UK Civil Aviation Authority

Comment Response Document:

Carbon Monoxide in Piston Engine Aircraft

CAP 3024

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Summary

1.1 CAP 2975 (Consultation: Carbon Monoxide in Piston Engine Aircraft) was published in February 2024 and sought stakeholder views on the challenges facing pilots in obtaining an active carbon monoxide (CO) detector, the importance of protecting passengers from CO, the role that maintenance plays in combatting CO, and whether active CO detectors ought to be mandatory for some operations. The consultation included nine specific technical questions as well as an opportunity for respondents to provide free-text comments. The consultation was managed via an online platform; respondents could also submit additional comments via email.

1.2 The CAA received a total of 271 responses to the four-week consultation and each response was considered individually.

1.3 This Comment Response Document summarises the responses received from the consultation and sets out the decisions taken as a result as well as the next steps.

Chapter 2

Consultation Questions and Responses

2.1 This section presents a summary of the responses received for each of the nine technical multiple choice questions asked in the consultation. A breakdown of the responses to each question is presented in the tables below and includes the total number of responses each answer option received (expressed also as a percentage of the total number of people who answered the question). Not all respodents answered all questions; a count of how many respondents answered each question is included below the tables.

2.2 The consultation question numbering presented below and used throughout this document follows CAP 2975, and is different to the question numbering of the actual consultation, which included four initial information gathering questions for data processing purposes.

2.3 **Q1. 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?**

Answer choices	Total	Percent
Agree, existing measures and guidance are sufficient to address the CO risk	58	21.56%
Partially agree, existing measures and guidance could be improved	138	51.30%
Disagree, existing measures and guidance are insufficient	54	20.07%
Unsure	19	7.06%

Answered by: 269/271

2.4 **Q2. 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?**

Answer choices	Total	Percent
Yes, for piston engine aircraft (excluding open-cockpit).	115	42.59%
Yes, for piston engine aircraft (excluding open-cockpit) operating recreationally or commercially with passengers.	47	17.41%
Yes, for piston engine aircraft (excluding open-cockpit) operating commercially with passengers.	62	22.96%
No, an active CO detector should never be mandatory.	29	10.74%
Other (please specify)	17	6.30%

Answered by: 270/271

2.3.1 Respondents were able to provide free-text comments when answering this question; a total of 36 such comments were received. An anonymised representative summary of the comments received is included in the table below. Some respondents requested that their comment not be published and therefore these comments do not appear in the table below, but were considered by the CAA.

Comments

". . . I would urge anyone who flies to get a portable, active, electronic CO monitor, take it with them whenever they fly, and remember to test it in their pre-flight checks. We should all do this regardless of the type we fly, and regardless of engine type (even turbines can produce noxious gases in certain circumstances, so nobody is risk-free). I regularly teach and examine in many school aircraft, none of which have active CO monitors, so I always take my own, and make a point of testing it in front of my student in the pre-flight.

These active CO monitors can be bought for £10 for a cheap one, £20 for a decent one. Are we seriously saying people who fly or own an aircraft can't reasonably be asked to spend afford £20 to save their life? Really? We routinely mandate effective mitigation of far lower risks at higher cost, so I find it truly extraordinary that we don't mandate this highly cost effective mitigation of a known, significant risk to life. This is a real anachronism, and it's high time the regulations caught up."

". . . Recommending a range of suitable ones might assist take up especially if backed up by a campaign to offset some of the cost (as used for the SkyEcho conspicuity campaign). Ensuring these are used as part of pilot training would also help integrate their use into the thought patterns for the future pilot."

"I am not much in favor of rules and laws. With common sense and proper explanation every sensible pilot / aircraft owner is able to do the right thing. If aviation regulation are allowing active CO monitors used in homes, there is no great barrier not to install a CO monitor (you buy one for 20 pounds or so)"

"Yes, for any piston engine aircraft (excluding open cockpit) that is fitted with an exhaust/air heat exchanger for cabin heating."

"There should be no mandatory requirement for private GA aircraft, the occurrence rate of severe CO problems is very low and doesn't justify it. If it was mandatory then it would no doubt have to be an approved type of detector that would be very expensive, rather then people now able to use a device that is of reasonable cost £20-30. Maybe there should be a requirement for commercial operations, particularly for aircraft equipped with separate heaters."

"Carriage should be 'Strongly Advised'"

"Yes and no, it depends how it functions, we have one of the stickers that changes colour in our aircraft, however how many times do I check it whilst in flight, no many, but I do carry an electronic monitor that alarms when a "unsafe" level is measured. The benefit of this is its not another thing to take you away from flying the aircraft including looking out the cockpit."

“Yes, for piston engine aircraft (excluding open-cockpit) operating commercially with passengers. BUT It needs to be made easy to install without paperwork and without an approvals process.”

“Generally I agree with the statement: ‘Yes, for piston engine aircraft (excluding open-cockpit).’

However, there may be some additional aircraft that this is not practical to mandate an electronic CO detector, such as: Small aircraft with small cockpit size / ergonomics. Aircraft used for aerobatics where securing electronic detector may be difficult and could cause a "loose article" hazard. Classic / vintage aircraft used for display flying. Aircraft that have no cockpit / cabin heater systems, so very unlikely for a CO leak to significantly penetrate the cockpit / aircraft cabin. Sailplanes with piston engines that are only used for self-launch or sustaining flight as the engine is only used for a few minutes at a time. (TMGs should be included).”

