
Parliament of the Commonwealth of Australia

# Air Safety and Cabin Air Quality in the BAe 146 Aircraft

## Report by the Senate Rural and Regional Affairs and Transport References Committee

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# ABBREVIATIONS

| | |
|---|---|
| AFAP | Australian Federation of Air Pilots |
| APU | Auxiliary power units |
| ASHRAE | The American Society of Heating, Refrigeration and Air Conditioning Engineers |
| ATSB | Australian Transport Safety Bureau |
| BASI | Bureau of Air Safety Investigation |
| CAA | Civil Aviation Authority |
| CAAP | Civil Aviation Advisory Publication |
| CAR | Civil Aviation Regulation |
| CASA | Civil Aviation Safety Authority |
| CO2 | carbon dioxide |
| CO | carbon monoxide |
| ECS | environmental control system |
| FAA | Federal Aviation Authority (USA) |
| FAAA | Flight Attendants Association of Australia |
| GCAT | Genetic Consulting and Testing Pty Ltd |
| IAQ | indoor air quality |
| ICAO | International Civil Aviation Authority |
| MCS | Multiple Chemical Sensitivity |
| MJO | Mobil Jet Oil |
| MMEL | Master Minimum Equipment List |
| NICNAS | The National Industrial Chemicals Notification and Assessment Scheme |
| NJS | National Jet Systems Pty Ltd |

| | |
|---|---|
| TCP | Tricresyl phosphate |
| TMPP | Trimethyl Propane Phosphate |
| TOCP | Triorthocresyl Phosphate |
| TVOC | Total Volatile Organic Compounds |
| VOC | Volatile Organic Chemicals |

# CONDUCT OF THE INQUIRY

On 22 March 1999 the Senate referred the following matters to the Committee for inquiry and report:

a) the impact of Airspace 2000 on airspace users, operators and providers, including its safety implications;

b) the application of competition policy to services provided by Airservices Australia;

c) the impact of location specific pricing; and

**d) the examination of air safety, with particular reference to cabin air quality in BAE 146 aircraft.**

The inquiry was widely advertised throughout Australia in mid-July 1999. It became apparent as submissions were received by the Committee that a large proportion of the submissions were concerned with item (d) of the terms of reference dealing with the BAe 146 aircraft. As a result of this public interest in this specific term of reference it was decided to treat item (d) as a separate inquiry.

During the inquiry the Committee received **53** submissions, **31** public and **22** confidential dealing with the BAe 146 (**Appendix 1** is a list of the public submissions made to the inquiry).

The Committee held a total of eight public hearings and three *in camera* hearings during the inquiry. The hearings were held in Canberra on 1, 2 November 1999, 13, 14 March, 10 April, 1 May 2000 and 17 August 2000, Sydney on 1 February 2000 and Brisbane on 2 February 2000 (**Appendix 2** is a list of witnesses who gave evidence in public hearings).

# EXECUTIVE SUMMARY

## Background

1. The Senate Rural & Regional Affairs & Transport References Committee commenced an inquiry on a range of airspace and air safety issues in early 1999. The Committee was aware at the time it started its inquiry that there had been a history of complaints concerning the quality and effects of cabin air quality in the BAe 146 aircraft.

2. As submissions were progressively received on the reference it became apparent that a large proportion of submissions were directed at issues raised by paragraph (d) of the terms of reference dealing with any link between air safety and cabin air quality on the BAe 146 aircraft.

3. As a result the Committee decided to hold a separate inquiry on the issue.

4. The Committee's report and recommendations result from that inquiry.

5. The general issue of cabin air quality on commercial passenger aircraft is a matter of growing international interest, and is currently the subject of a number of investigations, assessments and inquiries in the United Kingdom, Europe and the Unites States.

6. These inquiries are directed at determining how a variety of factors so to combine to affect the aircraft cabin environment on aircraft. The further aim of these inquiries is to re-examine whether current regulatory requirements and technical standards are adequate in relation to a range of health standards including cabin air quality.

## The BAe 146 - Cabin Air Quality

7. The focus of this inquiry concerned factors in aircraft design and engineering, particularly in relation to the BAe 146, which govern cabin air quality, and how poor quality cabin air quality can occur. It should be noted that, while its focus has predominantly been on the BAe 146, the question of cabin air quality has also been raised with respect to other aircraft types. Poor quality cabin air includes air affected by:

- Unpleasant odours
- Stale air
- Inadequate circulation of fresh air
- Fumes
- Smoke
- Chemical contamination

8. Drawing on the submissions received by the Committee from air operators, pilots, cabin crew, airlines, regulatory and air safety authorities and the aircraft's maker, British Aerospace, it is clear that, the problem with the BAe 146 took a considerable time to identify and to address.

9. It is conceded generally that cabin air in the BAe 146 has been, to use the most commonly used description, 'smelly' since its introduction into passenger service in the mid-1980's. The cabin air on the aircraft has been an identified as a persistent problem since the early 1990's.

10. As well as a record of unpleasant odours, from time to time fumes from lubricating oil used in the aircraft's engine have entered the aircraft's cabin.

**The BAe 146 - Cabin Air Quality and Occupational Health**

11. There has been for some time an occupational health effect suffered by a number of aircrew and cabin crew flying the BAe 146.

12. The record of a connection between an occupational environment problem and the manifestation of consequent health effects on staff, took time to recognise and a longer time to address.

13. As a result those employees who have experienced the most severe health effects have had to either cease flying, transfer from flying on the BAe 146 to other aircraft types or take varying periods of time off work to recover.

14. As the Committee details in the report, a number of these individuals are now in the process of pursuing claims in the appropriate tribunals. They are seeking compensation for the effects they claim result from exposure to poor quality or contaminated air in the BAe 146.

15. As the Committee also details in the report, professional associations representing pilots and cabin crew flying the aircraft have become closely involved in the issue and have ensured that protection of their members' health has been a principal issue for consideration in remedying the problem with the BAe 146.

**The BAe 146 - Recognising and Remedying the Cabin Air Problem**

16. A further focus of the report is on the response by the operators of the BAe 146 in Australia and the involvement to the problem of the aircraft maker, British Aerospace in assisting and advising operators.

17. The Committee describes the design and engineering of the provision of cabin air on the BAe 146, and how this system was studied, monitored and modified to address the problem.

18. In particular, the Committee highlights the remedial programs, largely in the hands of aircrew, which were set up by Ansett Airlines, operator of the majority of BAe 146 in Australia, and how these programs have resulted in detailed recording of events of poor cabin air quality on the aircraft.

19. The re-design of the aircraft's air circulation system, and the consequent modification of all BAe 146 currently flying in the Australian passenger fleet, and the programs followed to complete those modifications are given in the report.

**The BAe 146 - Cabin Air Quality and Air Safety**

20. In a number of places in this report, the Committee provides an account of the regulatory framework applying to cabin air quality in passenger aircraft.

21. An important feature of the Committee's account of these regulations and standards is that all are enacted as regulations - or orders - under Australian and international aviation regulatory frameworks and are directed at ensuring that all aircraft have systems or appropriate standards for safe flight.

22. The important discussion this inquiry has raised - and which the report addresses in its recommendations - is the extent to which the relevant Australian air safety regulatory bodies, the Civil Aviation Safety Authority and the Australian Transport Safety Bureau (a body which incorporates the previous Bureau of Air Safety Investigation) have responded to information that has been made available to them regarding the problems with the BAe 146.

23. In this regard, recommendations made in a BASI Incident Report in relation to a 1997 incident involving air quality problems on the BAe 146 were not accepted - and accordingly not acted upon - by CASA. This is a decision with which the Committee disagrees.

24. There have been recorded incidents, in Australia and elsewhere, involving the BAe 146 during which air quality on the aircraft has deteriorated during a flight to the extent that aircrew and cabin crew experienced effects such as dizziness, nausea and disorientation.

25. As the Committee notes in its report, the BAe 146 aircraft has been operating in many countries for some 15 years and has, according to available records, been involved in 5 accidents in which lives were lost. None of these accidents have been found to result from cabin air quality problems. The findings, with respect to one accident, are yet to be finalised and published.

**The BAe 146 - Issues Which Now Require Action**

26. In formulating its recommendations to the Senate in this inquiry, the Committee is acutely aware that, if the problems encountered with the BAe 146 are to be properly addressed, that there be a sound basis for doing so.

27. Accordingly, the Committee's recommendations are made with the aim of ensuring that appropriate assessments are made of the BAe 146 and other passenger aircraft to ensure that proper standards of air quality are made mandatory for Australian aircraft bearing in mind Australian operational conditions.

28. These recommendations are particularly addressed to CASA as the Australian air safety agency and the administrator of aircraft operating regulations and standards.

29. In addition, the Committee recommends that the Commonwealth initiate a number of responses to ensure that occupational health issues raised by this inquiry are addressed.

# RECOMMENDATIONS

## Recommendation 1

**(a)** **The Committee recommends that CASA should reassess matters recommended for further action by the BASI/ATSB incident report (No. 199702276) concerning the incident on 10 July 1997 involving Captain Kolver.**

**(b)** **The Committee also recommends that CASA reassess its requirements for monitoring the operations and cabin and cockpit air quality of the BAe 146 aircraft operating in Australia and, where necessary, introduce regulations under the *Civil Aviation Act 1988* specifying:**

- **a specific national standard for checking and monitoring the engine seals and air quality in all passenger commercial jet aircraft;**
- **maintenance procedures (including specific maintenance procedures for ageing aircraft);**
- **specific, appropriate maintenance and operational procedures for the BAe 146 which pay particular attention to the need to ensure aircraft are withdrawn from operational flying and serviced to ensure any operating faults resulting in oil leaks, fumes or smoke are immediately repaired;**
- **that incident reports should now be specifically designed so as to reflect the history of the cabin air problem that has been encountered on the BAe 146;**
- **sources of contamination in the cabin and cockpit environment in the BAe 146 be identified and further evaluated using appropriate sampling and analytical technology for the contaminants which, for example, might result from the burning of lubricating oil used in the BAe 146 engines;**
- **companies operating BAe 146 and other passenger commercial jet aircraft in Australia provide CASA with specific reports on the results of monitoring these matters within an appropriate timeframe, whether quarterly or six-monthly, in order that CASA can assess the operations of the aircraft; and**
- **air quality monitoring and compulsory reporting guidelines for all passenger jet aircraft operators.**

## Recommendation 2

**The Committee recommends that CASA adopt the modification to aircraft air circulation systems proposal for the BAe 146 aircraft by the aircraft's manufacturer as compulsory for all BAe 146 operating in Australia and that this be achieved by preparation and issue by CASA of an appropriate form of maintenance direction under the Civil Aviation Regulations.**

**The Committee also recommends that registration of BAe 146 aircraft operating in Australia be reviewed, and that renewal of Air Operating Certificates and registration of the BAe 146 be subject to completion of those recommended modifications as a condition for continued registration of the aircraft.**

## Recommendation 3

**The Committee believes that development of an appropriate and accurate test for the presence of any chemical fumes in aircraft cabins is essential. The Committee accordingly recommends that CASA liaise with operators to develop a standardised, compulsory monitoring program which provides for testing cabin aircraft air during fume events.**

## Recommendation 4

**That the issue of cabin air quality be reviewed by the National Occupational Health and Safety Commission with a view to including aerotoxic syndrome in appropriate codes as a matter of reference for future Workers Compensation and other insurance cases.**

## Recommendation 5

**The Committee recommends that the Minister for Transport request the Strategic Research Development Committee of the National Health and Medical Research Council to set up and undertake an appropriate research program on the effect of exposure to aircraft cabin air on air crew and passengers. The Committee also recommends that the Minister advise the Parliament on the form and duration of, such a program as part of the Government response to this report.**

## Recommendation 6

**While the Committee is aware that the cases referred to are a matter of state jurisdiction, the Committee recommends that the Minister for Transport, in co-operation with appropriate State Ministers, appoint an experienced, retired judicial officer or eminent person who is appropriately qualified to conduct a review of unsuccessful or inordinately delayed employees' compensation cases, pilots' loss of license insurance, personal income protection, and with-held superannuation/other insurance claims made for personal injury and loss of employment as a result of ill health claimed to result from exposure to fumes on**

**the BAe 146 and other aircraft. That person should be asked to report to the Minister on any conclusions they reach and whether those cases were dealt with according to requirements and appropriate standards of procedural fairness.**

**The Committee also recommends that the Minister table the conclusions and any recommendations it makes in the Parliament.**

## Recommendation 7

**The Committee recommends that the Minister for Employment, Workplace Relations and Small Business, as the Minister responsible for national issues affecting occupational health and safety authorise a review of the use of Mobil Jet Oil II and that the National Industrial Chemicals Notification and Assessment Scheme be requested to conduct this review.**

**The Committee also recommends that the potentially hazardous chemical components of Mobil Jet Oil II be referred to NICNAS as a priority for review and assessment.**

## Recommendation 8

**The Committee recommends that CASA assess how quickly fitting appropriate high-grade air filters can be made mandatory for all commercial airliners flying in Australia to minimise any deleterious health effects arising from poor aircraft cabin air on crew and passengers. In view of proposed standards currently under consideration in the United States of America and elsewhere, such a system should ideally be designed to remove at least 99% of particles 0.3 micron or larger from recirculated cabin air.**

# CHAPTER ONE

# INTRODUCTION AND BACKGROUND

## Introduction – the issues before the Committee

1.1 This inquiry was initiated to investigate reports that chemical fumes, particularly containing Tricresyl phosphate (TCP), have contaminated and continue to contaminate, cockpits and passenger cabins of the BAe 146 model aircraft operating in Australia, affecting the capacity of pilots and cabin crew to safely operate the aircraft.

1.2 The Committee particularly investigated whether TCP, which is a known toxin if inhaled, and other chemicals toxic to humans, have entered, and continue to enter BAe 146 aircraft cabin air. The impact on the health of flight crew and passengers as a result of possible exposure to fumes in the cabin air, was also a principal concern of the Committee's inquiry.

## Current Applicable Australian Regulatory Requirements – Flying and Airworthiness

*Civil Aviation Regulations (CARs)*

1.3 The Committee initially notes that several current regulations (Civil Aviation Regulations – CARs) made pursuant to the *Civil Aviation Act 1988* require pilots to be in a suitable state of health for flying an aircraft and therefore acknowledges the regulatory link between crew health and air safety. The following Civil Aviation Regulations on crew health are considered relevant:

- CAR 2 *(major defect)*

> …. as in relation to an aircraft, means a defect of such a kind that it may effect the safety of the aircraft or cause the aircraft to become a danger to person or property.

- CAR 48.0 (*Flight time limitations*).

> 1.4: Notwithstanding anything contained in these orders, a flight crew member shall not fly, and an operator shall not require that person to fly if either the flight crew members is suffering from, or considering the circumstances of the particular flight to be undertaken, is likely to suffer from fatigue or illness which may affect judgement or performance to the extent that safety may be impaired;

- Civil Aviation Advisory Publication (CAAP) 51-1 (O) advises

(c) smoke, toxic or noxious fumes inside the aircraft is considered a major defect.[1]

1.4 With regard to any relationship between cabin air quality on the BAe 146 and air safety, the Committee is also aware of the following Federal Aviation Regulations which are incorporated into Australian CAR's governing cabin air quality.

*Federal Aviation Regulations (FARs)*

- FAR 23.831 *(Ventilation and heating)*

(a) Under normal operating conditions and in the event of any probable failure conditions of any system which would adversely affect the ventilation air, the ventilation system must be designed to provide a sufficient amount of uncontaminated air to enable the crew members to perform their duties without undue discomfort or fatigue and to provide reasonable passenger comfort.

(b) Crew and passenger compartment air must be free from harmful or hazardous concentrations of gases or vapours.

(c) There must be provisions made to ensure that the conditions prescribed in paragraph (b) of this section are met after reasonably probable failures or malfunctioning of the ventilating, heating, pressurisation or other systems and equipment.[2]

1.5 The Committee also observes that the link between pilot health and air safety is explicitly acknowledged by the Civil Aviation Safety Authority (CASA), in a newsletter dated November/December 1999 and titled 'Fit to Fly' which counsels pilots on the impact that minor health problems can have on their capacity to fly.[3]

*Health and Safety Issues*

1.6 In addition to crew health, and aircraft airworthiness, the issue of fume contaminants should also be considered a safety issue with regard to the ability of cabin crew to properly supervise the evacuation of an aircraft and the ability of passengers to take part in an evacuation.

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1 See CASA website, www.casa.gov.au, *Legislation and Regulations*, Civil Aviation Advisory Publications, 51-1.

2 This regulation is an United States of America Federal Aviation Regulation (FAR) applicable as an Australian CAR under international regulatory harmonisation arrangements and, accordingly, apply to Australian registered aircraft.

3 Flight Safety Australia, *Nov-Dec 1999*, pp 33-34

1.7 Written submissions to this inquiry considered by the Committee, both public and confidential, provide evidence of more than 700 recorded incidents in the last 15 years where fumes have been reported to have entered the cabin and contaminating the cabin air on BAe 146 aircraft operating in Australian airspace. This evidence was provided by aircraft operators and by various unions and associations representing flight crew.

1.8 While the total number of reported incidents varies, a summary of fume reports provided by Ansett Australia and the Flight Attendants Association of Australia shows the figure of 700 incidents to be a conservative estimate of fume occurrences since the BAe began operating in Australia.[4]

1.9 Evidence was also provided of a successful application for employees compensation in the Compensation Court of New South Wales for the aggravation of a pre-existing illness caused to a flight attendant, Ms Alysia Chew, due to exposure to fumes during an incident on a BAe 146.[5]

1.10 Several other successful applications for workers' compensation for illness attributed to fumes on the BAe 146 have also been drawn to the Committee's attention. Currently two civil actions are being pursued for common law damages for illness allegedly resulting from exposure to fumes on a BAe 146.[6]

1.11 The Committee was informed that when this issue became a matter of general public concern, some 140 Ansett flight crew held medical certificates exempting them from flying on the BAe 146. Some of these crew requested exemption as a precautionary measure and were not suffering the effects of exposure to fumes on the aircraft. At the time of this report, Ansett has advised the Committee that nearly 80 per cent of previously exempt flight attendants have returned to flying on the BAe 146 'without any significant issues being raised or ill effects reported'.[7]

1.12 The Committee received approximately 20 individual submissions describing symptoms experienced by crew members and attributed to oil fumes leaking into the aircraft cabin. The Committee notes that of 31 public submissions made to the inquiry, a significant number argued that contamination of cabin air on BAe 146 aircraft was a continuing problem warranting further action and investigation.

1.13 These submissions described in detail symptoms crew members experienced as a result of exposure to cabin air in the aircraft. These submissions also set out how these exposures had affected their health and the processes they followed in dealing

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4 Flight attendant information kit, Ansett Australia. (Estimate of on average of 1 in every 131 flights is affected by fume occurrences); see also submission 24, *Flight Attendants' Association of Australia.*

5 Alysia Chew v Eastwest Airlines and Ansett Australia Ltd, *Compensation Court of New South Wales*, (Matter no 19652/1995)

6 Letter dated 22 September 2000, Ansett Australia to the Committee, *supplementary material.*

7 Letter dated 10 October 2000, Ansett Australia to the Committee, *supplementary material.*

with their employers concerning the health problems they experienced.[8] A number of other submissions argued there was not a continuing problem warranting further action and investigation. The remaining submissions did not advocate the implementation of any further action.

1.14 The Committee also received evidence from the operating airlines describing in detail the steps taken to address the problem, including compulsory reporting systems and extensive modifications to the BAe 146 air circulation system.

1.15 As noted, the Committee is particularly concerned to identify whether the BAe 146 presents a link between effects on occupational health of flight crew and the safe operation of the aircraft. This has emerged as a difficult and controversial issue.

1.16 The Committee received considerable evidence criticising aspects of the regulatory regime for the aircraft and focusing on issues that should be taken up by regulators, such as:

- oil leaks and exposure to oil fumes;
- responses to crew complaints;
- testing procedures for cabin air; and
- modifications measures necessary to remedy fume contamination.

1.17 The Flight Attendants Association of Australia (FAAA) told the inquiry in evidence that:

> There has been a significant exercise in semantic tap-dancing by the regulatory authority, CASA, over whether this is a health issue or a safety issue as though there is some need for distinction between the two. The flight attendants on board the aircraft are on board for this reason: there is a regulatory requirement that, to ensure the evacuation of all passengers in under 90 seconds through half the available exits, cabin crew are required to be there. Flight attendants are there for safety. If flight attendants are having to be carted off aircraft in wheelchairs and placed onto oxygen during descent, the health of these flight attendants has been affected to the extent where the safety of the flight and of those passengers has been compromised. Consequently, the issues of health and safety are not separate, but are inextricably intertwined.[9]

1.18 However, a letter to the Committee from the Australian Transport Safety Bureau (ATSB) responding in part to the issue of fumes in relation to neurological impairment, set out the view of the Bureau on this issue:

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8 Ms Judy Cullinane submitted a detailed submission and additional documents setting out details of her illness and her experiences in dealing with Ansett, *Submission 17*, Ms Judy Cullinane; see also *Submission 10*, Deborah Carter; and *Confidential submissions C20* and *C19*.

9 FAAA, *Evidence*, 2 February 2000, p 155

> This is in the field of occupational medicine and should not be confused with Aviation Safety unless there is immediate incapacitation of flight crew. If the latter occurred, then the ATSB, and for that matter CASA, would become involved.
>
> Long term incapacitation as a result of exposure in the workplace is covered by all State and Commonwealth legislation as an Occupational Health and Safety (OH&S) issue and is appropriately addressed as such.[10]

1.19 Opinion is divided on this issue within the ATSB. Mr Brett Leyshon of the ATSB supported the view of the flight attendants in relation to safety when he told the inquiry in evidence:

> The crew are not simply there to direct passengers to seats and to serve meals. They serve an important safety function throughout the flight, even a normal flight. Removing those removes a layer of safety to the passengers in the cabin.[11]

1.20 Potential links between air safety and health effects resulting from exposure to fumes on the BAe 146 are discussed in Chapters 4 and 5 of this report.

1.21 The Committee has had regard to those confidential submissions made during the inquiry by individuals currently pursuing claims for compensation through appropriate means and in the appropriate tribunals. The submissions allege exposure to fumes on the BAe 146 to be the source of the illness and incapacity to continue work and of damage to health, careers or both.

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10 Correspondence from ATSB to the Committee dated 10 April 2000, p 1

11 ATSB, *Evidence*, 13 March 2000, p 196

# CHAPTER TWO

# THE BAe 146 AND AIR QUALITY

## The aircraft

2.1 The BAe 146 aircraft was originally certified in the United Kingdom in 1983 and first entered service in 1984. The BAe 146 has been certified by 37 different national regulatory authorities, including Australia's CASA.[1]

2.2 According to British Aerospace, as of November 1999 there were approximately 350 BAe 146 aircraft operated throughout the world by 52 operators.[2] The 'World Airline Census' from the *Flight International* publication shows 205 BAe 146 aircraft of all series flown, both passenger and freight, by 36 operators.[3] The Committee was also told that, as of November 1999 the BAe 146 had carried approximately 4.5 million passengers without a single fatality "due to the technical standard of this aircraft."[4]

2.3 British Aerospace told the inquiry on 10 April 2000 that the company was

> … proud of the fact that after 5.2 million flight hours the 146 fleet has never suffered a fatal accident due to technical failure, which makes it one of the safest aircraft in operation today.[5]

2.4 The Committee also notes that, according to accident reports carried in the Aviation Safety Network, as set out on their internet site, there have been four fatal accidents involving BAe 146 aircraft since 1987 and that 156 people in total were killed as a result of those accidents. The Committee notes British Aerospace's evidence that there have been no fatal accidents involving the BAe 146 arising from the 'technical standard' of the aircraft.

2.5 The Committee also notes that, according to the publicly available information on the Aviation Safety Network, one of these accidents was attributed to a 'technical problem'. A China Northwest Airlines BAe 146 300 series aircraft crashed into an earth bank while attempting to take off from Yinchuan airport in China on 23 July 1993 killing 55 people. An investigation established that although takeoff flaps had been selected on the aircraft for takeoff they did not extend resulting in the aircraft crashing.[6]

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1 British Aerospace, *Evidence*, 2 November 1999, p 73

2 British Aerospace, *Evidence*, 2 November 1999, pp 73-74

3 'World Airliner Census', *Flight International,* 29 August – 4 September 2000, p 60

4 British Aerospace, *Evidence*, 2 November 1999, p 74

5 British Aerospace, *Evidence*, 10 April 2000, p 222

6 See www.aviation-safety.net - Aircraft Accident description, 23 July 1993, BAe 146 300

2.6 An accident in 1998, which occurred in Morocco in which all 38 passengers and crew on board died, is still the subject of investigation by air safety authorities in Morocco.[7]

*Aircraft configuration*

2.7 The BAe 146 aircraft has four wing mounted engines manufactured by the Arizona based company Allied Signal Aerospace. The engines used in Australia are the Avro Lycoming, ALF-502 with 18 aircraft using the ALF-507. The Australian Federation of Air Pilots (AFAP) told the Committee that the engine type was initially developed for use in military heavy lift helicopters. The engine was redesigned for "high by pass" use and was subsequently fitted to the BAe 146.[8]

*Number of BAe 146 aircraft operating in Australia*

2.8 'Airliner Census' quoted in paragraph 2.2 notes that as of September 2000 there are 31 BAe 146 aircraft operating with the following airlines in Australia:

| Operator | Aircraft Series | No |
|---|---|---|
| **Airlink** | 100<br>200<br>300 | 5<br>6<br>2 |
| **National Jet Systems** | 100 | 1 |
| **Southern Australia** | 100<br>200 | 1<br>3 |
| **Ansett** | 200<br>300 | 7<br>3 |
| **Ansett Australia Cargo** | 200QT | 2 |
| **Ansett New Zealand** | 300 | 8 |
| **Australian Air Express** | 100QT<br>300QT | 1<br>2 |

[9]

2.9 Ansett told the Committee that as of 2 November 1999 it had four 300 series passenger jets operating predominantly in the eastern part of Australia, and seven 200 series aircraft providing the airline's intrastate service in Western Australia. Ansett noted in its evidence that the BAe 146 is the only aircraft type in Australia suitable for servicing its air routes in north-west Australia.[10]

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7 See www.aviation-safety.net - Aircraft Accident description 25 September 1998, B, BAe 146 100

8 *Submission 14A*, AFAP, p. 2; see also *Submission 14B*, AFAP, pp 23-24

9 'World Airliner Census', *Flight International,* 29 August – 4 September 2000, p 60

10 Ansett Australia, *Evidence*, 2 November 1999, p 62

2.10 During the inquiry the number of BAe 146 aircraft operating in Australia changed. On each occasion that Ansett, Qantas or National Jet Systems appeared at public hearings the Committee was brought up to date with the current number of BAe 146s then being operated in Australia.[11]

2.11 The BAe 146 is configured in Australia to carry about 70 passengers with a normal air crew of five; two pilots and three flight attendants.

2.12 In November 1999 Ansett Australia told the Committee that of its 900 pilots, 165 were regularly flying BAe 146 aircraft.[12]

**Source of air in the BAe 146 cabin**

2.13 The Committee was given a detailed account by AFAP of the air source and circulation system employed on jet passenger aircraft. A concise description is as follows:

> The engine comprises a fan module, a high-pressure compressor, a combustion chamber and a turbine section. High pressure compressed bleed air is ducted from the rear of the final stage of the high pressure compressor, and is used to pressurise the cabin and to provide aircraft air conditioning (heating) and engine pneumatics. Thus the engine air is used to provide in flight air, pressurisation and air driven systems.[13]

2.14 The Committee was also provided with a detailed description of how the system used to bring air into the BAe 146 from the engines operated:

> The bleed air is air that has been passed from the engine air intake through the engine compressor and then bypasses the engine combustion chamber as it is bled off through the engine pylons. It is then diverted to various systems as well as ducted downstream through the environmental control system to the cabin and flight deck.
>
> As the air is ducted to the rear of the aircraft, it enters 2 air conditioning packs. The air conditioning packs are fed independently from the left or right engines and do not interconnect. One air conditioning pack can supply cabin air and pressurisation requirements for the whole aircraft. One engine per side can feed its related air conditioning pack.
>
> The engines on the left wing (engines 1 & 2) service air con pack 1, which provides air to the flight deck and passenger cabin. Engines 3 & 4 on the right wing supply pack 2, which supplies air to the cabin.

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11 For example see Ansett Australia, *Evidence*, 1 May 2000, p 242

12 Ansett Australia, *Evidence*, 2 November 1999, p 61

13 *Submission 14A*, AFAP, p 2

> The Auxiliary Power unit (APU) in the BAe 146 is either an Allied Signal Garrett or Sundstrand unit. The APU is a small turbine engine that supplies air and/or electrical power when the aircraft is on the ground and for certain periods of flight, such as take off or landing, when air cannot be spared from the main aircraft engines. [14]

2.15 The BAe 146 is designed to operate with the air conditioning system re-circulating a proportion of cabin air. It is generally considered that re-circulated air improves humidity levels in the aircraft cabin and cockpit and is a feature designed to reduce symptoms of watering eyes as well as nasal and throat dryness caused by dry air.[15]

2.16 The Committee was told that the cabin air of the BAe 146 is changed in under four minutes, 16 times an hour.[16] This air is approximately 60 per cent fresh and 40 per cent recycled.

2.17 Currently the only way of bringing air into a jet aircraft during flight is to bleed air off the engines.[17] British Aerospace explained:

> … the engine is the only source of high pressure, high temperature air on this or any other jet aircraft in the world today. It is the source used by every aircraft manufacturer today. The fact that air is removed before the air comes around and into the combustion process means that there are absolutely no combustion products in the air. …
>
> This air from the engine is fed to the rear of the aircraft. It is then conditioned in air conditioning packs to reduce the pressure, reduce the temperature and it is then fed into the cabin. …
>
> The cockpit has a similar arrangement: the air comes in through the pipes, is fed into the cockpit and the only difference is that the amount of air supplied is twice that per passenger.
>
> So we feed twice the amount of air - ten cubic feet per minute - to the pilots. We feed five cubic feet per minute to the passengers. Those are the regulatory requirements. All of the air comes from exactly the same place - the engine compressor.[18]

2.18 The Committee also notes advice that there are no combustion products in air circulated in the cabin, as air is bled from the engines before the combustion process takes place. However, as British Aerospace acknowledged:

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14 *Submission 14B*, AFAP, p 3; see also *Submission 6,* Associate Professor Chris Winder, p 4.

15 *Submission 11*, British Aerospace, p 2

16 Ansett Australia, *Evidence*, 2 November 1999, p 67

17 Ansett Australia, *Evidence*, 2 November 1999, p. 65

18 British Aerospace, *Evidence*, 2 November 1999, p 75

> … reports of cabin air odours have been received from time and time and have predominantly been determined to be due to minor systems failures such as leaks from oil seals on aircraft engines on APU.[19]

2.19 Dr Chris van Netten, Associate Professor, Faculty of Medicine, University of British Columbia in Canada drew the Committee's attention to another aspect of the BAe 146 design during his evidence to the inquiry:

> … the flight attendants and the passengers are serviced by air coming from engines 3 and 4, whereas the pilots are serviced from engines 1 and 2, …
>
> The pilots get air from engines 1 and 2 under normal conditions … as soon as you get an oil seal leak in engine 1 or 2 then the pilots get higher exposure than anybody else because they get more fresh air.[20]

2.20 The possibility of developing alternatives to the existing system of bringing bleed air into the cabin from the jet engines was raised several times during this inquiry. In response to such a suggestion Mr Ivor Williams, Chief Systems Engineer with British Aerospace, commented:

> The technology of today really means that to get a compressor to drive all that air into the aircraft there really need to be some bearings and some oil. To me, as an engineer, it does not matter much whether it is a separate compressor driven by an electrical motor or a compressor driven by an engine. It will come to the same thing in the end, because it will have oil and bearings in it and they will be subject to failure. Indeed, aeroplanes have been like that for a long while. There might come a day when you can develop a compressor that does not need oil - maybe some air bearings or something of that kind. But I suspect that engines will be that way as well.[21]

**Domestic and international laws and standards for the quality of air in aircraft**

2.21 Australia has adopted design standards and requirements for all aircraft which are certified to operate in Australian airspace. As noted above, these include United States Federal Aviation Regulations (FAR's) (section 25) and joint European Aviation Regulations (section 25). Both standards have requirements dealing with cabin ventilation and contamination in an aircraft. FAR 25.831 requires:

> (a) Under normal operating conditions and in the event of any probable failure conditions of any system which would adversely affect the ventilating air, the ventilation system must be designed to provide a sufficient amount of uncontaminated air to enable the crewmembers to perform their duties without undue discomfort or fatigue and to provide reasonable passenger comfort….

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19 *Submission 11*, British Aerospace, p 127 (vol 1)

20 Associate Professor C. van Netten, *Evidence*, 14 March 2000, p 206

21 British Aerospace, *Evidence*, 10 April 2000, p 227

> (b) Crew and passenger compartment air must be free from harmful or hazardous concentrations of gases or vapours. …
>
> (c) There must be provisions made to ensure that the conditions described in para B. .. are met after reasonably probable failure or malfunctioning of the ventilating, heating, pressurisation or other systems and equipment.

2.22 CASA confirmed to the Committee:

> Perhaps an important section is a statement under section 25.831 of FAR 25, which says that: 'Crew and passenger compartment air must be free from harmful or hazardous concentrations of gasses and vapours.' That is the only statement that is in there at present. What constitutes 'harmful' or 'hazardous' is left up to other standards, and generally they are getting into the health standards.[22]

2.23 In contrast, the Committee received evidence from the AFAP as a supplementary submission highlighting the requirements in paragraphs (a) to (c) of the regulation, and stated "… large number of crews are not getting 'a sufficient amount of uncontaminated air to enable crewmembers to perform their duties without undue discomfort and fatigue".[23]

2.24 The Committee was also advised that the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) United States' body specialising in assessing and recommending air quality standards in air conditioned and ventilated environments, has formed a specific Sub-committee to examine the issue of air quality on commercial aircraft. The eventual recommendations from ASHRAE may lead to the introduction of changes to standards in relation to aircraft air quality.[24] ASHRAE is:

> … developing a standard to ensure cabin air quality 1) is safe for flight and occupants; 2) minimizes the potential for adverse health effects; and 3) is comfortable to occupants.[25]

2.25 At this stage, the Committee assumes that any improvement in air quality requirements will be in addition to ventilation requirements. The AFAP's view however is that such a change may not be an adequate response:

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22 CASA, *Evidence*, 1 November 1999, p 38; see also Associate Professor C. van Netten, *Evidence*, 14 March 2000, pp 213-214. For further information on the issue of carbon dioxide in the cabins of plans see *Submission 5A*, Dr Jean Christophe Balouet, attachment pp. 5-7.

23 *Submission 14B*, AFAP, p 3

24 Jolanda N. Janczewski, *IAQ on Passenger Planes,* ASHRAE Journal, September 1999, p 18. For information on why Ansett withdrew from being part of this study see S*enate Hansard*, 25 August 1999, p 7723.

25 W. Mark Pierce and others, *Air Quality On Commercial Aircraft,* ASHRAE Journal, September 1999, p 26.

> It is … inappropriate to look to future general air quality standards when dealing with a specific aircraft problem, such as that of the BAe 146. This will not solve the BAe 146 problem and it is inappropriate for the manufacturer and others to mislead the committee by stating that ASHRAE proposals will solve the specific BAe 146 problem.[26]

## BAe 146 cabin air quality problems in Australia

*Australian Experience*

2.26 There have been reports of cabin air fumes on board Australian BAe 146 aircraft since at least 1985. In 1982 the United States Federal Aviation Authority and National Transport Safety Bureau conducted tests on the BAe 146. Ansett told the Committee its initial reported fume occurrence was in 1991, when an East West Airlines crew first reported odours on the BAe 146 series 300 aircraft. East West Airlines later became part of Ansett Australia.[27]

2.27 The ATSB told the Committee that between 1991 and 1 November 1999, when the Bureau gave evidence, 93 occurrences of fumes in aircraft had been reported.

2.28 These occurrences:

> … all fall into the general description of smoke, fumes or fire within the cabin or cockpit of an aircraft from whatever source. Those occurrences could be a simple as the spillage of food in a galley causing a fire to failure of an electronic components causing fumes to this particular occurrence - that is, the ingress of fumes from a failed seal within an engine - to multiple reports of 'nothing found' on investigation by the operator.[28]

2.29 The ATSB's only substantial investigation of fumes leaking into the cabin of a BAe 146 arose from an incident where the pilot of a National Jet Systems freight plane became incapacitated after being exposed to fumes in the cockpit while descending into Melbourne Airport in 1997. The ATSB which was then the Bureau of Air Safety (BASI) conducted an extensive inquiry of events of a similar nature and reported that the incidents were "far from rare".[29]

2.30

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26 *Submission 14B*, AFAP, p 5

27 Ansett Australia, *Evidence*, 2 November 1999, p 52

28 ATBS, *Evidence*, 1 November 1999, p 25

29 Bureau of Air Safety Investigation, *Occurrence Brief* 199702276, p 5

2.31 The BASI report also drew specific attention to the potential for further BAe 146 flight crew incapacitation due to the effects of fumes and found that the issue constituted a safety deficiency.[30] This BASI occurrence report is considered in more detail later in the report.

