Boeing 757-236, G-BIKW

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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):	10 February 1997 at 1248 hrs
Location:	Manchester Airport
Type of Flight:	Public Transport
Persons on Board:	Crew - 9 - Passengers - 89
Injuries:	Crew - 1 (minor) - Passengers - 1 (minor)
Nature of Damage:	None
Commander's Licence:	Airlines Transport Pilot's Licence
Commander's Age:	46 years
Commander's Flying Experience:	12,700 hours (of which 4500 were on type)
	Last 90 days - 150 hours
	Last 28 days - 41 hours
Information Source:	AAIB Field Investigation and Operators' Air Safety Reporting System

The aircraft landed on Runway 24, with a surface wind of 270/20to 30 kt following a shuttle flight from Heathrow to Manchester. The runway state was given as wet, although it was actually dryalong the centre portions and damp at the edges. Auto brake wasselected to level 2 with the Commander handling and the FirstOfficer briefed to select reverse idle only.

The landing was normal and after eight seconds, at a speed of95 kt the autobrake was cancelled by application of moderate pressureon the brake pedals to achieve a rapid exit. A few seconds latera severe vibration was felt through the airframe; the rudder pedalswere pulsating violently such that the Commander had difficultykeeping his feet on them. He felt the brakes were also pullingto the right. The aircraft came to a stop beside Rapid ExitX. The First Officer interrogated the Status page on the EngineIndication and Crew Alerting System (EICAS) which showed all brakesto be cold with no warnings.

The fire service attended but could find nothing abnormal. Followingan inspection by the airline's maintenance personnel they notedthat none of the main tyres had flat spots but there were heavyrubber deposits on the runway for the last 10m from the RightMain Gear. The aircraft was towed to a stand where the passengersdisembarked normally. After applying the parking brake on stand,it was noticed that the brake accumulator pressure was nearlydepleted. One passenger and the First Officer complained of "whiplash"type neck injuries and they received medical attention.

Initial Investigations

Once on stand all the main wheels were jacked and checks werecarried out but no faults were found. The main wheel inner bearingon No 6 was found to be "noisy" and the wheel was replaced. A BITE check was carried out on the autobrake/antiskid controlunit; this showed a fault in the 2 to 6 channel. The controlunit was changed and following additional anti-skid and brakefunctional tests, which revealed no faults, a high speed taxiand brake trial was conducted. The aircraft was then flown toBirmingham where 3 landings were performed satisfactorily, buton return to Heathrow some minor vibration was felt through thebrake pedals. Further engineering investigation was then carriedout.

Flight Recorders

The Operators' Quick Access Recorder (QAR) was used to obtaindata for the incident; it contains the same information as theaccident FDR as well as some additional parameters. The touchdownspeed was 123 kt, the speedbrake and reverse thrust were immediatelydeployed. The initial deceleration was around -0.15G. Aftereight seconds at around 95 kt, the wheel braking discretes showthat the pilot applied manual braking; the brake pressures arenot recorded. The deceleration increased then to around -0.25G,before decreasing gradually after 16 seconds to -0.118G. Thelongitudinal deceleration then increased to -0.452G as the aircraftstopped and there was a slight change in heading recorded of around4° left and then 9° right.

The brake temperatures were all constant at around 100° exceptfor No 6 which began to increase after the aircraft had stopped. The maximum recorded value was 134° and it was still increasingwhen the recording stopped 3 minutes after touchdown.

Antiskid/Autobrake System

The antiskid/autobrake system schematic is shown in Figure 1. The antiskid system is designed to prevent wheels skids by limitinghydraulic pressure to the brakes. It senses a rapid reductionin wheel speed as a skid, and releases the brakes. The autobrakesystem provides automatic braking with the braking level beingselected by the pilot. The system controls both normal and alternatebrake systems through antiskid valves. Eight normal valves controlthe individual wheels, four alternate valves control the lateral-pairwheels.

The autobrake system maintains a constant pilot-selected decelerationlevel during the landing roll, there is no interference with thenormal antiskid system operation. There are five levels of autobrakingwhich can be selected, 1 to 4 and maximum. In this case autobrakelevel 2 was selected. The autobrake can be deactivated eitherby selecting the switch to OFF or, as in this case, by manualbrake application.

Normal braking is provided by the right hydraulic power system,alternate braking is provided by the left hydraulic power systemwhich takes over if right hydraulic pressure is less than 1,500psi.

With both hydraulic systems powered, left hydraulic pressurecannot reach the brake system. The alternate brake selector valveprevents the left system fluid from reaching the brake systemwhen the right system is powered.

Subsequent Engineering Investigation

The investigation focused on the antiskid system. Both the leftand right normal anti-skid modules were changed, following whicha system check was performed which showed that a rapid brake applicationusing the alternate (left hydraulic) brake system, with the righthydraulic system depressurised, could produce a vibration whichwas felt through the pedals. However there was no evidence thatthe aircraft had been using the alternate system during the incident.

The left normal and left alternate brake metering valves wereinterchanged and rerigged; there was still significant vibrationon the alternate system. The only way that the aircraft alternatesystem could be active was for the alternate brake selector valveto be causing reversion to the alternate system. The alternatebrake selector valve was therefore changed, as were both the leftand right alternate brake metering valves. The vibration wasstill present when the brakes were powered through the alternate(left hydraulic) system; no vibration was demonstrated with thenormal (right hydraulic) system.

During the function checks it was also noticed that the accumulatorpressure dropped when the alternate (left hydraulic) system wasengaged and the brakes exercised. The brake selector valve andthe accumulator isolation valve were changed. No. 6 brake andtransducer were changed following tests which showed that thevibration could not be reproduced when brake No 6 was disconnected.

A flight test was carried out which showed the brakes to be 'fierce'and a vibration was noted during hard braking through the leftpedal on the normal system. Following further functional testsin conjunction with the manufacturer and a bleed of the hydraulicsystem, a taxi test was carried out using the normal braking systemwhich was found to be functioning satisfactorily, the aircraftwas returned to service. No further problems have been reported. The bleed of the hydraulic system revealed large amount of airin the system, introduced during the significant number of componentchanges, which may have been the cause of the problem on thistest flight.

Although the cause of the incident could not be established thefollowing four items were identified:

Failure of the antiskid/autobrake control unit (Channels 2 and6). This unit was changed at Manchester after the incident andreturned for testing. No fault was found which could accountfor this incident.

The alternate brake system should not operate until the normalsystem pressure is below 1,500 psi. The alternate brakeselector valve was changed.

Vibration of the brake metering valves was attributed to cumulativewear of all the components in the system and the slight out-of-rigof the normal/alternate interconnect system. System componentswere changed and rigging performed. This was a hidden defectas the alternate system does not normally function.

The left hydraulic system pressure should not drop when the lefthydraulic system is used for braking. The accumulator isolationvalve (AIV) was changed. The manufacturers' investigation

concludedthat these characteristics were the result of saturation of theleft system electric pump during hard and rapid brake pedal application. The resulting pressure droop allows the AIV to shuttle momentarilyand a small amount of accumulator fluid to escape into the normalbrake system. These characteristics are not experienced duringnormal aircraft operation when the engine driven hydraulic pumpsare used.