The Global Voice of Pilots

IFALPA

BRIEFING LEAFLET

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Cabin Fumes

NOTE

This paper supersedes 18HUPBL03, of the same name. Please also review IFALPA Position Paper 23POS19 Cabin Fumes.

BACKGROUND

For most modern commercial jet aircraft, cabin air is taken directly from compressors in the engine compartments without filtering. Under certain circumstances oil fumes from the hot section of the engine and/or APU may leak into this air in two fundamental ways: small amounts of oil may enter the compressor on a routine basis because seals minimize leakage but do not prevent it in certain transient phases. This especially occurs during both low-pressure phases and during transient engine/air supply changes.

Less frequently, larger volumes of oil can enter the compressor, either as a result of a worn or failed bearing seal, or due to a maintenance irregularity (e.g., oil over-filling), resulting in what is more widely recognized as a fume event.

These facts have been recognized by regulatory authorities, safety agencies, scientists, airlines, occupational doctors, airframe, engine and oil manufacturers, and crew unions. A fume event may result in the impairment or incapacitation of crew members which jeopardizes flight safety. There is an increasing concern that exposure to fumes may also result in longer-term health effects.

OBJECTIVES

This briefing leaflet focuses primarily on the safety case which results from a fume event; how to train for, mitigate against, and report fume events.

When a fume event occurs, cabin air contamination can cause short-term physical effects which may compromise flight safety. Evidence suggests a link between aircraft cabin air contamination and health effects in some crew. Therefore, mitigating actions should be taken to prevent exposure to contaminated air supply sourced fumes.

DEFINITIONS – TERMS USED IN THIS PAPER

Contaminant
The presence of an unwanted constituent or impurity in the air.

Odour(s)
An unpleasant smell. In the context of this paper, some odours sourced to the air supply system can indicate bleed air contamination.

Fume(s)
A mixture of gaseous compound(s) which may also contain particulate/aerosols, which are usually not visible but may be irritating, offensive, or noxious. Fumes may occur in an aircraft when cabin air is contaminated by fluids such as engine oil, hydraulic fluid, anti-icing fluid, or other potentially harmful or hazardous chemicals.

Fume event
A period of time, either transient or sustained, in which the aircraft personnel or occupants are exposed to fumes, sometimes without overt visual cues.

Note: Crewmembers should not assume that signs of contaminants (e.g., smoke or haze) must be visible in order to recognize, assess, and report them.

Smoke
The product of burning materials made visible by the presence of small particles.

BLEED AIR CERTIFICATION SPECIFICATIONS

The basic airworthiness design standards FAR 25.831 (U.S.) and CS 25.831 (EU) contain ventilation specifications. Both of these standards state that "Crew and passenger compartment air must be free from harmful or hazardous concentrations of gases or vapors." Additionally, there must be enough fresh air or uncontaminated air to enable crewmembers to perform their duties without undue discomfort or fatigue. However, regulators do not define the phrase "harmful or hazardous."

In addition, engine and APU standards and accompanying guidance material[1] state that the probability of engine/APU effects that produce toxic products sufficient to incapacitate crew or passengers should not be more than "extremely remote." Also, the

[1] In the US, these are FAR 33.75 and AC 33.75-1A. In the EU, these are CS-E 510/ CS-APU 210 and related Acceptable Means of Compliance.

probability of such engine/APU effects sufficient to cause crew impairment should not be more than "remote." These conditions must be met at initial design certification as well as on an ongoing basis known as continuing airworthiness. Compliance with these standards is typically achieved through analysis and ground simulator testing.

Detection systems for bleed air contaminants have been recommended by several aviation safety agencies, industry bodies, and in the scientific literature.

IFALPA is concerned about the lack of regulatory enforcement in relation to bleed air contamination. CEN Technical Report (TR) 17904[2] describes best practices in aircraft design, maintenance, and operation.

CREW ACTION

Crews must always follow the procedures published by manufacturers and operators. Consideration should also be given to advisory materials published by regulators.

ICAO Training Circular 344[3] provides a comprehensive framework for airlines to train/educate airline workers to recognize, respond to, and report fume events.

