INCIDENT

Aircraft Type and Registration:	Boeing 757-236, G-LSAA
No & Type of Engines:	2 Rolls-Royce RB211-535E4-37 turbofan engines
Year of Manufacture:	1988
Date & Time (UTC):	2 March 2009 at 1327 hrs
Location:	FL390, 30 nm north-east of Athens, Greece
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 9 Passengers - 183
Injuries:	Crew - None Passengers - 4 (Minor)
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	63 years
Commander's Flying Experience:	14,090 hours (of which 9,371 were on type) Last 90 days - 106 hours Last 28 days - 28 hours
Information Source:	Aircraft Accident Report Form submitted by the commander, and further enquiries by the AAIB

Synopsis

The flight crew carried out an en-route climb from FL370 to FL390. Shortly before the aircraft levelled at FL390 they heard a "popping" sound and felt a pressure change in their ears. The flight crew donned their oxygen masks and, with the cabin altitude seen to be rising and uncontrollable, executed a rapid descent. The aircraft subsequently diverted to Athens Airport. A number of the passengers complained of discomfort in their ears both during and after the event.

History of the flight

The aircraft was on a flight from Manchester Airport, UK, to Taba Airport, Egypt. There were three personnel on the flight deck, two pilots and a company maintenance engineer. In an area to the north of Athens the aircraft was climbed from FL370 to FL390 with a rate of climb of approximately 1,000 fpm.

Flight crew recollections

The first indication of a problem on the flight deck was a "popping" and "whooshing"sound. The three personnel felt a pressure change in their ears and the co-pilot observed that the cabin altitude was rising at a rapid rate; he thought he saw a rate of climb of approximately 4,000 ft/min. Also, the engineer noticed that the cabin differential pressure was about 9 psi. All three donned their oxygen masks.

The flight crew were not able to recall the exact sequence of events but made the following observations. The co-pilot attempted to control the cabin altitude by switching to the manual mode and closing the outflow valve; he considered that the valve had been in its normal position before it was closed. This action was not effective in controlling the cabin rate of climb, so the commander initiated a rapid descent to a lower level. The flight crew remembered seeing an Engine Indication and Crew Alerting System (EICAS) CABIN AUTO INOP caution message but could not recall exactly when it appeared. During the descent they also noticed that an EICAS CABIN ALTITUDE warning message was displayed but they observed that it ceased after a short time. A MAYDAY was transmitted to Athens ATC, in the descent, and a passenger announcement (PA) was made to advise the cabin crew and passengers. The initial memory actions for an emergency descent were carried out and, when the action '*passenger oxygen - ON*' was reached, the flight crew discussed whether or not this action should be performed. The cabin altitude was then below 10,000 feet so the commander decided not to deploy the oxygen masks. The maximum cabin altitude seen by the flight crew during the event was between 10,000 and 11,000 feet. The commander recalled that at 10,000 feet aircraft altitude the cabin altitude indicated zero feet.

The aircraft diverted to Athens Airport. After landing and parking on stand, the doors could not be opened until the outflow valve had been re-opened and the external and internal cabin pressures had equalised. The commander reported that it took some considerable time for this to be achieved. A number of the passengers complained of discomfort in their ears both during and after the event.

Recorded flight information

The flight data recorder (FDR) did not record cabin altitude but there was a discrete parameter, recorded once a second, that indicated when the cabin altitude exceeded 10,000 feet. This discrete (*CABIN ALTITUDE > 10,000 feet*) and other salient parameters recorded on the FDR are illustrated in Figure 1. The figure shows that the cabin altitude exceeded 10,000 feet for a period of 108 seconds, starting as the aircraft climbed through 38,700 feet and ending as the aircraft descended through 33,700 feet.

Technical investigation

Post-flight maintenance activity

During an investigation carried out after the incident by the operator, a post-flight maintenance inspection of the aircraft revealed that a cabin positive pressure relief valve (CPRV) had opened. A number of components of the pressurisation system were removed from the aircraft and tested. Several of them were found to operate marginally outside the required tolerances. The operator's investigation concluded that the reduction of cabin pressure was probably caused by the premature opening of a CPRV leading to a state in which the loss of cabin air exceeded the rate of inflow. This condition would have generated the CABIN AUTO INOP EICAS message, provided the outflow valve was closed at the time.

Examination and testing of components

Of the two CPRVs and the two Cabin Pressure Controllers (CPCs) which were removed from the aircraft and sent for investigation and testing, one of the CPRVs was found to have operating pressures 0.25 to 0.45 psi lower than specified. This could have caused it to operate at a lower pressure differential than intended. The cabin pressure sensor of the active CPC was found

