Australian Government
Civil Aviation Safety Authority

Airworthiness Bulletin

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Preventing Carbon Monoxide Poisoning in Piston Engine Aircraft

An Airworthiness Bulletin is an advisory document that alerts, educates and makes recommendations about airworthiness matters. Recommendations in this bulletin are not mandatory.

1. Effectivity

Crew and passengers in piston engine aircraft can potentially suffer from Carbon Monoxide (CO) poisoning due to cracked exhaust components and unserviceable heat exchange assemblies. This situation can be further exacerbated by unsealed penetrations through engine firewalls or other openings. Also, advice relating CO detection systems within piston engine aircraft.

2. Purpose

To advise owners, operators, and aircraft engineers of the dangers of potential CO poisoning via leaking exhaust collectors, heater muffs and openings in engine firewalls. Also, whilst audible/visual CO detectors are not mandated, they are available to assist in the detection of CO but should not be used as the primary protection method against CO emissions into aircraft.

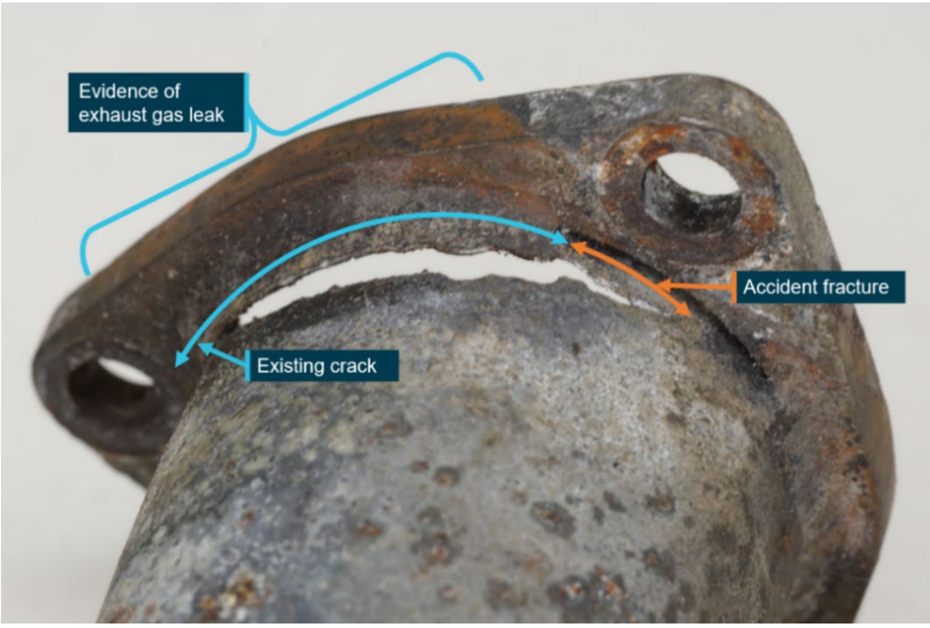

Figure 1.

Engine exhaust unit potential to leak CO into the aircraft cabin. Image provided by Australian Transport Safety Bureau.

3. Background

CO is a colourless, odorless gas and otherwise undetectable to the human senses. This makes it difficult to positively identify that operating crew and/or passengers are being exposed. In piston powered aircraft, CO is produced by incomplete combustion of fuel. For more aviation specific information refer to the ATSB website, Transport Canada, FAA (DOT/FAA/AR-09/49 on Detection and Prevention of Carbon Monoxide Exposure in General Aviation Aircraft), or the UK CAA (Carbon Monoxide in General Aviation landing page).

A recent aviation incident investigation by the Australian Transport Safety Bureau (ATSB) has revealed that several of the occupants of the incident aircraft had elevated levels of CO within their blood samples. The detailed investigation of the aircraft has revealed three major factors to be considered relating to CO.

Firstly, exhaust collector assemblies on piston powered aircraft are a known source of CO. Manufacturer’s instructions for continued airworthiness (ICA) require regular inspection of exhaust pipe collectors and heat exchangers. Their useable life is centred on an “on condition” maintenance inspection philosophy and as such these systems require increased vigilance, especially with ageing exhaust components.

Secondly, CO can potentially enter cockpits and cabins via heating ducts, open voids in the engine firewalls or open doors, vents and windows. Whilst the latter three are unavoidable, firewall integrity, heating ducts and control valves need to be inspected to ensure correct operation and seals remain serviceable and effective. Access panels installed within firewalls must be resealed and secured correctly following any inspections, maintenance, or modifications.

Finally, the fitment of CO detection placards designed to change colour when exposed to CO, may not necessarily provide adequate or timely warning to the pilot and passengers of elevated levels of CO within the cabin. More modern inexpensive devices which include audible and improved visual warnings are more suited to detect and warn cabin occupants of the elevated levels of CO.

Figure 2. Engine firewall openings that may be opened for maintenance and repairs.

4. Recommendations

The Civil Aviation Safety Authority recommends that when LAME/AMEs conduct visual inspections of exhaust collectors and heat exchange units, that a thorough inspection is conducted with the view of finding potential CO leak points. All shrouding and shields should be removed to allow for a detailed inspection. Whilst the internal condition and thickness of exhaust components is difficult to determine visually, if the component exhibits signs of thinning, cracking, bulging or any exhaust leakage (soot deposits or discolouring) the section should be removed and replaced with a serviceable item. Gaskets, brackets and clamps should also form part of these inspections. Pressure tests or other appropriate leak checks on exhaust components may help diagnose defects that are too small to be detected by visual inspections.

