Civil Aviation Authority

SAFETY NOTICE

Number: SN–2020/003

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Carbon Monoxide Contamination 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 of the means of minimising the likelihood of carbon monoxide contamination, the hazards associated with carbon monoxide exposure and to provide guidance on the use of carbon monoxide detectors in general aviation aircraft.

1.2 The potential dangers of carbon monoxide exposure have been highlighted by the UK Air Accidents Investigations Branch (AAIB) in Special Bulletin S2/2019, concerning an accident involving a Piper Malibu. A toxicology report on the passenger identified potentially fatal levels of carbon monoxide exposure.

1.3 It is considered timely to remind aircraft owners, operators and maintainers of measures that can be taken to reduce the likelihood of critical carbon monoxide poisoning during flight.

1.4 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. The symptoms in you and/or your passengers of exposure include; headache, fatigue, sleepiness, breathlessness, degradation in performance. Continued exposure to elevated concentrations can cause unconsciousness and death.

1.5 The best protection against carbon monoxide (CO) poisoning is to avoid exposure. 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 very low levels of CO is acceptable. Low levels of environmental CO could be considered just as dangerous as high levels, as the cumulative negative effect on human performance may not be noticed.

1.6 Preventive maintenance remains the first line of defence against CO exposure during flight. If that fails, effective alerting of its presence in the cockpit can be achieved through the use of an appropriate CO detector. This Safety Notice provides guidance on both topics.

2 Maintenance, Detection and Carbon Monoxide Presence

2.1 **Maintenance:** 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. Ingestion into the cabin can also occur through routes other than the firewall; there is usually a stream of exhaust gas flowing down the outside of the fuselage and poorly fitting cabin doors, access panels, wing root fairings and hatches can provide an entry path into the cabin. The extent may vary at different angles of attack. Research carried out by the FAA (see paragraph 3) unsurprisingly indicates that contamination incidents caused by leakage in exhaust system are more prevalent in the colder months and that systems with higher operating hours are more likely to be affected. Any changes to the position and configuration of the exhaust system over the life of the aircraft can notably affect the amount of CO entering the cockpit. To minimise the likelihood of carbon monoxide contamination during flight, aircraft 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, 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 expectations for 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.

- With due account taken of the material mentioned above, 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.

- Where fitted with combustion heaters, ensure that aircraft 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, consideration should also be given to the installation of a CO detector in the aircraft. There are a range of options available, with detectors falling into two categories:

- **Passive detectors** – These are the 'spot type' detectors that change colour when exposed to carbon monoxide. They are small, light, cheap (in the region of £5) and easy to fit, but they have a limited declared life, often 3 months. They therefore need to be replaced regularly for continued effectiveness. This can be facilitated by marking the expiry date on the indicator. Whilst better than no detector, the clear disadvantage of these components is that they lack attention-getting capability. Bearing in mind the nature of CO, this is not ideal.

- **Active detectors** – These provide audible, visible and/or vibration warnings when pre-determined carbon monoxide levels are exceeded (often 50ppm, although some can be self-adjusted). These detectors have the clear advantage of actively engaging the occupant's attention and are therefore far more likely to be effective than passive measures. Depending on the type, they can be either portable and 'carried on' to the aircraft or permanently 'installed' in a suitable position on the aircraft. Commercially available motorhome, caravan or boat-compatible units from a reliable source, a known manufacturer and with reasonable assurance of meeting an appropriate standard such as EN 50291-2 are available for as little as £15. Such units have a sensor life in the region of 7 years and battery lives of between 1 and 10 years. This makes them arguably at least as cost-effective as the 'spot-type' items and notably more effective at alerting. Aviation standard (e.g. approved in accordance with EASA's ETSO-2C48a) units are also available if permanent installation is preferred or required. These components often have additional functions and adhere to specific aviation-related requirements, but are more costly, typically around £200-300. Clearly, the effectiveness of these active detectors is dependent to an extent upon variables such as the trigger level for the alarm and the positioning in the aircraft. Adherence to the manufacturer's installation, usage and maintenance instructions should maximise the likelihood of effective operation.

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

- **Passive detectors** can simply be attached to a wall or panel in the cockpit and do not need to be professionally installed. The detector should be clearly visible to the pilot without obscuring any instruments or equipment used in flight. Positioning detectors in locations that might not reflect the typical CO concentrations in the cockpit (e.g. near fresh air vents) should be avoided.

- **Active detectors** Most 'installed' active detector units will usually be able to be fitted to UK-registered aircraft as 'standard changes' under the provisions of **CS-STAN, CS-SC107a** (for EASA aircraft) and through **CAP 1419** (for non-EASA aircraft). This removes the need for direct EASA or CAA involvement, including avoiding the cost and time associated with applying for a formal modification. For 'carry-on' examples, no airworthiness approval is required, although it is expected that the captain will have made an assessment of the unit's suitability and condition before flight – for example, 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

- **NOTE:** Due to the increased availability of inexpensive (commercial) active detectors, their advantages over passive detectors and the potential for an increased risk of CO contamination in an ageing fleet, the CAA intended to undertake a practical trial of such devices during the 2020 flying season covering a variety of GA types, particularly those that by dint of their age and/or configuration may be more prone to CO contamination. Due to the effect of the COVID-19 outbreak on GA flying, this has been put back to the 2021 season, or until reasonable levels of operation are able to resume. The aim of the trial is to

identify whether any potential disadvantages of carrying these units may outweigh the apparent advantages. A cross-section of the UK's GA community will be invited to participate and feed back results/observations to CAA. The data received will be used as a basis for further decision-making, including potential rulemaking. Even before this trial concludes, all GA pilots should give serious consideration to the likely net safety benefits offered by [EN 50291-2 or ETSO-2C48a] CO detector carriage.

2.3**: CO Presence: If you experience 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.

- 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.
- EASA **Safety Information Bulletins 2010-19 '**Exhaust Mufflers Inspection for piston engine Helicopters and Aeroplanes', and **2020-01** 'Carbon Monoxide (CO) Risk in Smallw 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:

GA Unit, Safety & Airspace Regulation Group,
Civil Aviation Authority,
Aviation House,
Gatwick Airport South,

West Sussex,
RH6 0YR Tel: +44 (0)1293 573988

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

5 Cancellation

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