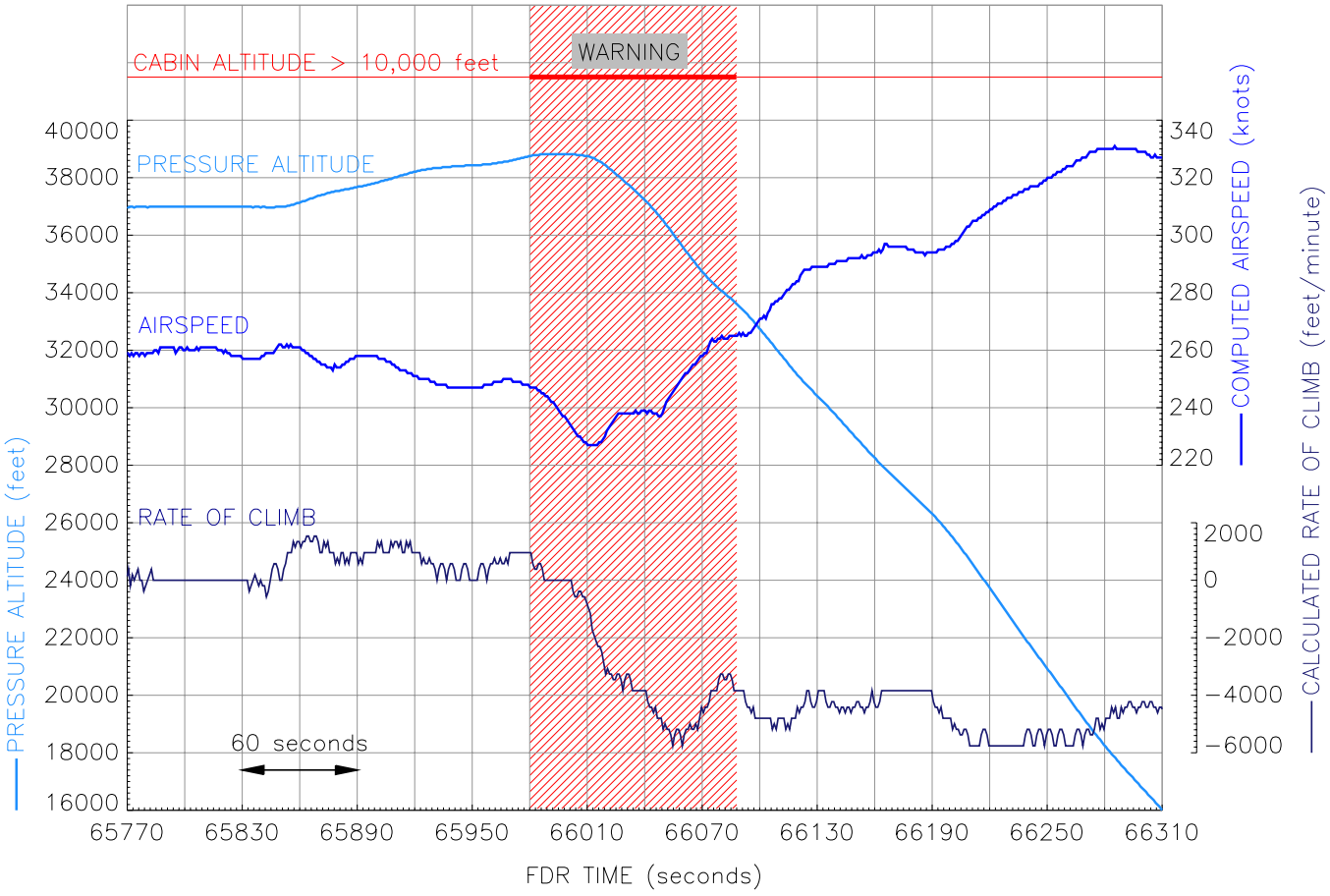

Figure 1

Salient FDR parameters

to be approximately 0.1 in Hg out of tolerance which may have raised the cabin pressure slightly higher than the 8.6 psi differential scheduled.

The manufacturer of the CPCs considered that the faults found with one CPC and a CPRV should not, individually, have caused a problem with maintaining the cabin pressure. However, it was possible that the combination of the faults caused the positive pressure relief valve to open too early which resulted in a rush of air from the cabin and caused the cabin altitude to increase.

A number of components were replaced on the aircraft and it was returned to service. No further problems with the pressurisation system have been recorded to date.

Aircraft information

A CABIN ALT discrete light and associated EICAS message are displayed when the cabin altitude exceeds 10,000 feet. There is a non-normal checklist in the Quick Reference Handbook (QRH) entitled '*CABIN ALTITUDE OR RAPID DEPRESSURISATION'*, the actions in which are all memory items.

The aircraft pressurisation system has both automatic (AUTO 1 and AUTO 2) and manual (MAN) operating modes. The EICAS caution message CABIN AUTO INOP displays when automatic control fails or when MAN mode is selected. When MAN is selected, all the automatic pressure control functions are locked out. The cabin pressure is then controlled in flight by

repositioning the outflow valve manually and the cabin must be depressurised, before landing, by opening the outflow valve. There is a QRH checklist with reference items for the EICAS caution message CABIN AUTO INOP; this gives guidance about the management of the cabin pressure when using the manual mode.

The following information is included in the manufacturer's QRH:

> *'Consequential EICAS alert messages can show as a result of a primary failure condition ..... The flight crew should do the checklists for consequential EICAS alert messages, unless the statement "Do not accomplish the following checklists:" is included.'*

Discussion

When the crew detected a loss of cabin pressure which they could not control, they carried out the QRH memory items, including the selection of manual mode, and initiated a rapid descent. The evidence suggests that the CPRV closed again as the aircraft descended and thus, with the outflow valve closed, the cabin re-pressurised. If the outflow valve is closed manually in flight and is not re-opened before landing, the fuselage will remain pressurised after landing, and consequently it will not be possible to open the external doors until the pressure has equalised. This seems to have been what happened in this incident.

The instructions in the manufacturer's QRH require the relevant checklists for all applicable EICAS alerts displayed to be carried out, unless there is a specific instruction not to do so. Had the *CABIN AUTO INOP* checklist been carried out, the cabin would have been depressurised before landing and the doors could have been opened.

Flight crews practise the management of pressurisation failures during recurrent simulator training. However, most often the scenario given is for a total or very rapid loss of cabin pressure, after which the cabin pressurisation remains unavailable for the rest of the flight. In this incident the circumstances were likely to be unfamiliar to the crew, in that the ability to control the cabin pressure was probably only lost for a short time; thereafter, the cabin could have been controlled manually.