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Our Ref: NAP/20333.9930
Your Ref: SSP/LJ/1004/12(W)

S.S. Payne
H. M. Senior Coroner
The Coroner's Court
Stafford Road
Bournemouth
BH1 1PA

13 April 2015

Dear Sir

Richard Mark Westgate (Deceased)

Regulation 28 Response

This letter is British Airways Plc's Response to the Report to Prevent Future Deaths issued by the Senior Coroner for Dorset dated 16 February 2015. This Response is made pursuant to Regulation 29(3)(b) of The Coroners (Investigations) Regulations 2013.

BA notes the matters of concern set out by the Coroner in the Report to Prevent Future Deaths. BA has given, and continues to give, the most serious consideration to the issue of cabin air quality.

The Matters of Concern in the Report to Prevent Future Deaths have been fully dealt with by official Government and regulatory bodies. They have studied the issue of cabin air contamination, and have provided guidance for airlines (including BA) to follow. The evidence does not support the conclusion that there is a risk that future deaths will occur unless action is taken. The most recent example of such advice may be found in the Committee on Toxicity's ("COT") Position Paper on Cabin Air in 2013.

Those regulatory investigations are continuing with the recently announced decision of EASA to undertake further research in the area.

BA follows the guidance and legislation to which it is subject. BA keeps abreast of research in this area, and has in place a system of monitoring such events.

The available evidence does not suggest that organophosphate chemicals are present in cabin air in sufficient quantities to pose a risk to health. The evidence with which you have been presented and which led to the issue of the Report unfortunately was selective and provided by only one Interested Party. We regard the future course of the Investigation as an opportunity to provide you with a balanced and fully evidence-based view on the Matters of Concern.

It is understood that the CAA concur with this view.

Yours faithfully

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Office of the General Counsel

Civil Aviation Authority

BY POST & EMAIL: Coroner@bournemouth.gov.uk

S.S. Payne
H M Senior Coroner
The Coroner's Court
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Dorset BH1 1PA

10 April 2015
Our Ref: OGC-23
Your Ref: SSP/LJ/1004/12(W)

Dear Sir

Richard Mark WESTGATE Deceased

Further to your Report to Prevent Future Deaths made under Schedule 5, para 7 Coroners and Justice Act 2009 and Regulation 28 Coroners (Investigations) Regulations 2013 dated 16 February 2015 ("the PFD Report"), I am writing to provide you with the CAA's response as required by 13 April 2015.

The CAA takes its regulatory responsibilities regarding passenger and crew health very seriously. The subject of cabin air quality has been considered by several expert studies over the years as referred to in the annex to the CAA's letter to you dated 23 March 2015, a copy of which we attach as an annex to this response. The overall conclusion of those studies is that there is no positive evidence of a link between exposure to contaminants in cabin air and possible acute and long-term health effects, although such a link cannot be excluded.

As our letter also made clear, further investigations are being conducted by the European Aviation Safety Agency (EASA). EASA is an agency of the European Union (EU) with regulatory and executive tasks in the field of civilian aviation safety across the EU. EASA has recently launched a Preliminary Cabin Air Quality Measurement Campaign and the contract was awarded on 18 March 2015 following a tender process published on 31 October 2014. This preliminary measurement campaign will develop the methodology, including validation of the equipment to be used, in performing cabin and cockpit air contamination measurements, and will be followed by a first flight measurement campaign which will provide initial indications of the cabin or cockpit air quality level. It will pave the way for EASA to commence a large-scale project, including an in-flight measurement campaign on board commercially operated large transport aeroplanes. The EASA preliminary study is due to be completed within 20 months of the award of the tender.

The CAA will co-operate fully with EASA's work on cabin air quality and will review its position in due course with the benefit of the results of EASA's study.

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In our opinion the above studies represent a proportionate, evidence-based response to the concerns that have been raised about the health implications of cabin air quality for passenger and crew. They were not taken in response to the PFD Report but have been ongoing for several years.

We would add, by way of postscript, that the evidence which has been provided to you by the legal representatives of the deceased, and upon which the PFD Report was based, is selective and contentious and does not reflect the outcomes of these expert studies. We remain of the view outlined in our letter of 23 March 2015 that it was inappropriate for the PFD Report to have been issued on the basis only of this material and without first inviting submissions from the CAA. Had we been given an opportunity to apprise you of the work that is being done we are confident that you would not have considered it necessary to issue the PFD Report at all.

