Civil Aviation Authority

SAFETY DIRECTIVE

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Active Carbon Monoxide Detectors for Piston Engine Aircraft Operations

This Safety Directive contains an Operational Directive requiring mandatory action that is necessary to restore an acceptable level of safety. It is issued in accordance with Article 248 of the Air Navigation Order 2016.

Recipients must ensure that this Directive 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 organisation and relevant outside contractors).

Applicability:	
Aerodromes:	Not primarily affected
Air Traffic:	Not primarily affected
Airspace:	Not primarily affected
Airworthiness:	Not primarily affected
Flight Operations:	Operators of piston engine aircraft
Licensed Personnel:	Pilots of piston engine aircraft

1 Introduction

1.1 This Safety Directive (SD) promulgates the Operational Directive (OD) (see page 5) issued by the Civil Aviation Authority (CAA) in relation to active carbon monoxide (CO) detection in specified piston engine aircraft operations.

1.2 CO poisoning has been cited as a factor in multiple general aviation (GA) accidents globally. In the UK, since 2000 there have been three accidents, two of which were fatal, where CO poisoning was identified as the likely cause. The dangers of carbon monoxide exposure have been highlighted by the UK Air Accidents Investigation Branch (AAIB) in several accident reports, most notably following the 2019 fatal accident involving N264DB[1].

1.3 The AAIB report for N264DB identified fifteen other UK events since 2000 where CO may have been a factor. In eleven of those a CO monitor alerted the crew to the presence of CO; in one case the crew was reported to be nearly unconscious when the aircraft landed and on four other occasions occupants experienced nausea and light-headedness. The AAIB also identified seven other reported occurrences of exhaust fumes in the cockpit where no CO detector was present. Additionally, the number of reported CO events has increased in recent years, likely due to better reporting; from 2020-2023 (inclusive) the CAA received 34 Mandatory Occurrence Reports (MORs) related to CO, but there is likely an under-reporting issue at play, especially

[1] N264DB was lost in international waters and is included in US accident statistics. The accident investigation was delegated by the State of Registration (USA), as represented by the NTSB, to the State of the Operator (UK), as represented by the AAIB.

considering that those who do not have a CO detector will be unaware of a potential CO problem.

1.4 Although many GA pilots of piston engine aircraft understand the risk posed by CO, the same cannot be said for passengers who may fly in piston engine aircraft on a commercial or recreational basis.

1.5 This SD prioritises the protection of passengers who are not expected to be aware of the risk posed by CO in piston engine aircraft, by introducing a limited mandate requiring an active CO detector for specified piston engine aircraft operations. Paragraph 2 provides more detail.

1.6 Although this SD focusses on the protection of passengers who are not also qualified pilots, the CAA strongly recommends that all pilots of piston engine aircraft at risk of CO fly with an active CO detector, regardless of who is on board.

2 Compliance/Action to be Taken

2.1 A functioning active CO detector capable of alerting pilots via aural and/or visual warnings (see paragraph 2.2) must be present in affected piston engine aircraft (see paragraph 2.3) when operating with passengers on board who do not hold a recognised pilot qualification (see paragraph 2.4).

2.2 Active CO detectors are electronic devices that can either meet a recognised aviation standard (e.g. ETSO-2C48a) or be commercial off the shelf units that are not specifically designed and certified for use in aircraft. To facilitate compliance with this SD the CAA will recognise both aviation standard and commercial off the shelf active CO detectors as acceptable. Pilots are free to choose a device that best suits their needs.

2.3 This SD is applicable to all piston engine aircraft, but excludes:

a) Single-seat aircraft;

b) Aircraft with an open cockpit/cabin;

c) Aircraft performing aerobatic manoeuvres (see paragraph 7(a) of the OD), unless as part of a Safety Standards Acknowledgement and Consent (SSAC) operation (see paragraph 7(b) of the OD);

d) Aircraft with piston engines located above/behind the cabin (e.g. helicopters, gyroplanes) unless cabin heat is also provided via an exhaust heat exchanger or a combustion heater; or

e) Aircraft with only wing-mounted piston engines unless cabin heat is also provided via an exhaust heat exchanger or a combustion heater.