“Yes, for piston engine aircraft (excluding open-cockpit) operating recreationally or commercially with passengers other than self-launching and self-sustainer sailplanes where the piston engine is mounted on a pylon. These self-launching and self-sustainer sailplanes use their small piston engines, which with their exhausts are on pylons mounted on the fuselage behind the wings, either take-off or fly level for a short period before closing down the engine and retracting the pylon and engine. There is no connection to the cockpit (no heater) other than an electrical loom and/or a mechanical linkage and a fuel on/off selector. Requiring these aircraft operators to use a CO detector would be nonsensical.”

“For commercially-operated (and private hire) aircraft, with the cost borne by the operator, not the user. I take issue with your term "affordable", as CO monitors are perceived as useful, but something that can be done without (regardless of the objective reality) and thus yet another expense related to aviation that can be avoided.”

“Yes provided there is no restriction of make or model of the active CO detector”

“There are some piston engine aircraft where the risk of CO poisoning is zero by virtue of the design of the cabin heating circuit. Continental diesel engine installations fall into this category. The requirement for a CO detector should, therefore, be dependant on the type of engine installation as well as whether or not the cockpit is enclosed.”

“All planes in the "hire market" should be obliged to fit them, ie club planes for both instructor and self hire. Clubs don't appreciate you wedging things on the dashboard to scratch the perpex or fall under the rudder pedals.”

“Yes, for piston engine aircraft (with some exemptions: open-cockpit, aerobatics, ab-initio solo flights”

“Also should exclude rear engine and wing engine mounted aircraft unless exhaust is ducted to the cabin.”

"I would like this to be extended to cover all aircraft that are used for instruction by flying schools or rented out commercially but dont believe it needs to include privately owned and operated aircraft"

2.5 Q3. 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.

Answer choices	Total	Percent
Cost	53	19.63%
Selecting an active carbon monoxide detector	129	47.78%
Deciding where to position and/or how to securely mount an active carbon monoxide detector in an aircraft	138	51.11%
Knowing how to respond to alerts from the active carbon monoxide detector	64	23.70%
There are no significant barriers	84	31.11%

Answered by: 270/271

*Respondents were able to select multiple answers for this question, therefore the total number of responses to this question (468) exceeds the number of people who responded to the question (270).

**The percentage column does not sum to 100% because they are calculated as a proportion of the total number of people who responded to the question (270) rather than the total responses to the question (468).

2.6 Q4. Recognising the wide range of active carbon monoxide detectors available, how confident are you of finding a device that suits your needs and budget?

Answer choices	Total	Percent
Very confident	124	45.76%
Somewhat confident	97	35.79%
Not confident	42	15.50%
Unsure	8	2.95%

Answered by: 271/271

2.7 Q5. To what extent do you agree that CO concentration checks ought to be a mandatory maintenance requirement for piston engine aircraft?

Answer choices	Total	Percent
Strongly agree	100	36.90%
Agree	76	28.04%
Neither agree or disagree	41	15.13%
Disagree	37	13.65%
Strongly disagree	17	6.27%

Answered by: 271/271

2.8 **Q6. 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)?**

Answer choices	Total	Percent
Not at all – both preventative maintenance and an active CO detector are necessary for an effective CO protection strategy.	175	64.58%
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.	48	17.71%
Completely discouraged – I do not see the need for additional maintenance tasks to prevent CO if carrying an active CO detector is required.	30	11.07%
Unsure	18	6.64%

Answered by: 271/271

2.9 **Q7. 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?**

Answer choices	Total	Percent
Strongly agree	97	35.79%
Agree	89	32.84%
Neither agree or disagree	58	21.40%
Disagree	20	7.38%
Strongly disagree	7	2.58%

Answered by: 271/271

2.10 **Q8. 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?**

Answer choices	Total	Percent
Strongly agree	112	41.33%
Agree	98	36.16%
Neither agree or disagree	36	13.28%
Disagree	18	6.64%
Strongly disagree	7	2.58%

Answered by: 271/271

2.11 **Q9. 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.

Answer choices	Total	Percent
Strongly agree	83	30.74%
Agree	100	37.04%
Neither agree or disagree	27	10.00%
Disagree	35	12.96%
Strongly disagree	25	9.26%

Answered by: 270/271

Chapter 3

Comments and Responses

3.1 The final question of the consultation included an opportunity for respondents to submit free-text comments and a total of 150 such comments were received. The CAA considered each comment individually and this section presents a summary of the issues raised. Comments have been grouped into six themes that emerged, as shown in the table below, with many of the comments fitting into more than one theme.

Themes	Number of related comments
Support for an active CO detector requirement	31
Confusion over why pilot-only operations are excluded from the active CO detector requirement as worded in the consultation (Q9)	28
Against introducing a requirement to have an active CO detector	27
Suggested changes to the active CO detector requirement as worded in the consultation (Q9)	21
Mandatory CO concentration checks (Maintenance)	9
Requests for additional guidance	14

3.2 The tables in each of the following sub-paragraphs contain a representative subset of the substantive comments received for each of the six aforementioned themes. Identifying information has been removed to preserve anonymity and comments are only published where permission has been given. A CAA response is provided for each theme to address the main points raised in the comments.

