AAIB Bulletin No: 6/2005 **Ref: EW/G2004/12/12** **Category: 1.1**

INCIDENT

Aircraft Type and Registration:	DHC-8-311, G-BRYU
No & Type of Engines:	2 Pratt & Whitney PW123 turboprop engines
Year of Manufacture:	1997
Date & Time (UTC):	21 December 2004 at 0723 hrs
Location:	Edinburgh, Scotland
Type of Flight:	Public Transport (Passenger)
Persons on Board:	Crew - 4 Passengers - 49
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	43 years
Commander's Flying Experience:	5,350 hours (of which 3,200 were on type) Last 90 days - 50 hours Last 28 days - 16 hours
Information Source:	Aircraft Accident Report Form submitted by the commander and further inquiries to aircraft manufacturer

Synopsis

On 21 December 2004 at 0723 hrs, the pilot experienced high control forces in pitch when rotating the aircraft to get airborne from Edinburgh Airport. Just as the pilot was considering aborting the takeoff above the rotation speed, the aircraft slowly became airborne. After takeoff the pilot exercised the aircraft pitch controls whereupon the control forces returned to normal. The pilot then decided to continue to Manchester where an uneventful landing was made. The cause of the high control forces in pitch as probably due to frozen spring tabs caused either by incomplete de-icing before flight, or by rehydration of the de-icing fluid residue. The aircraft manufacturer has subsequently issued two All Operators Messages applicable to Dash 8 series 100, 200 and 300 aircraft following two instances of a rejected takeoff in the Dash 8 series 200 aircraft due to the inability to rotate at the appropriate rotate speed. The AOMs cite as a potential cause the restriction of the spring tabs due to freezing of rehydrated de-icing fluid residue, and recommends periodic washing of specific aerodynamically "quiet" areas to remove this residue.

History of the flight

The aircraft was on a sector from Edinburgh to Manchester with 4 crew and 49 passengers on board. The aircraft mass was 18,186 kg (which was close to the maximum take-off mass of 19,000 kg); the centre of gravity was at the forward limit due to an almost full passenger load and a relatively light baggage load. The pitch trim was consequently set towards the aft limit of the take-off range.

The aircraft had been de-iced with de-icing fluid Type II 75/25 at 0400 hrs to remove hoar frost, for a planned departure time from Edinburgh at 0700 hrs. The minimum outside air temperature (OAT) during that period was -2°C, and the maximum OAT -1°C. It was a clear morning with no precipitation. The holdover time was five hours. Inspection of the aircraft prior to departure confirmed that the aircraft had been de-iced, with de-icing fluid evident on all visible surfaces. The commander observed that an excessive amount of fluid appeared to have been applied to the fuselage.

During the take-off roll at 0723 hrs the commander, who was the handling pilot, found that the pitch control force required to rotate at V_R (109 knots) was extremely high, which he initially attributed to the aircraft forward centre of gravity position and relatively high mass. However, continued and increased back pressure on the control column appeared to have no effect, and this resulted in a significantly extended take-off roll. He was on the point of rejecting the takeoff above V_R because he thought that the elevators may have jammed, when a very slow rotation was achieved using sustained and increasing back pressure on the control column. The aircraft then became airborne.

Once stabilised after takeoff, the commander carefully exercised the pitch control, whereupon the pitch control forces returned to normal. Further handling checks were conducted during the climb and the cruise with no recurrence of unusual pitch control forces. It was decided to continue to the destination airport, where the subsequent approach and landing at Manchester was completed without further incident.

A static full and free control check carried out after landing was normal. Post-flight examination of the aircraft also indicated that de-icing fluid was evident on the forward section of the tailplane, whilst the aft section, elevator hinges and spring tabs were completely dry.

The pitch control forces during rotation were well in excess of anything that the commander had experienced on this type of aircraft. He considered that there did not appear to be any aerodynamic assistance to the operation of the pitch control, which could have suggested that the elevator spring tab had been jammed or frozen. This explanation is also supported by the fact that the control forces returned to normal in the climb.

Discussion

There have been previous instances of abnormal pitch control forces either in flight or during takeoff, some of which have been attributed to elevator spring tabs becoming frozen with the rehydrated residues of anti-icing fluid. As a result of a serious incident to a Dash 8 aircraft in flight which was due to a frozen elevator spring tab in flight (fully described and discussed in AAIB Bulletin 12/2003, reference EW/C2003/03/01), two Safety Recommendations were addressed to the CAA. The first (2003-81) addressed the implementation of advice given to operators on airframe inspections and cleaning of aerodynamically "quiet areas" where residues can accumulate, and the second (2003-82) highlighted the need for anti-icing fluid manufacturers to develop gelling agents, with suitable hold-over times, that were not re-hydratable.

The CAA accepted Safety Recommendation 2003-81 in Follow-up Action on Occurrence Report (FACTOR) No F5/2004 dated 12 January 2004, and partially accepted Safety Recommendation 2003-82 in the same document.

It would appear that G-BRYU had been de-iced before flight, and the aircraft was being operated within the permissible holdover time of five hours. Thus one possibility is that the elevator spring tabs had become frozen when the aircraft had been parked overnight, and had remained frozen despite de-icing. A second possibility is that the elevator spring tabs had become frozen with the rehydrated residues of anti-icing fluids, as discussed in the AAIB Bulletin referred to above.

The aircraft manufacturer has recently issued All Operators Message (AOM) 784 on 13 January 2005 (applicable to Dash 8 series 100, 200 and 300 aircraft) following two instances of a rejected takeoff in the Dash 8 series 200 aircraft due to the inability to rotate at the appropriate rotate speed. The AOM cites as a potential cause the restriction of the spring tabs due to freezing of rehydrated de-icing fluid residue, and recommends periodic washing of specific aerodynamically "quiet" areas with Type I de-icing fluid when Type IV de-icing fluid has been regularly used. A further AOM 784A dated 23 March 2005 recommended the same procedures for Type II fluids.

The AAIB concurs with the advice given in the AOMs. A further measure to reduce the possibility of control problems due to frozen spring tabs during takeoff would be for aircrew to pay particular attention to the correct operation of these devices during the flight controls checks before takeoff following any de-icing procedure. According to the aircraft manufacturer, the normal characteristics associated with a slow, deliberate and full control throw in pitch have a very distinct feel, particularly at the maximum elevator trailing edge up position. With a fully functional and free elevator and spring tab control there is a constant pull force as the control column is moved toward the nose up position. At the point where the elevator reaches its maximum travel stop, the continued pull of the column gives the impression of winding up a spring, until the control column reaches its maximum

travel. If the spring tab is frozen, this latter force will not be felt, as only the elevator maximum travel stop that would be contacted. The aircraft manufacturer further asserted that there was also the possibility of breaking out the frozen tab, which would have a very distinctive feel, prior to reaching the control column maximum travel. The ability to make this assessment is contingent on the pilot having carried out the control throw checks in non anti-icing conditions in exactly the same manner in order to identify any unusual control feel characteristics. Moving the control column forward would result in similar force characteristics, but it was the manufacturer's view that an anomaly in the elevator circuit was more likely to be noticed by the aware and informed pilot when moving the control column aft.