ECA Position on Cabin Air Contamination

Due to the design of engines in combination with bleed air systems, oil fumes may enter the air-conditioning packs and pollute cabin air. As air flowing through the bleeds is not filtered, cabin air can be contaminated by chemicals from engine and hydraulic oil. This has been recognised by Regulation Authorities, scientists, airlines, occupational doctors, oil manufacturers and crew associations.

When it comes to the consequences of such leaks, it is important to make distinction between possible safety concerns resulting from abnormal situations (fume events) and potential long term health effects.

This ECA position focuses on the safety case resulting from a fume event, as we wait for more research on the possibility of long term health effects. At the same time, ECA proposes to strengthen existing safety barriers to further mitigate the safety risks related to fume events and to allow for a better and more systematic identification of such incidents. Filtering and detections systems, crew training and more explicit harmonised operating procedures/check lists for fume events are part of this, as well as systematic reporting of such incidents to the company and authority.

Also, in order to raise awareness with regulatory bodies at European and national level, a risk assessment needs to be performed to quantify the magnitude of the problem together with a study of sufficient power to characterise fume events (inhalation study). As long as research on long-term health effects is not conclusive, the basic principle guiding the ECA position is the application of the ALARA principle (As Low As Reasonably Achievable).

The Safety Case

When a fume event occurs, cabin air contamination can cause short term health effects which may compromise flight safety. The crew in such a case has to follow the relevant operating procedures and checklists which stipulate the donning of the oxygen mask, assure 100% oxygen supply to operating crew and then terminate the flight as soon as possible.

In order for the crew to act correctly when such an event occurs, the pilots should be given basic education so as to recognise and distinguish the different sources of fumes. Such basic education of the crewmembers should include a list of symptoms they could encounter in the case of a fume event.

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Basic education, in particular, should include:

1. Clarify the terminology: Today, checklists talk about 'smoke / fire / fume / smell'. A fume is defined as smoke, vapour or gas, especially when irritating or offensive. To non-native English speakers it may not be clear that fumes can be invisible. Crews should be trained to also react on an unexplained odour;
2. Improve the checklists: Today, some checklists state that the donning of oxygen masks is only necessary "if required" whilst others put it at the top and make it compulsory to don the oxygen mask. There should be only one standard practice and ECA recommends that this should be to always don the oxygen mask during a smoke / fire / fume / smell event. Furthermore, training in the correct use of oxygen masks should be reinforced;
3. Medical counsel: If after a fume event the crew feels unwell, they should immediately consult a medical doctor;
4. Reporting: Any such fume event must be reported by the crew to the operator as well as to the national authority (see below).
5. Job specific training on the immediate actions following a fume event should be reinforced

The training should not be limited to crew members and maintenance personnel only, but management should also be trained on the background, their responsibility, and the cooperation amongst the various stakeholders. Fumes and smoke hazards are a severe threat to flight safety and should be integrated in a company safety management system (SMS).

Besides recognition and responding to fume events, crew members should also be trained on how and where to report it (airplane tech log, Air Safety Report, etc.). In line with the EU Occurrence Reporting Regulation (Reg. 376/2014), a standardized reporting system should be implemented and crews must have the assurance the reporting will be handled in a non-punitive way, based on Just Culture[1] principles.

Following the reporting by the crew of a fume event to the maintenance department, improved training and maintenance procedures should include the requirement for the company to provide feed-back to the crew on the actions taken.

An ICAO circular addressing awareness, training and reporting of fume events has been published in late 2015[2]. In the circular, there is a model of standardized reporting form, which ECA encourages operators to use.

Any fume event should also be reported by the company to the national authority – which is not yet the case for many companies – to allow data-gathering on the extent of such events at a national scale. Similarly, crew should report such events to their national authority, in line with EU Accident Investigation Reg. 996/2010.

[1] Just Culture definition (Reg 376/2014 Art.2): "'just culture' means a culture in which front-line operators or other persons are not punished for actions, omissions or decisions taken by them that are commensurate with their experience and training, but in which gross negligence, willful violations and destructive acts are not tolerated."

[2] ICAO DOC "Guidelines on Education, Training and Reporting of Fume Events", to be published end 2015.

To facilitate correct and systematic reporting and to quantify the magnitude of the problem, a comprehensive, open and centralised reporting system would be required. This would allow monitoring and analysing of fume events on the European level.