3.3 As noted in paragraph 2.2, the consultation question numbering in the consultation document (CAP 2975) differs to that of the online platform used to submit responses. This was due to the inclusion of four initial information gathering questions for data processing purposes. Where respondents have referred to specific question numbers in their comments, the number will be different by four e.g. Q13 in a comment is Q9 in CAP 2975.

3.4 **Theme 1: Support for an active CO detector requirement**

Example Comments:

“I have a Forensics CO detector fitted to my panel. I think anyone who wishes to carry a passenger should have one fitted. They are inexpensive and easily obtained.”

“Existing off the shelf detectors are not expensive. Since carbon monoxide is so deadly and not obvious why would you not want to protect yourself and your passengers?”

“CO is very dangerous but is relatively cheap to detect. There seems to be no good reason not to require the presence of an active CO detector when non-pilot passengers are being carried.”

“Why is it taking so long to mandate a solution. Acceptable domestic CO detectors are readily available for around £20.”

“It seems reasonable to require an active CO detector provided that the definition of the type required is reasonably broad, i.e. easily commercially available (not aviation certified which would drive up cost and complexity).”

“In my opinion, all possible measures should be taken to protect against carbon monoxide being an issue. I am newly qualified holder of a PPL, and as I intend to take family and friends flying, I have purchased an off the shelf detector. My earlier selection about the cost of a detector was base on my obtaining a battery detector, with alarm and light indicators through Amazon, at a cost of £10.99. as a caravan owner, I have found such alarms to be most helpful. What would concern me would be the cost if the requirement was to fit such an alarm as sold by aviation specialists; buying one through such outlets is more costly. Personally, I don't like the round disc seen in aircraft, and consider something more visually and practically effective should be used. I feel that I should also point out that having being trained through a school, and not owning my own aircraft, I will be hiring as I fly. That's another reason why I have bought, and consider such a device essential; my aircraft will not be as well known to me as if I owned it.”

“Our CO detector normally reads zero in flight if the exhaust system is sound. We have had two occasions where a positive indication indicated cracks in the exhaust. These were not initially seen on inspection. However the positive readings led us to more detailed inspections which identified cracks. Without the active CO monitor we would flown with elevated CO levels for some time.”

“I'm a flying instructor working at several flying schools. Some have not always provided a simple and cheap CO detector. It is only by refusing to fly the aircraft they have then fitted one. And it's probably only because there is now a shortage of instructors that this refual to fly has happened. I incorporate thecCO detector check into the pre-landing and cruise check. I think they have to be mandatory for piston engine aircraft.”

“I use an active CO detector. Last year, it probably saved my life. Unknown to me, an exhaust component had failed with no visible or other sign of failure. The CO detector sounded an alarm. I landed and had the aircraft inspected. Initial visual inspection showed no apparent problem, but a closer inspection revealed the exhaust failure - which would not have been undertaken without the indication on the monitor. The relative modest cost of a good detector is low compared to other mandatory life-saving equipment on an aircraft. I selected the unit after reading a review of detectors in one of the flying magazines. Checking the unit is on, with battery levels OK, is part of our start-up checklist now.”

“Our CO detector normally reads zero in flight if the exhaust system is sound. We have had two occasions where a positive indication indicated cracks in the exhaust. These were not initially seen on inspection. However the positive readings led us to more detailed inspections which identified cracks. Without the active CO monitor we would flown with elevated CO levels for some time.”

CAA Response:

Over 77% of respondents to Q8 of the consultation supported the idea of introducing a requirement to have an active CO detector for piston engine aircraft operations involving passengers who are not expected to be aware of the risk posed by CO. Additionally, over 67% of respondents to Q9 of the consultation selected either 'strongly agree' or 'agree' with the proposed requirement for affected piston engine aircraft to have an active CO detector when operating with passengers on board who do not possess a recognised pilot qualification. A significant number of comments were supportive of the proposal, recognising the importance of prioritising passenger protection. The CAA also sought to be proportionate with the proposal set out in Q9 of the consultation by allowing pilots to decide for themselves what level of CO protection to have when flying alone or with other qualified pilots.

Several comments described occasions where pilots were alerted to a fault with their exhaust as a result of carrying an active CO detector, potentially saving lives. By sharing these valuable lessons pilots are helping each other to be aware of the risk posed by CO as well as how to effectively protect themselves from it.

Many comments recognised the fact that there is a wide range of inexpensive commercial off the shelf electronic CO detectors available and as long as such devices are accepted by the CAA, compliance with the proposed requirement set out in Q9 of the consultation ought to be straightforward.

3.5 **Theme 2: Confusion over why pilot-only operations are excluded from the active CO detector requirement as worded in the consultation (Q9)**

Example Comments:

"I think it should be mandatory for all planes regardless of whether there are passengers who have a pilot license or not, including single seat aircraft or aircraft that are capable of carrying passengers but don't."

"The proposal at 13 should be stronger, an active CO detector sould be a requirement in all piston powered aeroplanes except open cockpit aeroplanes."

