. When you breathe it, **it binds with the hemoglobin in your blood**, replacing the oxygen that the hemoglobin should be carrying to your brain and body. This causes oxygen deprivation, also called hypoxia. Carbon monoxide binds to hemoglobin more easily and more tightly than oxygen does, so you can be poisoned by carbon monoxide even at very low concentrations. Concentrations as low as 20 or 30 parts per million (PPM) can be harmful if you are exposed for several hours. According to **research estimates**, carbon monoxide (CO) poisoning affects 50,000 people a year in the United States, with a mortality rate ranging from 1 to 3%.

CO poisoning can happen in homes, vehicles, and workplaces, but it tends to happen faster in aviation because the higher the altitude, the faster CO enters your bloodstream. If you get enough CO in your blood, as little as 10%, it begins to affect your cognitive abilities, your vision, and other body functions. Over 50%, and it can cause permanent organ damage and death.

You can have a significant amount of CO in your blood just from environmental factors such as exhaust fumes, other pollution, and cigarette smoke. CO exposure from other sources can also build up in your aircraft before you even start your engine. For example, CO can drift into the cabin when ground servicing equipment or other aircraft are idling nearby. All these sources add up, and a GA aircraft cabin is typically a small, tight environment, so even moderate exposure can push your level over 10%. And because CO is 240x better than oxygen at binding with hemoglobin, it leaves your body very slowly. So, a low level of exposure over a long time can be just as bad as a short, high level of exposure. Plus, it can take days to recover from even moderate levels in your blood.




*If you get enough CO in your blood, as little as 10%, it begins to affect your cognitive abilities, your vision, and other body functions. Over 50%, and it can cause permanent organ damage and death.*

CHAPTER TWO

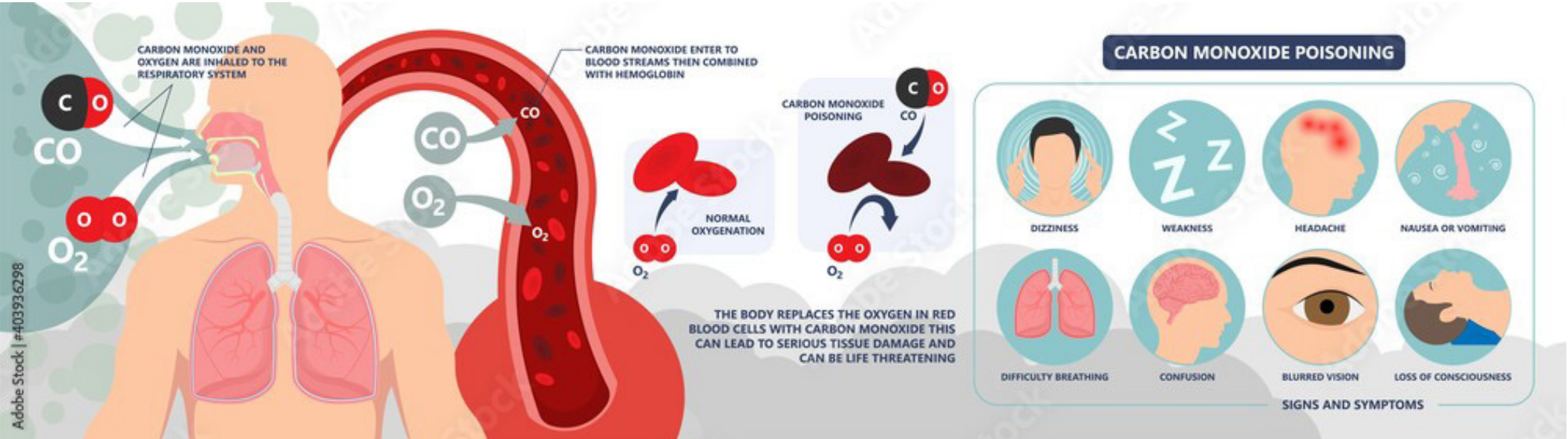
# The Signs of Carbon Monoxide Poisoning

