Smoke emergency, Boeing 747-436, G-BNLC

Micro-summary: **A smoke emergency prompts the diversion of this Boeing 747.**

Event Date: **2003-04-20 at 1200 UTC**

Investigative Body: **Aircraft Accident Investigation Board (AAIB), United Kingdom**

Investigative Body's Web Site: **http://www.aaib.dft.gov/uk/**

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Boeing 747-436, G-BNLC

AAIB Bulletin No: 9/2003	Ref: EW/G2003/04/27	Category: 1.1
INCIDENT		
Aircraft Type and Registration:	Boeing 747-436, G-BNLC	
No & Type of Engines:	4 Rolls-Royce RB211-524G2-19 turbofan engines	
Year of Manufacture:	1989	
Date & Time (UTC):	20 April 2003 at 1200 hrs	
Location:	Airborne, Riga FIR, Latvia	
Type of Flight:	Public Transport (Passenger)	
Persons on Board:	Crew - 18	Passengers - 307
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Overheating damage to cockpit door lock solenoid assembly	
Commander's Licence:	Airline Transport Pilot's Licence	
Commander's Age:	47 years	
Commander's Flying Experience:	12,000 hours (of which 9,000 were on type)	
	Last 90 days - 200 hours	
	Last 28 days - 60 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot and subsequent enquires by the AAIB	

Synopsis

During cruise the crew became aware of fumes and smoke in the cockpit. The crew went onto oxygen, declared a MAYDAY and diverted to Riga, Latvia. Subsequent investigation revealed that the smoke and fumes were as a result of an overheated cockpit door lock solenoid, which had failed due to spring clip being incorrectly installed during the manufacture of the unit.

History of Flight

G-BNLC had departed Calcutta and was in the cruise at FL360 in the Riga FIR. A crewmember, who had previously left the cockpit during the flight, requested access back to the cockpit so that he could begin his rest period. When he requested entry, this was initially denied by the flight crew. However, once they verified that he was a crewmember they electrically unlocked the cockpit door. The crewmember initially had difficulty opening the door but, after a few attempts, it was given a 'bang' after which it opened. Once the door was closed again it was found that it would not electrically lock and it was at this point the crew also noticed that the LOCK FAIL light on the centre pedestal was

illuminated. The crew consulted the minimum equipment list (MEL), as there were no other published procedures for dealing with a continuous LOCK FAIL indication. The technical manual carried on the aircraft, however, did give a description of what the LOCK FAIL light indicates and, in addition, a flight crew notice (FCN), issued in 2002, detailed procedures for dealing with door unserviceablities. Therefore, the crew manually locked the door as this was the required action given in both the MEL and the FCN. About 15 to 20 minutes later, the handling first officer (FO1) reported that he could smell fumes in the cockpit that were similar, in his opinion, to an electrical burning smell. The commander agreed that he could also smell the fumes, but thought that the source was from the galley. He consulted and confirmed with the upper deck purser that the upper galley ovens had just been switched on and so he thought that the smell would soon dissipate.

However, the smell continued. The commander then consulted the Cabin Service Director (CSD) as to whether there were any unusual smells in the cabin. The CSD stated that there was an unusual smell at seat 5K in the first class cabin, and that the power to the seat had been isolated. As a further precaution the commander requested that the in flight entertainment system be switched off. In addition, the commander selected off the air conditioning re-circulation fans. Following this, the upper deck purser and the CSD both reported to the flight deck but as they did so they stated that the smell was stronger on the flight deck than in the cabin.

At this point the commander considered that should the source of the smell not be isolated a diversion might be necessary. He had identified Riga Airport as a suitable airfield which he could see out of his right hand window.

The FO1 donned his oxygen mask whilst the commander left his seat to both check if the source of this smell was on the flight deck and to awaken the resting FO2. As FO2 left the rest area, he immediately became aware of the fumes. The commander returned to his seat, FO1 and FO2 swapped positions with FO2 taking over as the handling pilot. The flight crew donned their oxygen masks and were briefed by the commander on the intention to divert. A MAYDAY was declared and air traffic control (ATC) was told that the aircraft would divert to Riga.

The crew completed the initial Quick Reference Handbook (QRH) actions for an indication of SMOKE/FUMES and, at this time, the commander found communication between the crew, the cabin staff and ATC was difficult. The passengers were briefed on the problem and were informed that they were diverting. The commander then carried out a radar vectored approach to Riga but, due to misting in his oxygen mask visor, he removed his mask for better visibility during the final approach. The other crewmembers were asked to monitor his performance during the approach and landing.

