Boeing 767-304, G-OBYB

AAIB Bulletin No: 11/2003	Ref: EW/C2002/10/04	Category: 1.1
INCIDENT		
Aircraft Type and Registration:	Boeing 767-304, G-OBYB	
No & Type of Engines:	2 General Electric CF6-80C2B7F turbofan engines	
Year of Manufacture:	1996	
Date & Time (UTC):	29 October 2002 at 1715 hrs	
Location:	Birmingham International Airport, Birmingham	
Type of Flight:	Public Transport (Positioning)	
Persons on Board:	Crew - 9	Passengers - Nil
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	None	
Commander's Licence:	Airline Transport Pilot's Licence	
Commander's Age:	Not Relevant	
Commander's Flying Experience:	Not known	
Information Source:	Analysis of Flight recorder information plus further enquiries	

Summary

The aircraft landed on Runway 15 at Birmingham after a short positioning flight from Manchester with nine crew on board. After a normal touch down and initial deceleration the aircraft had reached 65 kt, using less than half of the runway distance available. It then continued at approximately 60 kt towards the turnoff, which was at the extreme end of runway. Just before the threshold of the reciprocal runway, with some 300 metres of paved surface remaining, the aircraft started gentle braking. When the speed had reduced to 40 kt, with 100 metres remaining, a left turn was commenced using rudder followed by differential braking. However the aircraft failed to complete the turn onto the taxiway and the nosewheels ran off of the paved surface by some 15 metres, but the main gears remained on the runway. There was some evidence of a reduction in runway surface friction coefficient over a small area as the turn was commenced. Runway surface friction testing after the incident indicated that the friction coefficient in that area did not fall below the value that would have required the promulgation of a NOTAM as 'liable to be slippery when wet'. The probable cause of this incident was the high speed at the start of the turn.

History of Flight

The aircraft was undertaking a positioning flight from Manchester to Birmingham International Airport. It took off from Manchester at 1657 hrs and during the short flight the aircraft climbed to

11,000 feet. After obtaining descent clearance it was given a direct approach R/W 15 at Birmingham. The crew's workload was high and some concern was expressed as to whether they could successfully complete the cleared approach. However by 2,000 feet above runway level the aircraft was close to both the localiser and glideslope. From there on the aircraft was maintained very close to the localiser and glideslope, in what appeared to be a stabilised approach. The final approach from about 900 feet above R/W level was flown at a speed of between 126 and 129 kt, and autobrake 3 had been armed.

At 1712 hrs the aircraft touched down firmly at a speed of 128 kt, and well within the normal touchdown zone. Spoilers were deployed and idle reverse was selected with autobrake 3 becoming active. Deceleration appeared normal and groundspeed had reduced to 65 kt by some 1,000 metres after touchdown, which was about 1,200 metres before the end of the paved surface. At this point reverse was cancelled, spoilers retracted and the brakes released. The aircraft continued along the runway with reasonably constant groundspeed of between 60 and 65 kt. The exit taxiway was on the left-hand side, at 90 degrees to the runway, right at the end of the paved surface. Just before the threshold markings for the reciprocal Runway 33, brake pressure was applied symmetrically to both main wheels. When the speed had reduced to about 40 kt the aircraft commenced a turn to the left, rudder and differential braking being used during the turn. However, the aircraft failed to complete the required turn and the nosewheels ran off the paved surface at a speed of about 12 kt. The aircraft travelled a further 15 metres before coming to rest, the main wheels remaining on the paved surface. The engines were shut down and the crew disembarked using stairs. Eventually the aircraft was towed out and, after the necessary inspections, was put back into service.

Weather

The ATIS Information Hotel obtained by the aircraft prior to the approach, gave the following. Runway in use 15, surface wind calm, visibility 4,000 metres with mist and slight drizzle, overcast at 900 feet, temperature +9, dew point +9, QNH 1009, runway "WET, WET, WET", with an advisory that there was bird activity on the airfield.

Flight Recorders

The aircraft was equipped with a solid state Digital Flight Data Recorder (DFDR) and a 2-hour duration Cockpit Voice Recorder (CVR). Both were manufactured by Allied Signal.

