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COMMERCIAL AIR TRANSPORT

FIXED WING

ROTORCRAFT

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FIXED WING

ROTORCRAFT

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SPORT AVIATION / BALLOONS

ADDENDUMS and CORRECTIONS

(ALL TIMES IN THIS BULLETIN ARE UTC)

ACCIDENT

Aircraft Type and Registration:	Airbus A319-111, G-EZEU
No & Type of Engines:	2 CFM CFM56-5B5/P turbofan engines
Year of Manufacture:	2004
Date & Time (UTC):	24 November 2005 at 0835 hrs
Location:	Nottingham East Midlands Airport
Type of Flight:	Public Transport (Passenger)
Persons on Board:	Crew - 6 Passengers - 110
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to left wing tip and left wing tip of a neighbouring aircraft
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	45 years
Commander's Flying Experience:	10,670 hours (of which 756 were on type) Last 90 days - 93 hours Last 28 days - 35 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft was departing on a scheduled passenger flight to Alicante. As it taxied off its stand the aircraft's left wing tip struck the left wing tip of an A320 parked on the neighbouring stand. The commander, who was normally based in Berlin, had initially requested a pushback off the stand, in accordance with the published procedures. ATC advised him that his company's aircraft normally self manoeuvred off that stand. The commander had this 'local procedure' confirmed by the co-pilot, who was relatively new to the company, and the ground crew. After this incident, ATC ensured that all aircraft departing from this stand were pushed back before being cleared to taxi.

History of the flight

The aircraft was departing on a scheduled passenger flight to Alicante. For the commander, who was normally based in Berlin, this was his first experience of a departure from Stand 50, Figure 1. When boarding the aircraft in preparation for the flight, he had noticed the proximity of a light pylon near the left wing tip and an unmanned Airbus A320 belonging to another operator, beyond the pylon on Stand 51, facing the opposite direction to his own aircraft. He checked the aerodrome charts for the Central Apron and confirmed that Stand 50 was designated a push-back stand.

When the flight crew requested clearance from ATC to 'push and start', they were advised that they were clear to start but pushback permission was omitted. The flight crew repeated the request for pushback clearance and ATC commented that the operator's aircraft normally self manoeuvred off that stand. ATC also pointed out that there was no tug vehicle present. The commander sought the opinion of the co-pilot, who confirmed that on the previous occasions he had departed from Stand 50 the aircraft had self manoeuvred. The commander also received confirmation from the ground crewman that this was the normal arrangement. Aware that it would take time to arrange for a tug vehicle to push the aircraft back, he elected to start the engines and taxi off the stand in common with the customary practice.

After the engines were started, the commander cleared the ground crewman to unplug his headset. The ground crewman walked out to the left of the aircraft and took up a position by the left wingtip of the A320 on Stand 51, in order to provide wing tip guidance. The co-pilot requested clearance to taxi and ATC cleared the aircraft to taxi to the holding point for Runway 27. The commander checked that the wingman was giving the 'thumbs up' signal and started to taxi the aircraft, with the intention of manoeuvring it onto Taxiway Q and then Taxiway A. The aircraft was taxied straight ahead for a few metres to gain some speed before the commander introduced a shallow turn to the right, aware that he needed to avoid the light pylon and left wingtip of the aircraft on Stand 51. He stated that he then saw the wingman making the 'stop' sign (crossed arms above his head) and applied the brakes. At the same moment he felt G-EZEU's left wing tip strike the A320's left wing tip.

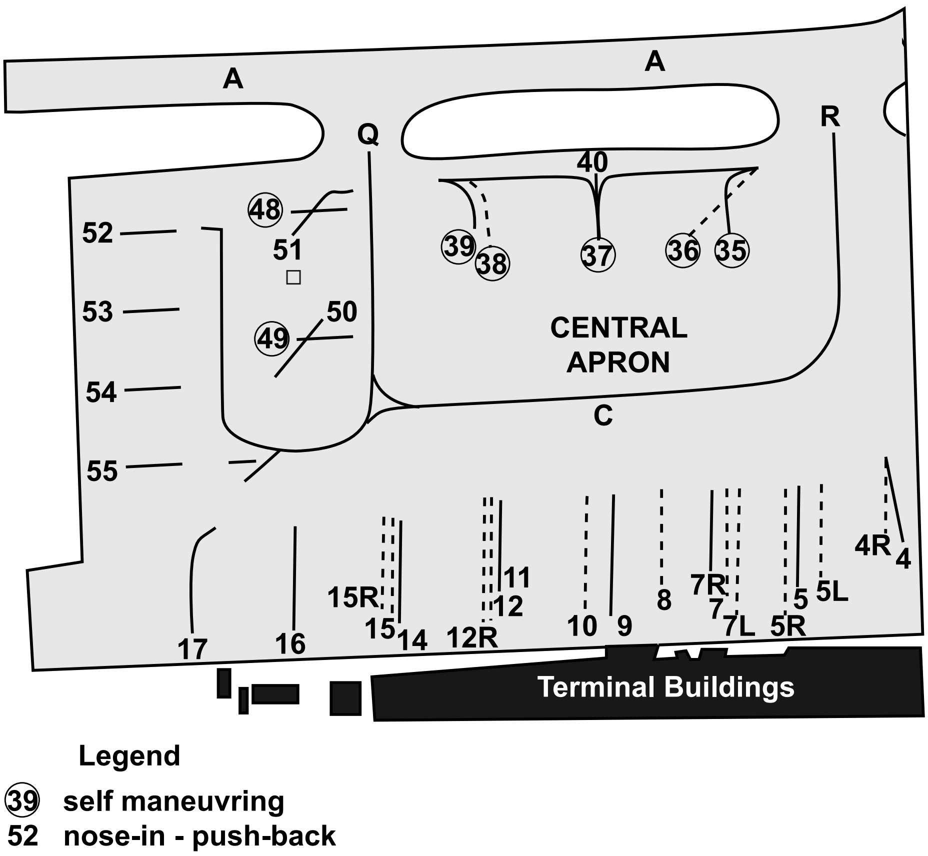

Figure 1

Diagram of stands layout of the central apron at East Midlands Airport at the time of the wingtips collision

The wingman stated that, having taken up his position by the A320's left wing tip, he gave the two thumbs up sign with outstretched arms to indicate wing tip clearance and the aircraft taxied straight ahead off the stand, instead of turning to the right as was usual. Although he expected G-EZEU to turn right, it did not and he realised that its left wing tip was going to contact the left wing tip of the aircraft on Stand 51. The wingman gave the stop sign by crossing his arms above his head but the reflection off the commander's side window prevented him from seeing whether the commander had observed his signal. G-EZEU continued to taxi and the two wing tips made contact, showering the wingman with debris. He recalled that he had given the stop sign when G-EZEU's left wing was abeam the A320's forward left door and that the aircraft stopped when its damaged wing tip was level with the A320's rear left door. Neither the occupants of the aircraft nor the wingman were injured.

After G-EZEU came to a standstill, the commander applied the parking brake. He visually confirmed that there was no sign of any fuel or hydraulic fluid leakage from his left wing and the co-pilot advised ATC of the incident. In the light of the minimal damage, the crew declined the assistance of the airport fire service and asked the handling agent to send an engineer out to the aircraft for a closer inspection. The passengers were reassured and, after an engineer had confirmed that it was safe to continue, G-EZEU was taxied on to Stand 1 via Taxiways Q, A and R.

On arrival at the stand, the crew carried out a normal shutdown and the passengers were disembarked on to coaches. As a precaution, the airport fire service had followed the aircraft to the stand.

Damage to the aircraft

The estimated relative positions of both aircraft at impact is shown in Figure 2. G-EZEU suffered damage to its left wing tip assembly and winglet. The upper section of the winglet had bent aft and a small section of the top of the winglet (approximately 20 cm by 15 cm) had separated and become embedded in the left wing tip leading edge of the A320. The navigation lights in the A320's left wingtip were damaged and the wing lower surface in this area exhibited scrape marks. Neither aircraft sustained any internal structural damage as a result of the impact.

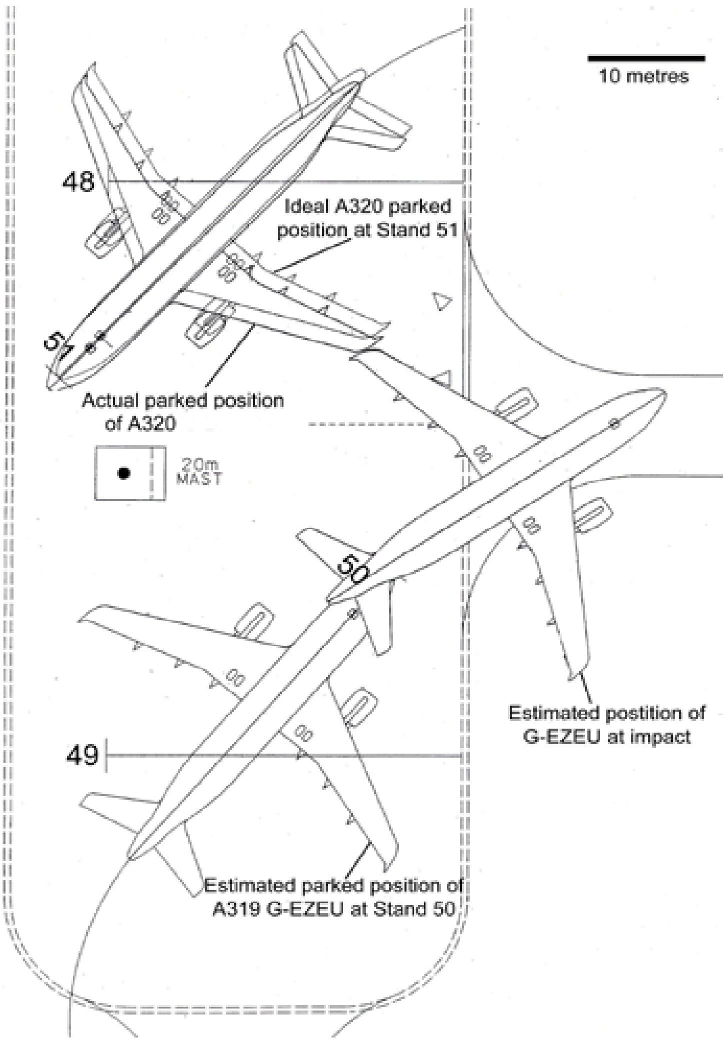

Figure 2

Estimated relative positions of the aircraft at impact

Personnel

The commander was employed by the operator at their Berlin base. He had positioned to Nottingham East Midlands Airport on 22 November to operate out of the airport, temporarily, for the first time. On 23 November, the day before the incident, he had commanded the same scheduled departure to Alicante from Stand 1, a push-back stand. On completion of the return flight back to Nottingham East Midlands, the aircraft parked on Stand 7L.

The co-pilot had joined the company four months earlier in July, to be based at Nottingham East Midlands Airport. He had completed his training by the middle of October and this was his fifth or sixth departure from Stand 50. The three other commanders, with whom he had operated on all his previous departures from that stand, had self manoeuvred the aircraft.

The co-pilot had been based at Nottingham East Midlands Airport with his previous employer but he had always operated their turboprop aircraft from other stands on the central apron. The accident occurred on his first duty following two weeks leave.

The wingman had been employed on ground crew headset duties, which included the wingman's role, for one year. He commented that during training he had been informed that Stand 50 was not a push-back stand.

Procedures

The charts that the operator provided for its flight crews indicated that Stand 50 was a pushback stand. This reflected the procedures contained in the United Kingdom Aeronautical Information Package (UK AIP) and, as a result, there were no taxiway markings leading forward off the stand.

The obstacle clearance dimensions for aerodrome aprons and stands are specified in CAP 168, entitled '*Licensing of Aerodromes*'. It states:

> *The dimensions of the apron should be such that the minimum clearance between a manoeuvring aircraft and any obstruction is 20% of wingspan.*
>
> *'For nose-in push-back stands this safety clearance may be reduced to 4.5m where a suitably managed guidance system, acceptable to the CAA, is acceptable.'*

The Central Apron at Nottingham East Midlands Airport, including Stand 50, was remarked in March 2003 and within a few months it had become common practice, agreed between the operator and ATC, for the operator's Boeing 737-300 aircraft to self manoeuvre off Stand 50. At the beginning of September 2005, the operator introduced the Airbus A319 to their base at Nottingham East Midlands and the practice of self-manoeuvring off Stand 50 continued. Having taxied forward off the stand, it was usual for the operator's aircraft to leave the Central Apron via Taxiway C.

The B737-300 has a wingspan of 28.89 metres and 20% of that span equates to a minimum clearance of 5.78 metres. The A319's wingspan is 5.2 metres greater, at 34.09 metres.

JAR OPS 1 places responsibility on the commander by stating:

> *'for the operation and safety of the aeroplane from the moment the aeroplane is first ready to move for the purpose of taxying prior to take-off until the moment it finally comes to rest at the end of the flight.'.*

This responsibility is reflected in the operator's Operations Manual, which also states:

> *'When departing from the ramp, local procedures for start up and taxi clearance are to be followed.'*

Further, under the heading '***Manoeuvring'*** it specifies that:

> *'It is the Commander's and/or the ground engineer's responsibility to ensure that there is adequate clearance when taxying in the vicinity of obstructions…. If necessary a wing tip watch shall be provided preferably at each wing tip'.*

Flight Recorders

The aircraft was fitted with a Solid State Memory Flight Data Recorder (FDR) capable of recording a range of flight parameters into solid state memory[1]. The aircraft was also fitted with a Cockpit Voice Recorder (CVR) which recorded crew speech and area microphone inputs into solid state memory, and which provided 120 minutes of combined recordings and area microphone and 30 minutes of separate higher quality recordings. Both recorders were downloaded at the AAIB and data and audio recordings were recovered for the ground-collision accident.

A time-history of the relevant parameters during the ground collision is shown at Figure 3. The data presented at Figure 3 starts one second before the parking brake is released and shows an initial recorded heading of just over 038ºM and about 24% N_1 on both engines.

Footnote

1 Parameters that would have been useful to the investigation but were not recorded included nose wheel steering angle and tiller angle, and distance travelled on the ground. Ground speed was recorded but with a resolution of one knot and a one second sample rate.

Five seconds after the aircraft started to roll forward, the N_1 started to increase on both engines, reaching a maximum of 31% on engine No 1 (left side) and 28% on engine No 2 (right side), three seconds later. As the thrust was increasing, and after approximately five metres of forward movement[2], the aircraft started a turn to the right; this was consistent with the use of differential thrust. There was no evidence of rudder pedal or brake pedal movement during the turn and nose wheel steering angle and tiller angle were not recorded.

The aircraft continued turning to the right for approximately 12 seconds to a heading of 058ºM before colliding with the A320. The rate of change of heading at the point of collision was about 2.8º per second and the ground speed, at most, six knots. The turn to the right immediately slowed, consistent with the left wing being temporarily constrained, and the brakes were applied, bringing the aircraft to a stop eight metres further on. The final heading was recorded at just over 059ºM and the aircraft had travelled a total distance of 38 metres.

Analysis

While responsibility for the safe operation of the aircraft lay with the commander, on this occasion he was presented with a set of circumstances which strongly encouraged him to follow an alternative plan to the one he had expected. He had intended to carry out the published procedure and his decision not to do so was influenced by those with whom he would normally liaise when departing from a self manoeuvring stand. Their advice was given greater credibility by virtue of their

Footnote

2 The parameter *DISTANCE [calculated]* was calculated by integrating twice the recorded longitudinal acceleration. The first integration generated the parameter *GROUND SPEED [calculated]* which is shown in Figure 3 against the recorded ground speed of lower resolution.

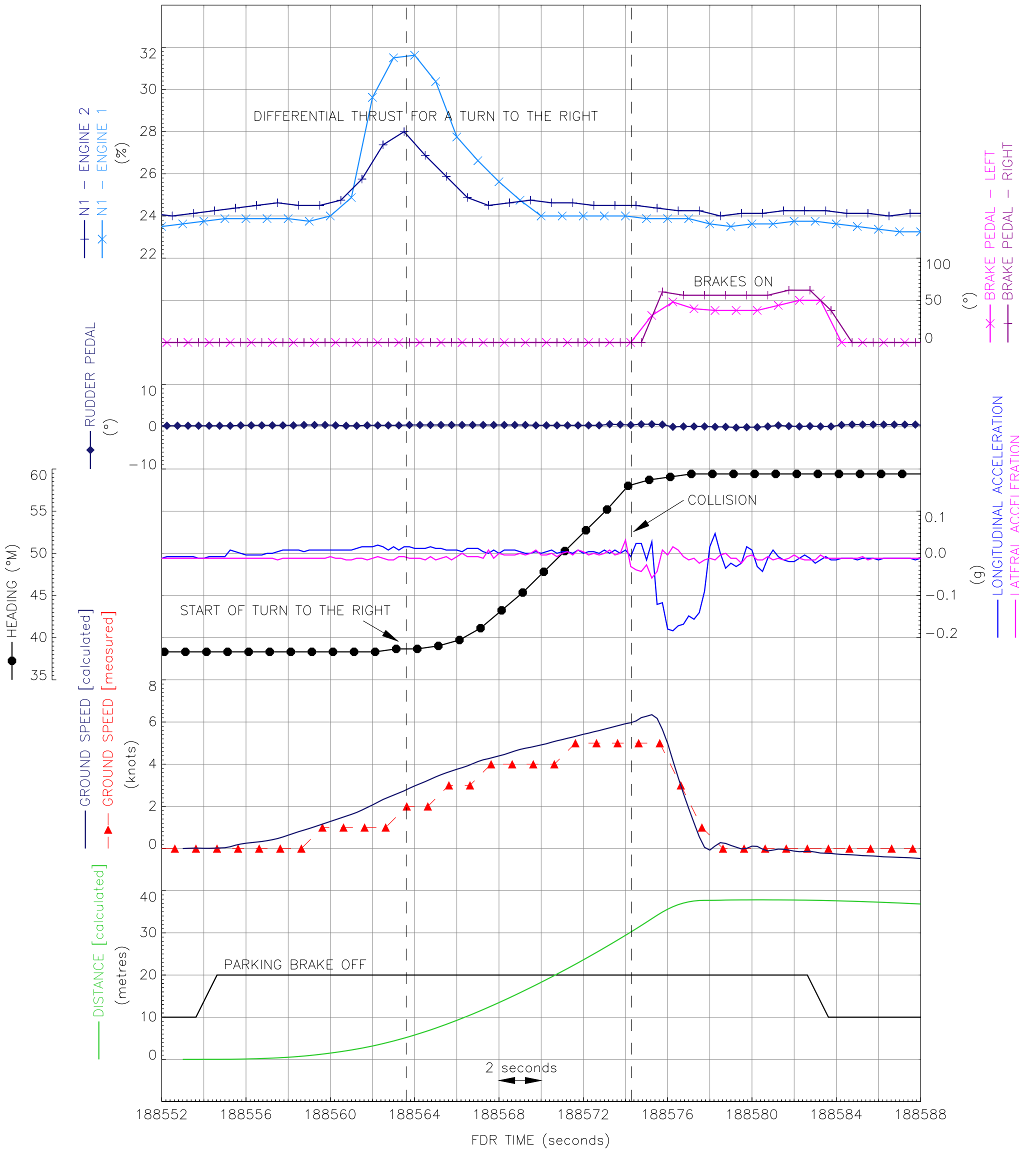

Figure 3

Salient FDR Parameters
(Accident to G-EZEU on 24 November 2005)

familiarity with operations at Nottingham East Midlands Airport. By contrast, this was the commander's first departure from Stand 50 and his second day on temporary loan from his home base in Berlin. In addition, the commercial pressure to depart on time mitigated against waiting for an available push-back tug.

The commander was aware of the nearby obstacles on the left side of his aircraft but was informed by ATC, the co-pilot and the ground crewman that it was normal to self manoeuvre off Stand 50. However, he was not advised that it was also customary to taxi to the right, on to Taxiway C, as opposed to turning left onto Taxiway Q, as he intended. In addition, the historical precedent was based on the initial operation of the B737-300, whose wingspan is 5.2 metres less than the A319-100. This difference in wingspan further eroded the A319's wingtip clearance from obstacles when self manoeuvring off Stand 50; a clearance that is provided for in CAP 168 when the approved (pushback) procedure is followed.

Despite the wingman giving the stop sign before the two aircraft left wing tips came into contact, the commander did not see the signal in time to stop G-EZEU and prevent the collision. A possible reason for this is that the commander was lulled into a false sense of safety because the non-standard procedure that was being advocated had become the norm.

After this incident ATC ensured that all aircraft departing from Stand 50 were pushed back before being cleared to taxi, thereby following the published procedure for that Stand and maintaining the approved obstacle clearance criteria. The operator issued a notice to crews (NTC) reminding them of the correct published procedure for the Stand. Subsequently, that part of the airport's manoeuvring area was redesigned, as part of an unrelated plan, and Stand 50 no longer exists.

INCIDENT

Aircraft Type and Registration:	Airbus A340-642, G-VGOA
No & Type of Engines:	4 Rolls-Royce Trent 556-61 turbofan engines
Year of Manufacture:	2001
Date & Time (UTC):	30 December 2005 at 1528 hrs
Location:	After takeoff from London Heathrow Airport
Type of Flight:	Public Transport (Passenger)
Persons on Board:	Crew - 18 Passengers - 308
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:	11,238 hours (of which 2,092 were on type) Last 90 days - 173 hours Last 28 days - 73 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

During takeoff part of the cabin filled with a light white mist and an accompanying 'oily' smell. The flight crew declared a PAN, dumped fuel and then made an uneventful return to the airport. The mist was probably caused by the ingestion of oil or other contaminant into the APU inlet which passed into the bleed air duct and cabin air conditioning system. The fluid contaminant probably emanated from a drain hole forward of the APU inlet. This drain hole was found blocked some time after the incident and, once cleared, it released almost a litre of an oil-water mixture.

History of the flight

The aircraft was on a scheduled flight from London Heathrow to Los Angeles. During the takeoff rotation a section of the cabin filled with a light white mist. The mist was accompanied by a smell which was described as 'oily' by the cabin crew. The Flight Services Manager (FSM), head of the cabin crew, notified the commander over the intercom that there was "smoke in the cabin". The flight crew had also become aware of an 'oily-type' smell on the flight deck, although no smoke or mist was present. The commander completed the after takeoff checks and then, after levelling off at a safe altitude, he asked the relief First Officer (who was occupying the jump seat) to enter the cabin and assess the situation. He reported back that the 'smoke/mist' had disappeared from the cabin and this was confirmed by the FSM. However, the 'oily' smell still lingered in the cabin.

The commander decided to return to Heathrow and declared a PAN (urgency call) to Air Traffic Control (ATC). The flight crew actioned the 'Smoke/Fumes Removal' checklist and then advised the FSM and the passengers of the situation. The aircraft was above its maximum landing weight so it was vectored by ATC to a suitable area to jettison fuel. Whilst jettisoning fuel the flight crew reviewed all the systems pages on the ECAM (Electronic Centralized Aircraft Monitoring) but no faults were noted. It took approximately 60 minutes to jettison the 83 tonnes of fuel required (1.38 tonnes/min). The subsequent approach and landing back at Heathrow were uneventful.

A fire service vehicle attended as the aircraft vacated the runway and a visual inspection of the aircraft was carried out; nothing unusual was noticed. The aircraft was then taxied to a remote stand where the passengers were disembarked.

Aircraft examination

The aircraft was examined by the operator's maintenance engineers to determine the source of the white mist and 'oily' smell. High-power engine runs were carried out while bleed air was selected from each engine in turn but no leaks or fumes were detected. It was the operator's standard practice on the A340-600 to have the auxiliary power unit (APU) operating during takeoff until a height of 1,500 ft had been reached. Therefore, the APU was also test-run but no leaks or fumes were detected. The galley equipment and the in-flight entertainment system were also operated but no faults were found. The APU had not been serviced recently so an oil over-servicing problem was discounted. To help identify the cause of the mist, the aircraft was operated on an additional seven flights with the APU inoperative and no smells or mist were reported during those flights. During a subsequent A5 maintenance check a slight 'oily' smell was noted after selecting bleed air from the APU, but an inspection of the APU bay did not reveal any evidence of an oil leak. The aircraft was released back to service with the APU still inoperative.

When the aircraft arrived in Johannesburg on a subsequent flight, additional down-time was available for troubleshooting the problem. A detailed inspection of the APU and its associated air conditioning ducts was carried out but no faults were found. However, a trace of an unknown fluid was detected on the underside of the fuselage, aft of the APU inlet. The area was cleaned and the APU was run but there was no report of mist or smells in the cabin. After the test run, no leaks inside the APU bay were found. A flight test was then carried out with the APU operating but again no mist or smell was detected.

A week later, during a routine inspection of the APU, an engineer noticed a small drain hole (approximately 1/8 inch in diameter) located aft of the curved APU diverter[1] (see Figure 1). He reported that it was very difficult to spot. When he attempted to check if the hole was clear almost a litre of an oil-water mixture drained out. The panel containing the drain hole was removed and the area inside was found to be wet and contaminated. The operator suspected that a build-up of dirt and dried oil had blocked the hole.

Footnote

1 The curved diverter on the underside of the aircraft, forward of the APU inlet, serves to divert any fluid streaming aft along the fuselage's underside from entering the APU. It does not prevent fluid from the drain hole entering the APU.

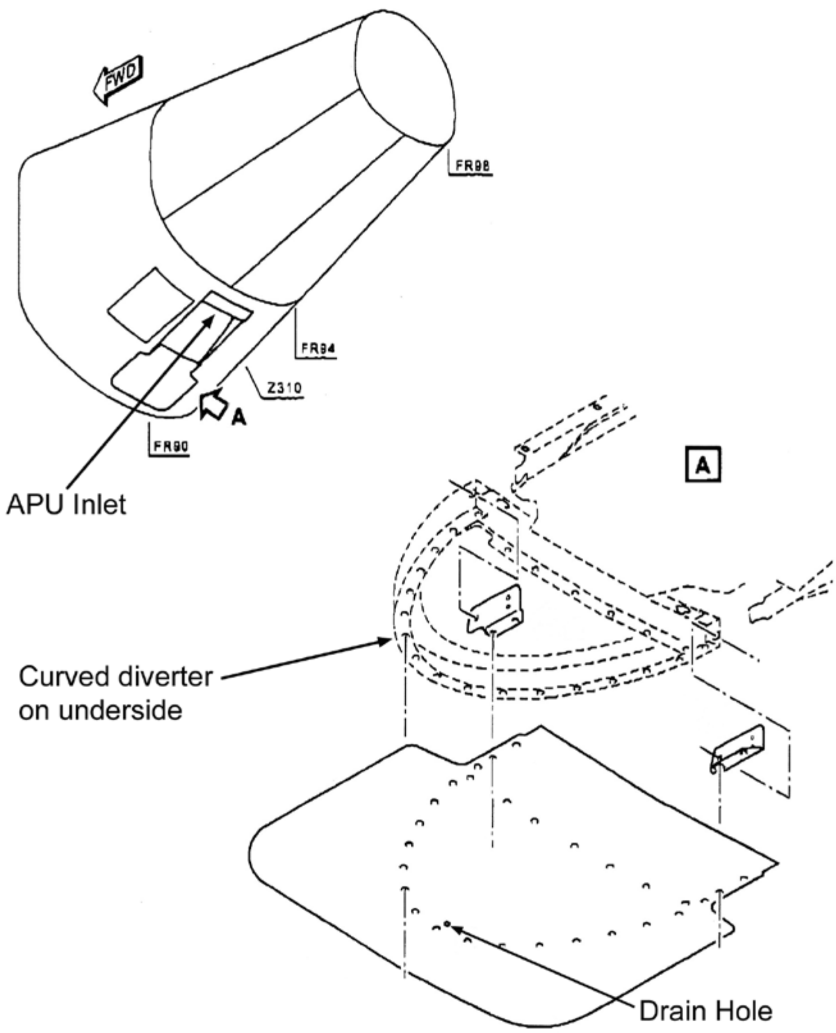

Figure 1
Location of drain hole relative to diverter and APU inlet

Fuel jettison rate

It took approximately 60 minutes to jettison 83 tonnes of fuel (1.38 tonnes/min), which was a slower rate than the 1.6 tonne/min figure published in the aircraft maintenance manual. The aircraft manufacturer stated that tests of the A340-600 fuel jettison system had produced jettison rates of between 1.83 tonne/min and 2.08 tonne/min, but that no tolerance band could be given because the actual rate was dependent upon aircraft attitude, wing bending, aircraft centre of gravity and the fuel temperature. At the time of writing, the AAIB had not received any response from the aircraft manufacturer explaining the low fuel jettison rate on G-VGOA.

Discussion

The crew of the aircraft were able to handle the situation and made a safe return to the airport. The commander reported that he received "excellent support" from ATC during the incident.

A build-up of dirt and oil in the drain hole aft of the diverter had caused a blockage which prevented oil and other fluid contaminants draining overboard. If this blockage were to unblock suddenly, for example due to the vibration during a takeoff, then the released fluid could easily be ingested by a running APU. Once ingested this contaminant could pass into the bleed air duct and subsequently into the cabin air conditioning system. This scenario probably explains the oily smell and mist observed in the cabin during takeoff.

Follow-up action

In response to this incident, the operator decided to raise a new maintenance task requiring an inspection of the drain hole at every A check. The aircraft manufacturer was informed of the decision. The reason for the low jettison rate had not been determined by the aircraft manufacturer at the time of writing.

INCIDENT

Aircraft Type and Registration:	Boeing 737-8AS, EI-DAP
No & Type of Engines:	2 CFM 56-7B24 turbofan engines
Year of Manufacture:	2003
Date & Time (UTC):	26 November 2005 at 1020 hrs
Location:	Stand 4 at Glasgow Prestwick Airport
Type of Flight:	Public Transport (Passenger)
Persons on Board:	Crew - 6 Passengers - 181
Injuries:	Crew - None Passengers - None
Nature of Damage:	Minor dent in aircraft fuselage and broken radar antenna
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	39 years
Commander's Flying Experience:	10,200 hours (of which 5,000 were on type) Last 90 days - 282 hours Last 28 days - 92 hours
Information Source:	Report submitted by Airfield Operations Manager and Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft had been parked on Stand 4 and the flight crew had started the normal aircraft shutdown checks. A baggage belt vehicle was being manoeuvred towards the front hold of the aircraft and subsequently struck the fuselage of the aircraft. No one was injured as a result of the incident. The report contains one AAIB Safety Recommendation.

