General Aviation Unit

UK Civil Aviation Authority

Consultation: Carbon Monoxide in Piston Engine Aircraft

CAP 2975

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Contents

Chapter 1

Introduction

1.1 Carbon monoxide (CO) poisoning has been cited as a causal factor in multiple general aviation (GA) accidents globally. A 2020 Air Accidents Investigation Branch (AAIB) review of UK accidents and incidents since 2000 identified two fatal accidents, each with two fatalities, and fifteen other events where CO may have been a causal factor. Since that review, there has been one additional non-fatal accident where CO poisoning was cited as the likely cause.

1.2 The potential deadly consequences of carbon monoxide exposure have been highlighted by the AAIB in several accident reports, most notably following the 2019 fatal accident involving N264DB[1]. The CAA received a safety recommendation in the final report for that accident recommending piston engine aircraft be required to have a CO detector with an active warning to alert pilots to the presence of elevated CO levels.

1.3 As a result, the CAA has been actively engaged on the topic of carbon monoxide (CO) in general aviation (GA) over the last three years and has undertaken multiple initiatives to raise GA pilot awareness of CO as well as the various prevention and protection measures that can be taken. Additionally, the CAA has sought to understand if modern domestic CO detectors with alerting capability could provide a low-cost effective solution for GA aircraft. The main initiatives undertaken include:

- Webpage dedicated to CO in GA
- Safety Notice SN-2020/003
- Two podcasts
- Clued Up article
- Two GA pilot surveys (Results)
- Leaflet with information on popular active CO detectors
- 12-month in-depth study of active CO detectors in GA aircraft (Report)

1.4 The CAA is keen to get the views of stakeholders on the themes and questions outlined in Chapter 3.

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

Chapter 2

How to respond and next steps

How to respond

2.1 Any enquiries regarding this consultation should be submitted via email to gaconsultations@caa.co.uk.

Next steps

2.2 We will review all the comments received following the closure of this consultation and will issue a Comment Response Document (CRD) summarising the consultation findings.

Chapter 3

Consultation themes and questions

Background

3.1 Carbon monoxide is a highly poisonous colourless, odourless, and tasteless gas produced by the incomplete combustion of fuel. When inhaled, it inhibits the blood's ability to carry oxygen around the body, causing damage to vital organs. Susceptibility to CO poisoning increases with altitude due to the lower quantity of oxygen in the atmosphere.

3.2 Mild CO poisoning may only be indicated by a slight headache and can be mistakenly dismissed as something less severe. Further exposure will cause worsening symptoms and may include a bad headache, increased respiration, dizziness, drowsiness, impaired judgement, difficulty breathing, blurred vision, and nausea. Continued exposure to elevated concentrations can cause unconsciousness and death.

3.3 AAIB Safety Recommendation 2020-008 was issued to the CAA following the 2019 fatal accident involving N264DB, and states:

"It is recommended that the Civil Aviation Authority require piston engine aircraft which may have a risk of carbon monoxide poisoning to have a CO detector with an active warning to alert pilots to the presence of elevated levels of carbon monoxide."

3.4 The insidious nature of carbon monoxide makes it very difficult to detect unaided. CO detectors that provide audible and/or visible warnings in the presence of elevated carbon monoxide levels are a highly effective means of alerting a CO threat. These devices are referred to as 'active CO detectors' and are different from passive detectors ('spot type' devices that change colour in the presence of CO) that lack any attention-getting capability.

Opening questions

Question 1

To what extent do you agree that existing measures and guidance are sufficient to address the threat posed by carbon monoxide (CO) in piston engine aircraft?

Agree, existing measures and guidance are sufficient to address the CO risk

Partially agree, existing measures and guidance could be improved

Disagree, existing measures and guidance are insufficient

Unsure

Question 2

Considering the risks posed by CO in piston engine aircraft and the availability of affordable active CO detectors, are there any circumstances where an active CO detector ought to be mandatory?

