Civil Aviation Authority

SAFETY NOTICE

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Carbon Monoxide Minimisation and Detection in General Aviation Aircraft

This Safety Notice contains recommendations regarding operational safety.

Recipients must ensure that this Notice is copied to all members of their staff who need to take appropriate action or who may have an interest in the information (including any 'in-house' or contracted maintenance organisations and relevant outside contractors).

Applicability:	
Aerodromes:	Not primarily affected
Air Traffic:	Not primarily affected
Airspace:	Not primarily affected
Airworthiness:	All BCAR A8-23 / A8-24 / A8-25 / A8-26, EASA Part-M/F, M/G and Part CAO/CAMO Organisations
Flight Operations:	Operators of General Aviation Aircraft
Licensed/Unlicensed Personnel:	General Aviation Pilots and Engineers

1 Introduction

1.1 This Safety Notice is published to raise awareness around minimising the likelihood of carbon monoxide (CO) contamination, highlighting the hazards associated with carbon monoxide exposure and to provide guidance on the use of carbon monoxide detectors in general aviation (GA) aircraft to protect pilots and passengers.

1.2 Carbon monoxide poisoning has been cited as a factor in multiple GA accidents globally. In the UK, since 2000 there have been two fatal accidents, one non-fatal accident, and fifteen other incidents where CO may have been a causal factor. The potential dangers of carbon monoxide exposure have been highlighted by the UK Air Accidents Investigations Branch (AAIB) in several recent accident reports - see the Recommended Reading section below.

1.3 Carbon monoxide, formed by the incomplete combustion of carbon-containing materials, is a colourless, odourless gas that can cause damage to the brain, heart and nervous system. Symptoms of exposure include headache, fatigue, sleepiness, breathlessness, and degradation in performance. Continued exposure to elevated concentrations can cause unconsciousness and death.

1.4 The physiological effects of CO poisoning are cumulative and take a very long time to disperse. Even a low level of CO ingestion, below the level that causes immediate physical symptoms, will cause a progressive reduction in blood oxygen levels which will reduce pilot performance and

potentially cause permanent damage to the brain, heart and nervous system. It is therefore a mistake to assume that a cockpit contaminated with relatively low levels of CO is acceptable as the cumulative negative effects on human performance may not be noticed.

1.5 When it comes to CO, prevention is always better than cure. Maintenance is therefore the first, and best, line of defence against CO exposure. However, should maintenance fail, effective alerting of CO presence can be achieved via an appropriate CO detector. This Safety Notice provides guidance on both topics.

1.6 In 2022, the CAA concluded a 12-month study of commercially available low-cost active CO detectors and found them to be a net safety benefit to GA. Whilst the risk of CO poisoning may be broadly understood by GA pilots, the same cannot be said for consumers and third parties generally, who may fly in piston engine aircraft on a commercial or recreational basis. Pilots and owners are therefore advised to consider the significant safety benefits offered by active CO detectors, both for their own protection and for their passengers' as well.

2 Prevention, Detection and Reaction

2.1 **Prevention:** Exhaust system failures and/or poor sealing of the bulkhead between the engine compartment and the cabin can cause CO to enter the aircraft cockpit. CO can also find its way into aircraft via poorly fitting cabin doors, access panels, wing root fairings and hatches, which can allow exhaust gas flowing along the outside of the fuselage to enter; the extent may vary at different angles of attack. Changes to the position and configuration of the exhaust system over the life of the aircraft can also notably influence the amount of CO entering the cockpit. Adherence to a thorough and regular maintenance programme is therefore key to minimising the risk of CO exposure throughout the life of the aircraft.

Research carried out by the FAA (see paragraph 3) indicates that contamination incidents caused by leakage in exhaust systems are more prevalent in the colder months and that systems with higher operating hours are more likely to be affected. The CAA's 12-month study similarly noted an increase in the number of CO alerts during winter months as well as with aircraft age. To minimise the likelihood of carbon monoxide contamination during flight, aircraft owners and maintainers are reminded to:

- Ensure that aircraft exhaust and associated systems are maintained in accordance with the applicable maintenance data. These can include physical inspection, physical inspection with partial dis-assembly, internal inspection, Non-Destructive Testing (NDT) and pressure testing.
- Re-familiarise themselves with the guidance in CAA Publication (CAP) 562 'Civil Aircraft Airworthiness Information and Procedures' **CAAIPS Leaflet B-190** 'CO contamination' which provides generic guidance on maintenance-related measures to minimise the likelihood of contamination. It addresses the nature and effects of carbon monoxide, the causes of contamination, the importance of routine inspections and means of testing for contamination. In addition, **FAA AC-43-13-1B Section 3 paragraphs 8-45 to 8-52** provides valuable information on typical failures, hazards, descriptions and inspections including pressure checks, repairs and replacement recommendations.
- Include a suitably frequent periodic inspection and test regime in each affected aircraft's Maintenance Programme (Approved or Owner-Declared, including programmes based upon the EASA Minimum Inspection Programme), an example of which is given in **Transport Canada Airworthiness Directive CF-90-03** and its accompanying **Safety Alert document CASA 2019-07** (see para 3). UK Reg (EU) No. 1321/2014 Annex Vb (Part-ML) now includes a specific CO concentration check as part of the Minimum Inspection Programme.
- Ensure that aircraft fitted with combustion heaters are compliant with CAA Publication **CAP 747** 'Mandatory Requirements for Airworthiness' **Generic Requirement (GR) 11.** This

covers servicing and overhaul requirements intended to prevent carbon monoxide contamination.