Because the APU had been kept running for some time after the aircraft came to rest the CVR continued to run, but as it was of two hours duration it had retained a record of all of the flight into Birmingham. The recording quality was generally good, however there was a shortcoming in the installation, in that the balance between the recording levels of the Air Traffic Control reception and the crew microphones was not ideal. On the CVR channels dedicated to crew speech, the incoming communications on occasion swamped the crew speech to such an extent that it was unintelligible at certain points during the flight, including the landing roll. This did not hamper this investigation as crew speech was intelligible on the area microphone recording. It is however a problem that has been noted before in a number of aircraft types, and for this reason is likely to be the subject of a future AAIB recommendation.

The DFDR yielded good quality information and the aircraft's position along the landing runway was derived from the recorded data. A plot of relevant parameters for the entire landing are shown against runway distance at Figure 1 and an expanded view for the last phase of the landing roll at Figure 2.

Figure 1

SELECTED DFDR PARAMETERS-FINAL APPROACH AND LANDING Figure 1

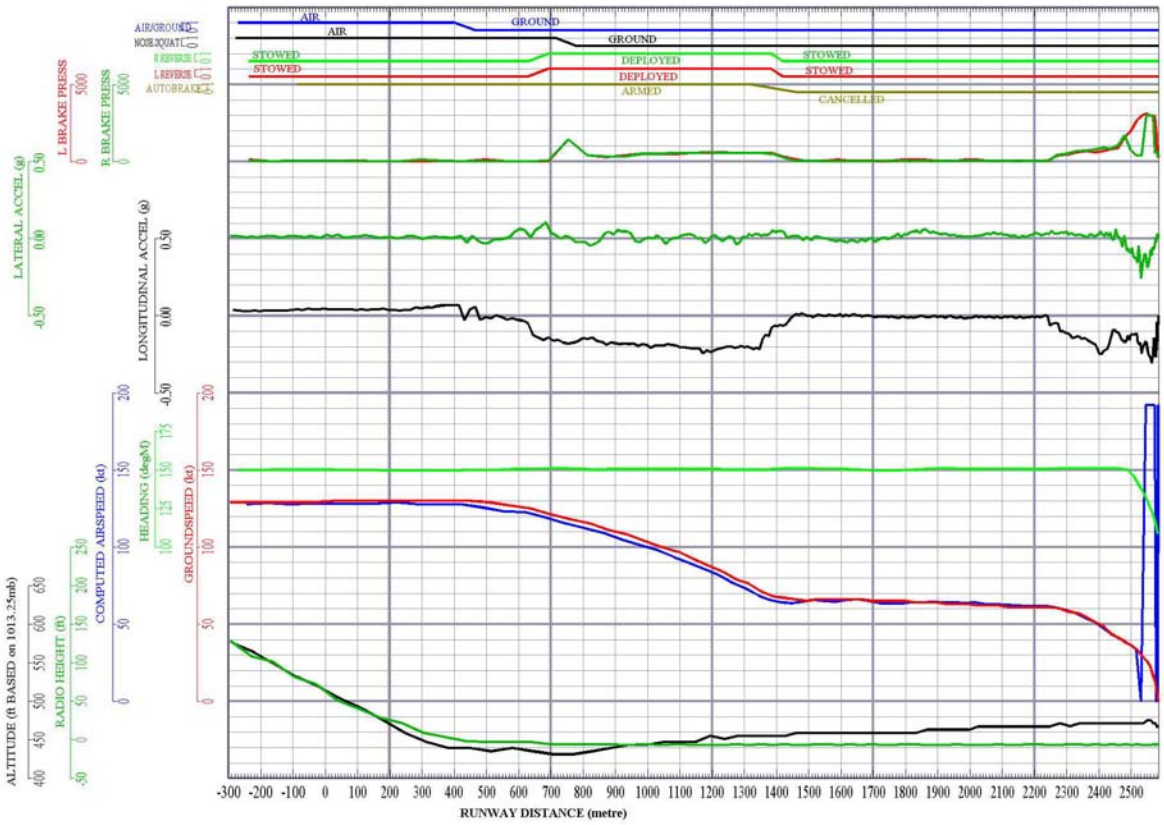


Figure 2

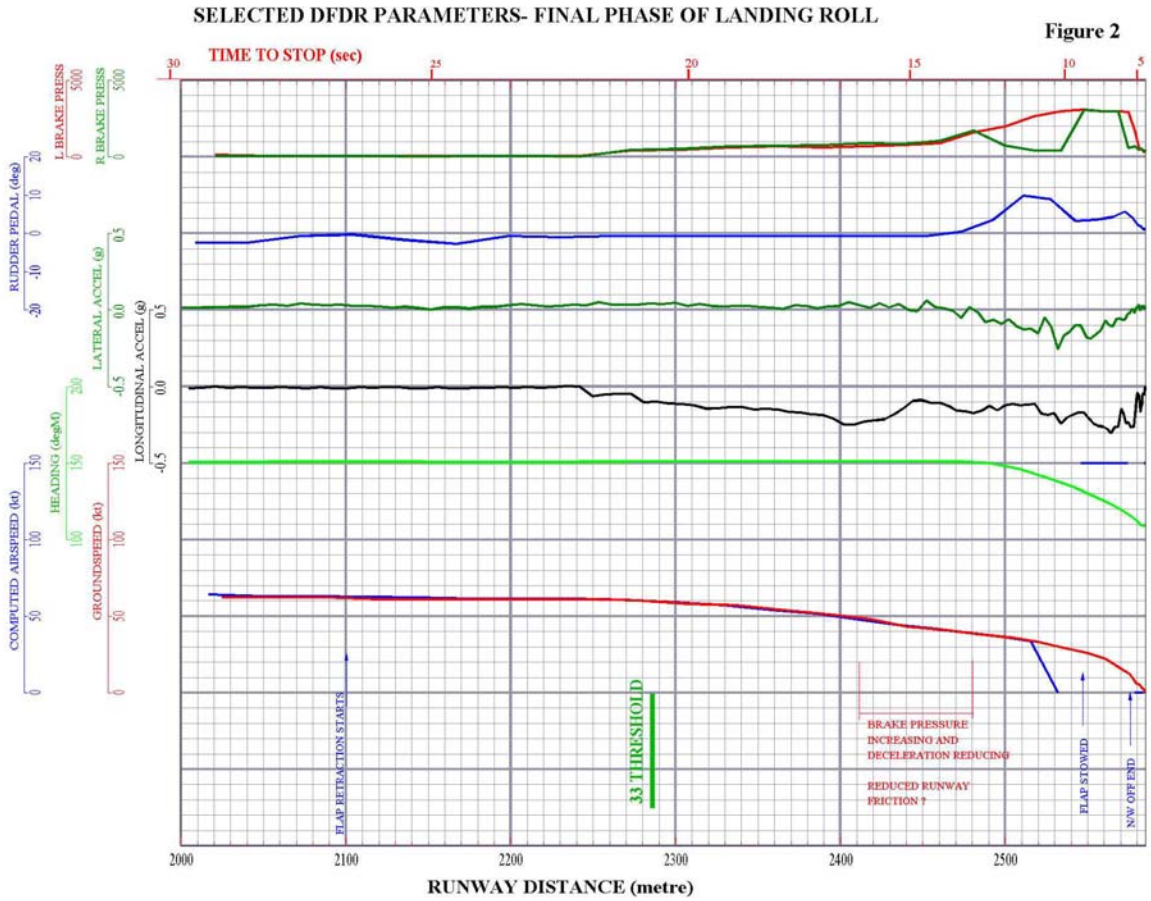


Figure 2

Significant Recorded Information

The approach and landing were normal with the aircraft touching down on the centreline and well within the normal zone. When the aircraft had slowed to 65 kt, thrust reverse and autobrake were cancelled and the brakes released. At this stage the aircraft was some 1,200 metres from the Runway 33 threshold