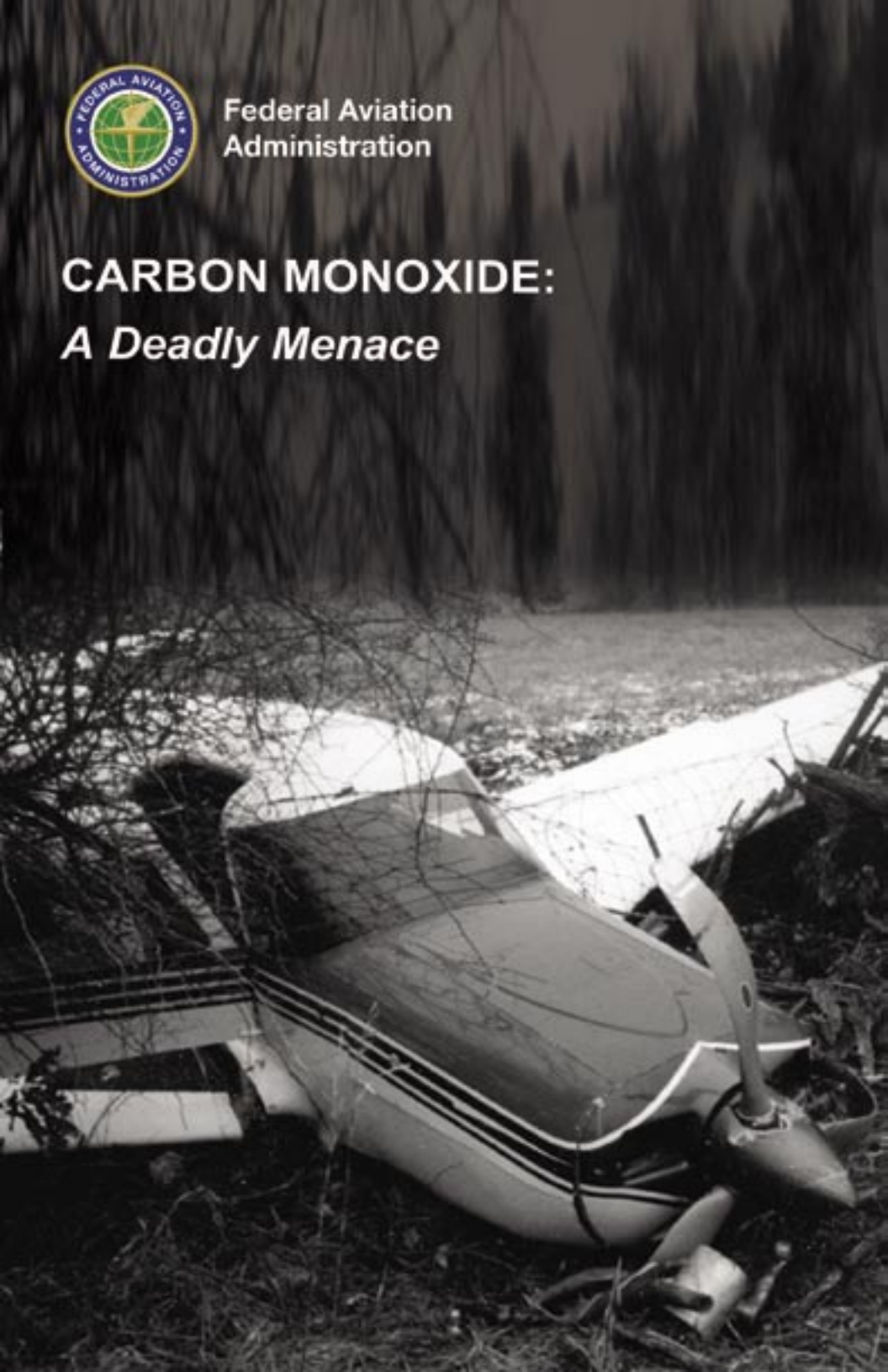
Federal Aviation Administration

CARBON MONOXIDE:

A Deadly Menace



An 'Unconscious' Landing

Plane Lands Itself in Hayfield as Pilot Slumbers

Physician Robert Frayser had lifted off in his Comanche 400 from the North Bend, Kansas, airport at 7 a.m., en route for a meeting in Topeka. He was flying alone, cruising at 5,500 feet on autopilot, with the sun coming up on a clear, beautiful day. Per established routine, he switched the fuel selector to the auxiliary tank and set up the navigation system for nearby Topeka.