2.32 The Committee also received evidence concerning crew reluctance to report fumes incidents. The reported reasons for this reluctance ranged from a fear for future employment, fear for the continued operation of the aircraft and an apparent lack of awareness as to the source of the problem and possible impact on health.[31]

2.33 The ATSB supplied the inquiry with a summary of reports of fumes and smells on aircraft between 1991 and October 1999, which also shows the type of aircraft involved in the reports. (This summary is shown in Appendix 3.)

2.34 The Flight Attendants' Association of Australia, listed a detailed record of reported fumes experienced on board BAe 146 aircraft between 5 August 1992 and 27 August 1999 in its submission to the inquiry. The FAAA also highlighted the effect of the occurrences on air crew. Some of these fume occurrences have had an immediate impact on the health of some air crew. (A listing of the reports is set out in Appendix 4.)[32]

2.35 The Committee received evidence from one medical professional, Dr Mark Donohoe, that he was "… unaware of any new health problems or new patients since December 1998".

2.36 Mr Michael Egan of the Ansett Pilots Association told the inquiry during a public hearing on 2 February 2000:

> … in preparation for this inquiry, I made some inquiries, and I particularly took the trouble to speak to captains on the 146 who have been in the company or been operating the 146 for a long time. That was where I heard the story of guys who had been sick, of the chaps being nauseous, and with eye and throat irritation. They were all quite positive about the fact that these appeared to them to be past problems - and quite significantly past problems - in Ansett aircraft; that these problems happened in the early nineties.[33]

The Committee notes that Mr Egan appeared unaware of the requirements of FAR 25.831. Mr Egan told the inquiry: "… there is no regulation that I am aware of that specifies the amount of, or quality of, air in the cabin."[34]

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30 Bureau of Air Safety Investigation, *Occurrence Brief* 199702276, p 6

31 See examples in *Submission 14A*, AFAP and *Submission 24*, FAAA.

32 See also *Submission 14B*, AFAP, pp 16-17.

33 Ansett Pilots Association, *Evidence*, 2 February 2000, p 167

34 Ansett Pilots Association, *Evidence*, 2 February 2000

2.37 The Committee received evidence of continuing health problems since December 1998 experienced by flight crew allegedly exposed to fumes both prior to and after completion of the modification programs.[35]

2.38 In addition, the Committee has received submissions from several flight attendants employed by Ansett and seven pilots employed by a number of operators reporting health effects from fume contamination.[36] This number appears additional to a first officer mentioned by Dr David Lewis of Ansett Australia.[37]

*International experience*

2.39 Dr Jean Christophe Balouet in his submission noted:

> It is estimated that about 70 major smoke/haze events, no fire but cabin air contamination by aircraft fluid leaks, occur world wide annually (with 25 to 30 for the commercial aviation in the USA) and that the number of severe fume events is over 500 annually (40 000 passengers and crew). Alaska airlines have filed over 1000 complaint flights in the past ten years. In Canada, over 600 complaint reports have been filed for the past 5 years. Over 30 legal cases are censused [sic] world wide.
>
> Some aircraft types, especially BAe 146, MD 80, B 737, A 300, and a limited number of companies (ANSETT/NJS, Alaska Airlines, Air BC, Canadian operating these aircraft) have been the cause of over 90 % of the world wide problems identified today, whereas they represent less than 3% of world flights. …
>
> Ansett NJS and BAe 146 are statistically the highest ranking for cabin air problems, before Alaska.[38]

2.40 In evidence to the inquiry Dr Balouet said:

> If you have at Ansett and NJS one leak in every 160 aircraft flights, that is probably one of the poorest statistics around the world. In 1992 the statistics for Ansett was one flight with an odour every 66 flights, and one flight leaking for every 160 flights. … Eight hundred reports in eight years time is basically 100 reports per year. Alaskan Airlines, which is another company with a high number of very significant problems has a fleet which is about three times the size of Ansett plus NJS and they only have 100 reports per year.
>
> … statistically it certainly is Ansett that ranks first.[39]

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35 *Submission 24A*, FAAA

36 Ansett Pilots' Association, *Evidence*, 2 February 2000, p 168

37 Ansett Australia, *Evidence*, 2 November 1999, pp 67-68

38 *Submission 5*, Dr Jean Christophe Balouet, p 2. Information on the experience of Alaskan Airlines and other US airlines was contained in a paper dealing with air quality on airlines by C. Witkowski at the ASHRAE Conference, Chicago, 24 January 1999, set out in *Confidential submission* C14.

2.41 The ATSB responded to the claims made by Dr Balouet by noting :

> If, as Dr Balouet asserts, Ansett and National Jet Systems are the statistically highest ranking for cabin air problems, that evidence has not been provided to the ATSB. Airlines have every right to conduct their own reporting and investigation program and under this program Dr Balouet's statement may be correct. However the ATSB is only concerned with immediate safety of flight issues. Longer term exposure is an OH&S issue …[40]

2.42 Mr Mick Toller, the Director of CASA, informed the Committee that from late 1997 to the first half of 1998, the Authority closely monitored reports of fumes on the BAe 146. CASA liaised with the UK Civil Aviation Authority (CAA) concerning this issue. The UK CAA carries responsibility for certification of the BAe 146, as it is a British built aircraft. Mr Toller told the Committee that; "While anecdotal reports have been passed on to me, I have not received any specific or substantiated reports of crew member sickness from any other airworthiness authorities."[41]

2.43 The Committee notes from media reports reported fume contamination on aircraft in the United Kingdom and a serious fume contamination incident on a BAe 146 in Sweden on 12 November 1999, which occurred during a flight between Bromma and Sturup. The Committee also notes reports of fume contamination incidents in Canada and the United States.[42]

2.44 Mr Toller also advised the Committee that as of 1 November 1999, although approximately 15 per cent of the world's fleet of BAe 146s operated in Australia, it appeared this was the only country where there had been a report of a pilot being incapacitated due to fumes while flying the aircraft.[43]

2.45 CASA also stated that the "… aircraft has a reputation for poor air quality and smells within the passenger cabin."[44] In evidence to the inquiry (13 March 2000) Mr Toller advised:

> There is no doubt that all aircraft from time to time suffer fumes within the aircraft. I think we have accurately reflected that that is a feature of the basic design of airconditioning systems in aircraft, being bleed air from engines, and that on occasions engines leak. I think it is safe to say, by reputation,

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39 Dr Jean Christophe Balouet, *Evidence*, 13 March 2000, p 177

40 Correspondence from ATSB to the Committee dated 10 April 2000, p 2.

41 CASA, *Evidence*, November 1999, pp 42-43. The term crew member here refers to the pilot or co-pilot.

42 See articles that appeared in Swedish newspapers following the incident.

43 CASA, *Evidence*, November 1999, pp 42-43; see also correspondence from ATSB to the Secretariat dated 10 April 2000.

44 *Submission 20*, CASA, p 3

> that the 146 engines historically have not been the best of the engines for that. They certainly do seem to suffer more oil leaks than others.[45]

2.46 The Committee received evidence that, apart from the incident involving Captain Kolver, four other Australian BAe 146 pilots have been affected by fumes in the course of a flight.[46] The November 1999 incident involving he flight between Bromma and Malmo is currently under investigation by the Swedish Board of Accident Investigation.

2.47 Despite the views of CASA, British Aerospace asserted:

> The BAe 146 is no different in design or to frequency of oil leaks than any other aircraft. … There was an oil leak problem in the BAe 146 in 1991-92 and that reputation persists today despite the fact that modifications have been in produced to engines and auxiliary power units which have reduced the frequency of oil leaks to an industry standard level.[47]

2.48 Mr Black, Senior Vice President, Engineering Customer Support and Quality at British Aerospace (UK) in his evidence referred to Professor Balouet's submission when he stated:

> The Balouet report, … identifies 500 fume events worldwide. If that 500 worldwide relates to the 93 that are recognised in Australia that does not seem unreasonable. In there, Balouet says that Alaskan Airlines have registered 1,000 complaints, that Canadian Airlines have registered 600 complaints and that, to his knowledge, there are 30 legal cases worldwide pending on this subject. But on the 146, to my knowledge, there are no cases pending and no cases ongoing. … Again, if I refer to the BASI statistics, only 12 out of their 93 were 146 related. [48]

2.49 In his evidence Mr Black appeared to agree that some crew members had been affected by flying on the BAe 146 but in the view of Mr Black those effects did not pose a threat to air safety:

> With the weight of human evidence and suffering, which is quite clear, there must be something there. We are comfortable on the one hand that there is no flight safety risk. We are comfortable that our aircraft meet all of the rules. But, when you look at the weight of evidence, it is impossible to conclude that there is an issue….

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45 CASA, *Evidence*, 13 March 2000, p 181

46 See *Submission 16*, Mrs Robin May; Ansett Australia, *Evidence*, 1 May 2000.

47 British Aerospace, *Evidence*, 2 November 1999, p 77. For a contrary view see *Submission 24A*, FAAA, p 1.

48 British Aerospace, *Evidence*, 2 November 1999, p 81

> But all of the evidence we have to date suggests that our aircraft does not leak any more than any other aircraft and does not produce harmful chemicals in the cabin. We know there is a health issue and we will continue to work with ASHRAE and with ASTM in order to determine what that is.[49]

2.50 Such assertions appear to ignore statistical evidence on the BAe 146 issue given to this Committee. As noted in Chapter 1, the operators acknowledge hundreds of reports of fume contamination on the BAe in Australia in recent years which continue to be identified by compulsory reporting systems.[50] The Committee received evidence that Ansett has, in addition to the above occasions, recorded reported fume occurrences of 1 per 131 flights. This appears to average one incident of fume contamination on an Ansett flight per week.

2.51 Mr Black also gave apparently contradictory evidence regarding the issue of the impact of fumes on BAe 146 aircraft passengers and crew. In a written supplementary submission, British Aerospace sought to clarify Mr Black's comments. The submission stated:

> The point that Mr Black was seeking to make was simply that, given the evidence of symptoms said to have been suffered worldwide by crew of a range of aircraft types (not just the BAe 146), it is difficult to deny the existence worldwide of some form of general health issue … [51]

and

> None of the test results or other data gathered to date has (to BAe's knowledge) produced any evidence of a connection between any such general health issue and the BAe 146 (or indeed the aircraft industry generally).[52]

2.52 Mr Bruce Jones of British Aerospace also told the Committee:

> During the evidence of earlier witnesses to this inquiry there were suggestions that BAe Systems accept that there are short-term health risks associated with the aircraft. We have not, in fact, accepted this. The aircraft test data available does not support such a conclusion and, indeed, points the other way. We therefore cannot accept this proposition. While we have no direct information on the clinical nature or cause of any individual symptoms, we are very much alive to the fact that there are reports of symptoms being suffered worldwide by crew of a range of aircraft types, not just the BAe 146.[53]

and

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49 British Aerospace, *Evidence*, 2 November 1999, p 90

50 Flight attendant information kit 5/2000, Ansett Australia. (Estimate of, on average, 1 in every 131 flights is affected by fume occurrences); see also *Submission 24*, Flight Attendants' Association of Australia.

51 *Submission 11C*, British Aerospace (dated 9 December 1999) covering letter.

52 *Submission 11C*, British Aerospace (dated 9 December 1999) covering letter.

53 British Aerospace, *Evidence*, 10 April 2000, p 223

> … the BAe 146 does comply with all applicable Australian airworthiness standards relevant to the cabin air issue. Also, this has been questioned in the evidence of a number of witnesses. We can assure you that the aircraft does fully comply and no dispensations or exemptions have been granted by the Australian authorities in this regard. It should not be overlooked that this aircraft is certificated not only in Australia but also in 36 other countries, including the UK and the US. Each of those countries applies exactly the same standards to matters relating to cabin air as does Australia. Over 50 different carriers operate approximately 350 aircraft of this family around the world.[54]

2.53 Notwithstanding, this advice, the Committee remains concerned regarding the issue of cabin air quality, and accordingly in Chapter 6 recommends a proposed research program to establish whether there is any link between health problems and flying in the BAe 146 and other aircraft.

*Ansett Australia's approach*

2.54 Ansett Australia advised the Committee that:

> … at its worst in 1992, an odour report was generated on only 1.5 per cent of all Ansett BAe 146 flights. Today that figure is much lower, even with our compulsory reporting system …[55]

> In 1992 engineering log reports showed an odour was reported once in every 66 flights. In the first half of this year, by contrast, engineering log reports recorded one odour occurrence in every 160 flights. Or, if we count only those events that cabin crew judged worth reporting, that figure is one report in every 460 flights. [56]

2.55 Captain Trevor Jensen, Executive General Manager Operations and Inflight Services with Ansett told the inquiry:

> In 1998 engineering odour reports were reduced to 0.7 per cent of flights. We had also introduced a cabin reporting system which yielded an odour report in less than one-half of one per cent of all BAe 146 flights. In the first half of the year, that figure has dropped again to an odour report of just 0.2 per cent of all flights for 1999.[57]

2.56 In a letter to the Committee dated 28 January 2000 Ansett advised that:

> … 209 employees report some symptoms while crewing the BAe 146. Not all of these reports have been in relation to the occurrence of odours. Some

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54 British Aerospace, *Evidence*, 10 April 2000, p 220

55 Ansett Australia, *Evidence*, 2 November 1999, p 52

56 Ansett Australia, *Evidence*, 2 November 1999, p 55

57 Ansett Australia, *Evidence*, 2 November 1999, p 55

> have occurred despite no smell and some may been due to other factors. Nearly all of the reported symptoms were minor irritant effects only.
>
> There have been 29 Workers Compensation claims lodged with the company since 1985 (of which 13 have been accepted, 5 denied, 4 accepted 'without prejudice', 7 pending and 3 employees have resigned "on medical grounds").
>
> Two staff have taken legal action against Ansett in relation to alleged ill health from exposure to fumes on the BAe l46. One case was settled in Sydney this year and there is one case pending in WA.[58]

*Incidence of Ansett fume reports*

2.57 Ansett Australia during the inquiry stressed that the reason it appears to have so many reports of fumes on its BAe 146 aircraft, compared to other airlines in Australia and overseas, is that:

> … we have made reporting odours compulsory to ensure we are fully aware of the extent of the issue and can take action on accurate and factual data. Unfortunately, that policy has exposed us to claims, which cannot be proven or substantiated, that the problem is more prevalent at Ansett than anywhere else.[59]

2.58 Captain Jensen of Ansett told the inquiry on 1 May 2000 that:

> Ansett is the only airline in the world that has made reporting odours compulsory. As neither Ansett nor any other operator in our knowledge actively solicits odour reports on any other aircraft type we suggest the inquiry exercise caution in the interpretation of incident data.[60]

2.59 To date Ansett's advice is that the only workers compensation claims to be settled resulted from acknowledgment of short-term employee illness. The Committee understands this result accords with a consensus statement produced by the panel of medical experts appointed by Ansett to investigate this issue. However this issue needs further examination.

2.60 The Committee notes the action taken by Ansett concerning this issue and notes that such action has ensured that Ansett is clearly accountable for its program. The Committee also notes Ansett's cooperation with this inquiry on this issue. Other airlines, it should be noted, do have a 'no blame' compulsory reporting of fume problems, and similar modification programs, yet have not been subject to the same level of scrutiny.

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58 Correspondence from Ansett to the inquiry dated 28 January 2000.

59 Ansett Australia, *Evidence*, 2 November 1999, p 55

60 Ansett Australia, *Evidence*, 1 May 2000, p 243, see also Ansett Australia, *Evidence*, 1 May 2000, p 257.

2.61 The Committee notes Ansett's claim to be a world leader in rectifying the BAe 146 problem is apparently accurate and that Ansett has been subjected to a high level of scrutiny as a result.

2.62 The Committee also notes recent submissions from Ansett air crew about the unsatisfactory performance of the company and the August 1998 cancellation of the company's 'Odour inquiry Committee', despite the odour issue remaining unresolved.[61] The Committee also notes with concern that Ansett has recently withdrawn medical exemptions for crew who do not wish to work on the BAe.

2.63 As noted in Chapter 1, the Committee is aware there are current claims for compensation arising from alleged fume exposure. One such case involves an Ansett air crew member, Judy Cullinane, who alleges her claim for damages for illness which is currently being litigated in Western Australia.

*Reluctance to report incidents*

2.64 It was submitted during this inquiry that there has been a major level of failure to report incidents involved with fumes on all Australian aircraft, including the BAe 146. The AFAP claimed that air crew:

> … are reluctant to identify the extent of odour incidents for a number of reasons, including fear that if identified with this issue it could effect legal operations of the aircraft as well as crew ability to fly according to the Civil Aviation Regulations.
>
> Crews are aware of the ongoing nature of this issue, and know that the technical problems have been unable to be fixed to date, and have obvious concerns for their own career, income etc. [62]

2.65 Pilots have in evidence to the Committee[63] asserted that there is a problem of 'under-reporting' of fume incidents. This is attributed to:

- lack of awareness of the source and effect of fumes until recent publicity associated with the Senate Inquiry and overseas developments;
- lack of faith that operators will treat complaints seriously;
- concerns that workers' compensation claims would be unsuccessful; and
- a desire to protect crews' jobs.

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61 See *Submission 24*, FAAA and Ansett Australia, *Evidence*, 2 November 2000.

62 *Submission 14A*, AFAP, p 6; see also *Submission 16*, Mrs Robin May, p 1. NJS in a supplementary submission to the inquiry detailed how confidential reports of fume incidents can be submitted to both the company and the ATSB, *Submission 23A*, NJS, p 1-2. This issue was further discussed by Captain Siebert during a public hearing held on 10 April 2000, NJS, *Evidence*, 10 April 2000, pp 207-208. During the public hearing on 10 April 2000 NJS attacked the credibility of AFAP in its criticism of NJS made during the inquiry, see NJS, *Evidence,* 10 April 2000, pp 210-211.

63 Confidential submissions and AFAP

2.66 For example, one confidential submission to the inquiry argued that the attitude of Workcover authorities and airlines to the effect of fumes on aircrew while flying "… will ensure that virtually no pilot will come forward to report aircraft fume incidents or associated health problems and therefore probably allowing a safety hazard to occur."[64]

2.67 Mr Clive Phillips, a former employee of the Bureau of Air Safety Investigation, now incorporated in the ATSB, told the inquiry that:

> I asked around on the Internet and through airline and union connections if anybody who had any concerns about the fumes, oil mist and fog, as it was determined that it was in aircraft, could please contact me. I was quite overwhelmed by the number of people who did. I was also overwhelmed by the number who wished to remain totally anonymous and did not want their names and phone numbers put on any files. There definitely seemed to be a reluctance to formally report these incidents …[65]

2.68 However, in contrast to this view, National Jet Systems Pty Ltd (NJS) claimed in April 2000 it had received very few approaches concerning the issue of air quality on board its BAe 146 aircraft:

> … we have never had an approach by the FAAA, the AFAP, our own pilots' body or any group of employees within our company about this issue (fumes on the BAe 146). The reports that we have had on this issue have all come through our safety reporting system. …
>
> … we have never, in a nine-year history, had technical matters raised by the AFAP with National Jet. …
>
> … the National Jet Systems Pilot Group … have not raised cabin air quality with National Jet Systems.[66]

2.69 The Committee is particularly concerned that some serious fume events are not reported even though it is clear from applicable aviation regulations, CASA publications and operators' internal manuals that such occurrences should be reported.

2.70 The 'no blame' anonymous reporting system used by operators, as well as the Ansett reporting system, means there should be a consequential improvement in reporting of future incidents.

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64 *Confidential submission* 18A, p 2

65 Mr Clive Phillips, *Evidence*, 1 February 2000, p 123

66 NJS, *Evidence*, 10 April 2000, p 216

*Attitude of airlines to staff suffering reactions to fumes*

2.71 Associate Professor Chris Winder of the University of New South Wales was critical of the attitude of airlines to staff who experience illnesses related to exposure to fumes on the BAe 146. According to Dr Winder:

> The response of the airlines to staff showing symptoms of toxicity has shown a lack of understanding of duty of care to employees. Information issued to staff on the issue has attempted to minimise the problem using the language of public relations. The basic approach to injured staff appears to be adversarial. Staff have been bullied and have been victimised. … Workers have been forced to persevere working in conditions that continue to aggravate their health, in some cases to permanent incapacity. Other staff have been offered demeaning duties, and genuine attempts at rehabilitation have been lacking.[67]

2.72 In response to this comment, Captain John Siebert, Group General Manager, Aircraft Safety and Regulation with NJS, denied claims by Dr Winder that "staff have been bullied and have been victimised"[68] Captain Siebert asserted that these claims were "clearly untrue":

> Professor Winder's statement that staff are being bullied and victimised is quite unfounded. … As an aside, Mr (Lawrie) Cox (of AFAP) commented that there had been unfair pressure on some pilots who are members of his industrial organisation who have gone sick during mid-tour of duty. This is completely unfounded; I have checked on that. We have actually had two cases of pilots going sick without a clear explanation, and they were investigated by a flight operations manager. There was certainly no commercial pressure, or any other sort of pressure, applied to those two instances. [69]

2.73 A further example of conflicting information concerning treatment of staff became evident during the Committee's public hearing on 10 April 2000. NJS noted that a former NJS pilot who had been retired from the airline as "not fit to fly" due to a heart condition, later alleged in her written submission to the Committee that, in fact, she had been forced to stop flying due to the effects of exposure to cabin air on a BAe 146.[70]

2.74 In refuting this allegation, NJS told the Committee:

> … We had a first officer become ill with severe chest pains in September 1994. They were investigated and after a period of time there was no

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67 Associate Professor Chris Winder, *Evidence*, 1 November 1999, p 6

68 NJS, *Evidence*, 1 February 2000, p 133

69 NJS, *Evidence*, 1 February 2000, pp 133-134. For information on the reporting system used by NJS see NJS, *Evidence*, 1 February 2000, pp 137-138.

70 *Submission 16*, Mrs Robin May, p 1

> pathological evidence as to why this lady had chest pains. However, it deteriorated into imbalanced and blurred vision and subsequently she was denied an air crew medical. In other words, CASA decided she was not fit to fly. She was then paid out on an insurance claim because of pericardium. In other words, she had inflammation of the pericardial tissue of the heart.
>
> So it was a great surprise to us when subsequently we read that this particular person was claiming that she had been poisoned by burnt hydraulic fumes, as she listed in her application to the inquiry, because, never in the period from 8 September 1994 up until her payout on 28 February 1996, was the matter of air quality raised.[71]

2.75 In her submission this pilot claimed to have been forced to retire prematurely from flying due to an "unexplained medical condition now linked with fumes on the BAe". The former pilot also claimed to have suffered deteriorating health since being exposed to "burnt hydraulic oil" fumes while crewing the BAe 146.[72]

2.76 The Committee finally notes that, in her submission, the pilot stated that she and her doctor had been unable to fully appreciate the source of the health condition she suffered until becoming aware through the media of the Committee's inquiry.[73]

*Exemptions for flight crew not to work on BAe 146 aircraft*

2.77 Ansett told the inquiry it had made efforts to meet the concerns of its staff in relation to the BAe 146:

> When collection and analysis of data was being completed, Ansett granted exemptions for crew crewing the BAe 146 to a number of flight attendants in recognition of their concerns for their health. There are currently 119 flight attendants who have been granted such an exemption, 40 of whom are pregnant and 11 of whom are attempting to conceive. While no evidence suggested BAe 146 cabin air presented a risk to them, or their unborn children, exemptions were granted in recognition of their concerns.
>
> Of those who have been granted an exemption, medical certificates have been accepted without challenge. … On no occasion has an issuing doctor sought any information from Ansett Australia before providing a certificate attesting to a flight attendant's inability to crew a BAe 146. In the light of the documented evidence verifying that there are no long-term health effects associated with the BAe 146 cabin air, a graduated fully supported return to work program is now being prepared. [74]

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71 NJS, *Evidence*, 10 April 2000, p 215

72 *Submission 16*, Ms Robin May

73 *Submission 16*, Ms Robin May

74 Ansett Australia, *Evidence*, 2 November 1999, p 56; see also *Submission 24*, FAAA, pp 3, 9.

2.78 In a letter to the Committee dated 11 February 2000 Captain Jensen advised that:

> Ansett Australia is fully satisfied that there are no long-term health effects associated with BAel46 cabin air. Aircraft modifications have now improved the working environment to such an extent that there should no longer be any distinction drawn between the BAel46 and other aircraft types in terms of crewing.
>
> …. it is Ansett's intention to cease its special exemptions for BAel46 flight crews and to commence a graduated and fully supported return to work program for staff currently exempted from flying on the BAel46 aircraft. Of course, all occupational, medical and workplace health and safety support, - including access to workers' compensation schemes, will continue unchanged.[75]

2.79 An attachment to Captain Jensen's letter stated:

> A large number of Flight Attendants have taken advantage of Ansett's liberal policy of granting exemptions from crewing the BAe l46 without having to go through any workers' compensation system. While collection and analysis of data was still being completed, Ansett granted exemptions to a number of Flight Attendants in recognition of their concerns for their health- …
>
> Around half of the exemptions were granted upon receipt of a medical certificate citing a Flight Attendant's inability to crew a BAe l46. These certificates are, in some cases, up to two years old and have not been reissued. On no occasion has an issuing doctor sought any information from Ansett Australia before providing a certificate.
>
> The remaining exemptions were granted to Flight Attendants who were pregnant or attempting to conceive. Again, while no evidence suggested BAe l46 cabin air presented a risk to them or their unborn children, exemptions were granted purely in recognition of their concerns.
>
> These exemptions relate to the BAe l46 only and the Flight Attendants involved remain on duty on all other aircraft types. Only two of Ansett's 2,000 Flight Attendants claim they are unable, for medical reasons, to crew any aircraft. [76]

2.80 In further evidence to the inquiry Captain Jensen advised:

> Whilst we were going through the process of collecting and analysing data we exempted a number of individuals from crewing the BAe146 in recognition of concerns that they had for their health. These exemptions

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75 Correspondence from Captain Jensen, Ansett Australia to the Secretariat dated 11 February 2000, p 2.

76 Correspondence from Captain Jensen, Ansett Australia to the Secretariat dated 11 February 2000, attachment pp 2-3.

> were granted, although there was no evidence of pathology or disease. Again, as far as I am aware, Ansett is the only airline to have done this. … We are moving to cease the special exemption applying to the BAe146 and to commence a graduated and fully supported return to work program. Of course, all occupational, medical and workplace health and safety support, including access to workers compensation schemes, will continue unchanged.[77]

2.81 However, in view of evidence considered by the Committee, including Ansett flight attendants, the Committee remains concerned at health problems allegedly occurring as a result of exposure to fumes on BAe 146, particularly as the majority of this group have medical evidence to support their claims.[78]

2.82 At a public hearing on 1 February 2000 in Sydney, a medical professional, Dr Mark Donohoe, commented on Ansett's approach to his stance following his treatment of a number of Ansett air crew:

> … in this particular issue of the BAe 146, there are political and commercial interests that have clouded the nature of inquiring into medical and health problems and into safety issues of the jet. Back in 1998 when I was first contacted by the Chief Medical Officer of Ansett and asked to a meeting, it was the first and only time that I can recall in dealing with employees of a company that a medical officer had made an attempt to get me to change my views on the health of patients that I had seen. At the time I felt there was a threat - an implied threat more than a direct threat - that it would be in my interests to withdraw statements that I had made about safety on the jets and the health of the people I had seen who had been flying on those jets.
>
> Never before, and not since, has any commercial body, where there has been a question of injury to employees, attempted to bring me into a meeting to influence my views and to ask directly for a retraction of my views.[79]

2.83 The Committee notes also evidence to the Committee from Dr Chris van Netten, whose research on cabin air quality has been used by one airline to assert that BAe 146 cabin air is safe and healthy. Dr van Netten, stated:

> My statement that British Aerospace has been quoting has also apparently come up, where I make the statement that the air quality in a BAe 146-200 is the same, if not better in certain conditions, than a Dash-8 Aircraft. This is only under conditions where everything is functioning normally, and this is quite correct. The air in a normally operating, properly functioning aircraft is the same as in a Dash-8 and is quite a normal experience. There is nothing wrong with that but they stop there. They do not mention, for instance, that I

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77 Ansett Australia, *Evidence*, 1 May 2000, p 243

78 See various submissions; eg, *Submissions* 1, 2, 3, 5, 6, 7, 10, 14, 16, 17, 18, 26, 27 and 28.

79 Dr Mark Donohoe, *Evidence*, 1 February 2000, p 94

> also make other conclusions which they do not always seem to be quoting me on. So I call it a case of selective quotation from my reports.[80]

2.84 The Committee views this evidence from two medical professionals with some concern. The Committee notes these views reinforce the need for further research on this issue, as recommended by the Committee in Chapter 6.

80 Associate Professor C van Netten, *Evidence*, 14 March 2000, p 22

# CHAPTER THREE

# SYMPTOMS OF ILLNESS AND POSSIBLE SOURCES

3.1 The central issue in this inquiry is whether health effects result from exposure to oil fumes in aircraft cabin air. Current medical science and technology available for measuring and analysing the clinical effects of exposure to minute combinations of chemicals are both relatively new. The Committee received submissions from several medical and occupational health professionals supporting claims by flight crew that exposure to fumes on BAe 146 aircraft resulted in deterioration of their health.[1]

3.2 The Committee is also aware that the Industrial Court of New South Wales has acknowledged that exposure to fumes on a BAe 146 exacerbated a pre-existing illness suffered by former Ansett flight attendant Alysia Chew.

3.3 One medical professional, Dr Robert Loblay, gave evidence to the Committee arguing that there are no health effects as a result of exposure to fumes. Unfortunately, his evidence consisted largely of attacking the personal and professional integrity and status of other witnesses. Dr Loblay did not supply a written submission to the inquiry.

3.4 The majority of the professional witnesses to the inquiry highlighted an absence of clinical testing of flight crew and passengers immediately after their exposure to fumes. In the absence of equipment sensitive enough to detect all potential chemical components present in human tissue following a fume exposure incident, it appears difficult to measure the health consequences of fume exposure.

**Examples of symptoms**

3.5 There was a commonality within the symptoms reported by affected flight crew exposed to fumes on aircraft which can be summarised as follows:

- dizziness;
- nausea;
- vomiting;
- headaches;
- head pressure;
- numbness;
- tingling;
- irritations to eyes, nose and throat;

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1 See – *Submissions* 2, 3, 5, 6, 7

- breathing difficulties;
- vision difficulties;
- fatigue;
- weakness;
- cognitive dysfunction;
- concentration difficulties;
- disorientation confusion;
- chemical sensitivities; and
- neurobehavioural difficulties.[2]

3.6 Associate Professor Chris Winder from the University of New South Wales set out in his submission both short term and long term symptoms exhibited by affected people he had interviewed who had flown on the BAe 146.

3.7 Dr Winder advised that symptoms from single or short term exposures, include:

- neurotoxic symptoms: blurred or tunnel vision, nystagmus, disorientation, shaking and tremors, loss of balance and vertigo, seizures, loss of consciousness, parathesias;
- psychotoxic symptoms: memory impairment, headache, light-headedness, dizziness, confusion and feeling intoxicated;
- gastro-intestinal symptoms: nausea, vomiting;
- respiratory symptoms. cough, breathing difficulties including shortness of breath, tightness in chest, respiratory failure requiring oxygen;
- cardiovascular symptoms: increased heart rate and palpitations; and
- irritation of eyes, nose and upper airways.[3]

3.8 Dr Winder also said symptoms from long term low-level exposure or residual symptoms from exposure events, include:

- neurotoxic symptoms: numbness (fingers, lips, limbs), parathesias;
- psychotoxic symptoms: memory impairment, forgetfulness, lack of co-ordination, severe headaches, dizziness, sleep disorders;
- gastro-intestinal symptoms: salivation, nausea, vomiting, diarrhoea;

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2 *Submission 14A*, AFAP, p 6

3 *Submission 6*, Associate Professor Chris Winder, p 12

- respiratory symptoms: breathing difficulties (shortness of breath), tightness in chest, respiratory failure, susceptibility to upper respiratory tract infections;
- cardiovascular symptoms: chest pain, increased heart rate and palpitations;
- skin symptoms: skin itching and rashes, skin blisters (on uncovered body parts), hair loss;
- irritation of eyes, nose and upper airways;
- sensitivity: signs of immunosupression, chemical sensitivity leading to acquired or multiple chemical sensitivity; and
- general: weakness and fatigue (leading to chronic fatigue), exhaustion, hot flashes, joint pain, muscle weakness and pain.[4]

3.9 Evidence to the Committee presented from pilots, cabin crew and their medical advisors that these generalised symptoms are common to those who have developed symptoms after being exposed to fumes while flying in the BAe 146.

3.10 However, Dr Robert Loblay of the University of Sydney told the inquiry:

> The Australian Institute of Health and Welfare has done population surveys for many years now showing that these non-specific symptoms are present at any one time in 10 per cent of the population. If you survey the population two years later, it is still 10 per cent but they are different people.[5]

3.11 Dr Loblay went on to state:

> Tunnel vision is not a symptom of neurotoxicity. It is not an uncommon symptom in people with acute anxiety and hyperventilation.
>
> I am not denying that there have not been problems with air quality and with fumes and so on in the BAe 146. That is absolutely clear from the evidence the expert panel was presented with. But when a belief system spreads in a population that a particular work or other environment is dangerous, then people come to attribute these common symptoms to their environment. It is a common phenomenon in this area …. People's beliefs often lead them to mistakenly attribute common symptoms or anxiety symptoms to toxic exposure when they are in an environment where they believe there are toxic chemicals. This is a phenomenon that has been demonstrated in healthy individuals in experimental circumstances as well. So I do not

4 *Submission 6*, Associate Professor Chris Winder, pp 13-14; see also *Submission 5*, Dr Jean Christophe Balouet, p 1, Dr Jean Christophe Balouet, Evidence, 13 March 2000, p 172, *Submission 2*, Dr Mark Donohoe, pp 1-2.

5 Dr Robert Loblay, *Evidence*, 1 February 2000, p 103

> necessarily believe that most of those symptoms that are described are symptoms of chemical neurotoxicity in the way that it has been claimed …[6]

3.12 The Committee notes that reported incidents of health problems among flight crew arising from claimed fume exposure on BAe 146 aircraft indicate a higher rate of problems than the 10 per cent in the general population quoted by Dr Loblay.[7]

3.13 Dr Loblay advised:

> I accept that when there are leaks and fumes come into the cabin people do experience irritant symptoms - irritation of the eye, nose and throat. Many people experience headache and nausea when they are exposed to unpleasant fumes and smells. That is a pretty common phenomenon. I have no difficulty with that. What I have difficulty with is the claim that flying in these aeroplanes regularly and being exposed to the usual cabin air, leaving aside those single episodes where there are significant leaks, is in any way responsible for long-term adverse health effects or even short-term adverse effects.[8]

**Possible enhanced effect on symptoms from flying**

3.14 It has been put to the Committee that symptoms of toxicity from fumes are not only caused by chemical exposure but may be "… exacerbated by the hypoxia of cabin pressure, other chemical exposures (such as carbon monoxide), temperature, humidity, workload or pre-existing health conditions."[9] This phenomenon is described by some in the medical profession as "aerotoxic syndrome" and is now a specialist area for medical and occupational health research.[10]

**Possible causes and sources of illnesses in the BAe 146**

3.15 Associate Professor Winder listed the following occurrences as possible sources of fumes and invisible smoke in a BAe 146 cabin:

- oil leaks to the air conditioning system;
- smoke from combustion/pyrolysis events;
- contamination following pack burn outs;
- exposures during times when contaminated engines/APU are being used; and
- residual contamination.[11]

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6 Dr Robert Loblay, *Evidence*, 1 February 2000, p 104

7 See Balouet, Winder, FAAA submissions.

8 Dr Robert Loblay, *Evidence*, 1 February 2000, p 104

9 *Submission 6*, Associate Professor Chris Winder, p. 2

10 *Submission 6*, Associate Professor Chris Winder, p 53 (subs vol 1)

11 *Submission 6*, Associate Professor Chris Winder, p 6

3.16 As noted in the description in Chapter 1, the BAe 146 contains an auxiliary power unit (APU) which primarily supplies compressed air for ground operation of the air conditioning system and is also used during take off and landing. According to Dr Winder; "Both the engines and APU have been implicated as sources of the fumes/mists that have entered the flight deck and cabin, although the engines are considered the main source of the problem." [12]

*Engine oil and oil seals*

3.17 The main engine oil used in the BAe 146 as well as in other jet aircraft in Australia is Mobil Jet Oil II, a synthetic phosphate ester product manufactured by Mobil USA and marketed in Australia by Mobil Australia.[13] The Committee understands that in various formulations, Mobil Jet Oil II has been in use in the world aviation industry for more than 38 years. During 1998 1.4 billion passengers were carried on jets using this oil.[14]

3.18 Mobil Oil told the inquiry:

> Mobil has roughly 51 per cent of a world market for turbine oils. Jet oil II is certainly the main grade and would account for over 90 per cent of that. … about 45 per cent of turbine engines worldwide would run on jet oil II.[15]

3.19 Several submissions from crew/and medical professionals maintained that the cause of fumes on the aircraft was burnt oil lubricants leaking from engines into the BAe 146's cabin air system:

> Excessive oil leakage from oil seals allows smoke and lubricating oil components to enter the cabin. Oil seals are used to ensure that engine oil does not mix with the air system. Oil is passing through the engine seals into the compressor bleed air system and therefore contaminating air used for the environmental control system (ECS). The engine bearing conditions are in some cases further allowing oil to pass the engine seal system and therefore enabling oil to enter the cabin bleed air system, being the source of cabin air-conditioning/heating and pressurisation involves the following problems:
>
> -residual oil leaks from engines/ APU into cabin air conditioning system - complete bearing / seal failure;
>
> -residual oil leaks remaining from intense exposures after air con pack burn (engines run very hot to produce very high air con pack temperature so as to push any residual oil contaminants through the system)[16]

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12 *Submission 6*, Associate Professor Chris Winder, p 4 See also BASI Occurrence Brief 199702276 (on internet site) incident involving Captain Kolver on 10 July 1997, p 2.

