AAIB Bulletin No: 8/2005 **Ref: EW/C2004/11/06** **Category: 1.1**

INCIDENT

Aircraft Type and Registration:	DHC-8-311 Dash 8, G-JEDE
No & Type of Engines:	2 Pratt & Whitney Canada PW123 turboprop engines
Year of Manufacture:	1999
Date & Time (UTC):	29 November 2004 at 0914 hrs
Location:	London City Airport, London
Type of Flight:	Public Transport (Passenger)
Persons on Board:	Crew - 3 Passengers - 32
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to skin of fuselage in tail section
Commander's Licence:	Airline Transport Pilot's License
Commander's Age:	64 years
Commander's Flying Experience:	17,500 hours (of which 1,400 were on type) Last 90 days - 59 hours Last 28 days - 19 hours
Information Source:	AAIB Field Investigation

History of flight

The aircraft and crew were engaged on their second of four sectors for that day from the Isle of Man to London City Airport (LCY). After an uneventful cruise, the first officer flew an ILS approach to Runway 10 which has a LDA of 1,319 metres. The 5.5º glidepath was intercepted from an altitude of 2,000 feet and manually flown with landing flap (15º) set. Although the first officer was the handling pilot for this sector, it is a company requirement for the commander to land the aircraft at LCY and handover of control was achieved at the ILS decision height of 430 feet. At this point the speed was V_{REF} +17 kt (108 kt). On taking control, the commander progressively reduced engine power and achieved V_{REF} +5 kt before entering the flare. He maintained the 5.5º glidepath using the precision approach position indicators (PAPIs) but on entering the flare reported heavy 'sink'. As the commander pulled back on the control column, the nose of the aircraft rose rapidly and the first officer called "six degrees pitch" in accordance with company Standard Operating Procedures (SOPs). The 'LDG ATT SIX DEG' message was also displayed on the advisory display unit. The first officer's call was not heard by

the commander and almost simultaneously a firm landing was made. During the roll out the 'TOUCHED RUNWAY' red warning light on the flight deck was observed to be illuminated.

Aircraft damage

Examination of the aircraft revealed evidence of a light scrape mark on the aft underside of the fuselage adjacent to the tail-scrape detector. Both the white frangible plastic cover and the detector were completely abraded away. The substantial freight floor above the region of the detector prevented initial access from being gained to the internal structure. The airframe damage was however, in the light of information supplied by the manufacturer, judged to be sufficiently slight to enable the aircraft to be ferried elsewhere for repairs. No control problems were reported during the ferry flight or during the subsequent landing. Internal examination carried out after removal of the freight floor was reported as confirming the absence of structural damage other than that visible externally to the skin.

Examination of the runway close to the western threshold revealed a fresh white mark, parallel to the runway axis, close to the centreline, identified as having been made by the cover of the tail-scrape detector. Fragments of the plastic material of the latter were recovered from that area. The position of the white mark was noted to be significantly nearer the threshold than the general touchdown region denoted by the concentration of tyre markings.

Weather

The meteorological report for LCY at 0850 hrs described a surface wind of 360º/8 kt with good visibility and little cloud. The crew reported that there was little turbulence on the approach but considered that the recently glazed building to the north of the runway may have induced some turbulence at their touchdown point. Other crews landing that morning did not report any turbulence but there is anecdotal evidence of turbulence when the wind is stronger from the same direction.

Company procedures

The company Operations Manual Section 2.2.1.23.1 entitled Precision Approach Diagram describes the company's approach speed procedure. It states that the speed is to be reduced to 120 KIAS prior to the final approach fix. This speed should be maintained to decision height at which point it should then be reduced to V_{REF}. Section 8.3.22 states that:

> *'Whenever practicable, all pilots should aim to fly stabilised instrument approaches in terms of IAS, approach configuration, power setting and rate of descent from 1,000 feet above DA/MDA.'*

Section 2.2.1.26.3 also notes that when conducting 5.5º approaches:

> *'The descent rate associated with the steep approach may require engine power to be maintained in the landing flare.'*

Company training emphasised the importance of maintaining stabilised power settings on the approach which in practise involved tapering the speed gradually towards V_{REF} having passed decision height. Although not written down, it was common practise to maintain V_{REF} +5 kt until touchdown when there were no runway performance issues.

Flight Recorders

The aircraft was fitted with a Solid State Flight Data Recorder (FDR)[1] capable of recording a range of flight parameters into 52 hours worth of solid state memory (for the number of parameters recorded) when power was applied to the aircraft. The aircraft was also fitted with a Cockpit Voice Recorder (CVR)[2] which recorded crew speech and area microphone inputs encrypted and compressed into solid state memory (two hours of combined low-quality and 30 minutes of separate high-quality recordings), again when power was applied to the aircraft.

