ACCIDENT

Aircraft Type and Registration:	DHC-8-402 Dash 8, G-ECOZ
No & Type of Engines:	2 Pratt & Whitney Canada PW150A turboprop engines
Year of Manufacture:	2001
Date & Time (UTC):	1 November 2009 at 0949 hrs
Location:	London Gatwick Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 4 Passengers - 42
Injuries:	Crew - None Passengers - None
Nature of Damage:	Tailstrike, aircraft skin abraded and fuselage frames deformed. Runway surface damaged
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	47 years
Commander's Flying Experience:	10,260 hours (of which 902 were on type) Last 90 days - 180 hours Last 28 days - 50 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft's tail struck the runway after an ILS approach to Runway 08R at London Gatwick. The tailstrike was caused by the aircraft's rate of descent not being arrested during the landing flare. The commander retarded the power levers to flight idle shortly before the flare due to an increase in airspeed, probably caused by windshear. One Safety Recommendation was made.

History of the flight

The crew and aircraft were operating the first sector of a return flight from Newcastle to London Gatwick. They were aware of forecast strong and gusty wind conditions throughout the south of England. The commander was the PF and, once the PNF received the weather, he briefed for an ILS approach to Gatwick Runway 08R using Flap 15 in accordance with the company standard operating procedures. The ATIS for Gatwick reported the wind as 170°/17 kt with the direction varying between 140° and 210°. This was less windy than the crew were expecting and there were no reports of gusts. The First Officer (F/O) also received the VOLMET for the en-route and alternate airfields, almost all of which were reporting significant gusts of 25 kt or greater.

The aircraft, which was being flown with the autopilot engaged, captured the localiser and glidepath having been radar vectored onto the ILS centreline. The crew noted at this stage on the approach that they had about

a 40 kt tailwind. There were significant variations in airspeed throughout the approach as the conditions became increasingly turbulent. The commander elected not to utilise reduced propeller RPM (N_p) for landing and selected max governing RPM (fine pitch) to allow a more rapid speed response to power lever movement. At about 700 ft agl the autopilot disconnected due to the turbulence. The commander immediately stabilised the aircraft and continued the approach manually with a target V_{REF} of 120 kt. At 500 ft the aircraft was cleared to land with the surface wind reported as 190°/12 kt gusting to 24 kt. During the final few hundred feet the speed varied between 115 and 135 kt with the torque varying between 0 and 20%. An average Flap 15 approach torque setting would be approximately 17%.

At 300 ft agl the commander was fully visual with the runway and asked the PNF to put the flight directors to standby. The aircraft descended slightly below the glideslope, with a visual indication of three red and one white light on the precision approach path indicators (PAPIs), and the commander added power to recover the aircraft onto the glidepath.

At about 40 ft agl the recorded data showed an indicated airspeed increase to 137 kt. The commander responded by reducing torque to 8%. The aircraft speed decreased to V_{REF} and stabilised with the rate of descent initially remaining constant at about the normal rate of 600 fpm. The aural radio altimeter counted down from 50 ft, in 10 ft increments, at a rate which sounded normal to the crew. At 25 ft agl, the commander became aware of an increasing sink rate and initiated a flare which increased the aircraft pitch from about 2.5° to 7.5° over three seconds. The FDR shows that the aircraft now had a significant tailwind with a groundspeed 10 kt greater than its airspeed. The flare did not arrest the rate of descent and the aircraft touched down heavily on both main gear and the aft fuselage.

The crew were aware that the TOUCHED RUNWAY caption illuminated following the landing. As the commander vacated the runway he called for the emergency check list for the touched runway caption. The F/O read this drill which, on the ground, only advises the need to contact engineering before the next flight. Therefore the aircraft was taxied to its parking stand before being shut down. The passengers disembarked normally.

Recorded information

The aircraft was equipped with a digital flight data recorder (DFDR) and cockpit voice recorder (CVR), both of which were successfully downloaded at the AAIB. Pertinent FDR data is included in the History of the Flight section and in Figure 1.

Meteorological data

The UK Met Office provided a detailed aftercast of the weather at the time of the accident. They reported that the local meteorological situation was dominated by low pressure to the north and west of Gatwick, maintaining a strong south to south-westerly flow over the Gatwick area. There was also a frontal band of cloud over the area at time, with evidence of heavy rain and indications of embedded cumulonimbus cloud.