"In the example draft regulation - why is there a differentiation between a passenger's need for protection and that of a licence holder? Surely we all face the same risk."

"Due to the low cost, easy availability, simple technology, and ease of fitting, I see no reason why all piston engined aircraft should not be fitted with a CO detector."

"The pilot is as important as any passenger! An active CO detector I feel should be required but the make/model should NOT be specified as the generally available models which are not aviation specific perform perfectly well at an affordable price. Also I feel CO detectors should be carried in single seaters including open cockpits."

"I feel that single seat aircraft should also be included. Persons on the ground should also be protected."

"I think that you are missing the point, any non open cockpit aircraft be it single or multiple occupancy should be treated the same, if the pilot is affected by CO to the point where they are unable to fly, there is a high risk of crashing which and both pilot, other occupants and whatever they hit being affected. It's a simple decision, should closed cockpit aircraft of whatever type have an active CO monitor with audible / visual alarm, and that answer has to be yes."

"The above mandate set out at Q13 does not go far enough. It obligates the carrying of active CO detection only when non-pilot pax are onboard. Globally there have been numerous CO incidents when only qualified pilots are onboard; and given the amount of time the UK GA fleet spends flying in this condition, the protection should be mandated at all times, not just when pax are onboard. The modest cost and the significant safety benefit the brings is surely a 'no-brainer'."

CAA Response:

Although over 67% of respondents supported the proposal set out in Q9 of the consultation there were 28 comments expressing confusion over why pilot-only operations were excluded from the proposed requirement. Additionally, some highlighted the fact that the safety of the aircraft is dependent on the pilot and therefore CO protection measures ought to prioritise pilot safety.

The CAA strongly encourages all pilots of affected piston engine aircraft fly with an active CO detector as CO does not discriminate based on who is in the aircraft. The CAA also acknowledges that the safety of the aircraft, those onboard as well as on the ground, is directly related to the wellbeing of the pilot. However, in developing the proposal set out in Q9 of the consultation the CAA sought to strike a balance between safety and proportionality.

Additionally, by requiring that a functioning active CO detector be present when flying with passengers who are not also qualified pilots, the CAA believes this could increase the uptake of these devices across other types of operation, including pilot-only flights, as pilots will become accustomed to flying with an active CO detector and may have the device fixed in their aircraft.

3.6 **Theme 3: Against introducing a requirement to have an active CO detector**

Example Comments:

"I support education programmes to encourage use of active detectors, but believe that driving the right culture by winning hearts and minds (i.e. a culture where people "get it" that its a good thing to do) is preferable to mandating this as a legal requirement (given legal requirements are usually just seen as necessary evils to be met to the minimum standard). Also, the moment you try and write it into a legal requirement, you are going to get drawn into all kinds of legalistic issues about what a suitable detector is - which might be more of a grey area when it comes to off the shelf products available from mainstream hardware stores. So, you end up specifying standards that undermine the concept that "a standard household detector will be OK".

“The questions are posed towards a presumption that possible CO poisoning is a serious threat in the GA fleet and thus fitting an active CO detector should be made mandatory for all GA aircraft. However there is no evidence presented which suggests that a significant number of GA aircraft have been found with CO leaks and proper maintenance would normally catch incipient problems which could lead to CO leaks. I have fitted an active CO detector in my aircraft; I would encourage others to do so and possibly mandatory action may be desirable for commercial passenger operations but am not presently persuaded that mandatory action is appropriate for all GA ops. If EASA, who regulate a much bigger GA sector than in the UK, were to decide on mandatory action, then my view may change.”

“My preference is more promotion of awareness of the hazard of CO leakage into cockpits, rather than regulation. I think CAA has done a good job of generating awareness of CO hazard in light aircraft in couple of years. This campaign resulted in myself electing to purchase and install a CO detector in my aircraft, and to pay attention to sealing potential firewall ingress between engine compartment and cockpit.”

“The cost and regulation for piston aircraft is already extremely prohibitive. Given the relative rarity of CO incidents it should be the choice of the pilot to make decisions about carrying detectors.”

“Until such time as a reasonably priced and aviation specific CO detector design is available (i.e not at £500-£1000), this should not be a mandatory requirement - most of the devices available at a lower price point (and many used by GA pilots) are intended for household use and not suitable for GA operations. There is also considerable misunderstanding relating to correct siting of the device and (non-significant) CO alerts created by ground idling etc.”

“I can't see that the case has been made. My experience is mostly with a chemical detector that changes colour. Simple. Is the CAA saying that these are not effective? Is there anything to show, 1. How many aircraft have no CO detection, 2. How many aircraft have some form of CO detection, 3. how many CO incidents there are every year. 4. how many incidents occurred in an aircraft with some CO detection. Without facts, what would be the justification for adding to the burden of ownership. If there isn't a reasoned argument then such an initiative would give an impression of regulation for regulation sake.”

