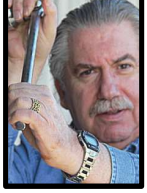

MIKE BUSCH
COMMENTARY / SAVVY AVIATOR

Silent Killer

If you think CO-related accidents are rare, think again

ON JANUARY 17, 1997, a Piper Dakota departed Farmingdale, New York, on a planned two-hour VFR flight to Saranac Lake, New York. The pilot was experienced and instrument-rated; his 71-year-old mother, a low-time private pilot, occupied the right seat. Just over a half-hour into the flight, Boston Center got an emergency radio call from the mother, saying that the pilot (her son) had passed out.

The controller attempted a flight assist, and an Air National Guard helicopter joined up with the aircraft and participated in the talk-down attempt. Ultimately, however, the pilot's mother also passed out.

The aircraft climbed into the clouds, apparently on autopilot, and continued to be tracked by ATC. About two hours into the flight, the airplane descended rapidly out of the clouds and crashed into the woods near Lake Winnipesaukee, New Hampshire. Both occupants died.

Toxicological tests revealed that the pilot's blood had a CO saturation of 43 percent—sufficient to produce convulsions and coma—and his mother's was 69 percent.

On December 6 that same year, a physician was piloting his Piper Comanche 400 from his hometown of Hoisington, Kansas, to Topeka when he fell asleep at the controls. The airplane continued on course under autopilot control for 250 miles until it ran a tank dry and (still on autopilot) glided miraculously to a soft wings-level crash-landing in a hay field near Cairo, Missouri.

The pilot was only slightly injured and walked to a nearby farmhouse for help. Toxicology tests on a blood sample taken from the lucky doc hours later revealed a CO saturation of 27 percent. It was almost certainly higher at the time of the crash.

Just a few days later, a new 1997 Cessna 182S was being ferried from the Cessna factory in Independence, Kansas, to a buyer in Germany when the ferry pilot felt ill and suspected carbon monoxide (CO) poisoning. She landed successfully, and examination of the muffler revealed that it had been manufactured with defective welds. Subsequent pressure tests by Cessna of new Cessna 172 and 182 mufflers in inventory revealed that 20 percent of them had leaky welds. The FAA issued an emergency airworthiness directive (AD 98-02-05) requiring muffler replacement on some 300 new Cessna 172s and 182s.

About 18 months later, the FAA issued AD 99-11-07 against brand new air-conditioned Mooney M20R Ovations when dangerous levels of CO were found in their cabins.

NOT JUST IN WINTER

A search of the NTSB accident database suggests that CO-related accidents and incidents occur far more frequently than most pilots believe. Counterintuitively, these aren't confined to winter-time flying with the cabin heat on. Look at the months during which the following accidents and incidents occurred during the 15-year period from 1983 to 1997:

March 1983. Piper PA-22-150 N1841P departed Tucumcari, New Mexico. After leveling at 9,600, the right front-seat passenger became nauseous, vomited, and fell asleep. The pilot began feeling sleepy and passed out. A 15-year-old passenger in the back seat took control of the aircraft by reaching between the seats, but the aircraft hit a fence during the emergency landing. None of the four occupants were injured. Multiple exhaust cracks and leaks were found in the muffler. The NTSB determined the probable cause of the accident to be incapacitation of the PIC from CO poisoning.

February 1984. The pilot of Beech Musketeer N6141N with four aboard reported that he was unsure of his position.

ATC identified the aircraft and issued radar vectors toward Ocean Isle, North Carolina. Subsequently, a female passenger radioed that the pilot was unconscious. The aircraft crashed in a steep nose-down attitude, killing all occupants. Toxicological tests of the four victims revealed carboxyhemoglobin (COHb) levels of 24 percent, 22 percent, 35 percent, and 44 percent.

July 1991. The student pilot and a passenger were on a pleasure flight in Champion 7AC N3006E, owned by the pilot. The aircraft was seen to turn into a valley in an area of mountainous terrain, where it subsequently collided with the ground near Burns, Oregon, killing both occupants. A toxicology exam of the pilot's blood showed a saturation of 20 percent COHb, sufficient to cause headache, confusion, dizziness, and visual disturbance.