The surface wind recorded in the METAR at 0950 UTC was 170°/13 kt, with gusts of 23 kt. The estimated 2,000 ft wind at the time was from 220°/60 kt. This gave an appreciable difference between the surface and 2,000 ft wind, indicative of the potential for severe windshear-induced turbulence. With a 2,000 ft wind of 60 kt, the Met Office would also expect there to be an element of friction-induced turbulence, due to the interaction of the earth's surface and the flow of air.

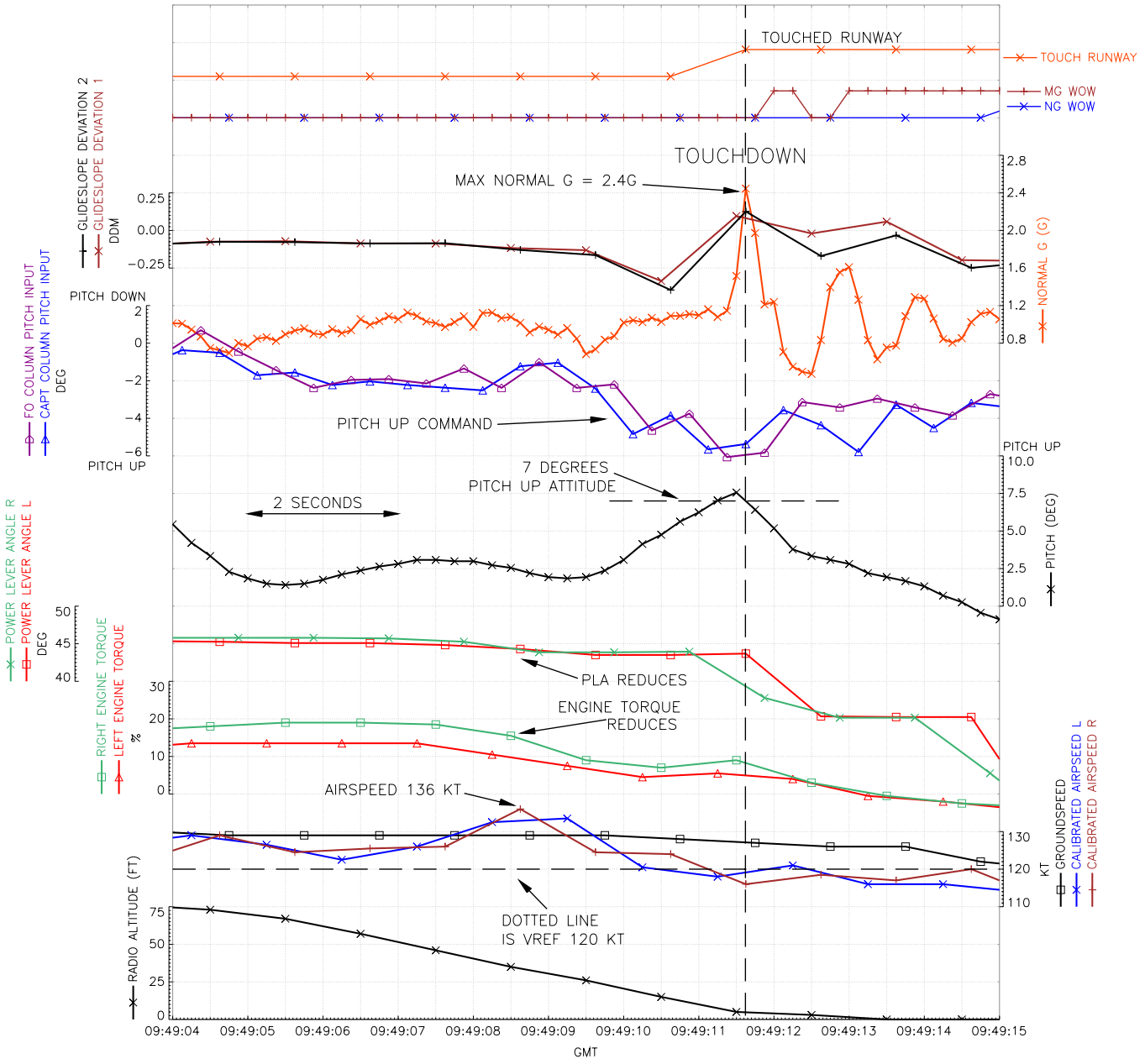

Figure 1

Structural damage

The fuselage lower skin was extensively damaged by abrasion over a region that straddled the centreline and extended some 2.25 metres longitudinally, and 0.75 metres laterally. Associated deformation of fuselage frames was also evident and the skin was fully penetrated by abrasion in the same area.