We shall be writing to the Chief Coroner in these terms inviting him to clarify his Guidance on PFD Reports. In our view, if a Coroner is concerned from information he has obtained that circumstances creating a risk of other deaths will occur, or will continue to exist in future, the Coroner should first establish (a) whether those concerns are reflected by information that he has not seen and (b) what action is already being taken to prevent the occurrence or continuation of such circumstances before issuing a PFD Report. The obvious way of doing that is to invite representations from the relevant public body.

Yours faithfully

Liz Ringo

pp Kate Staples
General Counsel and Secretary to the CAA

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Annex

A. Introduction

1 The external atmosphere at the operating altitudes of modern commercial aircraft is hostile and incapable of supporting human life. The aircraft Environmental Control System (ECS) operates to provide an adequate air supply, remove contaminants and maintain a comfortable thermal environment.

2 There has been ongoing debate for many years as to whether the regulatory standards are correct and sufficient, e.g. in relation to maximum permissible cabin altitude during normal operation. In addition, there have been concerns in some quarters as to possible adverse health effects arising from issues such as the spread of contagious disease and contamination of the air supply.

3 The UK has played an active role in supporting research into cabin air quality issues, for example through participation in the European 'Ideal Cabin Environment (ICE)' study and the Cranfield University/Institute of Occupational Medicine research studies on contamination of cabin air.

4 Although the ECS used on the Boeing 787 aircraft may be a model for the future, bleed air systems will continue to be the norm on large commercial aircraft for many years.

B Regulatory and other standards

5 ICAO Annex 8. The ICAO airworthiness standards in Annex 8 to the Chicago Convention state only that the design of the ventilation, heating and, where applicable, pressurisation systems should provide an adequate environment.

6 EASA CS 25.831, 25.832 & 25.841. The EASA airworthiness regulations specify minimum requirements for ventilation for each passenger and crew member, pressurisation and maximum permissible levels of carbon monoxide, carbon dioxide and ozone. There is also a statement that crew and passenger compartment air must be free from harmful gases and vapours.

7 In Sep 09 EASA issued A-NPA 2009-10, aiming to initiate a discussion around cabin air quality degradation onboard large aeroplanes. After a review of existing and on-going research studies and the analysis of information collected by the A-NPA, the Agency concluded that a causal relationship between the reported health symptoms and oil/hydraulic fluid contamination had not been established. The Agency could not justify a rulemaking task to change the existing designs or certification specifications.

8 FAA Part 25.831, 25.832 & 25.841. The FAA regulations are not significantly different from the EASA regulations in specified requirements and standards.

9 American Society of Heating, Refrigeration & Air-Conditioning Engineers (ASHRAE). ASHRAE develops and publishes standards documents in areas related to the specialist expertise of its members. The standards are intended to be evidence- and consensus-based. They have no regulatory standing, although regulators are invited to consider using them as the basis for regulation. In 2007 ASHRAE published a new standard 161-2007 Air Quality within Commercial Aircraft.

10 ASD-STAN. ASD-STAN is an association which establishes, develops and maintains standards on behalf of the European aerospace industry in a process agreed with the European Committee for Standardisation (CEN). The Ideal Cabin Environment (ICE) project was an EC 6th framework project, delivered by a consortium led by BRE (formerly Building Research Establishment) and including the CAA AHU, which included the development of a draft European pre-standard for cabin air quality. The existing standard, EN 4618, was published in 2009 and covers a broad range of air quality and thermal requirements. The

new document, prEN 4666, was intended to complement this with additional parameters in relation to air pressure, noise and vibration, humidity and combined effects, but has not been published.

11 The ASHRAE and ASD-STAN documents both specify limits that are in some areas more detailed than the current regulatory requirements and include limits for potential contaminants that are not covered by the regulations. However, neither document proposes safety requirements for ventilation, pressurisation or carbon dioxide, carbon monoxide and ozone levels that are more onerous than the current regulations.

C Cabin pressure and ventilation

12 Most modern commercial aircraft use engine bleed air to pressurise and ventilate the cabin. The notable exception is the Boeing 787, which uses separate air intakes and electrical compressors to meet cabin air requirements.