Incident description

The aircraft had been parked on Stand 4 and the flight crew had started their normal aircraft shutdown checks. The ground power was connected, the front hold door was opened and a baggage belt vehicle was being manoeuvred towards the front hold. As the vehicle approached the aircraft the driver put his foot on the brake, however the pedal went all the way to the floor without slowing the vehicle. The driver tried, but failed, to grasp the hand brake and he reacted by steering the vehicle to the right to avoid the open cargo hold. The conveyer belt, which overhangs the front of the vehicle, struck the aircraft bringing the vehicle to a stop (see Figure 1).

The captain felt the collision and later reported that he was not immediately aware how significant the incident was since he did not receive prompt communication

Figure 1
Photograph taken shortly after the collision showing the baggage belt vehicle and the aircraft fuselage

from the ground crew. The captain then opened the flight deck window and was informed by the ground crew that the baggage belt had struck the fuselage. He decided to disembark the passengers using the rear stairs. No one was injured as a result of the incident or the disembarkation.

Emergency response

Shortly after the collision the ground crew contacted their line manager who arrived promptly and they subsequently telephoned the Motor Transport department. However, it was not until 1040 hrs, around 20 minutes after the collision, that a ground operator, who as part of his job had a mobile patrol function, contacted ATC and made them aware of the situation. An 'Aircraft Ground Incident' was called and the fire services arrived at the scene shortly afterwards.

Airfield investigation

The Airfield Operations Manager, who undertook a comprehensive investigation, including interviews with several key personnel and an independent inspection of the vehicle, provided the AAIB with his report.

Baggage belt vehicle

The baggage belt vehicle was an Avia Lift model APL 900 Mk1 built in 1982. The vehicle was self propelled and had a cab on the left side and a conveyer belt, which overhung the front of the vehicle, on the right side. The footbrake operated a non-assisted single circuit hydraulic system to drum brakes fitted to the front and rear. The parking brake was hand operated, and this could be used in an emergency should the footbrake fail. The vehicle had automatic transmission with a PARK setting.

Ground vehicle maintenance

Service records indicated that in June 2005 and in September 2004 the vehicle had been given a six month service. In both cases a schedule with 63 maintenance actions was used. The vehicle was maintained by the airport authority and, as such, the inspections were not undertaken by an independent body, however the forms had signatures of both a maintainer and a supervisor. The inspections were in line with the 30 point safety check recommended in CAP 642[1]. Whilst CAP 642 does not specify how regular the inspections should be, it does state that the frequency of inspections, maintenance and servicing should be appropriate to the type and age of the vehicle used and should be in accordance with the manufacturer's instructions. CAP 642 is not mandatory, but UK airport operators have adopted Safety Management Systems (SMS) in accordance with CAP 168 '*Licencing of Aerodromes*' and CAP 168 makes specific reference to CAP 642 in this regard. The CAA expects airport operators, in the absence of any accepted alternative, to adopt the guidance provided in CAP 642 as part of their SMS.

Footnote

[1] CAP 642 *Airside Safety Management* – the CAA document that provides guidance to aircraft and airport operators on safe operating practices for airside activities.

The front section of the park brake cable had been replaced in June 2005 and records showed that parts of the brake pipe system had been replaced in September 2004 and November 2004. It was not possible to determine which parts of the brake pipes had been replaced.

Vehicle inspection

The vehicle was inspected after the accident by an appropriate independent organisation and the key findings are described below.

Footbrake system

It was possible to push the pedal through the full length of travel without resistance. The hydraulic pipe leading to the brake cylinder on the front offside wheel was found fractured which had caused immediate loss of brake fluid pressure and it was concluded that the driver would have had no prior warning of the failure. The independent inspection did not attempt to determine why the pipe had fractured.

Parking brake

The front section of the parking brake cable, which had been replaced in June 2005, was found to be seized. There was therefore no parking or emergency braking available, a defect that would have been noticeable, for example during a daily check. The parking brake system downstream of the seized cable was found to operate satisfactorily.

Use of PARK with automatic transmission

The vehicle's automatic transmission had a PARK setting that could have been used in preference to the parking brake. Regular use of the PARK setting could have meant less frequent use of the parking brake and this could have contributed to the cable seizure and a reduced probability of detecting a fault with the parking brake.

Analysis

The incident was caused by a failure in the hydraulic pipe for the brakes. The vehicle had been serviced twice in the 14 months prior to the incident and on two occasions (12 and 14 months prior to the incident) parts of the brake pipe system had been replaced. However, the vehicle became unsafe within six months of its last service. The impending brake pipe failure and the defective parking brake might have been detected had a daily check, or a quarterly service, together with an effective defect reporting system been used.

Airfield management safety actions

As a result of the mechanical failure of the vehicle and the delay in declaring an Aircraft Ground Incident, the airfield management recommended several safety actions:

a) A full review of: the ground vehicle fleet; the defect reporting system; the maintenance reporting process; the content and the frequency of the servicing schedule and the manning levels in the Motor Transport department.

b) A review of a range of activities to improve the awareness of prompt and effective use of emergency procedures. This includes the immediate reporting by ground handlers to the aircraft captain of any ground incident.

In view of these safety actions the AAIB is making only one Safety Recommendation.

Safety Recommendation 2006-060

It is recommended that the Civil Aviation Authority should remind airport operators that their Safety Management Systems should ensure that safe standards of maintenance and use are applied to all vehicles and mobile ground equipment used in the proximity of aircraft.

INCIDENT

Aircraft Type and Registration:	Boeing 747-412, 4X-ELS
No & Type of Engines:	4 Pratt & Whitney PW4056 turbofan engines
Year of Manufacture:	1992
Date & Time (UTC):	10 January 2006 at 1220 hrs
Location:	10 miles East of London Heathrow Airport
Type of Flight:	Public Transport (Passenger)
Persons on Board:	Crew - 15 Passengers - 450
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Not known
Commander's Age:	Not known
Commander's Flying Experience:	Not known
Information Source:	AAIB Field Investigation

Synopsis

During an ILS approach to Runway 27R with the autopilot engaged, the aircraft descended to 1,200 ft altitude at about 8 nm from the runway threshold. The flight crew recovered the aircraft to the ILS glidepath manually and landed normally. Investigations revealed no fault, either on the aircraft or in the ground equipment, to explain the incident.

History of the flight

On arrival in the London area, ATC directed the aircraft towards an ILS approach to land on Runway 27R at Heathrow, and the crew prepared for an approach using the autopilot. The visibility was good below a cloudbase of about 1,500 ft. The flight crew established the aircraft on the localiser in level flight at 4,000 ft and were instructed to descend with the glideslope. At about 14 nm from touchdown, the autopilot captured the glideslope and the aircraft began a descent.

The flight crew reported that after a short time, they identified that the glideslope indications were showing progressively greater 'fly down' commands, and the autopilot was attempting to pitch the aircraft's nose down to follow these indications. Seconds later, the glideslope failure indication appeared, and the EICAS[1] caution message 'NO AUTOLAND' was displayed to both pilots. The co-pilot (who was PNF) asked ATC whether there was a fault with the glideslope but congestion on the frequency and a misunderstanding rendered the communication ineffective.

Footnote

[1] Engine Indication and Crew Alerting System

The ATC controller communicating with the aircraft noticed the aircraft's unusually low altitude as it passed about 1,600 ft, and instructed the aircraft to climb, reassuring the flight crew that the glideslope was serviceable.

The aircraft reached a minimum altitude of about 1,200 ft at about 8 nm from touchdown and the maximum rate of descent had been in the order of 1,800 ft/min. The commander (who was PF) disconnected the autopilot and climbed the aircraft to 1,800 ft. With the glideslope indications then looking reasonable again, and no failure indications, the commander armed the autopilot to capture the glideslope, and it did so. A successful autopilot approach was completed and the landing was accomplished manually.

The flight crew passed a message to ATC as they taxied the aircraft towards its parking stand, explaining that the glideslope had fluctuated. Controllers asked subsequent landing aircraft whether they had perceived any problem and none had. No other landing aircraft reported any difficulties during the minutes preceding and immediately following the incident.

Ground Proximity Warning System (GPWS)

Had the aircraft continued its descent at 1,800 ft/min, approximately 18 seconds prior to ground impact the crew would have received a synthetic voice warning of "SINK RATE". Approximately 9 seconds before impact they would have received a synthetic voice instruction to "PULL UP".

Reporting

The incident was reported by ATC at the airport as a 'Level Bust'; the flight crew did not submit an incident report although they did complete the necessary entry in the aircraft's Technical Log. The AAIB did not become aware of the incident until some weeks after its occurrence. By that time the aircraft's Flight Data and Cockpit Voice Recorders had overwritten the incident flight.

Ground equipment

The air traffic service provider at London Heathrow also maintains the airport's navigation aids. The ILS equipment for each approach is self-monitoring with backup systems which activate rapidly should a fault occur in the active system. Electronic logs are kept of any faults or failures. The relevant logs showed no faults of failures on the day of the incident.

Engineering investigation

After arrival at London Heathrow the aircraft's central maintenance computer was interrogated and a report of any faults recorded during the flight was retrieved. This revealed the following fault:

'C 221000100
D 2287310JAN0612162211
Q L205 R205'

The above gives a fault code '22873' that was recorded on the 10 Jan 06 at 12:16 hours and relates to the ATA 100[2] code 2211. The Fault Isolation Manual (FIM) indicates that the code '22873' relates to an 'ILS BEAM ERROR (FCC[3])' and that no action is required by maintenance staff. Further discussions with the aircraft manufacturer revealed that this code is an indication of a loss of the external ILS signal and that the additional diagnostic codes of 'L205 and R205' indicate that the

Footnote

[2] ATA 100 coding is an international numbering standard for aircraft manuals that relate to aircraft systems. For example, ATA code 2211 relates to autopilot systems.

[3] Flight Control Computer (FCC).

fault was generated by a glideslope beam error that was detected by both the left and right ILS receivers. For these faults to be recorded, the glideslope must have already been detected and captured, followed by an error with the glideslope beam. Purposely flying below the glideslope after it has been captured does not generate these fault messages.

The loss of the glideslope beam, following its capture whilst in approach mode and with the autopilot engaged and the flight director ON, results in the flight director bars biasing out of view and an amber line through the glideslope mode indication on the primary flight display, coupled with a caution message on the EICAS.

A review of technical log entries made before and after the incident flight, which were made available to the AAIB, revealed several occurrences of 'NO LAND 3' messages, either during approach or shortly after landing. The information provided with the technical log reports does not indicate what the cause of the messages was; however, it did reveal that the FCCs were swapped on two occasions (left for centre and later right for centre), the left ILS receiver was replaced and the go-around switches were suspected as being faulty during troubleshooting. It is not known if the faults that generated the 'NO LAND 3' messages were related to this incident. The other significant defect that was reported over the period of December 2005 to February 2006 was an intermittent fault with the heading select switch on the autopilot mode select panel.

Conclusion

The available evidence suggested that an error in the glideslope signal arriving at the aircraft was sensed by both FCCs after the autopilot captured the glidepath. However, monitoring equipment on the ground showed no fault and no cause could be found for the error recorded on board the aircraft.

The AAIB is not aware of any similar incidents immediately before or after this event. Consequently, based on the available evidence, the problem was either external to the aircraft but experienced only by 4X-ELS, or an unidentified internal fault within the aircraft. However, the lack of recorded flight data and the inability to evaluate the aircraft soon after the incident rendered further investigation impracticable.

In this incident, the risk was minimal because visibility below the 1,500 ft cloud base would have permitted the flight crew to gain visual contact with terrain in good time to avoid any Controlled Flight Into Terrain (CFIT) hazard. Had the cloud base been lower, the aircraft's GPWS should also have provided a timely warning of proximity to the ground.

INCIDENT

Aircraft Type and Registration:	Boeing 757-236, G-CPET
No & Type of Engines:	2 Rolls-Royce RB211-535E4-37 turbofan engines
Year of Manufacture:	1998
Date & Time (UTC):	10 March 2006 at 0810 hrs
Location:	London Heathrow Airport
Type of Flight:	Public Transport (Passenger)
Persons on Board:	Crew - 7 Passengers - 149
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	35 years
Commander's Flying Experience:	7,165 hours (of which 5,505 were on type) Last 90 days - 195 hours Last 28 days - 80 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

After engine start, the crew were aware of an unusual odour in the cockpit and both started to feel unwell. Investigation suggested that a suspect oil leakage in the left engine may have been responsible for the smell.

History of the flight

After starting both engines, the co-pilot reported that he could smell fumes and discussed the matter with the commander. After about two minutes of taxiing, the co-pilot started to feel light-headed, euphoric and unwell, the commander also felt light-headed and the aircraft was halted on the taxiway to see if the situation improved. Both flight crew members continued to feel abnormal - the co-pilot considered himself partially incapacitated – but the cabin staff appeared unaffected. Both engines were shut down as the crew no longer felt fit to taxi the aircraft and it was towed back to the stand. During the tow, the co-pilot donned his oxygen mask.

The aircraft was withdrawn from service and the flight crew were stood-down after they had briefed the maintenance staff about the problem and had pointed out that there had been a previous entry in the technical log on 4 March 2006 concerning an 'occasional brief smell of oil on the flight deck. No smell in cabin'. During a check by engineering, no traces of oil were found and the aircraft had been returned to service.

Examination of the aircraft this time (10 March 2006) revealed one defect which may have contributed to the smell: staining on the oil feed tubes feeding the front bearing of the left engine appeared to indicate a leakage of oil into the gas path. However, it could not be established categorically that this was the source of the fumes and, having investigated the suspect leak, the aircraft was returned to service.

ACCIDENT

Aircraft Type and Registration:	Boeing B767-3YO ER, ZS-PBI
No & Type of Engines:	2 Pratt & Whitney PW4000 series turbofan engines
Year of Manufacture:	1992
Date & Time (UTC):	11 July 2005 at 1951 hrs
Location:	London Gatwick Airport
Type of Flight:	Public Transport (Passenger)
Persons on Board:	Crew - 11 Passengers - 207
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to tyre treads on two wheels
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	51 years
Commander's Flying Experience:	17,800 hours (of which 1,460 were on type) Last 90 days - 170 hours Last 28 days - 90 hours
Information Source:	AAIB Field Investigation

Synopsis

As the aircraft approached V_1 during the takeoff, a problem was detected by the crew with the No 1 (left) engine. The takeoff was rejected and the aircraft brought to a halt clear of the runway. The airport fire service arrived very promptly at the aircraft, extinguishing small fires which has started in the left and right main landing gear wheels. After the passengers had disembarked and been bussed to the terminal, the aircraft was towed to a stand.

Data on the 30 minute cockpit voice recorder covering the rejected takeoff was lost as this had been overwritten before it was isolated. Three safety recommendations are made relating to this standard of recorder.

History of the flight

The aircraft was departing from Runway 08R at London Gatwick Airport (LGW), on a scheduled flight to Johannesburg, at a gross takeoff mass of 183,981 kg. This was close to the maximum allowable takeoff mass of 184,612 kg. A reduced Engine Pressure Ratio (EPR) of 1.53 was selected for the takeoff and all proceeded normally until the aircraft had reached an indicated airspeed (IAS) of about 150 kt. At this point the co-pilot, who was the flying pilot (PF), noticed a 'flash' out of the corner of his left eye and heard a bang, followed by the aircraft yawing to the left. He looked at the engine gas temperatures (EGTs), saw that they were normal and returned his attention to the flight instruments. The commander also felt the aircraft yaw and heard a 'dull thump'. He looked at the engine instruments and noticed that the left engine (No 1) N_1 gauge (low speed rotor/fan section) needle was indicating about half full scale deflection and was increasing. He also noticed that there was no digital reading on that gauge. The commander heard a second 'thump' and saw the No 1 N_1 needle drop well below half scale deflection. Since the IAS was still less than V_1, which was 161 kt, he immediately called "stop", took control and carried out the procedure for a rejected takeoff. Reverse thrust was applied, as well as automatic Rejected Take Off (RTO) braking, and the crew reported that the engines behaved correctly as the aircraft decelerated.

The co-pilot advised ATC that they were rejecting the takeoff and requested the attendance of the Airport Fire and Rescue Service (AFRS) because the aircraft's brakes would be hot. When the aircraft had reduced speed to a walking pace, it exited the runway via taxiway BR and was brought to a halt on Runway 26R, facing west, as instructed by ATC.

AFRS response

The aircraft stopped in block 42S, some 300 metres from the Fire Station, and the AFRS response to the first call at 2048 hrs was very rapid, with the first appliances in attendance at the aircraft within one minute. On arrival, the AFRS informed the flight crew over the radio, on frequency 121.6 MHz, that there was a fire in the left main wheel assembly, which they were engaging. The flight crew were also advised by the AFRS that there was no need to evacuate the aircraft. After a minute, the AFRS informed the flight crew that they had extinguished the fire on the left main landing gear and requested that both the aircraft's engines be shut down. The flight crew did this, having started the APU, and released the parking brake. Meanwhile, the AFRS began to engage a brief fire which had started on the right main wheel assembly.

Two minutes after attending the aircraft the AFRS told the flight crew that the fires had been extinguished but that the brakes were extremely hot. While AFRS personnel continued to cool the brakes with a water mist, the flight crew communicated with the passengers, ATC and the airline's handling agent. Once the AFRS was satisfied that it was safe to do so, the passengers were disembarked from the aircraft via the forward left door, twenty two minutes after the takeoff had been rejected. They were then returned to the airport terminal by coach. A videotape of the incident showed that the fire crews were continuing to apply a mist to the tyres and brakes at this point, correctly positioned ahead of, and behind, the wheels. Despite the heat generated in the RTO, none of the protective fusible plugs in the aircraft wheels had melted. Following an inspection by engineers, the aircraft was towed back on to a stand one hour after the takeoff had been rejected.

At the start of the airport's response to the incident, the local emergency services were informed and were kept advised of progress throughout. There were no injuries to any of the passengers or crew during this event.

The incident report prepared by the AFRS showed a response with three major appliances and one light tender. They applied a total of 15,000 litres of water, generally as a mist, and used no other media .

The AAIB later discussed the extent, duration and appearance of the fires with several of the firefighters who attended. There were minor inconsistencies but the general account was that the larger fire was around wheel Nos 2 and 6 (inboard wheels of the left main gear) and that the appearance of the fire was "yellow-orange". The fires were extinguished "within seconds" and, on the left gear, briefly extended above the height of tyre Nos 2 and 6.

Meteorology

The weather conditions, as recorded by the flight crew from the Automatic Terminal Information Service (ATIS) prior to takeoff, were; surface wind 060º/10 kt, visibility greater than 10 kilometres, one to two octas of cloud at 4,000 ft temperature 24ºC, dew point 10ºC and a QNH pressure of 1031mb.

Recorded information

The aircraft was fitted with a Cockpit Voice Recorder (CVR) and a Flight Data Recorder (FDR). Both were successfully downloaded.

CVR

The CVR recorded 30 minutes of audio data. After filtering out a high level of extraneous noise, it was apparent that the recording began subsequent to the event, as the circuit breaker had not pulled at the time the engines were shut down, and therefore was of no assistance in the investigation. The start of the takeoff run (see FDR section) was at 1950 hours, and both engines had been shut down by 1957 hrs, some seven minutes later. There was, therefore, an opportunity to ensure the timely preservation of the recorded data in accordance with ICAO Annex 6 Part I, 11.6.

FDR

The FDR contained data covering just over 29 hours of operation prior to event. There were some anomalies with the recorded data that made the engine N_1 and the computed air speed parameters unreliable below 5.25% and 30.5 kt respectively, and so for the purpose of this report, values below this have been set to zero. All times stated are referenced to UTC. Figure 1 shows the pertinent parameters during the rejected takeoff.

The recording covering the RTO started at 1935 hrs, with the right engine N_1 speed rising, the aircraft moving and in a turn. The left engine was started at 1937 hrs after the brakes had been applied. With both engine temperatures stable, the left engine consistently ran cooler than the right by an average value of approximately 20ºC. This behaviour was mirrored in two of the three other recorded takeoffs, where the temperature differential, whilst never disappearing, reduced to smaller amounts. It is possible that the accuracy of the temperature sensors played a part in the temperature differential; there was insufficient information to make this judgement. Whilst stationary, the N_1 and N_2 values of both engines were the same, at about 25% and 65% respectively.

At 1942 hrs the brakes were released and the engine power was increased. The aircraft taxied with a ground speed of between 7 kt, in turns, and 25 kt, on straight sections of the taxiway. At 1950 hrs the aircraft was slowed to 12 kt and turned from the taxiway adjacent to the runway onto Runway 08R. The aircraft accelerated from half way through the turn, reaching 30 kt by the time the heading stabilised on the runway heading of 83ºM. At this point the auto thrust was engaged, in takeoff mode, and the aircraft continued to accelerate, with the engine parameters matched throughout the acceleration period. The N_2 values reached a maximum of just under 98%, five seconds after turning on to the runway. The rise in N1 and EPR started to stabilise shortly afterwards, although both continued to climb slightly throughout the takeoff run, and the EGTs continued to climb as the aircraft speed increased smoothly. Approximately 27 seconds after turning on to the runway, the N_1 of the left engine recorded a sharp drop from the previous 100% reading to a value of just over 70%. In the next second this recovered to 97% but the N_2, EPR and fuel flow values showed a drop. Over the next four seconds the N1 remained erratic and

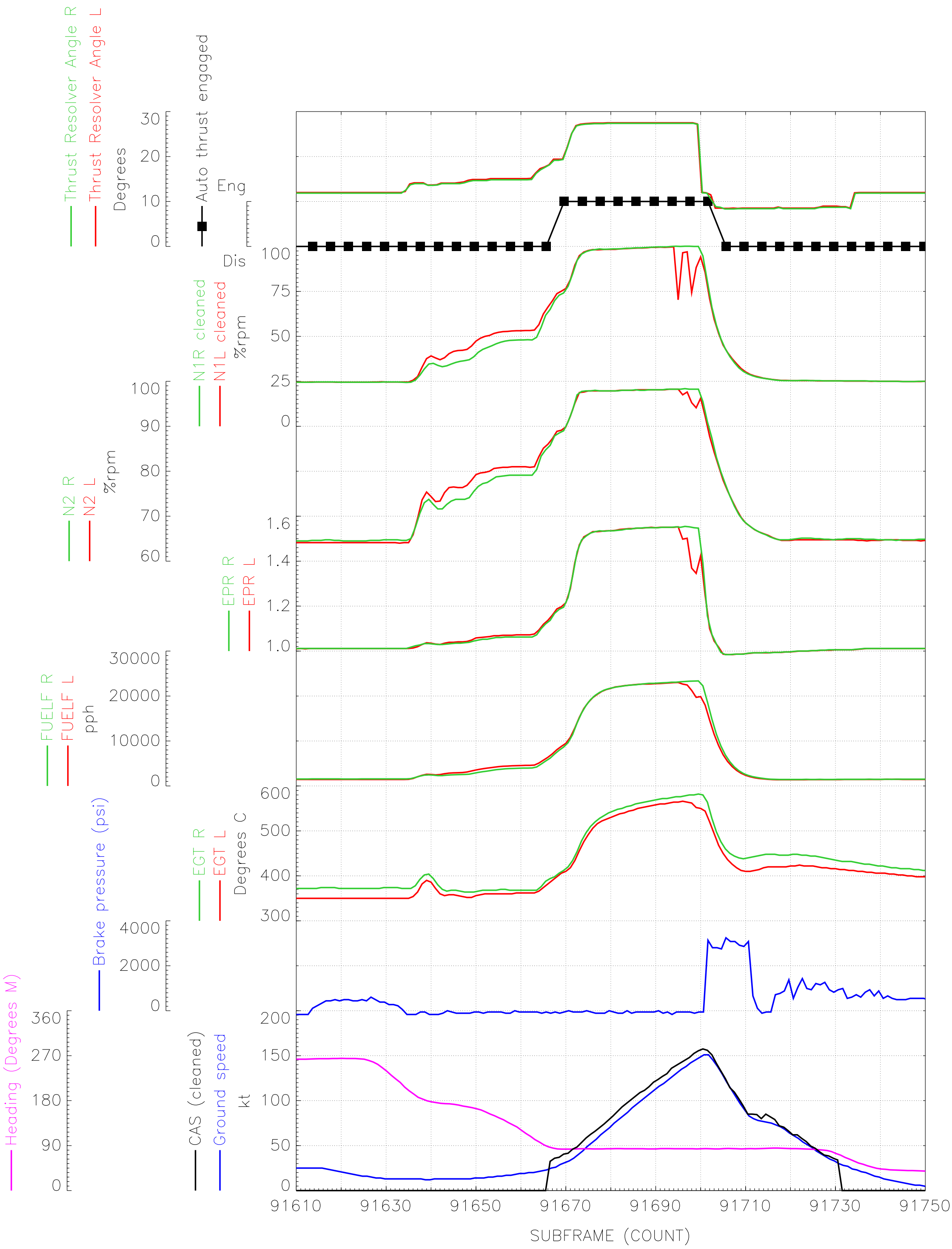

Figure 1

Recorded engine parameters during the rejected takeoff.

the N_2, EPR and fuel flow values decreased, at which point the thrust levers were retarded and the brakes were applied.

The highest calibrated air speed recorded was 157.5 kt and there was no indication of any rotation being initiated. After the takeoff was rejected the engine parameters converged. With the aircraft's computed air speed dropping through 80 kt, the braking action was relaxed for about five seconds and then re-applied with a reduced brake pressure. Throughout the takeoff run, the autobrake was armed and in RTO mode, and the thrust management computer was active in thrust/takeoff modes. The wheel well fire indication parameters were not triggered.

The aircraft was taxied and came to a halt at 1954 hrs, approximately 2 minutes and 40 seconds after the takeoff was rejected. At 1956 hrs the right engine was shut down and the recording ended at 1957 hrs, probably due to the shut down of the left engine; no master warning or caution alerts were triggered. The oil pressure, temperature and quantity parameters did not show any anomalies throughout the event and no engine fire or engine bleed overheat warnings were triggered. Also, the Electronic Engine Control (EEC) system related parameters did not show any anomalies.

Examination of the aircraft

The AAIB examined the aircraft on the evening of the incident in conjunction with the maintenance organisation. At this time, the carbon brakes were still warm and it was apparent that the fusible plugs in the wheels had not melted. The maintenance organisation performed the conditional inspections detailed in the manufacturer's Maintenance Manual (MM) section for a High Energy Stop (767 MM 05-51-14). For aircraft without brake temperature monitoring on the EICAS[1], such as ZS-PBI, these inspections require the use of an extensive chart to determine the approximate dissipated energy per brake unit and the likely maximum brake temperatures. Because of the high takeoff mass of the aircraft and the high maximum speed of the RTO, this chart indicated that the highest temperatures likely to have been achieved were in the 'brake temperature monitor' range of 8; well within the wheel 'Fuse plug melt zone'.

If the derived temperatures are in this zone, the Brake Energy chart notes require the crew to clear the aircraft from the runway, not to set the parking brake, not to approach the landing gear and not to attempt to taxi within one hour. In this case, it is likely that the application of the water mist to the tyres by the AFRS removed sufficient heat which prevented the fuse plugs from melting and hence the tyres deflating.

However, the aircraft's manufacturer's Maintenance Manual includes the following warning:

> *'DO NOT APPLY EXTINGUISHER OR COOLANT DIRECTLY ON THE INFLATED TYRE OR WHEEL. AN EXPLOSION CAN BE CAUSED AND INJURY TO PERSONS CAN OCCUR'.*

In discussion with the aircraft manufacturer on this issue, they commented that this warning is not intended to limit the activity of any AFRS.

Later detailed inspections of the brakes, wheels, tyres, hydraulic and electrical systems confirmed that no discernible damage had been done by the brief fires. The only items changed were two tyres which sustained physical tread damage during the RTO; damage unrelated to the fires.

Engine examination

The No 1 engine was removed by a working party from a Zurich-based maintenance organisation and

Footnote

1 EICAS, Engine Indication and Crew Alerting System.

a replacement engine installed. The suspect engine was sent for examination to an overhaul organisation in Singapore, where the subsequent examination did not show any physical anomaly within the engine. However, it appeared from the recorded data that the engine behaviour had probably been caused by an intermittently erroneous LP rotor speed (N_1) signal. Such a signal fault would cause the FADEC to schedule fuel flow in an unusual manner, with a rapidly decreasing fuel flow when the indicated N_1 increased, followed by a corresponding reduction in fuel flow when the N_1 signal returned to a more normal level.

Certification requirements

The certification requirements for large transport aircraft are principally specified in FAR Part 25 for the FAA and CS-25 (Certification Standards) for the EASA. With regard to braking systems, the requirements are essentially the same.

FAR 25.109 ('Accelerate-stop distance') describes a flight test equivalent to a maximum energy RTO, but does not include criteria as to whether a post-test fire is allowed to occur. FAR 25.735 ('Brakes and braking systems') specifies a five minute period for safe evacuation, as follows:

> *'Following the high kinetic energy stop demonstration .... it must be demonstrated that for at least 5 minutes from application of the parking brake, no condition occurs (or has occurred during the stop), including fire associated with the tire or wheel and brake assembly, that could prejudice the safe and complete evacuation of the airplane.'*

This is developed in the advisory material, AC 25.735-1:

> *'Regarding the initiation of a fire, it should be demonstrated that no continuous or sustained fire, extending above the level of the highest point of the tire, occurs before the 5-minute period has elapsed. Neither should any other condition arise during this same period or during the stop, either separately or in conjunction with a fire, that could be reasonably judged to prejudice the safe and complete airplane evacuation. Fire of a limited extent and of a temporary nature (e.g., those involving wheel bearing lubricant or minor oil spillage) is acceptable. For this demonstration, neither firefighting means nor coolants may be applied.'*

The short-lived fires at both main landing gears fell within the broad limits allowed by FAR 25.735 and its advisory material. A review of accidents to large transport aircraft indicates that the 5-minute 'post-RTO' period has, in almost all cases, allowed both for evacuation of the occupants and deployment of the fire services to the aircraft.