**Carbon monoxide (CO) poisoning comes on quickly, and by the time you and/or your passengers are experiencing symptoms, you've already passed the 10% mark and the situation is serious.**

The first sign of CO poisoning is generally a slight headache. From there, the headache worsens, and the next symptoms can include shortness of breath, a racing pulse, blurred vision, dilated pupils, drowsiness, and confusion. The lips can also turn cherry (bluish) red, on their way to turning blue from oxygen deprivation. If the CO exposure continues, the hypoxia can lead to vomiting, convulsions, unconsciousness, coma, and death. Smaller people (such as children) are even more susceptible: they may be affected faster and more severely.

But one of the problems with CO poisoning is that it affects each person differently, so it can be hard to spot until it's too late. It's too easy to chalk up early symptoms to lack of sleep, a cold coming on, or missing one's morning coffee. Here are several stories from survivors that illustrate how quickly and how differently CO poisoning can affect pilots.

> *By the time you and/or your passengers are experiencing symptoms, the situation is serious*



## STORIES FROM THE COCKPIT

# Dr. Robert Frayser

On a clear day in 1997, Dr. Robert Frayser took off at sunrise in his Comanche 400 from his hometown airport in North Bend, Kansas, en route to a medical meeting in Topeka. He was alone, flying on autopilot, and when he reached cruising altitude, he switched to his auxiliary fuel tank and set up his navigation system for the flight to Topeka. About 90 minutes and 250 miles later, he woke up, disoriented and with a throbbing headache, in the snowy Missouri hayfield where his plane had crashed after running out of fuel. He had no memory of the rest of the flight or the landing, in which the plane had skidded 500 feet before crashing into a row of trees.

> *"...He woke up, disoriented and with a throbbing headache, in the snowy Missouri hayfield where his plane had crashed."*

Frayser had blacked out in the cockpit with no warning symptoms that he could recall. He survived with minor injuries thanks to his autopilot, but when he was transported to a local hospital after the crash, the ER physician had to put him on 100 percent oxygen to treat near-fatal levels of carboxyhemoglobin (CO-induced hypoxia). The NTSB later determined that a cracked muffler had allowed exhaust gases to build up in the aircraft cabin, that the crack had opened after the plane's most recent inspection, and that it was behind the heat shield and therefore not visible during pre-flight check. Fraser had no CO detector with him that day and, given the lack of symptoms and the very simple, passive CO detectors available at the time, it's hard to say whether he would have even thought or been able to check a detector before he suddenly blacked out.

## STORIES FROM THE COCKPIT

# Dan Bass

One February day in 2017, lifelong pilot Dan Bass took off from Thunder Bay, Ontario, in his Mooney, headed home to Winona, Minnesota. In the bitter cold, he was running his cabin heat and defrost on full blast; otherwise, it was a beautiful day for flying. But in literally minutes, his flight took a terrible turn. By the time the tower handed him off to departure, his speech was slurred, and he knew something was very wrong. He thought about telling ATC he needed to land but he didn't. Instead, he lost consciousness four and a half minutes into his flight.

The airplane was trimmed, and the autopilot had the heading, so it kept the plane climbing until it couldn't fly higher, then it just kept on flying. The U.S. Air Force dispatched F-16s out of Madison, Wisconsin, to see what a Mooney was doing at that altitude and heading, and they flew alongside until they had to head back to base and refuel. Eleven minutes after Bass's plane finally ran out of fuel, it crash-landed in a field in Minnesota, and the shattered windscreen let the CO out and fresh air in to revive him. He spent weeks in the hospital recovering from the crash, but he survived.

Just 89 hours before the flight, his Mooney had passed annual inspection, including a pressure test of the exhaust. His best guess, looking back, is that a backfire at start-up caused or exacerbated the crack in the muffler that almost killed him.

Since the crash, Bass has become an advocate for CO awareness and safety. He didn't have a CO monitor on the plane that day, and he says, "I always assumed that I would 'know' [if I had CO poisoning], and that assumption nearly killed me." Today, he believes that the only way to detect and prevent exposure to CO is with a high-quality portable carbon monoxide detector or a safety wearable like the Lightspeed Delta Zulu with carbon monoxide detection built in. "If I had owned one of these digital detectors, I would have noticed a problem weeks or months before this accident."