October 1994. A student pilot returned to Chesterfield, Missouri, from a solo cross-country flight in Cessna 150 N7XC complaining of headache, nausea, and difficulty walking. The pilot was hospitalized, and medical tests revealed elevated CO levels that required five and half hours of breathing 100 percent oxygen to reduce to normal. Post-flight inspection revealed a crack in an improperly repaired muffler that had been installed 18 hours earlier.

August 1996. Mankovich Revenge racer N7037J was No. 2 in a four-airplane ferry formation of Formula V Class racing airplanes. The No. 3 pilot said that the No. 2 pilot's flying was erratic during the flight. The airplane crashed near Jeffersonville, Indiana, killing the pilot. The results of FAA toxicology tests of the pilot's blood revealed a 41 percent saturation of COHb; loss of consciousness is attained at approximately 30 percent. Examination of the wreckage revealed that the adhesive resin that bound the rubber stripping forming the firewall lower seal was missing. The NTSB determined probable cause of the accident to be pilot incapacitation due to CO poisoning.

FOR MORE INFORMATION

There is an outstanding October 2009 research paper titled "Detection and Prevention of Carbon Monoxide Exposure in General Aviation Aircraft" authored by Wichita State University under sponsorship of the FAA Office of Research and Technology Development. The paper is 111 pages long and discusses (among other things):

- Characteristics of CO-related GA accidents.
- Evaluation of CO detectors, including specific makes and models.
- Placement of CO detectors in the cabin.
- Exhaust system maintenance and inspection.

Visit *www.SportAviation.org* for a PDF of the research paper.

MIKE BUSCH

CHOOSING A CO DETECTOR

Chemical spot detectors: Stay away from those ubiquitous el-cheapo adhesive-backed cardboard chemical spot detectors that are commonly sold by pilot shops and mail-order outfits under trade names like Dead Stop, Heads Up, and Quantum Eye. They have a very short useful life (about 30 days) and are extremely vulnerable to contamination from aromatic cleaners, solvents, and other chemicals routinely used in aircraft maintenance.

These things often remain stuck on the instrument panel for years, providing a dangerous false sense of security. What's worse, there's no warning that the detector is outdated or has been contaminated—in some ways, that's worse than not having a detector at all.

Even when fresh, chemical spot detectors are incapable of detecting low levels of CO. They'll start turning color at 100 ppm, but so slowly and subtly that you'll never notice it. For all practical purposes, you'll get no warning until concentrations rise to the 200 to 400 ppm range, by which time you're likely to be too impaired to notice the color change.

Residential electronic detectors: Although battery-powered residential electronic detectors are vastly superior to those worthless chemical spots, most are designed to be compliant with Underwriters Laboratories specification UL-2034 (revised 1998). This spec requires that:

- The digital readout must not display any CO concentration less than 30 ppm.
- The alarm will not sound until CO reaches 70 ppm and remains at or above that level for four hours.

Even at a concentration of 400 ppm, it may take as much as 15 minutes before the alarm sounds.

For aircraft use, you really want something much more sensitive and fast-acting. I like the non-UL-compliant CO Experts Model 2015 ($199 from *www.Aeromedix.com*). It displays CO concentrations as low as 7 ppm and provides a loud audible alarm at concentrations above 25 ppm. It updates its display every 10 seconds (compared to once a minute for most residential detectors), which makes it quite useful as a "sniffer" for trying to figure out exactly where CO is entering the cabin.

Industrial electronic detectors: Industrial CO detectors cost between $400 and $1,000. A good choice for in-cockpit use is the BW Honeywell GasAlert Extreme CO ($410 from *www.GasSniffer.com*). This unit displays CO concentrations from 0 to 1,000 ppm on its digital display and has a very loud audible alarm with dual trigger levels (35 and 200 ppm).

Purpose-built aviation electronic detectors: Tucson-based CO Guardian LLC makes a family of TSO'd panel-mount electronic CO detectors specifically designed for cockpit use. These detectors detect and alarm at 50 ppm (after 10 minutes) or 70 ppm (after five minutes), and will alarm instantly if concentrations rise to 400 ppm. The digital display models ($599 and up) will show concentrations as low as 10 ppm. Available from *www.COGuardian.com*. Obviously, panel-mount detectors cannot be used as a sniffer to locate the source of a CO leak.