13 *Submission 6*, Associate Professor Chris Winder, p 4

14 Ansett Australia, *Evidence*, 2 November 1999, p 52

15 Mobil Oil Australia Ltd, *Evidence*, 1 February 2000, p 142

16 *Submission 14A*, AFAP, p 4; see NJS, *Evidence*, 1 February 2000, p 139

3.20 The AFAP also maintained that the problem in the BAe 146 involves the design of its engines and air conditioning system along with problems involving oil seals and filters.[17]

3.21 The AFAP claimed that:

> The BAe 146 appears to have a higher proportion than normal of oil leakage into the aircraft air conditioning system. The engine bearing/seal system is allowing excessive oil to leak into the aircraft bleed air system,[18]

3.22 Dr Chris van Netten of the University of British Columbia commented that:

> The engines used by the BAe 146 aircraft appear to have an inherent problem with leaking oils seals, specifically in the compressor section of the engine at bearing locations 1 and 9.
>
> Bleed air, used for pressurisation of the aircraft, from the compressor stage of the engine can become contaminated with engine oil constituents. The temperature of the bleed air can be in excess of 500' Celsius. At this temperature any oil constituents will pyrolize resulting in smoke formation. The presence of smoke in the cabin has been well documented in these aircraft.[19]

and

> …One is not exposed to carbon monoxide alone but a cocktail of pyrolised and original oil components. These combinations of exposures have not been studied and it would be wise to pay close attention, as this Committee is presently doing, to the complaints and symptoms of flight crew members.[20]

3.23 In its submission on this issue, CASA submitted that, early in its service, the BAe 146 did experience relatively higher engine malfunction rates than other similar sized aircraft:

> … however the engine reliability rates are now comparable to all other transport category aircraft of a similar size. Early engine problems included poor reliability of engine bearing oil seals, which resulted in engine oil mist being present in the air which is bled from the engines for cabin air conditioning. Tests have shown, however, that even with engine bearing oil seals missing close to where the bleed air is ducted from the engine to feed the air conditioning packs, oil residues do not pass through to the cabin environment.[21]

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17 *Submission 14A*, AFAP, p 4; see also *Submission 8*, Associate Professor C. van Netten, p 12.

18 *Submission 14A*, AFAP, p 3

19 *Submission 8*, Associate Professor C. van Netten, p 1

20 Associate Professor C van Netten, *Evidence*, 14 March 2000, p 214

21 *Submission 20*, CASA, p 3

*Pack burns*

3.24 A pack burn is a process under which, before the first flight by an aircraft on a given day, the first officer manually adjusted the aircraft air conditioning outlet temperature to a very high setting in order to vaporise residual oil traces in the air conditioning ducts of the BAe 146. As the procedure was normally carried out in the morning before aircraft operations commenced, cabin crew were often exposed to large amounts of smoky residue flushed from the ducting.[22]

3.25 The Flight Attendants' Association of Australia gave this additional information concerning pack burns:

> Pack burn offs were introduced in March 1997 as a BAe 146 Odour Inquiry Committee initiative. The intention was to remove the engine oil gathered in the sump, near the cabin air inlet, during overnight stops. It was demonstrated that pack burn-offs were counter-productive because they loaded the filters with carbon and bi-products from the burnt oil and the loaded filters were then unable to remove the contaminants from the air destined to air condition the cabin and flight deck. Pack burn offs were discontinued as a routine procedure in mid 1998.
>
> The process of pack-burn offs was used regularly on BAe 146 aircraft as it was believed that it cleansed the air conditioning systems, and thus reduced odour occurrences.
>
> After crew reported odours a pack burn would routinely be ordered during the turn-around or before start up for the next day's duty.[23]

and,

> Allied Signal, the APU manufacturers, warned of the danger of pack burns in their Richard Fox Report of November 1997.
>
> "Total contaminant levels, in the supply air to the cabin exceed 50% of the current Safety Standard Limit (NIOSH, ACCIH) during pack burn outs.
>
> Compounds present include formaldehyde, tetro-hydrofuran, and cumene. These compounds are recognised as causing skin, respiratory and eye irritation, as well as nausea and narcosis, if present in excessive levels. The majority of currently detected compounds do not have established exposure limits."
>
> Fox also states that " this exposure can continue for some time after the completion of this procedure". [24]

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22 *Confidential submission* C6

23 *Submission 24*, FAAA, pp 7-8

24 *Submission 24*, FAAA, p 8

3.26 The FAAA drew attention to a 1997 Ansett notice to cabin crew on BAe 146 aircraft directing them not to remain on board during pack burns. Ansett also issued a notice to its engineering section to discontinue pack burn procedures, "… in line with the recommendations of the Fox Report".[25]

**Difficulty in finding the source of fumes**

3.27 A confidential submission to the inquiry set out the difficulties involved in precisely locating the source of fumes on board the BAe 146:

> The result of this air condition design, the output temperature and pack contamination problems is that it is almost impossible to accurately locate the original source of an oil leak. In the event of more than one engine/APU leak combination, identification becomes almost impossible.[26]

**Issue of toxicity in relation to exposure to fumes**

3.28 Many of the submissions from flight crew and medical witnesses to the inquiry asserted that members of some flight crews had suffered health effects from exposure to fumes due to toxic ingredients in the oil fumes which leaked into the aircraft cabin and were inhaled. The issue of toxicity is controversial and difficult to effectively measure. The ingredient of Mobil Jet Oil II identified as a possible source of neurotoxic effects is Tricresyl Phosphate, classified by the National Industrial Chemicals Notification and Assessment Scheme (NINAS), as toxic.

3.29 The National Industrial Chemicals Notification and Assessment Scheme was established in 1990 under the *Industrial Chemicals (Notification and Assessment) Act 1989* (Commonwealth). NICNAS is a statutory scheme with staff and support services provided by the National Occupational Health and Safety Commissions. The objection of the NICNAS program is to establish the scientific basis for safe chemical use by assessing industrial chemicals for occupational, public health and/or environmental effects.[27] NICNAS' submission to this inquiry states:

> There are numerous case reports of human poisoning with TCP as a result of ingestion of adulterated or contaminated beverages, foods or drugs. In some cases transient gastro-intestinal symptoms such as nausea, vomiting and diarrhoea have occurred shortly after the ingestion, whereas the neurological symptoms are characteristically delayed and persistent. Initially, there are pain and paraesthesia in the lower extremities, with a mild impairment of cutaneous sensations and, at times, of vibratory sense. Muscle weakness may progress to paralysis of the lower extremities with or without an involvement of the upper extremities. Recovery can be extremely slow and extend over a number of months or years".[28]

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25 *Submission 24*, FAAA, p 8

26 *Confidential submission* 11, p 4

27 National Industrial Chemicals Notification and Assessment Scheme, Annual Report, 1991-9, p 47

28 *Submission 12*, NICNAS, p 6

3.30 NICNAS' submission also stated that the oil's manufacturer, Mobil, acknowledges possible toxic components but considers the performance of the oil is certainly an important factor in its continual use:

> The neurotoxicity of jet engine oil containing TCP has been reviewed in a recent paper from Mobil Business Resources Corporation and Mobil Technology Company (Mackerer et al., 1999). The paper states that although it has been known for many years that TCP contains neurotoxic components, lubricant formulators have been reluctant to replace the additive because of it's excellent performance in critical applications.[29]

3.31 Dr Chris van Netten told the inquiry:

> We have many different compounds which really have not been analysed yet… It appears, therefore, Mobil Oil has a rough idea of what the composition is of their oils but does not have a clear picture of the different isomers [30] that might be present.
>
> This is very important when one is dealing, for instance, with a mixture of closely related compounds. I understand Chris Winder has discussed these with you in detail, so I do not want to go into a large amount of detail here, but we have many of these compounds. … I think it is very important for us to know what is in these oils because if we do not know what all these isomers are we cannot really state anything regarding their inhalation exposures and their toxicity.[31]

3.32 Submissions were also made suggesting that the combination of chemical components in fumes leaking into the aircraft could have as yet unknown toxic effects. One submission to the inquiry raised a possible connection between genetic/chromosomal damage and exposure to oil fumes, although the Committee is not able to verify assertions of this nature.

*Toxic Exposure*

3.33 Between 1997 and 1999 the company Genetic Consulting and Testing Pty Ltd (GCAT) carried out blood tests on five people who flew on BAe 146.[32] The results of these tests, contained in a submission to this inquiry, found that two of those tested showed evidence of having been exposed to "clastogenic and/or aneuploidogenic chemicals."[33] The report went on to state:

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29 *Submission 12*, NICNAS

30 An isomer is a member of a group of chemicals. TCP has 10 isomers.

31 Associate Professor C van Netten, Evidence, 14 March 2000, p 207 - 208

32 Submission 7, GCAT, pp 2-4

33 *Submission 7*, GCAT, p 5

> The finding of notable disturbances in three people from the same environment is compelling evidence that there was significant toxic exposure.
>
> The absence of findings in the other two persons could be explained either by sampling error (we did not happen to detect abnormal cells because of the relatively small number of cells sampled) or that the two people did not have chromosome abnormalities. In our experience of repeat analyses … these results are most likely to mean that these two people do not have chromosome abnormalities. The finding of chromosome abnormalities is influenced by three factors. (1) The exposure (2) The person's genetic make-up and (3) The person's diet at the time of exposure; some foods are known to be protective. [34]

3.34 GCAT's report concluded; "The chromosomes analyses performed on these 5 persons show evidence of exposure to significant levels of chemical toxins, sufficient to cause grave, short and long term health consequences." [35]

*Tricresyl phosphate (TCP)*

3.35 The inquiry was told that jet engine lubricants can typically contain up to 3 per cent tricresyl phosphate as an antiwear agent.[36]

3.36 Dr van Netten stressed in his submission that his research indicated:

> … all engine oils tested to-date contain, among many other compounds, tricresyl phosphate (TCP) isomers. Tricresyl phosphates have been associated with neurotoxic properties. [37]

3.37 Associate Professor Winder told the inquiry:

> I believe that tricresyl phosphate is the particular chemical that causes the neurological problems that staff on planes have been exposed to. But I consider that in many of these exposures there is also a hydrocarbon component context, and it is possible that the hydrocarbon exposure may either exacerbate the effect or assist in increased absorption. I do not think it is necessarily one chemical. It may be one chemical, but it is possible that it could be exposure to other chemicals as well.[38]

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34 *Submission 7*, GCAT, p 5

35 *Submission 7*, GCAT, p 5

36 *Submission 8*, Associate Professor C. van Netten, p 14

37 *Submission 8*, Associate Professor C. van Netten, p 2.

38 Associate Professor Chris Winder, Evidence, 1 November 1999, p 16

*Aerotoxic syndrome*

3.38 In evidence to the inquiry Associate Professor Winder also asserted that symptoms reported by individuals after exposure to fumes on the BAe 146 were sufficiently consistent to indicate the development of a "discrete occupational health condition". This condition was described as 'aerotoxic syndrome'. Professor Winder said:

> Aerotoxic syndrome is a syndrome which is associated with aircrew exposure at altitude to atmospheric contaminants from engine oil or other aircraft fluids temporarily juxtaposed by the development of a consistent symptomology of irritancy, chemical sensitivity and neurotoxicity.[39]

and

> This syndrome may be reversible following brief exposures, but pictures are emerging of a chronic syndrome following significant exposures.[40]

Ansett in particular questioned this assertion.[41]

**Mobil Jet Oil II and the issue of toxicity**

3.39 While the majority of submissions to the inquiry from medical/occupational health professionals point to components of Mobil Jet Oil II as a source of health problems, some witnesses dispute the oil as a source of toxicity. Dr David Lewis, Chief Medical Officer with Ansett, told the inquiry in evidence:

> Last year 1.4 billion people flew on aircraft lubricated by this oil. You take that over the last 35 years and this must be the longest clinical trial for any chemical in the history of medicine. With the 30 cases claimed by Balouet, that would make it a one in 800 million chance of developing aerotoxic syndrome.[42]

3.40 The National Industrial Chemicals and Assessment Scheme (NICNAS) has placed Mobil Jet Oil II on a list of chemicals for review and assessment. NICNAS has informed the Committee that Mobil Jet Oil II may be selected as a priority for review and assessment - subject to given direction from the government - outside bodies and other factors.

3.41 NICNAS submitted a document titled 'Mobil Jet Oil II Overview of Available Scientific Background Information' to the Committee setting out information concerning the chemical ingredients in Mobil Jet Oil II. In the document, NICNAS points to the following information:

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39 Associate Professor Chris Winder, Evidence, 1 November 1999, p 6

40 Associate Professor Chris Winder, Evidence, 1 November 1999, p 6

41 Ansett Australia, *Evidence*, 2 November 1999, p 64

42 Ansett Australia, *Evidence*, 2 November 1999, p 64

According to Material Safety Data Sheets (MSDS) provided by the Australian Federation of Air Pilots and Mobil Oil Australia Ltd, Mobil Jet Oil II contains >90 per cent synthetic esters and <10 per cent additives and /or other ingredients 3% (or 1-5%) TCP and 1% (or 1-5%) PAN. A MSDS from 1992 also lists 2-naphthalenamine, N-phenyl (CAS No 135-88-6) as an ingredient. This chemical, also known as phenyl-beta-naphthylamine (PBN) is listed in the Australian Inventory of Chemical Substances, too.

*Tricresyl phosphate (TCP)*

When heated to decomposition, it can emit highly toxic fumes of phosphorous oxides (HSDB 1999). **…**The critical effects of TCP include delayed neuropathy ascribed to the TOCP isomer and reproductive toxicity.

Neuropathy may occur after both single and repeated exposure to TOCP and is similar in its mechanism of action and manifestations to the delayed nerve damage induced by other organophosphates. Clinical signs of paralysis typically appear after a latency period of 1-4 weeks. Histologically, there are degenerative changes in the axons which gradually spread towards the cell body. The lesions are attributed to the metabolite saligenin cyclic ortho-tolyl phoshate, which irreversibly inhibits a subset of nervous system esterases called neuropathy target esterases (NTE). **…**

The neurotoxicity of jet engine oil containing TCP has been reviewed in a recent paper from Mobil Business Resources Corporation and Mobil Technology Company (Mackerer et all 1999). The paper states that although it has been known for many years that TCP contains neurotoxic components, lubricant formulators have been reluctant to replace the additive because of its excellent performance in critical applications. **…**

In reproductive toxicity studies in rates and mice, TOCP has been shown to cause histopathological damage to the testes and ovaries, morphological changes in sperm, decreased fertility in both sexes and decreased litter size and viability, against without a clear cut no observed effect level.

*Human health effects*

There are numerous case reports of human poisoning with TCP as result of ingestion of adulterated or contaminated beverages, foods or drugs (IPCS, 1990). In some cases transient gastro-intestinal symptoms such as nausea, vomiting and diarrhoea have occurred shortly after the ingestion, whereas the neurological symptoms are characteristically delayed and persistent. Initially, there are pain and parasthesia in the lower extremities with a mild impairment of cutaneous sensations and, at times, of vibratory sense. Muscle weakness may progress to paralysis of the lower extremities, with or without an involvement of the upper extremities. Recovery can be extremely slow and extend over a period of months or years. **…**

*Hazard of the product as a whole*

In the available MSDS it is stated that the "Worksafe classification" of Mobil Jet Oil II is 'not hazardous by Worksafe criteria'.[43]

3.42 In its submission, Mobil Oil Australia Ltd responded to the NICNAS document by stating:

> We are concerned that the lack of context for these toxicological profiles may result in the Secretariat [of this Committee] (or members of the public who otherwise review the document) concluding that the product displays certain health and safety risks, when in fact it does not. When the product is viewed as a whole, MJO is not a hazardous material as classified pursuant to the National Occupational Health and Safety Commission (NOHSC) Work Safe criteria … Also, scientific studies, including the recent work by Macker et. al. … demonstrate that exposure to jet oils does not pose a significant risk to human health.[44]

3.43 The Mobil Oil submission went on to set out a number of "specific concerns with respect to the presentation of information in the Overview" document prepared by NICNAS, namely the presentation of a 'misleading picture of potential health and safety hazards associated with Mobil Jet Oil II".[45]

3.44 Later in its submission the company stated:

> … we believe the Overview could lead to undue public concern due to the statement regarding the presence of potential carcinogens in the product. In fact, these constituents are present as impurities only at trace levels and below the level at which an adverse health effect could occur.[46]

3.45 In a supplementary submission to this inquiry Mobil noted that:

> We do not believe that Mobil jet turbine oils pose any significant toxicological risk to individuals accidentally exposed to aerosols or vapours in aircraft cabins. Such exposures are not what we would refer to as "normal use" but the cabin levels that can be reached during such exposures are comprehended by our internal and published risk assessments and are considered safe. These assessments are based on Mobil toxicology testing as well as the extensive toxicology database found in the published literature.[47]

3.46 In response to specific claims that Mobil Oil II is toxic the company stated:

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43 *Submission 12*, NICNAS, pp 3-11

44 *Submission 13*, Mobil Oil Australia Ltd, p 1

45 *Submission 13*, Mobil Oil Australia Ltd, pp 1-2

46 *Submission 13*, Mobil Oil Australia Ltd, p 2

47 *Submission13A,* Mobil Oil Australia Ltd, p 2

> … based on the toxicological data developed over the years, Mobil Jet Oil II is a non-hazardous product based on the NOHSC document "Approved Criteria for Classifying Hazardous Substances". …
>
> With regard to phenyl-napthylamine, Mobil Jet Oil II contains approximately 1% of the alpha isomer. Testing has confirmed that this concentration did not cause sensitization in animals or humans. The concentration of the carcinogenic beta isomer and beta naphthylamine which might be present as impurities is negligible to non-existent in Mobil let Oil II…. [48]
>
> There has been much speculation that Mobil Jet Oil II may be the cause of the alleged adverse health effects. This is unsupported by the scientific evidence … The clinical symptoms reported are not the same as those that have been historically seen for TCP. The reported symptoms appear to closely match those for exposure to carbon monoxide (CO). These effects can be exacerbated by low oxygen levels and high carbon dioxide levels in the aircraft cabin. Possible sources for carbon monoxide include the ambient cabin air and, in the case of a malfunction of the aircraft mechanical systems, thermally degraded hydraulic oil and turbine oil that might enter the aircraft cabin. These oils may break down at very high temperatures and liberate carbon monoxide on contact with hot metal surfaces. Under these extreme conditions, carbon monoxide would be produced from virtually any oil and independent of any additives, including TCP, that might be present.[49]

3.47 During his oral evidence to the Committee, Mr Julian Plummer, Manger of Aviation Lubricant Sales with Mobil Australia made the following comment:

> Mobil do not consider accidental exposure to oil vapours in an aircraft cabin to be 'normal use', but the levels that can be reached are comprehended by our internal and published risk assessments and are considered safe. …
>
> The tricresyl phosphate (TCP) additive used in jet oils provides the lubricant with improved anti-wear and load carrying capability. Its properties are unique, and no replacement has been identified which can meet the stringent performance requirements of a modern jet engine oil. Our submission details that the TCP used in jet oil II is low toxicity, about 25 to 60 times less neurotoxic than TCPs used in the 1950s. …
>
> Our risk assessment details that it is not possible to receive a harmful dose by inhalation at the threshold limit value of five milligrams per cubic metre, which would be visible mist. It is also not possible to receive a harmful dose from accidental skin contact, and there is no record of a jet oil formulated with modern conventional TCP causing human toxicity. …
>
> Tricresyl phosphate is present in jet oil at approximately three per cent, which is around 30,000 parts per million. The neurotoxic components are

48 *Submission 13A,* Mobil Oil Australia Ltd, p 3

49 *Submission 13A,* Mobil Oil Australia Ltd, p 4

> orthoisomers which are only a small proportion of the TCP and are present at roughly 140 parts per million in the jet oil. Jet oil is neurotoxic if you drink it, and we have established doses for both a toxic one-off dose or a toxic ongoing dose, which is a smaller amount that you would have to ingest each day. Based on normal things, these would be impossible to achieve. …
>
> The studies show that it is possible to breathe a mist. We are now talking about a mist of the oil which contains three per cent, whereas I suspect the 0.1 milligram per cubic metre that was mentioned as the NOHSC requirement – the maximum – was just TCP. I am now talking oil containing three per cent TCP. It is possible to breathe a mist at five milligrams per cubic metre, which is the accepted maximum workplace level for lubricating oils, five days a week, eight hours a day, in an ongoing sense without absorbing a toxic dose through inhalation. For dermal contact, we have established that it is possible to cover your entire body surface with the liquid for six hours and not absorb a toxic dose through the skin. Our prime warnings are against ingestion of a product. It has always been believed that more pure forms of TCP would not do the same lubricating job. It relied on the variety of molecules in there to perform the function.[50]

3.48 In contrast to these comments, Dr Jean Christophe Balouet told the inquiry on 13 March 2000:

> … evidence presented to this committee suggests that covering the entire surface of the body with oil would not be hazardous. This may be the case for a mineral oil but not for a synthetic oil containing toxic ingredients.[51]

3.49 On 24 February 2000, Mobil Oil Australia replied to a series of questions put to the company by Associate Professor Winder. The following are excerpts from the response by Mobil Oil to Dr Winder's inquiry, a copy of which was supplied to the inquiry:

> From the historical literature, the reported symptoms from exposure to TCP consist of transient gastrointestinal complaints followed some days or weeks later by a progressively developing "dying back" neuropathy starting in the feet and migrating upward toward the hips; in some cases the hands are affected and paralysis migrates upward toward the elbows. This neuropathy is often referred to as organophosphate induced delayed neuropathy (OPIDN). There have been upwards of 60,000 human poisonings from TCP with remarkable similar symptomatology and neuropathology. We do not believe that other human toxic effects are produced by TCP whether the exposure is acute, subacute or chronic. …
>
> In summary, we do not believe that any of the symptoms, reported by individuals claiming to have been exposed to mists or odours of Mobil Jet Oil 11, were caused by exposure to the oil or any of its components. Neurological effects claimed to occur from low-level chronic exposure, or

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50 Mobil Oil Australia Ltd, *Evidence*, 1 February 2000, pp 141-142

51 Dr Jean Christophe Balouet, *Evidence*, 13 March 2000, p 173

> cumulative effects from multiple exposures, are strictly anecdotal and are not supported by concurrent documentation of exposure or of biochemical, or pathological effects known to be produced in humans by TCP. In the absence of proven exposure and recognisable toxicologic sequelae known to be related to TCP, the allegations appear to be simply unfounded speculation. …
>
> We believe that the toxicity of Jet Oil 11 would not be altered by reduced pressure or oxygen level - however, this would not necessarily be true of pyrolysis or combustion products of the oil. …
>
> The more frequent symptoms, i.e. disorientation, blurred vision, impaired memory, altered coordination, nausea, loss of balance, headache, dizziness, increased heart rate, loss of consciousness, shortness of breath.... are consistent with hypoxia. 1 suggest that hypoxia might result from one or more of the following: low oxygen level, presence of carbon monoxide, elevated oxygen demand possibly resulting from increased muscular activity and/or hyperventilation possibly aggravated by high carbon dioxide levels and stress from lack of sleep.
>
> Mobil's turbine oils are designed to meet appropriate standards for engine performance, safety and product stewardship. Our risk assessments define the conditions under which we consider Jet Oil 11 to be of negligible risk through inhalation, dermal and ingestion exposure. That information has been provided to our customers and is available publicly through our published papers in the peer-reviewed scientific literature. Based on the results of this research, we believe Jet Oil 11 is of negligible risk to maintenance workers, passengers, and flight staff potentially exposed to an oil vapour or mist. … [52]

3.50 The Committee notes NICNAS' statement in it's submission that its findings relate to absorption of TCOP through the skin and that 'there are (sic) no reliable data on absorption via inhalation'.[53]

*Labelling of Cans Containing Mobil Jet Oil II*

3.51 In his evidence to this inquiry, Dr Winder drew the inquiry's attention to a change that has occurred in label information on cans of Mobil Oil II, while displaying two oil can labels:

> This is a container of Mobil jet oil 2 with a pre-1992 label which states:
>
> Warning!
>
> Contains Tricresyl Phosphate.
>
> Produces paralysis if taken internally.
>
> Do not use as a medicine or food product.
>
> Wash thoroughly after handling.

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52 Correspondence from Ms S Potts, Manager External Relations, Mobil Oil Australia to the Secretariat dated 5 April 2000 containing letter to Associate Professor Chris Winder dated 24 February 2000, pp 3-4.

53 *Submission 12*, NICNAS, p 4

3.52 Dr Winder went on to comment:

> The label was modified after 1992. The small square is the warning on the pre-1992 label and the warnings are now in this white box in 13 languages. It says:
>
> Warning!
>
> Contains Tricresyl Phosphate.
>
> Swallowing this product can cause nervous system disorders including paralysis.
>
> Prolonged or repeated breathing of oil mist, or prolonged or repeated skin contact can cause nervous system effects.[54]

3.53 According to Dr Winder; "The important thing is it is recognised that the tri-orthocresyl, especially the orthocresyl phosphate containing molecules in the tri-orthocresyl mixture, cause nervous system effects."[55] He went on to state; "While I accept it is unlikely that anybody flying and exposed to this material is going to get paralysis sufficient that they would need to be put in a wheelchair for the rest of their lives, I do not accept that lesser exposures do not cause other nervous system or even neuro behavioural effects."[56]

3.54 In Mobil Australia's supplementary submission to the inquiry the company dealt with the issue of how their cans of Mobil Oil II came to be labelled in the way they are. According to the company:

> … animal studies showed the jet oils tested, containing a maximum of 3% TCP, might be potentially harmful. Subsequently we updated the product Material Safety Data Sheets to include this information and recommended that exposure via skin, inhalation and ingestion be minimised. The emphasis was on ingestion as there had been reports that individuals in certain developing countries may have suffered from delayed neurotoxic effects after ingestion of foodstuffs or beverages adulterated with aryl phosphate esters. …

and

> A formal risk assessment was conducted by Mobil in 1990 which provided confirmation that ingestion was, in fact, the principal route of exposure that could potentially produce neurotoxic effects. Because of the ingestions that had earlier been reported, it was decided that communication (through labelling) of this potential ingestion hazard to individuals working directly with the jet oils was appropriate. The risk assessment clearly showed that a potentially harmful dose is not possible via inhalation at levels at or even higher than Threshold Limit Value of 5.0 mg/m3 for the oil mist. These levels would produce a clearly visible oil mist. Also, an accidental contamination of the entire body surface with an oil containing 3% TCP for 6 hours would not result in the absorption of more than an estimated non-toxic single dose. …

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54 Associate Professor Chris Winder, *Evidence*, 1 November 1999, p 8, see also AFAP, *Evidence*, 1 February 2000, p 113.

55 Associate Professor Chris Winder, *Evidence*, 1 November 1999, p 8

56 Associate Professor Chris Winder, *Evidence*, 1 November 1999, p 8

> Additional joint toxicology studies by Mobil and a major manufacturer of TCP confirmed that an oil with 3% TCP could produce neurotoxic effects in animals administered very high oral doses. This led Mobil to adopt a very conservative labelling approach for its jet oils by including language recommending minimising exposure by all routes and emphasising the importance of good personal hygiene practices. The decision was made in the early part of 1997 and labelling was phased in during the year. …
>
> Mobil's decision to label these products was based solely on its own policies and product safety stewardship practices. …
>
> In summary, recent changes that have been made to the label and Material Safety Data Sheets do not reflect any underlying change in product composition or any new information about health hazards. Mobil Jet Oil 11 has been, and continues to be, safe for its intended purposes. The changes to the label were based solely on Mobil's own product stewardship practices and a very conservative approach to labelling, It must be emphasised that the revised labelling and MSDS statements do not reflect new information on Mobil Jet Oil II, suggesting hazard, where none exited before.[57]

3.55 Mr Plummer of Mobil Oil also told the inquiry:

> … we resubmitted the basis for our labelling and that Mobil jet oil II is non-hazardous by Worksafe criteria to the National Occupational Health and Safety Commission. On 17 June last year we received their reply, agreeing that our labelling is correct and that Mobil jet oil II is correctly classified as non-hazardous.[58]

*Development of a new Mobil jet oil*

3.56 The inquiry was told by British Aerospace that trials are currently taking place in Australia and Europe to produce a Jet oil with different contents to those in Mobil Jet Oil II. Mr Black of British Aerospace noted:

> "Though recognising that no firm scientific link has been made between the sick people and the contents of this oil, we have immediately launched an action to try to change to the oil which is claimed to not have these things in it."[59]
>
> and "We have never actually seen any of these dangerous chemicals getting through into the cabin. Nevertheless, due to that fact that those chemicals exist in the oil and that we have sick people at the other end of the chain, we have initiated this action to try to find a better oil which does not contain those constituents." [60]

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57 *Submission 13A,* Mobil Oil Australia Ltd, pp 3-4

58 Mobil Oil Australia Ltd, *Evidence*, 1 February 2000, p 141

59 British Aerospace, *Evidence*, 2 November 1999, p 85

60 British Aerospace, *Evidence*, 2 November 1999, p 86

3.57 Mr Plummer of Mobil Oil told the inquiry his company has developed a new jet oil named jet oil 291. Mr Plummer advised that:

> … we have got a product now which has lower deposit forming tendencies both in the liquid and vapour phase …. it has a non-toxic additive pack. We have developed a TCP which has effectively eliminated the ortho isomers, which were the 140 parts per million of toxic elements previously.[61]

3.58 Mr Plummer went on to stress that:

> … we want to make it clear that the oil was not developed just to eliminate the toxic elements of TCP. That was just one of a number of development parameters for it. [62]

3.59 Captain Trevor Jensen of Ansett told the inquiry:

> Ansett is currently trialing Mobil 291, a new generation oil, on the BAel46-300 series aircraft. Depending on the results of the trial (engine wear and tear, etc.) Ansett will investigate using Mobil 291 on the other aircraft types.[63]

3.60 The claimed advantages of the new oil were not supported by Dr Balouet when he stated:

> I understand that evidence presented to the committee suggests that new generation modern jet oils have been modified so that the concentrations of some toxic ingredients will be reduced. Please note that these jet oils are still being tested and are not yet in commercial use. Jet engines still contain the older generation of jet oils, known to be toxic, while removing TOCP will not necessarily solve the problem.[64]

**The Alysia Chew case**

3.61 On 28 April 1999 a judgement was delivered in a case brought by an Ansett cabin crew member, Ms Alysia Chew, heard in the Compensation Court of New South Wales.[65] The basis of Ms Chew's claim was that between January 1992 and 30 October 1993, when a flight attendant with Eastwest Airlines, she was exposed to fumes, toxic substances and other irritants whilst carrying out duties as a flight attendant on BAe 146 aircraft. Ms Chew also claimed that fumes within the aircraft to which she was exposed contained Mobil Jet Oil II which contained the substance triorthocresyl phosphate (TOCP).

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61 Mobil Oil Australia Ltd, *Evidence*, 1 February 2000, p 142

62 Mobil Oil Australia Ltd, *Evidence*, 1 February 2000, p 142

63 Correspondence from Captain Jensen to the Committee dated 11 February 2000, attachment p 2.

64 Dr Jean Christophe Balouet, *Evidence*, 13 March 2000, p 173; see also *Submission 14B*, AFAP, pp 17-18.

65 Alysia Chew v Eastwest Airlines Ltd & Ansett Australia Ltd, Compensation Court of New South Wales, (Matter 19652 of NSW), Moran J.

3.62 Ms Chew alleged two alternative causes for her illness:

a) that TOCP caused damage to her physiology which gave rise to her chronic ongoing symptoms and disabilities diagnosed by her doctors as Multiple Chemical Sensitivity (MCS); or

b) Alternatively she alleged her symptoms and incapacity resulted from aggravation of a condition of glandular fever or a viral infection described as Epstein Barr virus.[66]

3.63 In respect of Ms Chew's first basis of claim, Justice Moran noted that:

> The applicant puts her case in the alternative so I do not think it necessary for me to decide whether or not a diagnosis of multiple chemical sensitivity is appropriate in this case. I must say at the outset though that there certainly is a weight of medical evidence in this case against such a label …
>
> I prefer the evidence given by the respondent's doctors, in particular, Dr Carroll and Professor Loblay, that the diagnosis of multiple chemical sensitivity is wrong and that the applicant is suffering from an aggravation of glandular fever or Epstein Barr virus. [67]

3.64 Justice Moran ultimately found in Ms Chew's favour in respect of her second submission and decided that:

- Ms Chew suffered injury arising out of and in the course of her employment with the respondents from January 1992 to 30 October 1993; and
- Section 47 of the *Workers Compensation Act* applies and that the applicant as a result of the injury, "is unable without substantial risk of further injury to engage in employment of a certain kind because of the nature of that employment shall be deemed to be incapacitated for her employment at that kind." [68]

3.65 Justice Moran also commented that evidence in relation to contaminants was as follows:

> The levels of measured chemical contaminants in the cabin air were not a threat to the health of aircrew or passengers.
>
> Contaminant levels were well below internationally accepted occupational health standards and cannot precipitate any chronic disorders.
>
> The levels of contaminants were hundreds to thousands of times below those levels known to cause neurotoxic sequelae.[69]

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66 Judgment given in the Alysia Chew case heard in the Compensation Court of New South Wales and delivered on 28 April 1999, pp 1-2.

67 Judgment given in the Alysia Chew case heard in the Compensation Court of New South Wales and delivered on 28 April 1999, p 10.

68 Judgment given in the Alysia Chew case heard in the Compensation Court of New South Wales and delivered on 28 April 1999, pp 12-13.

69 *Submission 11*, British Aerospace, p 4; see Judgment given in the Alysia Chew case heard in the Compensation Court of New South Wales and delivered on 28 April 1999, pp 8-9.

3.66 In its submission to the inquiry Ansett referred to the Chew case stating that:

> The Compensation Court of NSW made a decision in April 1999 that a Flight Attendant's rare pre-existing viral condition was aggravated by exposure to fumes aboard a BAe 146. The judge accepted expert evidence from witness Dr Crank that there was no toxicity in the fumes coming into the cabin and that they posed no threat to anyone without an extraordinary susceptibility, such as the claimant.[70]

**Medical evidence**

3.67 During its public hearing in Sydney on 1 February 2000 the Committee heard evidence from medical professionals, Dr Mark Donohoe and Dr Richard Teo, both of whom have examined patients affected by fumes while working on BAe 146 aircraft. Both Dr Donohoe and Dr Teo gave evidence supporting claims that exposure to fumes on BAe 146 have led to long term illness and evidence of neurotoxicity.

3.68 Dr Donohoe told the inquiry:

> I am saying that in this case we have doctors and toxicologists saying that there are long-term health problems. In other words, people who have been exposed to these fumes and developed short-term symptoms at the time have had long-term consequences.[71]

3.69 Dr Teo in his evidence to the inquiry stated:

> … the people I have tested have been affected about two years, and they are still not good. So for two years I can say they are not good. [72]

3.70 Dr Robert Loblay put a contrary view at the hearing in Sydney on 1 February 2000:

> Almost anything can be toxic if given in sufficiently large dose or if a person is exposed to a sufficient quantity. The real question is: are the people in the cabin – under normal cabin conditions, not when there is a leak – exposed to levels of any of these compounds which could conceivably cause toxic effects? The evidence the expert panel was presented with seemed pretty clear, that that was not at all likely.[73]

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70 *Submission 22*, Ansett Australia, p 5

71 Dr Mark Donohoe, *Evidence*, 1 February 2000, p. 95

72 Dr Richard Teo, *Evidence*, 1 February 2000, p. 95

73 Dr Robert Loblay , *Evidence*, 1 February 2000, p 105

## Other clinical symptoms

3.71 It is apparent that although some crew members have reacted to the fumes on the BAe 146, other crew members have had limited, or no reaction to the same exposure. One confidential submission to the inquiry advised that it appeared women were more susceptible than men to the fumes.[74] Dr Winder stated:

> There are a whole range of individual reasons why exposure may be increased and also a whole range of issues related to susceptibility. … There are a range of different factors which may underlie why some people are more affected than others.[75]

3.72 Dr Balouet told the inquiry in evidence:

> … individual susceptibility is not the same with all people around the world and even within a small population. Some people would be really allergic, for example, to a compound and others would not. …
>
> There might be genetic factors interfering with these problems. In fact, there are a number of enzymes, one of which especially play a major role in eliminating and controlling the effects of organophosphates. Particularly what we have seen from the preliminary studies is that the people sharing the two same enzymes will show very high effects, while those people who have either the R type or the 2 plus R type will not have such severe symptoms.[76]

3.73 In his evidence to the inquiry Dr Chris van Netten noted that:

> The most sensitive people get sick first and they are your early warning signs of a potential problem. Often these people are looked upon as hypochondriacs or complainers or whatever else, and this is doing the system an injustice because it is actually quite dangerous to not pay attention to these people. They are really your early warning signs that something is wrong. The person next to you might get sick now because of a certain different physiology or background whereas you might get sick next, and this is the important component we have to worry about.[77]

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74 *Confidential submission* C11, p 3

75 Associate Professor Chris Winder, *Evidence*, 1 November 1999, p 13

76 Dr Jean Christophe Balouet, *Evidence*, 13 March 2000, p 176

77 Associate Professor C. van Netten, *Evidence*, 14 March 2000, p 210, see also pp 208-209

3.74 Captain Frank Kolver of NJS commented on the health effects he suffered following his exposure to fumes, an incident dealt with later in this report:

> In my experience, after the first incident I seemed to become sensitive to very strong chemical smells. I think I noted in my submission an example of when I would go into a hardware store and walk past the shelf with insecticides and pesticides. If I continued to stay there, probably within the next 10-15 minutes I would start getting a headache. This was predominantly once again a pain in the left temple. Some other chemical effects were exhaust fumes from motor vehicles in dense traffic and some strong chemically based perfumes. They all seem to have some effect. If I did not do so something about getting away from the source, I would start trying to suffer a headache….The problem we want to solve here is to rectify the problem we have which we believe has been caused by oil fumes.[78]

78 Captain F Kolver, *Evidence*, 2 February 2000, p 149

# CHAPTER FOUR

# TESTING BAe 146 CABIN AIR FOR FUMES - AUSTRALIAN INITIATIVES AND RESULTS

## Study of toxic fumes on US aircraft

4.1 The American Society of Heating, Refrigeration and Air Conditioning Engineers' Aviation Sub-committee to Technical Committee (TC) 9.3, Transportation Air Conditioning has been examining cabin air quality on passenger jet airliners. It must be noted that the ASHRAE study, and its findings, are not necessarily specific to the BAe 146 aircraft.

