IFALPA
The Global Voice of Pilots

Human Performance
Briefing Leaflet

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Cabin Fumes

BACKGROUND

For most modern commercial jet aircraft, cabin air is taken directly from compressors in the engine compartments without filtering. Occasionally, oil fumes from the hot section of the engine and/or APU leak into this air, resulting in what is known as a fume event. This fact has been recognized by regulatory authorities, safety agencies, scientists, airlines, occupational doctors, oil manufacturers, and crew unions. A fume event may result in the incapacitation of crew members and jeopardize flight safety, but some of the consequences of such leaks are still subject to debate. Immediate safety concerns resulting from an abnormal situation (fume events) should be differentiated from any potential short and long-term health effects.

OBJECTIVES

This briefing leaflet focuses on the safety case resulting 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. Sufficient scientific concern exists requiring more studies in order to determine any short and long-term effects of fume exposures.

DEFINITIONS USED IN THIS PAPER

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

Odour(s): A particular and distinctive smell. In the context of this position paper, odours can be an indicator of bleed air contamination.

Fume(s): Gaseous, often odorous compounds which are not necessarily visible but may be irritating, offensive, or noxious. Fumes may occur in an aircraft when bleed air is contaminated by fluids such as engine oil, hydraulic fluid, anti-icing fluid, or other potentially hazardous chemicals.

Fume event: A period of time, transient or sustained, in which the aircraft occupants are exposed to fumes.

Note: Crew members 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 airworthiness design standards FAR 25.831 (U.S.) and CS 25.831 (Europe) contain ventilation specifications. Both state, "Crew and passenger compartment air must be free from harmful or hazardous concentrations of gases or vapors." However, clean air has not been adequately defined. This condition must be met at initial design certification as well as on an ongoing basis known as 'continuing airworthiness'. There are currently no required methods for air sampling after events. There is a lack of certification specifications for continued airworthiness once engines have been installed on the aircraft.

Detection systems are also required by FAA & EASA 25.1309(c), although these requirements have never been enforced regarding bleed air. They are also recommended by several aviation safety agencies, by industry bodies, and by scientific literature.

IFALPA is concerned with the lack of regulatory enforcement in relation to bleed air contamination.

CREW ACTION

Crews must always follow the manufacturer's and/or operator's procedures. ICAO Training Circular 344 addresses basic procedures that should be followed when faced with a fume event.

Oxygen masks

Since the inhalation of fumes/smoke may lead to incapacitation, the first action in the event of smoke or fumes in the flight deck should be for the flight crew to don oxygen masks. If it appears during flight that both pilots are suffering from some form of incapacitation or that one pilot appears to be in any way incapacitated for no obvious reason, then the flight crew should don oxygen masks without delay.

Operations 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 no longer producing fumes in the cabin.

Communication

Flight crew members should establish communication with cabin crew members and 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.

Follow the associated emergency procedures
For example, in case of incapacitation, the flight crew should follow the incapacitation procedures, including declaration of emergency and possible diversion.

REPORTING

To facilitate accurate and systematic reporting and to quantify the magnitude of the problem, a comprehensive, open, and centralized reporting system is required. This would allow monitoring and analysis of fume events on an international level. In the ICAO circular 344, there is a model of standardized reporting form, which IFALPA encourages operators to use.

Every suspected contaminated cabin air event should be reported to your company. Some jurisdictions require direct reporting to the authorities. An aircraft technical log entry should be completed. In particular, the use of oxygen masks, crew impairment, and positive identification of oil leaks should always be documented.

The data from such reporting should be used by maintenance to review and assist their efforts in establishing 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 in-flight incident by the Captain which should include consultation with the flight and cabin crew as soon as practicable;
2. Determine whether any crewmember felt unwell, and/or whether their performance was adversely affected;
3. Require 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.
4. Flight crew members should report the event and complete required documentation, which may include:
   - mandatory reports, as required by the State of the Operator
   - aircraft technical log
   - smoke and fumes reporting form
5. Follow the recommendations of your doctor, operator, and pilot association.