“I have experience of an aircraft that had been crashed because the pilot incorrectly perceived a risk of CO. This is not the first case I am aware of. I have used active CO detectors for years and not trusted spot detectors however I would not recommend it to everyone. Some aircraft will alarm during certain manoeuvres where brief encounters with exhaust gasses are to be expected (R44 Start up for instance) This can be distracting. A faulty detector or battery can cause an alarm, the resulting emergency action could more risk than the perceived danger. There needs to be data driven change from pilots with experience of these systems not just pilots points of view. Denney Kitfox Mk 3, G-BUDR, 24 September 1993 - GOV.UK (www.gov.uk)”

"This is an example of a proposed gold plated regulation. A better way of doing this would be to issue strong guidance and training materials including examples of accidents that could have been prevented with a CO detector. Another idea would be to make it an item for noting at the annual maintenance check. This is to say that the engineer would have to notify the operator if a CO detector is not present in the aircraft as a warning."

CAA Response:

Approximately 10% of respondents to Q8 of the consultation disagreed with introducing a requirement to have an active CO detector for piston engine aircraft operations involving passengers. Additionally, approximately 22% of respondents disagreed with the proposed requirement set out in Q9 of the consultation. There were 27 comments submitted covering a range of concerns associated with introducing a requirement to have an active CO detector for specified piston engine aircraft operations.

One of the concerns raised is the perception that introducing a requirement to have an active CO detector may result in the need for a detector specification to be issued, which could limit choice and drive up cost. The CAA recognises that the wide range of commercial off the shelf electronic CO detectors available and their relative low cost are important factors that make the adoption of these devices possible and therefore must be present. The CAA does not intend to introduce a CO detector specification, but will instead issue guidance to help inform pilots when it comes to selecting an active CO detector. It is not therefore expected that a requirement to have an active CO detector would limit pilot choice or increase cost.

Although the CAA recognises that overall cost associated with GA is an issue for many pilots, by allowing commercial off the shelf electronic CO detectors to be used, the CAA does not consider cost to be a significant factor when it comes to active CO detectors. A wide range of commercial off the shelf devices are available for less than £50 and have sensor/battery lives lasting years.

Several comments highlighted a lack of statistical information regarding UK GA accidents/incidents due to CO. Since 2000, there have been 3 UK accidents (two of which were fatal) where CO was identified as the causal factor. This does not include the 2019 fatal accident involving N264DB, which occurred in international waters, but was investigated by the UK Air Accidents Investigation Branch (AAIB). Additionally, the AAIB final report for N264DB identified fifteen other 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. 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 the CAA believes there is likely an under-reporting issue at play, especially considering that those who do not have a CO detector will likely be unaware of a potential CO problem. The CAA does not have accurate data on the number of aircraft that currently have some form of CO detection.

Some commenters questioned how prevalent CO is in GA aircraft. In 2021 the CAA conducted a 12-month study of low-cost commercial off the shelf active CO detectors (CAP 2560). The study involved 98 participants and found that about 25% experienced at least one CO alert during the year. The CAA therefore considers CO to be a persistent background threat although it is acknowledged that the sample size for the 12-month study was relatively small, but this data represents the best estimate the CAA currently has with regards to CO prevalence in the UK GA fleet.

Several comments suggested that introducing a requirement to have an active CO detector for piston engine aircraft operations involving passengers who do not hold a pilot licence could be deemed as overregulation. The CAA does not share this view; the proposed requirement set out in Q9 of the consultation balances safety and proportionality, whilst prioritising the protection of passengers. Furthermore, recognising the insidious nature of CO and the fact that there is a wide range of affordable active CO detectors available, the CAA considers the proposal in Q9 of the consultation to be reasonable.

The aforementioned CAA 12-month study found commercial off the shelf active CO detectors to be a net safety benefit with very few reports of the devices themselves posing any safety risk (e.g. loose article hazard, distraction, etc.). Although, the CAA acknowledges that introducing a new piece of equipment comes with some risk, such issues could be largely overcome by selecting a suitable device and securing it appropriately; the CAA will look to address this with enhanced guidance material. One comment highlighted a 1993 accident where the pilot became aware of fumes in the cockpit (no CO detector was present) and decided to land ahead fearing carbon monoxide may be an issue; the aircraft sustained damage due to obstructions in its path. The CAA considers that had an active CO detector been present the pilot would have known whether or not CO was in fact present and potentially in what quantities, which would have helped with decision making.

3.7 **Theme 4: Suggested changes to the active CO detector mandate as worded in the consultation (Q9)**

Example Comments:

“Generally I agree with the statement:‘Yes, for piston engine aircraft (excluding open-cockpit).’However, there may be some additional aircraft that this is not practical to mandate an electronic CO detector, such as: Small aircraft with small cockpit size / ergonomics. Aircraft used for aerobatics where securing electronic detector may be difficult and could cause a "loose article" hazard. Classic / vintage aircraft used for display flying. Aircraft that have no cockpit / cabin heater systems, so very unlikely for a CO leak to significantly penetrate the cockpit / aircraft cabin. Sailplanes with piston engines that are only used for self-launch or sustaining flight as the engine is only used for a few minutes at a time. (TMGs should be included).”

“Re question 13 - aircraft without heaters are low risk and should not be required to have detectors. Off the shelf detectors should be allowed without gold plating the standards.”

“These rules should only apply to front engine piston engine aircraft.”

“Student pilots should not be considered “passengers” for the purposes of this mandate.”

“I believe the mandatory requirements should be limited to those aircraft operating commercially, and not be applied to those operating purely for recreational use, with or without passengers. Whilst this distinction is made in the early part of your survey it is not made in the latter questions, thus I have no choice but to disagree with your statements.