end of the paved surface. The aircraft was then allowed to 'coast' with the speed slowly reducing to 61 kt until some 30 metres before Runway 33 threshold markers, where the brakes were gradually applied. Brake pressure was slowly increased with a corresponding increase in retardation. Some 120 metres beyond the 33 threshold (175 metres from the end of the paved surface) brake pressures were approximately symmetrical (660 psi left and 880 psi right), and the retardation was about -0.25 g. Over the following 50 metres mean brake pressure increased slightly (770 psi left and 825 psi right), but the retardation dropped to only -0.1 g. At this point the brake pressure increased more rapidly and over a further 20 metres of travel had reached about 1600 psi per side, but retardation only increased to -0.16 g. At this point the speed was about 40 kt and a turn to the left was commenced, using rudder and differential braking. It is not known if nosewheel steering was used as the steering tiller position was not a recorded parameter. At this point the aircraft was some 110 metres from the end of the paved surface. Left brake pressure then increased to maximum (3000 psi) and the right decreased to 400 psi as the turn continued. When the aircraft was 50 metres from the runway end, right brake pressure was increased rapidly also to maximum and the retardation then rose to a peak of -0.3 g with the aircraft continuing to turn left at a similar rate. The symmetric full brake pressure was held for two to three seconds before the nosewheel ran off the end of the paved surface, at about 12 kt, where brake pressure was relaxed, and after a further 6 seconds (10 to 15 metres of travel) the aircraft came to rest. On the CVR towards the end of the ground roll there were sounds possibly consistent with the nosewheel slipping on the surface, but these were after it had run off the paved surface.