4.2 Writing in the ASHRAE Journal in September 1999 Dr Jolanda N. Janczewski, a member of the ASHRAE's Aviation Sub-committee, stated:

> The controversy surrounding airliner cabin air quality has been debated for some time. The perception that the air quality within commercial aircraft is the cause of, or can be associated with symptoms experienced by passengers and crew has been the subject of scientific, public and even congressional debate. However, despite numerous studies, meetings, seminars, hearings and press coverage, no definitive association between in-flight cabin air quality and symptoms has been identified.[1]

4.3 According to Dr Janczewski flight attendants asserted that:

> … their workforce suffers from both long- and short-term health effects that are caused by pollutants or conditions within their working environments. They provide the committees with anecdotal stories about crewmembers (and sometimes passengers) experiencing headache, hypoxia, neurological disorders and other symptoms while onboard aircraft. To date, however, no scientific studies or data substantiating these assertions have been provided for the committees' review. [2]

4.4 Dr Janczewski wrote that ASHRAE air quality committee:

> … is comprised of various experts in environmental testing and evaluation, as well as a host of engineers. Reports and presentations provided by these committee members have shown aircraft cabin contaminant levels well below those likely to cause significant health effects. In addition, these experts continue to assert that there is a lack of evidence to support the theories being expressed. Using the most state-of the-art sampling strategies, and conducting continuous review of the data provided by committee members and outside studies, the data has failed to establish a recognised risk. [3]

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1 Jolanda N. Janczewski, *IAQ on Passenger Planes ,* ASHRAE Journal, September 1999, p 18

2 Jolanda N. Janczewski, *IAQ on Passenger Planes ,* ASHRAE Journal, September 1999, p 18

3 Jolanda N. Janczewski, *IAQ on Passenger Planes ,* ASHRAE Journal, September 1999, p 18

4.5 The air quality committee carried out its air monitoring procedures on eight Boeing 777 commercial airline flights operated by a US carrier. The monitoring was performed between 9 and 22 July 1998. Sensors were used to detect a number of contaminants on board the aircraft including volatile organic compounds (VOC).[4]

4.6 In a document supplied to this Committee by ASHRAE it was stated:

> Based on information collected during this study, including the air quality monitoring data, the responses to the comfort questionnaire and the information gathered during the literature search, there does not appear to be significant air quality-related health hazards present for either the passengers or the crew. However, this study was not an industry-wide evaluation involving different manufacturers, airlines and aircraft. The results from this project reflect a very narrow scope since it involved only one airline and one aircraft type. To fully assess the impact of cabin air quality, more research is needed to determine if significant health hazards are present and to identify solutions to correct problem areas.[5]

4.7 This document went on to note that:

> Exposure to harmful concentrations of volatile organic compounds (VOCs) does not appear to present a significant health hazard for passengers or flight attendants. This study, as well as other published and unpublished data seem to indicate that concentrations of total VOCs are lower on aircraft than in other public environments. Also, other than the issue concerning the potential for hydraulic fluid entering the cabin … there does not appear to be sources present in the aircraft cabin that are likely to produce VOCs at levels that would result in significant health effects for the majority of the population. The most abundant VOC, especially on international flights, appears to be ethanol (approximately 80% of the TVOC), which is not a highly toxic inhalation hazard. The most obvious source of ethanol is associated with alcohol consumption of passengers. Two chemicals that posed a concern to the PMS were formaldehyde and acrolein. Both of these chemicals were measured during this study and the results indicated that acrolein was not present in detectable levels. and formaldehyde was present in very low levels (less than 5 ppb). More data needs to be collected on other types of aircraft to confirm that VOCs are not a significant health hazard onboard commercial aircraft. [6]

4.8 Notwithstanding this comment, on 13 March 2000, during his appearance before the inquiry, Dr Jean Christophe Balouet criticised the study by ASHRAE and noted:

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4 W. Mark Pierce and others, *Air Quality On Commercial Aircraft,* ASHRAE Journal, September 1999, p 26

5 *Submission 25*, ASHRAE, Enclosure D, p 44

6 *Submission 25*, ASHRAE, Enclosure D, p 45

> I think you need to understand that ASHRAE is not taking action on this issue (fumes on aircraft). You need to know too that the composition of the Standard Project Committee is under complete reconstruction as ASHRAE found that the committee was totally unbalanced. In fact, out of 16 members, basically two or three may have been representing the users and all the others were representing the industry. It is not the practice in ASHRAE to have such biased committees. So this committee will be totally restructured, starting in the next meeting in June 2000.[7]

**Study of toxic fumes on BAe 146 aircraft in Australia and conclusions**

4.9 British Aerospace noted that three independent analyses of the air supply on the BAe 146 aircraft have been carried out and no specific health or toxicity issues have been identified with the aircraft air supply. [8]

4.10 In its written submission British Aerospace advised that:

> In 1992 Dr V. Vasak conducted an analysis of air in BAe 146 aircraft operated by Eastwest Airlines (now part of Ansett Australia). The report stated that there was no evidence which would support the opinion that reported cabin odour would have lasting adverse health effects on flight crew or passengers … .
>
> In 1996 Chris van Netten of the British Colombia University conducted a comparison of air quality in various types in the Air BC fleet. No health or toxicity issues were identified and his published report stated that the air quality of a normal BAe l 46 compared favourably with that of a Dash 8 aircraft not associated with cabin air problems….
>
> In 1997 Allied Signal in conjunction with Ansett undertook toxicity testing on Ansett aircraft. The report concluded that the air supply was within safety limits. …[9]

4.11 The Committee notes also a section of the report by Dr Vasak dated 16 May 1992:

> In the case of justified medical concern following a continuing inhalation exposure to the contaminated air…some biological tests may be of help (eg: inhibition of cholinesterase in a case of proven exposure of a toxic organophosphate).[10]

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7 Dr Jean Christophe Balouet, Evidence, 13 March 2000, p 179

8 *Submission 11*, British Aerospace, p 1; see also British Aerospace, Evidence, 10 April 2000, p 222

9 *Submission 11*, British Aerospace, p 2; see also report prepared for Dr D Davis of Ansett by Scientific Services of the Queensland Department of Health dated 15 December 1997 set out in *Submission 18*, Ansett Pilots Association; see British Aerospace, *Evidence*, 2 November 1999, p 87.

10 *Submission 14B*, AFAP, p 27

4.12 In a supplementary submission to the inquiry British Aerospace attached a copy of a report titled "Air Quality Testing Aboard Ansett Airlines BAe 146 Aircraft" dated 25 November 1997 prepared by Richard Fox of Allied Signal Aerospace. This report contained the following statement:

> Generally, levels of VOCs in the air supplied to the cabin are very low, when compared with other models of aircraft in use. Contamination originating in the aircraft air-supply system is similar to that seen in airframes of other manufacturing origin.[11]

4.13 The Richard Fox report went on to advise:

> The quality of the supply of air for the cabin and cockpit is within safety limits. Based on the filter analysis, there is no evidence to back claims of triorthocresyl phosphate exposure. [12]

4.14 During evidence to the inquiry Mr Bill Black of British Aerospace commented:

> The additional testing, which has been done by Richard Fox of Allied Signal and by Van Netten for Air BC, have provided additional sampling and additional evidence. They all conclude conclusively that there is no evidence whatsoever of harmful chemicals in the cabin of the BAe 146.[13]

4.15 In relation to the reference to Professor van Netten, the Committee notes evidence quoted earlier in the report that no such conclusions could be drawn from Professor Van Netten's research which he considered had been selectively quoted.[14]

4.16 The Committee also notes evidence from Dr Winder, which argues that the testing upon which BA and the airlines base their arguments - that there is no presence of dangerous levels of chemicals in cabin air - are inadequate for a variety of reasons including:

- no tests have been performed at altitude during serious leak incidents;
- no clinical tests have been performed on affected crew immediately following serious leak incidents; and
- testing equipment is not sensitive enough to detect the isomers, which may be harmful to human health.[15]

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11 Report by Allied Signal Aerospace, *Air Quality Testing Aboard Ansett Airlines BAe 146 Aircraft,* 25 November 1997 p 7, set out in *Submission 11A*, British Aerospace.

12 Report by Allied Signal Aerospace, *Air Quality Testing Aboard Ansett Airlines BAe 146 Aircraft,* 25 November 1997 p 10-12, set out in *Submission 11A*, British Aerospace.

13 British Aerospace, *Evidence*, 2 November 1999, p 89

14 See paragraph 2.83

15 Associate Professor Chris Winder, *Evidence*, 1 November 1999, p 15

4.17 The Committee notes that Ansett contests the assertion that their equipment is not sensitive enough. The committee inspected the equipment at Ansett's Occupational Health and Safety Centre in Melbourne. The Committee is appreciative of the cooperation of Ansett at every point with the Inquiry and of their willingness to make equipment and senior staff available.

4.18 In relation to carbon dioxide the Fox report advised that although levels of CO2 in the main cabin of the BAe 146 were very low, compared to other aircraft carbon dioxide levels in the aft gallery could be high due to the presence of dry ice. It was noted in the report that high carbon dioxide levels, coupled with low humidity, could cause the sensation of burning eyes, as well as muscle aches, headaches, and so on.[16]

4.19 In evidence to the inquiry on 1 May 2000 Captain Jensen of Ansett advised that:

> 115 air samples were taken by flight attendants in air sampling devices designed by Ansett and approved by the Australian Government Analytical Laboratories. This enabled us to capture air for testing at the precise moment an odour was detected. In all the chemicals identified, all levels measured were less than one-tenth of the maximum levels set for safe exposure. More were less than one-thousandth of the maximum levels set. These levels were set by government regulation.
>
> We have also installed carbon monoxide detectors on all BAe 146s in the fleet. The results show that the carbon monoxide levels on board are insignificant.[17]

4.20 On 1 May Dr David Lewis, Chief Medical Officer with Ansett, advised that there was:

> … concern, particularly amongst pregnant flight attendants, that there were raised carbon monoxide levels. We put carbon monoxide data loggers in every aircraft. A data logger measures carbon monoxide literally every second. If it detects any, it measures at half a second. If it detects an appreciable level, it charts it at every quarter of a second. This is down loaded onto a lap top and sent back to us in Melbourne to analyse. The graphs are quite remarkable. They are: zero, zero, zero, spike, zero, zero, zero, spike. And when we put this against the time tapes of what the aircraft were doing, we found zero for flying and spikes for when you open the door in the airport, where there was carbon monoxide from the engines of other vehicles and aircraft. It is at standard levels at airports. We found zero in flight for all the aircraft for a period of over nine months.[18]

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16 Report by Allied Signal Aerospace, *Air Quality Testing Aboard Ansett Airlines BAe 146 Aircraft,* 25 November 1997 p 11, set out in *Submission 11A*, British Aerospace.

17 Ansett Australia, *Evidence*, 2 November 1999, p 55; see also Ansett Australia, *Evidence*, 1 May 2000, p 241

18 Ansett Australia, *Evidence*, 1 May 2000, p 252

4.21 On 25 March 1998 an external panel of specialists released a consensus statement to Ansett dealing with odour occurrences on the BAe 146. This statement read in part:

> The panel reviewed and discussed the comprehensive information provided and is of the opinion that the air conditioning contaminants at the levels detected for both in-flight, and the worst case scenario of pack burn offs', will not cause long term health effects. The panel accepts that short term symptoms associated with odours that have been reported on the BAe 146 and other types are substantiated - These have been generally linked with inadequate ventilation together with aircraft system defects. …
>
> The panel finds that the low levels of detected exposure to all the measured chemical contaminants are not a threat to the health of aircrew or passengers. In particular these pose no carcinogenic, mutaqenic, teratogenic or cumulative toxicological hazard.
>
> Contaminant levels were found to be well below the internationally accepted occupational health standards and cannot precipitate any chronic disorders. The possibility that these odour exposure events could cause flight crew incapacitation was considered. All the measured levels were hundreds to thousands of times below those levels known to cause acute neurotoxic sequel.[19]

4.22 Captain Jensen told the inquiry on 1 May 2000 that "… the panel accepted that there were short-term symptoms of an irritant nature associated with odours but said no cumulative effects are known to any of the chemicals detected at the levels measured."[20]

4.23 Mr Ivor Williams of British Aerospace told the inquiry on 10 April 2000:

> What we are proud of is the fact that the contaminants that they found in the system are incredibly low, way below the maximum levels that are permitted by the authorities. They compare very favourably with WorkSafe and occupational health and safety levels.[21]

4.24 Qantas in its submission to the inquiry commented:

> Qantas has been aware of a number of issues in the past relating to the cabin environment of the BAe 146, and has taken a number of initiatives to address them:
>
> (a) … The data available clearly demonstrates that the level of contaminants were well below Work Safe Australia standards and in some cases. are of the type found in many environments.

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19 Attachment to *Submission 17*, Judy Cullinane

20 Ansett Australia, Evidence, 1 May 2000, p 243

21 British Aerospace, *Evidence*, 10 April 2000, p 238

> (b) In December 1998 the Qantas Safety and Environment Department commissioned its own study, conducted by Australian Environmental Health Services, which tested the air quality of a Southern BAe 146-200 aircraft. This study confirmed that the level of organic compounds and other compounds was significantly below the Work Safe Australia standards.[22]

4.25 Mr David Cox, Group General Manger, Regional Airlines and Fleet Planning with Qantas told the inquiry:

> … the various documents and reports produced by manufacturers, doctors, academics, airlines and individuals have been evaluated by Qantas staff. It is the view of Qantas that the information available in these documents demonstrates that the level of contaminants found in the BAe146 cabin environment are well below health authority standards. [23]

4.26 National Jet Systems was of the view that in its experience "contamination does not occur at levels which exceed permitted limits". The company submitted that it had examined the technical reports on trials conducted during 1997 and 1999 into the levels of contamination on board the BAe 146 and that; " The trial reports conclude that the various contaminants that can be detected in the air are well below the limits published by Work Safe Australia."[24]

4.27 On 10 April 2000 Mr Nottage, Executive Director with NJS, informed the inquiry:

> Having looked at that weight of evidence from all of those reports and then considering the way the Southern test was done, being in what we class a worst case situation that could never eventuate mid-flight, where you are doing a pack burn mid-flight, you had levels that, if memory serves me correctly, were less than one-tenth of the current allowable occupational health and safety limits for those chemicals. We believe there is no feasible way you could get levels in excess of the allowable limits in our cabins.[25]

4.28 Mr Nottage went on to claim; "We believe that the work we have done puts our fleet basically as a world leader in this issue."[26]

4.29 However, The Committee notes a memo to Southern Airlines prepared by National Jet Systems, a QANTAS contractor, in which manager Barry Lodge warns staff that:

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22 *Submission 21*, Qantas, pp 9-10

23 Qantas, *Evidence*, 1 February 2000, p 125

24 *Submission 23*, NJS, p 1; see also NJS, *Evidence*, 10 April 2000, p 207

25 NJS, *Evidence*, 10 April 2000, p 217

26 NJS, *Evidence*, 10 April 2000, p 218

> Oil fumes … while medically not harmful can cause irritation of the nose, throat, eyes and can cause headaches. These effects can be very distracting and in some circumstances cause a flight safety hazard.[27]

4.30 The Committee sought a clarification of this issue and received a reply from Mr Paul Lidbury, General Manager E & M and Business Planning, QANTAS, which said, in part:

> The complex nature of commercial aircraft operations means that many flight safety hazards exist, they may be technical, environmental or as a result of human factors. An airline has a duty of care to constantly investigate and address all hazards that it is aware of.[28]

*Criticisms of tests and studies carried out on the BAe 146 in Australia*

4.31 The Australian Federation of Air Pilots was critical of the methods used by some researchers in examining fumes on board the BAe 146. The AFAP submission stated:

> While Ansett and its expert panel claimed to have reviewed all available medical and scientific data relating to cabin air contamination, this is clearly not the case.
>
> There are numerous international studies that demonstrate the effects of contaminated aircraft air on crew and passenger health and safety. Once again, the symptoms and exposure environments and background history is about identical as those being experienced by crew operating the BAe 146.
>
> The effects of chronic exposure to chemicals and particularly cholinesterase inhibiting organophosphates are identified and fall into the same pattern of symptoms that are being seen in Australia. The symptoms are generally not connected to workplace over exposure, and appropriate testing is therefore not being conducted in the required time frame and format.
>
> Other newer areas of science and medicine, both within Australia and overseas, including that of low dose long term/ chronic exposure to chemicals and the common symptom of acquired chemical sensitivity are clearly available, yet are being ignored by the airline industry, even though the strong pattern of symptoms occurring both in Australia and overseas supports this.
>
> Medical data relied upon by the aviation industry concerning the effects of chemicals is limited as long term effects are denied based upon their own admission that disease/tissue pathology, although inaccessible in this case, is the only accepted identifier of long term effects.

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27 'NJS Bae 146 Oil Fumes in Summary – 17 November 1998, *Memorandum signed 'Barry Lodge, GGM, Aircraft Safety & Regulation*, supplementary material lodged with report.

28 Letter dated 2 June 2000 from Paul Lidbury, General Manager, E & M Business Planning, QANTAS, supplementary material lodged with report.

> There are a number of medical Professors in Australia who accept that repeated low dose exposure to certain chemicals can lead to numerous long term symptoms, chronic fatigue and chemical sensitivity, even though the etiology of the later 2 are to date unknown. …[29]

4.32 The AFAP also called into question the credibility of the "independent panel's" statement to Ansett dealing with fumes on board the airlines' BAe 146 aircraft. As stated by the AFAP:

> Much of the testing is irrelevant, unsuitable and uses very selective information and often misinterpreted by Ansett and it's selected external panel, which is now claimed to be an "Independent expert panel". The six member Panel is most certainly not independent as it is made up of 2 Workcover consultant Doctors, as well as the principal medical Officer and senior Industrial Hygienist of Workcover Queensland and one other with very definite pre-existing conclusions on a number of health matters involved.[30]

4.33 The Flight Attendants Association of Australia was of the view that "… testing of cabin air quality parameters by Ansett has been inadequate or inconclusive".[31]

4.34 According to the Association, it:

> … then, as now, questions the pertinence of such tests carried out on a limited number of flights with little or no fume occurrences. That is, the tests were done on "normal" flights, not on flights with air quality, fume or odour problems.
>
> At no stage has Ansett ever tested or sampled the air on an aircraft with a significant seal failure. [32]

4.35 The FAAA submitted that the sampling kits used by Ansett on the BAe 146 aircraft;

> …. worked on rare occasions due to the seal required on the vacuum contained within being hard to maintain in a non-laboratory situation … The failure rate of the kits was so high that with hundreds of attempted samplings, only 57 successful samples could be analysed.[33]

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29 *Submission 14A*, AFAP, p 7

30 *Submission 14A*, AFAP, p 10

31 *Submission 24*, FAAA, p 1

32 *Submission 24*, FAAA, p 1

33 *Submission 24*, FAAA, pp 5-6

4.36 Dr Chris Winder was critical of the studies and tests conducted in relation to fumes on board the BAe 146 aircraft and the effect of exposure to these fumes on aircrew. In Dr Winder's view it is difficult to extract useful information from these studies and that the methodological considerations indicated that many of the studies were flawed. For example, according to the Dr Winder:

> Any sampling method that relies on sample collection of an air sample containing a mist, and analysis of a residual vapour (when all the mist has settled) could underestimate exposure by orders of magnitude…. Tricresyl phosphates are detected only in a method where the entire sample is captured and not allowed to disperse… [34]

4.37 Dr Winder was critical of the survey methods used by Ansett and its findings:

> In the main, these surveys use inadequate methods or inappropriate technologies to measure for all toxic contaminants. … Further, collection of contaminated air into sample containers for subsequent analysis underrates the problem, as mist particles will settle and coalesce on the walls of the container, leaving only small amounts of vapour to be analysed at a later date. Further and perhaps most critically, there has never been a monitoring survey conducted during a leak event to actually identify what the actual contaminants might be. [35]

4.38 Dr Winder detailed what he saw as the methodological problems with these studies, namely:

- the monitoring was carried out using inappropriate conditions, such as testing at ground level;
- the monitoring was carried out using inappropriate methods, such as analyses of samples collected in summa canisters or Tedlar bags, when mists could coalesce onto the surface of the sample container;
- storage of sample containers was too long (for example, over 72 hours after sample collection when some compounds could be lost, or semi-volatile compounds would adhere to the inside of the bag); some studies are not relevant to the BAe 146, or to Mobil Jet Oil II;
- little evidence is presented to indicate if monitoring was carried out after scheduled maintenance, or seal, oil or filter changes, so it is difficult to assess whether the monitoring was representative of typical exposures;
- most importantly, no monitoring was conducted out at a time when an odour incident had occurred.[36]

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34 *Submission 6*, Associate Professor Chris Winder, p 11

35 Associate Professor Chris Winder, *Evidence*, 1 November 1999, pp 5, see also 13-14

36 *Submission 6*, Associate Professor Chris Winder, p 11, see also pp 14-15

4.39 Dr Winder argued that:

> Airline claims that the results of monitoring indicate that exposures are within recommended exposure standards and that there is no problem are nonsensical. Survey methods are inadequate and the results severely underestimate exposure. … Air monitoring does not measure skin exposure at all and therefore exposure from another route is completely ignored. Lastly, and perhaps most critically in this particular area, is that the operation of exposure standards is not allowed at altitude. So statements that exposure standards are being met go beyond what the exposure standards bodies recommend that they be used for.[37]

*Response to criticisms of current Australian testing methods*

4.40 Dr Lewis of Ansett told the inquiry in evidence that Tedlar bags used during the tests on the BAe 146 were:

> … closed off and returned to Melbourne and tested by the Australian Government Analytical Laboratories. The testing procedure for volatile organic compounds, which is what we were looking for, was approved by the Australian Government Analytical Laboratories.[38]

4.41 Dr Lewis went on to state:

> … Allied Signal, the manufacturers of the engines and the APU, … came out and did extensive testing in summa canisters - another more expensive way of testing - and took the results back to the States where they met all the American standards for testing. Thirdly, we had Dr Lee from the Queensland Health Scientific Services, who had a real time gas chromatograph. This was real time analysis that he could do on flights and on the ground. He also used a liquid nitrogen entrapment thing which actually sucked the cabin air through a flask of liquid nitrogen. Every molecule was frozen and sealed off and then taken back to the Queensland gas chromatography laboratories and tested. Additionally, very early on, Professor Vasak from Sydney together with New South Wales Workcover laboratories did swabs and air testing by separate methods. The numbers were small admittedly, but that was our first try at analysis. With the number of samples we have taken, approved by governments and done by government agencies, I fail to see that this was an unreliable test method.[39]

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37 Associate Professor Chris Winder, *Evidence*, 1 November 1999, p 5, see also pp 13-14

38 Ansett Australia, *Evidence*, 2 November 1999, p 59

39 Ansett Australia, *Evidence*, 2 November 1999, p 59; see also Ansett Australia, *Evidence*, 1 May 2000, p 251

4.42 In response to claims that some tests on the BAe 146 were not conducted at high altitudes but on the ground Mr David Villiers of CASA told the inquiry:

> If you run the engines on the ground at the appropriate power with the airconditioning systems on it makes no difference, because the fumes will come through the aircraft on the ground as if it were in the air.[40] …
>
> Where these fumes have been generated is inside the engine and, while there may be some minor differences, the temperature changes from ambient to the inside of the engine are very significant. While they will be different altitude, I do not think they are going to make a great deal of difference to what we are looking at. [41]

*New testing program by British Aerospace*

4.43 On 10 April 2000 Mr Bruce Jones of British Aerospace advised the inquiry:

> … we are developing our own test program to enable us to develop further data on any potential contaminants in the cabin air supply. The intention is to use a portable detector to carry out a series of controlled measurements of the cabin air environment, having introduced known quantities of specific contaminants into the airconditioning system of a non-service - or test aircraft. This will enable us to build up a profile of the signature of each potential contaminant at each stage of flight. The detector can then be used by individual operators to determine the precise profile of any contamination suspected on a particular aircraft. This should enable more precise corrective maintenance action to be taken and may also identify any further design enhancements which can be introduced.[42]

## Australian attempts to resolve the problem of fumes on the BAe 146

4.44 In the Occurrence Brief dealing with an incident involving Captain Frank Kolver published by the Bureau of Air Safety Investigation in early September 1999 and dealt with in detail later in this report, it was noted that:

> As a result of testing and research, operators undertook a number of corrective maintenance actions and modifications to BAe 146 aircraft in the Australian fleet in an attempt to mitigate odour occurrences within the cabin. These actions included more frequent air filter cleaning, replacement of APUs with an alternative unit, modifications to APUs to improve ventilation in and around the unit and associated air intakes, assessment of filter life, air duct cleaning, and the replacement of ducts likely to trap oily deposits. The air conditioning packs were also "burnt out" on a daily basis. This procedure was intended to increase pack operating temperatures in an attempt to burn off any remaining oil residues within the air conditioning

40 CASA, *Evidence*, 1 November 1999, p 45; see also Ansett Australia, *Evidence*, 2 November 1999, p 69

41 CASA, *Evidence*, 1 November 1999, p 45

42 British Aerospace, *Evidence*, 10 April 2000, p 223

> system, but was discontinued by Australian operators because it apparently caused deterioration of the packs. There was also an increase in the frequency of engine oil seal inspections and replacement.[43]

*Actions taken by Ansett*

4.45 On 2 November 1999 Ansett detailed to the inquiry the initiatives it had taken to deal with the issue of fumes on its BAe 146 aircraft. Captain Jensen advised this Committee:

> To the best of our knowledge, we have done more than any other airline in the world, including the four other BAe 146 operators in Australia, to address this issue and the improvements we have made to our fleet of 13 aircraft ensures air quality aboard Ansett's fleet is superior to that of the other 20 BAe 146s operating in Australia. …
>
> When the first odour reports came from East West crew in 1991, full medical examinations were arranged for the flight attendants who reported fume exposure at the time. An occupational medical consultant found no associated health risks. Since then, we have worked with a large number of external experts and we have sought to involve our staff and their unions throughout the process. …
>
> We have also taken care to communicate with our people. We have provided not only written material but also briefing sessions around the country. This has given our people information and the opportunity to ask questions and to provide feedback. …
>
> Ansett's BAe 146 Odour Inquiry Committee was established as a problem solving committee. It comprised representatives of all relevant departments of the airline as well as the Flight Attendants Association of Australia, the FAAA; the Ansett Pilots Association, the APA; and representation from British Aerospace. The committee oversaw a number of initiatives. …
>
> A network of doctors was made accessible for timely medical assessment of any crew member suspected of being affected by odour exposure. Practitioners were given a brief on the issue but were not constrained in any way by Ansett in the performance of their duties. A cabin air sampling program was also undertaken …
>
> We also sought to involve external expertise. This included Professor Vlad Vasak, an aviation occupational hygienist, and the New South Wales WorkCover laboratories that conducted air and ventilation duct sampling on the aircraft; Richard Fox of AlliedSignal - the manufacturer of the engine and the auxiliary power unit, APU conducted comprehensive air quality testing in-flight and on the ground; George Lee of the Queensland Health Scientific Services conducted ground and in-flight air sampling using a real-

43 BASI Occurrence Brief 199702276 (on Internet site) incident involving Captain Kolver on 10 July 1997, p 3.

> time gas chromatograph and a novel liquid nitrogen device; Dr Rob Liddell, the former medical director of the Aviation Safety Authority, flew with and interviewed over 80 flight attendants and pilots; an independent panel of experts with toxicological, immunological and occupational medicine expertise was convened to review all of the extensive data available; and Professor Westerman of Monash University carried out a study of the effects of low level carbon monoxide on pregnancy.[44]

4.46 Captain Jensen told the inquiry on 1 May 2000 that, "… Ansett has not only improved cabin air quality on aircraft but has also collated arguably the most detailed set of data on BAe 146 air quality anywhere in the world."[45]

4.47 Ansett claims that it has pioneered the development of engineering modifications and procedures to address cabin air quality in the BAe 146 aircraft. Engineering enhancements include:

- engine and auxiliary power unit modifications to prevent oil and/or APU exhaust leaking into the air conditioning system, and
- modifications to the air conditioning system to improve airflow in the cabin.[46]

4.48 According to Ansett; "These modifications have resulted in a significant reduction in the number of reported odour occurrences."[47]

4.49 On 1 May 2000 Captain Jensen advised the inquiry that Ansett estimated the cost of the modifications it had made to its BAe 146 aircraft and other in house activities and initiatives related to dealing with air quality on these aircraft to be in the "vicinity of $7 million".[48]

4.50 On 13 March 2000 Mr Mick Toller, the Director of Aviation Safety with the Civil Aviation Safety Authority, brought the inquiry up to date concerning progress on modifications being made to engines on Ansett's BAe 146 aircraft when he stated:

> Ansett now have 12 aircraft in their fleet. I think they had 13 probably when they appeared before you, but they are now down to 12. All of those aircraft have had their APUs modified. I understand that, of the 60 engines that they have, one engine still has all the modifications outstanding so there has not

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44 Ansett Australia, *Evidence*, 2 November 1999, pp 53-54. Captain Jensen went on to advise that all of these experts had concluded that the aircraft was "… well within safety standards and that there is no serious health hazards associated with exposure to BAe 146 cabin air." Ansett Australia, *Evidence*, 2 November 1999, p 54

45 Ansett Australia, *Evidence*, 1 May 2000, p 200

46 *Submission 22*, Ansett Australia, p 4; see also Steve Creedy, *Air of Mystery,* Weekend Australian, 11 September 1999.

47 *Submission 22*, Ansett Australia, p 4

48 Ansett Australia, *Evidence*, 1 May 2000, p 243

> been anything done to it. One has two of the modifications outstanding; four just have one outstanding. So of the 60 engines, 53 have been fully modified and, of the aircraft modifications, eight have been completed or, for various reasons, do not require modification because they were built later. The remaining four are due to be modified by the end of October 2000.[49]

4.51 British Aerospace told the inquiry:

> During 1998 British Aerospace and Ansett reviewed a number of options to enhance the working environment within the vestibule (galley) area of the BAe 46. Subsequently optional modifications have been introduced as follows:
>
> - Removal of potential odours from the toilet compartment and the reduction in carbon dioxide levels (caused by the use of dry ice) by installing an electrically operated toilet extraction system.
>
> - Improved air movement in the vestibule (galley) through an additional air outlet in the forward and rear vestibule.
>
> - Improved lighting within the vestibule area.
>
> - Extension of the conditioned air tubes in order to provide air outlets in the roof panels between the overhead luggage lockers.[50]

4.52 In evidence to the inquiry on 10 April by Mr Ivor Williams of British Aerospace made the significant admission that modifications undertaken on BAe 146 aircraft in Australia would not solve entirely the problem of fumes entering these aircraft. Mr Williams stated:

> We all acknowledge, and we have acknowledged it here tonight, that the modifications will not solve the problem completely. They are to reduce the number of events, and that is what is important.[51]

*Comment on Ansett's actions on the BAe*

4.53 A former employee of BASI, Mr Clive Phillips, told the inquiry:

> … we found that the work that was being conducted by Ansett and their approach to the problem of this aeroplane was a bit unique. They had put together special committees. The amount of attention that they spent on this aircraft went way beyond its value within the fleet. It was obvious to me that they were concerned about the health and safety issue.[52]

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49 CASA, *Evidence*, 13 March 2000, p 184

50 *Submission 11*, British Aerospace, p 3

51 British Aerospace, *Evidence*, 10 April 2000, p 236

52 Mr Clive Phillips, *Evidence*, 1 February 2000, p 122

4.54 Mr Phillips went on to state in relation to the report of fumes on the BAe 146 aircraft; "… They obviously took those very seriously and were working within their own organisation but also with British Aerospace to carry out tests which did find a lot of deficiencies in the aircraft, and they are working to overcome those deficiencies to try and improve it." [53]

4.55 In evidence to the inquiry the Ansett Pilots Association expressed strong support for the actions taken by Ansett to deal with the problem of fumes on the BAe 146. Mr Michael Egan of the Association stated:

> … based on the reports that we have received from our members who operate the British Aerospace 146 aircraft, that the actions that Ansett Australia has taken to improve the quality of air provided to the cabin and cockpit of the aircraft have been very successful. Over recent months, we have received no complaints of fumes in the cabins or cockpits of British Aerospace 146 aircraft. On questioning crews, we have been informed that mild cabin smells have been noticed on a small number of flights and that the aircraft in question has had engineering attention at the first available moment to investigate the source of the odour. These odour occurrences generally appear to be related to the efficiency of the cabin air filtration systems fitted by Ansett Australia. As noted in the Queensland Government Health Department report, these filters are very efficient at reducing contaminants and it becomes difficult to relate a smell event to an engine event. Apart from a major component failure, such as a bearing seal failure that will overcome the filters, the filters provide a significant safety circuit. The completion of the aircraft modifications and the current continuing monitoring of the aircraft air quality seems to be keeping occurrences of contamination of cabin air on the 146 Ansett Australia aircraft to a minimum.[54]

4.56 Mr Egan later went on to comment:

> It would appear that the unmodified British Aerospace 146 seemed susceptible to poorer than normal air quality and that this air appeared to contain a number of contaminants that affected to varying degrees the crew and passengers that they carried. The Ansett Pilots Association believes that the modifications that Ansett Australia has carried out on its British Aerospace 146 aircraft and the ongoing preventive and reactionary maintenance program that Ansett Australia has put into place has significantly reduced the frequency and severity of cabin odours in these aircraft. [55]

and:

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53 Mr Clive Phillips, *Evidence*, 1 February 2000, p 123

54 Ansett Pilots Association, *Evidence*, 2 February 2000, p 163

55 Ansett Pilots Association, *Evidence*, 2 February 2000, p 163

> I think Ansett has been very good about this whole issue. They have investigated a number of different ways of handling the problem. They have looked for pilot input into better ways of operating the aeroplane that may not cause fume smells. They have always been interested in reports of any occasion when there is a smell. I think they have been very proactive. [56]

*Actions taken by Qantas and National Jet Systems Pty Ltd*

4.57 According to National Jet Systems Pty Ltd maintenance and operating procedures have been developed in concert with British Aerospace to enhance the quality of the cabin air in the BAe 146. These initiatives included:

- frequent overhaul of the air-conditioning packs;
- installation of improved engine oil seals; and
- changed Auxiliary Power Unit air switching procedures.[57]

4.58 Captain John Siebert of NJS told the Committee on 1 February 2000:

> To update the committee on the progress of our efforts to improve the quality of the cabin air in the 146, I can report that all of the engines have now been modified with new and improved bearing oil seals. Modifications are being incorporated into the distribution pipes, which will improve the cabin air circulation patterns. Those are the pipes that I understand the senators had a look at in Brisbane. They are exactly the same as the ones going into our fleet. These modifications are part of an ongoing process that applies to all areas of the aircraft. Operating procedures have been adjusted so that descents are flown with engine thrust levels at above flight idle. In addition, the APU air supply is selected at a late stage during the approach to landing. Both of these measures have proved to be quite beneficial.
>
> A major leap forward in the reliability of the engine oil seals can be identified as a result of the Allied Signal, which is now Honeywell, XRP extended reliability program for the engines, and the decision by NJS to send the engines back to the manufacturer's Phoenix Arizona facility for all the overhauls. During the overhauls all of the bearing oil seals are replaced by new parts rather than being reinstalled after the existing seals have been inspected.[58]

4.59 On 13 March 2000 during a public hearing in Canberra Mr Toller of CASA advised the inquiry:

> National Jet Systems have a total of 21 aircraft. I think they probably had 20 before. … Only four of those aircraft have been modified for the aircraft

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56 Ansett Pilots Association, *Evidence*, 2 February 2000, p 165

57 *Submission 23*, NJS, p 1; see also Qantas, *Evidence*, 1 February 2000, pp 126 - 130

58 NJS, *Evidence*, 1 February 2000, p 134

> modifications (sic). However, our information on the engine modifications is that they only have four engines that remain to be modified. I think there is only one APU in National Jet that is outstanding. That is the latest information that we have been given. National Jet are talking about the aircraft modification being complete by mid-2001, so they appear to be about nine months behind Ansett on the completion of modification.[59]

4.60 On 10 April 2000 Captain Siebert told the inquiry, "NJS modifications to the auxiliary power units and the engines are substantially complete and, indeed, they are well ahead of other operators of this type of air craft."[60]

4.61 On 2 February 2000, Captain Frank Kolver, a First Officer with National Jet Systems became the first pilot to give evidence publicly on the fumes issue. Captain Kolver told the Committee:

> … I was certainly pleased to see that each time we reported oil fumes our company went to considerable lengths to rectify the problem. As I said before, many engine changes had been done at considerable cost to the company. I know they are trying to improve the quality of the oil seal.[61]

*Criticism of airline measures to address the fumes issue*

4.62 Captain Kolver also informed the Committee that he believed exposure to fumes on the BAe 146 were the cause of his medium to long-term health problems and that he was incapacitated a second time after being exposed to fumes on a BAe 146 following the BASI report. In his evidence, Captain Kolver told the Committee he had not donned an oxygen mask when suffering ill effects from exposure to fumes because he had been assured by his safety manager, Mr Barry Lodge, that the fumes were not harmful. He also informed the Committee he suffered headaches and nausea and chemical sensitivity for periods between 10 days and two months after being exposed to fumes on a BAe. He gave an opinion that the problem stemmed from a "design problem with the engine".[62]

4.63 The Australian Federation of Air Pilots in its submission criticised the Australian airline industry for the manner in which it has dealt with the problem of fumes on the BAe 146. Set out below are a number of quotes from the AFAP exhibiting its views:

> …. the airline industry has failed to deal with this issue effectively and adequately and often used non-independent sources, misinterpretation of data, limited data, or often outdated and irrelevant information. Symptoms encountered and effects upon aircraft safety, have often been ignored, so as

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59 CASA, *Evidence*, 13 March 2000, p 184

60 NJS, *Evidence*, 10 April 2000, p 205; see also p 209

61 NJS, *Evidence*, 1 February 2000, p 149

62 Captain Kover, *Evidence*, 2 February 2000, pp 146-147

to reduce that apparent extent of the problem. While crew who have been effected to a more serious longer term degree have been isolated so as to ensure no long term nexus is made between aircraft fumes and occupational health issues. ….