2.4 Operations in which all occupants hold a recognised pilot qualification are not required to comply with this SD. Recognised pilot qualifications include any ICAO-compliant pilot licence as well as any of the following sub-ICAO licences/certificates:

a) National Private Pilot Licence (NPPL) with any rating

b) Light Aircraft Pilot Licence (LAPL) for any category

c) Private Pilot Licence (Gyroplanes)

d) British Gliding Association (BGA) Gliding Certificate with at least a Solo Endorsement

3 Further Information

3.1 Carbon monoxide is a colourless, odourless gas produced by the incomplete combustion of fuel. Piston engine aircraft are known to produce particularly high concentrations of CO that are

normally directed away from the aircraft via the exhaust system. However, cracks in the exhaust system and/or poor sealing can result in CO entering the cabin.

3.2 When CO enters the bloodstream, it mixes with haemoglobin (the oxygen-carrying protein in red blood cells) to form carboxyhaemoglobin (COHb), which reduces the ability for blood to carry oxygen to vital organs. Symptoms worsen as COHb levels rise in the body. Furthermore, CO susceptibility increases with altitude, putting those who fly at increased risk. Mild CO poisoning may only be indicated by a slight headache and can be mistakenly dismissed as something much less significant.

3.3 The following table shows the most common symptoms associated with mild, moderate, and severe CO poisoning based on CO concentration and the duration of exposure.

Severity	CO in Parts per Million (ppm)	Exposure Time	Typical Symptoms
Mild	50	8 hr	None or slight headache
Moderate	200	2-3 hr	Bad headache, nausea, fatigue, dizziness, increased respiration, impaired judgement, drowsiness, blurring vision, difficulty breathing, stomach pain
Severe	400	1-2 hr	Pounding headache, confusion, marked shortness of breath, marked drowsiness, increasing blurred vision, unconsciousness, heart attack, life threatening after 3 hr
	800	45 min	Symptoms as above, unconscious within 2 hr, death within 2-3 hr
	1600	20 min	Symptoms as above, death within 1 hr

3.4 The insidious nature of carbon monoxide makes it very difficult to detect unaided. Active CO detectors provide audible and/or visible warnings in the presence of elevated carbon monoxide levels and are a highly effective means of alerting a CO threat. These devices can either be portable and 'carried on' to the aircraft or permanently installed. Active CO detectors broadly fall into the following two categories:

3.4.1 **Aviation standard** - Active CO detectors approved in accordance with an aviation standard (e.g. ETSO-2C48a) can be permanently installed in aircraft and usually offer better cockpit integration as well as additional functionality. It is also becoming increasingly common for active CO detectors to be built in as standard with other aviation equipment such as ADS-B and even headsets.

3.4.2 **Commercial off the shelf** - There is a wide range of competitively priced commercially available active CO detectors designed for use in domestic environments. Although not specifically approved for aviation use, findings from the CAA's 12-month study of low-cost active CO detectors suggest that these devices can function reasonably at typical recreational GA altitudes. Some of these detectors display CO levels in real time and offer data logging capability, helping pilots to be aware of low-level CO and detect any small changes over time, both of which could indicate the start of a problem. Commercially available devices meeting an appropriate industry standard such as EN 50291-2 are recommended.

3.5 Installing or carrying an active CO detector on board does not require CAA approval. Active CO detectors can be permanently installed in UK Part 21 and UK non-Part 21 aircraft as a 'standard change' under the provisions of CS-STAN (Standard Change CS-SC107a) without any CAA

involvement. Portable CO detectors can also be carried on board without any airworthiness approval. Regardless of which active CO detector is selected, pilots should ensure the device is functional, audible (and visible if equipped with a digital screen) and securely positioned in the aircraft before each flight.

3.6 In addition to active CO detection, adherence to a thorough and regular maintenance programme is key to minimising the risk of CO poisoning. CAA Safety Notice **Safety Sense Leaflet 34: Carbon Monoxide Safety** provides guidance on how to minimise the likelihood of encountering CO via routine maintenance, how to best recognise when CO is present by using an active detector, and also how to react in the event of a CO alert whilst flying.

3.7 The CAA website has a webpage dedicated to the issue of carbon monoxide in GA where valuable information can be found, including how to reduce the risk of CO poisoning as well as how pilots can protect themselves and their passengers by carrying an active CO detector. The webpage also contains links to other useful information sources on this topic.

3.8 This SD has been partly informed by the findings from the CAA 12-month study of low-cost active CO detectors undertaken in 2021-2022 as well as the pilot surveys conducted in 2021 and 2023. The results of the 12-month study and both surveys are available on the CAA webpage.

4 Queries

4.1 Any queries or requests for further guidance as a result of this communication should be addressed to ga@caa.co.uk

4.2 Otherwise, queries should be addressed to the following e-mail address: safetypublicationsteam@caa.co.uk

5 Cancellation

This Directive will remain in force until further notice.

