SERIOUS INCIDENT

Aircraft Type and Registration:	Boeing 757-21B, G-LSAI
No & Type of Engines:	2 Rolls-Royce RB211-535E4 turbofan engines
Year of Manufacture:	1987
Date & Time (UTC):	7 September 2011 at 1135 hrs
Location:	In the cruise, in Bulgarian airspace
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 7 Passengers - 219
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	38 years
Commander's Flying Experience:	10,232 hours (of which 3,611 were on type) Last 90 days - 178 hours Last 28 days - 53 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and subsequent AAIB enquiries

Synopsis

Whilst cruising at FL390 the aircraft's left AC electrical bus lost power, resulting in multiple flight instrument failures. After the flight crew completed the Quick Reference Handbook (QRH) drill for loss of power from the left generator, a thin haze of smoke and electrical fumes entered the flight deck. An attempt to power the aircraft's left AC electrical bus from the APU bus was unsuccessful and the aircraft diverted to Kavala Airport in Greece, where a normal landing was carried out. The source of the electrical fault with the left AC power generation system was traced to a corroded crimp terminal at the D1114J connector at the left pylon bulkhead. The source of the smoke that entered the flight deck was not positively identified.

History of the flight

The aircraft was on a flight from Leeds-Bradford Airport to Larnaca Airport, Cyprus and was established in the cruise at FL390. At 1135 hrs, approximately 2 hours and 50 minutes into the flight and whilst in Bulgarian airspace, the crew recalled observing L AC BUS OFF and L GEN OFF warning captions on the lower EICAS display, along with multiple failures of flight instruments. The commander completed the QRH drill for the L GEN OFF caption, which included resetting the left bus tie, after which power was momentarily restored before being lost again. The second power loss was associated with a thin haze of smoke and a strong smell of electrical burning in the flight deck. The crew responded by donning their oxygen masks and

© Crown copyright 2012

goggles. The commander declared a MAYDAY to ATC and an immediate descent and diversion was carried out to the nearest suitable airport, Kavala Airport in Greece, which was approximately 38 nm to the south. Two minutes after the left AC bus initially lost power the commander started the APU, which then powered the left AC electrical bus for a further 17 seconds before it lost power again. No additional attempts to supply power to the left AC bus were made and aircraft landed without further incident at 1156 hrs. During the final approach it was apparent that the fumes had dissipated and the passengers were disembarked normally.

Previous maintenance actions

The aircraft had experienced an 'L AC BUS OFF' event 13 flights prior to the incident flight and following inconclusive troubleshooting actions, the left integrated drive generator (IDG) was disconnected and the defect was transferred to the list of deferred defects in the aircraft's Technical Log. Subsequent investigations by the operator's maintenance personnel included wiring continuity checks in accordance with the aircraft's Fault Isolation Manual, replacement of the left Generator Control Unit (GCU) and the Bus Power Control Unit (BPCU), in addition to replacement of the circuit breakers for the left generator and the left bus tie. None of these actions were successful in resolving the defect.

On the morning of the incident flight, further maintenance troubleshooting was performed which revealed an open circuit at pin 12 between the D1014P plug, which mates with the D1114J bulkhead connector at the left pylon bulkhead, and the left IDG. The wiring loom between the D1014P plug and the left IDG was replaced and following a successful operational check, the left AC generator system was declared serviceable.

Post-incident maintenance actions

Following the incident, visual inspection of the circuit breaker for the left generator and the left bus tie was carried out, with no defects found, and the source of the smoke was not determined. Examination of the BPCU's built-in test equipment revealed that the fault messages LH GEN DP TRIP and MAIN BUS/OVERLAP ZONE had been recorded in the BPCU memory, indicating that the current demanded by the loads on the aircraft's left AC bus had not been detected to be in balance with the current output from the left IDG. The left GCU and the BPCU were replaced and the aircraft's engines were ground run for 45 minutes, during which the left and right AC power generation systems operated correctly and no electrical burning or smoke was apparent.