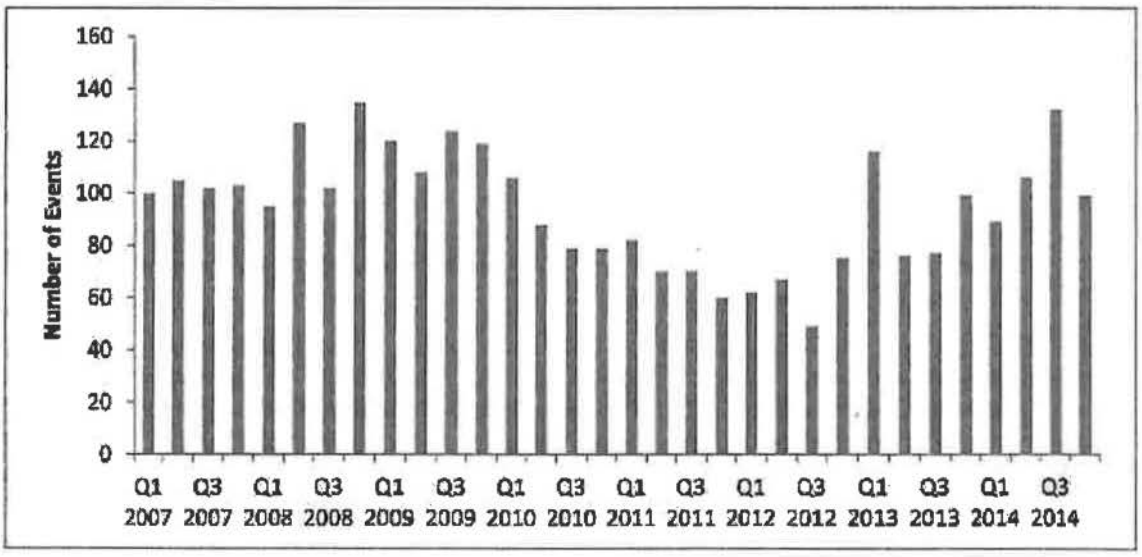
13 The pressurisation ensures that the oxygen level in the cabin air is adequate to meet the respiratory needs of healthy passengers and crew. The flow of air required to ventilate the cabin far exceeds that required to maintain an adequate level of oxygen.

14 Cabin air contamination. The cabin air may be contaminated from a number of external and internal sources. External sources on the ground include exhaust fumes from other aircraft and vehicles and de-icing fluid. Ambient air at cruising altitudes is generally free of contaminants, including microorganisms. Internal sources of contamination include toilet smells, cooking odours and overheating ovens, as well as bleed air contamination.

15 Re-circulated air and contagious disease. In the vast majority of modern large commercial aircraft approximately 50% of the cabin air is re-circulated. This results in improved fuel efficiency and helps to slightly increase the level of humidity in the air, but has led to concerns about spread of contagious disease due to microorganisms. However, re-circulated air is passed through filters of the same efficiency as those used in operating theatres and studies have shown that the microbial content of the air is comparable to that of domestic or office environments.

16 Bleed air contamination. A particular area of concern for some has been fumes events resulting from contamination of bleed air, usually with engine oil and as a result of failure of seals or maintenance errors. Issues raised include acute health effects, with potential flight safety implications, and long-term health effects.

17 Fume events. The CAA MORS reporting system collects data on fumes events on aircraft. This dataset includes those reports due to bleed air contamination. The chart shows the number of such reports received since Q1 2007:



18 Australian Senate. The Australian Parliament conducted a Senate Investigation in 1999 into air safety and cabin air quality. This followed concerns raised by crew members who reported feeling unwell due to unpleasant odours of engine oil inside BAe 146 aircraft. In response to the enquiry, BAe redesigned the original air circulation system in the BAe 146.

19 House of Lords Science & Technology Committee. The Committee launched an Inquiry into the impact of air travel on the health of passengers and crew in response to growing public concern in the press and elsewhere. Its report, 'Air Travel and Health' was published in November 2000. The report's recommendations covered a wide range of issues and led to the establishment of the AHU. Recommendations in relation to cabin air quality included that airlines collect data on the cabin environment, and that regulators consider extending cabin air quality standards beyond the existing requirements.

20 US National Academy of Sciences (NAS). In 2002, the US National Academy of Sciences published an FAA sponsored report, 'The airliner cabin environment and the health of passengers and crew'. The report updated a previous report from 1986 and reviewed the scientific evidence on air quality in aircraft cabins. Many of the report's conclusions were similar to those of the House of Lords enquiry. The NAS report also concluded that there was insufficient consistency and objectivity to support the establishment of a clearly defined 'aerotoxic syndrome'.

