COMMITTEE ON TOXICITY OF CHEMICALS IN FOOD, CONSUMER PRODUCTS AND THE ENVIRONMENT

NON-TECHNICAL LAY SUMMARY

STATEMENT ON THE REVIEW OF THE CABIN AIR ENVIRONMENT, ILL-HEALTH IN AIRCRAFT CREWS AND THE POSSIBLE RELATIONSHIP TO SMOKE/FUME EVENTS IN AIRCRAFT

What are the concerns regarding contamination of cabin air in commercial jet planes?

There have been a number of reports of smoke/fume incidents occurring in some aircraft and of ill-health in aircraft crew. Concerns have been raised that such incidents might result from contamination of cabin air with oil/hydraulic fluid, and that this is responsible for the ill-health effects reported in aircraft crews. In response to these concerns, the Department for Transport (DfT) asked the COT to conduct an independent scientific review of data submitted to DfT by the British Airline Pilots Association.

Where does cabin air originate?

Cabin air in jet aircraft needs to be pressurised and heated during flight. This is achieved by drawing compressed air from the engines, although at the start and end of a flight it can also originate from an aircraft's auxiliary power unit in some aircraft types. The hot, pressurised air taken from the engines, referred to as 'bleed air', is cooled and conditioned in the aircraft's air-conditioning system before being vented into the aircraft cabin.

Air pressure reduces with altitude. Consequently, pressurisation of an aircraft cabin is required for aircrew and passenger comfort and health. However, cabin pressure during flight is less than that at ground level.

What is a contaminated air event?

A contaminated air event occurs when an engine oil seal fails, allowing jet oil or hydraulic fluid to leak into the compressed air passing through the engine and to be taken up into the bleed air supply, resulting in an oil mist or odour in the aircraft. The high temperatures and pressures in the engine might cause the oil/hydraulic fluid to form droplets/vapours and to breakdown into various carbon-based compounds, which could give a characteristic smell of burning. However, not all odours detected within an aircraft cabin arise from oil contamination of the air supply. For example, they can also originate from toilets and galley areas.

Which chemicals might contaminate bleed air?

There is a lack of information regarding the normal background range of cabin air contaminants and the identity and levels of chemicals released into cabin air during a contaminated air event.

It is difficult to determine exactly what substances are present in contaminated bleed air. A limited number of experiments have been conducted to estimate what could be present. Jet oils and hydraulic fluid subjected to very high temperatures, produce potentially harmful gases (e.g. carbon monoxide, aldehydes (that can irritate the airways) and various acidic compounds (that produce unpleasant odours)). Further, tests on faulty engines have been undertaken to identify compounds that might be released into bleed air systems. However, these approaches are of limited use as they did not take place on aircraft in flight, and hence can only tell us what compounds could be present; they cannot tell us the amount to which aircraft crew are actually exposed.

Exposure monitoring of cabin air under actual flight conditions would provide very useful information on aircraft crew exposures.

Exposure monitoring involves taking real samples of contaminated air while the plane is in use. This method allows scientists to identify what substances are present and also the amount to which aircraft crew are exposed.

What action did the COT take?

Before going though the evidence in detail, the COT made some general points. It recognised that aircraft crew health was a serious concern, and considered that, regardless of the cause of the reported adverse symptoms, appropriate action should be taken to prevent cabin air contamination events from occurring. The COT also emphasised how difficult it would be to pinpoint a specific chemical or mixture of chemicals responsible for the reported symptoms. The COT, however, did note that irritant chemicals could be released during smoke/fume events, and that therefore exposure to such chemicals might be responsible for some of the reported symptoms.

The COT considered all the information received from a range of different sources, for example airline industry conferences, meetings, pilot testimonies of symptoms, records and reports of smoke/fume events (including data from the Civil Aviation Authority), peer-reviewed scientific reports, advice/guidance documents from experts, and unsolicited information. The COT also searched the published literature for additional information to ensure its review was as comprehensive as possible. Every piece of information was critically examined to ensure that conclusions were based on reliable scientific evidence and that gaps in current knowledge could be identified.

Table 1 summarises specific actions undertaken by the COT in the course of the review, highlights key findings/conclusions and sets out COT advice for developing and designing further studies. The COT proposed that a stepwise approach should be used to address the problem, with results from each stage used to inform the next stage.

Table 1. Summary of the COT's actions, conclusions and recommendations.