MEDICAL EXAMINATION AFTER A FUME EVENT

Scientific research in the field of Cabin Air Quality is ongoing, and the types of tests that would need to be performed routinely after a fume event have not been established yet. Therefore, only general guidelines on what medical tests should be performed can be given.

Some airlines have their own medical procedures in case of fume events, and these should be followed if your airline has such a procedure. Additional tests may be performed as part of ongoing research. There are some more specific volatile organic compounds (VOCs)/organophosphate tests under development for fume events, but they are not yet in routine use.

In all cases the following is recommended:
- 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,
- Perform medical examination as soon as possible,
- Document contact details of other crewmembers,
- Ask for your medical report.

The examination should include:
- Clinical history,
- Physical examination, including neurological evaluation,
- Laboratory tests, depending on the clinical situation, that may include, but are not limited to,

  - o O2-Saturation and arterial blood gas analysis (PaO2, PaCO2, Ph, HCO3-)
  - o Hemoglobin, methemoglobin, carboxyhemoglobin
  - o Blood-glucose, lactate, electrolytes
- In case of respiratory problems, spirometry, and lung diffusion capacity test (Note, Lung diffusion capacity test time),
- Any additional tests deemed necessary by the treating doctor.

TRAINING

Crews should be given basic and recurrent training on fume events. ICAO Training circular 344 addresses awareness, training, and reporting of fume events. The training should include:

A - Sources and types of on-board fumes

Examples of Potential Types of Fumes

Potential contaminants in the ventilation supply air:
• De-icing and/or anti-icing fluid • Electrical faults • Engine compressor wash • Engine 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 fumes:
• 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

Often, oil fumes do not smell like oil. Instead, they are typically described as smelling like dirty socks/ smelly feet, foul, or musty. Hydraulic fluid often has a distinctive and recognizable odour that is often described as acrid. 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 over time.

Odour Descriptors in Fume Events

Oil:	Hydraulic fluid:
oily, dirty socks, smelly feet, foul, musty	odorless, oily, acrid

C – Potential for impairment

D – Procedures to apply during and after fume events

E – Reporting of fume Events

LONG TERM HEALTH EFFECTS

It is unclear whether fume events cause long-term health effects. It is acknowledged that flight crew are exposed to minimal seal leakage even in normal operations. This may explain why only some of the crew experience symptoms whilst others remain asymptomatic after a fume event. Those whose "cumulative dose" exceeds a certain threshold may experience symptoms. There is concern, as yet unproven, that this may have cumulative long-term health effects. Genetic differences in metabolism may play a role in the cumulative effects.

IFALPA awaits further scientific evidence.

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.

NEW TECHNOLOGIES/ SOLUTIONS?

a. 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, or as successfully shown on trial retrofits of A320 and ATR72.

b. Bleed air filtration
Although bleed air filters are not 100% effective, they are a more promising alternative
than simple recirculation filters, which do little to alleviate the actual problem.

c. Fume event detection/monitoring
Fume event detection/monitoring devices are being developed and tested in operations. These can assist pilots in their decision-making and can help airlines to avoid diversion costs in the case of false negatives.

d. Reduced toxicity oils
Less toxic chemicals have been developed as a substitution for current anti-wear engine oil additives, and their certification should be carried out with priority to allow them to substitute the more toxic varieties.

e. Separate checklists for fume events

Some companies have generated a separate checklist for fume events to prevent ambiguity. For example, the current Airbus Smoke/Fire/Fumes checklist can lead you to a smoke removal procedure, which may not correctly address the situation. This may aggravate the situation by introducing higher flow rates into the cabins when the fumes are sourced to oil contamination in the packs.

IFALPA advocates bleed air free design as an ultimate solution. Meanwhile, filters and detection systems should be improved and installed. For more information see **Position Paper 18POS24-Cabin Fumes**.