Boeing 747-438, VH-OJD

AAIB Bulletin No: 6/99 EW/C98/11/7 Category: 1.1

Aircraft Type and Registration:	Boeing 747-438, VH-OJD
No & Type of Engines:	4 Rolls Royce RB-211-524G turbofan engines
Year of Manufacture:	1989
Date & Time (UTC):	28 November 1998 at 1550 hrs
Location:	After departure from London Heathrow Airport
Type of Flight:	Public Transport
Persons on Board:	Crew - N/K - Passengers - N/K
Injuries:	Crew - Nil - Passengers - Nil
Nature of Damage:	Damage to wires and airframe insulation blanket below forward cargo compartment floor
Commander's Licence:	N/K
Commander's Age:	N/K
Commander's Flying Experience:	N/K
Information Source:	AAIB Field Investigation

Approximately 45 minutes after departing London Heathrow Airport (LHR), reportedly when the aircraft was still in the climb, an 'equipment cooling' amber message was displayed on the Engine Indication and Crew Alerting System (EICAS) screen, together with the amber flashing attention light. After a brief discussion with the aircraft's maintenance organisation, the crew decided to return to LHR where the aircraft landed without incident. It was subsequently established from the aircraft's Central Maintenance Computer that there was an apparent fault associated with the Electronic Equipment (E/E) bay cooling system ground exhaust valve. A related circuit breaker was also found to have tripped. This valve is located on the lower centreline of the aircraft near Station 540 in an open bay below the floor of the forward cargo compartment, and vents the cooling airflow from the equipment cooling system in the E/E bay overboard when the aircraft is on the ground. In flight, the valve closes and the cooling airflow is re-circulated within the system. This exhaust valve also operates as a smoke clearance valve by opening in flight if smoke is detected in the electronic equipment cooling system (ECS).

In order to re-dispatch the aircraft as soon as possible in accordance with the Minimum Equipment List (MEL), the maintenance crew manually closed the exhaust valve and fitted a 'shorting link' to remove the EICAS message. However, despite this action the warning message persisted. As part of the ensuing troubleshooting process the valve, in addition to the ECS card and an associated

relay, were all replaced; however the problem persisted. By this time crew duty time limitations had intervened and so the aircraft remained overnight at LHR, enabling the maintenance crew to further investigate the problem. Wiring continuity checks were carried out and eventually an area of damaged wires was found close to, and associated with, the exhaust valve. These damaged wires had been hidden from view by having been previously installed, incorrectly, beneath the bilge thermal insulation blanket and next to the fuselage skin. It was evident that a localised fire had occurred between the outer film of the blanket and the fuselage structure. This had been associated with several damaged 24 gauge wires within a small electrical harness connected to the exhaust valve, and the outer film of the thermal insulation blanket had been consumed in the fire. The fire had affected an area of approximately 18 inches x 6 inches, but it was apparent that the insulating foam, although thermally 'singed' in this area, had not burnt (see Figure 1). Some water, resulting from condensation, was present in the bilge of this aircraft and it was considered possible that this may have limited the extent of the fire. The damaged wires were 'sooted' with combustion products from the fire, but did not require complete replacement. Repairs were effected to four wires by inserting in-line splices after their fire affected ends had been trimmed, but the severed ends were not retained and were therefore unavailable for examination. It was considered probable by the maintenance crew that the wires may have previously been inadvertently damaged by being 'stepped upon', particularly as they had been hidden from view under the insulation blanket, since it is not uncommon for maintenance personnel to loose balance and trip when working within cargo bay underfloor areas.

Insulation blanket materials

The airframe thermal and acoustic insulation blankets on Boeing aircraft, in common with almost all large aircraft, are fabricated by encapsulating insulating material (typically fire retardant expanded foam or glass fibre materials) within a thin reinforced plastic bag, tailored to fit the appropriate local structure. One of the functions of the bag is to seal the insulating medium against the ingress of water, oil and grime etc to preserve the fire resistance of the blanket and to avoid an unacceptable increase in weight. When examined approximately one week after the incident it was apparent that the damaged insulation bag had not been re-sealed, and evidence of the burnt bag material remained.

All materials used for such blankets are tested by the manufacturer to the Boeing Material Specification documents, in this case BMS 8-300 type I, grade 0.3, for the insulating foam and BMS 8-142 type 11, class 2, for the insulation blanket bag. The blanket in question had recently been changed for a 'lightweight' item fabricated by the operator from approved materials. These were polyimide foam, which had not burnt, and a polyester scrim reinforced polyester film, which had burnt (Figure 2). Certification testing of these materials includes a requirement to pass 'vertical' flammability tests, as specified in Federal Aviation Regulation (FAR) 25.853, Appendix F and in which the material test sample is presented vertically, alongside the heat source. However, a recent report issued by the FAA indicated that the primary response during thermal degradation of such blanket film materials is for the film to rapidly 'shrink away' from the heat source and the report therefore questioned the validity of this current vertical flammability certification test in simulating realistic combustion conditions. This report described an alternative flaming 'cotton swab' test method which it considered more rigorous for certification testing. Boeing has recently incorporated this latter test method into its own material specifications requirements. Two other blanket bag materials, which remain in service but which are no longer manufactured, were also reported upon in this FAA report, ie metallised PET film which was considered 'flammable and which possibly could propagate a fire in a realistic situation', and the much more effective 'Kapton' polyimide film bag material (originally installed at manufacture on all Lockheed L10-11 Tristar

aircraft). This latter material is currently being re-evaluated for future widespread use as insulation blanket bag material on public transport aircraft due to its excellent flammability resistance.