Australian Government
Australian Transport Safety Bureau

Aviation Safety Investigation Report - Final

British Aerospace Plc BAe 146-200, VH-JJU

Occurrence Details

Occurrence Number:	200103238	Location:	Perth, Aero.
Occurrence Date:	18 July 2001	State:	WA
Occurrence Time:	1020 hours WST	Highest Injury Level:	None
Occurrence Category:	Incident	Investigation Type:	
Occurrence Class:		Investigation Status:	
Occurrence Type:		Release Date:	04 July 2002

Aircraft Details

Aircraft Manufacturer:	British Aerospace Plc	Aircraft Model:	BAe 146-200
Aircraft Registration:	VH-JJU	Serial Number:	E2116
Type of Operation:	Air Transport, Domestic, High Capacity, Passenger, Scheduled		
Damage to Aircraft:	Nil		
Departure Point:	Perth, WA	Departure Time:	
Destination:	Kununurra, WA		

Factual Information

During the takeoff roll, the cabin manager of the BAe 146 aircraft became aware of a smoky, burning smell coming from an air vent in the region of her crew seat at the forward (L1) exit door. Initially there was a mild odour. That was followed by the rapid onset of strong fumes for a short period after which the fumes dissipated quickly. The event was of 2-3 minutes duration.

The cabin manager felt overwhelmed by the fumes and was on the verge of passing out when her colleagues became aware of the situation and provided her with portable oxygen. After approximately 10 minutes of using oxygen, the cabin manager felt well enough to attempt a resumption of her duties but was unable to continue due to the effect of the fumes exposure.

The cabin manager, who had ten years of operational experience on the BAe 146, spent the duration of the flight seated at the rear of the aircraft; breathing portable oxygen for most of that time. The cabin manager reported that when she was not using oxygen she felt unwell, she had difficulty in thinking clearly and she found it difficult to coordinate her thoughts with her actions. No other members of the crew or any of the passengers reported being affected by the fumes.

Upon arrival in Kununurra, engineering inspections were performed on the aircraft and further action was deferred in accordance with the Civil Aviation Safety Authority airworthiness directive AD/BAe146/086. That airworthiness directive required certain actions to be performed whenever a cabin air quality problem was identified, which was suspected of being associated with oil contamination of the air supply from the airconditioning packs. Subsequent engineering inspections revealed that the cause of the oil contamination was a worn number one bearing seal in the number-3 engine. The engine was replaced and no further fumes were evident during following flights.

The cabin manager sought medical treatment and tests in Kununurra on the day of the incident and in Perth on the following day. Although she was eventually cleared to return to work, symptoms of anxiety, impaired judgement, and light-headedness remained with her for in excess of one week. Of note was the result of a blood test that

revealed she had been exposed to a higher than normal level of carbon monoxide (CO). When inhaled, CO combines with the haemoglobin, the blood's oxygen-carrying molecule, to form carboxyhaemoglobin (COHb). Once in that state, the haemoglobin is unable to carry oxygen. Thus, the blood's ability to carry oxygen to body tissues, including vital organs such as the heart and brain, is inhibited.

CO is the product of incomplete combustion of carbonaceous material. It is found in varying amounts in the smoke and fumes from burning aircraft engine fuels and lubricants. The gas itself is colourless, odourless, and tasteless but is usually mixed with other gases and fumes that can be detected by sight or smell. Individuals that have been exposed to CO should be removed from the exposure and administered 100 percent oxygen through a tight fitting mask until all symptoms have been resolved. If blood testing for measurement of COHb level is required, the samples should be drawn as soon as possible after the exposure, as COHb has a short half-life in the body of 4-5 hours. If an individual is administered 100 percent oxygen, the half-life is reduced to 40 to 80 minutes.

The same aircraft was the subject of a pilot report three days prior to the cabin manager's experience, in which an oil-like smell was evident in the cockpit but not in the cabin. The event was of short duration and occurred just after takeoff, when the source of air supply was changed from the Auxiliary Power Unit (APU) to the engines. Inspection by maintenance engineers of the engines, APU, and air-conditioning system revealed no signs of contamination and the defect was cleared.

Evidence from previous incidents of air system contamination on this type of aircraft has indicated that fumes were associated with engine or APU oil contamination of the airconditioning system. The BAe146 is similar to many aircraft in that the supply of cabin air originates in the aircraft's engines. Air is bled from the final stage of the engine's high-pressure compressor just prior to the combustion chamber. The air destined for the cabin then passes through a catalytic converter in order to clean the air of any oil contaminants. Catalytic converters operate at maximum efficiency under highly specific conditions of temperature and contaminant to air ratio. The air is then passed through a heat exchanger and then through one of two airconditioning packs before entering the cabin. During normal operation bleed air from engines one and two is fed to pack one, which in turn supplies conditioned air to the flight deck and cabin. Bleed air from engines three and four is fed to pack two, which normally only supplies air to the cabin. Additionally, bleed air from the APU is used by either pack during the takeoff and landing phases or when airconditioning is required on the ground.

Analysis

The cabin manager's observations, during the takeoff roll, of a smoky burning smell, and her subsequent symptoms, suggested contamination of the cabin air supply with the by-products of engine combustion. Her blood test results, appearing consistent with CO exposure, seemed to confirm that hypothesis. Although maintenance engineers traced the source of oil contamination to the number-3 engine, the investigation was unable to positively determine the exact origin of the fumes that affected the cabin manager. At the stage of flight when fumes affected the cabin manager, the air conditioning packs were being supplied with air from the APU, not from the engines.

It was considered possible that, at some stage prior to the flight, airconditioning pack number two was contaminated with the by-products of the thermal degradation of oil from the number-3 engine. That would have resulted in the tainting of the APU air as it passed through airconditioning pack two before entering the cabin. It is also possible that the cabin air became contaminated from an external source. While taxiing, the aircraft's engine exhaust or a preceding aircraft's engine exhaust may have been ingested into the APU air intake, resulting in the cabin air contamination.

The fumes had a detrimental effect on the well being of the cabin manager. The potential effect on her ability to effectively carry out her duties in the event of an emergency could not be determined.

Safety Action

On 6 September 1999, the Australian Transport Safety Bureau issued recommendation R19990052 to the Civil Aviation Safety Authority. That recommendation stated 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 BAe 146 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."

The Civil Aviation Safety Authority responded on 14 March 2000 stating:

"In the lengthy period between the incident and the release of your report, CASA has investigated this issue in considerable detail, in conjunction with the aircraft manufacturer and the major Australian operators. As a result of this work, and discussions with the certifying authority (the UK Civil Aviation Authority), CASA is satisfied that the BAel46 aircraft in service in Australia are safe for public transport. CASA technical specialists are available to brief your investigators on the scope and findings of this work.

"As your recommendation does not specify the nature of any additional deficiencies that the Bureau believes need to be addressed by CASA and the aircraft manufacturers, I am seeking details of any deficiencies that you believe have not been appropriately dealt with. It would also assist us in providing a meaningful and constructive response to your recommendations if you were to provide us with details of any incidents that have occurred since the original incident in 1997.

"In the meantime, we will continue to monitor the situation and review any information that comes to hand."

The Bureau classified the response as "Open" and has initiated further correspondence with CASA. On 12 October 2000, the Senate Rural and Regional Affairs and Transport References Committee tabled its report into Safety and Cabin Air Quality in the BAe 146 Aircraft. The Government tabled its response to the References Committee's report on 28 June 2002.