Oxygen Masks

Inhaling fumes may lead to impairment and/or incapacitation, even when no visible cues are present. The immediate response to the presence of fumes must be to don oxygen masks. If it appears during flight that both pilots are suffering from some form of impairment or that one pilot appears to be in any way impaired for no obvious reason, then all flight crew should don oxygen masks without delay.

Operation manuals should contain detailed instructions on the necessity of oxygen mask use at 100% whenever contamination is present or suspected until the source has been corrected or isolated and is no longer producing fumes.

Communication

Flight crew should establish communication with cabin crew and inform air traffic control. Cabin crew should maintain communication with the flight crew, but this should not be to the detriment of other emergency procedures such as dealing with cabin smoke or fires, especially where only one cabin crew member is onboard. If one or more of the flight crew is impaired/incapacitated, then the flight crew must declare an emergency and consider a diversion.

[2] PD CEN/TR 17904:2022 Cabin air quality on civil aircraft.
[3] ICAO Circular 344: Guidelines on Education, Training and Reporting Practices related to Fume Events

REPORTING

To facilitate accurate and systematic documentation of fume events, a comprehensive, accessible, and centralized reporting system that is overseen by each regulatory authority is required. This would allow regulators and airlines to track the frequency, causes, and impacts of fume events. In ICAO Circular 344, there is a model of standardized reporting form, which IFALPA encourages operators to use.

For every fume event, an aircraft technical log entry must be completed. The maintenance response and resolution will also be documented. Also, crewmembers should submit an event report to their airline, including a description of onboard conditions, crew symptoms, and oxygen mask usage. Some jurisdictions require direct reporting to the authorities.

The event description and technical log entry should be used by maintenance to review and assist their efforts in establishing and addressing the source of the fume event. Pilots should be entitled to feedback on technical findings in relation to their reports.

Additionally, ICAO encourages operators to incorporate the outcomes into their Safety Management System (SMS).

POST EVENT

After the event, the following steps are recommended:

1. A review of the fume event by the captain, which should involve consultation with the other flight crew members and the cabin crew as soon as practicable. The review should include:
   a) A determination of whether any crewmember felt unwell, and/or whether their performance was adversely affected;
   b) A requirement for any crewmember who felt unwell, or felt their performance was affected, not to operate as a member of the crew until they have been assessed as fit by a medical practitioner. The medical check should be done as soon as practicable after the fume event.

2. Flight crew members should report the event and complete required documentation, which may include:
   a) reports required by the regulatory authority;
   b) aircraft technical log entry; and
   c) airline event reporting form.
   d) your member association reporting form

3. Follow the recommendations of your doctor, operator, and pilot association. Best practice medical protocols have been published.

MEDICAL EXAMINATION AFTER A FUME EVENT

Suitable medical tests will vary and best practice medical guidance[4][5] has been published. Also, some airlines have their own medical procedures to follow post-event.

Symptomatic aircrew or passengers should be sent to a suitable medical facility or to the emergency department at the nearest hospital. Ideally, the airline should facilitate best practice medical recommendations by ensuring that the medical provider/hospital is aware of published best practices.[6]

In all cases, affected crewmembers should follow the steps below:

- Note all symptoms and record them continuously thereafter. Note when and for how long they appeared;
- Take pictures or make a video recording of visual symptoms if any, for later use;
- Take notes with you to the medical examination;
- Be medically examined as soon as possible;
- Document contact details of other crewmembers; and
- Keep a copy of all medical reports.

TRAINING

Airlines should provide crewmembers with basic and recurrent training on fume events consistent with ICAO Circular 344. The training should include:

A. Sources and types of onboard fumes

It is important for crewmembers to attempt to identify the apparent source of the fumes in order to take the appropriate action. Examples of potential types of fumes:

[4] Hageman et al., Chapter Four - Aerotoxic syndrome: A new occupational disease caused by contaminated cabin air?,
Advances in Neurotoxicology, Volume 7, 2022, 77-132, https://doi.org/10.1016/bs.ant.2022.04.001

[5] Burdon et al. Health consequences of exposure to aircraft contaminated air and fume events: a narrative review and medical protocol for the investigation of exposed aircrew and passengers. Environmental Health (2023). https://doi.org/10.1186/s12940-023-00987-8

[6] Harrison et al., Exposure to aircraft bleed air contaminants among airline workers: a guide for health care providers. January 2008.