2.2 **Detection:** In addition to adopting best practice maintenance measures, it is recommended that pilots also fly with a CO detector in the aircraft that is capable of providing audible/visible warnings that actively engage a pilot's attention when pre-determined carbon monoxide levels are exceeded (typically 50 parts per million); these are so called 'active detectors'. Passive, non-alerting, CO detectors that change colour when exposed to CO are also available, but they lack attention-getting capability, which is undesirable given the nature of CO. Active CO detectors broadly fall into two categories:

- **Aviation standard** – These devices are approved for aircraft use in accordance with a recognised aviation standard (e.g. **EASA ETSO-2C48a**) and can therefore be permanently installed in aircraft. These instruments tend to cost more, typically around £300 plus installation, but often come with additional functions and better aircraft integration. Some aviation equipment manufacturers now also offer devices (e.g. ADS-B and headsets) with an active CO detector built in as standard.
- **Commercial off the shelf** – There is a wide range of active detectors designed for use in homes, caravans and boats that are readily available for less than £20; these devices were the focus of the CAA's 12-month study (see paragraph 3). Although these devices are not approved for aviation use, findings from the CAA study suggest that they can function reasonably at typical recreational GA altitudes (up to 5,000 ft). With sensor lives of up to 7 years and battery lives up to 10 years, they can be very cost-effective. Purchasing a device that meets a commercial standard (e.g. EN 50291-2) is also recommended.

The effectiveness of any active detector is largely dependent on variables such as the alarm trigger level and the detector's location in the aircraft. Adherence to the manufacturer's general guidance for installation, usage and maintenance should maximise effective operation.

2.2.1 **Installing or Carrying a Carbon Monoxide Detector**

- **Aviation standard** – These devices can be fitted to UK-registered aircraft as 'standard changes' under the provisions of **CS-STAN** (Standard Change CS-SC107a) for Part 21 aircraft and through **CAP 1419** for non-Part 21 aircraft. This removes the need for direct CAA involvement, including avoiding the cost and time of applying for a formal modification.
- **Commercial off the shelf** – No airworthiness approval is required for these devices, and they can be carried on board. Pilots should assess the suitability and condition of the detector before flight e.g. to ensure that an aural CO warning would not be so loud as to create a distraction in flight yet still be audible even when wearing noise-cancelling headsets, nor be confused with other onboard warnings. Most participants in the CAA's 12-month study kept their detector attached to the instrument panel; by keeping the device in the pilot's line of sight, alerts are more likely to be noticed.
- Passive detectors can simply be attached to a wall or panel in the cockpit and should be clearly visible to the pilot without obscuring any instruments or equipment.

2.3 **Reaction:** If you experience CO poisoning symptoms or the detector alarm sounds:

- Turn off the cabin heat supply and maximise fresh air entry into the cabin
- Keep flying the aircraft and make a radio call to alert others to your predicament
- Land as soon as possible
- Seek medical attention when on the ground
- Ensure the problem is identified and rectified before further flight

3 Recommended Reading

The following sources contain useful information concerning the nature and effects of carbon monoxide, the causes of contamination and means by which the likelihood of exposure can be reduced.

- Piper PA-46 Malibu (N264DB) AAIB Special Bulletin S2/2019 and Final Report
- Scheibe Super Falke SF25E (G-KDEY) AAIB Final Report
- LAA 'Light Aviation' magazine article ***'The Canary & the Silent Killer'***, July 2017.
- FLYER article '*Top Gear; Carbon Monoxide Monitors'*; Summer 2019
- (BS) EN 50291-2; 'Electrical apparatus for the detection of carbon monoxide in domestic premises. Electrical apparatus for continuous operation in a fixed installation in recreational vehicles and similar premises including recreational craft. Additional to EN 50291-1 'test methods and performance requirements'.
- FAA report **DOT/FAA/AR-09/49** *'Detection and Prevention of Carbon Monoxide Exposure in General Aviation Aircraft'*, 2009.
- CAA CAP 2560 '*Carbon Monoxide Detector Trial Summary Report*', 2023
- EASA **Safety Information Bulletins 2010-19 '**Exhaust Mufflers Inspection for piston engine Helicopters and Aeroplanes', and **2020-01** 'Carbon Monoxide (CO) Risk in Small Aeroplanes and Helicopters'.
- Transport Canada **Airworthiness Directive CF-90-03R2** 'Exhaust Type Cabin and Cockpit Heaters', August 1992 and associated Civil Aviation Safety Alert (CASA) 2019-07.
- EASA European Technical Standard Order **ETSO-2C48a** Carbon Monoxide Detector Instruments.

4 Queries

4.1 Any queries or requests for further guidance because of this communication should be addressed to:

General Aviation Unit
Civil Aviation Authority
Aviation House
Beehive Ring Road
Crawley
West Sussex,
RH6 0YR

Tel: +44 (0)1293 573988

E-mail: **GA@caa.co.uk** or **CODE@caa.co.uk**

5 Cancellation

5.1 This Safety Notice will remain in force until further notice.