An ideal maintenance program would involve exhaust system replacement at engine change or at a predetermined interval gained from operating experience. To operate these items to a point of failure is not considered appropriate. Registered operators, maintenance repair organisation or CAMOs can instigate periodic CO detection functional tests, during which, the CO level in the cabin can be measured. CASA suggests conducting a carbon monoxide check at each annual or 100 hours-time in service, whichever occurs first, and each time the exhaust system or related components are disturbed. The CO level entering the cabin must be less than 1 part in 20000 parts of air (equivalent to 50 parts per million), derived from FAA FAR 23.831.

Additionally, any modification or reduction in the length of the tail pipe/exhaust system must be conducted with original equipment manufacturer approval or local Australian CASR Part 21 approval.

Approved modifications that include access panels and attachments to firewalls must be re-sealed following any disturbances to prevent CO entering the cockpit or cabin. Heating ducts and ‘ON/OFF’ valves should function and seal correctly, particularly in the ‘OFF’ position to allow crew to stop the flow of contaminated air entering the cockpit or cabin.

If an access panel on the engine firewall is opened/removed during maintenance/servicing, close attention needs to be paid, to ensure access panels, seals/gaskets and hardware are reinstalled correctly to prevent the flow of gases and flammable fluids entering the cockpit and cabin.

Exhaust tail pipes are designed for forward flight with the dispersion of exhaust gases rearwards. Lengthy engine run ups and taxi periods with tail or cross winds can draw the exhaust into the cabin. Pilots should ensure adequate fresh air ventilation is available to them and that the aircraft is directed into the wind.

Carbon monoxide detectors, while strongly encouraged, should not be used as the primary means of carbon monoxide poisoning prevention.

CASA strongly recommends pilots wear and carry personal active CO detectors or have an approved/certified CO detection system fitted to aircraft. Not all aircraft are required to have

CO detector systems fitted. But there are many small electronic personal devices readily available at affordable prices. These devices allow for continual monitoring of CO levels with audible and/or visual warnings when escalated CO levels are detected.

Operators are reminded that non-certified equipment is not necessarily tested to nor required to meet rigorous environmental requirements for aviation vehicles like certified equipment is. Users of CO detectors need to be aware that there have been defect reports raised relating to unreliable or false indications. Nevertheless, operating crew should never disregard warnings of any system in use.

Figure 3.
Electronic CO detector devices available for personal use.

Figure 4.
TSO approved panel mounted CO detectors.

Aircraft certified products are available that can be installed by approved maintenance organisation.

Reliance on only the visual CO detection placard, that changes colour in the presence of CO, is considered suboptimal.

If aircraft are fitted with the placard type CO indicator, the operator should ensure the placard is placed in the field of view of the pilot, regularly checked to ensure it is not time expired and the indicator is not faded from ultraviolet exposure or contamination.

CO detection placards are limited by the following issues:

- Are passive - No audio alarm - relying on occupants to regularly monitor them.
- Require frequent replacement every 3-12 months.
- Effected by direct sunlight and some may revert back to their original colour when exposed to fresh air.
- Degradation due to chemicals (fuels, oils, lubricants and cleaning products)
- Do not show the level of CO present.

Finally, operators of piston engine aircraft should be aware of the cumulative effect of CO. Commonly reported symptoms of acute (short term) exposure to high levels of CO include:

- headaches, dizziness, nausea
- metallic taste
- darkened vision
- muscular weakness, incoordination and impaired judgement
- numbed reflexes and reaction times
- sleepiness, collapse and unconsciousness
- increased pulse and breathing
- convulsions
- heart attack or stroke.

Ongoing chronic exposure to high levels of CO may result in:

- recurring headaches
- irritability
- insomnia
- foetal changes in pregnant women (including miscarriage)
- personality changes
- impaired judgement.

5. Other information from National Airworthiness Authorities

The FAA have produced an interactive on-line presentation Aircraft Exhaust Systems as part of their FAA AMT Course. An overview of exhaust systems and examines many of the components, issues and techniques used in inspecting and maintaining exhaust systems.

UK CAA - *Carbon monoxide in general aviation - Carbon monoxide – prevention and protection strategies*.

Transport Canada - CASA 2019-07 - REDUCING RISK OF CARBON MONOXIDE POISONING IN GENERAL AVIATION AIRCRAFT

FAA - DOT/FAA/AR-09/49 - Detection and Prevention of Carbon Monoxide Exposure in General Aviation Aircraft

FAA - SAIB CE-10-19 R1 - Engine Exhaust and Carbon Monoxide Detectors

6. Reporting

All defects found within any of the following, should be submitted to CASA via the Defect Reporting System.

- exhaust sections
- ducting
- heat exchangers
- firewall assemblies and
- CO detection equipment.

7. Enquiries

Enquiries with regard to the content of this Airworthiness Bulletin should be made via the direct link email address:

AirworthinessBulletin@casa.gov.au

or in writing, to:

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