Additionally your survey does not distinguish as to where the power plant is mounted. The risk associated with a pylon mounted engine in a powered sailplane or a pusher mounted engine in a small aircraft is minimal and mandatory installation would represent excessive regulation.”

“when operating with any passengers on board who do not possess a recognised pilot qualification**. Is a very strange approach. Any mandate should follow existing, well understood and legally based protocols around commercial and non commercial operations (and potentially look at divisions around aerial work ie instruction/examination in a DTO or ATO if required)”

“Question 13 - we disagree only because the statement in the question does not recognise the significant difference with self-launching and sustainer sailplanes with pylon mounted engines. A Touring Motor Glider (the CAA-traditional image of a Self Launching Motor Glider) which has a fuselage mounted piston engine and, usually, a cabin heater, should be in scope.”

“Closed cockpit vintage and "war bird" aircraft should perhaps be exempted if the carbon monoxide sensor is incompatible with the visual appearance of the restored aircraft.”

“I believe the requirement as set out is disproportionate for privately owned and operated aircraft and is ridiculous for twins and pusher configurations. It is fair ONLY where people are paying to be passengers (commercial flights or experience flights not including cost sharing flights) or paying to use the aircraft for instruction or rental (this would not include paying an instructor to instruct in a privately owned and operated aircraft).”

“The best protection for passengers is to ensure that the pilot remains compos mentis and able to function fully. Ground crew also need to be protected due to the insidious nature of CO poisoning. Suggest amending the last 2 lines of the policy to read "is present in the aircraft at all times, including ground taxiing and testing by ground crew"

CAA Response:

The CAA is keen to ensure that any requirement to have an active CO detector does not inadvertently capture aircraft that do not have any risk of CO; the CAA will therefore review the requirement as set out in Q9 of the consultation to ensure this. Aircraft with engines mounted on the wings or behind the cockpit will be excluded unless they also use an exhaust heat exchanger to provide hot air to the cabin. The CAA acknowledges that aircraft with small, cramped cockpits pose a challenge with regards to finding space to position an active CO detector, however there are small devices available that can be kept close to the pilot e.g. clipped to clothing. Aerobatic aircraft pose a different challenge in terms of ensuring that loose items are secured and the applicability of the requirement as set out in Q9 of the consultation will be considered by the CAA.

Several commenters suggested that the requirement set out in Q9 of the consultation ought to only be applicable to commercial operations. The CAA considered this closely and determined that although some passengers may be more aware of the risk posed by CO, especially if they participate in recreational GA frequently, an expectation of awareness amongst passengers cannot be assumed. Therefore any requirement to have an active CO detector should also include non-commercial operations involving passengers who are not qualified pilots.

One comment suggested that consideration be given to excluding vintage and warbird aircraft if the active CO detector is incompatible with the visual appearance of the aircraft. The CAA disagrees as this prioritises aesthetics over safety. Additionally, many of these devices are portable and can be securely mounted when flying and then removed when on the ground for static display purposes, ensuring the original look of the aircraft is preserved.

3.8 **Theme 5: Mandatory CO concentration checks (Maintenance)**

Example Comments:

“Question 10: Existing maintenance checks are sufficient e.e. pressure testing.”

“Checks of CO levels at Annual should be mandatory.”

“Road vehicles are checked for carbon monoxide so why not aircraft? We live in 2024 not 1924!”

“I do not follow the idea of extra CO testing during maintenance enforced by law. The testing does not prevent any problem and does not change the design concept of the aircraft. Furhtermore many aircraft have in their maintenance instructions leak-test for the exhaust and heating system.”

“Question 10 identifies preventative maintenance as a concentration check. This approach to questioning is likely to erroneously slew your consultation data in favour of concentration checks. Most powered aircraft owners and engineers will be aware that other preventative maintenance takes place (eg leak checks) and will be supportive of that if not supportive of concentration checks (and associated maintenance equipage costs as well as actual added value).”

“I believe that maintenance checks on CO may be unhelpful and will result in many 'false positives'. Experience tells me that there are a number of aircraft in which exhaust gas ingress through air vents triggers a CO detector while stationary on the ground, but in which there is no CO ingress while taxi-ing or in flight.”

“CO risk while a known danger in flight cannot be absolutely eliminated as countermeasures are never foolproof - even in combination. Therefore, with consideration of risk mitigation, the key aspect is that the pilot is alerted on the occasion of a CO buildup in the cockpit. Mandated testing at maintenance is only really good on the day or shortly thereafter. An active sensor and alerting in the cockpit in the event of a detection is far more valuable to flight safety. The additional costs and paperwork for maintenance based

testing for CO is of more limited value and can not provide the necessary assurance on a flight-to-flight basis."

"Regarding my answers to questions 9 and 10: the extent of 'preventative maintenance' has to be defined; a leak in an exhaust system is relatively unlikely to occur very shortly before an annual check, so monitoring is more important than a specific detection test at that check; any check for CO at an annual maintenance visit has to be designed to be representative of flight conditions, otherwise the check will have little or no value."