21 CAA report on cabin air quality. The CAA initiated a research programme in 2001 after a small number of events where flight crew were partially incapacitated. The research included investigation of the pyrolysis products of aviation lubricants, which found no component or set of components which would definitely cause the symptoms reported in cabin air quality incidents. Analysis of deposits from the cabin air supply ducts of two BAe 146 aircraft found compounds consistent with the pyrolysis products of engine oil. The report was published in 2004.

22 Aviation Health Working Group (AHWG). The DfT AHWG brought together a broad range of stakeholders, representing various Govt departments and agencies, as well as representatives of industry, unions and passengers. In July 2005 the BALPA representative presented a dossier of scientific and other evidence on the health effects of contamination of cabin air. BALPA were particularly concerned about possible exposure to organophosphates (OPs), used as anti-wear agents in lubricating oils. This dossier was considered by the AHWG Research Sub-Group, referred to the Dept of Health (DoH) Toxicology Group at Imperial College, and subsequently passed to the Committee on Toxicity.

23 Committee on Toxicity (COT) report 2007. The COT is an independent scientific committee that provides advice to the FSA, DoH and other Government Departments and Agencies on matters concerning the toxicity of chemicals. The COT review of the BALPA evidence was extended to include a review of all scientific evidence on cabin air quality as well as industry data and reports from regulators, airlines, aircraft and engine manufacturers and oil companies. Their 2007 report concluded that:

23.1 It was not possible to confirm a causal relationship between cabin air exposures and ill-health, but there was evidence of a plausible association between smoke/fume contamination incidents and acute health symptoms.

23.2 In view of the uncertainty about the chemicals released in fume incidents, any exposure monitoring should address a full range of possible contaminants and not focus on any single chemical group or compound.

23.3 Further research was needed to obtain objective measures of exposure but should not focus on OPs.

23.4 Further epidemiological research on neuropsychological impairment in pilots was warranted, although the evidence to date did not support acute or chronic health effects due to cabin air contamination incidents.

24 Cranfield University cabin air study. In response to the COT recommendations, the AHWG Research Sub-Group developed a protocol for a study to carry out in-flight monitoring of cabin air. An initial functionality study was carried out to validate the testing equipment and did capture a fume event. A range of chemical compounds were identified, but none at levels exceeding occupational exposure limits.

25 The main study successfully completed a range of air quality measurements during the course of 100 flights. The tests were conducted on two aircraft types particularly associated with fumes events, the BAe 146 and B757, with Airbus A319/320/321 aircraft as 'controls'. No fume events that triggered the airlines' protocols for formal reporting of incidents (including submission of a MOR report to the CAA) occurred during these flights. Flight and cabin crew, as well as the investigating scientists, reported a number of fume / smell events in a post-flight questionnaire. Samples taken during these events did not have elevated concentrations of any of the individually measured pollutants. Therefore, with respect to the conditions of flight that were experienced during this study, there was no evidence for target pollutants occurring in the cabin air at levels exceeding health and safety standards and guidelines. The study results were published in May 2010.

26 Institute of Occupational Medicine (IOM) swab study. In response to anecdotal reports of OP contamination found on aircraft cabin walls, an additional study was commissioned to test for OPs in swabs taken both in aircraft cabins and in other environments. The very low levels of OP encountered made the sampling and analysis challenging, with a significant possibility of contamination of blank and site sampling media from environmental. The amounts of all of the organophosphates detected on surfaces within aircraft and airport vehicles during the study were higher than those collected in offices; there may have been a contribution to the overall amount of organophosphates from flame retardants and other additives in the aircraft fasciae or electronic equipment. To provide a comparison with contemporary research into airborne levels of organophosphate compounds, the maximum airborne concentrations for isomers of TCP and for TBP were estimated by calculation. These estimated concentrations are in agreement with those detected in studies of cabin air quality. The study report was published in April 2012.

27 Civil Aviation Safety Authority (CASA) 'Expert Panel on Aircraft Air Quality' (EPAAQ). In September 2008, following concerns raised by individuals and groups concerning the possibility of low level chronic exposure to contaminants in aircraft cabin air, CASA convened the independent EPAAQ. The terms of reference required the panel to establish the current international state of knowledge, to consider the need for additional research in addition to that already being undertaken and to recommend any further action required to address health and safety risks. The Panel's report was published in October 2010.