While one of the airlines involved indicates that the acknowledged problem has been fixed, exposure incidents have continued to occur within the Australian BAe 146 fleet. It has only been through the efforts of concerned crew that the issue, has been investigated.[63]…

Ansett claims to have rectified the technical problem, via a series of modifications, yet it is understood that exposures have since occurred at Ansett as well as NJS where these modifications have not taken place. [64] …

While reviewing their own product/service, they have clearly placed priority on the issues of commercial, financial operations, liability and others, over work health and safety issues.

The recognition of the problem by industry has only developed as pressure has increased from growing numbers of effected crew, though limited to short-term health effects only, so as to reduce possible ramifications from such an acknowledgement. [65] …

… the issue of air contamination in the 146 cabin has now been accepted by Ansett associated with reported short-term symptoms. The commercial, operational and legal implications of recognising the full extent of the problem involving contaminated air on the BAe 146 would appear to be the reason the issue has not been resolved. [66] …

While the airlines have a clear duty of care to the operating crew in the workplace, as well as passengers, the commercial and operational considerations necessary to keep the aircraft flying, have in all cases limited the airline view of the extent of the problem and taken priority over the clear safety issues and subsequent short, medium and longer term health effects experienced by the crew. The issue has only been further investigated because the crews effected have suffered such extreme hardship as well as in flight safety hazards, that they have sought further recognition. [67]

63 *Submission 14A*, AFAP, p 2

64 *Submission 14A*, AFAP, p 5

65 *Submission 14A*, AFAP, p 8

66 *Submission 14A*, AFAP, p 10

67 *Submission 14A*, AFAP, p 11

4.64 The AFAP was highly critical of the performance of Ansett's "expert committee" claiming that:

> … material being collected has delivered a result that was wanted. It was not considering alternative arguments that were being put to get a proper balanced result.[68]

4.65 In his evidence to the inquiry on 1 May 2000 Captain Jensen of Ansett commented on the AFAP's views:

> … the AFAP does not represent any air crew - pilots or flight attendants - employed by Ansett Holdings. Indeed, the AFAP has not participated in any research or evaluation conducted by Ansett and has never been provided with official documentation by authorised officers of the company. Any comments provided by the AFAP relating to Ansett or its employees can, at best, be viewed as hearsay or supposition.[69]

4.66 The Committee understands that the AFAP represented Ansett pilots prior to the 1989 pilots dispute whereupon it ceased to represent pilots employed by the two major airlines. The AFAP has members flying with regional airlines including Southern and National Jet Systems.[70] In relation to Captain Jensen's assertion that the AFAP has not been given official Ansett documentation relating to the BAe issue, this is at odds with the appendixed information attached to the AFAP submissions 14A and 14B, which refer to internal and external Ansett documentation, as well as academic, industry and staff literature produced on the BAe 146 issue in Australia and overseas.[71] Therefore the Committee does not accept Captain Jensen's assertion that the AFAP's evidence is 'based on hearsay'.

4.67 It is the view of Dr Winder that although airlines in Australia knew about the problems of fumes on the BAe 146 since at least 1992:

> … attempts to deal with the situation, such as establishing an odour committee or "panel of experts" seem to be more about addressing industrial relations issues, rather than establishing genuine efforts to rectify the problem through design or engineering solutions.[72]

4.68 Dr Winder argued that attempts by Ansett to deal with the problem of fumes were and are ,"reactive and piecemeal" due to:

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68 AFAP, *Evidence*, 1 February 2000, p 116

69 Ansett Australia, *Evidence*, 1 May 2000, p 244

70 Australian Federation of Air Pilots, *Evidence*, 1 February 2000, p 113

71 *Submission 14B*, Australian Federation of Air Pilots, pp 14-17

72 *Submission 6*, Associate Professor Chris Winder, p 6

- minimal compliance with maintenance requirements, for example, no consideration is given to the maintenance requirements of ageing aircraft;
- attitudes which place pressure to fly aircraft over the health of staff; and
- the unimportance that the airlines give to staff complaints about air quality.[73]

4.69 However, Dr Winder admitted in evidence that he was unsure as to whether the modifications carried out on Ansett BAe 146 aircraft complied with regulatory requirements and he did not know if they had been evaluated for effectiveness.[74]

4.70 The Committee notes evidence from British Aerospace that the modifications are only intended in an experimental capacity and aim to reduce, not eliminate the rate of fume incidents.[75]

4.71 A confidential submission by a former BAe 146 Captain to the inquiry stated; "Ansett have only attempted to play down any problems due to the odours and it appears that commercial considerations rather than providing a safe working environment for staff as well as the travelling public is their prime priority."[76]

4.72 The Flight Attendants Association of Australia was also critical of the modifications carried out on Ansett BAe 146 aircraft:

> Since the Fox Report Ansett has made some modifications to airflow in this area, however these modifications have proved ineffective (numbers of Fume Reports have not decreased) or have proven impractical and have had to be reversed (extraction fans in the toilet caused the smoke alarm to malfunction).
>
> It is also of note that Ansett's modification to the cabin ventilation system; the repositioning of air vents to higher on the interior fuselage, was completed by August 99 as planned. This did not produce any noticeable reduction in fume reports.
>
> Ansett has not done any follow-up testing to determine whether total contaminant levels are now within Safety Standard limits.[77]

4.73 In evidence to the inquiry on 2 February 2000 Mr Brendan Treston of the FAAA commented:

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73 *Submission 6*, Associate Professor Chris Winder, p 2

74 Associate Professor Chris Winder, *Evidence*, 1 November 1999, p 5

75 British Aerospace, *Evidence*, 10 April 2000, p 229

76 *Confidential submission* C6

77 *Submission 24*, FAAA, p 11; see also *Submission 17*, Judy Cullinane, p 57.

> The current system of modifications which Ansett has put into the aircraft, it must be remembered, are experimental modifications. Ansett does not know in advance that that will fix the problem. Nor does any other operator. It is trialing this as another way of attempting to fix the problem. … We will be convinced that this is a total fix when the fume reports dry up and the flight attendants no longer ring us up wanting to be removed from duty on the aircraft, and fume reports stop coming in. Then we will know that the modifications programs have been effective. Until then, as far as we are concerned it is still in the experimental.[78]

4.74 With regard to the Ansett Odour Inquiry Committee referred to earlier in this chapter, the Committee notes evidence from a flight attendant, who served on this committee, that the Committee was wound up for unexplained reasons without completing its investigations.[79]

4.75 The AFAP was critical of the work done by NJS and Qantas in relation to dealing with fumes on the BAe 146. The Federation told the inquiry:

> National Jet Systems appears to have done no independent testing or research itself, but has rather made an arrangement with Ansett to share information and test results.
>
> Southern Australia maintenance and certain other expertise are undertaken by National Jet Systems as both operate the 146 within the Qantas group, and is believed to have undertaken some limited air sampling of its own, yet using procedures similar to those at Ansett.[80]

## CASA's support for airline action

4.76 In its submission to the inquiry CASA endorsed the initiatives undertaken by both Qantas and Ansett to deal with the problem of fumes on their BAe 146 aircraft. CASA stated it:

> … is entirely satisfied that the BAe 146 aircraft in service with QANTAS and Ansett are safe for public transport and that the airlines have discharged their responsibilities to the public and regulator in maintaining the aircraft to the standards required. … CASA commends the responsible attitude demonstrated by the two Australian major carriers for their open and comprehensive research into the cabin environment on their aircraft. The research conducted by the two operators, particularly Ansett, is probably the most intensive ever carried out on in-service aircraft anywhere in the world and will certainly be used in setting even higher standards for future airliners.[81]

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78 FAAA, *Evidence*, 1 February 2000, p 138

79 See *Submission* 17, Ms Judy Cullinane.

80 *Submission 14A*, AFAP, p 10

81 *Submission 20*, CASA, p 5

4.77 Mr Mick Toller, of CASA, told the inquiry during a public hearing on 13 March 2000:

> It is interesting to us that on a first analysis the level of incidents in Ansett seems to have decreased significantly, to the extent that with their modified aircraft I do not believe we have had a single result yet of an incident that is attributable to smoke or fumes in an Ansett modified aircraft.[82]

4.78 However the Committee has received advice that many continuing reports of fume incidents on modified Ansett aircraft have been reported to Ansett. [83]

**CASA's view on the significance of fumes on-board the aircraft**

4.79 CASA outlined in its submission its views on the issue of air quality on the BAe 146 aircraft. According to the Authority:

> A team of Australian medical experts has reviewed the test methods and results and has declared that there is no contaminant present in the cabin environment that will induce any long term or permanent effects on the passengers or crews. In particular, at no time was tricresylphosphate ever identified in any sample gathered in an Australian aircraft.
>
> The subject of "smells" in the cabin is most frequently the trigger for complaints from the crews and passengers and the source, apparently, of their discomfort. The air quality of so-called "smelly" aircraft has been carefully analysed and the results were found to be no different, chemically, from the other aircraft types being sampled at the time. … The medical teams also noted that the humidity of the cabin air was extremely low (5-10%) and that this would certainly be a cause for human discomfort. Modifications to improve cabin air circulation and eliminate stagnant areas have been introduced by both Australian operators.[84]

4.80 The claim that TCP has never been found to be present in aircraft cabin air was also made to the Committee by Dr David Lewis and Dr Loblay. It is incorrect, a fact later acknowledged by Dr Lewis when questioned in a Committee hearings.[85] The Inquiry Chair referred Dr Lewis to the report done by George Sleigh for Ansett, which did find TCP present in aircraft cabin air in minute quantities. Dr Lewis replied:

> That is right. When you took it back, there was an unmeasurable blip where the TCP group occurs. When it was analysed further and further—it would have been meta TCP, which is virtually non-toxic anyway—it was not

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82 CASA, *Evidence*, 13 March 2000, p 182

83 Based on the evidence from Ansett that all Ansett passenger aircraft have been modified so any incidents in the past 6 months have been on modified aircraft see Ansett memo 26 May 2000. The Committee could refer and quote from incident reports submitted to it in June 2000.

84 *Submission 20*, CASA, p 4

85 Ansett Australia, *Evidence*, 1 May 2000, p 260

> measurable, it was just a little hiccup on the graph. Professor George Sleigh has written a summary to that effect. We are talking about equipment that can measure molecules, and when they finally enlarged and enlarged the test thing it was meta TCP, not ortho and not the others, and it is supposed to be non-toxic. We have never had a positive TCP ever.[86]

4.81 The Committee notes that this contrasts with claims that no form of TCP had ever been detected in BAe 146 aircraft air, although it occurred in minute quantities.

4.82 In his evidence to the inquiry on 13 March 2000 Mr Toller of CASA stated, in relation to air quality on the BAe 146:

> … this is an occupational health and safety issue. We are an aviation safety regulator. That is not meant to show in any way that we are not tracking the situation, aware of the situation, or concerned about the situation. But it is well outside the standard expertise of the aviation regulator who is concerned about what are, effectively, the short-term to medium-term effects on aviation safety.[87]

4.83 The Committee notes however, the reference to the health of pilots as a safety issue (see CAR 48.0 1.4: and CAR 256: (2) and CAR25.831) on airworthiness and ventilation and heating (see 1.1) which state that air quality and pilot health extend beyond 'occupational health and safety concerns' as stated by Mr Toller and into the areas of flight safety and aircraft airworthiness. These references to air quality as safety and airworthiness issue in the Civil Aviation Act were not addressed by CASA's evidence to the Inquiry.

**CASA's view on the BAe 146**

4.84 CASA noted in its submission that it:

> … has reviewed the certification of the BAe 146 aircraft and is satisfied that the aircraft meets the design standards applicable at the time of introduction of the aircraft into Australian service. Indeed, in the passenger configuration in which the aircraft are operated in Australia, they meet the latest standards for conditioned air quality.[88]

4.85 However the Committee notes evidence from former CASA Airworthiness Inspector Mr Richard Best. Mr Best told the Committee in his submission that:

> It is recommended to the Committee CASA should be required to independently, obtaining whatever recognised expertise is needed, review the air contamination as a certification issue so as to ensure the Australian public and persons involved with the BAe 146 can be assured or have a level of confidence that the aircraft type is safe.[89]

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86 Ansett Australia, *Evidence*, 1 May 2000, p 260

87 CASA, Evidence, 13 March 2000, p 182

88 *Submission 20*, CASA, p 4

89 *Submission 30*, Mr R Best, p 2

4.86 CASA has advised the Committee that:

> The cabin environment in the BAe 146 aircraft is as chemically clean, if not cleaner, than other transport aircraft in service today. In terms of national standards for offices and workplaces, these aircraft are far cleaner (less contaminated) than their earthbound counterparts.[90]

## Criticism of CASA's approach

4.87 The Australian Federation of Air Pilots was critical of the performance of CASA in relation to air contamination on the BAe 146. The AFAP argues that this contamination represents a breach of civil aviation regulations. In evidence to the Committee, the AFAP argued that the aviation industry, including the aircraft manufacturer, the engine manufacturer and the airlines operating the aircraft were all aware of this situation. However, according to the AFAP, CASA appears to have accepted the view expressed by these groups that there is no safety hazard, despite the fact that civil aviation regulations are not being met.[91]

4.88 The AFAP's contention that contamination of cabin air represents a potential breach of civil aviation regulations on air quality, pilot health and aircraft airworthiness is supported by two other submissions, one from Captain Susan Michaelis and one from former CASA Airworthiness Inspector, Mr Richard Best.[92]

4.89 In a submission to the inquiry a former CASA District Airworthiness Manager at Bankstown Airport in Sydney, Mr Richard Best, told the Committee:

> In approximately the middle of 1998 following industry intelligence I made an internal Risk Observation Report to the appropriate persons in CASA concerning reports of air contamination leading to medical problems with a number of Flight Deck and Cabin crew. The numbers were significant and warranted detailed investigation by CASA. It appears to me that CASA has not carried out any independent investigations into the situation but has relied on the reports provided by the operators claiming the situation to be an occupation health and safety issue as distinct to a safety issue.
>
> In my experience and discussing the issues with industry personnel and former colleagues I am unable to reconcile the situation and am unable to differentiate between the two. Surely even a momentary incapacitation of the pilot in command is a safety issue. The certification standards for the aircraft require clean air into the cockpit and cabin therefore contamination of air flowing to these areas with oil mist must be a Certification Issue as well as a safety issue.[93]

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90 *Submission 20*, CASA, p 5

91 *Submission 14A*, AFAP, p 7; see also *Submission 14B*, AFAP, p 4

92 *Submission 26*, Ms Susan Michaelis; *Submission 30*, Mr Richard Best.

93 *Submission 30,* Mr Richard Best, pp 1-2

4.90 Mr Best was directly involved in assessing the BAe 146 for a certificate of airworthiness for a BAe 146 300 series aircraft operated by East West Airlines in approximately 1990. On 13 October 1998 Mr Best, submitted a Risk Observation Report dealing with the BAe 146 aircraft through CASA's South Australian District Office. The report was passed onto Mr David Villiers, Acting General Manager Airworthiness via e-mail. According to CASA: "Mr Villiers was responsible for the aircraft certification and airworthiness policy of the aircraft, and was the CASA Officer primarily responsible for actioning Mr Best's Report." [94]

4.91 In evidence to the inquiry on 17 August 2000 Mr Best stated:

> … I became aware of problems with clean air in the BAe 146 because of consultation with two ladies who had been adversely affected by the air quality in the 146. As a consequence of that, I made a submission internally within CASA to bring it to the appropriate attention of the people that should know about it.[95] …

4.92 Mr Best went on later in his evidence to comment:

> … All I am saying to you is that I was asked about it by two ladies and I became aware that all these people were affected. I thought it was appropriate that someone, an independent arbiter, look at the situation. [96]

4.93 The following is an extract from Mr Best's Risk Observation Report:

> There is an apparent problem with the quality of air in the BAe 146 aircraft cabin
>
> The report indicates there has been a smell like vomit in the cabin going back as far as 1992
>
> It is believed NJS raised a memo advising cabin crew as to how to handle customer complaints
>
> It is also believed air contamination has adversely effected cockpit and cabin crew- a fact apparently disputed by both the operator and the aircraft manufacturer
>
> - surveys conducted apparently do not identify the root problem in distinguishing the contamination components arising from bleed air from the APU into the cabin
> - Mac Robertson of C.O. and Clive Phillips of BASI are aware of the problem but apparently have not been able to have a high priority assigned to this situation

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94 Correspondence from CASA to the Committee dated 8 September 2000, p 1.

95 Mr Richard Best, *Evidence*, 17 August 2000, p 272

96 Mr Richard Best, *Evidence*, 17 August 2000, p 286

> Action recommended
>
> It is believed the quality of the air to meet certification standards for this type of aircraft should be tested by "Gas liquid chromatography" to determine levels of organophosphates and their interaction with Hydrocarbons/volatile organic compounds in the ambient cabin air[97]

4.94 Mr Best told the Committee that he received no response, or follow up, from CASA to this Risk Assessment Report.[98]

4.95 The Committee was concerned to ascertain CASA's response to Mr Best's assertions in this matter. In a letter to the Chairman of the Committee dated 8 September 2000 the Director of CASA, Mr Toller, refuted the allegation by Mr Best that he had not received any response to his report on the BAe 146. Mr Toller stated:

> Mr Best received confirmation of the submission of his Report on 13 October 1998, via email from Mr Dick MacKerras…. Mr MacKerras subsequently requested that Mr Best provide additional information relating to the submission of the Report, to which Mr Best replied…..
>
> In response to Mr Best's Report submission, Mr Villiers advised Mr Best on 14 October 1998 by email that his Report had been received, and provided an overview of investigations conducted to that dale by the inclusion of the brief which had been provided to the CASA Board Safety Committee….
>
> The contact with Mr Best on 13 and 14 October 1998, was considered to be the closing action of the submitted Report….
>
> A search of CASA's records clearly show that contrary to Mr Best's supplied evidence (reference RRA&T 272, Thursday 17 August 2000), he did in fact receive a response to his Risk Observation Report submitted on 13 October 1998. The response provided to Mr Best via email from Mr Dick MacKerras on 13 October 1998 and Mr David Villiers on 14 October 1988 was adequate and appropriate to the level of information provided in Mr Best's report, and provided Mr Best with details of CASA's investigation to that date.[99]

4.96 Mr Toller's letter to the Chairman of the Committee on 8 September 2000 included a number of attachments setting out correspondence which had taken place between Mr Villiers of CASA and Mr Best in response to his Risk Assessment Report on the BAe 146. On 14 October Mr Villiers wrote in part:

> It is a pity that you did not see fit to talk to Mac Robertson on this issue before launching the RoR into the system. Had you done so you would have discovered that much work has been done in recent times, by CASA, the

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97 Risk Observation Report dated 13 October 1998 from Mr Richard Best to CASA.

98 Mr Richard Best, *Evidence*, 17 August 2000, pp 272, 283-284

99 Correspondence from CASA to the Committee dated 8 September 2000, pp 1-2.

> manufacturer and the operators, to resolve this issue. Obviously your "Industry intelligence" has come from a source who is either out of date with events, or has an axe to grind.
>
> I particularly take issue with your statement that we have "... apparently not been able to have a high priority assigned to this, situation". The BAe 146 cabin air quality issue has absorbed a good deal of AWE effort in the last six months.[100]

4.97 The Committee notes that CASA did respond to Mr Best's Risk Observation Report, but views with concern the response of Mr Villiers of CASA. Such a response would, undoubtedly discourage staff such as Mr Best from making further RoR's and this would be highly undesirable.

4.98 In his e-mail to Mr Best, Mr Villiers attached a brief prepared for the CASA Board Safety Committee dealing with the BAe 146 which Mr Villiers had approved on 13 October 1998, coincidentally on the same day as his response to Mr Best. This brief read in part:

> CASA review of. the extensive testing performed by the airlines showed that the cabin air of the 146 posed no hazard to passenger or crew health. However, there was a perception of poor air quality in the 146 aircraft in general amongst passengers and crew. The aircraft was found to be compliant with the certification baseline, but the airflow and distribution of the air was not conducive to a comfortable environment. In particular, the practice by the airlines of operating the cabin ECS in 'full fresh" at all times meant that the humidity levels in the cabin were extremely low (<5%) and this was probably the cause of the eye and throat irritations being experienced.
>
> Smells in the cabin were found to be mainly due to ingestion of hydrocarbon by-products from the engine exhaust of the aircraft itself and also from other aircraft on the apron. Improved maintenance practices an the engines have reduced the transfer of "oil" smells to the cabin, although at no time. did chemical analysis show that any toxic by-products from the engine oil were present in the cabin.
>
> Extensive chemical analysis of fumes from cabin air samples proved conclusively that there was nothing harmful in the cabin environment however, cabin flow tests showed there to be areas of stagnant air in the cabin which could lead to discomfort for the crew over a long working day.[101]

4.99 At one point during his evidence to the inquiry on 17 August 2000, Mr Best commented as follows on the standard of communications within CASA:

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100 E-mail dated 14 October 1998 from Mr David Villiers of CASA to Mr Richard Best.

101 Brief prepared for CASA Board Safety Committee, October 1998.

> There are a great number of issues that arise every day in CASA, and CASA have a limited work force. It is up to someone down there to set the priorities. These questions get answered in time, but you cannot expect them to drop everything and come back to do whatever is necessary just because Dick Best put an ROR in. They have to work out their priorities, because they are the people who are charged with setting the agenda and ensuring that aviation is safe.[102]

4.100 The Committee notes the brief prepared for the CASA Board Safety Committee confirms two assertions made in evidence. Firstly, that CASA relied on testing done by the airlines and secondly that air in BAe 146 aircraft was a problem.

4.101 Mr Lawrie Cox, Senior Industrial Officer with the AFAP, told the inquiry in evidence at a public hearing:

> The role of the Civil Aviation Safety Authority throughout this process is, to say the least, appalling. …
>
> The Civil Aviation Safety Authority has simply taken the advice of a commercial operator that is obviously protecting its basic interests as the regulatory authority, as being the basis of their position that there are no safety concerns in the operation of this aircraft and there are no health effects and no changes or effects on pilots' licensing. It is an unacceptable position from our point of view that the authority can take that stance, particularly with the amount of material that has been given.[103]

4.102 Mr Cox went on to state:

> CASA should not be operating in such a way that they simply take a commercial entity's report - and I am not casting aspersions on Ansett here, but they may have compiled that report for their own purposes. That is being accepted by the regulatory authority as the be-all and end-all. That is totally unacceptable in our view.[104]

4.103 The Federation submitted that the limitations placed upon air crew in identifying the past and present state of the contamination issue, allows the airlines to strongly influence CASA and the Commonwealth Government, "…indicating that the issue is no longer of concern, while failing to indicate the full extent of the effects on crew health and safety."[105]

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102 Mr Richard Best, *Evidence*, 17 August 2000, p 285

103 AFAP, *Evidence*, 1 February 2000, p 114

104 AFAP, *Evidence*, 1 February 2000, p 117

105 *Submission 14A*, AFAP, p 7

4.104 The AFAP went on in its submission to allege that:

> The Civil Aviation Safety Authority has been aware of the air quality issue in detail for some time as (sic) has been thoroughly briefed by Ansett, yet has done little if anything in the way of objectively reviewing the issue from all perspectives, with the prime requirement being to ensure that all regulations are met, in order to maintain air safety.
>
> Crew that have tried to ensure that CASA is aware of the full extent of the problem have been told that there is no evidence of the air quality being unsafe, yet is aware of cabin air circulation problems on the 146, but overall there is no evidence on safety grounds that warrants any form of action, and that the problem is being adequately dealt with by Ansett.
>
> … To date, CASA has been unwilling to recognise the implications of the in-flight safety issues connected to contaminated air and has therefore allowed the issue to remain unresolved and ongoing. Operating crews are reluctant to come forward until health effects are critical as the Aviation authority has not been willing to objectively assess the situation and ensure that the Civil Aviation rules and regulations are being met.
>
> Although CASA medical department is aware of the issue of fumes on the 146, and even had a representative attend the 1998 Aerospace Medical Assoc. General meeting, at which in-cabin contamination was a major topic, no support has been given to pilots raising the associated health issues with the medical Department. [106]

4.105 Mr Cox of the Federation asserted in his evidence to the inquiry that "… we have serious doubts about CASA's role in this whole process of the fumes issue generally and their ability to conduct proper investigations."[107]

106 *Submission 14A*, AFAP, p 10

107 AFAP, *Evidence*, 1 February 2000, p 115

# CHAPTER FIVE

# IMPACT OF AIR QUALITY ON AIR SAFETY

## Introduction

5.1 The Committee received conflicting evidence on the critical issue of air safety as it relates to air quality. Submissions arguing that contamination of cabin air represented a safety hazard relied on evidence where pilots and flight attendants have been incapacitated by exposure to fumes.

5.2 Submissions arguing that contamination of cabin air did not represent a safety hazard, also argued that engine oil seal failures as a source, have been adequately investigated. These submissions argued there is no implication for flight safety as existing procedures control potential hazard. These aircraft accordingly continue to be certified as airworthy as modifications have either remedied or significantly diminished the problem.

## Safety implications of illnesses

5.3 The Australian Federation of Air Pilots is of the view that:

> There has been a noticeable effort made by industry to distance short-term repetitive symptoms that are affecting crew duties, from the forum of flight safety. The nature of health symptoms encountered and in many cases documented, all have the ability and in many cases do degrade the level of safety required by the Civil Aviation Act and Regulations.[1]

5.4 The AFAP in a supplementary submission to the inquiry argued that:

> … the Industry and the regulator, CASA are clearly ignoring the relationship between … acknowledged short term health effects suffered and their effect on air safety. … while industry is happy to say that the long term symptoms are a health issue not related to air safety, these longer term symptoms were once short term repetitive symptoms suffered by BAe 146 crew.[2]

5.5 Dr Richard Teo told the inquiry that he had observed and treated five patients who were referred to him for assessment for "… brain function deficit as a consequence of their exposure to chemicals in the workplace as flight crews of the BAe 146 aircraft."[3] These patients included two pilots and three flight attendants.

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1 *Submission 14A*, AFAP, p 9; see also *Submission 24*, FAAA, p 1; see also ATSB, *Evidence*, 13 March 2000, p 198

2 *Submission 14B*, AFAP, p 6

3 *Submission 3*, Dr Richard Teo, p 1

5.6 According to Dr Teo:

> The results of the assessments indicated that in each case, there was a significant dysfunction in their ability to process information efficiently. This dysfunction has impacted on their ability, adversely affecting their performance on mental and psychomotor tasks. This could significantly increase the risk of air safety should they be performing tasks required of aircrews as part of their employment schedules. This risk could be exacerbated during the course of their duties as flight crews as a consequence of further exposure to the aircraft environment of the BAe 146 aircraft. [4]

5.7 During a Committee hearing the following exchange took place between the Chairman and Dr Teo:

> CHAIR—Would you say that there is any connection between alteration in brain function or loss of brain function and an ability to fly an aircraft? I think that is a critical question. Could we have your advice on that?
>
> Dr Teo—Yes, there is. If you are slow in the ability of making decisions, especially in flying, and if the ability is diminished, then there is greater risk. I would say, in terms of cause and effect, there is greater risk.[5]

5.8 The Flight Attendants' Association of Australia told the inquiry in evidence:

> … there has been a significant exercise in semantic tap-dancing by the regulatory authority, CASA, over whether this is a health issue or a safety issue as though there is some need for distinction between the two. The flight attendants on board the aircraft are on board for this reason: there is a regulatory requirement that, to ensure the evacuation of all passengers in under 90 seconds through half the available exits, cabin crew are required to be there. Flight attendants are there for safety. If flight attendants are having to be carted off aircraft in wheelchairs and placed onto oxygen during descent, then the health of these flight attendants has been affected to the extent where the safety of the flight and of those passengers has been compromised. Consequently, the issues of health and safety are not separate but are inextricably intertwined.[6]

5.9 Mr Brett Leyshon of the Australian Transport Safety Bureau supported the importance of the role flight attendants play in relation to safety:

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4 *Submission 3*, Dr Richard Teo, p 1

5 Dr Richard Teo, *Evidence*, 1 February 2000, p 112; see also Dr Robert Loblay, *Evidence*, 1 February 2000, p 106; see also Dr Jean Christophe Balouet, *Evidence*, 13 March 2000, p 178

6 FAAA, *Evidence*, 2 February 2000, p 155

> The crew are not there simply to direct passengers to seats and to serve meals. They serve an important safety function throughout the flight, even a normal flight. Removing those removes a layer of safety to the passengers in the cabin.[7]

## BAe 146 cabin air quality and air safety

5.10 As has been previously noted, the central issue of this inquiry is whether fumes entering the BAe 146 have the potential to affect pilots or cabin crew to the extent that they are unable to operate an aircraft. It is the immediate impact of fumes on pilots leading to their possible incapacitation which is of primary importance to an examination of fumes on the BAe 146 and whether adequate safety systems exist.

*The Frank Kolver incident – BASI Occurrence Brief No 199702276*

5.11 The most serious reported and investigated incident of a pilot being affected by fumes on board a BAe 146 in Australia took place in 1997. On 10 July 1997 a National Jet Systems BAe 146 freighter aircraft piloted by Captain Frank Kolver was involved in a serious incident during a night decent into Melbourne following a freight flight from Sydney. The flight crew at the time was Captain Kolver, a co-pilot and a Senior Captain in the jump seat who was carrying out crew monitoring.

5.12 In his submission to this inquiry Captain Kolver detailed what happened during the aircraft's descent to landing:

> During the latter stage of the decent shortly after passing 10,000 feet I smelt strong oily odours and fumes in the cockpit. Some 3 to 4 minutes later after making a directional change of 25 degrees it was necessary to make another direction change in the opposite direction of about 10 degrees. 1 had great difficulty trying to do this because 1 felt it would roll the aircraft to an excessive angle towards becoming inverted. This was followed by considerable difficulty in flying the aircraft and concentrating on making the approach to land, I became confused and was not quite sure what was going on at the time but realised I was having some sort of difficulty so I asked the first officer to take over flying the aircraft. He did so and continued to land safely.[8]

5.13 Captain Kolver went on:

> For the next ten days or so 1 felt as if I was having a continues hangover with a constant headache. This was accompanied with a feeling of strong pressure on the top of my head. At night if 1 got out of bed I had difficulty in standing upright. When I travelled in a motor vehicle the headache would get worse and after 20 minutes 1 would get nauseous and had to stop and get out for some relief.[9]

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7 ATSB, Evidence, 13 March 2000, p 197

8 *Submission 1*, Captain Frank Kolver

9 *Submission 1*, Captain Frank Kolver

> During this period I was on sick leave and for the next two months my health slowly improved to moderate continuous headaches and later mild headaches with a constant pain in the left or right temple area, Several medical examinations, blood tests and a CT scan gave no indication of any medical disorder or problem. At the time and prior to this incident I was medically and physically fit and had no sickness or virus of any kind. [10]

5.14 Captain Siebert of NJS told the inquiry in evidence that Captain Kolver:

> … became dizzy and recognised he had some vertigo, but he certainly was not incapacitated. He formally handed control across to the first officer, which is a standard operating procedure between the crew, and the first officer went ahead and landed the aeroplane…. The first officer never smelt anything and was not affected. The supernumerary pilot, in his first report to the company, said that, yes, he could smell it and felt a little bit nauseous but was unaffected generally. There is a slightly different interpretation put on it in the final report from BASI.[11]

BASI Occurrence Brief

5.15 In early September 1999, following an investigation by BASI, an Occurrence Brief dealing with the incident involving Captain Kolver was published. This brief stated in part:

> The pilot in command advised that, following the onset of the fumes, he had experienced difficulty in concentrating on the operation of the aircraft, and had suffered from a loss of situational awareness. By the time the aircraft had reached an altitude of approximately 2,000 ft, his control inputs had become jerky and he began suffering vertigo. He relinquished control of the aircraft to the co-pilot, who continued with the approach and landing. The supernumerary pilot advised that he had felt nauseous. The pilot in command advised that because no smoke or mist was present within the cockpit, he did not consider it necessary to follow the smoke-removal checklist. He also advised that the crew did not consider the use of crew oxygen masks was necessary in the situation.
>
> After boarding the flight in Sydney, the supernumerary pilot had examined the aircraft maintenance release and noted a deferred defect concerning oil residue at the number two air conditioning pack inlet, resulting from an oil leak from the number four engine. This maintenance release entry was dated 17 June 1997. Maintenance trouble-shooting had isolated the problem to a

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10 *Submission 1*, Captain Frank Kolver. Dr Richard Loblay presented an alternative explanation for Captain Kolver's experience when he told the inquiry: "I do not know whether that particular incident was caused by fumes. It may have been that the pilot smelled something. … where a person is exposed to a smell and believes that that smell might be toxic or dangerous, they can become acutely anxious, hyperventilate and then lose control of their faculties. The symptoms that were described in that particular case suggest to me that the pilot panicked." Dr Robert Loblay, *Evidence*, 1 February 2000, p 106.

11 NJS, *Evidence*, 1 February 2000, p 135

failing oil seal within the number four engine. The aircraft had been cleared for further flight without any operational restrictions being noted, and the defect was listed for rectification at company convenience.

On experiencing the fumes during the descent into Melbourne, the supernumerary pilot recalled that he had noted a defect concerning the number two air conditioning system, and rechecked the maintenance log to determine which bleed air system may have been contributing to the source of contamination.

After shutdown at Melbourne, the crew vacated the aircraft. Following exposure to fresh air for about 30 minutes, the effects of the oil fumes dissipated. As a result, the crew did not consider it necessary to seek medical advice before continuing the scheduled flights. This decision was reinforced by the fact that the co-pilot had not reported being affected by the fumes. The crew further advised that because the technical log already contained an entry regarding the number four engine, and because Maintenance were aware of the problem, another entry regarding the same problem was unnecessary. They elected to continue the remaining scheduled flight sectors with the number four-engine bleed air system turned off, in accordance with the provisions of the master minimum equipment list (MMEL). The remainder of their tour of duty was completed without incident.[12]

5.16 At the end of this Occurrence Brief BASI stated:

The Bureau of Air Safety Investigation is particularly concerned about the potential for further BAe 146 flight and cabin crew to become incapacitated during flight due to exposure to odours being introduced into the aircraft cabin environment. In this occurrence, two of the three flight crew members on board the aircraft suffered from symptoms that prevented them from properly carrying out their assigned duties. The introduction of fumes and odours into the cabin environment following an engine defect constitutes a possible safety deficiency that should be addressed by the regulatory authority, in accordance with its statutory responsibility to monitor the continued airworthiness of aircraft.

The implications of long-term exposure to cabin air contamination for the health of passengers and crew requires further examination, together with the development and implementation of suitable counter-measures. The competent authority to co-ordinate such activities is the regulatory authority.[13]

12 ATSB, www.atsb.gov.au, Occurrence Brief 199702276, pp 1-2. For information on the use of oxygen by flight attendants see *Submission 24A*, FAAA, p 2.