About 90 minutes later, Dr. Frayser found himself in a hay field. The engine was silent. He was confused, disoriented, and groggy as he struggled to rouse himself from a deep sleep. His head was throbbing.

Thinking he was still in the air, he went through his landing checklist. As he became more oriented to his surroundings, a new reality dawned: The airplane's right wing was nearly torn off from an impact with a tree, but the plane was otherwise intact. Aside from a fractured wrist, minor cuts, and bruises, he seemed to be relatively uninjured. But he had no idea where he was. He had no memory of landing.

Dr. Frayser stated that there were no early warnings or symptoms to alert him. "I just went to sleep." The plane, trimmed for cruise flight and on autopilot, flew a perfectly straight course over Kansas and into Missouri until it ran out of fuel, and then the autopilot gently brought the Comanche in for landing.

Since the engine had stopped, no one heard the aircraft glide to a landing on the open field. "I was alone, disoriented, injured, and had a severe headache and ringing in my ears," he said.

The aftermath of a near-fatal accident caused by carbon monoxide poisoning.

Extracting himself from the aircraft, he struggled a quarter of a mile through snow-covered fields for help, finally stumbling onto a farmhouse. Dr. Frayser was taken by ambulance to a hospital, where the emergency room physician put him on 100 percent oxygen to overcome near-fatal blood levels of carboxyhemoglobin.

Carbon monoxide poisoning from a cracked muffler had allowed the deadly, odorless gas to seep into the cabin through the heater and caused him to fall asleep. The crack, which had apparently opened after the last annual inspection, was concealed by the heat shield and could not be detected during the pre-flight inspection. "The crack could have been there for a long time, just waiting for someone to turn on the heater," he said. Frayser did not have a carbon monoxide detector on board to alert him of its presence.

Another 30 minutes in the air might have been fatal. Carbon monoxide poisoning would have claimed another victim.

Overlooked Safety Issue

Carbon monoxide poisoning is a safety issue that pilots tend to ignore, even though it is the most common industrial poisoning accident in the United States. When carbon monoxide poisoning occurs, it can have significant and fatal consequences for aircraft occupants.

Carbon monoxide is a by-product of the incomplete combustion of carbon-containing materials. Aviation fuel contains carbon and is a ready source of carbon monoxide when burned. Expect carbon monoxide whenever an internal combustion engine is operating, and even though piston engines produce the highest concentrations of carbon monoxide, exhaust from turbine engines could also cause carbon monoxide poisoning. In addition, expect carbon monoxide whenever a fire occurs, as commonly happens in a post-crash environment.

Carbon monoxide is truly a hidden menace because by itself, it is both a **colorless** and **odorless** gas. An individual would not be aware of its presence until symptoms developed, or during treatment it was determined exposure had occurred. The least desirable situation would be incapacitation. In this case, the victim is powerless to do anything about the

exposure. Fortunately, because it is a by-product of combustion, carbon monoxide is frequently associated with other gases that do have an odor and color.

By avoiding an environment with known combustion fumes, you will also avoid carbon monoxide. The true problem comes when exposure is so gradual that you don't perceive it. You can become incapacitated before you can vacate the environment. In an airplane, the result most likely will be a fatal accident.