The aircraft was then ferried back to Manchester Airport with just a flight crew and two of the operator's maintenance personnel on board. Approximately 2 hours and 20 minutes into the flight, whilst cruising at FL380, the left AC bus again lost power and the crew observed L AC BUS OFF and L GEN OFF messages on the EICAS display. The crew reported no smoke or fumes following this event. They performed the QRH actions, which included starting the APU, and on this occasion the left AC bus remained powered from the APU bus and the aircraft was able to continue to Manchester Airport, where it landed uneventfully. Following this landing the crew attempted to reconnect the left AC generator to the left AC bus, and were successful. The BPCU's built-in test equipment was interrogated and once again it had recorded LH GEN DP TRIP and MAIN BUS/OVERLAP ZONE fault messages, as was the case for the previous incident.

Additional maintenance troubleshooting actions followed, which identified that pin 12 at the 30-way D1114J left pylon bulkhead connector was open

© Crown copyright 2012

circuit, and the central area of the connector's rear face was coated with soot. Disassembly of the connector revealed that the crimp terminals at pins 11 and 12 on the connector had parted from their wiring and the connector's backshell was loose, due to stripped threads. Pin 11 connects an earth shield to the left IDG's exciter field wiring, whilst pin 12 connects a winding around the 'A' output AC phase to the left generator differential protection current transformer, for use in fault sensing logic.

All the crimp terminals were renewed, the D1114J bulkhead connector was replaced with a new component and the electrical continuity of the associated wiring looms was checked, with reference to the Wiring Diagram Manual, and determined to be satisfactory. Following this maintenance action there was no further recurrence of a fault with the aircraft's left AC power generation system.

Inspection of the D1114J bulkhead connector

The D1114J bulkhead connector was sent to the AAIB for detailed examination. The connector holes at the pin 11 and 12 positions were blocked by crimp terminals that were pushed to the bottom of the connector; they were withdrawn (Figure 1) and examined using visual and scanning electron microscopy. Both crimp terminals showed that the multi-strand wire had completely parted within the crimped portion of the terminal and the exposed surface of the wire was heavily contaminated with black corrosion products. The wire end's surface had a rounded appearance, with no evidence of ductile overload. A significant quantity of dark-coloured powder was removed from inside the connector's holes by tapping the body of the connector. Analysis of the chemical composition of this powder revealed high levels of copper, carbon, silicate and oxygen, consistent with corrosion of the connector's internal components.

Analysis

The cause of the intermittent disconnection of the left IDG from the left AC electrical bus was traced to a corroded crimp terminal at pin 12 of the left pylon's D1114J bulkhead connector. The backshell of the connector was loose due to stripped threads, probably caused during previous over-tightening and this defect allowed moisture to enter the connector, causing corrosion of the connector's internal components. The loose backshell also prevented support of the connector's wiring loom, which allowed the loom to vibrate during flight, promoting mechanical damage of the individual wires at their point of attachment to the crimp terminals.

Figure 1

D1114J connector,
showing the detached crimp terminal at pin 12

© Crown copyright 2012

Loss of electrical continuity at pin 12 caused the left IDG's differential protection current transformer to erroneously sense that the 'A' output AC phase carried zero current, causing the left GCU, via logic within the BPCU, to disconnect the left IDG from the left AC bus. The intermittent nature of the connection, due to corrosion within the crimp terminal, made isolation of the defect difficult to diagnose and following two occurrences of an in-flight loss of left AC power, the defect cleared and the aircraft produced left AC power during subsequent ground running.

During the initial loss of left AC power 13 flights prior to the incident flight, no electrical smell was apparent to the flight crew, nor was it on the return flight to Manchester Airport. It is therefore probable that the presence of an additional factor was required to cause the electrical overheating fumes experienced prior to the diversion to Kavala Airport. Following the incident, inspection of the components associated with the left AC power generation system, other than the D1114J connector, did not reveal any visible electrical overheating damage that would indicate a component fault. However, loss of electrical continuity at pin 11 of the D1114J connector, as determined from examination of the crimp terminal, disconnected the earth shield from the left IDG's exciter field power supply wiring. It is therefore possible that electromagnetic interference could have affected the exciter field voltage and, in turn, the left IDG output AC voltage. The aircraft manufacturer confirmed that a reduction in AC voltage can cause fuselage-mounted electrical motors and transformers to overheat, resulting in a hot electrical smell and possibly light smoke, but without leaving any visible evidence once these components have subsequently cooled.

© Crown copyright 2012