New Technology – Addressing Cabin Air Contamination

Over the last years there have been continuous technical improvements addressing cabin air contamination:

- ECA is aware of the development of detection systems. These assist pilots in their decision-making and can help airlines to avoid diversion costs in the case of false negatives. To comply with EASA's CS25.1309(c), such detection devices should already have been installed. CS25.1309 states that «information concerning unsafe system operating conditions must be provided to the crew to enable them to take appropriate corrective action» and notes that «a warning indication must be provided if immediate corrective action is required.»
- Electrical packs that could be installed on future versions of aircraft types have been developed. The manufacturer announced they will be integrated and flight-tested on a modified ATR 72 and an A320 before the end of 2015.
- An intermediate mid-term mitigation measure could be to filter the air. To date, the B757 is the only current aircraft that can be fitted with bleed air filtration and for which EASA has certified a supplemental type certificate. Although these 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).
- Furthermore, EU regulations state that the employer must take the necessary preventive measures and risks must be eliminated or reduced to a minimum following the 'hierarchy of prevention' measures (EU Directive 89/391/EEC Article 6). The hierarchy of prevention is a well-established and mandatory Health & Safety practice, by which the EU sets out a priority-based flow-chart to avoid workplace exposure. Accordingly, in any workplace design the first step would be to eliminate the risk at the source. When this first step has been carried out, but the risk is still present, then can 'collective protection' measures be applied. Only as a measure of last resort, can personal protective equipment be considered.
- Some, such as the Boeing 787's bleed-free technology solve the problem at the source, by using external air inlets instead of bleeding air from the engines.

ECA therefore calls for the following:

- Detection and warning systems in line with EASA regulation CS25.1309 should be installed on all aircraft. Such monitoring systems have already been recommended by other bodies such as the ASHRAE engineering committee (2007), the Australian Senate inquiry (2000), the US national Research council (2002) and the UK AAIB (2004). ECA points out that the Safety Recommendation 2007-02 from the UK AAIB to EASA and Safety

Recommendation 2007-03 to the FAA – that recommend monitoring – have until today not been put into effect.

- Future-built aircraft should use a bleed-free architecture in line with the EU hierarchy of prevention principle and stipulated in the EU workplace provisions of Directive 98/24/EC and Directive 89/391/EEC.
- 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.

Warning labels should clearly describe the chemical hazards according the GHS[3] classification system.

Medium/Long-term Health Effects

Today, the research community is divided and has not yet found agreement if there are medium/long-term health effects related to cabin air contamination.

A chronic exposure to compounds such as TCP has often been suggested to cause such health problems. At the same time, other organophosphorus compounds, such as triphenylphosphate (TPP), dibutylphenyl phosphate (DBPP) and tri-n-butyl phosphate (TnBP) originating from hydraulic oils were sometimes more prominent in the flight deck air samples. At which levels these chemicals cause medium/long-term health problems remains so far unclear.

Only robust inhalation studies that take into account the specific reduced pressure and low humidity conditions as found in aircraft environment, could answer if the levels that are present under normal and abnormal operating conditions are safe to breath. Such inhalation studies should take into account the whole mixture and its possible synergetic effects.

Until such studies have been performed, the exact causative mechanisms, including the symptoms they could produce remain unclear. ECA therefore calls for such inhalation studies to be carried out as a matter of urgency and recommends that its experts should be involved in designing these studies.

ECA further calls for more research on biomarkers, which could deliver valuable new data on the long-term health effects, because so far a truly specific biomarker for fume events has not been identified.

Conclusion

Cabin air contamination by chemicals from the engine and/or hydraulic oil, is a known problem that can cause serious short-term health effects which compromise flight safety when a fume event occurs.

[3] GHS: Globally Harmonized System of Classification and Labelling of Chemicals

ECA calls for improvements to be made to existing flight and reporting procedures as well as introducing appropriate job specific training for all stakeholders. It calls for continuous development and application of new technologies that can assist in further reducing the occurrence and effects of fume events. Studies need to be run to ascertain whether long term health effects do exist. In the meantime, the As Low As Reasonably Achievable (ALARA) principle should guide action and measures in this area.

ECA therefore demands to strengthen existing safety barriers and calls for the following concrete preventative measures:

Technology:

1. Short-term: Real-time detection systems and cockpit warning devices;
2. Mid-term: Bleed-air filtration;
3. Mid-term: Less toxic chemicals to be certified and applied;
4. Long term: Bleed-free aircraft design;

Training & reporting:

5. Short-term:
   a. Basic education for air crews on nature, effect and symptoms of fume events, as well as awareness & safety management training to company;
   b. Improved and harmonised operating procedures/check lists for smoke / fire / fume / smell events, requiring to always don the oxygen mask in such an event;
   c. Improved and systematic reporting of fume events to the operator, based on Just Culture principles, and by the operator – as well as crews – to the authority;

Research:

6. European risk assessment to quantify the magnitude of the problem;
7. Robust inhalation studies (based on aircraft environment);
8. Research on biomarkers specifically for fume events.

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