Why Carbon Monoxide Poisoning Should Concern Pilots

What is not known is the full extent of carbon monoxide poisoning in aviation. Analysis of toxicology samples from fatal U.S. aircraft accidents between 1967 and 1993 showed that at least 360 victims had been exposed to sufficient carbon monoxide before or after the crash to impair their abilities. Non-fatal carbon monoxide poisoning in aviation is likely a more common occurrence than currently believed. No one is sure how many times pilots or passengers became ill, not realizing they had been exposed to carbon monoxide. Because no significant incident or incapacitation occurred, the matter was not reported and, hence, not investigated. Symptoms that could be attributed to airsickness, altitude hypoxia, fatigue, or a variety of other conditions actually could have been carbon monoxide poisoning.

Exposure and symptoms may occur repeatedly over several flights until, finally, someone suspects carbon monoxide or, tragically, an accident claims a victim. No database presently exists that accurately collects or tracks non-fatal aviation carbon monoxide exposure information.

Toxicity Mechanism

Carbon monoxide has a very high affinity for hemoglobin, the molecule in blood responsible for transporting oxygen through the body. Carbon monoxide has affinity of 240 times that of oxygen. Carbon monoxide tightly attaches to the hemoglobin, creating the compound carboxyhemoglobin, which prevents oxygen from binding, thereby blocking its transport. The result is hypoxia but through a mechanism different from that produced by altitude. However, with respect to symptoms, the end-effects can be very similar.

There should be little or no carbon monoxide in the blood of individuals who have not been exposed to smoke or other by-products of combustion. People living in polluted urban environments may have between 3-10% carboxyhemoglobin concentrations because of the carbon monoxide contained in the smoke and fumes they inhale, while a cigar smoker could have up to 15%. People in certain occupations such as foundry workers, welders, mechanics, firefighters, and tollbooth or tunnel attendants that expose them to products of combustion may also have elevated carbon monoxide baseline levels.

Symptoms

The most common symptoms of carbon monoxide exposure are shown in Table 1. These symptoms are typical for an individual with normal hemoglobin at sea level. You can expect these symptoms to worsen at altitude and/or appear sooner than they otherwise would. Wide personal variations may also occur, depending on the circumstances and whether or not the indificual smokes.

Table 1: Carbon Monoxide (CO) Blood Levels and Possible Symptoms

Percent CO in Blood	Typical Symptoms
<10	None
10-20	Slight headache
21-30	Headache, slight increase in respirations, drowsiness
31-40	Headache, impaired judgment, shortness of breath, increasing drowsiness, blurring of vision
41-50	Pounding headache, confusion, marked shortness of breath, marked drowsiness, increasing blurred vision
>51	Unconsciousness, eventual death if victim is not removed from source of CO

Protection From Carbon Monoxide Exposure

First and foremost is pilot education and awareness. Pilots must understand the danger posed by carbon monoxide poisoning and should be alert to the symptoms.

Any unusual cabin smell or sensation of illness should call for immediate troubleshooting.

- Turn the cabin heat fully off.
- Increase the rate of cabin fresh air ventilation to the maximum.
- Open windows if the flight profile and aircraft's operating manual permit such an action.
- If available **(provided it does not represent a safety or fire hazard)**, consider using supplemental oxygen.
- Land as promptly as possible.
- Do not hesitate to let Air Traffic Control know of your concerns, and ask for vectors to the nearest airport.
- Once on the ground, seek medical attention.
- Before continuing the flight, have the aircraft inspected by a certified mechanic.

Safeguards

- The best protection against carbon monoxide poisoning is to avoid exposure.
- Aircraft operators and pilots must ensure that heating/ventilation systems and exhaust manifolds in their aircraft are all in good working order, as specified by the manufacturer and the Federal Aviation Administration.
- Certified mechanics must conduct all required inspections.
- Special attention should be paid to older aircraft because of corrosion or simple wear and tear.
- A certified mechanic should verify firewall and aircraft structural integrity and seal any defects.
- Finally, several devices are available to monitor for carbon monoxide. The least expensive are handheld or stick-on colorimetric devices that change color in the presence of carbon monoxide. While effective, they are not perfect or foolproof. Powered detectors for aviation use are available as either portable or panel-mounted units and provide greater reliability.

Don't become a statistic.
Learn to prevent and avoid this deadly threat to your flying safety.

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