Analysis

The aircraft was departing near to its maximum allowable takeoff mass, on a warm evening. The takeoff was rejected at a speed which was approaching rotation speed, V_1, following a rapid assessment of a left engine fault by the flight crew. The recorded data supports this diagnosis and the actions taken. Before the takeoff roll commenced, there were no recorded indications of any problems with the engines or their control systems. During the takeoff roll, the left engine parameters indicated erratic N_1 values and a drop in engine performance but, after the rejected takeoff, the engine parameters, again, showed no anomalies.

The prompt request for the attendance of the AFRS meant that the fires, which started on both the main landing gear wheel assemblies, were rapidly extinguished. The situation was under control throughout and all interested agencies inside and outside the airport were advised and kept informed. The radio frequency that was used for communications between the AFRS and the flight crew, 121.6 MHz, was recorded and proved to be of use during the investigation. This reflects the sentiments expressed in the AAIB report on a wheel fire event to a Boeing 777, AP-BGL (see AAIB Bulletin 1/2006).

With regard to the short-lived fires at both main landing gears, it is clear that they fell within the broad limits allowed by FAR 25.735 and its advisory material. Whilst this may appear permissable, a review of accidents to large transport aircraft does not indicate that any justification for stricter criteria for fires associated with brake systems is required: the 5-minute 'post-RTO' period has, in almost all cases, allowed both for evacuation of the occupants and deployment of the fire services to the aircraft.

In this particular incident, it is likely that the steady application of water mist by the AFRS prevented the melting of the fuse plugs in the main wheels. This would appear to be in contradiction of the instruction in the MM proscribing the application of '*extinguisher or coolant directly on the inflated tyre or wheel*'. However, the aircraft manufacturer comments that this instruction is only intended for maintenance activities and should not limit the activity of the AFRS.

Safety Recommendations

Had the CVR not been overwritten, further evidence, such as communications and engine noise, may have proved useful to this investigation. The installation of a 30 minute duration CVR on this aircraft, instead of one with a 2 hour duration, was a significant factor in the loss of significant recorded data, in addition to the circuit breaker not being pulled when the engines were shut down after the event. Often, the time between an occurrence of an incident and the first appropriate opportunity to isolate the flight recorders is greater than 30 minutes.

During a previous AAIB investigation involving an FAA registered aircraft (see N781UA, Boeing 777 N781UA, 14 July 2004, AAIB Bulletin 9/2005), the CVR evidence was lost in a similar manner. In the report on that incident Safety Recommendation Nos. 2005-051, 2005-052 and 2005-053, shown below, were made to the FAA and the JAA.

'Safety Recommendation 2005-051

It is recommended that the Joint Aviation Authorities, in common with the Federal Aviation Administration intent, mandate a minimum recording duration of two hours for all aircraft currently required to be fitted with a Cockpit Voice Recorder.'

'Safety Recommendation 2005-052

It is recommended that the Federal Aviation Administration and the Joint Aviation Authorities review their processes of oversight of Operator's procedures and training support to ensure the timely preservation of Cockpit Voice Recorder recordings in accordance with ICAO Annex 6 Part I, 11.6, following a serious incident or accident. The operator procedures and training should provide the necessary skills and information to identify accidents and serious incidents and implement the necessary tasks to preserve these recordings in a timely manner.'

'Safety Recommendation 2005-053

It is recommended that the Federal Aviation Administration require [the operator], and any other airline regulated by the Federal Aviation Administration with similar procedures, to amend their procedures to ensure prompt identification of accidents and serious incidents and timely preservation of Cockpit Voice Recorder recordings.'

The JAA responded to these recommendations with positive intent. At the time of writing, the FAA had yet to respond to the recommendations. These recommendations are also appropriate to this investigation and hence are now addressed to the South African Civil Aviation Authority.

Safety Recommendation 2006-061

It is recommended that the South African Civil Aviation Authority, in common with the Federal Aviation Administration intent, mandate for a minimum recording duration of two hours for all aircraft currently required to be fitted with a Cockpit Voice Recorder.

Safety Recommendation 2006-062

It is recommended that the South African Civil Aviation Authority review their oversight processes of Operator's procedures and training support, to ensure the timely preservation of Cockpit Voice Recorder recordings in accordance with ICAO Annex 6 Part I, 11.6, following a serious incident or accident.

Safety Recommendation 2006-063

It is recommended that the South African Civil Aviation Authority require Nationwide Airlines, and any other airline regulated by them with similar procedures, to amend their procedures to ensure the timely preservation of Cockpit Voice Recorder recordings in the event of an accident or serious incident.

INCIDENT

Aircraft Type and Registration:	Bombardier DHC-8-402 (Q400), G-JEDW
No & Type of Engines:	2 Pratt & Whitney Canada PW150A turboprop engines
Year of Manufacture:	2004
Date & Time (UTC):	20 October 2005 at 0810 hrs
Location:	Leeds Bradford International Airport
Type of Flight:	Public Transport (Passenger)
Persons on Board:	Crew - 4 Passengers - 60
Injuries:	Crew - None Passengers - None
Nature of Damage:	'Runway touched' sensor fairing abraded
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	44 years
Commander's Flying Experience:	4,150 hours (of which 200 were on type) Last 90 days - 126 hours Last 28 days - 42 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft was conducting a practice CAT II ILS approach to Runway 32 at Leeds Bradford International Airport in VMC. Contrary to company standard operating procedures, the co-pilot flew the approach and the landing. At a height of approximately 80 ft, the co-pilot retarded both power levers, resulting in a high rate of descent. Both pilots applied power and the co-pilot flared positively in an attempt to reduce this rate of descent. In doing so, the aircraft was pitched-up to an angle sufficient to cause the underside of the rear fuselage to contact the ground. Damage was confined to the composite fairing covering the 'runway touched' sensor. There were no injuries. Although not a cause of the incident, the investigation revealed that the heading selectors for the commander and co-pilot operated independently, resulting in a temporary deviation from the ATC assigned heading. This was not noticed immediately by the non-handling commander. Two safety recommendations are made.

History of the flight

The crew reported for duty at Belfast City Airport (BHD) at 0515 hrs and checked in as normal. The co-pilot needed to complete six practice CAT II ILS (CAT II) approaches, before he could be issued with a company authorisation to fly approaches below CAT I weather minima. He had not practiced his full complement and asked the commander if he could practice a CAT II approach into their destination, Leeds Bradford Airport (LBA). The commander agreed.

The aircraft departed its stand at BHD at 0631 hrs and took off for LBA at 0640 hrs. The climb and cruise were uneventful. Analysis of the cockpit voice recorder (CVR) indicated that the pilots briefed for their arrival shortly before commencing the descent towards LBA. The co-pilot briefed the commander, who was not a training captain, for a practice CAT II approach to Runway 32 at LBA, referring as he did so to an 'aide memoire' in the quick reference handbook (QRH). This is provided by the operator to ensure that crews are familiar with the standard calls and considerations appropriate to this type of approach. He noted, however, that whereas the standard procedure was for the commander to land the aircraft from such an approach, the co-pilot would land the aircraft himself on this occasion.

The LBA approach controller instructed the aircraft to turn onto a heading of 070° for base leg and subsequently onto a heading of 350°, in order to intercept the Runway 32 localiser. Both pilots set new headings on their respective heading selectors in response to these instructions. The commander, having observed the aircraft make a left turn as expected, saw that it was going to fly through the localiser and realised that the aircraft was in fact established on a heading of 035°, which the co-pilot had set using his selector. When so alerted by the commander, the co-pilot immediately set the correct heading of 350°. The approach controller asked if the crew were able to position the aircraft back onto the localiser without radar assistance, and the commander replied that they could.

The aircraft was flown with the autopilot engaged until shortly before touchdown. Having intercepted the localiser, and subsequently the glide slope, the aircraft maintained a stable final approach. Having configured the aircraft for a standard CAT II approach, with landing gear down and 15° of flap (FLAP 15) set, the co-pilot called for FLAP 35, the normal configuration for a visual landing. The commander reminded him that a CAT II approach and landing was flown with FLAP 15 set. The co-pilot agreed, and the flaps remained at this setting. The co-pilot adjusted the power levers to approximately 17% torque in order to achieve and maintain a V_{REF} of 120 kt.

At a height of approximately 650 ft agl, the commander switched off both bleed air selectors, thus completing the before landing checks. During a standard CAT II approach the co-pilot should call "100 above" followed by "Decide" at decision height (DH), which is usually 100 ft agl. On this occasion, however, these calls were not made and the co-pilot remained at the controls in accordance with the briefing he had given. At approximately 80 ft agl, the commander called "disconnect", prompting the co-pilot to disconnect the autopilot. Almost simultaneously, the co-pilot retarded both power levers. Shortly afterwards the commander said "DON'T PULL THE POWER BACK…YOU PULLED ALL THE POWER BACK…." The co-pilot flared the aircraft positively in an attempt to reduce the developing high rate of descent, and both pilots advanced the power levers, but the aircraft touched down heavily and the tail touched the runway.

The commander stated that the touchdown, though hard, was not markedly different to some others he had experienced on the Q400 aircraft. He did, however, notice that the red master warning light and the TOUCHED RUNWAY warning caption were illuminated. The aircraft was taxied to a parking stand, the engines were shut down and the passengers disembarked without further incident.

The cabin crew reported that, although the landing had seemed hard, particularly so to the cabin crew member seated in the rear of the aircraft, they had not been aware that the fuselage had come into contact with the runway. They had difficulty opening the left rear passenger door although no such difficulty had been encountered prior to departure from BHD. The passengers appeared unaware of the incident.

Aircraft information

The DHC-8-Q400 is a stretched derivative of the DHC-8 family of high wing twin turboprop powered aircraft. The Q400 is considerably longer, heavier and more powerful than its predecessors, with performance approaching that of some jet aircraft. Airflow over the wings produced by the wash from the large propellers, provides significant lift at low speeds. This can be affected if power is reduced prior to touchdown. Consequently, the usual landing technique is to maintain some power until the main wheels make contact with the runway.

The power levers fitted to the Q400 are not mechanically linked to the engines, but instead operate through full authority digital engine control (FADEC) units. The sensitivity of torque to power lever movement increases as the levers are retarded, such that at low torque settings, very small changes in lever angle result in relatively large changes in torque. At 17% torque, which typically is sufficient to maintain a stable approach with FLAP 15 set, the power levers will be very sensitive, and pilots reportedly acknowledge difficulty in correctly setting such values.

Heading selections on G-JEDW can be made on either of two rotary selectors mounted on the central flight guidance control panel (FGCP). Heading selections made using the left selector are shown on the left horizontal situation indicator (HSI)[1] and those made on the right selector are shown on the right HSI. In heading mode, if the left HSI is selected as the master, the autopilot will follow the heading bug on the commander's instrument but, if the right HSI is selected as the master, the autopilot will follow the heading bug on the co-pilot's instruments. The two are totally independent. Consequently, heading selections made by one pilot can only be monitored by the other pilot if he looks across to the heading displayed on the opposite HSI.

Engineering inspection

The operator, which did not have its own engineers based at LBA, requested a local maintenance organisation to inspect the aircraft for structural damage. An engineer attached to this organisation reported that the 'touched runway' sensor fairing was abraded but that no other damage was apparent. He reported that the rear passenger door could not be opened from outside but, because the door could be opened without difficulty from inside the cabin, he judged this to be the result of a fault with the external handle, rather than damage to the door or its aperture. The rear service door, on the right side of the fuselage opposite the rear passenger door, was not opened and consequently was not assessed for comparison.

Later on the day of the incident, the operator dispatched two of its own engineers and another flight crew to LBA who, upon its release from the AAIB, flew the aircraft to its maintenance base without incident.

Additional information

The co-pilot's intention to carry out a practice CAT II approach meant that he would not only fly the approach, using instruments, but land the aircraft, visually, using FLAP 15. However, he had little experience of this particular task. Under current provisions, the operator has stated that there is insufficient time available in the

Footnote

1 Compass and radio navigation indicator presented on the left and right electronic flight instruments.

simulator to include such an exercise in the course of training for low visibility operations.

Flight Recorders

General

The aircraft was equipped with a flight data recorder (FDR), capable of recording the last 25 hours of flight data, and a cockpit voice recorder (CVR) that was capable of recording the last two hours of audio data from the flight deck environment. Both the FDR and CVR were removed from the aircraft and successfully replayed at the AAIB. The entire incident flight was recovered from the FDR and both the approach and landing phases had been recorded on the CVR.

The aircraft was also equipped with a quick access recorder (QAR) which was utilised by the operator to support its flight data monitoring (FDM) program. The QAR data was successfully replayed but was not utilised by the AAIB as it recorded the same data as that recorded by the FDR.

Flight Data

All times quoted are whole minute UTC values. At 0756 hrs, as the aircraft descended through FL130, the crew discussed the approach and landing. During the discussion regarding autopilot disconnection, which would normally occur at 80 ft agl, the co-pilot said "... EIGHTY FOOT, NORMALLY YOU WOULD TAKE CONTROL THEN, BUT I AM GOING TO LAND IT…IS MY UNDERSTANDING", to which the commander replied "YEAH".

At 0809 hrs, the aircraft was level at FL036 on a heading of 069°. The autopilot was engaged with the heading and altitude modes active. A short time later ATC advised a left turn onto a heading of 350°, which was acknowledged by the commander. The autopilot selected heading was set to 035° and the aircraft commenced a left turn. Approximately 20 seconds later the aircraft rolled wings level onto a magnetic heading of 035°. Shortly after this the commander prompted the co-pilot to make the correct selection and the autopilot selected heading was changed to 350°. The aircraft started a further turn to the left and, at about this time, the autopilot heading mode disengaged and the localiser mode engaged. Approximately one minute later the landing gear was lowered and the flaps were extended, initially to 5º and then to 15º.

The aircraft continued the left turn and the localiser parameter indicated that the localiser deviation was reducing. However, as this reduced towards zero, the aircraft continued to turn to the left and the deviation started to increase. The aircraft then made a right turn followed by a small correcting left turn as localiser deviation reduced, this time, to zero. With the aircraft now at a height of approximately 2,500 ft, the autopilot altitude hold mode disengaged and the glideslope mode engaged.

Recorded parameters indicated that the aircraft continued to descend as it tracked both the ILS glideslope and localiser signals. At about 130 feet agl, the airspeed was approximately 120 kt and the left and right engine torques were approximately 16 % and 18 % respectively. At 75 ft agl, the autopilot disconnected. Almost coincident with this, both power levers were retarded slightly (Figure 1 Point A) and both the engine torques and airspeed started to reduce. Shortly afterwards the commander said "DON'T PULL THE POWER BACK… YOU PULLED ALL THE POWER BACK…."

Two seconds later, at 50 ft agl and 115 kt airspeed, the aircraft started to flare. By this time both engines had stabilised at about 5% torque. Two seconds later, at 25 ft agl, with the pitch attitude approximately 7.5º nose

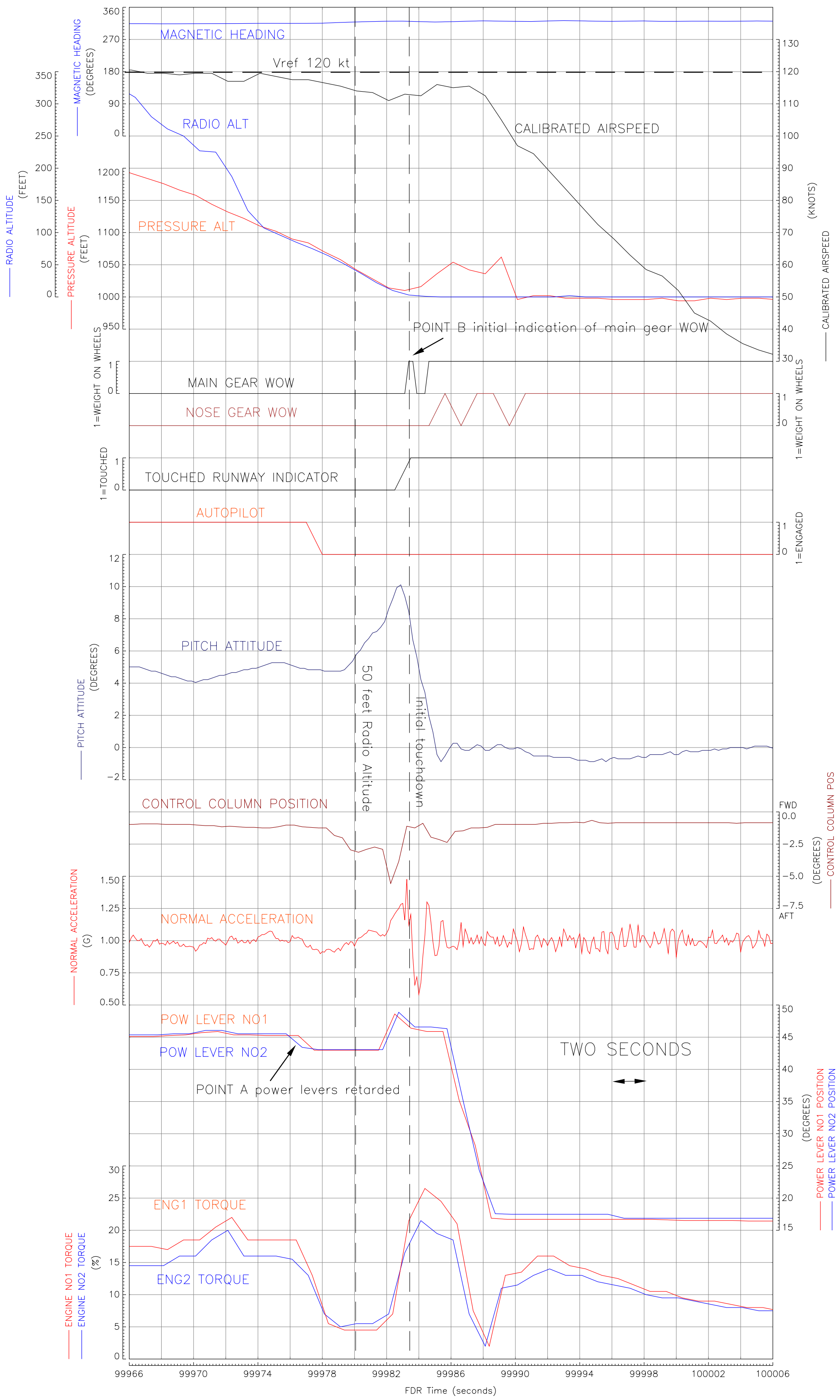

Figure 1

Salient FDR Parameters
Incident to G-JEDW on 20 October 2005

up and the airspeed at 113 kt, both power levers were advanced and the engine torque started to increase. The pitch attitude continued to increase to approximately 10º before reducing slightly to 9.4º, at which time a normal acceleration value of about 1.47g was recorded. This was coincident with the main gear weight on wheels parameter indicating that the aircraft had touched down (Figure 1 Point B). Almost simultaneously, the master and 'touched runway' warnings were recorded.

After the initial touchdown the aircraft momentarily became light before the main gear finally remained in a 'weight on wheels' condition. Shortly afterwards, the nose gear touched down and the aircraft oscillated in pitch slightly before settling, as evidenced by the pitch attitude and nose gear 'weight on wheels' parameters. The aircraft then began to decelerate. As it vacated the runway the crew advised ATC that they had a warning indicating that the aircraft tail may have touched the runway. The aircraft taxied to a stand where, at approximately 0820 hrs, the engines were shutdown.

Weight and balance

The maximum permissible landing mass for this aircraft was 28,009 kg. The fore and aft CG limits, which vary with aircraft mass, were approximately 18.5% and 33.5% MAC[2] respectively. Calculations made after the event indicated that the aircraft was operated within applicable limits at all times, with a landing mass of 25,245 kg and the CG located at approximately 27.5% MAC.

Discussion

Heading selection

The standard procedure when selecting the heading on this aircraft is for each pilot to operate the heading selector on his side of the FGCP, except when the aircraft is being flown manually. In this case the pilot not flying (PNF) should operate both heading selectors. In practice, the PNF often omits to set his own heading, because it plays no active role in the conduct of the flight and serves merely as an 'aide memoire'. In this instance, both headings were set, but the independent nature of the selections resulted in an incorrect heading selection being made by the PF that initially went unnoticed by the PNF. On this occasion the error was quickly resolved but, in the absence of additional cues (such as localiser deviation or positive radar supervision) it may not have been.

The aircraft manufacturer has stated that each customer can specify heading selectors which are either 'independent' or 'coupled'. The electronic flight instrumentation system (EFIS) can be specified with speed, altitude and vertical speed information presented either in the form of tapes or dials, but coupled heading selectors are only available on those with a tape presentation. The operator chose initially to have its Q400 aircraft delivered with a dial presentation, in order to maintain commonality with its DHC-8-200 and -300 series aircraft, equipped with electro-mechanical instruments. When these earlier series aircraft were retired, the operator decided to take delivery of Q400s with a tape presentation, but with independent heading selectors, to maintain commonality with those already delivered. The operator is now in the process of reconfiguring the EFIS on all of its Q400s to a tape presentation and when this process is complete, it will remove the historical pretext for using independent heading selectors. However, the timescale for completion of this re-configuration is not established and it is of concern that aircraft with independent heading selection systems may still be in service for the

Footnote

[2] An expression of the longitudinal position of the aircraft's centre of gravity to the mean aerodynamic chord (MAC) of the wing.

foreseeable future. Therefore, the following safety recommendation is made:

Safety Recommendation 2006-049

It is recommended that the aircraft operator, Flybe, expedite the reconfiguring of the heading selector systems on their DHC-8-400 (Q400) aircraft that do not have coupled heading selectors, such that operation of either heading selector results in an identical selection being presented on both the commander's and co-pilot's flight instruments.

In June 1996, The Federal Aviation Administration (FAA) Human Factors Team (HFT) issued a report titled '*The Interfaces Between Flightcrews and Modern Flight Deck Systems*', which evaluated the interface between the flight crew and flight deck systems in the current generation of transport category aeroplanes. As a result, the HFT recommendations, and a number of related NTSB[3] recommendations, are being considered by a working group comprising representatives of the JAA[4], FAA and industry, which was formed to develop new airworthiness standards for flight guidance systems. The JAA responded by submitting a Notice of Proposed Amendment (NPA) to JAR 25[5], JAR NPA 25F-344, which aims to introduce a revised code for flight guidance systems that is harmonised with United States Federal Airworthiness Requirements (FARs). It includes the following text:

1. *'The function and direction of motion of each command reference control (e.g., heading select, vertical speed) must be readily apparent or plainly indicated on, or adjacent to, each control if necessary to prevent inappropriate use or confusion.*
2. *The flight guidance system functions, controls, indications, and alerts must be designed to minimise flight crew errors and confusion concerning the behaviour and operation of the flight guidance system'.*

Although these changes do not specifically preclude the use of independent heading selectors, the existing design of the FGCP on DHC-8-400 series aircraft would not meet the proposed criteria.

Standard operating procedures

The operator's Part B4 Dash 8 Q400 operating manual (B4) describes the procedure to be followed when carrying out a CAT II approach[6]. The issue current at the time of the incident stated:

'The F/O is pilot flying for the approach and, if necessary, for the go-around. In the case of a "visual" call, the Captain takes control and lands the aircraft.

Further:

At 100 feet above RA[7], the F/O calls "100 above". The Captain responds "Looking" and searches for visual references.

Footnotes

[3] National Transportation Safety Board of the United States.

[4] Joint Airworthiness Authorities, representing the civil aviation regulatory authorities of contracting European states.

[5] Joint Airworthiness Requirements (JAR) 25 relates to certification of large aeroplanes.

[6] The B4 refers to the commander as the "Captain" and the co-pilot as the "F/O" (First Officer)

[7] RA, the decision height (DH) as set on the radio altimeter.

> *When the radio altimeter indicates the set DH, the F/O calls "Decide". The Captain responds "Visual" or "Go-around". If the call is "Go-around", the F/O immediately initiates a go-around. If the call is "Visual", the Captain takes control.*

It also states that, after successful completion of the ground and simulator courses, pilots may carry out practice approaches to CAT II decision heights provided:

a) The reported cloud ceiling is not less than 500 ft and clear visual reference to the runway is established by 400 ft.

b) The RVR is not less than that required for CAT I operations.

Otherwise, the B4 does not differentiate between practice and actual CAT II approaches and it may be inferred that the procedure for each is identical. Indeed, a practice CAT II approach carried out in any other manner would not constitute practice of the required procedure and would not fulfil its purpose. However, the operator's General Manual (GM), which describes general procedures to be used on all aircraft types, states:

> *'The first officer may act as the operating pilot when the reported conditions are not worse than the Cat I minima.'*

Elsewhere, it states that the operating pilot will signify his intention to continue the approach by calling "visual", implying that it is the operating pilot who will land the aircraft. However, it is not clear that this section of the GM refers to Dash 8 Q400 operations. The GM adds:

> *'...it is emphasised that the company operations manual Part B1[8] (sic) should be regarded as having precedence over this material whenever there may be differences'.*

In summary, it appears that the operator did not intend co-pilots to practice landing from a CAT II approach, but sufficient ambiguity existed for flight crews to believe that it was acceptable for the co-pilot to do so under certain conditions. The aircraft was operated contrary to standard procedures but in accordance with a reasonable interpretation of them.

Training

Whereas most pilots will, from time to time, have flown down to, and landed from, a CAT I decision height of approximately 200 ft agl, the view from 100 ft agl is somewhat different. The touchdown threshold may be hidden by the aircraft's nose and the touchdown zone appears much closer. This may give the impression that the aircraft is above the normal approach path. It is conceivable, in this case, that because the co-pilot was relatively inexperienced, his instinctive reaction to these visual cues was to retard the power levers in order to regain what he perceived to be the correct approach path.

The sensitivity of the power levers at angles corresponding to approach torque makes setting the correct values very difficult. This phenomenon is highlighted in training; most pilots are able to achieve accuracy with practice. The co-pilot, who had recently completed his training on type, may not yet have been familiar with these characteristics, or the sudden reduction of lift resulting

Footnote

[8] Part B1 refers to the operation of another type of aircraft but the reference occurs within a part of the GM which is not obviously limited to discussion of that type.

from large power reductions prior to touchdown. Much of his previous experience was gained on types such as light singles and a procedure simulator representing a jet aircraft, on which neither of these factors was present or significant. Indeed, the operator has reported that pilots with many thousands of flight hours, whose most recent experience is on jet types, tend to reduce power too soon on landing when flying the Q400.

A further factor for less experienced pilots is that most visual approaches are flown using FLAP 35, whereas all CAT II approaches are flown using FLAP 15. Training is given in the use of both configurations for visual landings, and crews may elect to land using FLAP 15 on runways with an LDA of 1,800 m or greater. They are, nevertheless, unlikely to practice FLAP 15 landings in the course of normal line operations. On the incident flight, the co-pilot flew both the approach and the landing. He had first to fly the aircraft by sole reference to the flight instruments until 100 ft agl, and then acquire the runway visually before landing, using the flap setting with which he was least familiar.

Training records revealed that the co-pilot had experienced some difficulty achieving consistently acceptable approaches and landings, but that these issues had been quickly addressed by some additional line training.

In the event of the commander becoming incapacitated, the B4 provides that:

> *'If the Captain does not respond to the "Decide" call, the F/O takes control and lands or makes a go-around as appropriate. A landing should only be made if it is obvious that the landing criteria have been met at first glance.'*

In addition, the GM stipulates that:

> *'During training conducted in the simulator the co-pilot shall be familiarised with the duties assigned to him during a Cat II approach (instrument monitoring, call-outs etc)'.*

It follows, therefore, that co-pilots should receive training and practice in landing the aircraft from a CAT II approach to the appropriate weather minima, but there was no provision in the training syllabus for the co-pilot to do so. Furthermore, the operator has confirmed that under current provisions there is insufficient time available in the simulator to include such an exercise in the course of training for low visibility operations. It is therefore recommended that:

Safety Recommendation 2006-050

The Civil Aviation Authority should ensure that co-pilots of Bombardier DHC-8-400 series aircraft operated by Flybe, receive training and practice in landing the aircraft from a Category II ILS approach.

Follow up action

The operator has notified the AAIB that from January 2007, when additional simulator capacity becomes available, co-pilots of Bombardier DHC-8-400 series aircraft will receive training and practice in landing the aircraft from a Category II ILS approach.

The operator has also notified the AAIB that it is rewriting its general and type specific operating manuals, in order to remove ambiguities in the description of standard operating procedures highlighted by this investigation.

INCIDENT

Aircraft Type and Registration:	British Aerospace Jetstream 3102, G-CCPW
No & Type of Engines:	2 Garrett AiResearch TPE331-10UGR-516H turboprop engines
Year of Manufacture:	1987
Date & Time (UTC):	7 March 2006 at 1905 hrs
Location:	Belfast City Airport
Type of Flight:	Public Transport (Passenger)
Persons on Board:	Crew - 2 Passengers - 6
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to propellers and three runway lights
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	34 years
Commander's Flying Experience:	2,600 hours (of which 370 were on type) Last 90 days - 110 hours Last 28 days - 40 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquires by the AAIB

Synopsis

While taxiing along Runway 04 to line up on Runway 22 the aircraft's nose wheel left the paved surface at the end of the runway. Damage was caused to the aircraft's propellers and three runway lights.

History of the flight

The crew were operating their third sector of the day from Belfast City Airport to Ronaldsway, Isle of Man. The commander was the PF for this sector and taxied the aircraft. The weather was light drizzle with a visibility of 5 km, the wind was 150º/5 kt and it was dark.

The commander reported that after an uneventful start up, the aircraft was cleared by ATC to enter, back track and line up on Runway 22. He planned to use the turning circle at the threshold of Runway 22 to turn the aircraft around. Due to the weather, he was using the windscreen wipers intermittently.

The commander taxied the aircraft slowly down the centre of Runway 04 towards the threshold of Runway 22 and he could see continuously the red stop-end lights at the end of the runway. Suddenly he became aware that he had nearly reached the end of the paved surface and quickly applied the toe brakes. At the same time he heard the co-pilot shout "Stop, Stop."

The co-pilot reported that as he was writing down the ATC clearance, he was monitoring the aircraft's progress down the runway. He noticed that the red stop end lights were slowly approaching. He quickly realised that the aircraft was not entering the turning circle and was not going to stop before the end of the runway. He shouted "Stop, Stop" and applied his toe brakes.

The aircraft came to rest with its nosewheel off the paved surface. The aircraft was shut down and the crew and passengers vacated the aircraft, uninjured, with the airfield emergency services in attendance.