Ground marks - runway scrape

A scrape mark some two metres long was found on the runway near the threshold, approximately one metre to the right of the runway centreline. The scrape started at a point, and broadened to a maximum width of about 0.75 metres at its furthest point, consistent with the damage to the aircraft.

DHC-8-Q400 flap options

The operator had two landing flap positions approved for use, Flap 15 and Flap 35. There is no intermediate setting available. The operator's Operations Manual states that unless limited by weight or temperature, Flap 15 is recommended for normal landings on runways of 2,000m or greater length

To assist with ATC speed control requirements on approach, the company had issued an aircrew notice stating that all landings at Gatwick were to be with Flap 15.

The commander commented that in turbulent conditions he would prefer to conduct a Flap 35 approach. However, he was aware of the company Standard Operating Procedure (SOP) for Flap 15 landings at Gatwick and based on the ATIS, he did not feel the reported conditions warranted conducting a non-standard approach.

Tail strikes during landing

The operator's manual contains advice that deviation from the normal landing procedure is the main cause of tail strikes. It lists the most common causes as:

> '● *Allowing the airspeed to decrease well below V_{REF}*
> ● *Inappropriate reduction in power.*
> ● *Prolonging the flare for a smooth touchdown.*
> ● *Starting the flare too high.'*

Flaring too high

The company manual stated:

> *'If the flare is started too high above the runway, airspeed will decrease below V_{REF} and the sink rate will eventually increase. There is a tendency to increase pitch to arrest the excessive sink rate. However, the correct action is to immediately reduce the pitch attitude and apply a small increment in power, flying the aircraft on to the runway before the airspeed reduces further. While the landing will be firm, taking this corrective action will prevent a tail strike. Remember, executing a go-around is always an option.'*

Service Letter

On 11 September 2008 the manufacturer issued service letter DH8-400-SL-00-020. This letter stated that operators should include, in their procedures, an alert call at five degrees pitch (Pitch 5 call) and that:

> *'Descent rate control, below 200 feet agl., must be through power lever management rather than adjusting pitch.'*

The manufacturer later commented that this was meant to reinforce to the flight crew that power management during the final stages of the approach is the appropriate means of adjusting the descent rate (while maintaining the appropriate V_{REF}).

Operator's Pitch Call

The operator's SOPs requires the PNF to make a warning call of *"PITCH"* if the pitch angle displayed on the pilot's ADI reaches six degrees during the flare.

Previous tailstrikes

The manufacturer was aware of a total of nine tailstrikes to DHC-8-Q400 aircraft causing significant damage. Their analysis of these events showed that typically power had been at or near flight idle prior to the initiation of the flare. The manufacturer stated:

'It would appear that training guidance appropriate to use of the POWER levers to arrest the sink rate has not been as effective as hoped, at changing the piloting "second nature" action of flaring to arrest a sink rate immediately prior to arriving on the runway. The result of a small POWER lever movement ahead of Flight Idle is an immediate reduction in the sink rate even before there is an actual increase in power due to the effectiveness of lift due to slipstream.'

Operational Flight Data Monitoring (OFDM)

The operator was utilising a comprehensive set of OFDM event monitoring software. The system had an event 'high pitch on landing' set to report landings in excess of seven degrees nose-up at touchdown. This system had logged 403 events in the 24 months prior to this accident. a rate of one per 476 flights. No tailstrikes had occurred in this period. For the three months prior to 16 February 2010, the operator recorded 25 events, corresponding to a rate of one per 1,111 flights.

Tailstrike angles

The manufacturer commented that, in a worst case scenario, with a descent rate of ten feet per second, the tail will contact a crowned runway at a nose-up pitch of 6.5º. Marketing information from the manufacturer, relating to a further product stretch, had caused some confusion by referring to the Q400 as having an 8.5º rotation angle. This, supported by a large number of OFDM 'high pitch' landings with no damage, had led to a general belief amongst the operator's staff that tailstrikes at low pitch angles were impossible. (The Airplane Flight Manual rotation limit is 8° with rotation referring to take off and not landing.)