A time-history of the relevant parameters during the incident is shown in Figure 1. For comparison, data, typical of other landings recorded on the FDR, is also presented in Figure 1 (time-aligned for main-wheel touchdown), for a non-event landing, carried out by G-JEDE, two days earlier into LCY. The data presented for the incident starts five seconds before the first officer hands over control to the commander with the aircraft on the glideslope; 450 feet above the ground (radio altitude); V_{REF} +17 kt (108 kt) IAS; descent rate of 1,100 ft/min; with just under 15% torque on the No 1 engine and just over 10% torque on the No 2 engine; both reducing.

At the time the commander took control, the torque on both engines had reduced to 12% and 9% respectively; however, they started to reduce even further and more rapidly three seconds later, reaching a minimum of 3.5% and 2% over a ten second period. A change in the elevator angle and corresponding 4º nose up change in aircraft pitch is also evident just before the minimum-recorded torque is reached. Also, the descent rate slowed to 900 ft/min and the airspeed began to reduce.

Ten seconds before the tail struck the ground, the torque on each engine began to increase (reaching 10% and 7% at the time of the tail strike) while the propeller speed remained nominally the same. The descent rate remained at 900 ft/min and the airspeed continued to reduce.

[1] L3 (Fairchild) F1000 FDR: *Part Number S800-2000-01, Serial Number 02557.*
[2] Allied Signal Solid State Memory CVR: *Part Number 980-6022-001, Serial Number 0639.*

Four seconds before the tail struck the ground there was a large positive elevator deflection (trailing edge up) to 60% full deflection, pitching the aircraft nose-up. The maximum calculated pitch rate was 5º/second and the maximum positive pitch attitude was just under 9º, occurring just after the elevator deflection was reduced, and a fraction of a second before the tail struck the ground. The airspeed at the time of the tail strike was 91 kt (V_{REF}).

The nose gear touched down four seconds after the tail strike with the airspeed at 80 kt.

Effects on environmental conditions

The United Kingdom Aeronautical Information Publication (UK AIP) entry for LCY 2.20 paragraph 4 states, '*pilots are warned when landing on Runway 10 or Runway 28 in strong wind conditions, of the possibility of building induced turbulence and/or windshear*.' LCY's Operations Department produced a set of Aerodrome Safeguarding Procedures in July 2004 in order to assess the effects of proposed building development on airfield operations. Paragraph 5.8, entitled Wind Assessments, states that:

> *'Any new developments proposed … should include an appropriate assessment of any potential implications the development may have by providing for unusual changes to wind conditions with regards the airfield operation at LCY following the completion of the development. These assessments should be carried by a competent authority in consultation between the developer and LCY.'*

Existing building development at LCY required no such wind assessment.

Analysis

Data from the FDR suggests that at handover of control from the first officer to the commander, the aircraft was on the glideslope and 12 kt slower than that specified in the company SOPs. The commander then reduced engine torque to an unusually low level in order to reduce the speed to V_{REF} as soon as possible. Comparison with three other landings at LCY showed that this was the only occasion that engine torque was significantly reduced after handover of control. The effect of this was to destabilise the power on the final stages of the approach and, although the torque started to increase 10 seconds prior to the tail strike, it never attained the levels normally achieved on LCY landings. This low power setting combined with an airspeed close to V_{REF} provided the aircraft with less energy than normal approaching the flare. Without significant power increase and with the onset of sink, the pitch angle had to be increased rapidly to reduce the rate of descent, resulting in the tail strike.

The company SOP regarding speed control on the precision approach into LCY required the aircraft to decelerate from 120 KIAS at decision height to 91 KIAS at touchdown whilst maintaining a 5.5º approach. It is difficult however, to reconcile achieving this whilst maintaining a stabilised approach. Analysis of other approaches into LCY on this airframe reveal that commanders have chosen to fly stabilised approaches and accepted landings at speeds sometimes considerably higher than V_{REF}. There is anecdotal evidence of the commander's air speed indicator over reading which may have led to commanders maintaining higher landing speeds. The Landing Distance Available (LDA) at LCY is such that there are no performance issues with this type of aircraft if touchdown is achieved at the correct point and this probably influences commanders to accept the higher touchdown speeds. When aiming to land at V_{REF} from this type of steep approach, the company advice to *'maintain engine power in the flare'* is significant. This extra energy combined with the increased lift from the propeller slipstream over the wings allows the rate of descent to be reduced without a large increase in pitch angle.