Discussion

The commander feels that this accident might have been caused by a distortion of his depth perception due to water droplets on the windscreen. This would have made the red stop end lights appear further away than they were.

He added that while he had back tracked to Runway 22 at Belfast City "several thousand" times, he also operates regularly from Ronaldsway Airport, Isle of Man. He thinks there might be a "very small possibility" that he subconsciously thought he might have been at Ronaldsway. While there are no turning circles at Ronaldsway, both Runway 26 and Runway 08 have displaced thresholds. This means that an aircraft would taxi over the red stop-end runway lights before turning around at the end of the paved surface prior to takeoff.

The aircraft suffered damage to its propeller tips when they struck and broke three runway stop end lights as it left the paved surface.

Conclusion

As a result of water droplets on the aircraft's windscreen the commander's depth perception might have been distorted so he was unable to correctly assess the length of runway ahead. This resulted in the aircraft taxiing off the end of the paved surface and the propellers striking the runway end lights.

The possibility that the commander subconsciously believed he was at Ronaldsway or some form of distraction can not be discounted.

INCIDENT

Aircraft Type and Registration:	De Havilland Canada DHC-8 Series 311, G-NVSB
No & Type of Engines:	2 Pratt & Whitney Canada PW123 turboprop engines
Year of Manufacture:	1998
Date & Time (UTC):	9 August 2005 at 0830 hrs
Location:	On departure from Manchester Airport
Type of Flight:	Public Transport (Passenger)
Persons on Board:	Crew - 4 Passengers - 33
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to right engine and propeller assembly
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	62 years
Commander's Flying Experience:	15,735 hours (of which 3,634 were on type) Last 90 days - 205 hours Last 28 days - 81 hours
Information Source:	AAIB Field Investigation

Synopsis

Shortly after takeoff from Manchester the No 2 (right) engine failed and subsequent attempts to feather the propeller were unsuccessful. The aircraft returned to Manchester where it made an uneventful landing. The No 1 propeller blade support bearing of the right propeller assembly had failed catastrophically, resulting in large imbalance loads through the engine. This led to the fracture of the Power Turbine (PT) shaft, and a consequent overspeed of the PTs, leading to the loss of the PT blades and an exhaust baffle plate from the rear of the engine. The failure of the propeller to feather was due to a ball from the failed bearing becoming jammed between the propeller blade root and the propeller hub. The origin of the bearing failure was not determined although metallurgic examination revealed that cracking had been occurring for a period of time. Six days prior to the incident, heavy vibration was reported but, as vibration survey equipment was not available at the time, the defect was deferred in accordance with the aircraft operator's technical instruction. When vibration survey equipment was fitted, it was set up incorrectly and a full vibration survey was not carried out prior to the incident flight. Two safety recommendations are made.

History of the flight

The aircraft was on a scheduled passenger flight from Manchester to Aberdeen. Prior to the flight the commander and co-pilot had been informed by the company operations department that a propeller vibration survey was required during the flight. The commander had flown the aircraft the previous day, during which he was due to take readings using a monitoring kit that had been fitted specifically for the measurement of reported propeller vibration. During this flight, the commander felt that the vibration levels peaked during propeller speeds of between 900 rpm and 1200 rpm and that this was worse than normal. However, the vibration monitoring equipment was not working correctly so the commander was unable to take any meaningful readings.

The co-pilot was the pilot flying (PF) on the incident flight; the commander was the pilot not flying (PNF). After the engines were started normal checks were carried out with no reported problems, except that during the de-icing checks, airframe vibration was felt with the propellers at 900 rpm. When the aircraft lined up on the runway, a check of the autofeather system was carried out, again with no problems. However, during the takeoff the commander felt the airframe vibration again and thought it had worsened compared with the flight he had carried out the previous day. As the flaps were retracted the crew discussed the vibration level and considered a possible return to Manchester.

In accordance with standard procedure, the autofeather system was deselected and engine power was reduced, at which point there was a 'pop' and a 'bang', heavy vibration was felt and the aircraft yawed to the right. The PF noticed that the torque indicator for engine No 2 was showing 0% and therefore he called for the engine shutdown drill to be carried out. The PNF completed the shutdown drill but the propeller did not feather when the condition lever was selected to START & FEATHER. ALTERNATE FEATHER was selected, but the propeller would still not feather. The propeller speed indication remained at about 500 rpm for the remainder of the flight.

A MAYDAY call was made and ATC gave the crew a priority visual circuit for an approach to runway 24R. The flight crew briefed the cabin crew about the problem and instructed them to prepare for an emergency landing. At about four miles from touchdown the landing gear was selected down, but only the main landing gears indicated as 'down and locked'; the nose landing gear indicated 'unsafe'. The alternate landing gear release was used, successfully, and the approach continued to an uneventful landing. The aircraft vacated the runway and was met by the airfield Rescue and Fire Fighting Service (RFFS), who reported that there were signs of overheating on the left main gear wheels. A precautionary evacuation of the passengers was carried out using the integral airstairs on the forward left door. The co-pilot had remained as PF during the incident, as the commander felt that there was not an appropriate opportunity for him to have safely taken control.

On the day of the incident, a member of the public had been riding a horse in a field to the south of Manchester airport, and had seen a "sizzling hot" object the size and shape of a dinner plate fall from an aircraft and land nearby. The time at which this object had fallen was concurrent with the overflight of G-NVSB and it was later confirmed that the object was a baffle from the rear exhaust section of the aircraft's No 2 engine.

Weather

The weather at the time was reported as being good with a wind of 150°/5 kt, visibility 9 km and broken cloud at 8,800 ft.

Aircraft Description

General

The Dash 8-300 aircraft is powered by two Pratt and Whitney PW123 turboprop engines, each driving a four-bladed Hamilton Sundstrand constant speed propeller, which can be feathered and reversed. G-NVSB was fitted with Type 14SF-15 propeller blades.

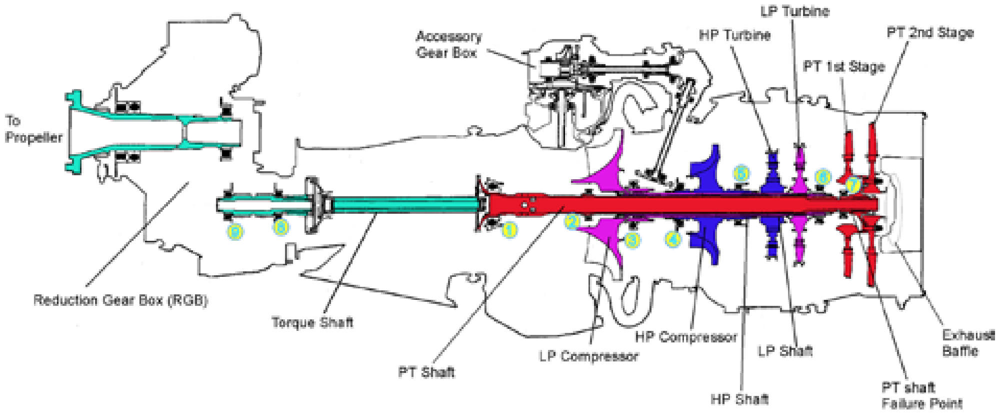

Figure 1

PW123 Engine Shaft Layout and Bearing Locations

Engine

The PW123 engine gas generator is comprised of two spools. The first spool is a single Low Pressure (LP) centrifugal compressor which is shaft driven by a single LP turbine. The second spool is a high pressure (HP) centrifugal compressor, also shaft driven, by a single HP turbine. Power is provided to the propeller, via a reduction gear box, by a two stage free PT located at the rear of the engine. This shaft rotates clockwise and runs internally within the LP shaft, which in turn rotates anticlockwise within the clockwise rotating HP shaft. Each shaft is supported by various bearings throughout the engine.

The engine contains a wet sump oil lubrication system, pressurised by a pump driven by the accessory gear box (AGB). Scavenge pumps, also driven by the AGB, return used oil to the sump. An auxiliary oil tank is located within the reduction gearbox and this is kept full, being replenished with pressurised oil whenever the engine is running.

To the rear of the engine, aft of the PT stage, is an exhaust assembly, the centre of which contains a baffle plate.

Engine Control and Indication

Two engine power levers control the engine speed in the forward power range, and propeller blade pitch angle in idle and reverse 'beta' range. Two condition levers, located to the right of the engine power levers, provide control over propeller speed between 1,200 rpm (MAX) and 900 rpm (MIN), by altering the propeller blade pitch over a range of +26° to +86°. Moving the condition lever aft to START&FEATHER causes the propeller blade angle to be manually commanded into the feather setting. The full aft position is FUEL OFF, which cuts off fuel supply to the engine.

Engine torque for each engine is indicated as a percentage and is displayed to the flight crew on the centre instrument panel. The torque signal is taken from a sensor located on the front inlet case of the engine and this senses the passing of teeth on the PT torque shaft as it rotates. A similar set of teeth are mounted on an unloaded reference tube and it is the phase difference between the passing of the teeth on the torque shaft and the reference tube which determines the torque output indication of the engine. The passing frequency of the teeth on the torque shaft also determines the PT speed (N_{PT}).

The speed of each propeller is also indicated to the flight crew and is generated by a speed sensor located within the reduction gear box.

Propeller

The propeller assembly consists of four propeller blades retained within a hub, which contains the blade pitch change mechanism. Each blade is retained and supported by bearings which consist of a single piece outer race, a single or split inner race, and steel balls separated by a nylon cage. A nylon bearing race retainer ring holds the outer bearing race in position. Spring blade seals, kept in place with a seal support ring and spacer, seal the blade to the hub and are retained statically by an aluminum retaining ring.

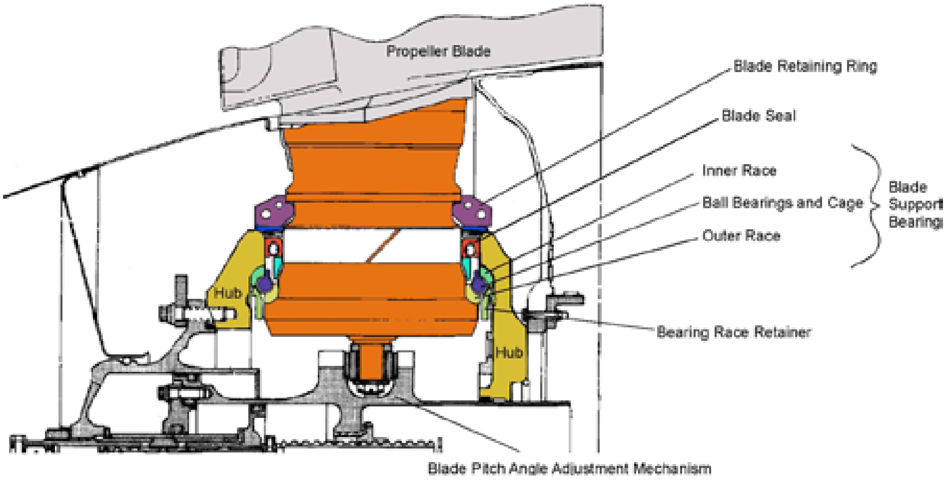

Figure 2

Cross section of a typical propeller blade to hub installation

The propeller control unit (PCU) uses high pressure oil supplied from the engine oil system to control the propeller blades pitch angle. This is determined from propeller speed, engine speed and condition lever position. The PCU controls the supply of oil to the pitch change mechanism piston, which then drives yokes connected to rollers on the bottom of each of the propeller blades. The fore and aft motion of the yokes imparts a rotational movement to each blade, thereby changing the pitch angle.

Propeller feathering

Propeller feathering on the DHC Dash-8-300 can be either automatic, when the system is armed, or manually commanded by the flight crew. There is also an alternate feather system, to be used should either the automatic feather system not operate or there is a loss of engine oil pressure.

Automatic feathering is only armed during takeoff and is disarmed by the crew once established in the climb. Should the engine torque drop below 28% during takeoff or the initial climb, the PCU is commanded to move the propeller blades of the affected engine into feather and the remaining engine is then commanded, via its engine control unit (ECU), to increase power (up-trim).

The manual command to feather a propeller, whilst the engine is running, is accomplished by selection of the condition lever into START&FEATHER position but there is no associated 'up-trim' of the remaining engine.

An 'alternate feather' system is provided so that a propeller may be feathered, via the PCU, but using the auxiliary oil supply and separate oil pump. This system is designed so that it can provide feathering oil pressure to the PCU in the event of a loss of engine oil pressure. 'Alternate feather' is actuated by a switch on the centre console in the cockpit, and requires the engine power lever to be in a position at, or greater than, flight idle and the condition lever to be below the MIN setting.

Flight Data Recorder

Data from the aircraft's flight data recorder covering the incident flight is presented in Figures 3 and 4.

Aircraft examination

The aircraft was inspected by the aircraft operator's maintenance organisation. Externally, there was evidence of a significant oil loss from the No 2 engine propeller hub with oil staining evident on the outside of the engine cowls. On their removal, and after further inspection of the propeller assembly, it was revealed that one of the propeller blade support bearings had failed catastrophically. The remains of the bearing inner race, ball and ball race support cage had been retained within the propeller hub. All four propeller blades had remained attached to the hub.

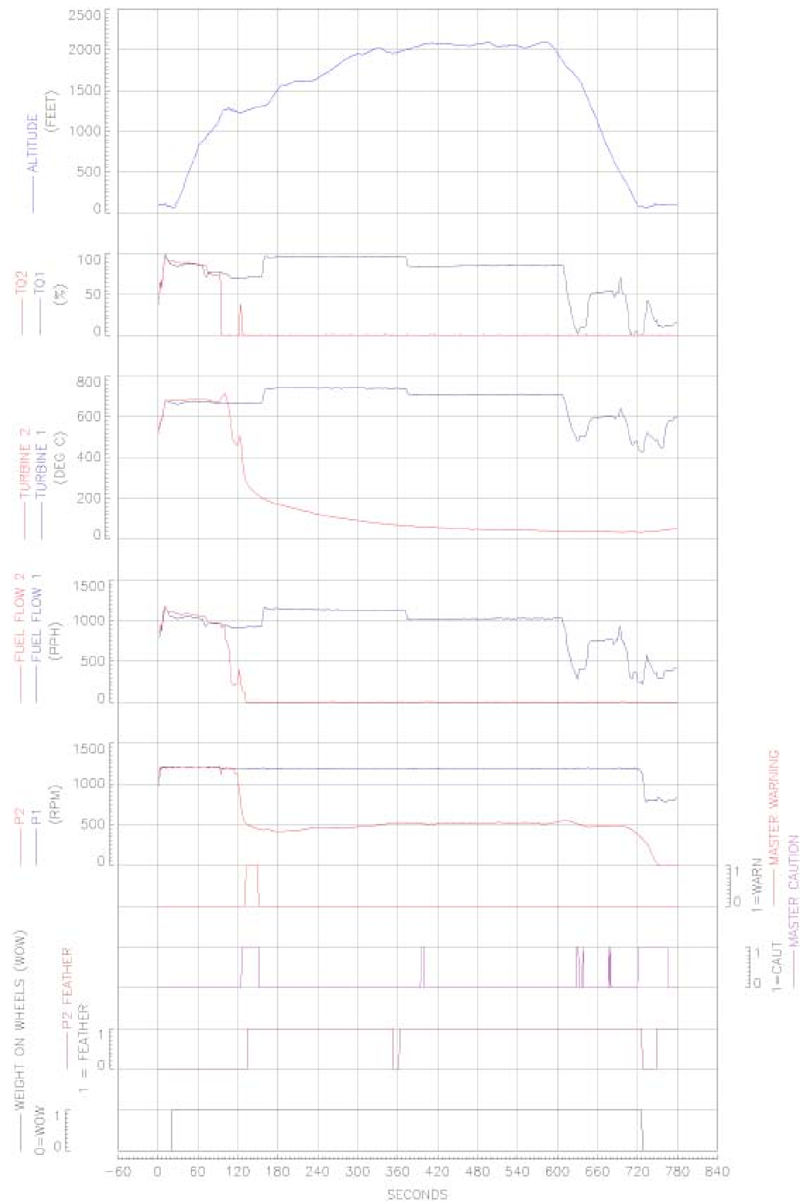

Figure 3

Salient FDR Parameters
(Incident to G-NVSB on 9 August 2005)

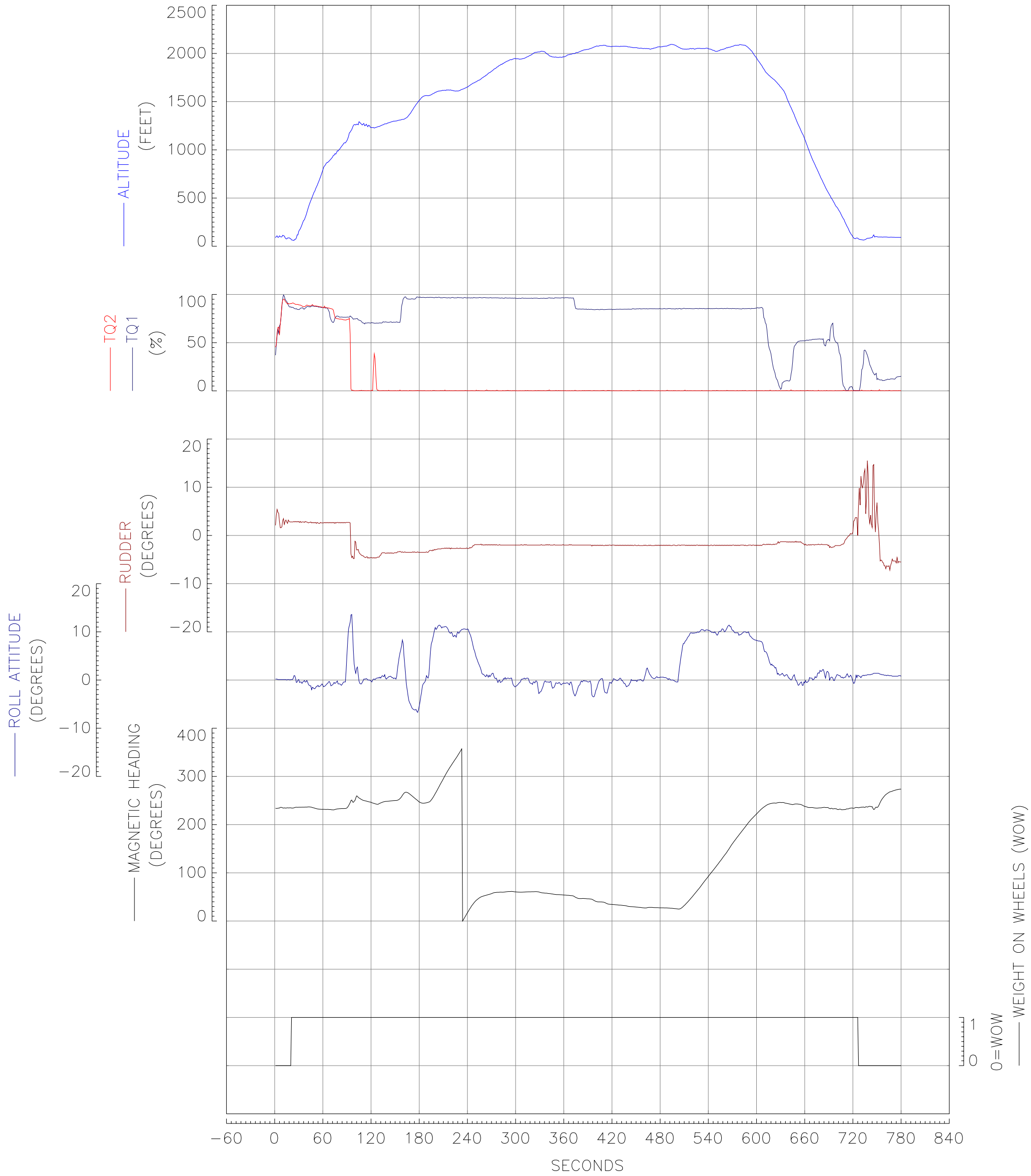

Figure 4

Salient FDR Parameters
(Incident to G-NVSB on 9 August 2005)

Additional inspection of the No 2 engine revealed that the PT had been damaged significantly, with most of the turbine blades on the first and second stage missing. A large section of the rear exhaust baffle was also missing. There was no evidence of an uncontained engine failure, all debris having exited the engine through the exhaust duct.

Both the No 2 propeller assembly and engine were removed from the aircraft and taken to specialist organisations for further detailed examination.

Engine examination

The engine was strip examined at the manufacturer's UK overhaul workshops and from this it was clear that the PT shaft had become disconnected. The two PT discs had been severely damaged and had lost all of their blades. Also, the second stage PT disc had

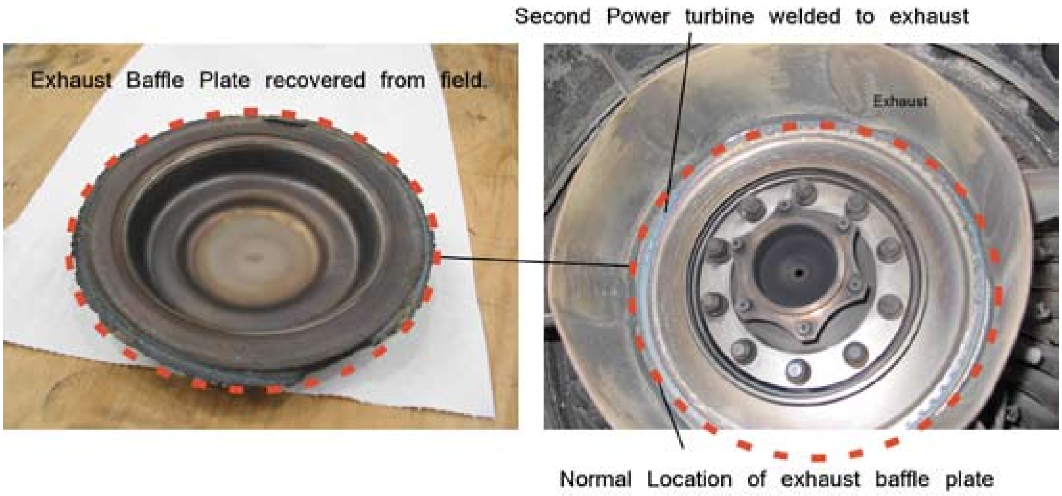

Figure 5

Damage to the exhaust components

come into contact with the exhaust duct and, in the process, had 'machined' into the baffle plate, causing it to depart from the rear of the engine. This disc had then friction welded itself to the remains of the exhaust duct, Figure 5.

The PT shaft had failed just forward of the PT stages and, on its removal, evidence of damage consistent with a torsional failure became apparent, Figure 6. Associated rubbing damage was present on the inner section of the LP shaft. The HP and LP turbine discs were relatively intact with some rubbing evident on the tips of the blades; additionally, there were some light marks evident on the HP and LP centrifugal compressors where they had made contact with the engine caseing.

Propeller examination

The propeller assembly was strip examined at a specialist workshop. This revealed that the failed blade support bearing was that associated with propeller blade No 1. Blade Nos 2, 3 and 4 had been removed from the hub prior to shipping and all appeared to be in a satisfactory condition; the damage associated with blade No 1 precluded its immediate removal. Once removed, it was evident that the inner race, ball race and ball retainer of the blade support bearing had all been significantly damaged and were in many pieces, Figure 7. The outer race remained in one piece in the hub, although it exhibited signs of

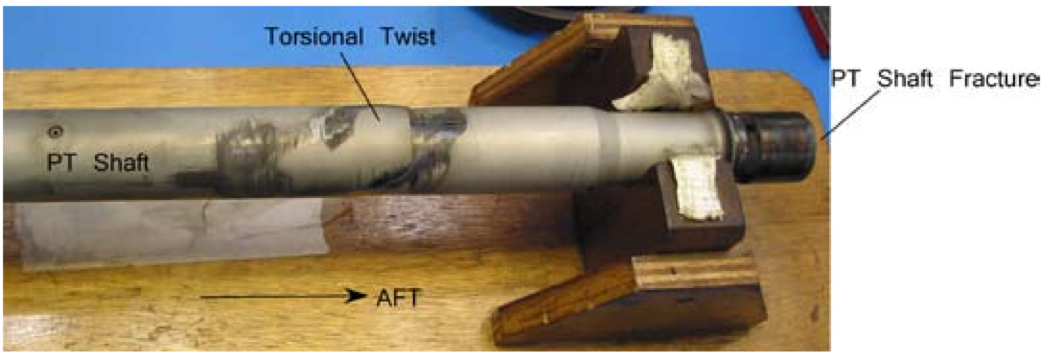

Figure 6

Power Turbine shaft damage

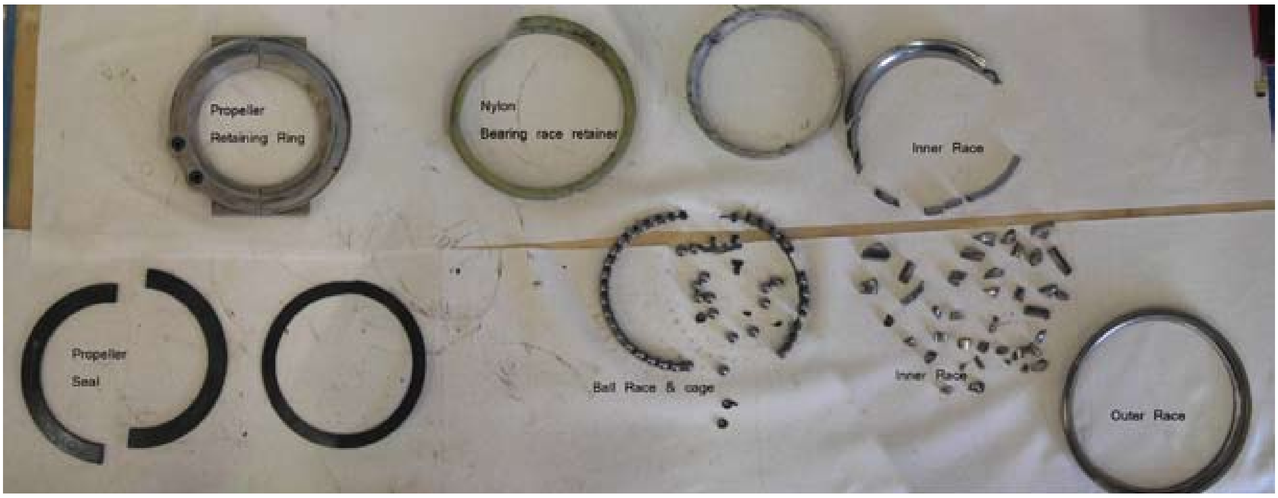

Figure 7

Damaged components of the No 1 propeller blasé support bearing

galling, brinelling and impact damage. The nylon bearing race retainer was also damaged and found in two pieces.

Evidence was found that a ball had become trapped between the blade shank and the hub, with heavy witness marks consistent with the ball having moved with the rotation of the blade toward the feather pitch position, Figure 8. The relative positions of these marks indicated that the blade pitch angle was 31° when the damage occurred. It was evident that the ball had jammed the propeller blade pitch at this position and, consequently, had prevented further movement of all the propeller blades into the feather (86° pitch) position. In addition, the drive roller at the base of the No 1 blade was bent.

No 2 engine propeller assembly history

In the original build, the blade retention bearings used in this hub assembly used a single piece inner race. A split inner race could have been retrofitted whenever the propeller assembly was overhauled or partially disassembled for any reason, if judged necessary.

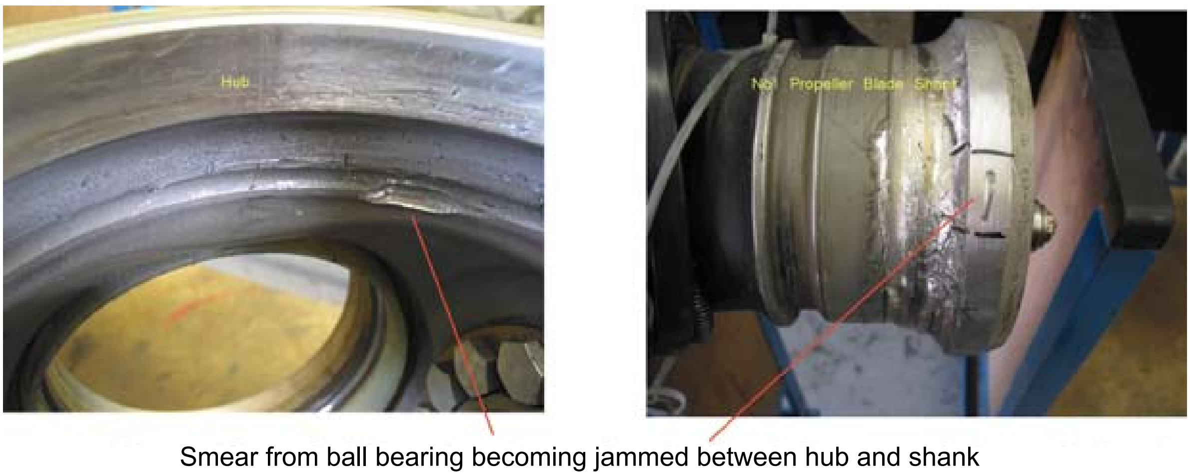

Figure 8

The propeller pitch change mechanism and the PCU were checked and found to be satisfactory

Bearing histories

Bearing No 1		Overhauled at 10,583 hours on 10.10.01 and fitted to G-NVSB with TSO of 1083.49 hours on 25.08.02. Failed at 16,714 hours. Single piece inner race.
Bearing No 2	24,737 hours TSN	TSO 19,288 hours. Single piece inner race
Bearing No 3	12,010 hours TSN	TSO 2,106 hours. Single piece inner race
Bearing No 4	10,443 hours TSN	TSO 3,083 hours. Split inner race

Metallurgic examinations

Engine

The circumferential scoring on the inside of the LP shaft and the torsional overloading of the PT was as a result of contact with each other. The fracture of the PT shaft occurred at its splined aft end and the fracture exhibited evidence of fatigue cracking, with the final failure due to torsional loading. Neither of the two shafts possessed any pre-existing defects and their material was confirmed as being to design specification.