> *"I always assumed that I would 'know' [if I had CO poisoning], and that assumption nearly killed me."*



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## STORIES FROM THE COCKPIT

# Carl Hancock

Carl Hancock is one of the few, lucky pilots who have experienced carbon monoxide (CO) poisoning, recognized what was happening, and reacted in time to land safely. He was at a top-rated flight school, getting ready to take up a REMOS GX. There weren't enough mounts for both the cameras he wanted to bring and for his digital CO sensor, so he decided to leave his CO sensor behind. He thought, "I know they take good care of their aircraft. It'll be fine."

During pre-flight checks, Carl could actually smell exhaust, because the REMOS ran on automotive-type gas, not avgas. But the REMOS' gull-wing doors were open, so the exhaust smell wasn't unexpected, and Carl and his flight instructor closed the doors, took off, and got to their cruising altitude of 2,500 ft. Forty-five minutes later, when he was headed back to the runway for some touch-and-gos, Carl realized that he had a headache, still smelled exhaust, and was beginning to feel fuzzy-headed. Fortunately, he had recently interviewed Dan Bass, so Carl knew the signs and dangers of CO poisoning. He told his instructor that he suspected CO problems, and they decided to land and call it a day.

> *"Always, always have an active CO monitor with you."*

Carl collected his gear and went home as the flight instructor began inspecting the plane for the source of the fumes. An hour later, he emailed Carl: he had found a loose flange on the exhaust manifold, which had allowed exhaust to escape into the cowling and thus into the plane. The flight school repaired the problem immediately, bringing the story to a happy ending. Carl's biggest lesson from flight school that day: "Always, always have an active CO monitor with you."

CHAPTER THREE

# Keeping Carbon Monoxide out of Your Aircraft

**As illustrated by Robert Frayser's and Dan Bass's stories of carbon monoxide poisoning in the previous chapter, the most common source of CO poisoning in light aircraft is heating,** when air flowing over the manifold picks up exhaust fumes. The best prevention against this source of fumes is careful maintenance. A Federal Aviation Administration (FAA) report found that inadequate maintenance and inspection has contributed to many carbon-monoxide–related accidents.

If you're flying your own aircraft, you can protect yourself from CO poisoning through regular maintenance and inspection.

## Look for and promptly correct these common problems:

- **Cracks in the manifold**
- **Cracks in the engine firewall**
- **Exhaust system holes or cracks**
- **Bad seals or gaskets in exhaust system or around doors**
- **Cracked heat exchanger**
- **Soot at cockpit vents**
- **Smoky odor in cockpit**
- **Drop in engine RPM when carb heat turns on**

The older the aircraft, the higher the risk of CO poisoning. The FAA has also found a correlation between the age of mufflers and CO-related accidents, so make sure your mufflers are replaced every 1,000 flight hours or more often. When you're flying, also be aware of exhaust smells or any other unusual odors.

## CHAPTER FOUR

# Use the Right CO Detector to Protect and Save

**Regardless of how well an aircraft is maintained, problems can sneak up on us.** A part can crack between inspections, or an off-airport landing might stress a worn part or shake something loose. Cracks aren't always visible on pre-flight inspections. And many pilots rent planes or fly planes belonging to others, so they don't always know the maintenance history.

Because CO can be present in an aircraft despite our best efforts, and because even small concentrations of CO can begin to affect brain function, the single best protection for a pilot and everyone in the aircraft is a CO detector that will provide a warning actively, early, and obviously.

> *The single best protection for a pilot and everyone in the aircraft is a CO detector that will provide a warning actively, early, and obviously*

The FAA doesn't require CO detectors in GA aircraft, but the NTSB has been recommending them in aircraft with closed cabins and forward-mounted engines since 2004. Before digital CO sensors, the most common detector was a card coated with a chemically treated dot that would change from gold to black with CO exposure. These test cards are still available and they're inexpensive. However, it can take a lot of CO exposure to change the color, by which time the pilot would probably already be in trouble. And the dots change back to gold when the CO disperses, for instance, after a crash, so they won't even necessarily provide evidence after the fact.

