Shorts 3-60 Variant 100, EI-BPD

AAIB Bulletin No: 10/2001 **Ref: EW/ C2001/2/1** **Category: 1.1**

Aircraft Type and Registration:	Shorts 3-60 Variant 100, EI-BPD	
No & Type of Engines:	2 Pratt & Whitney PT6A-65AR turboprop engines	
Year of Manufacture:	1984	
Date & Time (UTC):	4 February 2001 at 1921 hrs	
Location:	Sheffield City Airport, Yorkshire	
Type of Flight:	Public Transport	
Persons on Board:	Crew - 3	Passengers - 25
Injuries:	Crew - Nil	Passengers - Nil
Nature of Damage:	Left main landing gear destroyed and sponson severely damaged.	
Commander's Licence:	Airline Transport Pilots Licence	
Commander's Age:	36 years	
Commander's Flying Experience:	4,484 hours (of which 1,392 hours were on type)	
	Last 90 days - 136 hours	
	Last 28 days - 45 hours	
Information Source:	AAIB Field Investigation	

History of the flight

The crew were planned to fly a scheduled passenger flight from Dublin to Sheffield airport and the commander was the handling pilot for the flight. Both pilots had operated into Sheffield between five and ten times in the previous three months. The aircraft, which was serviceable, took off from Dublin at 1814 hrs and was routed to Sheffield via the VOR/DME navigation beacon at Wallasey at FL90. Prior to descent, the crew obtained the most recent information from the Automatic Terminal Information Service (ATIS); this report, timed at 1820 hrs, was identified as 'Information Hotel'. The reported conditions at Sheffield were: surface wind variable at 03 kt, visibility 4,000 metres in rain and snow, a few clouds at 600 feet, scattered cloud at 1,200 feet and broken cloud at 3,000

feet, the temperature and dew point were coincident at +1°C and the QNH was 989 hPa. Air traffic control was passed to the Sheffield approach controller when the aircraft was 12 nm from the overhead at which time it was descending to 5,000 feet on the QNH. The crew were informed that the current ATIS was now 'Information India' and the aircraft was cleared to descend to 3,000 feet when within 10 nm of the airport. 'Information India', timed at 1850 hrs, contained no significant changes from 'Information Hotel'.

The aircraft weight for the landing was calculated to be 11,100 kg with an associated threshold speed of 103 kt. The aircraft was cleared for the ILS/DME procedure for Runway 28 and the crew requested the QFE which was 980 hPa. The decision height for the approach was 400 feet. During the initial stages of the manually flown ILS approach the commander's flight director warning flag appeared briefly but then disappeared and did not reappear during the remaining period of flight. The de-ice boots had been selected to 'ON' early in the descent when the aircraft had briefly encountered light icing. These de-ice boots were selected to 'OFF' when at 5 nm from the runway at which stage there were no indications of icing and the indicated outside air temperature was +5°C. (This is indicative of an actual air temperature of +2°C.)

At 1918:11 hrs the crew reported that they were established on the localiser. When the aircraft intercepted the glidepath, the flaps were set to 15° correctly configuring the aircraft for the approach. The handling pilot recalled that initially the rate of descent was slightly higher than the expected 650 ft/min leading him to suspect the presence of a tailwind, however, the rate of descent returned to a more normal value when approximately 4 nm from the runway. The propellers were set to the maximum rpm at 1,200 feet agl. When the crew reported that they were inside 4 nm they were cleared to land and passed the surface wind, which was variable at 2 kt; they were also warned that the runway surface was wet.

Both pilots saw the runway lights when approaching 400 feet agl; the flaps were selected to 30° and confirmed at that position. Both pilots believed that the airspeed was satisfactory but, as the commander checked back on the control column for the landing, the rate of descent increased noticeably and the aircraft landed firmly. Both pilots believed that the power levers were in the flight idle position and neither was aware of any unusual control inputs during the landing flare.

Two separate witnesses saw the aircraft during the later stages of the approach and the subsequent landing, one of these witnesses was in the control tower and the other was standing in front of the passenger terminal. They both saw the aircraft come into view at a height of approximately 400 feet and apparently travelling faster than normal. They described the aircraft striking the ground very hard with the left wing low; both heard a loud noise coincident with the initial contact. They then reported that the aircraft bounced before hitting the ground again, this time with the nose wheel first, before bouncing once more. Crew statements and flight data evidence indicate that the aircraft lifted no more than 8 feet before settling on the runway and then remained on the ground. The aircraft was then seen to travel about half way along the runway before slewing to the left and running onto the grass. When the aircraft stopped the left wing tip appeared to be touching the grass.

When the aircraft came to rest the tower controller asked the crew if they required assistance, this call was timed at 1921:15 hrs. The crew asked for the fire services to be placed on standby but the controller judged that the situation required an immediate and full emergency response and activated the fire and rescue services. The airfield fire services arrived at the aircraft at 1924 hrs and all the passengers had been evacuated by 1925 hrs. The South Yorkshire fire and rescue services arrived at 1933 hrs and assisted in ferrying passengers to the terminal building.