No 1 propeller blade support bearing

Metallurgic examination of the remains of the No 1 blade retention bearing revealed that its inner race had failed mainly due to overload. Due to the severe nature of the damage, it was not possible to determine the root cause of the failure; however, corrosion of the fracture surfaces indicated that cracks had developed over a relatively long period of time prior to its final failure and break up. Some of these cracks had originated from brinelling of the inner race surface, which was also evident on the outer race, and was consistent with the balls striking, or hammering, the bearing race surface. The irregular pattern of the brinelling suggested that this damage had also been progressive over a period of time. The bearing material conformed to the original design specification.

Bearing life

The propeller blade support bearings do not have a specified life and are considered to be 'on condition'. Due to their location, they cannot be inspected in-situ and can only be inspected if the propeller blade is removed, which normally will only occur during a workshop visit. The time this is likely to occur is during a major overhaul of the propeller assembly, following damage to a propeller blade or following a report of an overtorque on the propeller assembly.

Aircraft vibration history

The technical log for the aircraft revealed that an entry had been made on 3 August 2005 for propeller vibration and it stated:

> *'Prop vibration felt throughout RPM 900 - 1200 particularly bad between 980 - 1080 RPM'*

The action taken was:

> *'Noted with thanks. Due nil test equipment @ MAN ADD[1] P147 raised IAW TI D83-61-02'*

Technical Instruction (TI) D83-61-02, issued in December 2003 by the operator, allowed, at the discretion of the engineer, the deferral of a reported propeller vibration defect for a maximum of 50 flying hours. There were no other entries relating to the propeller vibration until 6 August 2005 when the

Footnote

1 ADD – Acceptable Deferred Defect, which is a numbered reference to a reported defect that has been deferred for later rectification.

propeller balance test equipment was fitted, with a reference to ADD P147. During the subsequent flight, in which the propeller balance survey was carried out, the results contained a fault code on the equipment, indicating that it had been incorrectly set up. This problem was addressed and a request was made for an additional survey to be carried out on the next sector. However, despite the equipment being fitted, no record was found of any in-flight vibration survey being carried out. Overnight 8/9 August 2005, another request was made, using the technical log, for a vibration survey to be carried out on the next flight. The incident occurred on the first flight following this request.

The commander of the incident flight had flown the aircraft on the previous day and had attempted to carry out a vibration survey, but found the vibration monitoring equipment to be faulty; no record of this was found in the technical log.

Vibration monitoring

G-NVSB was not equipped with any form of propeller vibration indication or other monitoring equipment for use in normal operation. The aircraft maintenance manual (MM) provides details on how to conduct propeller vibration measurements on these aircraft. This requires the use of test equipment to be fitted to the aircraft to enable the vibration levels from each propeller to be recorded. The MM specifies the use of the Chadwick-Helmuth CH-8500 series vibration analyzer. However, at the time of the incident, the operator of G-NVSB was using alternative equipment, and its associated operating manual, in lieu of that given in the aircraft MM.

The maintenance manual states:

> *'Note: Propeller dynamic balancing cannot be successfully performed on the ground. Operate aircraft in stable air (nominally 10,000 ft altitude) with no icing conditions. Aircraft should be trimmed for straight and level flight…'*

It also states:

> *'Because of the propeller vibrations produced by both propellers are at the same frequency (same RPMs), one propeller may influence the reading obtained for the other propeller. Therefore an extra data collection flight (or two) may be necessary before an acceptable balance (0.15 IPS or less) is achieved'*

The only limit given with regard to vibration levels is that specified above, ie 0.15 inches per second (IPS). The aircraft manufacturer does not provide vibration limits which would trigger investigation of the propeller or engine prior to a further survey flight.

At the time of the incident, the operator conducted propeller vibration surveys on normal scheduled passenger flights, with the flight crew expected to operate the monitoring equipment to take the readings.

The Dash 8 Q400 series of aircraft is fitted with a propeller vibration and balance monitoring system which is coupled to the active noise cancelling system.

There are permanent on-board propeller vibration and balance monitoring systems that can be fitted to the DHC 8-311. These are not provided by the aircraft manufacturer, but by other component manufacturers and are certificated to be fitted to the aircraft by the issue of an approved supplemental type certificate (STC).

Previous Occurrences

According to the propeller manufacturer, over at least the last twenty years, they know of five previous occurrences in which the propeller blade support bearing has failed. In each of these events the initial symptom was vibration, with a resulting engine shutdown or a reduction in engine power. All propeller blades were retained in the hub in these events.

Analysis

The failure of the No 2 engine, and subsequent failure of the propeller to feather at a critical stage of flight, exposed the flight crew to a situation which they would not normally experience and one for which they were not trained. However, the prompt actions taken by the flight crew enabled a safe return and landing. It was fortunate that despite the propeller not being fully feathered, sufficient rudder authority was available to maintain directional control.

The cause of the incident was due to a catastrophic failure of the No 1 propeller blade support bearing, forming part of the No 2 engine propeller assembly. The bearing appears to have broken up just after takeoff just as engine power was being reduced. The 'pop' and 'bang' reported by the flight crew was likely to have been the propeller blade support bearing failure and the subsequent rapid engine failure; all damage identified in the engine was consistent with being a direct result of the failure of this bearing.

Following the failure, large out of balance loads would have been generated which affected not only the propeller assembly but also the engine's power drive system, in particular, the PT shaft. The out of balance loads caused the PT shaft to 'whip' and come in contact with the inner surface of the contra-rotating LP shaft, resulting in a large torsional load in the PT shaft and its eventual fracture. This disconnected the two PT stages, which very quickly oversped, moving aft in the process, and shedding their blades from the engine exhaust. The 2nd stage PT disc had also come into contact with, and welded itself to, the exhaust assembly, which removed enough material to allow the rear exhaust baffle plate to become detached.

The PT shaft failure removed all torque to the propeller and produced the 0% torque indication in the cockpit. The subsequent shutdown of the engine was successful, however, the feathering of the propeller could not be completed. A ball from the failed bearing prevented complete movement of the propeller blade in pitch, when it had become jammed between the blade shank and the hub. This effectively locked the propeller pitch angle at 31º, causing the propeller assembly to windmill at about 500 rpm.

The cause of the bearing failure was not determined. The bearing had completed 16,714 hours in service so, initially, it was thought that its age was a contributing factor. However, the blade No 2 bearing of the same assembly had completed 24,737 hours and showed no signs of an impending failure. The propeller manufacturer has knowledge of only five previous instances of bearing failures in service and, as such, this failure is considered quite a rare occurrence. Therefore, it is unlikely that the failure was 'time-in-service' related. It was also unlikely that the failure was due to an installation problem as the propeller had been fitted within the hub and had apparently been operating satisfactorily for over 5,000 hours, of the four and had not been disturbed during that time. The brinelling damage to the bearing races indicates that the balls had been free to move within the races, as the marks were generated by the balls striking the races. It is possible that there had either been a failure of the ball cage, or the retaining clip for the ball race had fractured or become detached, as it was not located in the remains recovered from the propeller hub. It was also possible, in the manufacturer's view, that the lubricating oil within the propeller hub could have been contaminated with hard particles, which may have induced fatigue cracking and precipitated the initial failure of the inner bearing race.

As the failure was limited to only one bearing within the propeller assembly, it is unlikely that an overtorque event had precipitated the failure, as this would equally affect all the bearings. Similarly, there was no external damage to the propeller blade or a report of any previous damage that could have induced loads required to initiate the bearing failure.

Although, it was not possible to determine the exact cause of the bearing failure, it appears there were warning signs (vibration) of the impending failure that, if heeded in time, might have prevented the failure. Metallurgic examination has shown that cracks had developed, and been in existence for some time, prior to the break up of the inner race and that some of these cracks originated from brinelling marks. The reports in the technical log indicated that vibration had been evident during a flight on 3 August 2005, some six days prior to the incident. It is considered likely that this vibration was due to the early stages of propeller blade support bearing failure.

At the time of this incident, the operator allowed propeller vibration defects to be deferred, despite having no method to quantify the severity of the vibration or its origin. This operator's aircraft type is not equipped with an on-board vibration monitoring or indication system, so the determination of severity of any vibration is purely a subjective assessment by the crew. The only way to measure vibration is to fit test equipment and conduct a flight on which the vibration level can be ascertained. Indeed, it would appear that the intention of a deferral is to allow the aircraft to continue in service until vibration test equipment becomes available.

In the case of G-NVSB, the raising of a deferred defect in the technical log, was due to the unavailability of test equipment. It was not until 6 August 2005, that the test equipment was finally fitted. Despite this, the subsequent measurements taken were unusable due to a fault in its set up. This included an attempt by the commander of the incident flight, the day before, during which he also found the survey equipment faulty. Finally, a request was made, via the technical log, for a survey flight. Unfortunately, the incident flight was the first flight following this request.

Had a full vibration survey been successfully carried out, it is not known whether the failed bearing would have been immediately identified. The maintenance manual procedure is to, initially rebalance the propeller, based on the survey information, and to continue to do so until the vibration drops to the specified acceptable limit of 0.15 IPS. There is no information in the maintenance manual to guide the operator to look deeper into the propeller assembly for other possible causes, or damage; indeed, there is no upper limit to the vibration level at which it is deemed unacceptable to continue flight without a thorough examination of the assembly.

Therefore the following safety recommendation is made:

Safety Recommendation 2006-067

It is recommended that Transport Canada require the aircraft manufacturer, Bombardier Aerospace, to amend the maintenance manual for the DHC Dash 8-300 aircraft with regard to propeller vibration measurements and to provide instructions when to investigate the propeller and/or engine assembly for possible internal damage, based on measured vibration levels, and to provide specific vibration level limits at which detailed inspections are required.

In a response to this safety recommendation, Transport Canada stated the following:

'Transport Canada agrees with the intent of this recommendation. If appropriate Instructions for Continued Airworthiness (ICA) or other operational limitations for procedures regarding significant or unusual vibration events were in place at the time of the initial event noted in the "Aircraft Vibration History" [page 47 in this Bulletin]*, the bearing failure and subsequent events may have been prevented.'*

In response to this safety recommendation, the aircraft manufacturer have provided the following information:

'We were recently informed by Hamilton Sundstrand that they are planning to incorporate a "Vibration Note" into their maintenance documentation. Bombardier Aerospace will review this note and make a similar change to our Aircraft Maintenance Manual (AMM). At present, there are two independent Supplemental Type Certificates (STCs) available to permantly install propeller vibration monitoring equipment in the Q100, 200 and 300 DHC-8 aircraft………

…..Reporting of abnormal vibrations in flight is very subjective. Flight crew experience and familiarity with the subject aircraft is an important criteria with identifying abnormal aircraft vibration. In our opinion, the investigation of a flight crew noted vibration scenario would highlight potential areas of concern including engine and propeller issues. The response to the reported inflight vibration will confirm either a propeller imbalance or direct maintenance to persue investigation elsewhere.'

As it is not possible to conduct a meaningful vibration survey with the aircraft on the ground, the aircraft has to be flown, but with the risk that an incipient defect may become critical during the flight. It has been a common practice to conduct these vibration surveys on revenue passenger carrying flights, using line pilots, who may not be fully conversant with the monitoring equipment. This practice comes with the attendant risk of a failure occurring, which may necessitate an emergency, as was the case with G-NVSB. It also leads to the possibility of incorrect use of the monitoring equipment and incorrect readings being taken, requiring further survey flights. If a vibration problem has already been identified on an aircraft, it would seem more prudent to conduct the vibration survey using crew members that are experienced in using the test equipment and to fly the aircraft without passengers.

Therefore the following safety recommendation is made:

Safety Recommendation 2006-068

It is recommended that Transport Canada require the aircraft manufacturer, Bombardier Aerospace, to amend the DHC Dash 8-300 maintenance manual with regard to propeller vibration monitoring flights, to ensure that vibration surveys are only conducted on non-revenue flights by appropriately trained crews.

As a direct result of this incident, the operator now carries out all airborne checks of propeller vibration levels using AMM approved equipment which is deployed only during dedicated non-revenue 'function flights'.

In addition, the aircraft manufacturer has stated that they support:

> *'the fact that flight crews must be adequately trained and proficient in the use of the propeller balancing* [vibration measuring] *equipment, prior to undertaking this task.'*

However, they:

> *'believe that mandating of this recommendation* [2006-068] *must remain at regulatory authority level. If it is decided that this task can be performed on a revenue flight, it is mandatory that it be performed during low workload periods (such as cruise flight), by an appropriately trained proficient crew.'*

ACCIDENT

Aircraft Type and Registration:	Learjet 45, D-CNIK
No & Type of Engines:	2 Honeywell TFE731-20 turbofan engines
Year of Manufacture:	2003
Date & Time (UTC):	17 March 2006 at 2029 hrs
Location:	London Gatwick Airport
Type of Flight:	Public Transport
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - 1 (Serious) Passengers - N/A
Nature of Damage:	Fuselage and entry door plus damage to a parked motor vehicle
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	42 years
Commander's Flying Experience:	9,500 hours (of which 2,450 were on type) Last 90 days - 54 hours Last 28 days - 26 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft was being prepared for departure to Paris. The commander was at the rear of the cabin and the co-pilot was on the flight deck. The right engine was running in order to provide electrical services and air conditioning for the cabin. The engine power was inadvertently increased to 70% N_1 and the aircraft moved forwards, unobserved by the co-pilot. Whilst moving forwards through the cabin, the commander fell from the open doorway. The outer part of the left wing struck a parked motor vehicle and the aircraft swung rapidly to the left, turning through 180º before coming to rest again against the side of the vehicle. The commander and a ramp handling agent were both struck by the aircraft and knocked to the ground. The commander was seriously injured.

History of the event

The aircraft had arrived at London Gatwick earlier in the day and was parked facing south on Stand 143 by the off-going crew. The nosewheel, which was chocked in front and behind with the aircraft's own chocks, was positioned on the yellow painted centreline of the stand. The weather conditions at the airport were dry and clear with a surface wind from 050º at 18 kt.

The flight crew were driven to the aircraft by a handling agent. The vehicle was parked in front of the left wing facing approximately north. The co-pilot went on board and set the park brake by pulling and turning the handle. He then climbed into his seat, selected all three batteries ON, the cockpit lights ON and started the right engine. Once the engine was running he selected the air conditioning ON.

The co-pilot recalled that he had been seated half in his seat facing rearwards. After a few seconds he sensed that something was wrong and realised that the aircraft was moving. He climbed back fully into his seat so that he could apply the toe brakes, but the aircraft was now swinging round rapidly to the left and he was unable to act in time to stop it. He heard a crash as the aircraft came to rest against the side of the parked van. He pulled the thrust lever back to idle and a few seconds later shut down the engine.

Meanwhile the handling agent had brought the catering to the aircraft and the commander stowed it in the galley. The commander then went to the rear of the aircraft cabin to stow his baggage. While he was there, he noticed an increase in engine noise, he tried to call to the co-pilot but because of the air conditioning noise could not be heard. He moved forward up the cabin and as he came alongside the steps realised that the aircraft was moving. He was partially on the steps when he lost his balance and fell to the ground outside the aircraft.

After the aircraft came to rest the co-pilot could hear someone calling and so he looked back into the galley area; he was surprised to see that no one was there. He climbed out of the aircraft, over the van which was now partially blocking the doorway, and found the commander lying on the ground injured. The handling agent, who had also been knocked over by the aircraft, was back on his feet and together they assisted the commander towards the van. The handling agent telephoned airfield operations and asked them to contact the emergency services.

Accident sequence

The aircraft had been parked with the nose wheel aligned with the painted central guidance line for stand 143L on a heading of 169ºM. Alongside the aircraft was a Volkswagen 'Sharan' Multi-Purpose Vehicle (MPV) acting as a ground support vehicle (see Figure 1). The aircraft had moved forward and initially struck the left hand side of the MPV, and had then turned to the left around the rear of the ground support vehicle. It had then struck the right side of the MPV, coming to rest against the vehicle on a heading of 013ºM, approximately 8.6 m from the centre of the stand marking. The MPV had been pushed sideways in the final impact and moved approximately 0.6 m, forcing the left front tyre off its rim.

At some stage during the aircraft movement the commander had fallen to the ground outside the aircraft. The trailing edge of the nose landing gear door had been bent by impact with the commander and there was a faint mark on the concrete surface of the stand that had been made by his clothing. The mark followed an arc corresponding to the path of the nosewheel (see Figure 1) as he was dragged by the aircraft.

Personnel information

The commander was employed by the operator on an occasional basis as a freelance pilot. He had flown some 50 hours on their behalf over a period of 15 months prior to the accident. He held a Type Rating Examiner (TRE) qualification on the aircraft and had previously carried out some check flights on other pilots on behalf of the operator. He flew this aircraft type on behalf of several other operators and also flew another commercial aircraft type.

The co-pilot had been employed by the operator for a period of 18 months. He had flown a total of 920 hours

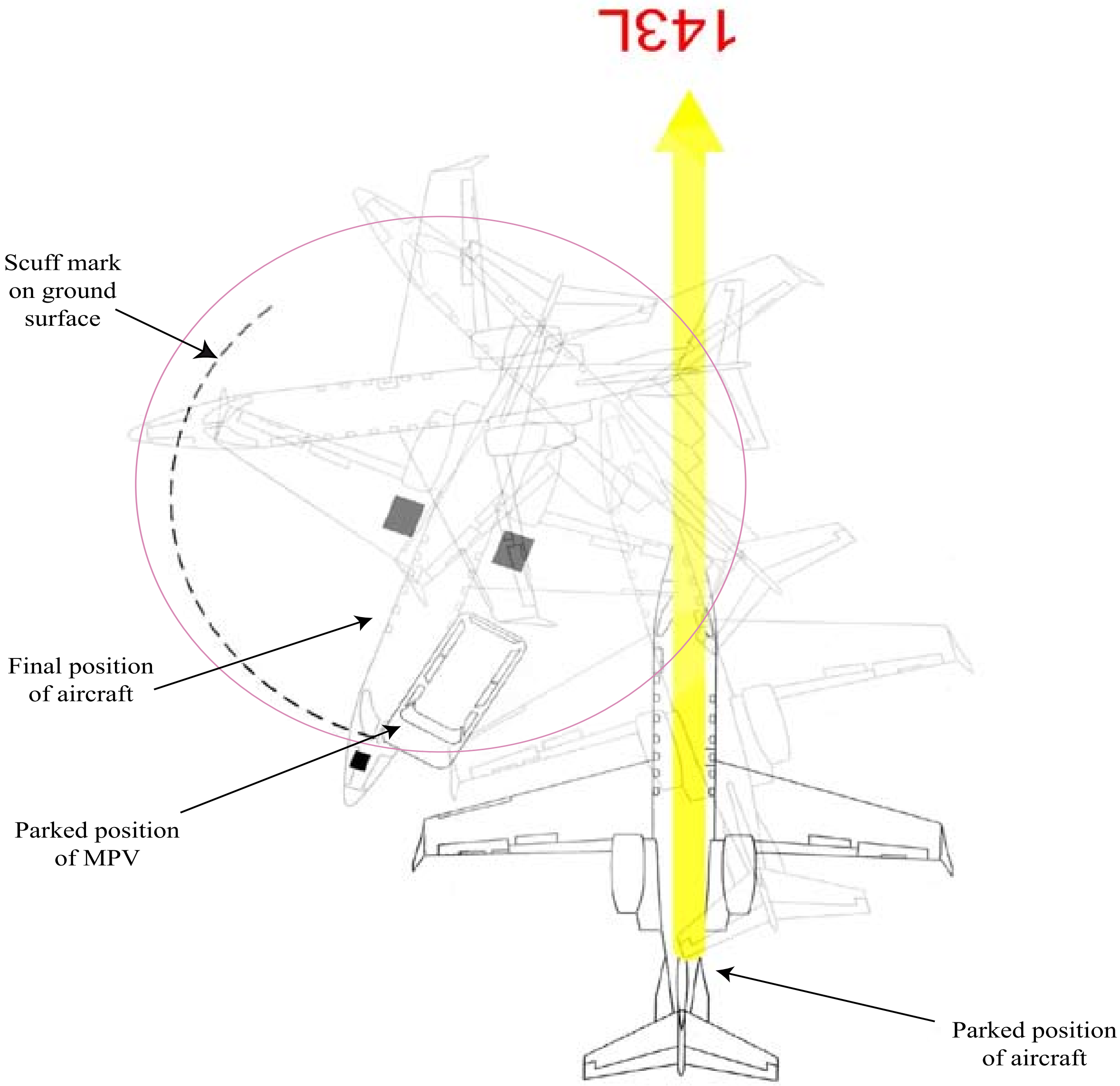

Figure 1

Location of aircraft and ground support vehicle

on the aircraft type. He had not flown any other type in the preceding 90 days. When the co-pilot started his employment with this operator, he was already qualified on the aircraft type.

Aircraft information

General

This type of aircraft is fitted with two engines mounted high on the rear fuselage. D-CNIK was not fitted with an APU, it is an item of optional equipment for the aircraft. A pair of small wooden chocks weighing approximately 1 kg each was carried aboard the aircraft.

Brake systems

The braking system on this type of aircraft comprises the normal brake system and the emergency/parking brake system. The normal brake system is controlled by a two channel brake control unit which controls hydraulic pressure to the brake control valves under a combination of pilot brake pedal demand, anti-skid, locked wheel protection and touchdown protection. The main hydraulic system supplies a nominal system pressure of 3,000 psi to the normal braking system from two engine-driven pumps. An auxiliary DC motor-driven hydraulic pump provides pressure to the brake system if the engine driven pump supply is lost. A separate brake accumulator, fed by the auxiliary system provides hydraulic pressure to the emergency/parking brake system.

The emergency/parking brakes are applied by pulling upwards the emergency/parking brake handle located on the centre pedestal. The handle is connected via a lever and a cable to the emergency/parking control valve, which opens to allow hydraulic pressure from the emergency/parking brake accumulator to the emergency/parking brake shuttle valves. Turning the emergency/parking brake handle through 90º when the handle is fully extended from the pedestal holds the emergency/parking control valve open to maintain the hydraulic pressure to the brakes for parking.

The emergency/parking brake control valve internal switch signals the data acquisition system that the valve has been opened and displays a white PARK BRAKE ON annunciation on the engine instrument and crew alert system (EICAS) display. The emergency/parking brake accumulator hydraulic pressure is also displayed on the EICAS. The pressure is displayed in amber at less than 2,600 psi or more than 3,600 psi and a BRK ACUM PRESS warning is displayed.

The auxiliary DC motor-driven pump is automatically switched on when the landing gear is transitioning UP or DOWN, or selected manually using the push button AUX HYD switch. Operation of this pump recharges the emergency/parking brake hydraulic accumulator which provides reserve hydraulic pressure at 3,000 psi. The accumulator is designed to provide at least six emergency brake applications or to maintain parking brake pressure for approximately 48 hours.

The procedure in the Airplane Flight Manual (AFM) required the accumulator to be charged by activating the AUX HYD pump before applying the park brake. The emergency/parking brake system pressure cannot be charged by the engine driven pumps. However, if the park brake handle is set to ON when there is sufficient residual pressure in the system, the brakes will be applied. When applied with full system pressure available, the brakes are capable of holding the aircraft in position at high power settings.

Nose wheel steering system

The nosewheel steering system is used to steer the aircraft during takeoff, landing and taxiing. The nosewheel steering computer senses pilot rudder pedal demand, via differential transformers, and operates an electrical steering actuator to turn the nosewheel. Steering is only available when the aircraft is on the ground and only functions if the nose steering push switch, located on the forward instrument panel, is armed. The system is normally armed after start and before the aircraft is taxied.

Engine control system

Each engine is controlled by its own Digital Electronic Engine Control (DEEC) computer. This is normally left switched to the ON position, although there are two other modes of use, MANUAL and OFF.

Flight Recorders

The aircraft was equipped with a solid state Flight Data Recorder (FDR) capable of recording and retaining data for a minimum duration of 25 hours and a solid state Cockpit Voice Recorder (CVR) capable of recording 120 minutes of communication and ambient noise from the cockpit environment. Both recorders were removed from the aircraft and subsequently downloaded at the AAIB's replay facility. The accident data was successfully recovered from both the FDR and CVR.

Both recorders were electrically powered when battery power was applied and remained powered for 64 minutes after the accident. The FDR was capable of recording a total of 139 parameters, which included the position of both engine thrust levers and the N_1 shaft speeds from both engines.

Recorded Data

Figure 1 provides the salient parameters of the accident. The No 2 engine thrust lever was set to about 19º[1] and shortly afterwards the No 2 engine N_1 shaft speed started to increase. As the engine was started there was a short conversation on the flight deck that lasted about six seconds. As the aircraft's avionics systems powered up the magnetic heading parameter became active, indicating that the aircraft was on a magnetic heading of 169º. The number two engine N_1 shaft speed continued to increase until it settled at idle thrust, which was about 21% N_1. Some 10 seconds later the bleed air was heard to be selected ON.

The No 2 engine thrust lever remained at the idle thrust position until about 17 seconds later when it was quickly advanced to about 80º, some 12º before it would have entered the MCR[2] position. Just prior to and also coincident with the movement of the No 2 engine thrust lever, a series of clicks was heard on the flight deck, but the exact origin of those noises could not be determined. The No 2 engine N_1 shaft speed started to increase from idle thrust until about eight seconds later it had reached 59%, at which time the aircraft began to move forwards. The N_1 speed increased until it reached 72%, at about which time the aircraft then started to accelerate rapidly forwards and turn to the left. About five seconds later the No 2 engine thrust lever was quickly moved to the idle position and the N_1 shaft speed started to reduce. Almost coincident with the No 2 thrust lever moving to idle, a noise was recorded that was similar to brakes being applied. About one second later the aircraft stopped turning. The aircraft had turned onto a magnetic heading of 013º having turned through 154º in 6 seconds.

About seven seconds after the aircraft had stopped turning, the No 2 engine thrust lever was closed and the engine was shutdown. Both recorders continued recording for about 64 minutes before electrical power was removed.

When the No 2 thrust lever was set to the idle position, the number one engine thrust lever was slightly advanced to about six degrees and a sequence of three chimes was recorded.

DEEC data

Data is stored in the DEEC and can be accessed by the operator to obtain engine operational and fault information. Within the stored data file there is a restricted area accessible by the engine manufacturer for the purpose of accident investigation. A data download of the DEEC was carried out for the investigation. The data obtained from the DEEC did not provide any useful additional information to that obtained from the FDR.

Footnotes

1 Idle thrust setting is between 9º and 23º thrust lever angle.

2 MCR (maximum cruise thrust), which is the first de-tented position and is between 91.5º and 96.9º thrust lever angle.

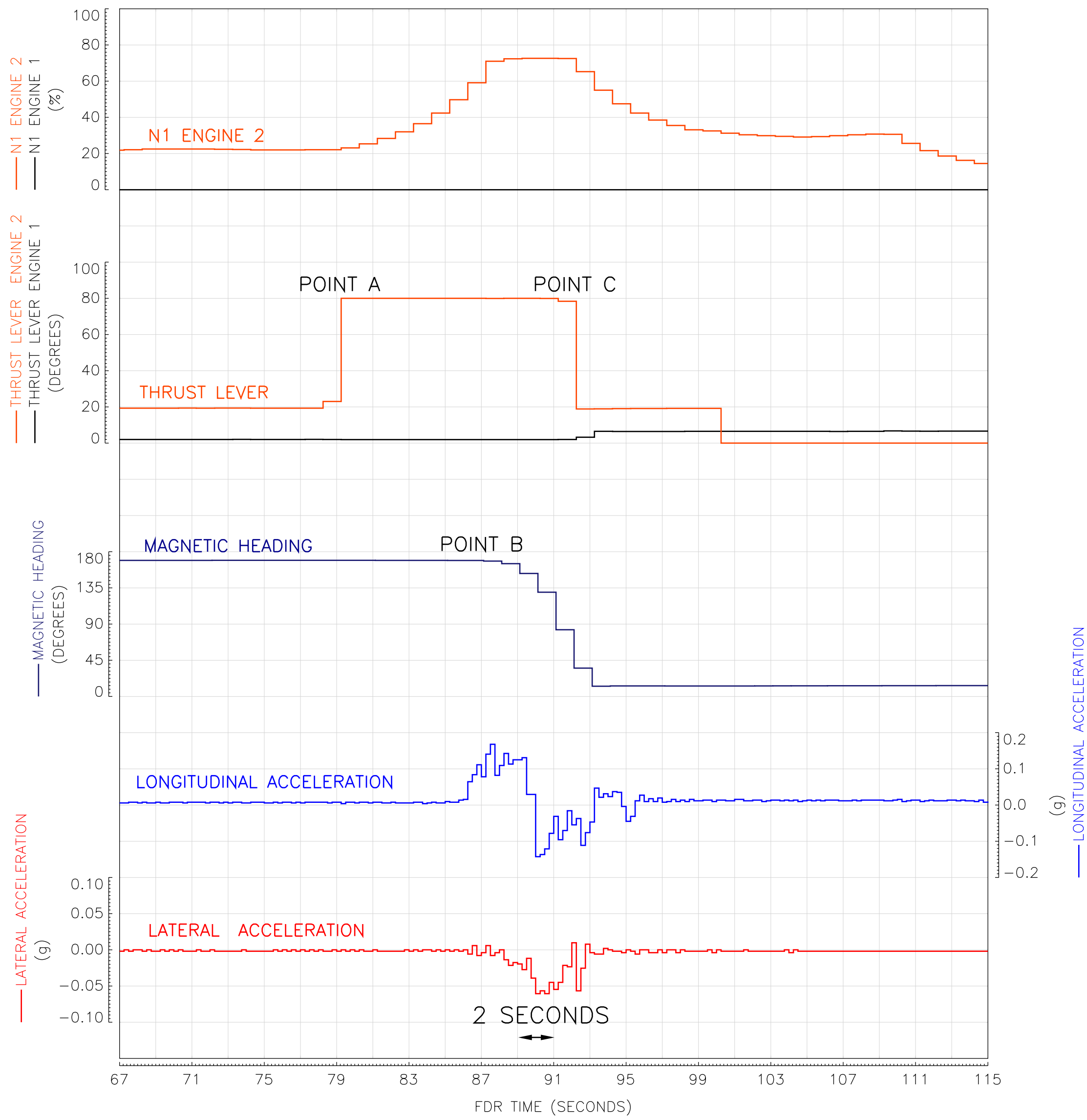

Figure 2

Selected data from FDR and CVR

Wreckage and impact information

The aircraft suffered impact damage to the left side of the fuselage between the passenger entry door and the leading edge of the left wing. There was some scuffing to the left wing leading edges and the trailing edge of the left nose landing gear door had been bent inwards. The MPV had suffered impact damage to both its left and right sides, the front windscreen was cracked and the left front tyre had been pushed off its wheel rim.