Overall, deaths from unintentional CO poisoning have dropped sharply since the mid-1970s thanks mainly to lower CO emissions from automobiles with catalytic converters (most CO deaths are motor vehicle related) and safer heating and cooking appliances. But CO-related airplane accidents and incidents haven't followed this trend. The ADs issued against Independence-built Cessna 172s and 182s and Mooney Ovations demonstrates that even brand new airplanes aren't immune.

CLOSE CALLS

In addition to these events in the NTSB accident database where CO poisoning was clearly implicated, there were almost certainly scores of accidents, incidents, and close calls where CO was probably a factor.

In January 1999, for example, a Cessna 206 operated by the U.S. Customs Service was on a night training mission when it inexplicably crashed into Biscayne Bay a few miles off the south Florida coast. The experienced pilot survived the crash, but had no recollection of what happened. The NTSB called it simple pilot error and never mentioned CO as a possible contributing factor. However, enough COHb was found in the pilot's blood that the Customs Service suspected that CO poisoning might have been involved.

The agency purchased sensitive industrial electronic CO detectors for every single-engine Cessna in its fleet and discovered that many of the planes had CO-in-the-cockpit problems. On-board CO detectors and CO checks during maintenance inspections have been standard operating procedure for the Customs Service ever since.

HOW MUCH CO IS TOO MUCH?

It depends on whom you ask.

EPA calls for a health hazard alert when the outdoor concentration of CO rises above 9 parts per million (ppm) for eight hours, or above 35 ppm for one hour. The U.S. Department of Labor's Occupational Safety and Health Administration originally established a maximum safe limit for exposure to CO in the workplace of 35 ppm, but later raised it to 50 ppm under pressure from industry.

The FAA requires that CO in the cabin not exceed 50 ppm during certification testing of new GA airplanes certified under FAR Part 23 (e.g., Cessna Corvalis, Cirrus SR22, Diamond DA40). Legacy aircraft certified under older CAR 3 regulations required no CO testing at all during certification.

Once certified, the FAA requires no CO testing of individual aircraft by the factory, and no follow-up retesting during annual inspections. A March 2010 FAA SAIB (CE-10-19 R1) recommends checking CO levels with a handheld electronic CO detector during ground run-ups at each annual and 100-hour inspection, but in my experience very few shops and mechanics do this.

UL-approved residential CO detectors are not permitted to alarm until the concentration rises to 70 ppm and stays there

Five CO detectors (left to right): chemical spot, UL-compliant residential (Kidde), non-UL-compliant (CO Experts 2015), industrial (BW Honeywell), TSO'd panel-mounted (CO Guardian 551).

for four hours. (This was demanded by firefighters and utility companies to reduce the incidence of nuisance calls from homeowners.) Yet most fire departments require that firefighters put on their oxygen masks immediately when CO levels reach 25 ppm or higher.

It's important to understand that low concentrations of CO are far more hazardous to pilots than to nonpilots. That's because the effects of altitude hypoxia and CO poisoning are cumulative. For example, a COHb saturation of 10 percent (which is about what you'd get from chain-smoking cigarettes) would probably not be noticeable to someone on the ground. But at 10,000 feet, it could seriously degrade your night vision, judgment, and possibly cause a splitting headache.

After studying this hazard for many years and consulting with world-class aeromedical experts, I have come to the following conclusions:

- Every single-engine piston aircraft should carry a sensitive electronic CO detector.
- Any in-flight CO concentration above 10 ppm should be brought to the attention of an A&P for troubleshooting and resolution.
- Any in-flight CO concentration above 35 ppm should be grounds for going on supplemental oxygen (if available) and making a precautionary landing as soon as practicable.
- Smokers are far more vulnerable to both altitude hypoxia and CO poisoning, since they're already in a partially poisoned state when they first get into the aircraft. Because of COHb's long half-life, you'd do well to abstain from smoking for eight to 12 hours prior to flight. EAA

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