28 The Panel concluded that there was insufficient evidence at the time to confirm or deny biologically significant exposure to cabin air contamination that would lead to significant absorption by crew or passengers. They found no direct evidence that pilots and cabin crew were being exposed to 'sub-detectable' levels of contaminants or that ill-health associated with cabin air contamination was associated with unique individual susceptibility to low levels of airborne toxic chemicals. The Panel did note the possibility that genetic polymorphism in metabolism of OPs might account for some individuals having an inherent susceptibility to toxicity. The Panel considered the evidence that exposure to contamination may result in

chronic (long-term) illness and concluded that, although there were a large number of papers which reviewed the relationship between exposure and reports of chronic ill-health, there was a lack of high-quality epidemiological studies and the question could not be resolved.

29 The Panel made a number of recommendations, particularly concerning enhancements to reporting of incidents, the follow-up of reported incidents including the medical assessment of those reporting symptoms and changes to the air conditioning systems of both current and future aircraft. In its response to the report, CASA commented that the panel's inability to reach definitive conclusions highlights the fact that this is an area of research where reasonable people's views can differ. In the circumstances, it was not considered prudent for CASA to make major policy and regulatory decisions on the basis of inconclusive evidence.

30 COT Position Paper 2013. In 2013 the COT considered the outcome of the Cranfield University and IOM research that had been commissioned by DfT following the COT report of 2007 (see paragraphs 23 to 26 above), as well as the reports of further research published in the peer-reviewed scientific literature since the 2007 report. The COT position paper was published in December 2013.

31 On the basis of their consideration of the latest research, plus the findings of the 2007 report, the COT concluded that:

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

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

31.3 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.

31.4 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.

31.5 The patterns of illness that have been reported following fume events do not conform with that which would be expected from exposure to triaryl phosphates such as *o*-TCP. Over-exposure to tricresyl phosphates would be expected to cause delayed peripheral neuropathy. Given the short duration of reported fume incidents, in order to cause such toxicity peak exposures would have to be much higher than those which have been indicated by monitoring to date.

31.6 A toxic mechanism for the illness that has been reported in temporal relation to fume incidents is unlikely. However, uncertainties remain, and a toxic mechanism for symptoms cannot confidently be ruled out.

32 The Committee also concluded that decisions to undertake further research will need to balance the likelihood that it will usefully inform further management of the problem against the costs of undertaking the work. However, they did make some suggestions for further avenues of research that might be considered, including enhanced data collection and collation following incidents (particularly with regard to engineering records), biological sample collection and analysis following events and further cabin-air monitoring studies.

E. Future research

33 EASA. The issue of cabin air contamination was discussed at a meeting of the EASA Rulemaking Advisory Group on 7 October 2014. The meeting again noted that there is insufficient safety evidence to justify the launch of a rulemaking task in this area. However, EASA is now commissioning further research based on a programme of in-flight measurements.

34 An initial tender document was published in October 2014 for a preliminary measurement campaign, intended to develop the instrumentation to perform cabin air measurements and

to perform an initial campaign of in-flight measurements. The tender closed on 8 December 2014 and the contract award was announced on 18 March 2015.

35 Following completion of the preliminary project, it is envisaged that a large-scale project, including a program of in-flight measurement on board commercially operated large transport aeroplanes, will be undertaken. This project will benefit from the preliminary campaign, both in terms of the validated material and the lessons learned.

36 AHU. In its response to the COT Position Paper, the Government noted that successive Governments have devoted considerable resources to the study of cabin air and that an international approach to the resource costs of future research investigations now seems justified. With this in mind, the Government does not plan to undertake any additional research.

37 The Secretary of State has identified the AHU as the focal point on aviation health issues for all UK stakeholders. Through its close links to all of the stakeholder groups and an extensive national and international network, the Unit will continue to provide evidence-based information and to influence and facilitate future research.

38 Airliner Cabin Environment Research Center (ACER). ACER was established as a centre of excellence in 2005 and is funded through a cooperative agreement with the United States Federal Aviation Administration. The participants include several universities, as well as a number of external organisations and companies and it has its headquarters at Auburn University, Alabama.

39 The ACER programmes, which address issues affecting the health and safety of the aircraft occupants and cover all aspects of the cabin environment, including potential air contamination, are focused in two areas:

39.1 Performing rigorous, scientifically valid environmental health research in aircraft cabins and cabin simulators

39.2 Testing and developing advanced technologies to sense and prevent safety and health incidents within aircraft cabins.

40 Reports are published on the ACER website and include several reporting aspects of cabin air contamination, including measurement equipment and procedures, cabin air monitoring and evaluation of contamination of cabin air re-circulation filters. There has been particular interest in the development of real-time sensors, which might allow incidents of contamination to be identified and quantified, but to date there are no reports of the use of such equipment or any indication of current / future research in this area.