Aerodrome details

The published ILS/DME approach for Runway 28 has a localiser track of 279°M, this was coincident with the Runway QDM, the localiser was therefore directly in line with the runway centre line. The ILS glideslope was set to 3°. The runway has a published landing distance of 1,199 metres and is 30 metres wide; the runway surface is asphalt. Runway 28 has precision approach path indicators set to 3°, a high intensity approach lighting system with three cross bars, threshold lighting with green wing bars and runway edge lighting. A lighting check had been completed at 1822 hrs and was satisfactory; the radio aids were serviceable.

Meteorological conditions

The synoptic situation at 1900 hrs indicated that an area of low pressure was centred near Cardiff with an occluded front lying through Dublin, Chester and Grantham. A south-easterly airstream covered the area. An aftercast provided by the Meteorological Office reported the following conditions at Sheffield at the time of the accident.

Height (agl)	Wind velocity	Temperature
Surface	variable 02 kt	+2°C
1,000 feet	110° / 22 kt	+1°C
2,000 feet	120° / 25 kt	Zero

'Information India', timed at 1850 hrs, reported the following conditions: surface wind variable at 02 kt, visibility 4,000 metres in rain, a few clouds at 500 feet and broken cloud at 1,600 feet, the temperature was +2°C and dew point was +1°C and the QNH was 988 hPa. 'Information Juliet', timed at 1920 hrs reported similar conditions except that 'rain' had been replaced by 'rain and snow'.

The surface wind information at Sheffield airport is derived from two anemometers located on the airfield. On this approach the wind passed to the pilots by ATC, variable 02 kt, was derived from an anemometer located on top of the ILS glide path aerial. This is located 220 metres from the threshold of Runway 28 and approximately 100 metres to the south of the runway. This wind information is the mean velocity for the previous 2 minutes. The wind reported as part of the ATIS information, variable 02 kt, was derived from an anemometer situated on the windsock close to the threshold for Runway 10. This wind information is the mean velocity for the previous 10 minutes. The recorded wind from this source had been less than 4 kt since 1750 hrs.

Flight recorders

The aircraft was fitted with a 25 hour duration flight data recorder (FDR) and a 30 minute duration cockpit voice recorder (CVR). Both recorders and all inputs to the recorders were serviceable and they were successfully replayed. The recordings were consistent with the flight being uneventful until the approach into Sheffield. Appendix A *(JPG 373kb)* is an extract of the FDR data recorded during the approach and landing.

When the aircraft was about 3 minutes from touchdown, the crew reported that they were established on the localiser. 54 seconds before touchdown the commander, the handling pilot, commented '..... MUST HAVE A TAIL WIND', he then asked for power ' .... ALL THE WAY BACK'. There was no indication from the FDR data of any windshear or turbulence during the approach. The crew saw the runway when the aircraft was about 100 feet above the decision height. Flap 30 was selected and the commander stated "The decision is to land". At 18 seconds prior to touchdown, when the recorded airspeed was 118 KIAS, the FO called, 'ABOUT 20 KNOTS'. Seven seconds prior to touchdown, at a recorded height of 120 feet and an airspeed of 112 KIAS, the FO called 'THREE REDS'.

Three seconds prior to touchdown, at an airspeed of 105 KIAS, the FDR recorded that the propeller blade angle changed from the flight range to the ground range. An examination of the recordings for landings made in the previous 25 hours showed that this situation had not occurred on any of them. During the following 3 seconds the CVR recording contained sounds consistent with the propellers 'disking' and the FDR indicated that the aircraft decelerated longitudinally and accelerated downwards. Full nose up elevator, right aileron and right rudder were applied but the aircraft rolled left and sounds consistent with a very heavy landing were recorded on the CVR.

The impact of the landing caused the FDR tape speed to fluctuate and this resulted in a brief period when the data were corrupted. Even after appropriate recovery techniques were applied, 0.5 seconds of recorded data were lost. When the data resynchronised the recorded status of the propeller blade angle had returned to the flight range. Interpolating the data through the corrupted region yielded a bank angle of between 5° and 7o left wing low at touchdown. Recorded normal G was corrected for the effects of pitch and roll. Integration of the resulting vertical acceleration indicated a sink rate immediately before touchdown of between 12 and 15 feet per second.

After the initial touchdown the aircraft bounced. It then pitched nose down and rolled to the right before recording a second touchdown 2 seconds later. A maximum value of 2G was recorded on this second touchdown. Reverse thrust was then selected to slow the aircraft and right rudder was applied to maintain runway heading. As the aircraft slowed it veered to the left before coming to rest on a heading of 278°magnetic.