13 ATSB, www.atsb.gov.au, Occurrence Brief 199702276, p 3

Criticism of BASI Occurrence Brief

5.17 The BASI Occurrence Brief dealing with the Captain Kolver incident attracted criticism from both CASA and British Aerospace. In a letter to the inquiry, dated 16 September 1999, Mr Toller of CASA, stated that CASA had responded to the draft Occurrence Brief expressing concern about aspects of the draft and seeking additional information concerning certain claims made in the draft:

> I am most concerned that CASA did not receive a response to its letter and that the final Report in no way acknowledges our comments which, in my view provided information which should have significantly influenced its content.[14]

5.18 CASA's submission to the inquiry set out a letter which was sent to Dr Rob Lee of BASI on 3 June 1999 relating to the BASI draft Occurrence Brief. This letter read in part:

> You recommend that CASA, in conjunction with the aircraft manufacturer, investigate failures within the engine. This was done in considerable detail and resulted in the manufacturer sending a team to discuss the issues with CASA and the major Australian operators. The engine design is not unusual, in that if a seal fails upstream of the bleed air take-off, some fumes can pass into the air conditioning system. However, they then pass through the conditioning packs, filters and ducting before distribution into the aircraft. In trials to measure contamination from a failed seal, a seal was removed and the engine run - no harmful fumes passed into the cabin. The conclusion of the manufacturer and the UK CAA, who issued the type certificate for the aircraft, is that the aircraft meets the requirements for a type certificate and is safe for all operations. [15]

5.19 Captain Siebert of NJS expressed the following criticism of the Occurrence Brief during his evidence to the inquiry:

> The BASI investigation failed to address the aviation medicine aspects of the incident. …
>
> The maintenance procedures detailed in the BASI investigation report were incorrect with respect to the airconditioning units. …
>
> NJS is in agreement with the CASA assessment reported to the committee during the Canberra hearings that the BAe146 meets all airworthiness regulatory requirements. There was no flight safety compromised during the night freighter incident as existing procedures acted to control the hazard.[16]

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14 *Submission 20*, CASA, p 1

15 *Submission 20*, CASA, pp 6-7

16 NJS, *Evidence*, 1 February 2000, p 134

5.20 British Aerospace was critical of the Occurrence Brief in relation to both how it was written and its content. British Aerospace's submission dealing with the content of the Brief stated:

> British Aerospace disagrees with the conclusions of the Occurrence Brief. In particular, its Safety Recommendations fail to take account of the modifications introduced both by BAe and the engine and APU manufacturers since the early 1990's specifically designed to address the issue of possible contamination of the cabin air supply.
>
> On the basis of the circumstances described in the Occurrence Brief, this incident would not have occurred had the procedures set out in BAe's Master Minimum Equipment List … been applied to the known "defect" in the aircraft's bleed air system.
>
> The Occurrence Brief refers to anecdotal reports of "health problems" suffered by flight and cabin crew of various Australian operators. … however, British Aerospace believes that recent complaints regarding cabin air quality on BAe 146 aircraft have largely no connection with the subject incident.[17]

5.21 British Aerospace also advised the Committee that, in relation to the specific matters relating to the aircraft's configuration:

> British Aerospace has expressed its disappointment to BASI regarding the procedures followed in the preparation of the Occurrence Brief and in particular the level of consultation afforded to it.
>
> According to the Occurrence Brief, the cause of the incident was oil contamination of the cabin air supply due to a leaking oil seal.
>
> The problem with the leaking oil seal was first noted by the operator on 17 June 1997, some 23 days before the incident.
>
> Had the corresponding engine bleed air system been treated as inoperative, the provision of the MMEL would have required it to be isolated and placarded … Application of these procedures would have avoided any contamination of the air supply. The Occurrence Brief makes no reference to this.
>
> Once the contaminated air supply was isolated, the remaining sectors were flown without incident.
>
> British Aerospace accepts that from time to time oil may leak into the cabin air system. However, between 1991 and 1992, when it became evident that this was an issue, British Aerospace in conjunction with AlliedSignal developed modifications to reduce the frequency of such leaks.

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17 *Submission 11B*, British Aerospace, p 1

> As part of the modifications an air filtration system was offered to the operators as a customer option. The Occurrence Brief makes no mention of whether air filters or other modifications had been installed on the aircraft in question.

5.22 In relation to matters affecting occupational health, British Aerospace noted:

> The Occurrence Brief also refers to anecdotal reports of health problems alleged to have been suffered by flight and cabin crew of various Australian operators and suggests that there is a link between these and the incident under investigation. While the nature of the Occurrence Brief makes it impossible for British Aerospace to comment on or assess the details of any of these further incidents, it is British Aerospace's view that recent complaints regarding cabin air quality have largely arisen from circumstances unconnected to oil contamination and are therefore not relevant to the incident investigated by BASI. British Aerospace has in any event recently been working with Ansett to introduce a package of enhancements to improve the BAe 146 cabin environment … none of which are mentioned in the Occurrence Brief.[18]

5.23 Mr Clive Phillips, the officer responsible for writing the BASI Occurrence Brief, disputed the claim that British Aerospace was not adequately consulted as the report was being written:

> … British Aerospace's representative was at pains to say that the bureau's investigation had gone ahead without reference to British Aerospace. … The files currently held by the Bureau of Air Safety Investigation and ATSB in Canberra have quite a body of evidence that was given, via faxes, telephone calls and emails, from British Aerospace specialists whom we spoke to at Woodforde in England. [19]

*Incidents of pilot incapacitation in Australia and overseas*

5.24 As noted in paragraphs 5.11-5.14, the most widely publicised incident of a BAe 146 pilot incapacitation involved Captain Frank Kolver. Captain Kolver provided detailed evidence to the Committee concerning this incident.

5.25 Captain Kolver advised the Committee that on 12 June 1997 he had noticed oil fumes on this same aircraft. Following this observation Captain Kolver submitted an in-house safety occurrence report to National Jet Systems.[20]

5.26 When asked whether he was capable of landing the aircraft on the night of 10 July 1997. Captain Kolver stated:

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18 *Submission 11B,* British Aerospace, pp 1-2

19 Mr Clive Phillips, *Evidence*, 1 February 2000, p 120

20 Captain Frank Kolver, *Evidence*, 2 February 2000, p 146

> It is difficult to say. I believe, had all the other crew become incapable of doing so, that I probably would have under difficult conditions. It may not have been a smooth landing, but I still believe that probably there was that capability. … I was able to assist the first officer with the rest of the approach and supporting him, mainly in the selecting of the flap position as the approach was conducted. [21]

5.27 Captain Kolver was asked whether he was aware of any other pilot who had to hand over control of his aircraft due to fumes. Captain Kolver replied:

> Not to my knowledge. I am not aware of any other pilots in our company that were affected. [22]

5.28 There are four other incidents, three in Australia and one in Sweden, which the Committee has become aware of where pilots or co-pilots of BAe 146 aircraft in were affected by fumes while flying the aircraft. These effects appear to have had some potential to cause affected flight crew to become incapacitated.

5.29 Nevertheless, it should be noted the affected flight crew during the three incidents were able to control and land their aircraft. In addition, a recent incident on a flight from Perth to Port Hedland in WA is also discussed. This incident - involving the entry of fumes into a BAe 146 passenger aircraft - did not apparently affect air crew.

1 29 October 1997 - Hamilton Island incident

5.30 The following is an extract from an Occurrence Brief prepared by BASI dealing with an incident which took place on a BAe 146 on 29 October 1997:

> The BAel46 aircraft was operating from Brisbane to Hamilton Island and return. The pilot noticed some odours when he boarded the aircraft, and enroute to Hamilton Island the cabin crew commented about odours in the cabin. During the turnaround at Hamilton Island the cabin crew felt ill. After getting some fresh air they appeared to recover and were able to resume duties.
>
> Shortly after takeoff the flight crew again detected odours and, while attempting to isolate the source, the co-pilot began to feel ill. Both fight crew members donned their oxygen masks. The smells subsided when the number 2 engine bleed air was switched off. At approximately 10,000 ft the crew removed their oxygen masks. …
>
> Both fight crew members continued to suffer from sore and dry throats, and headaches and the co-pilot also suffered from nausea. Oxygen was used intermittently for the remained (sic) of the flight.

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21 Captain Frank Kolver, *Evidence*, 2 February 2000, p 151

22 Captain Frank Kolver, *Evidence*, 2 February 2000, p 148

> Air samples were taken on decent and again when more odours were noted concurrent with changes to bleed air switching. On arrival at Brisbane the cabin crew advised that they had been similarly affected throughout the flight and were not well enough to continue flying. The flight crew also elected not to continue and advised that they suffered from symptoms for a further 24 hours.[23]

2 1997 - Brisbane incident

5.31 The Committee has been told of an incident in 1997 when a pilot experienced difficulty landing a BAe 146 in Brisbane. The information concerning this incident was set out in a confidential submission to the Committee and it is not possible to provide complete details of the incident without identifying the pilot involved. However, the pilot made the following statement in the confidential submission:

> As we were preparing to land in Brisbane I experienced a feeling like drunkenness and I had difficulty lining up the aircraft for landing. I did not tell my first officer how I was feeling and did not hand over to him because I was not aware of the extent of my incapacity. [24]

5.32 This statement went on:

> After I became ill and established to my satisfaction the link between my condition and exposure to the fumes from Mobil Jet Oil II, I deemed it appropriate to submit a report to the Bureau of Air Safety Investigations (BASI) in respect of the episode on or about …. 1997 when I was caused to feel drunk by exposure to the oil fumes. I am now aware of the fact that certain other pilots have experienced the same or similar special disorientation sensations. … I point out that the symptoms I experienced on or about … have safety implications potentially so grave that my professionalism demands they be acknowledged at the highest levels.[25]

3 31 March 2000 - Sydney/Melbourne incident

5.33 On 31 March 2000 during a flight of an Ansett BAe 146 freighter between Sydney and Melbourne the pilot was affected by fumes in the cockpit. This incident is currently under investigation by the ATSB. On 1 May 2000 the pilot, Captain Roger Goulet gave evidence to the Committee regarding its circumstances. The following are excerpts from his comments concerning the incident which occurred shortly after leaving Sydney on the flight to Melbourne:

> When switching air supplies from the APU to the engine air supplies, we got this odour in the Cabin - I call it the dirty sock smell. I have smelled it numerous times in the past. I might add that most of the time, and I have

23 BASI Occurrence (Incident) Brief 199703707, 29 October 1997, pp 1-2

24 *Confidential submission* C10, attached paper p 4

25 *Confidential submission* C10, attached paper p. 4

> smelled it in the past, it has never bothered me - it is just uncomfortable. … a very short time later, about a minute later, I felt just a slight light-headedness coming about, so what I did was I took the oxygen mask. I did not actually properly don it; I just took it and held it up to my face … What happened, as I pretty much expected it would, was that the symptoms of this sort of light-headedness went away pretty much straightaway. … The flight progressed. …
>
> The smell went away. …
>
> …. two minutes after take-off … halfway between Wollongong and Canberra, and the light-headedness thing sort of came back again and a very, very dull headache transpired, so I started breathing the oxygen again. Lo and behold, it started to go away and, as the flight progressed and once again I was not breathing oxygen the whole time - it went away and then it started coming back again. And then later I just had very dry scratchy eyes, a sore throat, that sort of thing, a taste in my mouth, and the only way I could describe it is it tastes like it smells. … on descent at the lower altitudes going into Melbourne, I then became aware that with the points of light, … there was some blurring in my long-distance vision. Once again it was not major.
>
> We landed without incident … It was not until that point, in walking across the ramp at Melbourne, that I realised that I had a slight disorientation. I do not really know how to describe it - not staggering, falling over drunk, but it was very obvious that there was something wrong, that there was a minor incapacitation, …
>
> I have had exposure to these fumes before; it had never bothered me, and now it bothered me. …[26]

5.34 During this incident the co-pilot noticed the smell in the cockpit but was not significantly affected by it. During the flight to Melbourne Captain Goulet did not hand over command of the aircraft to the co-pilot. [27]

5.35 Mr John Johnson, Engineering Fleet Manger with Ansett told the Committee that this incident had occurred as a result of a failure of a bearing seal in one of the aircraft's engines. This failure had allowed oil to leak through a bearing into the compressor and out through the diffuser duct eventually allowing fumes to enter the cockpit.[28]

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26 Ansett Australia, *Evidence*, 1 May 2000, pp 247-248

27 Ansett Australia, *Evidence*, 1 May 2000, p 247

28 Ansett Australia, *Evidence*, 1 May 2000, p 248

5.36 Mr Johnson also told the Committee that airframe modifications had not been incorporated on this aircraft or on other freighter aircraft.[29] When questioned on the difference in the modifications that have been carried out on passenger carrying BAe 146 aircraft and those that only carry freight Mr Johnson advised:

> With the freighter, with the air frame, we have put in a cockpit filter and a cabin filter. With the passenger aircraft, we have recirculated the air so that it is a more sensible movement. We have put airconditioned air through the toilet areas and the aft and forward galleys, and we have also put in the filtration mod on the cabin and the cockpit. What we have not done on the freighter is everything to do with the cabin, because it does not carry passengers.[30]

4 13 April 2000 - Perth/Port Hedland incident

5.37 On 13 April 2000 a BAe 146 passenger aircraft was forced to return to Perth when smoke appeared in the cabin. Apparently no member of the air crew was affected by fumes during this incident. The following details of the incident were provided to the inquiry by Mr Johnson of Ansett:

> … there was smoke visible in the cabin from the airconditioning system, and that particular engine was shut down. The number three engine was shut down because of low oil quantity and high oil temp, and the aircraft returned to Perth. We found on investigating that engine that there was oil coming out of the tailpipe … there was an immediate rejection of the engine….
>
> The evidence given to us in the investigation and what we found in discussions with the crew was that the crew saw the smoke in the cabin, they saw it clear with the shutting down of the engine and they provided towels to the customers while there was smoke present. None of the crew was affected. The crew continued on as normal. Nobody was taken off the roster or requested to come off the roster as a consequence of the occurrence.[31]

*Incident in Sweden - November 1999*

5.38 On 12 November 1999 during a flight between Bromma and Sturup in Sweden a flight crew on a BAe 146 operated by Braathens Malmo Aviation had to use oxygen when they were effected by fumes. According to the Captain of the aircraft:

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29 Ansett Australia, *Evidence*, 1 May 2000, p 248

30 Ansett Australia, *Evidence*, 1 May 2000, p 249

31 Ansett Australia, *Evidence*, 1 May 2000, p 250

> We broke out the oxygen masks. From the onset of the feeling of sickness, I rapidly became worse and worse, feeling, dizzy and groggy despite the oxygen. After about two minutes I slowly began to recover. As the first officer was feeling much better he took over the controls.[32]

5.39 This media report went on to state that following an investigation the airline had come to the conclusion that "the oil leak was the reason for the air in the cabin being made toxic."[33]

5.40 Mr Mick Toller of CASA told the inquiry:

> … although the Swedish incident happened on a 146, it could have happened on any aircraft. As we understand it, immediately after the incident the engine was changed and there was no recurrence. This is one of these classics where you get a problem but you can diagnose the fault and cure it immediately. I would not say those happen on a daily basis in aviation throughout the world, but they are certainly not uncommon incidents.[34]

5.41 Despite the incidents in Australia and Sweden, British Aerospace made the following statement to the Committee on 10 April 200 "… it is fair to say that in the course of the investigation to date, which has included full engine testing and strip down and in-flight testing of the aircraft, nothing has been encountered which has made either BAe Systems or the investigator in charge think it necessary to take further safety action at this time."[35]

5.42 The Committee has considered the above evidence and draws attention to its conclusions in Chapter 6 – paragraphs 6.26 to 6.34 and recommendations 1 and 2.

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32 From a media report supplied to the Committee titled *Poisoned Pilots Almost Crashed* by Lars Dahl and Elisabeth Sjokvist, p. 1. For further information on when British Aerospace believes oxygen should be used by pilots see British Aerospace, *Evidence*, p 235.

33 Ibid.

34 CASA, *Evidence*, 13 March 2000, p 191

35 British Aerospace, *Evidence*, 10 April 2000, p 223; see also p 225.

# CHAPTER SIX

# CONCLUSIONS AND RECOMMENDATIONS

## Introduction

6.1 The Committee's inquiry into the possible impact on air safety of cabin air quality in the BAe 146 aircraft indicates, as a general proposition, that chemicals introduced into an aircraft cabin can be an important factor in an aircraft's safe and comfortable operation. Excessive levels of chemical contamination can affect two aspects of aircraft operations: the operational environment and the working and travelling environment; a fact apparent to airline operators, to aircrew and to every airline passenger.

6.2 While the BAe 146 is not unique among jet aircraft regarding the entry of oil fumes into the passenger cabins and cockpits, the BAe 146 is the focus of the majority of complaints of fume contamination made to Australian airlines. The BAe 146 was the source of the two most serious incidents of pilot incapacitation resulting from oil fume contamination of cabin air. However, the Committee also notes that several other aircraft have been identified during the course of the inquiry as suffering similar problems to the BAe 146 including A320s and MD90s.

6.3 Although the incidence of reports of fumes affecting BAe 146 flight and cabin crews has reduced in the last three years, there appears to be no real possibility of such occurrences being eradicated totally as long as air is brought into the jet aircraft by bleeding air from its engines. There also is no current prospect of an alternative engineering arrangement being implemented in the BAe 146 for bringing air into the aircraft.

6.4 It appears to the Committee that contamination of cabin aircraft air on the BAe 146 aircraft has led to short-term and medium-term health problems for a number of BAe 146 flight crew. Some scientists link these health problems to contaminants, although the link has not yet been definitively established. Similarly, while definitive links have not been made between the toxic chemical components of Mobil Jet Oil II and illness in flight crew, this remains a question to be further investigated and assessed.

6.5 This inquiry has collected a considerable amount of evidence, and a wide range of claims have been made, in relation to the safe operation of the BAe 146 aircraft in Australia. The major issues for consideration are:

- the design, engineering and working operations of the air conditioning and air supply system in the BAe 146 aircraft and the physical effects - both short and medium-term - on cabin crew and passengers of that system in day-to-day flying operations in Australia;

- incidents and occurrences relevant to the level of safety achieved in day-to-day flying operations of the BAe 146 in Australian conditions;
- the response by the BAe 146 aircraft manufacturer, by Australian aircraft operators, by air industry regulators, and by air safety supervisory and investigation bodies to continuing complaints regarding cabin air quality in the BAe 146.

**BAe 146 – cabin air quality**

*Current Australian approach to the effects on air safety of BAe 146 cabin air quality*

6.6 The observation, monitoring and reporting on cabin air quality in the BAe 146, and its effect on air crew and passengers, may be described as one of the most, if not the most, closely observed and recorded aspect of the operations of a currently certified passenger aircraft type in Australia.

6.7 Notwithstanding this apparent effort, the Committee received conflicting evidence that testing programs claimed by the operators to be thorough were viewed by others as inadequate. The Committee has established that for a considerable period no operator has carried out clinical testing on flight crew exposed to cabin air fumes immediately following the exposure to fumes. Two witnesses, Dr Chris van Netten and Dr Winder, provided evidence suggesting that results of testing carried out on cabin air on BAe 146 aircraft flying in Australia cannot be used as a basis for claiming the air is not hazardous to human health.

6.8 Equally, it should be observed that, due to the factors described in this report, the focus of these observations, as far as air safety is involved, placed a particular emphasis on the short-term effects of poor air quality on individual aircrew and aircraft operations in specific events. These specific cases have raised the question of whether aircraft safety is affected by such occurrences.

6.9 The monitoring of the BAe 146, as far as air safety considerations are concerned, does not currently extend to systematic observation, collation and reporting of long-term occupational health and safety matters. Monitoring is carried out on an operator by operator basis, and little or no central assessment or record collection of individual airline monitoring and recording results is currently made.

6.10 The appropriate bodies to conduct such centralised assessment and monitoring of air quality on aircraft are the Civil Aviation Safety Authority and the Australian Transport Safety Bureau. However, CASA has relied on the internal responses and studies carried out by the industry and has conducted no independent monitoring or assessment of the issue. The Committee notes that the closest thing to a detailed assessment by a regulator of this issue was the BASI/ATSB Occurrence Brief number 199702276 issued in September 1999 and discussed in detail in the report.

6.11 The Committee notes that CASA, British Aerospace and Australian airlines operating the BAe 146 did not implement the recommendations of the BASI/ATSB report. It is clear to the Committee that the decision not to implement the recommendations was not justified.

6.12 It appears that Mr Mick Toller, the Director of a CASA, was mistaken in evidence to the Committee regarding instructions provided by an operator, NJS, to a senior pilot, Captain Kolver, about the nature of a possible defect on the aircraft on which Captain Kolver later experienced exposure to fume contamination and subsequent incapacitation.[1]

6.13 This Committee notes that contamination of aircraft cabin air may conflict with the requirements of at least three civil aviation regulations; CAR 48.0 1.4 and CAR 25.831: on cabin air quality and CAR 2 on major defects. Civil Aviation Advisory Publication (CAAP) 51-1 (O), counts (c) smoke, toxic or noxious fumes inside the aircraft as a major defect.

6.14 The Committee notes that the BASI/ATSB Occurrence Report of September 1999 expressed concern that the potential for future crew to become affected in flight due to exposure to odours in the cabin air environment constitutes a 'safety deficiency'. The Committee notes further the evidence provided by the airlines, the manufacturer and CASA that day to day safety of the aircraft is not in question. However, the reported occurrences, some of which are serious, provide an argument that CASA, the manufacturer and airlines have not yet provided a satisfactory solution to this question.

6.15 When questioned on the application of the civil aviation regulations, CASA told the Committee that: "what constitutes 'harmful or hazardous' is left up to other standards and generally is getting into the area of occupational health".[2]

6.16 Mr Toller acknowledged that oil leaks did occur on the BAe 146, leaving the question open as to whether these occurrences conflict with the civil aviation regulations.[3] Given emphasis of an explicit link between occupational health of pilots and the safety of the aircraft made by BASI/ATSB, several medical professionals and some pilots the Committee finds the response of CASA to this issue to be inadequate.

6.17 Four Australian pilots gave evidence to this inquiry detailing incidents in which they had been affected, by fumes entering the cockpit of the BAe 146. A serious incident of pilot incapacitation on a BAe 146 was reported in Sweden in November last year.

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1 CASA, *Evidence*, 1 November 1999, p 40

2 CASA, *Evidence*, 1 November 1999, p 48

3 CASA, *Evidence*, 1 November 1999, p 42

6.18 By contrast, the Committee also notes the strong evidence of a tendency of pilots to under-report incidents of this nature. The Committee was told in evidence by operators and some pilots that the principal reasons for not reporting incidents relating to air quality are:

- reporting such incidents either to their employer or regulator may place an individual's career at risk;
- many pilots and flight attendants were advised by their employers that there was no health hazard from the fumes. Some flight crew suggested that they only became aware of the potential hazards as a result of publicity associated with the Senate inquiry and overseas fume contamination incidents;
- the incident posed no immediate threat to safe operations;
- the incident involved physical effects which, while apparent, were short-term and recovery was quick and complete; or
- the incident involved physical effects which affected a minority of crew.

*Performance of modifications*

6.19 The Committee accepts that Australian airline operators currently operating the BAe 146 have completed extensive modifications to the aircraft, in cooperation with the manufacturer, to reduce the current cabin air problem. Their modifications have reduced the reporting of fume events.

6.20 The Committee observes that there remain some passenger carrying aircraft that have not been modified which continue to suffer fume contamination as well as evidence that fume events do continue on some BAe 146 aircraft, including modified aircraft.

6.21 It is clear to the Committee that while modifications are effective in improving systems to recirculating air in the aircraft cabin, they do not eliminate the incidence of fume exposure.

**Current Australian approach to assessment of aircraft air quality**

*Exposure to aircraft cabin air*

6.22 Exposure of air crew and, potentially, passengers to cabin air which may be contaminated, or even minutely affected, by fumes originating in an aircraft's engines raises the potential of occupational illness and, for certain individuals, an incapacity to continue work.

6.23 The air quality factors which principally concern the Committee in this inquiry are possible short and medium term effect on aircrew, pilots and attendants, of exposure to chemicals originating in an aircraft's engines and passed into the aircraft through its air conditioning systems.

6.24 The Committee notes that opinion on the hazardous nature of exposure to oil fumes is divided almost exactly between affected flight crew and their medical advisers on the one hand, and the airline industry and CASA on the other. It is clear that exposure to chemicals can have long-term deleterious affects. In the past scientists have concluded that threshold values of exposure to a number of substances in the workplace environment were not harmful. These theories are now shown to be incorrect. Long-term exposure to a number of substances has been shown to be harmful.

6.25 The aircraft's manufacturer, British Aerospace/BAe Systems, acknowledges that there is a health issue associated with the fumes.[4] While the weight of evidence to the inquiry suggests that a number of flight crew have suffered from toxicity, the Committee cannot readily accept assurances that there is no hazard associated with exposure to oil fumes in aircraft cabin air.

6.26 The Committee is convinced that aircraft operators recognise that there exists a possibility that individual aircrew can and do reach a 'saturation' level of cumulative exposure to chemicals. Such a possibility should be recognised and further investigated.

6.27 The Committee is also convinced that there is sufficient evidence before this inquiry to justify further examination of the following factors:

- the effects on human health of the introduction into the aircraft cabin and cockpit of engine oil, by-products of engine oil combustion and other compounds as a result of leaking seals and bearings; and
- the cumulative physical effect of exposure to these substances which can affect particular individuals.

*Air safety*

6.28 The Committee has carefully considered all evidence put before it during this inquiry, and has also given consideration to the current safety regulatory structure imposed on air operators of aircraft, such as the BAe 146, by CASA under the *Civil Aviation Act 1998*.

6.29 A principal statutory function of CASA in relation to the oversight and maintenance of safe regulation and safe flying operations for civil aircraft in Australia is to:

- conduct comprehensive aviation industry surveillance, including assessment of safety related decisions taken by industry management at all levels for their impact on aviation;

4 *Submission 6*, British Aerospace, p 6

- conduct regular reviews of the system of civil aviation safety in order to monitor the safety performance of the industry to identify safety related trends and risk factors and to promote the development and improvement of the Australian aviation system.[5]

6.30 As a further statutory requirement, CASA is required to:

- foster an awareness in industry management and within the community generally of the importance of aviation safety;
- promote full and effective consultation and communication with all interested parties on aviation safety issues; and[6]
- ensure that the Civil Aviation Regulations covering Australian airspace are complied with.

**Committee Conclusions**

6.31 The Committee believes that CASA erred in rejecting the finding of Occurrence Brief No. 199702276 dealing with the incident involving Captain Kolver, published in September 1999. The Committee was not provided with a substantive reason for this action by CASA. The Committee believes that CASA should now accept the BASI/ATSB recommendations and develop an action plan for implementing them.

6.32 In its Occurrence Brief of September 1999, BASI recommended that:

> The Civil Aviation Safety Authority, in conjunction with the aircraft manufacturer, British Aerospace Plc, address deficiencies that permit the entry of fumes into the cockpit and cabin areas of BAe146 aircraft. These deficiencies should be examined by the regulatory authority as part of its responsibilities for initial certification and continued airworthiness of the BAe 146 aircraft.[7]

6.33 In relation to statutory requirements, the Committee consider CASA should ascertain whether current reporting requirements in respect of the operation of the BAe 146 and other aircraft, specifically related to the effect of cabin and cockpit air quality, are adequate. There is sufficient evidence from operators, the British Aerospace, CASA and BASI to conclude that CASA should re-assess and enhance its current scrutiny of the Australian BAe 146 fleet. The Committee believes such a monitoring program, which can be established under existing civil aviation regulations must re-assess and monitor the following matters:

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5 *Civil Aviation Act 1998* (Cth), s 9

6 *Civil Aviation Act 1998* (Cth), ss 9(1) & (2)

7 ATSB, www.atsb.gov.au, Occurrence Brief 199702276, p. 4; see also *Submission 24A*, FAAA, p 2.

- the need for a specific national standard for checking and monitoring the engine seals and air quality in all passenger jet aircraft;
- the maintenance procedures, including specific maintenance procedures for ageing aircraft;
- specific, appropriate maintenance and operational procedures for the BAe 146 which pay particular attention to the need to ensure that aircraft are maintained and serviced for a minimum operating time to ensure that faults resulting in oil leaks, fumes or smoke are repaired;
- that incident reports should now be specifically designed so as to reflect the history of the cabin air problem that has been encountered on the BAe 146;
- the need for sources of contamination in the cabin and cockpit environment in the BAe 146 to be identified and further evaluated using appropriate sampling and analytical technology for the contaminants which, for example, might result from the burning of fuel and lubricating oil used in the BAe 146 engines; and
- the need for companies operating the BAe 146 and other aircraft in Australia to provide CASA with specific reports on the results of monitoring these matters within an appropriate timeframe, quarterly or six-monthly, in order that CASA can assess the operations of the aircraft.

*The role of the Minister for Transport in safety considerations*

6.34 The Committee notes that under the *Civil Aviation Act 1998*, the Minister for Transport cannot make a direction to CASA on specific matters, but has the power to provide direction to CASA generally on the performance of its functions.[8] In September 1999, for example, the Minister provided CASA with a comprehensive set of directions on performance of its functions,[9] although section 12 of the *Civil Aviation Act 1998* requires that these directions shall be '…only of a general nature…'

6.35 The Committee considers the Minister for Transport has a responsibility to raise with CASA the need for enhanced assessment and monitoring of cabin and cockpit air quality in Australian aircraft, with particular reference to the BAe 146. This appears to reflect overseas trends particularly with regard to examination, analysis and observation of the effects of the commercial jet aircraft cabin environment, including air quality, on pilots, crew and passengers.

8 *Civil Aviation Act 1998* (Cth), s 12

9 Letter from Minister for Transport, John Anderson dated 30 September 1999.

*Monitoring, assessment and measures to address the problem*

6.36 The Committee has noted in paragraph 6.13 that a number of Civil Aviation Regulations (CAR) provide for control of unacceptable aircraft cabin air quality. Any detectable leaking of oil fumes into aircraft cabin air can only mean that there is a defect which renders aircraft not airworthy until such a defect is remedied. The Committee is concerned that such defects may not be remedied immediately, that modifications are only partially effective, and as a result, aircraft not completely airworthy continue to fly.

***Matters the Committee considers must be addressed by CASA***

**Recommendation 1**

**(a) The Committee recommends that CASA should reassess matters recommended for further action by the BASI/ATSB incident report (No. 199702276) concerning the incident on 10 July 1997 involving Captain Kolver.**

**(b) The Committee also recommends that CASA reassess its requirements for monitoring the operations and cabin and cockpit air quality of the BAe 146 aircraft operating in Australia and, where necessary, introduce regulations under the *Civil Aviation Act 1988* specifying:**

- **a specific national standard for checking and monitoring the engine seals and air quality in all passenger commercial jet aircraft;**
- **maintenance procedures (including specific maintenance procedures for ageing aircraft);**
- **specific, appropriate maintenance and operational procedures for the BAe 146 which pay particular attention to the need to ensure aircraft are withdrawn from operational flying and serviced to ensure any operating faults resulting in oil leaks, fumes or smoke are immediately repaired;**
- **that incident reports should now be specifically designed so as to reflect the history of the cabin air problem that has been encountered on the BAe 146;**
- **sources of contamination in the cabin and cockpit environment in the BAe 146 be identified and further evaluated using appropriate sampling and analytical technology for the contaminants which, for example, might result from the burning of lubricating oil used in the BAe 146 engines;**

- **companies operating BAe 146 and other passenger commercial jet aircraft in Australia provide CASA with specific reports on the results of monitoring these matters within an appropriate timeframe, whether quarterly or six-monthly, in order that CASA can assess the operations of the aircraft; and**
- **air quality monitoring and compulsory reporting guidelines for all passenger jet aircraft operators.**

***Specific matters required for Airworthiness Certificates for BAe 146 aircraft operating in Australia***

**Recommendation 2**

**The Committee recommends that CASA adopt the modification to aircraft air circulation systems proposal for the BAe 146 aircraft by the aircraft's manufacturer as compulsory for all BAe 146 operating in Australia and that this be achieved by preparation and issue by CASA of an appropriate form of maintenance direction under the Civil Aviation Regulations.**

**The Committee also recommends that registration of BAe 146 aircraft operating in Australia be reviewed, and that renewal of Air Operating Certificates and registration of the BAe 146 be subject to completion of those recommended modifications as a condition for continued registration of the aircraft.**

***Appropriate tests for chemicals present in aircraft cabins***

**Recommendation 3**

**The Committee believes that development of an appropriate and accurate test for the presence of any chemical fumes in aircraft cabins is essential. The Committee accordingly recommends that CASA liaise with operators to develop a standardised, compulsory monitoring program which provides for testing cabin aircraft air during fume events.**

*Occupational Health & Safety – occupational health issues*

6.37 The Committee notes from the evidence it has received the considerable concern amongst a number of aircrew and medical specialists that some aircrew might experience health effects, both short term and possibly long term, from exposure to cabin and cockpit air in the BAe 146 aircraft.

6.38 The Committee heard evidence from operators of the BAe 146, particularly from Ansett, that the monitoring of the health affects on aircrew flying in the BAe 146 aircraft is now part of operational routine. The Committee held discussions with medical personnel who were employees of or consultants to airlines, and who have treated a number of individuals who claim to suffer, in several cases, severe and debilitating health affects resulting from exposure to fumes and cabin air on the BAe 146.

6.39 The Committee notes also other evidence presented to the inquiry that testing of human health and medical support for affected flight crew has not been adequate. The majority of affected flight crew who gave evidence to the inquiry asserted that medical examiners appointed by the operators deny they suffer from medical problems related to the BAe 146 and have recommended refusal of support or compensation.

6.40 The Committee is aware that several flight crew lost employment due to ill health they attribute to fume exposure and that their employers have opposed and may have unnecessarily delayed the settlement of employees' compensation and insurance claims.

6.41 The Committee observes the response of the airline operators, particularly Ansett, who have attempted, as yet without complete success, to establish the exact cause of reported symptoms suffered by flight crew. The Committee considers that occupational health and safety standards in Australia should accordingly be carefully assessed to better ensure that the effects of long term exposure to aircraft cabin air are recognised.

6.42 Accordingly, the Committee believes it is appropriate that a clinical investigation be initiated to ascertain whether possible health effects are caused by exposure of air crew and passengers to contaminated aircraft cabin air.

**Recommendation 4**

**That the issue of cabin air quality be reviewed by the National Occupational Health and Safety Commission with a view to including aerotoxic syndrome in appropriate codes as a matter of reference for future Workers Compensation and other insurance cases.**

*Occupation Health & Safety – a detailed health and medical research program*

6.43 The Committee considers that the National Health and Medical Research Council (NMHRC) is the appropriate, independent research body to initiate any long term investigation of the effects on health of aircraft cabin air.

6.44 The Strategic Research Development Committee of the NMHRC has initiated a number of programs in recent years, particularly in relation to issues which may have long-term unspecified but potentially important effects on occupational health.

6.45 By way of example, the Committee draws attention to a current program of the Strategic Research Development Committee of the NMHRC that is examining the possible long-term effects of electro-magnetic exposure, particularly to mobile telephones and possible adverse biological effects on individuals.

6.46 It is important to note that the nature of this research program is long term, will rely on independent research by a number of bodies, and will be particularly reliant on information and observations which have been made by industry.[10]

6.47 In case it is considered that the initiation of such a research program will take a lengthy period of time, the Committee considers it worth noting that the National Health and Medical Research Council, through its Strategic Research Development Committee, has a well developed and effective method of dealing with urgent research questions.[11]

*Future medical research involving aircraft cabin air quality*

**Recommendation 5**

**The Committee recommends that the Minister for Transport request the Strategic Research Development Committee of the National Health and Medical Research Council to set up and undertake an appropriate research program on the effect of exposure to aircraft cabin air on air crew and passengers. The Committee also recommends that the Minister advise the Parliament on the form and duration of, such a program as part of the Government response to this report.**

*Conduct of proceedings arising from compensation claims*

6.48 The Committee has described and discussed in Chapter 3 the evidence raised during this inquiry from several pilots and cabin crew who have claimed that exposure to cabin and cockpit air on the BAe 146 has led to health effects of sufficient severity to prevent them from continued flying in the aircraft.

6.49 In several cases, these health affects have rendered these individuals incapable of continued employment as pilots or cabin crew.

6.50 The Committee also heard evidence from several of those individuals regarding difficulties they have encountered in achieving any final result in claims for employee compensation, pilot's loss of licence insurance payments, personal income protection insurance payments, and claims for the payment of other benefits.

6.51 Due to a number of these actions being incomplete or unheard, the Committee considered it appropriate to receive evidence from those individuals in camera.

6.52 Four such cases were considered by the Committee, and in each case, each individual told the Committee that they had encountered attitudes and approaches of hostility, rejection, disbelief, and unreasonable delay in settling their claims. In addition, the Committee was advised in camera by one litigant, that at least one

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10 See, National Health and Medical Research Council, *Annual Report 1998*, pp 30-38.

11 See, National Health and Medical Research Council, *Annual Report 1998*, pp 38-45.

medical specialist involved in that person's case heard by a state employee compensation tribunal was engaged by an operator as a medical consultant.