In the above, all runway distances quoted are referenced to the approximate centre of gravity of the aircraft.

Runway Surface

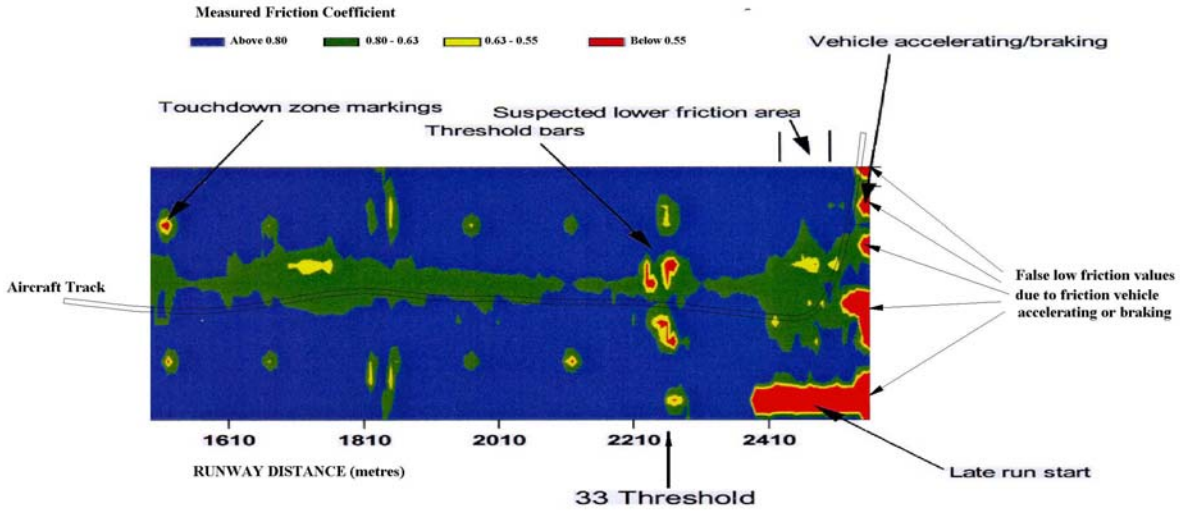
Shortly after the incident Birmingham Airport Authority measured the runway friction using their own measuring equipment which was of a type known as a 'Grip Tester'. The results indicated that the average surface friction coefficient was greater than 0.8 in the area between the 33 threshold and the end of the runway. Later they commissioned Cranfield Aerospace Limited to carry out a runway friction classification on Runway 15/33 according to the procedures set out in CAA CAP 683 *Procedures for Runway Friction Classification and Monitoring*. This was carried out on 16 January 2003. Under these tests a series of Grip Tester runs were made at 3 metre spacing over the central 40 metre width of the runway, these produced a series of continuous readings of friction coefficient. CAP 683 classifies the friction in terms of this coefficient. A coefficient of 0.8 is the design objective for a new runway. If the coefficient is below the maintenance planning level of 0.63 and down to 0.55 it should trigger an evaluation of the need to undertake a runway maintenance programme. 0.55 is the minimum friction level below which, when occurring on a portion of the runway, would normally require the runway to be promulgated by NOTAM as '*liable to be slippery when wet'*, unless agreed otherwise by the CAA. (ICAO Annex 14 also recommends that corrective maintenance action should be taken without delay.)