When the aircraft was examined after the incident it was noted that the right engine DEEC was selected to the OFF position. However, the FDR readout confirmed that the DEEC was on during the incident.

Tests and research

Following the accident, in the presence of the operator, aircraft battery power was applied. The EICAS indicated that the emergency/parking brake accumulator pressure was 1,440 psi. This was sufficient to hold the aircraft on a dry level surface against ground idle power. The system was then depleted by multiple applications of the parking brake and the accumulator recharged by means of the auxiliary hydraulic pump. Engine ground runs were performed to test the effect of turning off the DEEC with the engine running. The table below shows the results. At around 30% N_1 on one engine, the aircraft would start to move on a dry, level surface with the brakes off.

DEEC Position	N_1 % RPM
ON	22.8
MANUAL	28.7
OFF	30.4

Table 1

Effect of DEEC selection on engine N_1 at idle

Organisational and management information

Operation of the flight

The intended flight was being operated in accordance with the requirements of JAR-OPS. The operator provided a Flight Operations Manual (FOM) for their flight crews. The FOM contained procedures derived from the AFM, some of which were abbreviated, together with specific company operating procedures. The FOM was intended to be used in conjunction with the AFM. The FOM included a requirement for a pilot to be seated during flight but this requirement did not specifically apply to pre-flight operations.

Checklists

The aircraft was equipped with the operator's own checklist card. The cockpit preparation and before start checklists from the card are reproduced below at Figure 3. The operator's checklist card allocates responses to CM1 (commander), CM2 (co-pilot) or B (both pilots) but the operator considers this does not necessarily represent the designation of the task. If only one pilot is on the flight deck, that pilot has to read the checklist and action all the items. The PARKING BRAKE/HYD response was allocated to CM1.

The aircraft manufacturer provides full checklists in the AFM; there are no abbreviated versions provided. In the AFM both the *'Exterior Pre-Flight'* and the *'Before Starting Engines'* checklists require that the parking brake be set. The *'Before Starting Engines'* checklist also requires the crew members to be in their seats with their seatbelts fastened before engine start. The manufacturer did not provide - and the operator did not have - a checklist specifically for engine start for ground service use.

Cockpit Checklist		
Outside Check	Completed	CM1
Seats, Belts, Harnesses	Secure/Adjust	B
Oxy Masks & Smoke	Checked	B
Circuit Breakers	Set	B
Gear Handle	DN	CM1
Audio Panels	Set	B
DU & REVERSION Panels	NORM	B
ELEV DISC & ROLL DISC	Stowed	CM1
Electrical System	EMER&BATT	CM1
Crew Lights	Set	B
Rudder Panels	Adjust	B
SYSTEM TEST Panel	Test	CM1
RUD BOOST	ON	CM1
PAX OXY/PRESSURIZATION	Checked	CM2
Standby ATT Indicator	Uncaged	CM2
Cockpit Checklist compl.		

Before Start Checklist		
PARKING BRAKE/HYD	Set & Checked	CM1
Cabin Door	Closed	CM2
NO SMOKING BELTS	ON	CM1
Passenger Briefing	Completed	CM2
ANTI-ICE	OFF	CM1
EICAS	Checked	CM1
FUEL QTY & BAL	Checked	CM1
VOLTS	Checked	CM1
BCN / NAV	ON	CM1
Before Start Checklist compl.		

Figure 3

Cockpit Preparation and Before Start checklists

Analysis

The evidence derived from the recorded data was that the aircraft had moved on the stand as a result of a forward movement of the right (No 2) engine thrust lever which led to a corresponding increase in the right engine power. The chocks were pushed out of the way as the aircraft moved forward. The left wing contacted the parked vehicle and the aircraft started to pivot around it to the left. The direction and rate of turn thereafter was affected by a number of factors which were additive: the restraint on the left wing, the high power on the right engine and the absence of nose wheel steering which allowed the nosewheel to caster freely. The wind which was strong and gusty would also have acted in the direction of the turn.

On his arrival at the aircraft the co-pilot had checked that chocks were in place; they were positioned at the nosewheel. The chocks used were those carried with the aircraft; they were made of wood and of relatively light weight. These chocks could easily be pushed aside were any force applied and would not have been sufficient to hold the aircraft against any significant power. The fact that the chocks were in position may have given the co-pilot a false impression that the aircraft was secure against movement.

This particular model of the Learjet 45 did not have an APU which meant that in order to supply air to the cabin and to regulate the temperature, an engine needed to be running. It was normal practice, therefore, to start the right engine to supply bleed air to the cabin whilst preparing for a flight.

The co-pilot reported that his first action on boarding the aircraft was to put on the park brake. The park brake position is not one of the parameters recorded on the FDR so whether or not the action was carried out could not be definitely determined. For the aircraft to have moved, there were three possibilities. Firstly, the park brake was not effective because the handle was never set; secondly the handle was set but there was insufficient pressure in the accumulator to apply the brakes at the wheels; and thirdly, the brakes could have been applied but overcome by the additional thrust when the thrust lever was advanced. It was not possible to determine which of these occurred but it was noted that unless the correct procedure was used to set the brake then it was possible to set the handle without actually applying the brakes. The procedure in the AFM required the accumulator to be charged by activating the AUX HYD pump before applying the park brake. However this action was not carried out and the co-pilot seemed to be unaware that it was a required procedure. Nevertheless, if sufficient residual pressure had been retained in the system, the brakes would have been applied.

The co-pilot stated that he had been in his seat to start the engine. There were a number of activities that may have distracted him and caused him to move from his seated position afterwards. There was no specific requirement in the Operations Manual which required a pilot to be seated at the controls while an engine was running. It seems likely that as he moved around, he inadvertently moved the right thrust lever forward, either directly through physical contact or indirectly through snagging with clothing or equipment. At first he did not notice that the aircraft was moving and when he did, he was not in a position from where he could immediately apply the brakes. The movement cues could have been reduced by the lack of external visual cues in the dark and, if his attention was focused elsewhere, he would not necessarily have noticed the movement.

In an aircraft such as this, where it is necessary to run an engine to supply ground services, it may be that there is insufficient awareness amongst flight crew of the associated hazards. It is also possible that ground personnel working around the aircraft are less aware and therefore less cautious than when engines are started for flight. It is likely that a general practice had developed within the operation whereby one engine was started as a routine without reference to a checklist procedure. If the co-pilot's actions were not in accordance with the general practice then this should have become apparent during his training.

The operator's checklist did not specifically require the co-pilot to set the park brake. Although the AFM did provide a procedure to set the park brake, it was part of the *'Before Starting Engines'* checklist. This checklist was lengthy and not necessarily appropriate for starting one engine just to supply ground services as in this case. Failure to use a checklist in such circumstances is made more likely by the absence of an appropriate abbreviated procedure. Conversely, when the engines are started for the purpose of flight, more formal attention would probably be given to the required procedures and awareness levels would be raised.

Safety action

In order to be certain that the park brake is properly applied and functional, it is essential to follow the correct procedure. An additional checklist designed specifically for starting an engine for ground operation could facilitate this procedure. Since this accident, the operator has stated that it intends to redesign its Learjet 45 checklist card to include a procedure for the ground operation of one engine.

INCIDENT

Aircraft Type and Registration:	SAAB-Scania SF340B, G-LGNJ
No & Type of Engines:	2 General Electric CO CT7-9B turboprop engines
Year of Manufacture:	1989
Date & Time (UTC):	9 January 2006 at 1719 hrs
Location:	40 nm north-west of Glasgow VOR
Type of Flight:	Public Transport (Passenger)
Persons on Board:	Crew - 3 Passengers - 13
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	45 years
Commander's Flying Experience:	5,250 hours (of which 1,312 were on type) Last 90 days - 130 hours Last 28 days - 40 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During a descent in icing conditions the autopilot disengaged and the aircraft pitched nose down. Initially, the pilots could not move the control column fore and aft but they were able to re-engage the autopilot and complete the flight in safety. No mechanical fault could be found that would have affected the control system.

History of the flight

The aircraft departed Stornoway on a scheduled passenger flight to Glasgow. Engine anti-ice was selected ON when the aircraft entered icing conditions during the climb to FL135. The pilots selected continuous operation of the airframe de-icing boots when a small accumulation of ice appeared on the wing leading edges and windshield. Thereafter, they monitored ice accumulation and the correct operation of the de-icing boots. Later, when the aircraft encountered turbulence, the co-pilot reduced speed to 200 kt. Approximately 50 nm northwest of the Glasgow VOR, at an indicated outside air temperature of -12ºC, the pilots observed an increased build-up of ice on the propeller spinners, windshield and wipers and so they selected NORMAL operation of the propeller de-icing system. The commander requested descent for arrival at Glasgow and received clearance to descend to FL080. As the co-pilot initiated a descent at 1500 fpm using the autopilot VERTICAL SPEED mode, one of the propellers shed a large piece of ice which struck the fuselage, causing vibration through the airframe. In order to assist symmetrical shedding of ice from the blades, the co-pilot increased propeller rpm to maximum but airframe vibration increased.

Shortly afterwards the autopilot and yaw damper disconnected without command and the pilots perceived that the aircraft abruptly pitched about 5º nose-down. The co-pilot took control manually, confirming visually that the autopilot and yaw damper were deselected, but found that he could not move the control column in pitch. The commander confirmed that his control column also appeared to be stuck and instructed the co-pilot to continue to attempt to fly the aircraft while he assessed the situation. The aircraft appeared to be descending in a stable trimmed descent and the co-pilot was able to re-engage the autopilot and yaw damper. Autopilot function was checked immediately in pitch and roll and found to be working normally. Thereafter, no attempt was made to fly the aircraft manually until shortly before landing. The commander advised ATC that the aircraft needed to descend due to ice and declared a PAN, following which ATC gave radar vectors for the aircraft to intercept the ILS approach to Runway 23 at Glasgow. The commander, who took control of the aircraft for landing, found that during the ground roll the power levers could not be retarded below flight idle. The co-pilot pulled the FLIGHT IDLE OVERRIDE handle, enabling the power levers to be retarded to ground idle for deceleration. The aircraft was taxied to a parking stand and all occupants disembarked normally.

Aircraft information

Ice protection system

The SAAB 340 is a conventional twin turboprop powered aircraft equipped with electrical propeller ice protection and pneumatic de-icing boots on the leading edges of the tailplane and wings. The tailplane is not visible from the cockpit but the severity of any ice accretion on it may be inferred by inspection of aircraft surfaces that are visible, such as the wing leading edges and windscreen. Inflation and deflation of each element of the pneumatic de-icing system is indicated by a gauge in the cockpit.

Autopilot

The aircraft is equipped with an APS-85 three-axis digital flight director and autopilot system which processes outputs from various aircraft sensors, provides information for the Attitude Director Indicator (ADI) command bars and positions the control surfaces using servos. The autopilot also provides automatic pitch and yaw trimming which compensate for any long term servo torque[1] to reduce servo loads and maintain the aircraft in a trimmed condition.

The system consists of one Flight Control Computer (FCC) with dual channels, two Mode Select Panels and an Auto Pilot Panel in the cockpit, and three control servos. Force is applied by each servo to the operating cables of the relevant control surface via an electromagnetic clutch located within each servo. Coupling of the electromagnetic servo is achieved by applying high voltage to one side of the coil of the electromagnet. The other side of the coil is earthed.

The autopilot has three modes: engaged, disengaged and engaged in "cut-off" mode.

The autopilot can be disengaged manually as follows:

By pushing the autopilot disconnect button on the control wheel.

By moving the autopilot/yaw-damper lever to the disengaged position.

By pressing the GO-AROUND buttons.

By operating the pitch trim switches.

Footnote

1 The trim function logic senses servo voltage. The output from the trim logic drives the electric trim actuator. The auto trim function is actuated 0.6 s after servo voltage exceeding a fixed threshold is sensed.

The following will cause automatic autopilot disengagement:

Operation of the stall warning system.

Detection of a fault in the servo-loop circuits.

Loss of valid altitude information.

Bus transmissions errors.

Input data not updated within a specified time.

The autopilot will also disengage automatically if it detects any abnormal values in parameters used by the system. The "cut-off" mode is active when certain conditions are met such as high g values, roll limits and rate limits. In this mode, the autopilot remains engaged but the servos are held in a fixed position until normal parameters return.

There is a diagnostic mode in the FCC that stores autopilot fault codes in volatile memory.

De-icing treatment

The most recent aircraft ground de-icing was completed three days before this incident, early during the morning of 6 January 2006. A type II fluid was used in a mixture of 75% fluid and 25% water; the recorded mixture temperature was 75ºC.

Quick Reference Handbook (QRH) procedures

There was no QRH procedure for autopilot disengagement but there was a procedure for 'ELEVATOR SYSTEM JAMMED'. The memory items were as follows:

AUTOPILOT	DISENGAGE
INTERCONNECT UNIT	OVERPOWER
PITCH DISCONNECT HANDLE	PULL

Meteorological information

A synoptic chart produced by the Met Office indicated a freezing level of 5,000 ft and the possibility of moderate icing[2] in cloud in the area in which the flight was conducted. The commander judged that moderate icing conditions existed when the incident occurred.

Recorded data

The flight data recorder (FDR) was successfully downloaded and provided information about control surface position, autopilot engagement, aircraft attitude, altitude and speed. It showed that at a time corresponding to the reported incident the autopilot was disengaged for seven seconds, after which no disturbance of the system was detected. There was an upward trend of both left and right elevator position before disengagement of the autopilot, indicating that the system acted to maintain the selected vertical speed. No other abnormal data were found.

Engineering inspection

The operator conducted a detailed inspection of the aircraft after the incident flight. All control surfaces and mechanisms were found to function normally and without restriction. In particular, there was no evidence of de-icing fluid residues or mechanical restriction of any surfaces. Inspection of the flight-idle stop system of the power levers revealed no faults. A non-revenue test flight was completed before the aircraft was returned to service. It performed satisfactorily throughout the flight and there have been no further reported instances of flight control restriction on G-LGNJ.

Footnote

2 Moderate icing conditions are said to exist when the rate of accumulation is such that even short encounters become potentially hazardous and the use of de-icing or anti-icing equipment or flight diversion is necessary.

Additional information

Re-hydration of thickened de-icing fluid residues

AAIB Bulletin EW/C2005/03/09 explored the effect of de-icing fluid residues on control surface movement. Several reported occurrences were found to be associated with residues of 'thickened' de-icing fluids that had accumulated in aerodynamically 'quiet' areas of the elevator and aileron controls. These residues re-hydrated on exposure to precipitation and could freeze at altitude, possibly restricting control surface movement. In most cases, controls became restricted whenever the aircraft operated at temperatures below freezing but functioned normally after the aircraft had descended into warmer conditions. The AAIB has conducted several investigations of occurrences related to Type II and Type IV de-icing fluid residues, but none involved Saab 340 aircraft.

Previous ice related occurrences

A review of previous occurrences involving Saab 340 aircraft did not reveal a history of flight control restrictions resulting from flight in icing conditions.

Analysis

Control surface restriction

In response to the AAIB investigation, the aircraft manufacturer explored possible causes of elevator control restriction. It determined that binding between the gear-train in the autopilot servo and its mounting, or an undetermined mechanical problem, could have caused an actual control jam. Alternatively, when the autopilot disengaged, if the high voltage applied to the electromagnetic servo clutch fell slowly instead of instantaneously, the clutch would not have released immediately and would have given the impression of control restriction until it became fully disengaged. Such a condition might occur if there had been chafing of associated wiring or moisture in electrical connectors. However, because no recurrence has been reported by the operator, it is unlikely that either of these conditions existed on G-LGNJ.

The event was not typical of an occurrence related to de-icing fluid residues because the reported control restriction was of short duration and ceased while the aircraft was above the freezing level. No de-icing fluid residues were found during the subsequent inspection.

It was not possible to isolate which action or fault triggered autopilot disengagement in this event.

Ice accretion on the tailplane

Recorded data showed that, in the period immediately before autopilot disconnection, elevator deflection increased in the nose-up sense, but the aircraft maintained an approximately constant attitude, speed and flight path. This is consistent with the autopilot attempting to compensate for reduced tailplane effectiveness, perhaps caused by ice accretion. When the autopilot disconnected, elevator deflection reduced. This might have occurred if the autopilot had not automatically trimmed the increased elevator deflection. A reduction in elevator deflection would account for the nose-down pitch following autopilot disconnection reported by the pilots, although no pitch reduction was apparent from the FDR data.

The manufacturer conducted tests to assess the effects of ice accretion on the tailplane, using a flight mechanics simulator provided with data from the incident flight. It concluded that the aircraft responses to power change and elevator movement were normal and that there were no indications of reduced elevator effectiveness.

Interpretation of wind tunnel data[3] suggested that ice on the leading edge of the horizontal stabiliser resulted in a small reduction in elevator effectiveness with flaps set at 20º and 35º but no reduction with the flaps in the fully retracted position, as in this incident. However, in the absence of flight tests conducted on a representative aircraft with the same (unknown) amount of ice accretion, it is not possible to discount completely the possibility that there had been an accretion of ice on the tailplane sufficient to impair its aerodynamic performance.

There was no evidence to support the commander's assessment that severe icing caused the elevator to become physically jammed.

Inspection of the flight idle stop system revealed no faults. Failure of a weight-on-wheel switch to operate during the landing would prevent the power levers from being retarded aft of the flight idle gate. Such a failure might be temporary if caused by foreign matter ingress or the effects of low temperature.

Conclusion

No explanation was found for the elevator control restriction experienced by both pilots. However, the possibility of some form of temporary ice-related restriction could not be eliminated. Similarly, the possibility of some temporary malfunction of the autopilot clutch seemed very unlikely but could not be entirely eliminated. The 'ELEVATOR SYSTEM JAMMED' checklist was not invoked because the incident began with an uncommanded autopilot disengagement and full control was restored when the autopilot was re-engaged.

The service history of the SAAB 340 suggests that it is not prone to control restrictions relating to ice accretion or accumulations of de-icing fluid residue.

Footnote

3 These data were acquired separately and were not specific to this investigation

ACCIDENT

Aircraft Type and Registration:	Auster 5J1 Autocrat, G-AMTM
No & type of Engines:	1 Blackburn Cirrus Minor II piston engine
Year of Manufacture:	1952
Date & Time (UTC):	22 April 2006 at 1910 hrs
Location:	Oaklands Farm Strip, Stonesfield, Oxfordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Left main landing gear, left wing tip and propeller
Commander's Licence:	Private Pilot's Licence
Commander's Age:	63 years
Commander's Flying Experience:	1,125 hours (of which 1,050 were on type) Last 90 days - 10 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

Upon landing at Oaklands farm strip, the aircraft's left main landing gear struck a wooden electricity pole. The pole was lying on the ground across the beginning of the strip.

Background

Early in March 2006 the pilot, who was the farm strip owner, had placed two wooden electricity poles across the beginning of Runway 30. This was to stop vandals from gaining access to the strip from an adjacent road and using it as a skid pan for their cars. Since the poles were in place, the pilot reported that he had landed on Runway 30 two or three times before without incident.

History of the flight

After an uneventful flight from Hinton-on-the-Hedges the pilot positioned for a straight in approach to land on Runway 30 which is 400 m in length. The wind was calm and the weather was CAVOK but the grass surface was damp. The pilot reported that he normally plans to "float" across the field, road and poles in the undershoot before touching down at the beginning of the strip.

When the aircraft was on final approach, at approximately 150 ft height, the pilot was distracted by a runner, on his right, going around the edge of the field in the undershoot.

As the aircraft touched down the left main landing gear struck one of the poles. As a result, it was bent rearwards and the left wing tip touched the ground. The aircraft then veered to the left and went into an arable field that surrounds the strip. As the aircraft came to a stop the main landing gear dug into the soil, causing the aircraft to briefly tip over onto its nose before coming to rest on its tail wheel in its normal three-point attitude. The pilot and his passenger vacated the aircraft uninjured.

Damage was sustained to the left main landing gear, left wing tip, propeller and nose cowling. The engine was shock-loaded when the propeller touched the ground.

Discussion

In an open and frank report the pilot believes that he was initially distracted by the runner he noticed during the final approach. Although he has landed on this strip "hundreds of times" before, when he was distracted he forgot about the poles. He also stated that he was complacent due to the calm wind. He feels that had the wind been more demanding, by way of a crosswind, or by being stronger, he would have been concentrating more during the approach and landing, and the accident would not have happened.

ACCIDENT

Aircraft Type and Registration:	BAC 167 Strikemaster MK80, G-FLYY
No & type of Engines:	1 Rolls-Royce Viper 535 turbojet engine
Year of Manufacture:	1969
Date & Time (UTC):	7 July 2006 at 0917 hrs
Location:	Kemble Airfield, Gloucestershire
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Underwing tanks worn flat and holed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	54 years
Commander's Flying Experience:	6,000 hours (of which 40 were on type) Last 90 days - 5 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During circuit flying, neither pilot noticed that the landing gear was not down and locked and the aircraft landed with the landing gear retracted.

History of the flight

The pilot/owner of the aircraft was undertaking some refresher training with another pilot, who was the pilot in command. They were carrying out circuit practice at Kemble with the pilot/owner flying the aircraft. During one of the circuits the pilot/owner forgot to select the landing gear down and also missed the 'three greens' check. The pilot in command did not notice the omission and the aircraft landed with the landing gear retracted. The aircraft touched down smoothly and slid along the runway; as it did so the engine was shutdown. The aircraft came to rest on the centreline, the only damage sustained was to the underwing fuel tanks.

ACCIDENT

Aircraft Type and Registration:	Cessna 150M, G-BRNC
No & type of Engines:	1 O-200-A Continental Motors piston engine
Year of Manufacture:	1976
Date & Time (UTC):	2 July 2006 at 1035 hrs
Location:	Netherthorpe Airfield, Nottinghamshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Front engine cowling and propeller damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	38 years
Commander's Flying Experience:	143 hours (of which 137 were on type) Last 90 days - 15 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During landing, the aircraft failed to stop within the runway distance available; it departed the runway to the left and struck a steel gate. The pilot, in a full and frank statement, attributed the accident to his failure to initiate a go-around at an early stage of the landing. He also considered that his approach speed, the wet grass runway and the lack of a headwind were contributory factors.

History of the flight

The pilot had flown the aircraft on an uneventful local flight and had positioned the aircraft to land on the grass Runway 06 at Netherthorpe; the wind was from 030º at 5 kt. He flew the approach without difficulty and landed 'on the numbers' with a reported airspeed of about 60 kt, some 8 kt above the normal 50 ft threshold speed of 52 kt. The aircraft continued down the runway, past the intersection with Runway 18/36. At this point the pilot thought there was enough runway left on which he would be able to stop. However, it soon became clear to him that the aircraft was not slowing down enough to stop within the remaining runway distance. He was also beyond the point at which a go-around would have been possible. He continued to apply the brakes, and then purposely steered the aircraft to the left. It departed the runway and struck a steel gate causing damage to the engine cowl and the propeller. The pilot was uninjured.

Runway 06 at Netherthorpe has a grass surface and a declared landing distance available (LDA) of 407 m.

It also has a 1.9% downslope, and on the day of the accident the grass was wet.

According to the CAA Safety Sense Leaflet 7c '*Aeroplane Performance*', it is 'strongly recommended' that pilots of private flights apply the various factors to the landing performance information contained in the flight manual. This is because flight manuals for light aircraft usually contain unfactored performance information. For the landing of the accident flight the following factors were relevant:

> 'Wet grass', which has a factor of 1.35; with an increase of up to 1.6 for 'very short grass'.
>
> A '2% downhill slope', which has a factor of 1.1
>
> An 'additional safety factor' of 1.43.

For G-BRNC the flight manual had a declared landing distance required of approximately 330 m and applying the factors above gave the following distance:

> 330 m x 1.35 x 1.1 x 1.43 = 701 m. This was 294 m longer than the declared LDA for Runway 06.

In addition, the faster approach speed in this case would further extend the landing distance required.

The pilot, in a full and frank statement, attributed the accident to his failure to initiate a go-around at an early stage of the landing. He also considered that his approach speed, the wet grass runway and the lack of a headwind were contributory factors.

ACCIDENT

Aircraft Type and Registration:	Cessna 150M, G-BTGP
No & type of Engines:	1 Continental Motors Corp O-200-A piston engine
Year of Manufacture:	1976
Date & Time (UTC):	28 June 2006 at 13:55 hrs
Location:	Leicester Airport
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Damage to front fuselage, engine, nose landing gear and both wings
Commander's Licence:	Student pilot
Commander's Age:	61 years
Commander's Flying Experience:	44 hours (of which all were on type) Last 90 days - 14 hours Last 28 days - 6 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The student pilot was landing at Leicester Airport during a qualifying cross country flight. The aircraft was too high and too fast on the approach and touched down on the nose landing gear approximately halfway along the runway. The nose landing gear subsequently collapsed and the aircraft continued along the runway before veering left and coming to rest.

History of the flight

The student pilot was completing the second leg of the qualifying cross-country flight requirement for his PPL, from Gloucester to Leicester. He joined the circuit to land on Runway 28; however, due to his inexperience, he was too high and too fast on the approach but, rather than performing a go-around manoeuvre, he attempted to land. The aircraft touched down on the nose wheel approximately halfway down the runway. The nose landing gear subsequently collapsed allowing the propeller to contact the runway surface. At this stage the pilot attempted to increase power and takeoff, however, the aircraft did not lift off. Witnesses observed the aircraft continue along the remainder of the runway, on the propeller and nose wheel, before turning to the left at the end of the runway and coming to rest in a field. The pilot sustained minor injuries but was able to evacuate the aircraft without difficulty.

INCIDENT

Aircraft Type and Registration:	Cessna 152, G-BNRK
No & type of Engines:	1 Lycoming O-235-L2C piston engine
Year of Manufacture:	1984
Date & Time (UTC):	7 June 2006 at 1325 hrs
Location:	Blackbushe Airport, Camberley, Surrey
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to nose gear wheel and tyre
Commander's Licence:	Student pilot
Commander's Age:	33 years
Commander's Flying Experience:	32 hours (all of which were on type) Last 90 days - 17 hours Last 28 days - 7 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft was returning from a navigation exercise, which was part of the training syllabus for the student pilot's Private Pilot's Licence. The approach to land at Blackbushe Airport was flown at a higher than normal approach speed and the aircraft bounced heavily twice, before finally touching down. At some point during the landing the nose wheel tyre detached from the wheel rim and several pieces of the wheel were shed onto the runway.

History of the flight

As part of the training syllabus for a Private Pilot's Licence (PPL) the student pilot had planned a navigation flight from Blackbushe Airport, which included a landing at Kemble Airfield before returning to Blackbushe. The weather was good, with CAVOK conditions, a light and variable surface wind and a temperature of +24°C. The flight was uneventful, and the landing at Kemble had been normal.

On his return to Blackbushe the pilot joined the left-hand circuit for Runway 25 and positioned onto the final approach, electing to land with two stages of flap selected. As he approached the runway threshold he noted that the airspeed was 70-75 kt instead of the normal 65 kt approach speed. The flare was not sufficient to prevent the aircraft landing heavily and it bounced. The pilot held the column central and as the aircraft descended, he moved the column aft but the aircraft again landed heavily and bounced. The height of the bounce was estimated to be about 15 ft and the aircraft landed heavily again, but remained on the runway whilst oscillating in yaw several times. The pilot applied the wheel brakes and noticed a vibration through the rudder pedals. He informed ATC that he had landed heavily and suggested that they should carry out a runway inspection. After vacating the runway the pilot shut down the aircraft and carried out an external inspection. He found that the nose wheel tyre had detached from its wheel rim and several pieces of the wheel had broken off. The aircraft was subsequently pushed to the parking area.

The airfield Rescue and Fire Fighting Service recovered several wheel fragments from the runway during their inspection.

Analysis

The pilot considered that the faster than normal threshold speed and insufficient flare caused the initial bounce and at which point he should have initiated a 'go-around' without delay. Not doing so allowed the second bounce before the final heavy touch down and landing roll. He could not identify the point at which the damage to the nose wheel occurred.

ACCIDENT

Aircraft Type and Registration:	Cessna 180K, G-BETG
No & Type of Engines:	1 Continental Motors Corp O-470-U piston engine
Year of Manufacture:	1977
Date & Time (UTC):	3 June 2006 at 1620 hrs
Location:	Private airstrip, near Chewton Mendip, Somerset
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Propeller and cowling damage
Commander's Licence:	Private Pilot's Licence
Commander's Age:	55 years
Commander's Flying Experience:	342 hours (of which 31 were on type) Last 90 days - 3 hours Last 28 days - 0 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

After a normal landing the aircraft ran off the side of the grass airstrip and pitched forward in soft ground, causing damage to the engine cowling and propeller.

History of the flight

The pilot was returning from a local flight to a private airstrip adjacent to the Mendip Hills in Somerset. The weather was fine, with a surface wind from the north at less than 10 kt. After 45 minutes of fight, the pilot made a normal approach and landing on 'Runway' 05. However, towards the end of the ground roll the aircraft veered to the left and ran into a ploughed field adjacent to the landing strip. The aircraft 'nosed over' in the soft ground causing damage to the engine cowling and propeller.

The pilot, who was wearing a lap strap and diagonal harness, was uninjured and able to vacate the aircraft normally through the left main door. He considered that the aircraft's swing to the left on landing was because he had not sufficiently compensated for the crosswind.

ACCIDENT

Aircraft Type and Registration:	Cessna 182P Skylane, G-BBGX
No & Type of Engines:	1 Continental Motors Corp O-470-R piston engine
Year of Manufacture:	1973
Date & Time (UTC):	30 May 2006 at 1402 hrs
Location:	Shobdon Aerodrome, Leominster, Herefordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Extensive to aircraft and crops
Commander's Licence:	Private Pilot's Licence
Commander's Age:	57 years
Commander's Flying Experience:	359 hours (of which 237 were on type) Last 90 days - 8 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

On landing, the pilot experienced a strong gust of wind, which resulted in the aircraft becoming airborne again. After a subsequent bounce, the pilot attempted a go-around but could not prevent the aircraft leaving the runway to the left into a field of crops.

History of the flight

Prior to his second flight of the day, the pilot had contacted Shobdon Aerodrome to check the weather. He was informed that the surface wind was approximately 10 kt from a north to north-westerly direction.