Yes, for piston engine aircraft (excluding open-cockpit).

Yes, for piston engine aircraft (excluding open-cockpit) operating recreationally or commercially with passengers.

Yes, for piston engine aircraft (excluding open-cockpit) operating commercially with passengers.

No, an active CO detector should never be mandatory.

Other (please specify)

Theme 1 – Active CO detectors

3.5 The best way to prevent CO poisoning in piston engine aircraft is to avoid exposure by adhering to a thorough and regular maintenance programme. However, preventative maintenance is not perfect, therefore having an effective means of detecting and alerting CO presence in piston engine aircraft is vital. This can be achieved by flying with an active CO detector.

3.6 Active CO detectors broadly fall into two categories as follows:

Commercial off the shelf – There is a wide range of competitively priced (around £20) commercially available active CO detectors designed for domestic use. Although these devices are not intended for use in aircraft, findings from the CAA 12-month study suggest that they can function reasonably well at typical GA altitudes (up to 5,000 ft). Opting for a device that meets a commercial standard (e.g. EN 50291-2) can result in improved durability and reliability. With sensor lives of up to 7 years and battery lives up to 10 years, these devices can be very cost-effective. Additionally, active CO detectors designed for industrial applications are also available. These devices often cost more (typically starting at around £100), but tend to be more accurate and durable.

Aviation standard – These devices are approved for aircraft use in accordance with a recognised aviation standard (e.g. EASA ETSO-2C48a). They tend to be costly, 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.

3.7 Findings from the CAA 12-month study of active CO detectors included multiple reports of pilots being alerted by their detector to an engine and/or exhaust system fault. Active CO detectors were also used by some pilots in the study to help identify pathways for CO to enter the cabin e.g. worn seals, gaps, etc.

Questions

Question 3

In your opinion what are the biggest barriers facing pilots/owners when it comes to getting an active CO detector for their piston engine aircraft? Select all that apply.

Cost

Selecting an active carbon monoxide detector

Deciding where to position and/or how to securely mount an active carbon monoxide detector in an aircraft

Knowing how to respond to alerts from the active carbon monoxide detector

There are no significant barriers

Question 4

Recognising the wide range of active carbon monoxide detectors available, how confident are you of finding a device that suits your needs and budget?

Very confident

Somewhat confident

Not confident

Unsure

Theme 2 – Piston engine aircraft maintenance

3.8 Many piston engine aircraft utilise a heat exchanger to provide cabin heat by taking advantage of the hot air flowing through the exhaust system. In normal operation the exhaust gas and cabin air are kept separate, but in the event of a failure of the exhaust manifold (e.g. cracks) exhaust gas (typically containing between 5% - 7% CO) can escape and enter the cabin via the heater vents. Changes/modifications to the configuration of the exhaust system have been shown to notably affect the amount of CO entering the cockpit. CO poisoning incidents tend to be more prevalent in colder months when cabin heater use is high. Additionally, exhaust systems with higher operating hours are also more likely to be affected.

3.9 CO has also been known to enter occupied areas due to poor sealing of the bulkhead between the engine compartment and the cabin, as well as via poorly fitting cabin doors/windows, access panels/hatches, and fairings which can allow exhaust gas flowing along the outside of the aircraft to enter.

3.10 Initial airworthiness requirements for UK Part 21 and UK non-Part 21 GA aircraft ensure newly built aircraft are sufficiently safe with respect to CO by stipulating that CO concentration does not exceed 50 parts per million. Adherence to a

thorough and regular maintenance programme is key to minimising the risk of CO exposure throughout the life of the aircraft. There are currently no mandatory requirements in this regard.

3.11 UK Reg (EU) No. 1321/2014 Annex Vb (Part-ML) AMC1 ML.A.302(d) includes a CO concentration check in the Minimum Inspection Programme (MIP) for UK Part 21 aircraft, but not all Part 21 aircraft are maintained in accordance with the MIP. There is no equivalent CO concentration check for non-Part 21 aircraft.