"Q 10 doesnt allow me to give the answer I want. I already have a maintenance requirement to check my exhaust for cracks/ holes in the area used for the cabin heat heat exchanger, so I don't need any additional CO concentration test, particularly one that probably involves use of some expensive test equipment no readily available for most private aircraft owners. Whether I have a CO detector in the cockpit is irrelevant to the check I do."

CAA Response:

The consultation included two questions (Q5 and Q6) on preventative maintenance as it relates to CO, including the idea of introducing mandatory CO concentration checks for piston engine aircraft. Although the majority of respondents to Q9 expressed a preference for introducing such checks, there were multiple comments highlighting issues with such an approach.

Some respondents highlighted the fact that a satisfactory CO concentration check really only confirms that the aircraft does not have a CO issue at the time of the check, but does not provide assurance on a per flight basis. Considering that mandatory CO concentration checks could result in significant costs for aircraft owners, the benefits of mandating them may not justify the additional cost. It was also noted that the results of such a check are highly dependent on how the test was conducted e.g. what equipment was used, where the measurements were taken, conditions at the time of testing, etc. This would likely require a defined procedure for performing CO concentration checks. The CAA recognises that some aircraft manufacturers already include a CO concentration check as part of their instructions for continued airworthiness.

Notwithstanding the comments above, the CAA considers preventative maintenance to be an important part of an effective CO protection strategy. The CAA was encouraged to see that the majority of respondents (almost 65%) to Q6 of the consultation felt similarly. The CAA will continue to strongly encourage piston engine aircraft owners ensure that their aircraft exhaust and heating/ventilation systems are in good working condition and maintained in accordance with a thorough and regular maintenance programme. Maintenance can include physical inspection, inspection with partial dis-assembly, internal inspection, non-destructive testing (NDT) as well as pressure testing to ensure there are no leaks in the muffler/exhaust system. Consideration should also be given to performing scheduled CO concentration checks

3.9 **Theme 6: Requests for additional guidance**

Example Comments:

"I wish to clarify my answer at Q7; whilst I acknowledge that the CAA would wish to leave some decisions to the owner/operator, I think that many GA pilots would welcome more advice about which detectors, especially easily sourced domestic ones, are suitable for use. I think they would also welcome advice on the best areas to mount the detector and how."

"The exposure levels and duration of exposure should be thoroughly explained. CO monitors sound at a low threshold which poses no risk for short durations normally experienced in GA aircraft. The alarms can be distracting and misleading."

"Having tried several digital Carbon Monoxide detectors all of which failed prematurely I'm very cautious on this subject. My experience is that a typical detector fails permanently when the temperature of a cockpit exceeds the devices maximum safe operating temperature. Furthermore there is no fail flag on the devices to alert the unwary. So please don't advocate that aircraft should have them without training the pilot in how to safely install and operate. Otherwise you inadvertently create a greater problem."

"In my experience the only risk with CO detectors is with household detectors going off at very low concentration levels that are still safe for prolonged exposure. This can cause a huge distraction. So I would like to see the CAA include a CO ppm value for their alerts."

"Guidance on suitable models of CO detectors is needed, as many cheap household models might not be suitable for use in aircraft."

"Alongside making it compulsory for there to be one in the aircraft, training on their use and how to appropriately brief passengers and react to an CO alert should be provided by the CAA in the form of follow-up documentation and guides."

"Very difficult to find an active CO detector which is thoroughly reliable in light of the RF environment in small aircraft. CAA should look at testing active CO Detectors to find ones which are immune to interference."

CAA Response:

There were fourteen comments submitted calling for additional guidance to be published by the CAA on topics such as what to consider when selecting an appropriate active CO detector, where to position a CO detector in an aircraft, how to securely fit it, how to respond to alerts from the device, as well as guidance on exposure levels and thresholds for alarms.

The CAA has previously published information on all of the aforementioned topics, which can be found on the CAA's carbon monoxide webpage. Additional guidance covering these topics will be published in the near future.

3.10 Other questions and comments

3.10.1 Although most of the consultation comments were able to be grouped together into one of the above six themes, there were some comments that did not clearly fit into one of the themes, but nevertheless were noteworthy. The CAA therefore opted to capture a summary of these comments/questions below, and provide a response to each of them.

3.10.2 **Comment:** “I believe the visual alert is more significant than aural as headsets and cockpit noises generally may require greater technical understanding of how to adapt equipment to receive aural wanrings beyond the immediate simplicity that a visual alert gives. There are no additional barriers to operation and awareness this way. I would also then include ‘C’ in my FREDA(C) checks every 15 mins or so to attract my attention to the CO unit.”

CAA response: The CAA acknowledges that for some pilots the visual alert (e.g. flashing red light) that an active CO detector provides may be more significant than the aural alert, particularly if the aircraft environment is very noisy. However this won’t be the case for every pilot, especially those who have headsets capable of providing audio CO alerts. The CAA believes it is important that pilots are able to find a detector that best suits their needs with regards to alerting, for some the visual alert may be especially important whilst others may rely more on audio alerts. Incorporating a check of the CO detector into FREDA checks is also worthwhile, especially if hearing audio alerts is an issue.

3.10.3 **Comment:** “I think the main issue is the size of current carbon monoxide detectors, which are large and often there is not a clear location to position this in the cockpit of small aircraft. Making it visible to the pilot or passengers is difficult. Many have an audio alarm, but it is unlikely to the heard over the engine and when wearing headphones.”