During the subsequent flight, the pilot was aware that the wind was strong and from the north when near the coast but that the forecast was for lighter winds inland. On arrival at Shobdon, he completed an overhead join for Runway 27. Subsequently, during the final approach with flap 30 selected, the crosswind appeared to be consistent with the wind reported by 'Shobdon Information' as northerly at 8 kt. Then, at about the aerodrome boundary, the aircraft was subjected to some windshear after which the pilot was able re-establish a stable approach. The subsequent touchdown was good and in the centre of the runway. However, the pilot was then aware of a strong gust of wind on the aircraft which resulted in it becoming airborne again for a brief period. After a subsequent bounce the pilot applied full power to go-around but he felt that the aircraft was not accelerating. He also starting retracting the flaps to reduce drag but this did not seem to improve acceleration. The aircraft departed the left side of the runway into a field of crops and turned through 180º before coming to rest. After switching off the main battery the pilot and his passenger both exited the aircraft through the pilot's door.

Eye witness account

A witness later confirmed that the initial touchdown had appeared to be good but that the aircraft had then bounced twice with the nose high and the tail very close to the ground. The witness heard engine power being applied but then saw the right wing rising before the aircraft went off the runway to the left. He also considered that the surface wind at the time was north to north-westerly at 12 to 15 kt but gusting to 20 kt.

ACCIDENT

Aircraft Type and Registration:	Cessna F150L, G-AZXC
No & Type of Engines:	1 Continental Motors O-200-A piston engine
Year of Manufacture:	1972
Date & Time (UTC):	25 May 2006 at 1440 hrs
Location:	500 metres south-west of Netherthorpe Airfield, Nottinghamshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Minor) Passengers - 1 (Minor)
Nature of Damage:	Beyond economic repair
Commander's Licence:	Private Pilot's Licence
Commander's Age:	65 years
Commander's Flying Experience:	656 hours (of which 642 were on type) Last 90 days - 6 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

Shortly after takeoff the engine failed and a forced landing was made in a field beyond the end of the runway. The aircraft landed heavily causing the nose gear to collapse and the aircraft to flip upside down. The engine failure was caused by excessive water in the fuel. It was not possible to determine how the water entered the fuel system but it is probable that the heavy rainfall during the week leading up to the accident flight, while the aircraft was parked outside, was a contributory factor.

History of the flight

The pilot was planning a flight to Sherburn-in-Elmet with one passenger who was also a private pilot. The weather was good with a visibility greater than 10 km and no cloud below 2,500 ft. The wind was from 250° at 5 to 10 kt. During the pre-flight checks the passenger removed the lockable fuel caps (which are used to secure the tanks overnight) and replaced them with the aircraft's standard fuel caps. The pilot reported that he drained a fuel sample from each wing tank and from the gascolator beneath the engine and confirmed that no water was present. The aircraft had approximately 96 litres of fuel onboard (total capacity was 144 litres) which was sufficient for the flight so no refuelling was carried out. The pilot started the engine and taxied the aircraft to a holding point to carry out the engine checks. The magneto check produced a 100 rpm drop when selecting both left and right magnetos, which the pilot considered to be more than usual but still within limits. The engine backfired when the throttle lever was reduced to IDLE but then ran normally at 600 rpm.

After waiting for another aircraft to land, the pilot taxied onto Runway 24 (grass) and initiated the takeoff. The aircraft accelerated normally and reached 40 KIAS before the runway intersection[1]. The pilot rotated at 50 KIAS and then, after lift off, he held the aircraft in ground effect until reaching 60 KIAS. At 60 KIAS he initiated a climb and shortly thereafter the engine noise suddenly faded and stopped. The pilot reported that the engine failure was as sudden as someone pulling the mixture lever to IDLE-CUTOFF. He pumped the throttle but this had no effect so he lowered the nose to maintain airspeed and aimed for a field directly ahead. There was a hedge-lined road just short of the field so the pilot raised the nose to try to clear it. The aircraft cleared the hedge but then touched down heavily in the field. The nose gear collapsed and the aircraft flipped upside down and came to rest. Both the pilot and passenger were able to exit the aircraft unassisted via the right door.

Footnote

1 The pilot reported that it was his normal procedure to abort a takeoff if 40 KIAS had not been attained at the point of runway intersection.

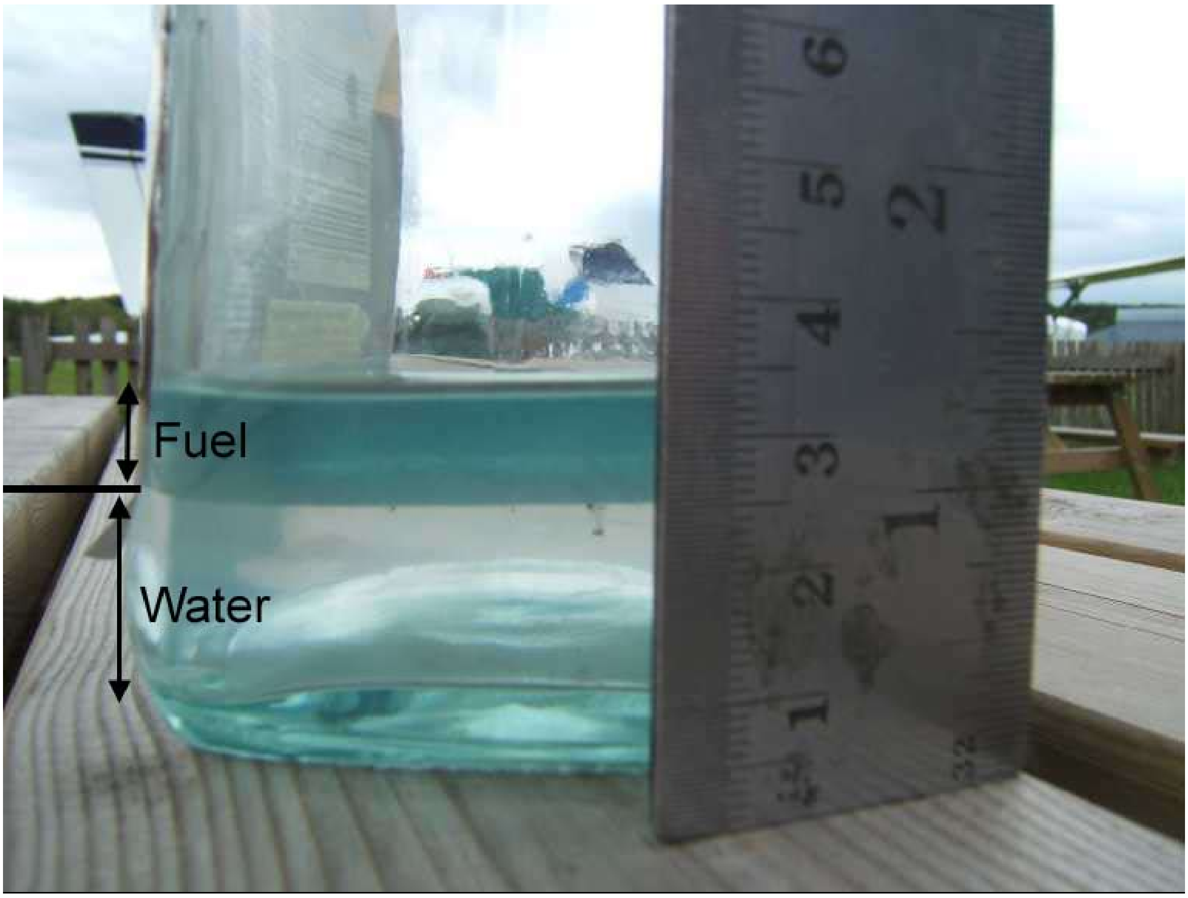

Figure 1

Contents of the fuel gascolator bowl

Aircraft examination

The maintenance engineer for the flying club recovered the aircraft to a hangar and drained the fuel from the wing tanks into a container which already contained some fuel. The aircraft was then left to await inspection by an insurance assessor. The insurance assessor removed the fuel gascolator bowl and emptied the contents into a jar (see Figure 1). Approximately two-thirds of the gascolator bowl's contents was water and only one-third was fuel. A few days later the maintenance engineer removed the wings of the aircraft and when the right wing was placed on the ground a small amount of a water/fuel mixture drained out of the right wing tank's fuel line. No fuel or water was seen to drain from the left tank when the left wing was removed. The pilot reported that the aircraft had been parked slightly right wing down.

The aircraft's previous flight before the accident flight was on 18 May 2006. During the ensuing seven days the aircraft was parked outside and there was a significant amount of rainfall. A weather station 20 nm south of Netherthorpe reported a total rainfall of 43.6 mm between 18 May and 25 May 2006 and a weather station 31 nm to the west reported a total rainfall of 46 mm for the same period.

The insurance assessor examined the standard fuel caps that were installed on the aircraft and also examined the lockable fuel caps that had been removed. He reported that the rubber seals on all four fuel caps appeared satisfactory and he could not explain how water might have entered the fuel tanks.

Analysis

The sudden engine failure after takeoff was probably caused by excessive water in the fuel. Water is heavier than aviation fuel and will settle in the bottom of a fuel tank. The pilot reported that he carefully drained both wing tanks and the gascolator but did not find any water. However, the aircraft had been parked right wing low and therefore it is possible that the right tank drain was not at the lowest location when the sample was taken. It was not possible to determine how the water entered the fuel but it is probable that the heavy rainfall during the week leading up to the accident flight, while the aircraft was parked outside, was a contributory factor.

ACCIDENT

Aircraft Type and Registration:	Cessna F172M, G-BAOS
No & Type of Engines:	1 Lycoming O-320-E2D piston engine
Year of Manufacture:	1973
Date & Time (UTC):	30 May 2006 at 1755 hrs
Location:	Near Seething Airfield, Norfolk
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Minor) Passengers - 1 (Minor)
Nature of Damage:	Substantial
Commander's Licence:	Private Pilot's Licence
Commander's Age:	42 years
Commander's Flying Experience:	431 hours (of which 7 were on type) Last 90 days - 13 hours Last 28 days - 9 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft suffered a partial loss of engine power during a go-around. The weather conditions were conducive to carburettor icing. The pilot, with carburettor heat applied, continued to fly the aircraft hoping that the power would recover. The engine continued to lose power and a forced landing was made in an arable field. The aircraft suffered substantial damage.

History of the flight

The aircraft was on a cross country flight from Hawarden, Cheshire, to Seething Aerodrome, Norfolk. When approaching Seething the pilot descended towards the airfield and crossed overhead at 800 ft to check the wind direction and the runway. He then climbed to 1,100 ft and joined the circuit on a left base for Runway 24.

The weather conditions recorded at nearby Norwich Airport were as follows; surface wind from 330º at 14 kt, visibility more than 10 km, few cloud at 1,400 ft, scattered cloud at 4,500 ft, temperature 8ºC, dewpoint 6ºC and pressure 1018 hPa. There had also been a few rain showers in the area.

The approach was made with 20º flap set and the carburettor heat was selected to HOT. On final approach the pilot selected 30º flap but realised that he was rather high. He continued the approach for a while and then carried out a go-around from about 200 ft agl. He applied full power and selected carburettor heat COLD. During the go-around, realising that he had probably had a tailwind on the approach, he decided to position to a right base for Runway 06. As the aircraft climbed he noticed a reduction in power; he lowered the nose to maintain airspeed and selected carburettor heat HOT. He also selected flap from 20º to 10º, although he later commented that it may in fact have gone to 0º. The engine was still producing some power so, hoping it would recover, he decided not to commit to a forced landing ahead but instead to turn left hand downwind where there were still several options for a forced landing should it become necessary.

The power continued to reduce and the pilot realised now that he would probably have to land. He had already identified a field and continued towards it but as he got close was made aware, by his passenger, of some power lines ahead. He continued turning, away from the power lines, closed the throttle and landed ahead in the field. The field had a standing crop in it which was damp following recent rain. As the aircraft touched down on the main wheels it decelerated very rapidly and pitched forwards, coming to rest inverted.

The pilot and his passenger were disorientated after the aircraft came to rest, and had suffered a number of minor injuries in the accident, but they were able to vacate the aircraft using the side doors.

The pilot in his report said that he had suspected that carburettor icing was the cause of the loss of power. He continued flying the aircraft, rather than accepting an immediate forced landing, because there was some power available and he had an expectation that the use of carburettor heat would restore the power.

The atmospheric conditions at the time of the accident would have been conducive to serious carburettor icing at any power setting. The Civil Aviation Authority Safety Regulation Group Safety Plan 2006 provides the following information with respect to carburettor icing:

> *'Since 1976 Carburettor Icing has been a contributory factor in 14 fatal accidents and in over 250 other occurrences in the UK with numerous AAIB recommendations to SRG. Progress has repeatedly been hampered by the lack of data on where ice forms, how quickly and how much heat is effective in removing it. There has also been some doubt that the level of carburettor heat required by the Airworthiness Requirements (e.g. EASA CS-23) is adequate to mitigate the risk. CAA has conducted research using a specially designed carburettor test rig in conjunction with Loughborough University and an industry partner for systematic data collection. The CAA will publish a report on carburettor icing, including potential mitigation.'*

ACCIDENT

Aircraft Type and Registration:	Diamond Aircraft Industries DA20-C1, G-NIKK
No & Type of Engines:	1 Continental Motors IO-240-B piston engine
Year of Manufacture:	2000
Date & Time (UTC):	5 June 2006 at 1255 hrs
Location:	Redhill Aerodrome, Surrey
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Fuselage fractured, propeller damage, engine shock loaded
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	68 years
Commander's Flying Experience:	16,000 hours (of which 250 were on type) Last 90 days - 14 hours Last 28 days - 11 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot, examination by AAIB and a metallurgist

Synopsis

Following a normal approach for a 'touch-and-go' landing on a grass runway the aircraft touched down smoothly on its main wheels, followed by the nosewheel gently lowering onto the runway. Engine power was applied and the flaps selected to their takeoff position when a bang was heard and the aircraft stopped violently, coming to rest in a nose-down position. Examination revealed that the nose landing gear leg had failed in overload following severe plastic deformation, consistent with a high upward vertical load being applied to the nosewheel. It was not possible to determine the number of flights between the deformation occurring and the final failure.

History of the flight

Following a normal approach for a 'touch-and-go' landing on a grass runway the aircraft touched down smoothly on its main wheels, followed by the nosewheel gently lowering onto the runway. Engine power was applied and the flaps selected to their takeoff position when a bang was heard and the aircraft stopped violently, coming to rest in a nose-down position. The fuel and electrical master switches were selected off and the crew vacated the aircraft normally.

Engineering examination

The nose landing gear leg had failed in the area immediately to the rear of the weld that attached the nosewheel castoring pivot to the leg. Metallurgical examination showed that there had been severe plastic deformation in the area of the failure and that the deformation had induced high residual tension stresses. The deformation was consistent with a high upward vertical load being applied to the nosewheel. Following the deformation, cyclic loading caused very high-stress low-cycle fatigue cracking to initiate and propagate, which progressively reduced the strength of the strut until it fractured under overload conditions. There were no 'beach' or event markers found on the fracture surface, indicating that the fatigue crack propagation took place over one landing event. It was not possible to determine the number of flights between the deformation occurring and the initiation of the fatigue crack.

ACCIDENT

Aircraft Type and Registration:	Gulfstream AA-5A, G-MSTC
No & type of Engines:	1 Lycoming O-320-E2G piston engine
Year of Manufacture:	1979
Date & Time (UTC):	17 June 2006 at 1040 hrs
Location:	Andreas Airfield, Isle of Man
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Extensive damage to lower fuselage, wings, landing gear, engine and propeller
Commander's Licence:	Private Pilot's Licence
Commander's Age:	78 years
Commander's Flying Experience:	3,223 hours (of which 32 were on type) Last 90 days - Not known Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot and telephone inquiries by the AAIB

Synopsis

An unexpected change in the wind direction resulted in the pilot landing with a strong tail wind. Realising that there was insufficient distance in which to stop, he commenced a go-around during which the flaps remained in the fully down position. During the climb the aircraft hit a hedge at the end of the runway and landed heavily in the adjacent field.

History of the flight

The pilot reported that he took off with a passenger from Runway 11 at Andreas, an unlicensed airfield on the Isle of Man, with the intention of flying a number of circuits. The wind, when he took off, was from the south-east at 3 to 4 kt. During the fifth touch and go the pilot assessed the wind as being very light and, therefore, in order to save a long taxi back to the parking area he decided to make his final approach and landing using Runway 29. The pilot reported that he selected full flap and established the approach to land deep, but that he touched down later than he had intended. As the braking action on the loose runway surface appeared to be poor he commenced a go-around by fully opening the throttle and selecting the flaps up. He reported that the aircraft was quickly airborne and began to climb slowly when it hit a hedge at the end of the runway, within which was an old farm trailer. The aircraft subsequently landed heavily in the field beyond the hedge having sustained extensive damage. Both the pilot and passenger were uninjured and vacated the aircraft through the sliding canopy.

After exiting the aircraft the pilot noted that the wind had increased to between 10 and 12 kt and that the flaps on the aircraft were still extended.

Damage to aircraft

An aircraft surveyor reported that the aircraft was extensively damaged and beyond economic repair. The left landing gear had been torn from its mountings and the nose landing leg had fractured and collapsed. The left wing was badly distorted, both flaps were damaged, the propeller blades were bent and the engine shock loaded.

Description of airfield

Andreas is an old World War II airfield, which is currently the home of the Andreas Gliding Club. Runway 29/11 is approximately 1,100 m long and has a surface of degraded tarmac covered in loose stones and debris. The Gliding club allows fixed wing aircraft to use the unlicensed airfield at their own risk. The pilot stated that because of the risk of damage to the propeller his normal practice was to keep the taxiing distance to a minimum by landing deep.

Flap system operation

The flaps on the aircraft are electrically operated by a flap selection lever. To select flaps down the lever is held forward and the flap indicator is monitored. The flap selection lever is released once the required amount of flap is obtained. To select flaps up the selection lever is moved to the up position. Once the up circuit is engaged the flaps will continue to retract even if the selection lever is moved to the off position.

Comment

On this occasion the pilot believes that he did not move the flap operating lever sufficiently for the flap up selection to engage. He also believes that the accident occurred as a combination of landing down wind with a stronger than expected tail wind and then attempting a go around with the flaps in the incorrect position.

ACCIDENT

Aircraft Type and Registration:	Jabiru SK, G-MITT
No & type of Engines:	1 Jabiru Aircraft Pty 2200A piston engine
Year of Manufacture:	2000
Date & Time (UTC):	29 July 2006 at 1840 hrs
Location:	Top Farm, Roystone, Hertfordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to the nose gear, main landing gear, fuselage, propeller and engine
Commander's Licence:	Private Pilot's Licence
Commander's Age:	50 years
Commander's Flying Experience:	380 hours (of which 1 was on type) Last 90 days - 19 hours Last 28 days - 7 hours
Information Source:`	Aircraft Accident Report Form submitted by the pilot

Synopsis

The pilot reported that after a short flight he made a stable approach but misjudged the flare and landed hard on the firm grass runway. He had earlier collected the aircraft from another airfield and that had been his first flight in the type. That flight had lasted one hour and five minutes and had been uneventful.

History of the flight

The pilot had flown the aircraft from Henstridge Airfield to Top Farm earlier in the day, when collecting it for its new owner. It was his first flight in the type and after receiving a briefing on the aircraft he had an uneventful flight lasting one hour and five minutes. Upon arrival at Top Farm he shut the aircraft down and had a conversation with its new owner. With the possibility of buying the aircraft in mind, the pilot then decided to carry out one last circuit.

The weather was fine and the surface wind, which was from 220º at 10kt, suited a circuit to the grass Runway 24. The pilot reported that the final approach to the runway was stable at 60-65 kt, the same airspeed as on his previous approach, but that he flared late and landed hard on the firm surface. The nose gear and main landing gear collapsed and the propeller struck the ground; the aircraft veered to the right and stopped at the edge of the runway. During the landing the aircraft also suffered damage to its fuselage and the engine was shock loaded. The pilot, who was wearing a lap strap and diagonal harness, was uninjured and exited the aircraft normally. There was no fire.

A witness to the accident commented that after a normal approach, the aircraft did not flare but appeared to pitch down just before striking the runway surface.

The pilot concluded that the accident was the result of misjudged handling of the aircraft during the landing. He stated that he is the owner of a Cessna 182 and that his previous experience also included other light aircraft.

ACCIDENT

Aircraft Type and Registration:	Jabiru SP-470, G-SIMP
No & Type of Engines:	1 Jabiru Aircraft Pty 2200A piston engine
Year of Manufacture:	2002
Date & Time (UTC):	3 June 2006 at 1540 hrs
Location:	Wellcross Farm, near Horsham, West Sussex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Substantial damage to wing and cockpit
Commander's Licence:	Private Pilot's Licence
Commander's Age:	68 years
Commander's Flying Experience:	679 hours (of which 171 were on type) Last 90 days - 9 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During the landing run, the pilot lost directional control and the aircraft struck a tree, sustaining considerable damage.

Background

The pilot reported that he had operated from a grass strip at Wellcross Farm for nine years, initially using a Piper J3 Cub and, for the last three years, using the Jabiru. Flights had taken place in a wide variety of weather and surface conditions. A tree alongside the strip served as a mounting for a windsock.

The accident flight

On the day of the accident, the pilot returned to the field following a flight to Popham and Sandown. He flew overhead the strip at 800 ft to view the windsock. This indicated a slight preference for Runway 04 although the wind was some 80° off the runway direction. The pilot subsequently estimated the wind velocity to be of the order of 5 kt.

He noted before landing that the cross-wind and lack of component parallel to the runway would result in a higher than normal ground speed on touch-down. He was aware that the strip surface was quite uneven, particularly at the 04 end with several transverse ridges which cause some aircraft to become briefly airborne again after initial touch-down. He considered that this was more likely to happen if the aircraft was flown solo and the landing was fast. He was also anxious that the comparatively fragile landing gear of the Jabiru, particularly the nose gear, did not suffer unduly during landing on this strip. It was therefore his normal practice to hold the nosewheel off on rough surfaces until the speed had decayed, applying intermittent brake pressure between bumps to slow to taxi speed.

On this occasion the pilot used his normal approach airspeed of 60 kt with full flap, thereafter using his normal braking technique. He recalled applying some power after one bump to cushion the touch-down. As he reached the tree, by which point the aircraft had usually decelerated to taxi speed, the aircraft speed was higher than usual but sufficient distance remained to stop before the end of the runway. At this point, however, the aircraft suddenly yawed to the left and hit a tree with the port wing.

The pilot considered that the benign conditions of the day may have rendered him complacent so he was caught out by the sudden swing of the aircraft. He observed that the aircraft type is normally easy to land on smooth runways but more challenging on undulating surfaces.

Discussion

Sudden loss of directional control on the ground is unusual in tricycle landing gear aircraft. It has been known to occur, however, when significant pressure is applied to the nosewheel during the roll-out with sufficient airspeed remaining to generate some wing lift. This results in much of the loading being removed from the main gear, yet sufficiently low airspeed to limit the stabilising effect of the tailfin and control available from the rudder. This phenomenon is known as wheel-barrowing. With an undulating surface it is possible that sufficient pressure was briefly on the nosewheel whilst wing lift remained and therefore contributed to this phenomenon.

ACCIDENT

Aircraft Type and Registration:	Nord NC858S, G-BPZD
No & type of Engines:	1 Continental C90-14F piston engine
Year of Manufacture:	1947
Date & Time (UTC):	1 July 2006 at 1236 hrs
Location:	London City Airport
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Both propeller blades broken off, right landing gear leg collapsed, damage to front cowling and damage to right wing strut and tip
Commander's Licence:	Private Pilot's Licence
Commander's Age:	39 years
Commander's Flying Experience:	147 hours (of which 17 were on type) Last 90 days - 10 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and subsequent enquiries by the AAIB

Synopsis

Immediately after touchdown the aircraft veered to the right. In trying to regain the runway centreline the pilot applied excessive left brake causing the aircraft to momentarily tip on its nose and the right landing gear leg to collapse.

History of the flight

At the time of the accident London City Airport was operating as an unlicensed aerodrome and was preparing for an air display associated with a charity event. The pilot was flying to the airport where he was due to assist with the display. At the time of his arrival the weather was good with a headwind of about 10 kt and little or no crosswind component.

The pilot flew an uneventful approach to Runway 10 and made a three-point landing but immediately after touchdown the aircraft veered to the right. He applied left rudder and left wheelbrake in an attempt to compensate at which point the tail of the aircraft rose into the air, causing the propeller blades to strike the runway surface and break off. The aircraft continued to tip forwards until the underside of the engine cowling hit the runway. The tail then dropped back down to the ground with the aircraft coming rapidly to a halt, pointing slightly to the left of the centreline, and with the right landing gear leg collapsed underneath the fuselage.

There was no damage to the cockpit area and the pilot and his passenger were able to leave the aircraft by their respective doors unaided and uninjured. Although the airport was operating as an unlicensed aerodrome, full AFRS cover was available and emergency vehicles attended the scene.

Description of damage to the landing gear

The main landing gear leg consisted of a gas filled oleo supported by two struts. Inspection by the pilot after the accident revealed the oleo had 'snapped' and that one of the supports had bent. There appeared to be no signs of corrosion in the area where the break had occurred.

Aircraft history and description

The aircraft was built in 1947 in France where it was initially operated by the military. About four years later, and after various modifications by the manufacturer, the aircraft passed into private ownership. It was acquired by one of the current group owners about 20 years ago.

The aircraft has a tail wheel undercarriage and two seats, side by side. One of the owners described the brakes as 'powerful'.

Pilot background

The pilot had accumulated about 100 hours experience on tail-wheeled aircraft including the Tiger Moth and Piper Cub. The majority of this flying had been from grass runways and he estimates that he had only operated from hard surfaced runways about five times.

Analysis

From the evidence presented it is unclear why the aircraft swung to the right after landing. The pilot was unaware of having any right brake applied on landing but conceded that it was possible that he had inadvertently applied right brake before touchdown. The brakes on his aircraft were highly effective and it appears that in an attempt to get the aircraft straight, the pilot may have applied excessive left brake. The resultant deceleration had the immediate effect of causing the tail to rise. It rose uncontrollably and so the propeller and underside of the engine struck the runway. The secondary effect of the asymmetric braking could have been to apply considerable lateral force to the right undercarriage leg. The absence of any visible corrosion or fatigue symptoms on the oleo leg suggests that this force exceeded the designed limit for the leg resulting in its collapse.

Whilst the majority of the pilot's flying had been on tail-wheeled aircraft of various types, this was almost exclusively on grass airfields where the braking effects would have been different to those experienced at London City Airport. This, combined with the powerful nature of the brakes, is likely to have contributed to the excessive application of left brake after touchdown.

ACCIDENT

Aircraft Type and Registration:	Piper PA-28-181 Cherokee Archer II, G-BPTE
No & Type of Engines:	1 Lycoming O-360-A4M piston engine
Year of Manufacture:	1976
Date & Time (UTC):	12 May 2006 at 1225 hrs
Location:	Blackbushe Airport, Camberley, Surrey
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Propeller destroyed, right wing leading edge skin damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	42 years
Commander's Flying Experience:	82 hours (of which 11 were on type) Last 90 days - 2 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft struck two fire tenders while taxiing away from a fuel installation because, in his own judgement, the pilot had left insufficient space to manoeuvre the aircraft safely. The investigation revealed no evidence to contradict this assessment.

History of the flight

After refuelling the aircraft the pilot started the engine and requested aerodrome and weather information prior to his intended flight. In order to taxi away from the fuel installation, the pilot increased power and attempted to turn left, away from the pumps. He was unable to complete this manoeuvre before the starboard wingtip struck a fire tender parked nearby, causing the aircraft to swing to the right. Despite applying the wheel brakes and reducing power, the aircraft continued to swing to the right until its propeller hit a second fire tender that was parked parallel to and slightly beyond the first. During this impact the propeller became trapped between the bumper and chassis of the second fire tender and the engine stopped suddenly. The pilot and his passenger vacated the aircraft using the normal entrance door on the right hand side of the fuselage. Both occupants were uninjured.

The pilot judged that he had failed to allow sufficient clearance between his aircraft and nearby obstacles as he taxied away from the fuel installation.

A member of the airfield Rescue and Fire Fighting Service (RFFS) present at the time of the incident commented that, shortly after it left the fuel installation, the aircraft stopped very close to the first fire tender with its engine operating at sufficiently high power to attract his attention. When he approached the aircraft the pilot appeared to be using the aircraft radio. The aircraft then moved off but impacted the first fire tender shortly afterwards.

Damage to aircraft

Impact with the first fire tender caused damage to the outboard and centre sections of the right wing leading edge skins and impact with the second fire tender damaged the propeller. The propeller was destroyed when RFFS crew cut the trapped blade in order to remove the aircraft. Subsequently, the engine was removed for an inspection to determine the effects of shock loading caused by its sudden stoppage. A visual inspection of the aircraft revealed no pre-existing faults with the steering or brake systems that could have contributed to the incident.

Damage to fire tenders

The first fire tender received only superficial damage. The second fire tender received damage to its nearside front wing, bonnet and bumper caused by the propeller and nose of the aircraft. Although both tenders remained serviceable, they were blocked by the aircraft until it could be removed, 20 minutes after the occurrence. Two spare fire tenders, equipped to provide a reduced category of fire cover and occasionally substituted for tenders under maintenance, were parked elsewhere on the airfield. They could not be manned at short notice because all available crew were occupied with removal of the incident aircraft. The airfield was therefore without dedicated fire cover and all commercial flying activities were curtailed for that period.

Follow up action

The CAA does not require fire tenders to be dispersed or protected from collision damage when parked. In order to minimise response time, fire tenders and their crew will inevitably be co-located within the RFFS compound, which itself must be situated near to aircraft manoeuvring areas for the same reason. The airport RFFS considered, therefore, that it would be impractical to change the parking arrangements for its fire tenders in a manner that would guarantee the continued provision of at least one unit. The CAA concurred with this assessment.