Although the commander considered that the aircraft may have been subject to the wind effects from proximate buildings, this is unlikely with such a low wind speed. However, the effects of wind around existing buildings have not been studied and the airport's proactive stance towards future development and their effect on wind conditions is to be commended.

Follow up actions

As a result of this incident the commander received three days of line training with a company type rating examiner (TRE) and was released back to line flying.

For reasons unconnected with this incident, the company no longer operates this type of aircraft and has withdrawn all operations from LCY.

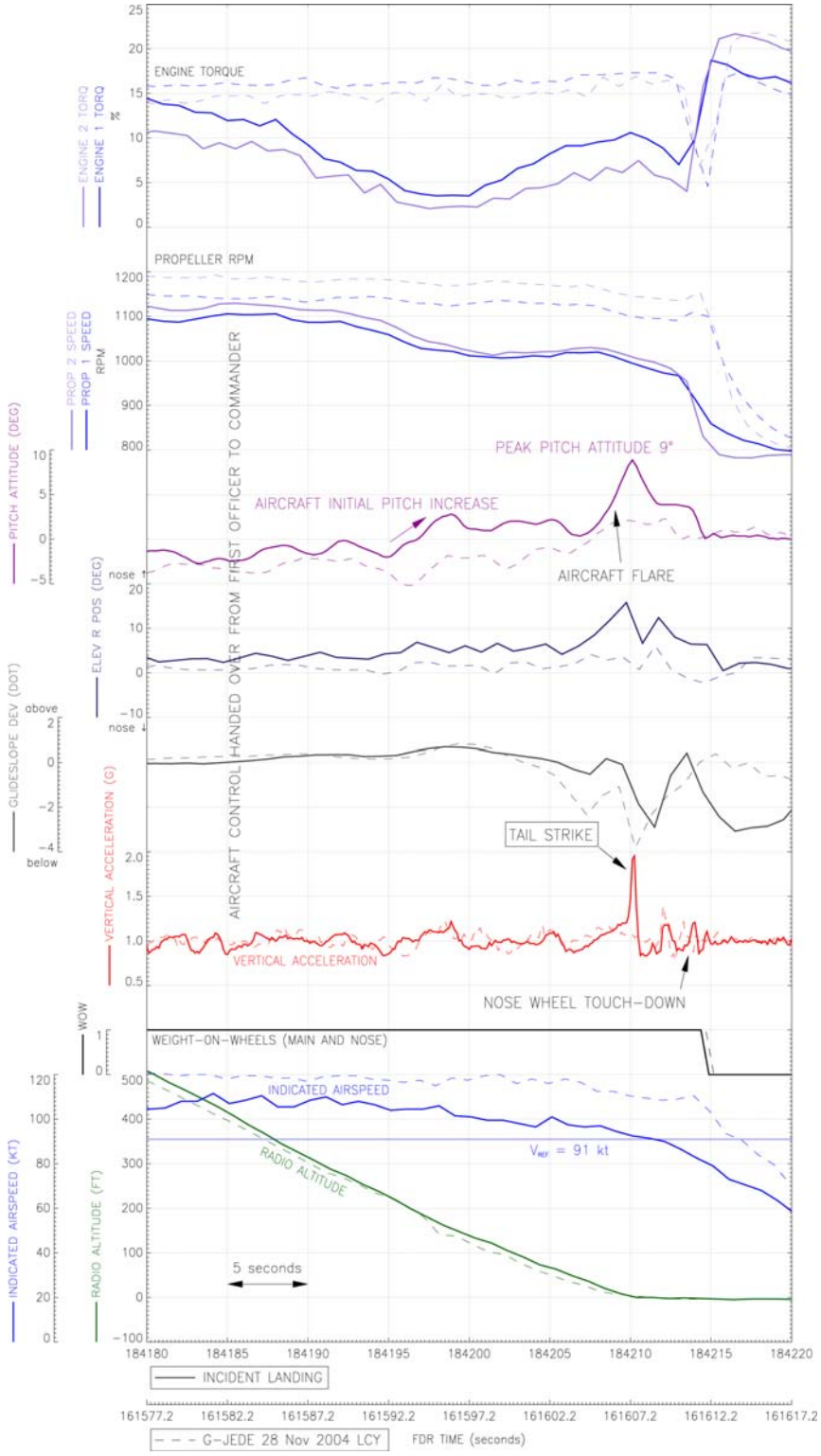

Figure 1

FDR Parameters for G-JEDE on 29 November 2004