Signed: James Shipp

Date: 3 February 2025

Operational Directive

1. The Civil Aviation Authority (CAA), in exercise of its powers under article 248 of the Air Navigation Order 2016 ('the Order'), directs operators of piston engine aircraft that are:

   (a) registered in the United Kingdom; or

   (b) registered other than in the UK and intending to conduct flights within UK airspace,

   to comply with the requirements set out in paragraphs 3 and 4.

2. This Directive is made in the interests of promoting safer piston engine aircraft operations involving passengers who are less likely to be aware of the risk posed by carbon monoxide. It is made in response to the Air Accidents Investigation Branch (AAIB) Safety Recommendation (SR) 2020-008.

Requirements

3. From **01 January 2025**, operators of piston engine aircraft, but excluding:

   (a) Single-seat aircraft;

   (b) Aircraft with an open cockpit/cabin;

   (c) Aircraft performing aerobatic manoeuvres (see paragraph 7(a)), unless as part of a Safety Standards Acknowledgement and Consent (SSAC) operation (see paragraph 7(b));

   (d) Aircraft with piston engines located above/behind the cabin, unless cabin heat is also provided via an exhaust heat exchanger or a combustion heater; or

   (e) Aircraft with only wing-mounted piston engines unless cabin heat is also provided via an exhaust heat exchanger or a combustion heater

   must ensure that a functioning active carbon monoxide detector, capable of alerting via aural and/or visual means, is present in the aircraft when operating with any passengers on board who do not hold a recognised pilot qualification that meets the requirements of paragraph 4.

4. If all occupants hold a recognised pilot qualification, an active carbon monoxide detector is not required, but is nevertheless highly recommended. Recognised pilot qualifications include any ICAO-compliant pilot licence as well as any of the following sub-ICAO licences/certificates:

   (a) National Private Pilot Licence (NPPL) with any rating

   (b) Light Aircraft Pilot Licence (LAPL) for any category

   (c) Private Pilot Licence (Gyroplanes)

   (d) British Gliding Association (BGA) Gliding Certificate with at least a Solo Endorsement

Responding to an Alert

5. CO alerts may occur on the ground or in the air. In the event of an alert while on the ground, pilots should:

   (a) Turn off the cabin heat supply and maximise fresh air entry into the cabin.

   (b) If the alert does not clear prior to takeoff, do not take off with the alert.

   (c) Inform the Air Traffic Service of the issue, taxi back to the parking area or apron and shut down the engine.

   (d) Seek medical attention if experiencing CO poisoning symptoms (e.g. headache, dizziness, nausea).

   (e) Ensure the problem is identified and rectified before further flight.

   (f) Report the occurrence to the CAA using the Mandatory Occurrence Report (MOR) scheme.

6. In the event of an in-flight CO alert, pilots should:

   (a) Keep flying the aircraft - the alert will likely come as a surprise to the pilot and could be a distraction, particularly at critical phases of flight.

   (b) Turn off the cabin heat supply and maximise fresh air entry into the cabin – this will normally be by use of fresh air vents rather than opening a window.

   (c) Make a PAN or MAYDAY call if appropriate (e.g. high CO reading or experiencing CO poisoning symptoms).

   (d) Land as soon as possible – don't wait for things to get worse. Consider that the nearest airfield may not be the intended destination; return to the departure airfield if that is closer. A precautionary landing (off-aerodrome) may need to be considered in the event of a persistent high CO reading or if experiencing CO poisoning symptoms.

   (e) Seek medical attention on the ground if experiencing CO poisoning symptoms (e.g. headache, dizziness, nausea)

   (f) Ensure the problem is identified and rectified before further flight.

   (g) Report the occurrence to the CAA using the Mandatory Occurrence Report (MOR) scheme.

Definitions

7. In this Directive:

   (a) 'aerobatic manoeuvres' has the same meaning as in Schedule 1 of the Air Navigation Order (ANO) 2016, as amended, and means loops, spins, rolls, bunts, stall turns, inverted flying and any other similar manoeuvre intentionally performed by an aircraft involving—

   (i) an abrupt change in its attitude;

   (ii) an abnormal attitude; or

   (iii) an abnormal variation in speed,

   not necessary for normal flight or for instruction for licences or ratings other than aerobatic rating.

   (b) 'Safety Standards Acknowledgement and Consent (SSAC)' operations are flights conducted in accordance with CAP 1395.

Revocation and Commencement

8. This Directive comes into force on **01 January 2025** and will remain in force until revoked by the CAA.