Potential fumes sourced to the ventilation supply air:

- De-icing and/or anti-icing fluid
- Electrical faults
- Engine compressor wash
- Engine/APU oil
- Exhaust (aircraft or ground vehicles)
- Fuel
- Hydraulic fluid
- Recirculation fan failure

Items in the cabin and/or flight deck that can be sources of odours:

- Carry-on baggage
- Cleaning products
- Disinfectants
- Disinsectants
- Food items
- Galley equipment
- Lavatories

B. Odour descriptors to recognize the presence of oil and hydraulic fluid fumes

Oil fumes rarely smell like oil. Odour is subjective, such that different people can experience and describe the same fumes differently. Also, olfactory fatigue reduces a person's ability to detect odours within a short period of time.

Common Odour Descriptors for Fume Events

Oil: dirty socks, smelly feet, foul, musty, vomit	TCP-free oil: Chemical, car wash	Hydraulic fluid: Acrid

C. Potential for impairment

When a fume event occurs, cabin air contamination can cause short-term physical effects which may compromise flight safety. Refer to ICAO Circular 344 for guidance on ensuring that flight crew respond appropriately to air supply system-sourced fumes, given the potential for symptoms to develop slowly. Degraded performance may not be initially obvious.

D. Potential for long-term health effects

Evidence is suggestive of a link between aircraft cabin air contamination and health effects in some crew. Quick Reference Guide for Health care providers[7] funded by Federal Aviation Administration Office of Aviation Medicine states: "Symptoms vary depending on the duration and magnitude of exposure, plus individual factors. Chronic and sometimes delayed neurological, psychiatric, respiratory, systemic, and dermal symptoms have been reported."

There is inter-individual variation in the severity and prevalence of symptoms reported after fume events for a variety of reasons including repeated exposures, intensity and duration of exposures, genetic variability, and related individual susceptibility factors. In rare cases, the pilot's medical certification has been revoked.

E. Procedures to apply during and after fume events

Refer to ICAO Circular 344 and airline/manufacturer emergency procedures.

F. Reporting of fume events

Refer to ICAO Circular 344 and the Reporting section of this briefing leaflet.

MAINTENANCE

Post event maintenance should be carried out in accordance with the Trouble Shooting Manuals and Aircraft Maintenance Manuals (TSM/AMM). These contain appropriate actions regarding how to proceed after a fume event, including the cleaning of the air conditioning ducts when an oil leak has been identified.

All maintenance actions shall be clearly documented and visible for the next operating crew.

One common reason for fume events is overfilling of engine and APU oil. Incident reports have revealed that sometimes appropriate procedures are not fully followed, e.g., cooling down time of an engine before replenishing oil or maximum oil level lines may not be adhered to.

[7] Harrison et al. 2009: Quick Reference Guide For Health Care Providers: Health Impact Of Exposure To Contaminated Supply Air On Commercial Aircraft.

MITIGATIONS AND EMERGING TECHNOLOGIES

Alternatives to bleed air systems

Pressurization of the aircraft without use of bleed air eliminates the risk of engine generated bleed air contamination, as used on Boeing 787.

Bleed air filtration

Bleed air filtration options are under development.

Fume event detection/monitoring

Fume event detection/monitoring devices are being developed

Reduced toxicity oils

Alternative TCP-free oils are being developed.

Dedicated fume event checklists

Some companies have created a dedicated checklist for fume events. Fume events are more common than smoke/fire events, but smoke/fire/fumes emergency checklists are often not effective for fumes and may not be implemented in the absence of smoke. For example, smoke removal procedures would introduce higher flow rates of ventilation air, worsening the onboard conditions if the fumes are caused by oil contamination in the packs.

IFALPA RECOMMENDS

- proper crew training and education regarding fume events
- a bleed air-free ventilation/pressurization design as an optimal solution
- installation of enhanced new bleed air filters when available
- real time detection systems be developed and installed.
- engine manufacturers expedite and prioritize the certification of TCP-free oils
- industry implements the use of TCP-free oils