One of the conclusions of the Cranfield classification was that the average friction level for the runway was 0.85, which is above the CAA design objective level. However it did note that in a number of areas over the painted markings the friction level fell below the minimum, and recommended that recoating with friction paint should be considered. As a result Birmingham Airport Limited evaluated a new paint formulation which provided a friction level above the maintenance planning level, and have renovated the threshold painted surfaces.

Examining in detail the results for the 33 threshold end of the runway indicated that there were a few areas beyond the threshold markings that were within the maintenance planning band (0.55 to 0.63), and one very small area where it fell to below the minimum friction level. Cranfield produced a friction contour map for the runway and the portion at the 33 end is reproduced at Figure 3 together with the derived aircraft track.

Figure 3

FRICTION LEVEL CONTOUR MAP **Figure 3**



Analysis

The approach and landing were perfectly normal, as was the first part of the ground roll down to the aircraft reaching 65 kt. The aircraft had reached this point with some 1,200 metres of paved surface remaining. The aircraft was then allowed to proceed at a reasonably constant speed towards the 33 threshold end of the runway. As it approached the Runway 06/24 intersection the commander commented on the option of vacating there, but then carried on towards the turnoff that was on the left at the extreme end of the runway. From the CVR information there appeared to have been no pressure to vacate the runway quickly, a following aircraft was told by ATC that there were no speed restrictions as they were 6 miles behind the 767. Braking was re-applied gently as the aircraft approached the Runway 33 threshold markings and the speed started to slow. As the aircraft approached 45 kt with brake pressure increasing slightly, retardation decreased as recorded longitudinal acceleration values changed from -0.25 g to -0.1 g. A subsequent increase in brake pressure yielded a minor increase in retardation. Just after this change in longitudinal acceleration, a left turn was initiated initially with rudder movement. At this point the aircraft's groundspeed was 41 kt. Boeing's 767 Flight Crew Training Manual states *'When approaching a turn, speed should be slowed to an appropriate speed for the conditions. On a dry surface, use approximately 10 kt.'* In this case the runway was wet and drizzle was falling. Due to the short time period between the reduction in retardation and initiation of the turn, even if braking action had been sufficient to maintain the retardation at -0.25 g, the speed at the initiation of the turn would have reduced only slightly and would still have been greatly in excess of the Flight Crew Training Manual figure of 10 kt.

The significance of the retardation reducing despite increasing symmetric brake pressure just before and subsequent to the turn being initiated indicates that the achieved runway surface coefficient of friction was reduced in this area. Once differential braking began to be used no conclusions could be drawn as to the runway surface friction. As there was no fault found in the aircraft's braking system and it has operated satisfactorily since the incident, it would appear therefore that there may have been an area of reduced friction between 100 and 180 metres from the 33 threshold end of the paved surface. Figure 3 indicates that there was some reduction in the coefficient in this area of the runway with one or two patches being reduced to the maintenance planning level. However these levels would not normally be expected to result in the reductions in retardation seen in this case. The calibration was done using a water film depth of 0.25 mm. At the time of the incident there were no reports that there was visible standing water but drizzle was falling. This may have affected the

achieved runway friction coefficient. From the CVR, the only indications of nosewheel slippage occurred after the nosewheels had left the paved surface. However, photographs of the end of the paved surface taken after the event indicated some surface cleaning by the nosewheels as they departed the runway. This would have been caused by the nosewheels slipping and the generated heat steam-cleaning the surface. It is probably an indication that nosewheel steering was being used, at least during the final stages of the attempted turn. As the derived track from the recorder information tied up closely with the known physical positions of the aircraft, there is little evidence of the aircraft sliding bodily sideways.

Conclusion

It appears likely that this event was caused by a high speed at the initiation of the turn.