Issue	**What did the COT do?**	**What were the COT's findings/conclusions?**	**What advice did the COT recommend as a way forward?**
Are aircraft crew exposed to contaminated cabin air?	Examined records of reports of smoke/fume events held in databases.	There was a suggestion that smoke fume/events were under-reported but it was not possible to determine the extent of under-reporting in existing records as databases held incomplete information. The rates at which incidents were reported varied depending on whether pilots felt there was a need to report an incident and what they perceived as a smoke/fume event. It was not possible to estimate the total number of smoke/fume events reported in British-regulated airlines due to the database limitations mentioned above and limitations of the method used to analyse the recorded smoke/fume incidents. However, based on information supplied from three different airlines, it has been estimated that smoke/fume events (arising from technical faults confirmed by an engineer) occur in one out of every 2000 flights (although this varies depending on the type of airframe, engine and level of servicing).	Aircraft crew should use official reporting procedures to report any odours/symptoms. Aircraft crew should use more standardised methods when reporting air contamination incidents rather than rely on what they perceive as a contaminated air event
	Examined studies providing data on exposure monitoring of in-cabin air.	Published studies of in-cabin experiments provide only limited information. This makes it difficult to conclude which chemicals might be present in bleed or in-cabin air.	There should be more research into monitoring pilots' exposures to all potential (widest possible range of) contaminants that might occur in cabin air.
	Evaluated the findings of a biomonitoring study designed to detect whether suspected cabin air contaminants are present in pilots' blood/tissue samples. The study was performed in 20 self-selected pilots.	The study reported that pilots had increased levels of solvents in their samples. However, the COT questioned the validity of this study as there were limitations associated with the methods used to analyse the chemicals present in pilots' blood/tissue samples, which cast significant doubt on the interpretation of the results.	Sufficient flights should be monitored to ensure a reasonable chance that some will include the occurrence of a smoke/fume event. Any biological samples from aircrew should be taken within 12-24 hours after an air contamination event. The monitoring approach used should link to airlines' records of the engineering status of the plane, reports of odours and any reported adverse health symptoms in aircrew.

Issue	What did the COT do?	What were the COT's findings/conclusions?	What advice did the COT recommend as a way forward?
Reports of ill-health in aircraft crew	Examined records of reports of ill health held in databases and individual testimonies.	Aircraft crew reported a variety of health symptoms. Some occurred over a short period i.e. irritation of the eyes, nose, throat, skin and gut. Others were apparent over a much longer/sustained period (i.e. were chronic) e.g. problems associated with the lungs/airways, nervous system, tiredness and sensitivity to multiple chemicals. Long-term symptoms that raised most concern were those associated with dampening of brain functions involved in perception, memory, judgement and reasoning (aka neuropsychological impairment). It was noted that the above symptoms have also been reported in some healthy individuals taking part in various studies/surveys.	Future analyses should find out how these reports of ill-health compare with reports from aircraft crew who work on planes where no records of smoke/fume incidents have been made. Pilots' health should be regularly monitored particularly with regard to investigating neuropsychological impairment.
	Examined the findings of neuropsychological tests carried out in a group of 18 self-selected pilots, only 9 of whom were still flying.	No firm conclusions could be drawn as the findings were based on a very small number of pilots and there was no control group.	A larger study should be conducted that includes an appropriate healthy control group for comparative purposes. The study should also measure the neuropsychological status of past and present pilots and follow-up on those who failed routine pilot proficiency tests.
Is the reported ill-health in aircraft crew linked to exposure to contaminated cabin air?	Examined the scientific literature to find out if there is published evidence that exposure to contaminated cabin air could possibly be associated with the symptoms of ill-health reported by aircraft crew. Anecdotal evidence (in the form of case reports/testimonies) was not used in drawing final conclusions as it did not meet the required standards of a properly designed/performed study in humans.	The rates at which concerns over air quality and health symptoms are reported vary according to, for example, job title, sex, age and employment status. The available evidence was not strong enough to determine whether being exposed to cabin air could be related to the reported symptoms of ill health experienced by commercial aircraft crew. Studies were not adequately designed to address this question. However, with regard to acute/short term health effects, the COT felt that it was possible that there could be a relationship. It was considered that long-term health effects could also arise through non-chemical mechanisms in some individuals working in a commercial aircraft cabin environment.	In view of the plausible nature of evidence linking exposures to short-term health effects, further research in humans should be conducted to determine whether exposure to contaminated cabin air is responsible for the reported ill-health in aircraft crew.

What action has the DfT taken so far?

In January 2008, the DfT published a report on the initial testing of proposed cabin air monitoring equipment http://www.dft.gov.uk/pgr/aviation/hci/cabinairtest.pdf and has planned a second and more substantive phase of in-flight testing of this equipment. Also, a steering group has been set up to oversee the next phase of the research.