6.53 The Committee draws attention to the recent decision of the Queensland Court of Appeal in relation to an action of Deborah Carter-v-Ansett Airlines. The decision in that matter notes that a specialist toxicologist, Dr Pat Carroll prepared a report on Ms Carter's case and subsequently became a consultant to Ansett.[12]

6.54 The Committee remains concerned at the possibility that proper procedural fairness has not been observed in these matters.

6.55 The Committee has not investigated these claims, and considers it should not investigate them further. They are matters before state workers' compensation tribunals and civil courts. However, the Committee does consider that an appropriate independent review should be undertaken of the cases it has considered.

**Recommendation 6**

**While the Committee is aware that the cases referred to are a matter of state jurisdiction, the Committee recommends that the Minister for Transport, in co-operation with appropriate State Ministers, appoint an experienced, retired judicial officer or eminent person who is appropriately qualified to conduct a review of unsuccessful or inordinately delayed employees' compensation cases, pilots' loss of license insurance, personal income protection, and with-held superannuation/other insurance claims made for personal injury and loss of employment as a result of ill health claimed to result from exposure to fumes on the BAe 146 and other aircraft. That person should be asked to report to the Minister on any conclusions they reach and whether those cases were dealt with according to requirements and appropriate standards of procedural fairness.**

**The Committee also recommends that the Minister table the conclusions and any recommendations it makes in the Parliament.**

*Test on Mobil Jet Oil II*

6.56 In Chapter 3, the Committee describes the process available for independent chemical analysis of compounds, such as Mobil Jet Oil II, used by industry. In Australia, the National Industrial Chemicals Notification and Assessment Scheme is such a body.

6.57 As the Committee notes in Chapter 3, the issue of the chemical conduct of Mobil Jet Oil II and its probable effect on health is a matter of contention between Mobil, the operators of the BAe 146 and aircrew and pilots.

6.58 NICNAS has now placed Mobil Jet Oil II on its list of candidate chemicals for review and assessment. NICNAS has informed the Committee that Mobil Jet Oil II

12 Carter-v-Ansett Australia, Queensland Court of Appeal, Appeal 5414 of 2000, para 8.

may be selected as a priority for review and assessment, subject to direction from the government and relevant bodies.

**Recommendation 7**

**The Committee recommends that the Minister for Employment, Workplace Relations and Small Business, as the Minister responsible for national issues affecting occupational health and safety authorise a review of the use of Mobil Jet Oil II and that the National Industrial Chemicals Notification and Assessment Scheme be requested to conduct this review.**

**The Committee also recommends that the potentially hazardous chemical components of Mobil Jet Oil II be referred to NICNAS as a priority for review and assessment.**

*Filtration of Aircraft Cabin Air*

6.59 The Committee notes in Chapters 1 and 2 that various aviation regulations, while regulating aircraft verification, do not currently require filtration of aircraft cabin air.

6.60 As the Committee also notes in Chapter 1, Ansett Australia, as part of its program of modification of its BAe 146 aircraft, has now installed filters on the recirculating aircraft's air circulation system.

6.61 The Committee considers that, in view of continuing concern about aircraft cabin air quality, CASA should, after assessment and consideration, give consideration to requiring fitting of such filters to all commercial passenger jet aircraft flying in Australia.

6.62 The Committee notes that an assessment concerning aircraft cabin air is currently under way in the United States by a committee of the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).[13] It will be important for the fitting of appropriate filters to be a uniform approach by all aviation regulators, to ensure there are uniform international standards.

13 See, 'Standardised Filtration Could Lead to More Comfortable Flights', News Release, ASHRAE, June 30, 2000, www.ashrae.org/ABOUT/stdfil.htm.

**Recommendation 8**

**The Committee recommends that CASA assess how quickly fitting appropriate high-grade air filters can be made mandatory for all commercial airliners flying in Australia to minimise any deleterious health effects arising from poor aircraft cabin air on crew and passengers. In view of proposed standards currently under consideration in the United States of America and elsewhere, such a system should ideally be designed to remove at least 99% of particles 0.3 micron or larger from recirculated cabin air.**

*Committee Summary*

6.63 The Committee finally observes that completion of this inquiry represents the first inquiry of its kind in the world. Extensive amounts of original information have been gathered on the issue of cabin air quality on BAe 146 and, to a lesser extent, on other aircraft. Similar investigations into cabin air quality are currently underway in the United Kingdom and the United States. The Committee will forward this report to all relevant international bodies with an interest or responsibility in this issue, including:

- The United States of America's National Institute of Occupational Safety and Health;
- The House of Lords Science and Technology sub-Committee inquiring into aircraft cabin environment;
- The American Society of Heating, Refrigeration and Air Conditioning Engineers;
- The United States Federal Aviation Authority;
- The United Kingdom Civil Aviation Authority; and
- The Civil Aviation Safety Authority, Australian Transport Safety Investigation and all other appropriate regulatory bodies.

Senator John Woodley
Chairman

# APPENDIX 1

## LIST OF SUBMISSIONS

| | | |
|---|---|---|
| 1 | Mr Frank Kolver | QLD |
| 2 | Dr Mark Donohoe, Environmental & Nutritional Medicine | NSW |
| 3 | Dr Richard Teo | NSW |
| 4 | Mr Stephen Tyrell | ACT |
| 5 | Dr Jean Christophe Balouet, | FRANCE |
| 5A | Dr Jean Christophe Balouet, | FRANCE |
| 5B | Dr Jean Christophe Balouet, | FRANCE |
| 6 | Dr Chris Winder | NSW |
| 7 | Dr Judith Ford , Genetic Consulting & Testing | SA |
| 8 | Dr C Van Netten, | CANADA |
| 9 | Mr Andrew Thom & Mr Jonathon Burdon | VIC |
| 10 | Ms Deborah Carter | QLD |
| 11 | British Aerospace Australia Limited | NSW |
| 11A | British Aerospace Australia Ltd | NSW |
| 11B | British Aerospace Australia Ltd | NSW |
| 11C | British Aerospace Australia Ltd | NSW |
| 11D | British Aerospace Australia Ltd | NSW |
| 11E | British Aerospace Australia Ltd | NSW |
| 12 | The National Industrial Chemicals Notification and Assessment Scheme | NSW |
| 13 | Mobil Oil Australia Ltd | VIC |
| 13A | Mobil Oil Australia Ltd | VIC |
| 14 | Australian Federation of Air Pilots | VIC |

| | | |
|---|---|---|
| 14A | Australian Federation of Air Pilots | VIC |
| 14B | Australian Federation of Air Pilots | VIC |
| 15 | Department of Public Health | WA |
| 16 | Ms Robin May | SA |
| 16A | Ms Robin May | SA |
| 17 | Ms Judy Cullinane | WA |
| 17A | Ms Judy Cullinane | WA |
| 18 | Ansett Pilots Association | VIC |
| 19 | Association of Flight Attendants | USA |
| 20 | Civil Aviation Safety Authority Australia | ACT |
| 21 | Qantas Airways Limited | NSW |
| 21A | Qantas Airways | NSW |
| 22 | Ansett Australia | VIC |
| 23 | National Jet Systems Pty Ltd | SA |
| 23A | National Jet Systems Pty Ltd | SA |
| 24 | Flight Attendants Association of Australia | QLD |
| 24A | Flight Attendants Association of Australia | QLD |
| 25 | American Society of Heating Refridgerating & Air-conditioning Engineers (ASHRAE) | USA |
| 26 | Ms Susan Michaelis | NSW |
| 27 | Ms Lesley Williams | ACT |
| 28 | Captain Richard Buncher | NSW |
| 29 | Ms Belinda Hall | WA |
| 30 | Mr Richard Best | NSW |
| 31 | Ms Kerri Allison | NSW |

# APPENDIX 2

## LIST OF WITNESSES

**CANBERRA, Monday, 1 November 1999**

**Associate Professor Chris Winder,**
**Head of the School of Safety Science, University of New South Wales**

**Australian Transport Safety Bureau / BASI**

Ms Carol Boughton, Director Safety Investigations

Mr Barry Sargeant, Deputy Director Safety Investigations

Mr Brett Leyshon, Team Leader, South East Operations

**Civil Aviation Safety Authority**

Mr Mick Toller, Director Aviation Safety

Mr Mike Smith, Assistant Director, Aviation Safety Promotion

Mr Rob Elder, Executive Manager, Government, Industry and International Relations

Mr David Villiers, Airworthiness Engineer, Aviation Standards Division

**CANBERRA, Tuesday, 2 November 1999**

**Ansett Australia**

Captain Trevor Jensen, Executive General Manager, Operations and Inflight Services

Dr David Lewis, Medical Director

Mr John Johnson, Engineering Fleet Manager

**British Aerospace**

Mr Bill Black, Senior Vice President, Customer Support, Engineering and Quality

Mr Ivor Williams, Chief Systems Engineer

Mr Bruce Jones, Senior Vice President, Australasian Support

**SYDNEY, Tuesday, 1 February 2000**

**Dr Mark Donohoe (private capacity)**

**Dr Robert Loblay (private capacity)**

**Dr Richard Teo (private capacity)**

**Australian Federation of Air Pilots**

Mr Lawrie Cox, Senior Industrial Officer

**Mr Clive Phillips (private capacity)**

**Qantas**

Mr David Cox, Group General Manager, Regional Airlines & Fleet Planning

Mr Paul Lidbury, Technical Manager, Regional Airlines

Mr Neville Kitto, Manager, Government Affairs

**National Jet Systems**

Captain John Siebert, Group General Manager, Aircraft Safety & Regulation

Mr Peter Nottage, Executive Director

Mr Christopher Snook, Technical Services Manager

Mr Barry Lodge, Consultant and Former General Manager

**Mobil Oil Australia Ltd**

Mr Julian Plummer, Manager, Aviation Lubricant Sales

**BRISBANE, Wednesday, 2 February 2000**

**Captain Frank Kolver (private capacity)**

**Flight Attendants' Association of Australia**

Mr Brendan Treston, Occupational Health & Safety Representative – QLD

Ms Susan Brookes, National Convenor, Occupational Health & Safety

**Ansett Pilots' Association**

Ms Erin Wood, Executive Director

Mr Michael Egan, Chairman, BAe146 Subcommittee, Member, Committee of Management

**CANBERRA, Monday, 13 March 2000**

**Dr Jean Christophe Balouet, Chair, Occupational/Environmental Sub-Committee of Aerospace Medical Association and Chair, Airborne Chemicals Committee of the International Society of Automotive Engineers**

**Civil Aviation Safety Authority**

Mr Mick Toller, Director of Aviation Safety

Mr Rob Elder, Executive Manager, Government, Industry and International Relations

Mr David Villiers, Airworthiness Engineer, Aviation Standards Division

**Australian Transport Safety Bureau**

Ms Carol Boughton, Director, Safety Investigations

Mr Brett Leyshon, Team Leader, South East Operations

**CANBERRA, Tuesday, 14 March 2000**

**Dr Chris van Netten, Associate Professor, Department of Health Care and Epidemiology, Faculty of Medicine; Chair, Division of Occupational and Environmental Health, Department of Health Care and Epidemiology; Faculty Member, School of Occupational & Environmental Hygiene, Faculty of Graduate Studies, University of British Columbia**

**CANBERRA, Monday, 10 April 2000**

**National Jet Systems**

Captain John Siebert, Group General Manager, Aircraft Safety & Regulation

Mr Peter Nottage, Executive Director

Mr Christopher Snook, Technical Services Manager

Mr Barry Lodge, Consultant & Former General Manager

**BAE Systems (formerly British Aerospace)**

Mr Ivor Williams, Chief Systems Engineer

Mr Bruce Jones, Senior Vice President, Australasian Support

**CANBERRA, Monday, 1 May 2000**

**Ansett Australia**

Captain Trevor Jensen, Executive General Manager, Operations and Inflight Services

Dr David Lewis, Medical Director

Mr John Johnson, Engineering Fleet Manager

Captain Roger Goulet, Pilot

**Qantas Airways Ltd**

Mr Paul Lidbury, General Manager, Engineering & Maintenance Business Planning

Mr David Forsyth, Executive General Manager, Aircraft Operations

**CANBERRA, Thursday, 17 August 2000**

**Mr Richard Best (private capacity)**

# APPENDIX THREE

## ABBREVIATED SUMMARY OF ATSB' DATABASE SEARCH FOR FIRE/EXPLOSION/FUMES AS A FACTOR - OCCURRENCES (1991 – 1999)

**Abbreviated Summary of Database Search for Fire/Explosion/Fumes as a Factor – Occurrences (1991 – 1999)**

| Aircraft Type | "Oil Fumes" | Galley | Electrical | Other [1] | Totals |
|---|---|---|---|---|---|
| BAe-146 | 6 | 3 | 1 | 2 | **12** |
| Boeing 737 | 4 | 13 | 4 | 10 | **31** |
| Boeing 747 | 1 | 1 | 5 | 6 | **13** |
| Boeing 727 | 1 | 0 | 1 | 0 | **2** |
| Boeing 767 | 1 | 3 | 9 | 9 | **22** |
| Fokker F28 | 1 | 0 | 1 | 1 | **3** |
| Fokker F27 | 0 | 0 | 0 | 2 | **2** |
| Airbus A320 | 0 | 3 | 2 | 1 | **6** |
| Airbus A340 | 2 | 0 | 0 | 0 | **2** |
| **Totals** | **16** | **23** | **23** | **31** | **93** |

"Oil Fumes" – includes occurrences where this description was used by crew to describe the odours present.

Galley – fumes associated with the contamination or spillage of food and other material in the galley area.

Hydraulic – failures with the hydraulic system that allowed fumes to enter the cabin.

Electrical – failure of electrical components.

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1 Other includes – engine/APU failure, hydraulic system failure, lightning strike, bird strike, passengers smoking, cleaning chemicals, cargo problems or nothing could be isolated on investigation.

# APPENDIX FOUR

## LIST OF INCIDENCES REPORTED TO FLIGHT ATTENDANTS ASSOCIATION OF AUSTRALIA INVOLVING FUMES ON BAe 146 AIRCRAFT (TO DATE)

**BETWEEN 5 AUGUST 1992 AND 29 DECEMBER 1999**

**PROVIDED BY THE**

**FLIGHT ATTENDANTS ASSOCIATION OF AUSTRALIA**

# SUMMARY BAE 146 FUMES IN CABIN - 300 SERIES

## 5/8/92 - 2/1/96

| DATE | REG | FLT | NO. | DESCRIPTION |
|---|---|---|---|---|
| 5/8/92 | EWJ | - | 1 | Shortness of breath, palpitations, need 02 |
| 24/12/93 | - | - | 2 | Vomiting, light-headedness, headache, faintness, breathlessness |
| -/11/94 | - | - | 3 | Severe headache for 2 days |
| 20 & 21/1/95 | EWS | 151 | 5 | Black soot from vents over each door exit. Cabin very hot on 2nd day |
| 2/2/95 | - | - | 6 | Nausea, lack of air, fatigue |
| 4,5,6/2/95 | EWI/EWS | - | 7 | Exhaustion, dizziness |
| 10/2/95 | - | - | 8 | Rotten egg type odour, nausea |
| 11/2/95 | - | - | 9 | Migraines, eyes stinging, heavy head, nausea every time on these aircraft |
| 12/2/95 | - | - | 10 | Shortness of breath, diagnosed as asthma, lung x-ray |
| 13/2/95 | EWI | - | 11 | Very nauseous, clumsy, light-headed, headache next morning |
| 14/2/95- | - | - | 12 | Hypoxia, very tired, sore eyes and throat |
| 15/2/95 | EWL | - | 13 | Eye sight blurry, nausea on landing, lack of oxygen |
| -/2/95 | - | - | 14 | Dry, fatigue, lethargy, smell in cabin |
| 17/2/95 | - | - | 14 | Shortness of breath, extreme fatigue |

| DATE | REG | FLT | NO. | DESCRIPTION |
|---|---|---|---|---|
| 17/2/95 | EWS | - | 15 | Headaches, tiredness, bad smell |
| 25/2/95 | - | - | 16 | Extreme fatigue, lack of 02 |
| 27/2/95 | EWL/EWS | - | 17 | Headache, sore eyes, tight chest, dry throat, even after 2 legs |
| 28/2/95 | EWR | 914/919 | 5 | Black soot coming out of air vents again |
| 28/2/95 | - | - | 18 | Strong fumes entered cabin on opening L1 |
| 2/3/95 | EWI | 213 | 19 | Blast of fumes in forward cabin on opening L1 |
| 8/3/95 | EWA | - | 20 | Hot and stuffy, lack of fresh air over rear flight attendant scat |
| 23/3/95 | EWS | - | 21 | Bad headache again, after only 2 legs |
| 20/4/95 | - | 283 | 22 | All 3 flight attendants smelt very strong smell in aircraft and on aerobridge. Tingling on end of tongue, headiness, dry sore throat, general sick feeling. Captain said there had been a battery acid spill in hold previous sector and smell in hold on previous sector and smell was cleaning agent. Smell over powering. Delayed departure but operated flights. Smell intensified on landing each sector. |
| 15/4/95 | EWL | 3052 | 5 | Black soot above door exits again |

| DATE | REG | FLT | NO. | DESCRIPTION |
|---|---|---|---|---|
| 3/5/95 | EWS | - | 23 | Headache, sore eyes, stomach cramps, nausea |
| 3/5/95 | EWS | 32 | 24 | Nausea, headache, dry throat, sore eyes, bad smell in cabin |
| 4/5/95 | EWS | 64 | 24 | Strong smell came through when Captain asked to heat cabin |
| 29/5/95 | EWI | 104 | 3 | Bad smell forward galley 40 mins after take off. Residue of soot on forward galley ceiling. Smell bad next 2 legs. Burning nostrils, smarting eyes |
| 31/5/95 | EWR | - | 25 | Nausea, burning eyes, fumes on boarding, pack bum done on arrival, fumes worse on subsequent legs |
| 31/5/95 | EWR | 197 | 26 | As above |
| 5/6/95 | EWL | 104 | 27 | Felt nauseous on 3 legs, worse on take off and landing |
| 22/7/95 | - | - | 28 | Hypoxia and headache - all crew |
| 22/7/95 | - | - | 29 | As above, 4 legs Syd/Mck x 2 |
| 28/7/95 | EWI | - | 30,31,32 | Fumes in rear galley on descent, nauseous on descent and for sometime after landing |
| 9/10/95 | EWR | - | 33 | Bad smell on take off and landing, dry eyes and throat, fatigue. Same aircraft had to be ferried, following week with flight attendants on 02 (heard) |

| DATE | REG | FLT | NO. | DESCRIPTION |
|---|---|---|---|---|
| 26/10/95 | EWR | 196 | 34 & 35 | Smoky haze and fumes in cabin on engine start-up. Irritation to eyes, nose throat. Engine shut down, doors open to ventilate. Ferried aircraft to Sydney and smoke re-occurred on taxiing for take off. No 4 & 35 required 02. Light-headed, sore eyes, headaches, nauseous. Flight attendants sough medical attention in Sydney. |
| 27/12/95 | EWS | 981 | 17 | One pac only operating. Difficulty breathing, tightness in chest, hot |
| 27/12/95 | EWS | 981 | 36 & 37 | As above. Dry eyes, throat and headache |
| 2/1/96 | EWL | 981 | 36 | Extremely stuffy in cabin. Short of breath and passengers also complained. |
| - | - | - | 38 | Headaches, fatigue, car problems |
| - | - | - | 39 | Stinging eyes, weeping eyes and nose similar symptoms to hayfever |
| - | - | - | 40 | Fuzzy headed, headache, drained, 02 starved. Clear rapidly once off aircraft |
| - | - | - | 41 | Nausea experienced at times after inhaling fumes |
| 21/10/? | EWI | - | 42 | Fuel smell in rear section of cabin |
| - | - | - | 43 | Nausea, headaches, migraine frequently when flying on 146 |

| DATE | REG | FLT | NO. | DESCRIPTION |
|---|---|---|---|---|
| -/4/ | EWI | 549 | 4 & 44 | All 3 flight attendants experienced sore eyes, dry noses and burning throats on these last two sectors. Smell in the cabin. Very dry air due to cooling to decrease odour. No 44 had a blood nose during the night. No 4 developed a migraine which carried over to the next day and had to consult a Dr who diagnosed sinusitis. |
| 31/3/96 | EWS | 196 | 45 | Hot and stuffy in cabin 30 mins after t/off . Asked Capt to lower cabin temp. Thermostat located in o/head locker. When air temp gauge read 00 it was bearable but still stuffy Dryness and burning at back of nose and throat. Still sore next day after gargling with salt water. There were no visible fumes in cabin. |

## SUMMARY BAE 146 FUMES IN CABIN - 200 SERIES

## 18/11/94 – 20/1/96

| DATE | REG | FLT | NO. | DESCRIPTION |
|---|---|---|---|---|
| 18/11/94 | JJS | 488 | 15 | Fumes in cabin. Burning eyes, shortness of breath, nausea, headaches, sore throat, swollen glands, fever (R) |
| 18/11/94 | JJS | 488 | 14 | As above. Flight attendants in rear cabin on $O^2$ (R) |
| 18/11/94 | JJS | 488 | 20 | As above (R) |
| 19/1/94 | - | - | 16 | Nausea and headache on several occasions |
| 20/1/94 | JJP | - | 10 | Sick on top of descent, shaky legs |
| 21/1/95 | JJX | 481 | 19 | Swollen glands, headache, nausea |
| 6/2/95 | - | - | 9 | Nausea, bronchial pneumonia, stomach cramps, migraine |
| 13/2/95 | - | - | 13 | Nausea, headaches |
| 25/2/95 | JJW | - | 11 | Hot oil smell, fuzzy headed by end of tour of duty |
| 20/3/95 | JJT | - | 6 | All 3 flight attendants felt nauseated |
| 31/3/95 | JJQ | - | 5 | Horrific smell at rear of cabin. Nauseated, had vomited on other flights |
| 6/6/95 | JJQ | 485 | 7 | Oily, strong fumes rear cabin. Coughing, sore eyes, congested complexion, dry nose and mouth |
| 8/6/95 | JJX | 368 | 8 | Hazy smoke in cabin |

| DATE | REG | FLT | NO. | DESCRIPTION |
|---|---|---|---|---|
| 26/6/95 | JJT | - | 1 & 25 | After take off very strong fumes in cabin. Stifling and irritating, nausea and headaches first 1/2 hour of flight |
| 28/6/95 | JJT | - | 3 | Fumes in rear of aircraft. Headache, nausea, fatigue |
| 5/7/95 | JJT | - | 1 & 4 | All 3 flight attendants had tightness in chest, sore throats, headaches, slurred speech from purser during P/A |
| 5 & 6/7/95 | JJT, JJX | - | 4 | Sore stinging eyes, nausea, fatigue, sore throat on descent |
| 7/7/95 | JJP | - | 1 | Sore eyes, glands came up, sore throat and red rash on neck, couldn't stop coughing for first 1/2 of flight |
| 8/7/95 | JJU | - | 5 | Irritation to eyes, sinus congestion, light headed |
| 8/7/95 | JJU | - | 6&25&27 | Affected by fumes in cabin. Stinging eyes, sore throat, tight chest, coughing. Flight sequence interrupted. |
| 10/7/95 | JJS | 481 | 1 | Nausea on take off for all 4 sectors |
| 11/7/95 | JJT | 481 | 1 | Nausea and burning nasal passages (3 legs) |
| 12/7/95 | JJT | 481 | 1 | Nausea, slight headaches, exhaustion |
| 14/7/95 | JJP | 481 | 1 | Usual smell and symptoms |
| 16/7/95 | JJQ, JJP | - | 2 | Runny nose, headache, sore eyes, fatigue |

| DATE | REG | FLT | NO. | DESCRIPTION |
|---|---|---|---|---|
| 17/7/95 | JJP | 481 | 1 | Dry throat, nausea, light headed, dry watery eyes |
| 17/7/95 | JJP | - | 5 | Burning eyes and light headedness |
| 20/7/95 | JJT | - | 5 | Eye pain, headache, vomiting |
| 31/7/95 | JJU | 481 | 1 | All 3 flight attendants affected by fumes which were odourless |
| 15/8/95 | JJT | - | 2 | Headaches, stomach upset, sore neck, watery eyes, bad smell throughout cabin |
| 14/9/95 | JJX | 481 | 1 | No smell detected but usual symptoms – headache, nausea, burning nostrils |
| 20/9/95 | JJQ | 481 | 21 | Overwhelming odour on descent & ascent, nausea, coughing, chest pain, headache |
| 6/10/95 | JJS | 488 | 3 | Sore throat, burning inside nostrils, burning eyes, dull headache, nausea, fatigue |
| 9/1/96 | JJT | 481 | 22 | 25 & 21 notice fume smell on boarding aircraft. Smell increased after take off. Red eyes, metallic taste in mouth, dull headache. After take off on each leg (3) and on landing the smell was detected strongly by Flight Deck and Purser |
| 15/1/96 | JJQ | 480 | 23 | Fumes in cabin, sharp headache behind eyes and forehead, nausea. No 4 had strange taste in mouth. No 21 had nausea and strange taste |

| DATE | REG | FLT | NO. | DESCRIPTION |
|---|---|---|---|---|
| 17/1/96 | JJS | - | 3 & 26 | Airless cabin on taxiing, hot, cabin filled up with smoke after take off. Returned to CNS. Dizzy, giddy, headache |
| 20/1/96 | JJU | - | 24 | Inhaled oil fumes, sore throat, burning eyes |
| - | - | - | 17 | Physically ill on two occasions. Passenger smelt fumes on another when flight attendant felt nauseous. Captain explained it was just oil fumes coming through the air conditioning vents |
| 9/94-1/95 | JJS, JJT, JJS | | 18 | Chest pains, headaches, fly symptoms, very sore throat, fatigue, sore eyes |
| 1/94 | JJQ? | - | 12 | Nose hurt when inhaling, burning sensation. No smell. Seemed to improve when Captain changed over air pacs. |
| 25/1/96 | JJP | - | 1 | Sore throat, nausea, tired, suffocated. No smell of fumes, dull headache next day |
| 1/2/96 | JJS | - | 1 | Nausea, dry sore throats, stuffy nose, sore dry eyes, haze in forward cabin |
| 2/2/96 | JJS | - | 1 | Headache, nausea, dry throat, sore glands, tight chest. Gasping for air when making P/A's, forgetful and clumsy by end of tour |

| DATE | REG | FLT | NO. | DESCRIPTION |
|---|---|---|---|---|
| 7/2/96 | JJT | - | 1 | All 3 felt ill on descent of first leg. Headache x 1 dry sore throats, runny noses x 2. F/0 had headache. Low energy levels, tried $0^2$. On 2nd leg all 3 flight attendants felt ill on take off and landing |
| 16/2/96 | JJT | - | 1 | Fumes on take off in rear cabin (2 legs) and on descent, very strong last (3rd) leg. Headache x 1, fatigue, lethargic after duty |
| 17/2/96 | JJT | - | 1 | All 3 flight attendants ill by end of 2nd leg. Headache x 1 on last (3rd) leg. Seventh day on this aircraft type with headache, neck pain |
| 17/2/96 | JJX | - | 6 | Pax asked on boarding about "awful smell". 3 flight attendants had sore red eyes by end of 1st leg |
| 9/3/96 | JJQ | - | 22 & 25 | Fumes smell strong on descent into DRW. Asked Captain to report as per procedure. Next day maintenance log checked because smell still present and it had not been reported. |
| 10/3/96 | JJQ | - | 22 & 25 | Strong smell on descent into CNS. Nausea and headache. All 3 flight attendants affected. |

## SUMMARY OF BAe 146 FUME REPORTS

## FROM 24TH MARCH 1996 TO 11TH FEBRUARY 1998

| DATE | REG | FLT | RESP | DESCRIPTION |
|---|---|---|---|---|
| 24/3/96 | JJP | 483 | 48 | Strong smell fumes take/off & ldg Nausea rear cabin. |
| 27/5/96 | JJX | 480 | 49 | Distinct metallic and nauseating smell all 4 sectors. |
| 16/6/96 | EWR | 185 | 45 | Fumes on boarding. |
| 6/8/96 | JJT | 485 | 44 | Smell and throat irritation on climb and in all sections of cabin. No air sampler. |
| 17/8/96 | EWM | 261 | 58 | Nausea, throat irritation cruise and descent in rear cabin. |
| 17/8/96 | EWM | 964 | 59 | All stages of flt, eye and throat irritation, trouble breathing. |
| 21/9/96 | EW | 271 | 47 | Fumes on boarding. Throat irritation, nausea. |
| 22/11/96 | EWM | 176 | 60 | Cabin filled with smoke on pushback. Controlled evacuation. |
| 16/2/97 | EWM | 966 | 61 | After take/off headaches, nausea, sweating, dizzy, on descent faint. |
| 7/3/97 | JJU | 485 | 46 | Smell, during cruise, through out cabin. Lethargic, headache. |
| 13/3/97 | EWM | 273 | 56 | Nausea on descent. Lack of concentration (6 legs 2 days). |
| 17/3/97 | EWM | 271 | 21 | Eyes and throat irritation. Nausea and on descent vomiting. |
| 17/3/97 | EWS | 272 | 21 | Vomiting. |

| DATE | REG | FLT | RESP | DESCRIPTION |
|---|---|---|---|---|
| 22/3/97 | EWM | 262 | 21 | All areas of cabin, breathing difficulties, tight chest take/off and landing. Headache tingling in nose etc nausea. |
| 8/4/97 | EWS | 104 | 21 | Rear to mid cabin eye and throat irritation burning noses, cruise till top of descent. |
| 8/4/97 | EWS | 283 | 21 | Headaches, burning sense in nose, dizzy, vague, dry throat, oily taste fatigue. |
| 9/4/97 | EWS | 67 | 53 | In c/pit, on ground till cruise eye and throat irrit. |
| 11/4/97 | EWI | 276 | 51 | Chemical odour. Stinging eyes cabin and c/pit. |
| 12/4/97 | ? | 64 | 54 | Nausea on descent, salivating, headache, clammy and sweaty. |
| 14/4/97 | EWS | 122 | 55 | Eye and throat irritation headache, dizzy, faint, nausea, vague, respiratory distress, vomiting. |
| 16/4/97 | EWS | 273 | 52 | Sinus symptoms, throat irritation, unusual taste, hypoxia. |
| 21/4/97 | EWI | 254 | 50 | Top of descent, tight chest stinging eyes, pain in nose light headed and faint. |
| 30/4/97 | JJS | 490 | 62 | Rear cabin plastic chemical smell. Throat irritation on take-off. |
| 30/4/97 | JJT | 62 | 63 | Eye irritation rear cabin on descent. |
| 1/5/97 | JJS | 490 | 42 | Fuel smell rear cabin. |

| DATE | REG | FLT | RESP | DESCRIPTION |
|---|---|---|---|---|
| 2/5/97 | JJP | 134 | 43 | Fuel smell on boarding. |
| 2/5/97 | EWI | 262 | 41 | Crew felt dizzy by end of 4th leg and for 20 mins after. |
| 5/5/97 | EWM | 548 | 57 | Nausea. 5 days S/L. Inflamed liver. Cause unknown. |
| 9/5/97 | EWI | 254 | 37 | Smell after take off mid cabin. |
| 13/5/97 | EWS | 262 | 40 | Burning throat and nose. Light headed. |
| 22/5/97 | JJW | 482 | 39 | Smell, eye and throat irritation, oily taste in mouth on ground |
| 25/5/97 | EWR | 151 | 38 | Itchy eyes all stages. |
| 15/6/97 | JJT | 323 | 36 | Strong smell last stages descent and landing. |
| 4/7/97 | EWS | 261 | 27 | Nausea and stomach cramps. |
| 17/797 | JJ | 117 | 28 | Nausea. Lethargy. Very noticeable fumes. Headache. |
| 23/7/97 | JJQ | 323 | 29 | Smell rear galley area. Taxiing, climb. Throat. |
| 23/7/97 | JJQ | 347 | 30 | Acid, chemical smell on taxiing. Dry throat and nasal passages. Desire to cough persistent. |
| 26/7/97 | JJT | 490 | 8 | Smell like varnish in c/pit on ground till cruise. |
| 27/7/97 | JJU | 482 | 31 | Smell rear cabin. |
| 27/7/97 | JJQ | 392 | 32 | Odour on taxiing. Dry cleaning fluid |
| 29/7/97 | JJQ | 393 | 33 | Odour. Take off and ldg at L1. Nausea top of descent. |

| DATE | REG | FLT | RESP | DESCRIPTION |
|---|---|---|---|---|
| 30/7/97 | JJP | 490 | 34 | Odour from LHS vent in c/pit in cruise. Sneezing & nasal irritation. |
| 1/8/97 | JJU | 326 | 35 | Oily smell in c/pit after take-off. |
| 8/8/97 | JJW | 1481 | 20 | Smell in c/pit on ground. |
| 9/8/97 | EWI | 285 | 21 | Oil smell climb and descent eye throat irritation. |
| 18/8/97 | JJQ | 487 | 22 | Smell fwd cabin. Nausea throat irritation. Headache. |
| 21/8/97 | JJQ | 487 | 19 | Acrid smell rear cabin on take off. 30 minutes into flt all through cabin. |
| 21/8/97 | JJQ | 457 | 18 | Acrid smell rear cabin. Dissipated on ground. |
| 24/8/97 | EWR | 64 | 16 | Nausea on t/off hot sweats headache 2nd leg, vomited. Light headed, fuel, gas smell rear and fwd cabin. |
| 24/8/97 | EWS | 263 | 17 | Electrical chemical smell. Nausea all stages of flt. |
| 29/8/97 | JJT | 354 | 15 | Capt noticed slight but definite smell in c/pit after take/off. |
| 20/9/97 | EWS | 261 | 68 | No odour. Stuffy cabin. Breathing difficult. Nausea. Vomiting. Metallic taste. |
| 21/9/97 | EWS | 2261 | 24 | Oil smell evident c/pit 1st fly this day. APU air on. Throat irritation. |
| 23/9/97 | JJS | 485 | 23 | Sore throat. Light headed. Odour on ground. Headache. Oily aftertaste c/pit & cabin. |

| DATE | REG | FLT | RESP | DESCRIPTION |
|---|---|---|---|---|
| 28/9/97 | EWM | 60 | 26 | Tight chest. Shallow breathing Running nose. No odour. 4 legs. |
| 30/9/97 | EWR | 264 | 25 | Eye irritation, sore throat oily smell rear cabin tight chest headache. |
| 30/9/97 | EWR | 51 | 25 | As above. |
| 2/10/97 | JJP | 134 | 43 | Fuel smell on boarding. |
| 5/10/97 | JJP | 480 | 43 | Fumes on boarding a/c persisted in flt. Metallic taste, sneezing all cabin zones. Stronger fumes rear cabin on shutdown. |
| 5/10/97 | EWS | 2130 | 71 | Mid cabin hot metal smell cruise. |
| 5/10/97 | JJP | 481 | 43 | Rear cabin throat irritation respiration difficulty headache. After take-off. |
| 6/10/97 | JJP | 139 | 62 | Smell on take-off. Sulphur, metallic taste. Odour fwd cabin also. |
| 6/10/97 | EWI | 262 | 63 | Hot cabin from take-off and all flt. Light headed Slight hypoxia. |
| 26/10/97 | EWS | 267 | 69 | Rear cabin vomit smell. |
| 29/10/97 | EWR | 254 | 70 | Fwd galley, cruise, throat irrit. |
| 29/10/97 | EWS | 151 | 4 | Fwd cabin on climb, c/pit odour. Eye throat irritation h/ache. Dizzy nausea Capt on 02 a/c grounded. |
| 29/10/97 | JJX | 328 | 8 | Smell oil fumes in c/pit on ground, taxi and take-off. |

| DATE | REG | FLT | RESP | DESCRIPTION |
|---|---|---|---|---|
| 4/11/97 | JJU | 492 | 66 | Oil fumes smell mid cabin on ground. |
| 7/11/97 | JJW | 404 | 64 | Rear & fwd cabin, eye irritation respiratory difficulty, headache fatigue take-off & descent 5 day trip this a/c Purser still off flying Loss of motor co-ordination, slurred speech etc. |
| 8/11197 | EWS | 263 | 65 | Rear f/a seat after take-off. Nausea and salivation. Light headed dizzy. |
| 8/11/97 | JJW | 407 | 12 | Increase in pressure after take off. Pax experienced nausea, hot. Seated 2A. |
| 8/11/97 | JJW | 407 | 13 | Pax felt puffy eyes & face. breathless, pressure in head and chest, take-off and Ldg. |
| 8/11/97 | JJW | 407 | 14 | Pax felt nausea. burning head, stomach queasy, t/off & ldg. |
| 8/11/97 | JJW | 404 | 6 | Nausea, hot, giddy exhaustion. 5 day trip. |
| 8/11/97 | JJW | 404 | 7 | After take-off. |
| 8/11/97 | JJW | 407 | 11 | Pax felt same effects and cock/ pit crew. |
| 10/11/97 | JJW | 372 | 8 | Smell, throat irritation on ground, taxi, take off. |
| 16/11/97 | EWR | 278 | 10 | Trembling hands, hot, tingling, sweating, dizzy, laboured breath on descent. No fumes. |
| 21/11/97 | EWS | 266 | 3 | Eye and throat irritation nausea dizzy, light headed, salivation. |