Approach pitch angles

The manufacturer utilised certification data to provide a range of approach angles for Flap 15 and Flap 35. A Flap 15 approach resulted in the aircraft being 2.5º to 3.5º nose-up at V_{REF}. Flap 35 data suggested that the aircraft would be 0.5º to 1º nose-up at V_{REF}, although the operator reported much lower figures were routine in normal service.

Analysis

Pitch 5 call

The aircraft's pitch angle increased beyond 5º two seconds before the tail struck the runway. There may have been time for the PNF to make a pitch call and the PF to assimilate the information and react. There is uncertainty, however, that this alerting call would have allowed sufficient reaction time for the PF to stop the increasing pitch rotation. The SOP alerting call at a pitch of 6º, one second before touchdown, was not made. During discussions following the accident the operator expressed concerns about additional pitch calls due to the possibility of the PNF becoming 'pitch fixated' on approach and this was the main reason why they had not adopted the Pitch 5 call outlined in the service letter. However, cognitively, it may be easier for the PNF to monitor pitch against a 5º standard than a 6º one. The Q400 ADI is graduated in 5º increments and thus the PNF does not have to interpret the instrument scale but just check to see if the aircraft symbol is on the 5º graduated line.

Flap selection

Company SOP's for Flap 15 landings at LGW were guided by the airport's desire to maximise runway utilisation.

A Flap 15 approach results in a nose-up angle on approach of 2.5º to 3.5º (based on certification figures). With a pitch limit of 6º and a nominal flare of 2º this allows only a 0.5º to 1.5º margin from a tailstrike. Consequently, late in the approach, there is little time available to use pitch to counter any sink that develops. The manufacturer's comment that pilots instinctively increase pitch to control sink appears to correlate with the operator's OFDM data. This reaction is likely to be more profound in pilots who have previously flown other types with larger tailstrike margins.

Likewise, pilots of this operator who have absorbed the company's general belief that tailstrikes are only likely above 8º, may think they have a margin of more than 3º (ie they can approach at 3º, flare to 5º and still have 3º to use to counter any sink). This may result in an increased flare which is an inappropriate response to sink. Where such a flare has been successful in eliminating the sink then no damage will have occurred and it is possible the pilots were unaware of the pitch attitudes attained.

In the turbulent conditions encountered during this accident, a large speed variation during the final few seconds, probably caused by windshear, caused the commander to reduce power. Although he subsequently flared to 7.5º, in an attempt to reduce the rate of descent, he was unable to prevent a heavy landing and consequent tailstrike.

Alerting ATC

Following the activation of the touched runway caution the flightcrew reviewed the required actions in the emergency check list. The only relevant information directed them to contact engineering support which they did once on stand.

Company publications had led crews to understand that a tailstrike would only occur at about 8 to 9° nose-up and the F/O was sure they had not reached those angles. It was not apparent to the flightcrew that a damaging tailstrike had occurred until after the aircraft was parked on stand, the passengers had disembarked and the commander had conducted a visual inspection. Only at this stage was information passed to airfield operations that a tailstrike had occurred.

The crew's first point of reference following a 'touched runway' warning is the emergency check list and this should ideally provide them with advice to support their decision making. A landing tailstrike is unlikely to cause significant risk to the aircraft occupants suffering the tailstrike, although debris left on the runway may cause damage to subsequent landing or departing aircraft. This potential hazard could be avoided by a runway inspection. Therefore:

Safety Recommendation 2010-028

It is recommended that Bombardier Aerospace modify the DHC 8-Q-400 (Aeroplane Operating Manual), "Touched Runway" Emergency check list to include the action "advise ATC"

Safety action taken

The operator intends to implement the wording of the safety recommendation in the next amendment to their check lists.

Conclusion

The approach was flown in difficult conditions. Flap 15 provides little pitch manoeuvre margin during the flare and the 'pitch six' call may be too late to prevent damage from occurring. The critical aspect of this approach was the rate of descent, which although normal for the

approach, was not arrested by the landing flare. The reduction of the power levers to eight percent torque at 40 ft, just before the flare, resulted in a rapid reduction in lift across the wing. This reduction in lift could not be countered by the increased flare and led to the aircraft landing heavily on the runway.