CAA response: There is a wide and ever-increasing range of active CO detectors available and they come in variety of sizes. While some commercial off the shelf units can be bulky, there are smaller devices available e.g. those aimed at the leisure market (caravans, boating, etc). There is also an increasing trend for active CO detectors to be included in other aviation equipment such as ADS-B, headsets, etc, which will help overcome space issues. Although these devices are usually more expensive, if you are purchasing a new piece of equipment anyway, it may be worthwhile considering getting one with a built-in CO detector.

3.10.4 **Comment:** “Does "alerting via ... visual means" cover the "Black Spot" type detectors? Or is this something that would have a flashing light to draw attention? My personal thought is that it needs to be something "active" - ie sound or flashing light, and not just a darkening spot.”

CAA response: No, the colour change associated with ‘spot type’ CO detectors is not considered to be a visual alert as there is nothing to draw the pilot’s attention to it. Compliance with the requirement set out in Q9 of the consultation document (CAP 2975) would require an electronic CO detector with aural and/or visual alerting capability; these are often referred to as ‘active CO detectors’.

3.10.5 **Comment:** “Include single seat aircraft as well. It would be difficult to enforce visiting foreign aircraft. It would be more appropriate to include them as a recommendation. Recommend 10 year battery life detectors. Include flight manual supplement, it’s is most likely that pilots will not have the detector instructions to hand so as be to able to interpret the sounds or how to test. Include the detector in the SDMP for regular checks and replacement. Provide guidance on location and mounting CS-STAN?”

CAA response: It would be the CAA's intention to apply the requirement for having an active CO detector to visiting foreign aircraft as well; this aspect was included in the proposal set out in Q9 of the consultation document (CAP 2975). Although enforcement may be challenging the CAA considers the risk to be the same and it is therefore important to hold foreign registered aircraft to the same standard when operating in the UK.

It is recommended that pilots get to know their active CO detector and understand what the various alerts mean before using it in their aircraft to avoid surprises or the need to troubleshoot, which takes attention away from flying the aircraft. Pilots are also encouraged to check that their active CO detector is functioining before each flight, but also including a check of the device during scheduled aircraft maintenance is worthwhile.

The CAA will publish additional guidance regarding locating/mounting active CO detectors in aircraft. It is worth highlighting that installing an active CO detector is already covered by CS-STAN (Standard Change CS-SC107a) and therefore does not require any separate airworthiness approval.

3.10.6 **Comment:** "There are a myriad of different detectors on the market, many of which we have concluded are not appropriate for aircraft use. The threat of distraction from an alarm at low level could pose a greater threat than CO does. I believe the low value reported in CAP2560 is mis-leading. Consideration must be given to the effect an alarm would have on a student pilot. Most ab-initio solo flights are of an hour or less duration so again the threat from CO is low. We have found a device that has a red flashing light at 50ppm which should be sufficiently attention grabbing, the alarm sounding at higher values and is smaller than the standard domestic unit, it may be more appropriate for use by low time pilots."

CAA response: The CAA acknowledges that distraction from a CO alert is a risk, particularly for ab-initio solo students and low-hour pilots. It is therefore especially important that an appropriate active CO detector is used, such as the device described in the comment. Additionally, by incorporating the active CO detector into the flying training environment, it is more likely that the student will be familiar with it. Nevertheless, the risk to ab-initio solo students will be considered by the CAA.

Chapter 4

CAA Decisions

4.1 The CAA has been actively engaged on the issue of carbon monoxide in general aviation over the last four years and has pursued multiple safety initiatives to highlight the risk posed by CO and what can be done to mitigate it.

4.2 Based on the findings from this consultation and the extensive work done in this area over the last four years, the CAA has come to the following decisions:

CAA Decision 1

The CAA will introduce a requirement to have a functioning active carbon monoxide detector, capable of alerting via aural and/or visual means, in specified piston engine aircraft when operating with passengers on board who do not possess a recognised pilot qualification. The comments provided in this consultation will be taken into account when developing the requirement.

CAA Decision 2

The CAA will not, at this time, introduce mandatory CO concentration checks in piston engine aircraft maintenance programmes beyond what is already specified by aircraft manufacturers and UK Reg (EU) No.1321/2014 Annex Vb (Part-ML), Minimum Inspection Programme (MIP).

CAA Decision 3

The CAA will publish additional guidance on topics including: selecting an appropriate active CO detector, where and how to securely position devices in aircraft, how to respond to alerts, as well as guidance on exposure levels and thresholds for alarms.

Chapter 5

Next Steps

5.1 The consultation provided the CAA with valuable insights into the views of the general aviation community regarding the risk posed by carbon monoxide in piston engine aircraft operations. The CAA is grateful to all those who took the time to respond to the consultation and submit comments.

5.2 The CAA will be issuing a directive requiring an active CO detector to be present in specified piston engine aircraft operations. The requirement will follow closely the proposal set out in Q9 of CAP 2975, but will be modified to take into account the responses and comments received in the consultation.

5.3 Once the directive comes into force, the CAA will monitor its effectiveness and determine if any changes are required to balance proportionality and safety whilst tackling the risk of CO in piston engine aircraft operations.