Questions

Question 5

To what extent do you agree that CO concentration checks ought to be a mandatory maintenance requirement for piston engine aircraft?

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

Question 6

Recognising that an effective CO protection strategy involves both preventative maintenance and detection, to what extent would a requirement to have an active CO detector discourage you from also performing preventative maintenance (e.g. CO concentration checks)?

Not at all – both preventative maintenance and an active CO detector are necessary for an effective CO protection strategy.

Somewhat discouraged – I might rely more on the active CO detector, but would consider preventative maintenance (e.g. CO concentration checks) as an additional protection measure.

Completely discouraged – I do not see the need for additional maintenance tasks to prevent CO if carrying an active CO detector is required.

Unsure

Theme 3 – Passenger protection

3.12 The CAA considers the protection of passengers to be paramount and is committed to prioritising passenger safety. The 2019 fatal accident of N264DB highlighted the dangers associated with CO in piston engine aircraft operations involving passengers.

3.13 In assessing risk, both the probability and severity of an occurrence are considered. Whilst the probability of a CO occurrence remains constant regardless of the number of people onboard, the severity, and therefore overall risk, of an occurrence increases with the number of people onboard. Furthermore, unlike GA pilots, passengers likely lack awareness of the risks associated with CO in piston engine aircraft, particularly if they do not hold a pilot qualification. The CAA intends to address this risk.

3.14 Active CO detectors have an important role to play in enhancing the safety of piston engine aircraft operations for all involved. This is especially important for operations involving passengers, who may fly in these aircraft on a commercial or recreational basis.

Questions

Question 7

Recognising that passengers in piston engine aircraft may not be aware of the risks associated with CO, to what extent do you agree that passenger protection from CO ought to be prioritised?

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

Question 8

To what extent do you agree that an active carbon monoxide detector, capable of alerting pilots via aural and/or visual warnings, should be required for piston engine aircraft operations involving passengers who may not be aware of the risk posed by carbon monoxide?

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

Theme 4 – Example active CO detector requirement

3.15 The CAA 12-month study of active CO detectors confirmed that although GA accidents where CO is a causal factor are relatively rare, the risk of CO exposure nevertheless remains a persistent background threat in piston engine aircraft operations.

3.16 Whilst many GA pilots may understand the risk posed by CO, the same cannot be said for passengers, who are not also qualified pilots, yet may fly in piston engine aircraft commercially or recreationally; the 2019 fatal accident involving N264DB made this clear.

3.17 Advances in detection technology have resulted in CO detectors with alerting capability being more widely available, reliable, and relatively inexpensive. Given this and recognising that CO is almost impossible to detect unaided, the CAA considers that active CO detectors are crucial role to combat CO in piston engine aircraft.

3.18 Notwithstanding the importance of detection, prevention is always better than cure and for this reason, the importance of preventative maintenance cannot be understated as part of an effective CO protection strategy.

Questions

Question 9

If the CAA introduced the requirement below, to what extent do you agree that it is proportionate given the risks posed by carbon monoxide in piston engine aircraft and the CAA's priority to protect passengers?

With the exception of single-seat aircraft and open-cockpit aircraft, all piston engine: aeroplanes, microlights, helicopters, gyroplanes, and motor gliders operating in the UK (including foreign registered aircraft) 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 possess a recognised pilot qualification**.

*Consider both aviation standard and commercial off the shelf active CO detectors to be acceptable.

** Recognised pilot qualifications include any ICAO-compliant pilot licence as well as the following sub-ICAO licences: NPPL, LAPL, PPL (Gyroplane), BGA gliding certificate with at least solo endorsement.

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

Note: The next question (Q10) provides an opportunity for you to make free-text comments in relation to this consultation so if you have any comments regarding this question, please include them there.

Question 10

If you have any comments in relation to this consultation, please detail them below.