Boeing 757-236, G-BIKW

AAIB Bulletin No: 9/2001 **Ref: EW/G2001/03/09** **Category: 1.1**

Aircraft Type and Registration:	Boeing 757-236, G-BIKW
No & Type of Engines:	2 Rolls-Royce RB211-535C-37 turbofan engines
Year of Manufacture:	1986
Date & Time (UTC):	14 March 2001 at 1750 hrs
Location:	Edinburgh Airport
Type of Flight:	Public Transport
Persons on Board:	Crew - 8 - Passengers - 93
Injuries:	Crew - None - Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilots Licence
Commander's Age:	53 years
Commander's Flying Experience:	14,000 hours (of which 2,100 were on type)
	Last 90 days - 90 hours
	Last 28 days - 35 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and correspondence with the operator's engineering department

History of the flight

The aircraft was on a scheduled passenger flight from London (Heathrow) Airport to Edinburgh. On the approach to Edinburgh all indications were normal. When the landing gear was selected

down, the three green landing gear 'down and locked' lights illuminated. During the approach, a go-around was initiated from 500 feet agl due to an aircraft back-tracking the runway for take off. The flaps were selected from 30° to 20° and the landing gear was selected up, at which point the left hydraulic system fluid quantity indication rapidly fell to zero. This was shortly followed by a left hydraulic system low pressure warning and flap and landing gear position disagree warnings. When the landing gear lever was reselected down, the green lights for the Nose Landing Gear (NLG) and left Main Landing Gear (MLG) illuminated, but the light for the right MLG remained off. The landing gear selector lever was cycled several times but the right MLG green light remained extinguished.

The flight crew performed the Quick Reference Handbook (QRH) procedures for left hydraulic system failure and alternate landing gear lowering but the right MLG green light remained off. The flap and landing gear position disagree warnings (which indicate a disagreement between the selected and actual positions) subsequently extinguished. The flight crew replaced one of the two filaments in the right MLG green light with a spare filament, but the light still remained off. After obtaining ATC approval, the runway was overflown at 3,000 feet and ATC reported that the right MLG appeared to be fully down. A flaps 20° approach was flown and the aircraft landed without further incident. As the nose wheel steering was inoperative due to the loss of the left hydraulic system, the flight crew stopped the aircraft on the runway and shut down the engines. The aircraft was towed from the runway after the passengers had been disembarked. The engineer attending the aircraft on the runway was able to insert the landing gear locking pins with no difficulty, confirming that the landing gears were locked down.

Landing gear system operation and indication

On the Boeing 757, hydraulic power for the operation of the landing gear and landing gear doors is supplied by the left hydraulic system. If the left hydraulic system fails, the landing gear cannot be raised and the landing gear doors cannot be closed, as there is no alternate source of hydraulic power. The landing gear may be lowered using the alternate landing gear lowering system. The "ALTERNATE GEAR" push button selector operates hydraulic actuators which release the uplocks for the landing gears and the landing gear doors. The landing gear hydraulic circuit is simultaneously depressurised, allowing the landing gear and gear doors to free-fall to the down position.

Proximity sensors on the landing gear locking links sense when the landing gear is down and locked. Sensors on the landing gear doors sense when the doors are open. These signals are sent to the Proximity Switch Electronic Unit (PSEU) which conditions the signals and transmits them to various aircraft systems. The PSEU output signals drive the operation of the green gear 'down and locked' lights in the flight deck and the amber 'gear doors open' lights and provide the discrete signals for the landing gear and landing gear door position status which are recorded on the Flight Data Recorder (FDR).

There are three landing gear 'down and locked' indicator lights on the instrument panel, one for each landing gear. Each has a dual filament, with each filament being supplied from an independent power source.

Flight Data Recorder information

A copy of the relevant FDR data was supplied by the operator. The data indicated that all of the landing gears were in the 'down and locked' position and that the landing gear doors were open

prior to landing. It was determined that the left hydraulic system low pressure warning had occurred 30 seconds after selecting the landing gear up for the go-around.

Engineering investigation

The source of the hydraulic leak was found to be the NLG gear-operated sequence valve which had cracked through the valve body across the 'UP' port due to fatigue. As the 'UP' port is pressurised only when the landing gear is selected up, it is likely that the valve failed coincident with the landing gear up selection on the go-around. The valve had accumulated 25,985 hours and 28,234 cycles in service and had not been previously overhauled. Boeing Service Bulletin 757-32-0046 was issued in 1988 to introduce a redesigned valve with a thicker valve body casting because of previous problems of fatigue failures of the valve body. This became the production standard for all new valves. The operator had not taken up the modification because they had not experienced any significant problems with the valve.
Station engineers at Edinburgh found the light cap of the right MLG green indicator light assembly protruding from from its normal position in the panel with neither filament illuminated. When the light cap was pressed back into its holder, the right filament lit up. On closer inspection it could be seen that the light cap had separated from the main body of the indicator assembly due to failure of the hinge lugs which attach the light cap to the main body of the indicator. The light cap and filaments were replaced, but on testing only the right filament illuminated. The complete indicator light assembly, minus its base, was then replaced, which rectified the defect. The replaced parts were discarded and so were not available for further examination. The indicator light assembly base was sent to the switch manufacturer for examination. The power contact pin for the left filament was found to be pressed back and loose due to the contact spring being stuck in the compressed position. Evidence was found of arcing on the spring back plate contact. It was evident that the left filament had shorted out to the case, causing the power contact spring to absorb a large amount of current and weld the spring in its compressed condition. However this did not explain why both filaments had failed.

In the previous 5-year period, the operator had experienced ten cases of failure of both filaments in other similar landing gear green indicator lights, which in some cases resulted in a go-around to clarify the situation. A more reliable light cap is available, which employs light-emitting diodes instead of filaments and this is directly interchangeable with the original light cap.

Discussion

The loss of the left hydraulic system was due to fatigue failure of the NLG gear-operated sequence valve body across the "UP" port, which failed when hydraulic pressure was applied as the landing gear lever was selected up for the go-around. This is a known failure mode and is addressed by a manufacturers Service Bulletin which introduces a valve with a thicker body casting. The reason for the failure of both of the right MLG green light filaments could not be established. The failure of the sequence valve and indicator filaments were coincidental and not related.

Regarding failure of the landing gear green down and locked indicator lights, the QRH states:- "If a full set of three green lights is not obtained after the gear has been selected down, it can be assumed that there has been a failure of the bulb(s) or their power supply, provided there are no Engine Indicating and Crew Alerting System (EICAS) messages present (allowing 40 seconds for EICAS delay) and there are no door lights showing". In this incident, the amber gear door open lights would have been illuminated and so the scenario differed from that presented in the QRH, which does not cater for multiple failure conditions. The coincidental loss of the left hydraulic system and

the unusual landing gear warning light indications would understandably have given the flight crew reason to assume that the failures were related and to also have doubts about whether the right MLG was down and locked. Once hydraulic pressure was lost, cycling of the landing gear lever would have had no effect and the landing gear would have fallen into the down and locked position under its own weight. The landing gear position disagree warning would have remained on until the landing gear selector lever was placed back to the down position.

The operator is continuing to monitor the performance of the valve across the fleet with the intention of taking appropriate action should a further failure occur. The operator also intends to replace the landing gear 'down and locked' indicator light filaments with improved LED-type light caps which are considerably more reliable.