| DATE | REG | FLT | RESP | DESCRIPTION |
|---|---|---|---|---|
| 21/11/97 | EWR | 278 | 4 | Nausea, fatigue, salivation. Hot. Dizzy on descent. |
| 22/11/97 | EWS | 272 | 4 | Eye, throat irritation, nausea dizzy, light headed, salivation. |
| 24/11/97 | EWM | 122 | 5 | Smell in c/pit on ground. |
| 28/11/97 | EWM | 273 | 9 | Acrid oily smell. Eye irritation lungs heavy, headache, breathless fwd and rear cabin. |
| 6/12/97 | EWS | 151 | 72 | Nausea, diarrhoea, dizziness, pressure in head, hot. |
| 13/12/97 | EWM | 272 | 56 | On ground. Smell only. |
| 10/12/97 | EWS | 276 | 72 | Nausea, dizziness, over heating severe headache, no odour. |
| 21/12/97 | JJT | 68 | 74 | Lethargic, weak on arrival. Other f/a sore itchy eyes, throat. |
| 28/12/97 | JJW | 323 | 75 | Cruise, strong burning rubber smell rear galley. Throat irritation headache. |
| 2/1/98 | EWS | 2273 | 4 | Fwd cabin. Nausea, salivation, hot and dizzy. |
| 4/1/98 | EWM | 64 | 73 | After take-off. Gas smell, headache. |
| 21/1/98 | JJS | 2330 | 2 | Chemical odour. Light headed on ground. |
| 23/1/98 | JJS | 323 | 35 | Oily smell in c/pit on ground. |
| 24/1/98 | JJQ | 417 | 1 | Burnt smell after take-off. |
| 24/1/98 | JJS | 370 | 76 | Strong fumes on taxiing throughout cabin. |

| DATE | REG | FLT | RESP | DESCRIPTION |
|---|---|---|---|---|
| 24/1/98 | EWR | 261 | 77 | On approach in cockpit. |
| 1/2/98 | EWS | 263 | 72 | Pax. Rear cabin. Throat irritation. Nausea. |
| 1/2/98 | EWS | 262 | 78 | Nausea throat irritation. |
| 2/2/98 | EWM | 64 | 79 | Tight chest. Eye irritation headaches. |
| 6/2/98 | JJX | 499 | 80 | Synthetic oily smell on take-off in cockpit. |
| 8/2/98 | JJT | 393 | 81 | Rear and fwd cabin. Electrical smell from air-con ducts. On take-off and 1dg. |
| 8/2/98 | JJT | 392 | 82 | On ground taxiing in, then turning before take off, fwd and rear cabin. Eye, throat irritation, smell. |
| 9/2/98 | EWS | 277 | 72 | Fwd and rear cabin, no odour, eye irritation after take-off until landing. |
| 11/2/98 | JJT | 71 | 23 | Hot metal fwd and rear cabin on ground. |
| 11/2/98 | JJT | 481 | 83 | T/off rear cabin metallic oil smell. Eye irritation 4 mins +. |
| 11/2/98 | JJT | 77 | 83 | Headache, sore eyes while taxiing. |
| 11/2/98 | JJT | 62 | 83 | Take-off climb and landing rear cabin. |
| 14/2/98 | EWM | 64 | 1. | Burning electrical smell then chemical. Faint dizzy, chest pain, light headed. On climb. |
| 14/2/98 | EWM | 151 | 1. | Headache, nauseous, as above sector |

| DATE | REG | FLT | RESP | DESCRIPTION |
|---|---|---|---|---|
| 27/2/98 | EWS | 262 | 2. | Stale sickly smell. Felt dizzy and shakey. Fumes from F/O's air vent rhs Ground, T/off, landing. APU on. |
| 27/2/98 | EWR | 151 | 3 | Cruise, engine air selected FWD galley. Eye and throat Irritation |
| 17/3/98 | JJQ | 401 | 4 | Shortly after take-off a noxious odour. Oil type smell. |
| 23/3/98 | EWI | 273 | 5 | Nausea, dizzy, shaking, difficulty breathing, numb toes fingers, tingling back scalp tongue. Improvement on descent using oxygen cylinders. Rear cabin, engine air. |
| 2/4/98 | EWS | 282 | 6 | Fwd cabin, petro-chem smell. On ground, disembarkation Strange taste in mouth APU operating. Instant headache. |
| 7/4/98 | EWR | 151 | 7 | Rear cabin during cruise Gasoline smell rows 16-18 Take-off and climb. Fatigue. |
| 10/4/98 | EWI | 142 | 8 | Rear cabin, acid smell, eye and throat irritation. Nausea, coughing. Tight chest 3 times during flt. During climb, engine air selected. Asthma attack induced. Sick leave. |
| 17/4/98 | JJS | 370 | 9 | Oily smell on ground. Flt deck only. Nausea. |
| 19/20/4/98 | EWR | 131 | 10 | All sections cabin .Nausea, odour, eye/throat irritation, faintness. |

| DATE | REG | FLT | RESP | DESCRIPTION |
|---|---|---|---|---|
| 16/17/4/98 | EWI | 131 | .10 | All sections of cabin. Eye/throat irritation. Metallic taste, stale smell, dryness, headache. Faintness. |
| 20/4/98 | EWM | 278 | 11 | Descent. Rear cabin. Foul smell. Headache f/a working rear cabin. Methane type odour row 15 to rear. APU s switched over at 4,000. |
| 22/4/98 | JJP | 401 | 12 | On pushback. Smoke detector in rear toilet. Blue smokey haze in rear cabin. Fire-fighting procedure initiated. Capt said it had occurred the day before. Fumes, burning eyes/throat irritation. APU selected. |
| 17/4/98 | EWM | 4 | 5 | On descent, metho smell approx. 1 minute duration fwd cabin. Sore throat nausea headache on descent. Engine air, no vents operating in cabin. |
| 16/4/98 | EWM | ? | 13 | Air vents not working. MEL 3 day limit. Cabin fan U/S. |
| 13/5/98 | JJS | 392 | 14 | Strong burning rubber smell mid cabin, 4-7 minutes descent. Headaches. Engine air. |
| 18/5/98 | JJX | 319 | 15 | Odour pre flt all cabin and flt deck. Headache nausea. APU air. |
| 21/5/98 | JJU | 346 | 16 | Smell when pax boarding. Strong acrid odour on take-Off, and inflt after turbulence. |

| DATE | REG | FLT | RESP | DESCRIPTION |
|---|---|---|---|---|
| 21/5/98 | JJU | 342 | 19 | On climb, smell rear galley burning, engine air. |
| 23/5/98 | JJP | 382 | 17 | Fwd and rear galleys. Strong electrical odour/fire. Eye/throat irritation, dizziness. Take-off and ldg. APU Change-over from engine. |
| 23/5/98 | JJP | 407 | 18 | Rear cabin burning smell on climb, APU air. |
| 24/5/98 | JJU | 319 | 20 | Hot oil smell, eye irritation, metallic taste, nausea, heavy head. Sore throat coughing after flt. Slight mist in cabin. Rear cabin at engine change over on take-off. |
| 26/5/98 | JJU | 381 | 21 | All sections of cabin, from start up on ground taxiing. APU air selected. Tight Chest, light headed, heavy Dusty feeling in throat. |
| 26/5/98 | JJU | 380 | 21 | On crew boarding, over-powering oily smell. Pack burn slight improvement. Rear cabin smell returned on climb. |
| 29/5/98 | JJP | 329 | 22 | Chemical smell rear and forward cabin take-off APU selected. Throat irritation, headaches. |
| 31/5/98 | JJS | 62/77 | 23 | Oily metallic smell, dizzy, eye irritation. On ground, take-off. APU selected. |
| 1/6/98 | JJU | 375 | 14 | Eye irritation, mild hypoxia dry eyes, skin, mouth, nausea, salivation, mild head-ache. No odour. Engine air. |

| DATE | REG | FLT | RESP | DESCRIPTION |
|---|---|---|---|---|
| 2/6/98 | JJS | 380 | 23 | Oily, CO vomitous smell. On crew boarding, eye and Throat irritation. Nausea. APU air selected. All cabin. |
| 2/6/98 | JJS | 381 | 23 | As above. Metallic, dusty taste. Stinging, streaming eyes APU air selected. APU MEL'd. |
| 3/6/98 | JJT | 319 | 15 | After take-off during climb. Eye irritation. |
| 4/6/98 | EWR | 262 | 24 | Flt deck, mild oily odour all phases of flt. Headache, eye throat irritation APU air selected. |
| 25/6/98 | JJT | 310 | 9 | Flt deck. Oily, vinegar smell. APU air. On ground on climb. |
| 26/6/98 | EWM | 276 | 27 | Fwd cabin flt deck. Eye |
| 27/6/98 | EWM | 271 | 27 | Eye irritation, respiratory difficulties. PU on 02 on descent. APU not operating Engine air selected |
| 28/6/98 | EWM | 131 | 28 | Hot and clammy, shortness of breath, disorientation, metallic taste, nausea, headache, fatigue. |
| 28/6/98 | EWM | 261 | 29 | Eye and throat irritation. Mild hypoxia. Whole cabin During cruise. Engine air. |
| 1/7/98 | EWI | 285 | 25 | Eye throat irritation. On climb. Engine air, rear cabin Chemical, burning smell. |

| DATE | REG | FLT | RESP | DESCRIPTION |
|---|---|---|---|---|
| 9/7/98 | JJU | 406 | 26 | Rear cabin, take-off and climb, chemical (chlorine?) cleaning fluid smell. Nausea and headache. APU and eng. |
| 10/7/98 | JJU | 310 | 21 | Flt deck and all cabin areas. On boarding ground. Felt intoxicated. Difficulty Concentrating. Memory lapse. Dissipated after take-off. |
| 10/7/98 | JJU | 310 | 21 | Sweet, acidic smell next sector on descent landing. Engine air selected. |
| 14/7/98 | JJW | 392 | 30 | On descent, burning throat, rear cabin. APU air selected |
| 18/7/98 | EWM | 541 | 32 | Eye and throat irritation Light headed. Rear cabin. |
| 20/7/98 | EWR | 285 | 31 | Rear cabin after t/off at |
| 28/7/98 | JJW | 343 | 24 | Occasional acrid oily odour flt deck. Engine air. Eye throat irritation. During cruise. |
| 30/7/98 | JJS | 381 | .33 | Smell on boarding a/c. Child pax 13 yrs felt nauseous. Parent said it was the smell. |
| 2/8/98 | JJX | 391 | 34 | Burning plastic smell in flt deck on take-off. Engine air |
| 4/8/98 | JJP | 310 | 35 | Electrical odour, rear cabin, descent and landing. Slight headache. APU selected. |
| 4/8/98 | JJP | 310 | 35 | Next sector, all flight odour, above last row of seats, headache became more severe after take-off 2nd sector APU and engine air |

| DATE | REG | FLT | RESP | DESCRIPTION |
|---|---|---|---|---|
| 4/8/98 | JJP | 310 | 23 | Headache instant when working rear galley. Smell all flight, became worse on landing. APU and Eng. Air. |
| 26/8/98 | JJP | 62 | 9 | On ground, climb, descent Varnish smell, metallic taste Flt deck, consistent with APU air on. |
| 19/9/98 | JJS | 499 | 21 | Fwd cabin fog/mist in cabin usual ? sweet smell. Descent engine air selected. |
| 26/9/98 | JJT | 2380 | 36 | Strong chemical smell. APU take-off rear cabin. |
| 19/10/98 | JJX | 374 | 18 | Rear cabin, nauseous after landing previous flt 321. |
| 6/11/98 | EWM | 542 | 37 | Chemical taste in throat Taxiing for take-off, And on descent. Tight chest, Throat discomfort. consistent with changing from Engine to APU air. |
| 7/11/98 | JJT | 234/5 | 38 | Rear cabin fumes and fwd Throat irritation. 2 pax had Headaches. Slight respiratory problems. Climb, cruise. Engine air. |
| 10/11/98 | EWR | 285 | 31 | Flt deck. Sweaty sox oil smell shortly after start up and selecting APU. Dissipated on taxi |
| 12/11/98 | EWI | 104 | 37 | On taxi, metallic taste, general feeling of un-wellness, mild hypoxia, light headed. Cruise, eng. Air. |

| DATE | REG | FLT | RESP | DESCRIPTION |
|---|---|---|---|---|
| 12/11/98 | EWI | 231 | 39 | Rear cabin, odour, eye, throat irritation, strong smell during cruise. Engine air. |
| 22/11/98 | JJX | 327 | 40 | Smell, eye irritation after take-off. Smelt like fuel. Engine air. |
| 22/11/98 | JJX | ? | 41 | On take off both f/a's felt unwell. Light headed, dizzy, blurred vision rear cabin. Fwd cabin PU developed thumping headache. One had to sit down after Landing due faint, nauseous. |
| 13/12/98 | JJQ | 364 | 42 | Rear cabin, all stages of sector. Dizziness, faint, confusion, nausea, fatigue, headache. 6 pax and 1 ccm. Pax vomited. APU and engine air selected. |
| 18/1/99 | EWI | 266/7 | 43 | Eye throat nose irritation Cruise. Engine air. All cabin |
| 19/1/99 | EWI | 266/7 | 43 | Headache nausea, throat irritation Poor ventilation |
| 20/1/99 | JJT | 320/3 | 24 | Oily foul odour, at switch over from engine air to APU in flt deck. On descent. Nasal irritation. |
| 8/2/99 | JJT | 394/5 | 45 | Flt deck. Smell, headache nausea, dizziness. Cabin crew no odour but mounting nausea, light headed. |
| 9/2/99 | JJT | 393 | 22 | Fwd cabin flt deck. On ground during climb. Supply duct inoperative. APU and engine air. Eye irritation headache, hypoxia, nausea. Cabin crew took 02. |

| DATE | REG | FLT | RESP | DESCRIPTION |
|---|---|---|---|---|
| 9/2/99 | EWM | 277 | 31 | Flt deck odour only. F/o sneezed. APU air selected On ground. |
| 12/2/99 | EWS | 131 | 47 | Air con pack U/S. Hot, tight chest, light headed. PU on 02. Later nauseous. Flt deck hotter than cabin. F/O had to sit in terminal After previous flt to recover. |
| 16/2/99 | EWS | 131 | 48 | Cabin never cooled down Extremely uncomfortable Working conditions. |
| 28/2/99 | EWI | 268 | 47 | APU u/s. Hot and uncomfortable until in the air. |
| 1/3/99 | EWI | 261 | 47 | As above. |
| 8/3/99 | EWS | 271 | 49 | Fumes in flt deck while on ground, taxi and t/off. And landing at switch over To APU from engine air. Eye and throat irritation. |
| 8/3/99 | EWS | 231 | 49 | As above. |
| 8/3/99 | EWS | 231 | 50 | Musty odour in flt deck. Flt deck crew asked PU to Bring sample kit fwd. |
| 23/3/99 | EWS | 543 | 51 | Only one air con pack working. Pax and cabin crew complained of heat, lack of air. Pax smelt fumes mid cabin, felt nauseous. |
| 2/4/99 | EWI | ? | 54 | Cabin crew had headaches, sore eyes from duty previous night into CBR. |

| DATE | REG | FLT | RESP | DESCRIPTION |
|---|---|---|---|---|
| 11/4/99 | JJS | 369 | 46 | Rear cabin, foul, dirty odour Nose itchy, dry, eye irritation. Breathing difficulty. Cabin crew 1 on 02. Cruise, engine air selected. |
| 4/5/99 | EWS | 261 | 52 | Smell only. Flt deck. APU air on ground. |
| 10/5/99 | EWI | 263 | 53 | Electrical, heat smell. On descent. Engine air. |
| 6/6/99 | EWR | 4 | 57 | Rear cabin. Burning oil smell. Felt faint, tingling fingers and hands, throat irritation, metallic taste. Hard to concentrate to Take air sample. On approach. Bad headache after. |
| 6/6/99 | EWM | 266 | 14 | Pax reported terrible smell rear mid cabin. Burning. On cruise, engine air selected |
| 23/6/99 | EWS | 542 | 55 | Oil smell flt deck on ground with APU air selected. |
| 27/6/99 | EWR | 4/67 | 56 | No odour, nausea, visual disturbances, breathing difficulties, tingling fingers, rushes of energy at top of head. Most severe at take-off and Landing. |
| 30/6/99 | EWS | 104 | 58 | On boarding a/c cheesey, dirty socks smell. Vented a/c by opening doors. Probably APU air selected. |
| 7/7/99 | EWR | 262 | 59 | Headache, breathlessness, cabin overheated. Inadequate airflow. |

| DATE | REG | FLT | RESP | DESCRIPTION |
|---|---|---|---|---|
| 23/7/99 | EWS | 151 | 60 | Rear and mid cabin after take-off strong acidic smell Cabin crew were hot, shivery, had headaches. APU air Selected for landing. |
| 23/7/99 | EWS | 151 | 61 | Pungent smell rear of a/c Felt ill just after take-off Acidic oily smell. F/a relieved from further duty. |
| 23/7/99 | EWS | 151 | 62 | Burning in back of throat, Cabin extremely hot. Asked for cabin to be Cooled. Did not happen. Nauseous on landing Cabin crew taken to medical centre after landing. |
| 25/7/99 | JJQ | 399 | 21 | Fume occurrence on descent. Possible oil leak. Mid/fwd cabin. Strong Oily odour. Engine air Selected. |
| 25/7/99 | EWS | 535/4 | 63 | Eye and throat irritation. On descent. APU air. |
| 31/7/99 | EWS | 273 | 64 | Flt deck. Smell, eye throat irritation. Cruise descent, engine air. |
| 3/8/99 | JJX | 372 | 66 | Chemical fumes rear and Fwd cabin. Nausea, pale, clammy, shaking. APU air on take-off. |
| 5/8/99 | JJP | 319 | 67 | Oil, mechanical smell. All cabin. Pax complained on push back and start up APU air selected. |
| 5/8/99 | JJT | 367 | 68 | Rear and fwd cabin, oily burning smell, short burst of nausea, just after take-off. Engine air selected. |

| DATE | REG | FLT | RESP | DESCRIPTION |
|---|---|---|---|---|
| 6/8/99 | JJT | 372/3 | 65 | Oily smell, just after power on for take-off both sectors. Rear cabin. |
| 11/8/99 | JJT | 347 | 69 | Hot engine oil smell. Rear cabin on climb. Throat Irritation. Light headed. Engine air selected |
| 11/8/99 | EWS | 151/122 | 51 | APU u/s. cabin became hot and oppressive on t/around. Asked for cabin to be cooled 5 times during flt, to no lasting effect. |
| 11/8/99 | EWS | 64 | 52 | Fumes in flt deck. Smell only. |
| 12/8/99 | EWS | 266/7 | 70 | Smelly socks. Fwd cabin and flt deck. Climb, APU and engine air. |
| 19/8/99 | JJQ | 343 | 66 | Dirty socks, vomit type odour. Eye and throat irritation Light headed and headaches. Rows 5-6. Engine air, cruise APU not operating. |
| 19/8/99 | EWS | 151 | 71 | 1st sector, huge headache, no smell. 2nd sector metallic smell at row 10. Burning, gritty eyes, metallic taste. Crew deplaned BNE sent to Drs. Sore throat all night. |
| 20/8/99 | EWM | 263 | 52 | Flt deck. Acrid oil smell. Throat irritation. On take-Off. Engine air selected. |
| 20/8/99 | EWS | 104 | 72 | Rear and fwd cabin. No odour, dry eyes and throat. All cabin crew felt ill. APU not operating. Engine Air selected. Shakey and Bad taste in mouth |

| DATE | REG | FLT | RESP | DESCRIPTION |
|---|---|---|---|---|
| 21/8/99 | EWS | 151 | 73 | Pax seated mid cabin reported strong burning rubber smell during cruise. APU not operating. Engine air. |
| 26/8/99 | JJU | 319 | 74 | Fluid leaking on taxi for take-off. Fluid stopped so departed. Smell evident on climb. Crew moved to fwd cabin away from odour. Burning oil smell. Throat Irritation and nausea. APU Operating. Engine air selected. |
| 27/8/99 | JJU | 310 | 67 | Smell rear and mid cabin. Oily smell. Pack burn had been done prior to crew boarding. Hot and uncomfortable. APU air selected. |

# APPENDIX FIVE

## RELEVANT CIVIL AVIATION REGULATIONS AND PUBLICATIONS

EXTRACT FROM CIVIL AVIATION REGULATIONS 1988 (CARs)

## 2 Interpretation

In these Regulations, unless the contrary intention appears:

**…**

***major defect***, in relation to an aircraft, means a defect of such a kind that it may affect the safety of the aircraft or cause the aircraft to become a danger to person or property.

EXTRACT FROM CIVIL AVIATION REGULATIONS 1988 (CARs)

**48 Maintenance release to recommence to be in force**

(1) Where a maintenance release in respect of an aircraft ceases to be in force by virtue of an endorsement made under subregulation 47 (1), the maintenance release shall again commence to be in force if:

(a) where the endorsement refers to a requirement or condition in respect of the maintenance of the aircraft not having been complied with—there is entered on the maintenance release or other document on which the endorsement was made a certification in accordance with regulation 42ZE or 42ZN, that the maintenance to which the requirement or condition relates has been completed;

(b) where the endorsement refers to the aircraft having suffered major damage or having developed a major defect—there is entered on the maintenance release or other document on which the endorsement was made a certification, in accordance with regulation 42ZE or 42ZN, that the maintenance required to remedy the damage or the defect, as the case may be, has been completed;

(c) where the endorsement refers to the aircraft having had imposed on it abnormal flight or ground loads—there is entered on the maintenance release or other document on which the endorsement was made a certification, in accordance with regulation 42ZE or 42ZN, that the maintenance required to be carried out to check whether that imposition has caused any damage to the aircraft, and to remedy any damage so caused, has been completed; or

(d) where the endorsement relates to the flight characteristics of the aircraft or the operating characteristics of an aircraft component, or system of aircraft components, installed in the aircraft—there is entered on the maintenance release or other document on which the endorsement was made a certification, in accordance with regulation 42ZE or 42ZN, that the maintenance required to correct the flight characteristics or operating characteristics, as the case may be, has been completed.

(2) Where a maintenance release in respect of an aircraft ceases to be in force by virtue of an endorsement made under regulation 47, the maintenance release shall again commence to be in force if there is entered on the maintenance release or other document on which the endorsement was made a further endorsement signed by an authorised person cancelling the first-mentioned endorsement.

(3) An authorised person shall not make an endorsement under subregulation (2) unless he or she is satisfied that there is no reason why the endorsement to be cancelled should continue in force.

Penalty: 25 penalty units.

(4) A maintenance release that has ceased to be in force by virtue of an endorsement made under regulation 47 shall not again commence to be in force except by virtue of an endorsement made under this regulation.

(5) This regulation does not have effect in relation to a maintenance release issued in respect of an aircraft if:

(a) the period during which the maintenance release is expressed to remain in force has expired; or

(b) a subsequent maintenance release has been issued in respect of the aircraft by virtue of paragraph 43 (7) (a).

EXTRACT FROM CIVIL AVIATION REGULATIONS 1988 (CARs)

**233 Responsibility of pilot in command before flight**

(1) An aircraft shall not commence a flight unless evidence has been furnished to the pilot in command and the pilot has taken such action as is necessary to ensure that:

(a) the instruments and equipment required for the particular type of operation to be undertaken are installed in the aircraft and are functioning properly;

(b) the gross weight of the aircraft does not exceed the limitations fixed by or under regulation 235 and is such that flight performance in accordance with the standards specified by CASA for the type of operation to be undertaken is possible under the prevailing conditions; and

(c) any directions of CASA with respect to the loading of the aircraft given under regulation 235 have been complied with;

(d) the fuel supplies are sufficient for the particular flight;

(e) the required operating and other crew members are on board and in a fit state to perform their duties;

(f) the air traffic control instructions have been complied with;

(g) the aircraft is safe for flight in all respects; and

(h) the latest of the aeronautical maps, charts and other aeronautical information and instructions, published in AIP or by a person approved in writing, that are applicable:

(i) to the route to be flown; and

(ii) to any alternative route that may be flown on that flight;

are carried in the aircraft and are readily accessible to the flight crew.

Penalty: 50 penalty units.

(1A) An approval under paragraph (1) (h) may be given subject to such conditions as are specified in the instrument of approval.

(2) An aircraft engaged in international air navigation shall not commence a flight, unless the pilot in command has completed an approved flight preparation form, certifying that the pilot is satisfied in respect of the matters specified in subregulation (1).

Penalty: 5 penalty units.

(3) Each completed flight preparation form shall be kept by an operator for a period of 6 months.

Penalty for a contravention of this subregulation: 5 penalty units.

EXTRACT FROM CIVIL AVIATION REGULATIONS 1988 (CARs)

**256 Intoxicated persons not to act as pilots etc. or be carried on aircraft**

(1) A person shall not, while in a state of intoxication, enter any aircraft.

Penalty: 5 penalty units.

(2) A person acting as a member of the operating crew of an aircraft, or carried in the aircraft for the purpose of so acting, shall not, while so acting or carried, be in a state in which, by reason of his or her having consumed, used, or absorbed any alcoholic liquor, drug, pharmaceutical or medicinal preparation or other substance, his or her capacity so to act is impaired.

Penalty: 50 penalty units.

(3) A person shall not act as, or perform any duties or functions preparatory to acting as, a member of the operating crew of an aircraft if the person has, during the period of 8 hours immediately preceding the departure of the aircraft consumed any alcoholic liquor.

Penalty: 50 penalty units..372 *Civil Aviation Regulations 1988*

(4) A person who is on board an aircraft as a member of the operating crew, or as a person carried in the aircraft for the purpose of acting as a member of the operating crew, shall not consume any alcoholic liquor.

Penalty: 50 penalty units.

(5) A person shall not, while acting in any capacity in either Air Traffic Control or Flight Service, be in a state in which, by reason of his or her having consumed, used, or absorbed any alcoholic liquor, drug, pharmaceutical or medicinal preparation or other substance, his or her capacity so to act is impaired.

Penalty: 50 penalty units.

(6) A person shall not act in any capacity in either Air Traffic Control or Flight Service if the person has, during the period of 8 hours immediately preceding the commencement of the period of duty in which he or she so acts, consumed any alcoholic liquor.

Penalty: 50 penalty units.

(7) A person who is on duty in either Air Traffic Control or Flight Service shall not consume any alcoholic liquor.

Penalty for a contravention of this subregulation: 50 penalty units.

EXTRACT FROM FEDERAL AVIATION REGULATIONS (FARs)

PART 23 - AIRWORTHINESS STANDARDS: NORMAL, UTILITY, ACROBATIC, AND COMMUTER

**Sec. 23.831 Ventilation.**

(a) Each passenger and crew compartment must be suitably ventilated. Carbon monoxide concentration may not exceed one part in 20,000 parts of air.

(b) For pressurized airplanes, the ventilating air in the flightcrew and passenger compartments must be free of harmful or hazardous concentrations of gases and vapors in normal operations and in the event of reasonably probable failures or malfunctioning of the ventilating, heating, pressurization, or other systems and equipment. If accumulation of hazardous quantities of smoke in the cockpit area is reasonably probable, smoke evacuation must be readily accomplished starting with full pressurization and without depressurizing beyond safe limits.

[Docket No. 4080, 29 FR 17955, Dec. 18, 1964; 30 FR 258, Jan. 9, 1965, as amended by Amdt. 23-34, 52 FR 1831, Jan. 15, 1987; Amdt. 23-42, 56 FR 354, Jan. 3, 1991]

EXTRACT FROM FEDERAL AVIATION REGULATIONS (FARs)

PART 25 - AIRWORTHINESS STANDARDS: TRANSPORT CATEGORY AIRPLANES

**Sec. 25.831 Ventilation.**

(a) Under normal operating conditions and in the event of any probable failure conditions of any system which would adversely affect the ventilating air, the ventilation system must be designed to provide a sufficient amount of uncontaminated air to enable the crewmembers to perform their duties without undue discomfort or fatigue and to provide reasonable passenger comfort. For normal operating conditions, the ventilation system must be designed to provide each occupant with an airflow containing at least 0.55 pounds of fresh air per minute.

(b) Crew and passenger compartment air must be free from harmful or hazardous concentrations of gases or vapors. In meeting this requirement, the following apply:

(1) Carbon monoxide concentrations in excess of 1 part in 20,000 parts of air are considered hazardous. For test purposes, any acceptable carbon monoxide detection method may be used.

(2) Carbon dioxide concentration during flight must be shown not to exceed 0.5 percent by volume (sea level equivalent) in compartments normally occupied by passengers or crewmembers.

(c) There must be provisions made to ensure that the conditions prescribed in paragraph (b) of this section are met after reasonably probable failures or malfunctioning of the ventilating, heating, pressurization, or other systems and equipment.

(d) If accumulation of hazardous quantities of smoke in the cockpit area is reasonably probable, smoke evacuation must be readily accomplished, starting with full pressurization and without depressurizing beyond safe limits.

(e) Except as provided in paragraph (f) of this section, means must be provided to enable the occupants of the following compartments and areas to control the temperature and quantity of ventilating air supplied to their compartment or area independently of the temperature and quantity of air supplied to other compartments and areas:

(1) The flight crew compartment.

(2) Crewmember compartments and areas other than the flight crew compartment unless the crewmember compartment or area is ventilated by air interchange with other compartments or areas under all operating conditions.

(f) Means to enable the flight crew to control the temperature and quantity of ventilating air supplied to the flight crew compartment independently of the temperature and

quantity of ventilating air supplied to other compartments are not required if all of the following conditions are met:

(1) The total volume of the flight crew and passenger compartments is 800 cubic feet or less.

(2) The air inlets and passages for air to flow between flight crew and passenger compartments are arranged to provide compartment temperatures within 5 degrees F. of each other and adequate ventilation to occupants in both compartments.

(3) The temperature and ventilation controls are accessible to the flight crew.

(g) The exposure time at any given temperature must not exceed the values shown in the following graph after any improbable failure condition.

[INSERT: Line graph illustrating the time--temperature relationship.] **(NOT INCLUDED)**

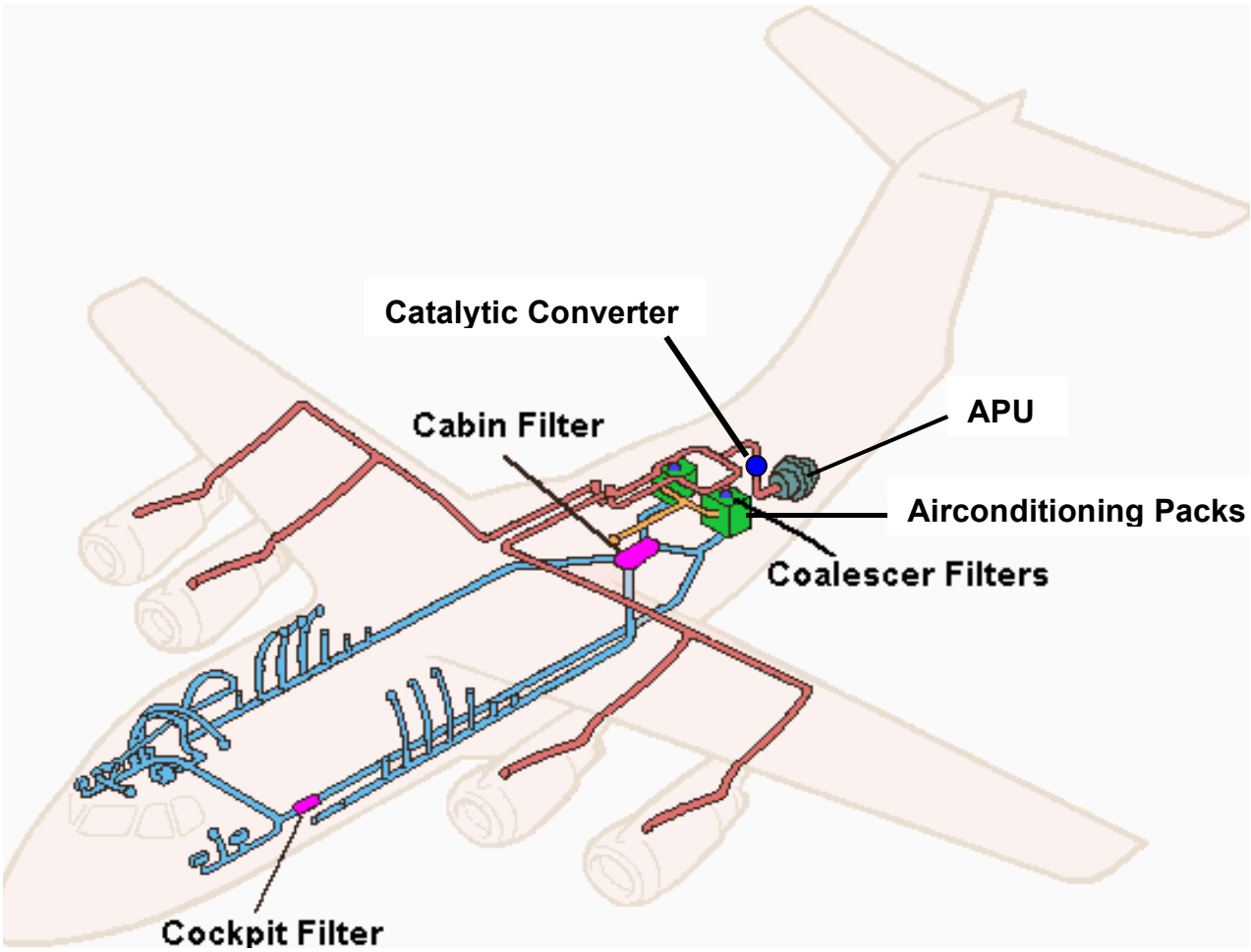
[Doc. No. 5066, 29 FR 18291, Dec. 24, 1964, as amended by Amdt. 25-41, 42 FR 36970, July 18, 1977; Amdt. 25-87, 61 FR 28695, June 5, 1996; Amdt. 25-89, 61 FR 63956, Dec. 2, 1996]

# APPENDIX SIX

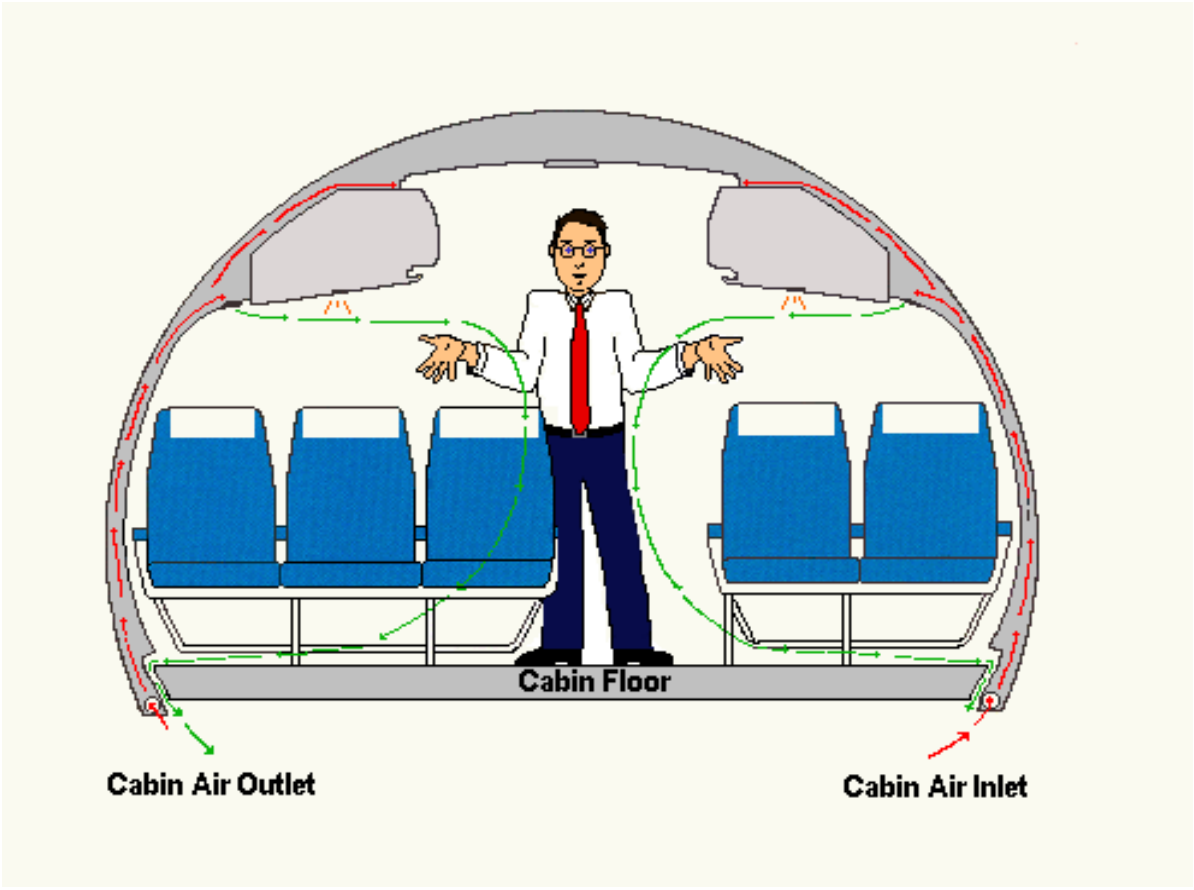
## DIAGRAMS OF AIR CIRCULATION SYSTEM ON BAe 146 AIRCRAFT

### PROVIDED BY ANSETT AUSTRALIA

# Airconditioning System



# Airflow Before Modifications



# Airflow After Modifications