Today, there's a wide range of digital CO detectors available to pilots. They vary in the levels of carbon monoxide they can detect, the types of indicators and alarms they provide, their ease of calibration and maintenance, ruggedness, battery life and, of course, cost.

## When you choose a CO detector, keep these three things in mind:

- **A CO detector can only help you if it's present, so choose one that you don't have to remember, one that will always be with you when you fly.**
- **CO exposure affects your brain, so a CO detector needs to get in your face and get your attention when there's a problem. You can't depend on remembering to check a test card or readout.**
- **If you have a good detector that's always with you and can measure low levels of CO, it can also help you spot developing CO issues and find the source before they become dangerous.**

A good CO detector is a small investment that can save so much: your life, your passengers, and your aircraft.

# The Delta Zulu Headset, with Built-in CO monitoring and Detection

The Delta Zulu headset provides automatic Carbon Monoxide detection and warnings. Integrated Kanari Smart Alert Technology gathers carbon monoxide data via a built-in sensor that processes the information and creates smart audio alerts all within the headset, based on cautionary and critical CO thresholds. Using the Lightspeed app, pilots can also monitor and track levels of CO in their environment, no matter the level, enabling proactive maintenance and providing sharper situational awareness and control of in-flight safety.

Delta Zulu. It's simple, seamless, and safer.



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CHAPTER FIVE

# What to Do If CO Is Present

If you get an alarm from your carbon monoxide (CO) detector while in flight, or if you start to experience symptoms of CO poisoning, it's important to act quickly. You need to get fresh air and get safely back on the ground. By the time there are symptoms of CO poisoning, you've passed the 10% mark and every minute of exposure will make the situation worse.

The most important thing is to get on the ground and out of the aircraft as quickly and safely as possible, then seek medical attention. Remember that CO can linger in your blood and damage your body even after the exposure stops.

## Here's what to do:

**Turn off the heater and increase cabin ventilation using air vents and windows, if possible, to flush out the bad air.**

**If you have supplemental oxygen on board, use it.**

**Reduce altitude to slow entry of CO into the bloodstream.**

**Notify ATC, so that they can guide you safely down and get other aircraft out of the way.**

# CO Poisoning at a Glance

## PREVENTING IT

- Regular maintenance
- Replace muffler regularly
- Regular inspection for:
- Cracks in engine firewall
- Exhaust system holes or cracks
- Bad seals or gaskets in exhaust system or around doors
- Cracked heat exchanger
- Soot at cockpit vents
- Smoky odor in cockpit
- Drop in engine RPM when carb heat turns on
- CO detector on board

## SPOTTING IT

- Increasing headache
- Shortness of breath
- Tingling
- Racing pulse
- Ringing in the ears
- Cherry red lips
- Drowsiness
- Blurred vision
- Impaired judgement and confusion
- Unconsciousness
- Vomiting

## SURVIVING IT

- Assume any unusual smell includes exhaust
- Notify ATC of possible CO poisoning
- Descend to lowest safe altitude
- Open air vents and windows
- Use supplemental oxygen
- Land as soon as possible
- Seek medical attention immediately after landing

## CONCLUSION

# Aim for Safe CO-Existence

As long as aircraft have combustion engines, we can't eliminate CO risks from aviation, but you can take steps to protect yourself from exposure, and you can learn the signs of CO poisoning and what to do if you suspect a problem. To protect yourself and your passengers, be vigilant about maintenance of your manifold and muffler, hoses, and gaskets. Conduct your pre-flight checks with CO hazards in mind. Have a quality, working CO detector with you always—one that lets you monitor CO levels day to day and that will alert you loud and clear if there's a problem. Be always alert for signs of CO poisoning, keeping in mind that each person will be affected differently. And if you don't feel 100% for any reason, get safely back on the ground.

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