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

DRAFT CONCLUSIONS ON EXPOSURE MONITORING OF THE AIRCRAFT CABIN ENVIRONMENT, ILL-HEALTH IN AIRCRAFT CREWS AND THE POSSIBLE RELATIONSHIP TO SMOKE/FUME EVENTS IN AIRCRAFT

1. The study to test air-sampling devices that might be used to monitor cabin air (Report 1) highlighted several problems that would need to be overcome in an air-monitoring study. These included a need for correct orientation of sampling tubes, better standardisation of methods (inter-laboratory agreement on quantitative measurements was poor), further validation of the analytical methods, and adaptation of the methods to measure compounds up to C17. It also indicated that one method – diffusive SPME fibres – was unsuitable. Measurements during a perceived fume event revealed a transient increase in ultra-fine particle concentration, lasting only a few seconds. With the technology that is available, peak concentrations of such short duration would be difficult to detect for many pollutants, unless the increases above background were extremely large.

2. These findings were taken into account in the design of the aircraft cabin air-sampling study (Report 3), although quality assurance was less than desirable. The specific flights that were monitored were determined by practical considerations, but the study design ensured that various types of aircraft and engine were covered, including some about which (based on anecdotal reports) there had been a priori concern. No major fume events occurred during the sampling. Only a limited range of analytes were measured, although retained gas chromatography traces would allow assessment of others if required. Visual inspection suggested that in the absence of a major fume incident, there was little correlation between pollutants in the temporal fluctuation of airborne concentrations (i.e. they did not all tend to go up or down at the same time). However, this was not examined by formal statistical methods.

3. Conclusions that can be drawn from the study are:

   i. Prospective monitoring of cabin air by the methods that were employed in this investigation is difficult because of the limited space in the flight deck and the need to accommodate both equipment and an operator. Given the rarity of major fume incidents, it would be extremely expensive to conduct such monitoring on sufficient flights to be confident of obtaining useful information about the patterns and levels of pollution during such incidents.

   ii. For the types of aircraft studied, and in the absence of a major fume incident, airborne concentrations of the pollutants that were measured

in the study are likely to be very low (well below the levels that might cause symptoms) during most flights. The data do not rule out the possibility of higher concentrations on some flights (only a limited sample of aircraft could be tested), or of higher concentrations of other pollutants that were not measured.

4 The study also provided data which had been useful in interpretation of the surface residues study (see below).

5 COT members did not identify any scientific questions of high priority that could be addressed by further analysis of data from the study.

6 The surface residues study (Report 4) looked at an even smaller number of chemicals – four organophosphate compounds selected because they were common additives in aircraft lubricants and fluids, and had been a source of concern because of their potential neurotoxicity. However, the methods used could be extended to other non-volatile pollutants. The 17 aircraft studied had not been subject to any major fume incidents, and the levels of chemicals that were measured were all low. The authors of the report concluded that they appeared consistent with those from the cabin air-sampling study. However, this assumed a single value for deposition velocity applicable to all particles, and that that all the contaminant was present as particles and not vapour, which may not be justified.

7 The statistical analysis of reported incidents (Report 2) was limited by a lack of information about the timing of fume incidents during the flights that were analysed. Thus parameters that were statistically associated with flights in which incidents occurred may have reflected the pilot's response to the incident rather than aspects of function that predict the occurrence of a fume event. The study did, however, demonstrate the feasibility of this type of statistical analysis, which with some refinement and simplification might usefully be applied in further research (see below).

8 The review of recent published literature on chemical pollutants in aircraft cabin air was consistent with the results of the studies commissioned by DfT in showing only low levels of pollutants in the absence of any major fume event. Of particular note was a biomonitoring study by Schindler et al (2013) in which urine samples had been collected from pilots and cabin crew members who reported fume/odour during their last flight. None of the samples contained *o*-TCP above the limit of detection (0.5 µg/l), and while the fume incidents may only have been minor, the study demonstrated the feasibility of collecting meaningful data in this way.

9 Taking into account what had been found previously, along with the results from the new research that had now been reviewed, the Committee agreed several conclusions:

i. Contamination of cabin air by components and/or combustion products of engine oils, including TCPs, does occur, and peaks of higher exposure have been recorded during episodes that lasted for seconds.

ii. Episodes of acute illness, sometimes severely incapacitating, have occurred in relation to perceived episodes of such contamination.

iii. There are a number of air crew with long-term disabling illness, which they attribute to contamination of cabin air by engine oils or their combustion products.

iv. The acute illness which has occurred in relation to perceived episodes of contamination might reflect a toxic effect of one or more chemicals, but it could also have occurred through nocebo effects.

v. While there is strong scientific evidence that nocebo effects can lead to, sometimes severely disabling, illness from environmental exposures that are perceived as hazardous, there is no simple and reliable way of establishing that nocebo responses are responsible for individual cases of illness. However, they are a plausible alternative explanation if toxicity seems unlikely. Distinguishing whether acute illness from fume events is likely to arise from toxicity or nocebo responses depends on: assessment of the patterns of symptoms and clinical abnormalities in affected individuals; the levels of relevant chemicals to which they might have been exposed; and what is known about the toxic effects of those chemicals and the levels of exposure at which such toxic effects occur (including the possibility that some individuals might be unusually sensitive).

vi. The patterns of illness that have been reported following fume events do not conform with that which would be expected from exposure to TCPs (which differs from the pattern of illness that occurs with over-exposure to organophosphate insecticides and nerve agents). Over-exposure to TCPs would be expected to cause delayed peripheral neuropathy. Given the short duration of reported fume incidents, to cause such toxicity, peak exposures would have to be much higher than those which have been indicated by monitoring to date.

vii. [We need to decide on our recommended way forward as regards exposure assessment – which chemicals and what methods]

viii. There could also be value in setting up a standardised system across airlines for collecting a limited set of information on all flights. The sort of information collected would be the date and time that the flight departed, the airport from which it departed, the duration of the flight, the type of aircraft and engines, the age of the aircraft and engines, relevant service history of the engines, and whether a fume incident was reported during the flight. For the small minority of flights on which fume incidents were reported, information would also be collected on the stage of the flight at which the incident occurred, its nature, duration and any consequences. This information could then be used to monitor the incidence of incidents by type and severity, and to assess their association with different features of flights (which might provide

clues to methods of prevention). Such associations could be explored using a case-control approach, which would not require analysis of the full dataset.

ix. A case-control approach could also be used to investigate associations of fume incidents with detailed parameters of the sort describe in Report 2, but restricted to those measured before the incident occurred.

x. While such studies are feasible, their design would require care, and if wished, members of the COT with relevant expertise would be pleased to advise on the specification of calls for research and to provide peer-review of proposals that are received.