Engineering investigation

An examination of the runway showed that the aircraft had contacted it first at about 30 metres past the threshold markers and come to rest about 700 metres from the point of touchdown. Although there was little evidence of hard metallic contact on the runway, there was a scattering of fragments of sponson structure and fairings and parts of the left main landing gear oleo strut between the initial touchdown point and about 200 metres into the runway. There was a considerable pool of oily residue to the left of the runway centreline immediately after the touchdown point.

Beyond the immediate area of the touchdown point, there were no further marks of scraping on the runway for about 500 metres. At that point there was evidence of the left sponson scraping on the surface with the aircraft gradually veering off the left side of the runway; the line of the scrape marks leaving the runway edge about 650 metres from the start of the asphalt surface. Once the aircraft had left the hard surface, the radius of the turn tightened rapidly and the aircraft came to rest on a heading about 70° left of the runway heading, with the fin just clear of the runway edge.

The aircraft was recovered to the apron and all the runway debris collected for examination.

Examination of the runway debris and the damaged landing gear components and attachments on the aircraft revealed that all the failures were consistent with those expected to result from a single overload event. The evidence was consistent with the oleo strut of the left main landing gear, which forms the lower end of the drag brace assembly of the trailing arm type gear, being compressed to the point at which the load in it had been sufficient to break the rear pintle attachment lug on the sponson outer rib. Consequently the rear pintle had been released from the sponson and the upper part of the drag brace assembly and its attachment to the rear pintle had also broken up; although it was unclear as to whether this occurred at the same time or after the failure of the pintle attachment lug. With the weight of the aircraft no longer acting as a restraint on the upper end of the heavily compressed oleo strut, the strut extended so rapidly that, when it reached full extension, the gland nut at the lower end of the oleo cylinder was sheared out and the cylinder continued as a free projectile, striking the underside of the wing at and inboard of the inboard flap drive position.

In general, for certification, the landing gear of a sizeable Transport Category aircraft, together with its supporting structure, is required to be capable of absorbing the energy of landing on the main wheels, at the maximum landing weight and a descent rate of the order of 600 ft/min, without sustaining any damage. It is ultimately required to be capable of withstanding a landing, at maximum landing weight, at a rate of descent of the order of 720 ft/min without collapsing but sustaining some permanent deformation of some of the affected parts of the aircraft.

Since the requirements are based on energy absorption considerations, the system is capable of withstanding landings at higher rates of descent if the aircraft is lighter than the maximum landing weight, but not proportionately so since the energy to be absorbed varies with the square of the descent rate. (the energy to be absorbed from a 900 ft/min landing is 2.25 times that of a 600ft/min landing)

This aircraft type was certificated to withstand a 600ft/min rate of descent landing, on both main wheels, without suffering any damage, and with some reserves of strength. In this case, not taking into consideration the side-loading resulting from its roll attitude, the aircraft would have been expected to survive a single wheel landing at its actual landing weight (11,100 Kgs) at a rate of descent in the order of 525 ft/min, but with some permanent deformation being sustained.

The landing load had also slightly creased the left side fuselage skin, forward of the sponson attachment, and the left side fuselage skin all round the sponson attachments appeared to have been slightly wrinkled; a feature which was not apparent on the right side. However, a geometric Symmetry Check of the aircraft showed it to be within the limits specified in the Aircraft Maintenance Manual and a Heavy Landing Check of the airframe and engines revealed no significant damage other than that which had occurred to the left sponson and its immediate surroundings.

Having arranged for the aircraft to be supported safely, the engines were run and a check of the propeller control rigging was performed. It was established that the flight idle baulk operated correctly; it not being possible to pull the levers back beyond the flight fine pitch stop without first releasing the baulk. Both engines producing near identical torques with the propeller levers pulled back onto the flight fine pitch stop, indicating that the rigging, as found, resulted in both propellers being at substantially the same pitch setting. After the baulk had been withdrawn, both propeller levers could be lifted and pulled back past the flight fine stop, by about 2 mm, before the propeller blade pitch, and subsequently engine torque, was reduced.

A simultaneous calibration of the two airspeed indicators was performed which revealed that there was never more than 2 knots disagreement between the P1 and P2 instruments and that both were within limits, particularly over the range 100 to 140 kts.

Conclusion

Evidence from the CVR indicated that the flight was conducted in a thoroughly professional manner in accordance the operator's normal procedures until the final stages of the approach. The recorded data indicate that three seconds prior to touchdown the propeller blade angle changed from the flight range to the ground range. Coincident with this change the CVR recorded sounds consistent with the propellers 'disking' and the FDR indicated that the aircraft then decelerated longitudinally and accelerated downwards. The engineering investigation revealed that the propeller control rigging and the operation of the flight idle baulk were correct. Selection of ground fine requires the pilot to firstly release the flight idle baulk and then lift and pull the propeller levers further back, this combined action rapidly becomes a programmed motor skill in the routine of daily operations. It is therefore possible that the handling pilot unintentionally selected the propellers into the ground fine position whilst still in the air.