The landing was without incident and the aircraft was parked away from the terminal building with the emergency services in attendance. The passengers disembarked normally via steps provided by airport personnel.

Once the aircraft had been fully shut down, the flight crew became aware that the flight deck door surround was hot and that there was a strong smell emanating from the cockpit door lock striker assembly in the doorframe.

Subsequent medical examination of FO2 revealed that he had raised levels of carbon monoxide in his blood.

Aircraft Examination

At Riga, examination of the aircraft revealed that the cockpit door lock mechanism had overheated with smoke issuing from the cut out for the door striker. The source of the overheating was from the cockpit door lock solenoid and this was subsequently electrically isolated before the aircraft was ferried back to the UK.

Cockpit Door Lock Description

The cockpit door lock on G-BNLC was a recent modification in February 2003, as a result of increased cockpit access security required by the FAA following the terrorist incidents in

September 2001. This was a 'phase 2' system having replaced the initial intermediate installation; 'phase 1'.

The 'phase 2' door lock system consists of a catch attached to the mid-position of the cockpit door. When the door is closed, a spring-loaded striker assembly in the doorframe retains the catch in place, holding the door closed. The door is locked in place electrically by a solenoid, which forms part of the strike assembly. The solenoid consists of a shaft that moves upward when an electrical current is applied. The solenoid shaft is attached, via a hexagonal nut (to allow for adjustment) to a locking pin. When the solenoid shaft moves upward, the locking pin is forced up behind the striker which holds it in place, thus locking the door. When the solenoid shaft has moved upward to its full extent, a micro switch within the solenoid operates and, to prevent overheating, reduces the electrical current to a level low enough to just hold the solenoid and the door in the locked position. At manufacture, the hexagonal nut is used to adjust the locking pin and is retained by the use of a spring clip. The door lock solenoid and the cockpit door system are protected by a 2.5 A circuit breaker.

The door lock system is controlled from a door switch module located on the centre pedestal. Should the door lock system fail, such as a failure of the door lock solenoid to fully lock when required, an amber LOCK FAIL light will illuminate on this module. Although the light is an amber caution warning, this is not linked to the aircraft's master warning system and therefore neither gives an annunciation on the glare shield nor a caution message on the central display of the EICAS.

It is possible for the crew to unlock the door, in the event of a failure of the electrical locking system, as a manual override of the door latch is fitted, which is only operable from the inside of the cockpit.

Detailed Aircraft Examination

The cockpit door lock striker assembly was removed from the doorframe and this revealed that the overheating was limited to the solenoid. No other damage to the surrounding area had occurred. Further investigation revealed that the spring clip, which retains the hexagonal nut, had rotated in such a way as to prevent the solenoid from fully retracting when electrical power was removed to unlock the door. Thus, with the solenoid shaft semi-retracted, the lock pin was not fully retracted from the spring-loaded striker. With the lock pin in this position the spring-loaded strike had become jammed on the top of the lock pin and this was confirmed by associated witness marks. This probably occurred when the door was electrically unlocked to allow the crewmember access to the cockpit and is consistent with the difficulty he had in opening the door. When the door was 'banged' the striker was forced over the top of the lock pin, jamming it in position.

With the spring-loaded striker jammed on the lock pin, the solenoid would not have been able to extend upwards when the door was subsequently electrically locked. This would explain the problems the crew had with locking the door after the crewmember had gained entry. Also, this would explain the illumination of the LOCK FAIL light, as the internal lock solenoid micro-switch, which signals both a locked door and a reduction in the electrical current to the solenoid, had remained open. This meant that full electrical current would have been flowing continuously. As the solenoid is not rated for this condition, it will overheat with the resulting smoke and fumes experienced by the crew.

Safety action

The aircraft manufacturer later confirmed that the hexagonal nut spring clip had been able to rotate due to improper installation during the original manufacture of the unit. Due to this finding, the door striker assembly manufacturer issued a Service Bulletin (SB) to inspect the door lock assemblies for correct installation. In addition, the aircraft manufacturer has informed all operators of the incident and the availability of the SB. The operator has already undertaken an inspection of the all their aircraft fitted with this system.

There were no procedures in place for the crew to cover the instance of a continuous LOCK FAIL illumination, except for the information contained in the MEL and FCN, and therefore there were no specific instructions to the crew to electrically isolate the system. The operator has since changed

their flight crew procedures such that crews are instructed to electrically isolate the system if the LOCK FAIL light remains illuminated, especially if a door lock solenoid overheat failure is suspected. Secondary security procedures are then invoked. The aircraft manufacturer is also amending their documentation to clarify the actions to be taken when a LOCK FAIL light illuminates.