INCIDENT

Aircraft Type and Registration:	Reims Aviation Cessna F150L, G-BBTZ
No & Type of Engines:	1 Continental Motors Corp O-200-A piston engine
Year of Manufacture:	1974
Date & Time (UTC):	9 March 2006 at 1825 hrs
Location:	Goswick Sands, Holy Island, Northumberland
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Private Pilot's Licence
Commander's Age:	45 years
Commander's Flying Experience:	473 hours (of which 201 were on type) Last 90 days - 30 hours Last 28 days - 20 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and information provided by the Met Office and the United Kingdom Hydrographic Office

Synopsis

The aircraft deviated from its intended route when the pilot encountered deteriorating weather conditions. Having become lost during the deviation, the pilot re-established his whereabouts with the assistance of the Distress and Diversion cell and was met by a Search and Rescue helicopter that had been dispatched to guide the aircraft to an airfield. However, the pilot was concerned that his aircraft contained insufficient fuel for the flight to the proposed airfield and on sighting a large area of clear sand beside Holy Island, he elected to land there instead.

History of the flight

The pilot intended to fly with a passenger from Cumbernauld to Carlisle in order to collect another aircraft. The flight was to be conducted in accordance with the Visual Flight Rules. The pilot stated that he "checked the weather from the usual sources" at Cumbernauld, checked that the aircraft had sufficient fuel onboard and departed Cumbernauld at 1515 hrs. Shortly after departure he contacted Scottish Information, which provided a Flight Information Service, and flew along his planned route at an altitude of approximately 3,000 ft. After passing abeam Talla VOR, approximately half way to Carlisle, the weather deteriorated rapidly and to avoid flying beneath a lowering cloud base, the pilot turned to the east where conditions appeared to him to be better. He intended to assess his options for diversion as soon as he had set course to the east but, as he became increasingly concerned about the weather, he also became uncertain of his position. When he realised he was lost, he informed Scottish Information that he would contact the Distress and Diversion cell (commonly referred to as "D&D") on 121.50 MHz. His first recorded contact with that service was at 1647 hrs. He was, however, unable to maintain continuous contact and subsequent transmissions relied upon relays from commercial aircraft flying at higher altitudes.

An incident record provided by D&D indicated that at 1700 hrs the pilot thought he was in the vicinity of Longtown, 7 nm northwest of Carlisle. Using the pilot's description of ground features below the aircraft, which included a race track to the north of a small town, D&D identified his position as close to Kelso, approximately 35 nm east of his intended route and 40 nm northeast of Longtown. An SAR helicopter based at Boulmer, on the east coast 30 nm south east of Kelso, was alerted to provide assistance but the pilot of G-BBTZ stated that he would divert via Coldstream to Charterhall Airfield, 8 nm northeast of Kelso, and the helicopter was stood down.

Later, having failed to find Charterhall, the pilot called D&D again. D&D suggested that he should return to Coldstream and proceed east along the River Tweed to Berwick. The SAR helicopter was tasked to meet him there. He found Berwick without difficulty and orbited in sight of the town until the helicopter arrived. Remaining on 121.50 MHz, the pilot then made contact with the crew of the helicopter, who advised him that he should fly south along the coast to Eshott, an airfield 9 nm south of Boulmer. The pilot advised the helicopter crew that because he had only a small amount of fuel remaining, he would prefer to land at Brunton, near the coast 18 nm south of Berwick. Approximately 10 minutes after setting course along the coast the pilot noticed a large area of sand. Increasingly anxious about the amount of fuel remaining and the fading light, he decided to land immediately and informed the helicopter crew of his intentions. The aircraft landed without further incident at 1825 hrs on Goswick Sands, having been airborne for 3 hours and 10 minutes.

The helicopter, which had been flying a short distance offshore and in sight of G-BBTZ, landed beside the aeroplane, marked its position with a portable strobe light, collected the uninjured pilot and passenger and returned with them to Boulmer. A coastguard vessel that had been monitoring the incident came ashore and members of its crew pushed the aircraft onto Holy Island, clear of the incoming tide.

Two days later the aircraft was collected by the Chief Flying Instructor (CFI) of the flying school which operated it. He stated that the aircraft was assessed by a licensed engineer prior to flight and filled, from an approved container, with sufficient fuel for a short positioning flight. It then took off from the metalled causeway between Holy Island and the mainland and flew directly to Eshott, 20 nm to the south, where it could be refuelled from a fixed installation and washed.

Aircraft information

The optional 'long range' fuel tanks fitted to G-BBTZ had a total useable capacity of 132.5 litres. Fuel quantity could be measured on the ground by placing a dipstick in each tank and inspecting the contents visually, a process known as "dipping". The pilot dipped both tanks prior to the flight and found that they contained a total of 70 litres, which was sufficient for the intended flight. During the flight, two fuel quantity gauges in the cockpit indicated fuel remaining in each tank, but instead of relying on these gauges, the pilot preferred to make an assessment of fuel remaining based on the known contents of the tanks prior to departure and an estimate of average fuel consumption. Information provided in the Cessna 150 *Owner's Manual* indicates that a representative aircraft cruising at 3,000 ft will consume approximately 20 litres per hour, giving an endurance of 3½ hours. When he collected the aircraft after the incident flight, the CFI found that the tanks contained a total of 18 litres, sufficient for approximately 55 minutes of flight[1]. This would have enabled the aircraft to continue to Brunton or Eshott.

Meteorological information

Visual Flight Rules

Rule 26 of the Rules of the Air Regulations 1996 states:

> *(1) An aircraft flying outside controlled airspace at or above flight level 100 shall remain at least 1500 metres horizontally and 1000 feet vertically away from cloud and in a flight visibility of at least 8 km.*
>
> *(2) (a) Subject to sub-paragraph (b), an aircraft flying outside controlled airspace below flight level 100 shall remain at least 1500 metres horizontally and 1000 feet vertically away from cloud and in a flight visibility of at least 5 km.*
>
> *(b) Sub-paragraph (a) shall be deemed to be complied with if:*
>
> *(i) the aircraft is flying at or below 3000 feet above mean sea level and remains clear of cloud and in sight of the surface and in a flight visibility of at least 5 km;*
>
> *(ii) the aircraft, other than a helicopter, is flying at or below 3000 feet above mean sea level at a speed which according to its air speed indicator is 140 knots or less and remains clear of cloud and in sight of the surface and in flight visibility of at least 1500 metres; or*
>
> *(iii) in the case of a helicopter the helicopter is flying at or below 3000 feet above mean sea level flying at a speed, which having regard to the visibility is reasonable, and remains clear of cloud and in sight of the surface.*

Typically, a Cessna 150 cruises at an indicated airspeed of 100 kt or less.

The elevations of Cumbernauld and Carlisle airports are 350 ft and 190 ft amsl respectively. The highest ground along the intended route, rising to 2,697 ft amsl, is close to the point at which the pilot noticed the deteriorating weather conditions. The highest terrain within 5 nm of the route rises to 2,726 ft, 1.5 nm east of Talla VOR. Consequently, it would not have been practical to remain at 3,000 ft above sea level throughout the journey and paragraph 2 (a) of Rule 26 would have been applicable.

Information available to the pilot before departure

Form F215 – *Forecast Weather Below 10,000 ft*, issued by the Met Office at 0950 hrs on the day of the incident, and valid from 1400 hrs to 2300 hrs, predicted visibility of 15 km in light rain reducing occasionally to 7 km in rain and drizzle and in isolated cases to 3,000 metres in heavy rain. Visibility was forecast to reduce further to 2,000 metres along a band of weather associated with an occluded front which was aligned

Footnote

[1] The extra fuel remaining might be accounted for either by lower than predicted fuel consumption or a conservative measurement of fuel on board prior to departure from Cumbernauld.

approximately from Stranraer to Norwich at 1800 hrs and moving in a north-easterly direction at 15 kt. Broken or overcast cloud was forecast with a base of 1,500 to 3,000 ft, with areas of low stratus base 300 to 600 ft and fog on hills, resulting in visibility of 800 metres or less.

The most recent aerodrome forecast available to the pilot prior to departure indicated that temporarily between 1500 hrs and 1800 hrs the visibility at Carlisle would reduce to 5,000 metres in rain and that the base of cloud would reduce to 1,000 ft aal. The forecast also indicated that at both Glasgow and Edinburgh, temporarily between 1300 hrs and 2200 hrs, visibility would reduce to 8,000 metres in light rain with cloud broken at 1,400 ft.

Aftercast

An aftercast produced by the Met Office showed low pressure lying to the west of Scotland feeding a south-easterly flow over the Borders region. An occluded front within the air mass was moving towards the Borders bringing rain and lowering cloud to the area. During the afternoon a band of rain moved into the area and covered the intended route. Surface visibility reduced from between 20 to 40 km generally to between 7 and 15 km in rain, but deteriorated to between 3,000 and 5,000 metres in moderate rain over high ground.

Radar imagery showed a band of rain running in a south-easterly direction from the north coast of Ireland to the South East of England, including strong returns indicating heavier rain in the area around Talla VOR at the time the flight deviated from its intended route.

Environmental information

Local sunset was at 1758 hrs. The pilot assessed the actual conditions at the time of touchdown as "dusk". The United Kingdom Hydrographic Office estimated low tide at Holy Island to have occurred at 1716 hrs on the date of the incident, subject to wind and pressure effects which were not evaluated. The water level would not have risen appreciably by 1825 hrs, when the aircraft landed.

Aids to navigation

The aircraft was fitted with a combined VHF navigation and communication radio capable of receiving VOR station signals. No other radio navigation aids were fitted. The planned direct route between Cumbernauld and Carlisle passed close to Talla VOR, but the pilot commented that, although he operated the VOR receiver "as an exercise", he did not use it as an aid to navigation on the incident flight.

Communications

The D&D cell at West Drayton, operated by the Royal Air Force, provides position information[2] ("fixes") derived from direction finding (DF) equipment which is able to determine the direction from which a signal is transmitted. The location of a transmission can be determined when it is received at two or more stations at different locations and the accuracy of a fix improves if the signal is received at three or more stations at widely separated locations. A computerised system enables fixes to be displayed on a variety of detailed topographical and aeronautical charts in order that D&D

Footnote

[2] This service is available routinely to pilots, even if they are not lost. The D&D cell encourages pilots to make use of it without embarrassment, and emphasises the value to both parties of "training fixes". Further details are available in 'Safety Sense' leaflets and on the CAA website.

can give pilots meaningful position information relative to their own charts and ground features visible from the air. It is usually possible to fix the position of an aircraft transmitting on 121.50 MHz at 2,000 ft or more above the surface, but not necessarily over hilly or mountainous terrain. In this incident, D&D was not able to establish the position of G-BBTZ accurately using DF alone but was able to do so in conjunction with the description that the pilot gave of ground features below the aircraft.

Recorded information

It was not possible to identify the track of the aircraft using radar recordings. It probably flew below the coverage of radar stations surrounding and within the area.

Additional information

Published guidance

CAA Safety Sense Leaflet 1e – *"Good airmanship"* published by the CAA includes the following advice about weather planning:

> *'Get an aviation weather forecast, heed what it says and make a carefully reasoned GO/NO-GO decision.'*
>
> *'Establish clearly in your mind the current en-route conditions, the forecast and the "escape route" to good weather. Plan an alternative route if you intend to fly over high ground where cloud is likely to lower and thicken.'*

Under the heading '*LOST' the same leaflet offers the following advice*:

> *a. If you become unsure of your position, then* tell someone. *Transmit first on your working frequency. If you have lost contact on that frequency or they cannot help you, then change to 121.5 MHz and use Training Fix, PAN or MAYDAY, whichever is appropriate (See CAP 413 'Radiotelephony Manual'). If you have a transponder, you may wish to select the emergency code, which is 7700. It will instantly alert a radar controller.*
>
> *b. Few pilots like to admit a problem on the radio. However, if any 2 of the items below apply to you, you should call for assistance quickly, 'HELP ME':*
>
> ***H*** *High ground/ obstructions – are you near any?*
>
> ***E*** *Entering controlled airspace – are you close?*
>
> ***L*** *Limited experience, low time or student pilot (let them know)*
>
> ***P*** *Position uncertain, get a 'Training Fix' in good time; don't leave it too late*
>
> ***M*** *MET conditions; is the weather deteriorating?*
>
> ***E*** *Endurance – fuel remaining; is it getting short?*
>
> *c. As a last resort, make an early decision to land in a field while you have the fuel and daylight to do so. Choose a field with care by making a careful reconnaissance. Do not take off again without obtaining a weather update or further advice.*

CAA Safety Sense Leaflet 5 – *'VFR navigation'* contains similar advice.

Beach landing

The pilot commented that he had landed several times at Barra, an aerodrome whose sand runways are located on a tidal beach. He said that this experience gave him confidence to carry out a landing on Goswick Sands.

Conclusion

Forecasts available to the pilot prior to the flight indicated that the flight could not be conducted under Visual Flight Rules at all points along the intended route.

The pilot manoeuvred the aircraft away from the worst weather associated with the approaching front but became lost before deciding on an alternative destination. He was assisted by the Distress and Diversion cell despite being at a height and in an area which limited the performance of its direction finding system. A rescue helicopter was able to find the aircraft and guide it towards suitable airfields but, concerned about the amount of fuel remaining, the pilot of G-BBTZ decided to land on a clear area of beach. Unknown to the pilot there was sufficient fuel remaining onboard the aircraft for it to have continued to either of the airfields suggested by the helicopter crew but, in view of the diminishing light and deteriorating weather, a decision to continue may not have resulted in a safe outcome.

ACCIDENT

Aircraft Type and Registration:	Reims Cessna F152, G-OSFC
No & Type of Engines:	1 Lycoming O-235-L2C piston engine
Year of Manufacture:	1981
Date & Time (UTC):	24 May 2006 at 1040 hrs
Location:	200 m short of Runway 22, Stapleford Aerodrome, Essex
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - None
Nature of Damage:	Substantial damage to nose, engine, propeller, and wingtips. Fuselage fractured aft of rear cabin bulkhead. Aircraft damaged beyond economical repair
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	37 years
Commander's Flying Experience:	1,025 hours (of which 524 were on type) Last 90 days - 123 hours Last 28 days - 30 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and subsequent AAIB enquiries

Synopsis

The aircraft crashed, whilst on short final approach to the runway, in blustery conditions.

History of the flight

As the aircraft returned to land from a navigation training flight, the radio operator at the aerodrome informed the crew that the wind was from 270º at 15 kt, the instructor asked the student to fly an approach to Runway 28. However, the wind then backed to 240º at 20 kt, and the instructor decided that the approach should now be flown to Runway 22. On turning onto the final approach, the instructor told the student to fly at 70 kt, rather than the usual approach speed of 65 kt, the final stage of flap was then selected. The instructor reported that the student flew a *'very good'* approach, and that the speed fluctuated between 60 and 80 kt in the gusty conditions. About 300 m short of the runway, and at 100 ft agl, the aircraft suddenly rolled and yawed to the right, and pitched down. The instructor took control, applied full power, and attempted to recover to normal flight. The aircraft impacted the ground nose first, destroying the nose landing gear and underside of the nose. The aircraft slid along the ground for approximately 25 m before coming to rest upright, with the fuselage broken just aft of the rear cabin bulkhead. There was no fire, and both occupants exited through the aircraft doors.

The instructor commented that the lap and diagonal harnesses had saved both occupants from serious injury.

The instructor reported that he believed the accident happened after:

> *'windshear or a down-draft caused by the flow of air over the nearby hangars and trees caused the right wing to stall, and the aircraft to enter a spin to the right'.*

An aftercast from the Met Office stated that:

> *'It is clear from both actual reports and radar imagery that a great deal of showery/CB activity lay over south-east and central England at the time of the accident'.*

ACCIDENT

Aircraft Type and Registration:	AutoGyro Europe MT-03, G-RSUK
No & Type of Engines:	1 Rotax 914T piston engine
Year of Manufacture:	2005
Date & Time (UTC):	29 April 2006 at 1730 hrs
Location:	Coventry Airport
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Rotor blades and propeller destroyed, damage to tricycle unit
Commander's Licence:	Private Pilot's Licence
Commander's Age:	45 years
Commander's Flying Experience:	245 hours (of which 21 were on type) Last 90 days - 8 hours Last 28 days - 7 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

During landing, as the nosewheel touched down, the autogyro turned left and rolled over. The pilot attributed the cause of the accident to a combination of his failure to prevent nosewheel contact before it could be centred, and a high turn speed. A modification to introduce a castoring nosewheel has been introduced.

History of the flight

The autogyro was returning from Popham Airfield to Coventry following an uneventful endurance flight lasting 90 minutes. The descent into Coventry was normal but included a hold on base leg to allow a Boeing 737 aircraft to land. The landing aircraft was about five minutes ahead of G-RSUK, avoiding any wake turbulence. The wind was calm. The pilot reported that the autogyro touched down, mainwheels first, with the engine power at idle. He held the nosewheel off the runway, however as the nosewheel touched down the autogyro turned left. The rotors struck the runway, one blade broke off and the autogyro rolled onto its right side. The propeller and engine stopped. The pilot was uninjured and climbed out of the open cockpit of the autogyro without difficulty.

The pilot stated that he normally turned left to vacate the runway after landing. However, he did not expect the combination of the immediate left turn, the increased groundspeed with no wind, and the reducing rotor speed to result in an immediate rollover.

Autogyro description

The AutoGyro Europe MT-03 is a tandem two-seater autogyro with an all metal frame, designed in Germany and first flown in 2003. The operator of G-RSUK, RotorSport UK, holds the UK Type Approval for the MT-03 and provides a factory built UK version, compliant with British Civil Airworthiness Requirements (BCAR) Section T. The accident flight was being carried out as part of the UK approval process.

G-RSUK was fitted with a steerable nosewheel connected directly to the rudder pedals. In order to allow the steering to be in the straight ahead position during takeoff when some rudder deflection is normally required, an angular offset of 10º was incorporated into the nosewheel steering system. During landing, with the power off and the rudder straight, the nosewheel was therefore offset to the left by 10º, and it was necessary for the pilot to centralise the nosewheel before it made contact with the runway.

Discussion

The pilot attributed the cause of the accident to a combination of factors. The nosewheel contacted the ground before the forward speed was low enough for it to be centred. He also commenced an immediate turn to the left. This, combined with the high ground speed and reducing stability as the rotor speed decayed, prevented the turn being completed without the autogyro rolling over. He considered that the calm wind conditions, high aircraft centre of gravity and fixed nosewheel to rudder pedal relationship made control of the landing overly sensitive.

There have been a number of similar ground rollover incidents in Germany. Design analysis by the UK Type Approval holder has shown that the sensitivity to rollover could be significantly reduced by the introduction of a self-centering, fully castoring nosewheel. The purpose of this modification is to allow the nosewheel to track in the direction of travel on touchdown. Additionally, due to the introduction of nosewheel castoring, as the ground speed increases, so does the turning circle thus making it more difficult for the combination of ground speed and turning circle to cause a rollover. The modification also allows the rudder to nosewheel offset to be reduced resulting in a more central pedal position during taxi.

This design modification has been incorporated in the aircraft configuration type approval and has successfully completed a ground and flight test program by both the CAA and RotorSport UK Ltd.

ACCIDENT

Aircraft Type and Registration:	Beagle Wallis WA-116/F, G-ATTB
No & Type of Engines:	1 Franklin 2A-120-B piston engine
Year of Manufacture:	1962
Date & Time (UTC):	18 May 2006 at 1500 hrs
Location:	Swanton Morley, Norfolk
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Nose nacelle, rudder, fin, aft keel tube, propeller and rotor, plus engine shock-loaded
Commander's Licence:	Private Pilots Licence
Commander's Age:	90 years
Commander's Flying Experience:	4,660 hours (of which 2,394 were on gyroplanes) Last 90 days - 12 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

After takeoff from a playing field, the gyroplane turned downwind for a "farewell pass" to a small group of spectators. At this point the gyroplane began to sink uncontrollably. The descent continued until the aircraft landed heavily resulting in severe damage.

History of the flight

The gyroplane was flown from its base at Reymerston Hall, near East Dereham, Norfolk to Robertson Barracks, Swanton Morley, Norfolk. It landed without incident on a large playing field for a planned visit.

The pilot reported that the wind was predominately from 250º at 24 kt gusting to 32 kt. He believed that some gusts may have been stronger.

After the visit the pilot took off into wind from the playing field. He initially climbed to 200 ft agl before turning downwind for a "farewell pass." While downwind at cruising power, the pilot sensed a sinking feeling and the gyroplane began to lose height. At this point he was downwind of a wood. He quickly turned left into wind and applied full power in a bid to arrest the rate of descent and regain height but the descent continued, "like a lift", until the gyroplane landed heavily on the playing field, where it hit a set of small football goal posts. The gyroplane was badly damaged but the pilot vacated it uninjured.

Discussion

The pilot believes this accident was caused by a localised downdraught as a result of a strong gust of wind blowing over the adjacent wood that continued down to ground level. He thinks the turn into wind kept the gyroplane in the centre of the down draught. He added that he had flown in extreme weather conditions worldwide without incident. He described the effect he experienced as "exceptional."

The wood on the north-western edge of the playing field is "V" shaped with a lake in between the 70 ft high trees. It is orientated approximately north-east/south-west, with an opening at the south-western end. With the wind from the south-west it is likely that a strong gust of wind might have been funnelled up the lake before rising over the trees resulting in a rotor forming and thus a down draught on the leeward side of the trees.

ACCIDENT

Aircraft Type and Registration:	Robinson R22 Beta, G-OPAL
No & Type of Engines:	1 Lycoming O-320-B2C piston engine
Year of Manufacture:	1986
Date & Time (UTC):	7 April 2006 at 1240 hrs
Location:	Wycombe Air Park (Booker), Buckinghamshire
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Extensive damage to landing gear, fuselage and main rotor blades
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	40 years
Commander's Flying Experience:	1,592 hours (of which 1,173 were on type) Last 90 days - 181 hours Last 28 days - 58 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

An instructor and his student were conducting a basic helicopter training flight when water droplets began to accumulate on the outside of the windscreens in light drizzle. This gradually reduced the pilots' vision through the windscreens and the instructor decided to fly a circuit in an attempt to clear the droplets. During the transition into the circuit the instructor was monitoring the relative position of another aircraft. Whilst doing so he resisted the student's attempts to raise the collective control lever, and he may even have lowered it slightly. This was in order to prevent entry into the 'avoid area' of the height-velocity envelope. The landing gear struck the ground and the helicopter crashed.

History of the flight

Prior to the flight, the instructor fully briefed the student on the main exercises to be flown. These included hovering, takeoff and landing, air taxiing and transitions to and from the hover. All of these exercises had been completed during previous flights. It was the student's third training flight with the instructor and his progress had been good.

The weather conditions were good, with a surface wind from 300° at 5-10 kt, intermittent light drizzle and an overcast cloud cover. During start-up, small patches of moisture had developed on the inside of the transparencies towards the edges of the windscreens. The heater/ demister was used and the screens were completely clear and dry during the early part of the lesson.

Following the hover-taxi to the airfield helicopter training area the pre-briefed exercises were practiced. The student was progressing well throughout the various exercises when a very light drizzle began, settling very small water droplets on the windscreen, which significantly impaired the pilots' vision through the windscreen. The instructor therefore suggested that they fly a circuit of the airfield in an attempt to clear the droplets: this would also serve as an opportunity to break up the hovering/hover taxiing aspects of the lesson.

As was normal, routine radio calls and clearances were not required for helicopters operating within the airfield helicopter training area. The instructor, who was monitoring the radio, heard another R22 request clearance to cross the active runway to operate within the helicopter training area. The instructor monitored the progress of the other R22 as it manoeuvred ahead of his helicopter. With sufficient clearance from the other helicopter, the student turned into a position that would enable him to transition from the hover to climbing flight. The student commenced a gentle transition whilst the instructor continued to monitor the other helicopter through the moisture contaminated windscreen whilst closely monitoring the flight controls. As the helicopter accelerated it achieved translational lift and began to climb. The instructor resisted the students attempts to raise the collective control lever in order to prevent entry into the 'avoid area' of the height-velocity envelope. Shortly after, the landing gear struck the ground and the helicopter crashed.

The 'avoid area' defines the combinations of altitude and airspeed from which a helicopter would be unlikely to successfully complete an autorotative landing following an engine failure.

Analysis

During the initial stage of the transition from the hover the moisture on the outside of the windscreen did not disperse. Whilst the other R22 was at no time in conflict with his aircraft, the instructor monitored it closely in order to ensure a suitable takeoff path was achieved. It was whilst monitoring the other R22 that the instructor prevented the student from raising the collective pitch control lever. This was in order to prevent his helicopter climbing into the 'avoid area' of the height-velocity envelope. In doing so, the instructor thought he may have actually lowered the collective control causing the aircraft to descend and the landing gear to contact the ground.

Survival aspects

There was insufficient time for either pilot to transmit a distress call before the impact, and immediately following the accident the instructor shut down the engine and isolated the fuel. Whilst the student remained conscious, he had some difficulty in talking to the instructor. They were unable to contact ATC as the radio was damaged and neither person carried a mobile telephone. After a few minutes the instructor noticed fuel leaking from the fuel tank on the left side of the aircraft. The student had now recovered somewhat and the instructor was able to confirm that neither pilot had sustained any serious injury. Having assisted the student out of the helicopter, they both moved clear of the wreckage and awaited assistance.

It was clear that ATC were not aware of the accident since normal aircraft movements continued. The instructor left the crash site to seek assistance. At about this time, ATC were informed of the accident and they activated the airfield crash alarm. The AFRS attended shortly afterwards and applied foam to the wreckage. The instructor estimated that some 10 minutes had elapsed since the time of the accident.

ATC were not initially aware of the accident. This was probably because the control tower is soundproofed and therefore the controllers did not hear the impact, and the location of the accident site made it difficult to see from the tower. As was normal, routine radio calls and clearances were not required for helicopters operating within the airfield helicopter training area and ATC were therefore not expecting any calls from the helicopter.

ACCIDENT

Aircraft Type and Registration:	Schweizer 269C, G-OGOB
No & Type of Engines:	1 Lycoming HIO-360-D1A piston engine
Year of Manufacture:	1987
Date & Time (UTC):	4 September 2005 at 1200 hrs
Location:	Putts Corner, Honiton, Devon
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - 1
Nature of Damage:	Significant damage to the cockpit, main rotors and tail boom
Commander's Licence:	Private Pilot's Licence
Commander's Age:	39 years
Commander's Flying Experience:	273 hours (of which 120 were on type) Last 90 days - 10 hours Last 28 days - 4 hours
Information Source:	AAIB Field investigation

Synopsis

The pilot and a passenger were returning to Dunkeswell after a short pleasure flight when, at approximately six nautical miles from the airfield and at a height of 650 ft, the pilot became aware that the helicopter would not climb in response to collective inputs. After clearing an approaching ridge line the pilot elected to carry out a precautionary landing in a large field ahead, with the intention of investigating the problem on the ground. During the deceleration and descent into the field, the rate of descent increased rapidly, causing the helicopter to land heavily and roll over. The passenger sustained injuries in the roll-over and was assisted from the wreckage by the pilot. One safety recommendation has been made as a result of this investigation.

History of the flight

The pilot planned to take a passenger on a short flight from Dunkeswell Airfield to the Sidmouth area. The intended duration of the flight was 30 minutes, however, the helicopter had sufficient fuel for three hours flying and, hence, was flying at a relatively high weight. During the pre-flight magneto checks, the engine speed drop on both magnetos was excessive, being 150 rpm and 175 rpm (maximum 125 rpm) on the left and right magnetos respectively. Also, the engine ran roughly when using only the right magneto. The pilot attributed this to oil fouling of the ignition plugs during enforced prolonged running at idle power prior to the flight whilst parachuting operations were concluded over the airfield. The engine was then run at 3,000 rpm, for approximately one minute, to clear the plugs. A subsequent magneto check resulted in a drop of 125 rpm on each magneto.

The flight to Sidmouth was uneventful but, during the return, when some six nm from Dunkeswell and at a height of 650 ft, the pilot became aware that the helicopter would not climb in response to collective inputs. He confirmed that the collective friction lock was free and slowed the helicopter to 60 kt, whilst attempting to climb using both the collective and cyclic controls. Some height was gained using cyclic inputs, but use of the collective failed to produce a positive rate of climb. The helicopter's height had decreased to 500 ft and, due to an approaching ridge line, the pilot elected to find a suitable area to carry out a precautionary landing. After clearing the ridge at a height of 400 ft, the pilot prepared to land, in to wind, in a large field ahead.

However, due to a line of telegraph wires in the helicopter's flight path, the pilot turned to land in a westerly direction. At the time of the accident the reported wind conditions were 120º/15 kt giving him a tailwind component for the landing. As the pilot considered that there was now a risk of colliding with the far boundary hedge if he landed with significant forward speed, he attempted to slow the aircraft and land using the power available. Initially the descent appeared normal, with the rotor speed 'in the green'; however, as the descent progressed, the helicopter 'twitched' left and right and the descent rate increased rapidly. The pilot's attempts to slow the rate of descent, by raising the collective lever, were ineffective and the helicopter landed heavily and rolled onto its left side. The engine continued to run until the main rotor blades struck the ground. The pilot made his exit unaided and then assisted his injured passenger from the wreckage.

The helicopter suffered significant damage to the left side of the cockpit structure, the tail boom and the rotor blades. It was reported by both the pilot and the local fire service that fuel was seen leaking from the fuel tank vent system. There was no fire.

Description of the helicopter

The Schweizer 269C is a two/three seat helicopter powered by a Lycoming HIO-360-D1A engine fuel injected piston engine. This helicopter was configured with twin fuel tanks, one on either side of the main rotor mask, each holding 18.8 US gallons of fuel. The fuel tank breather system on G-OGOB had been modified by the installation of Schweizer Helicopter fuel vent modification kit, SA 269K-101-1, in accordance with UK CAA Additional Airworthiness Directive 002-02-2000 Rev 1, Figure 1. This modification links both fuel tank vents to a valve assembly and was designed to meet the requirements of Federal Aviation Regulation (FAR) 27.975 (b), which states:

> *'The venting system must be designed to minimise spillage of fuel through the vents to an ignition source in the event of a rollover during landing, ground operation, or a survivable impact'.*

Aircraft Performance

The Schweizer 269C has a maximum takeoff weight of 930 kg, an empty weight of 499 kg and a maximum rate of climb at sea level of 750 fpm. The helicopter is fitted with a collective correlator, which increases the engine power as the collective lever is raised (to overcome the increased drag of the rotor blades as their pitch angle increases) to a level which maintains the desired rotor speed.

In forward flight, and at normal operating weights, the optimum climb performance for this helicopter is achieved at approximately 50 kt; at higher weights the

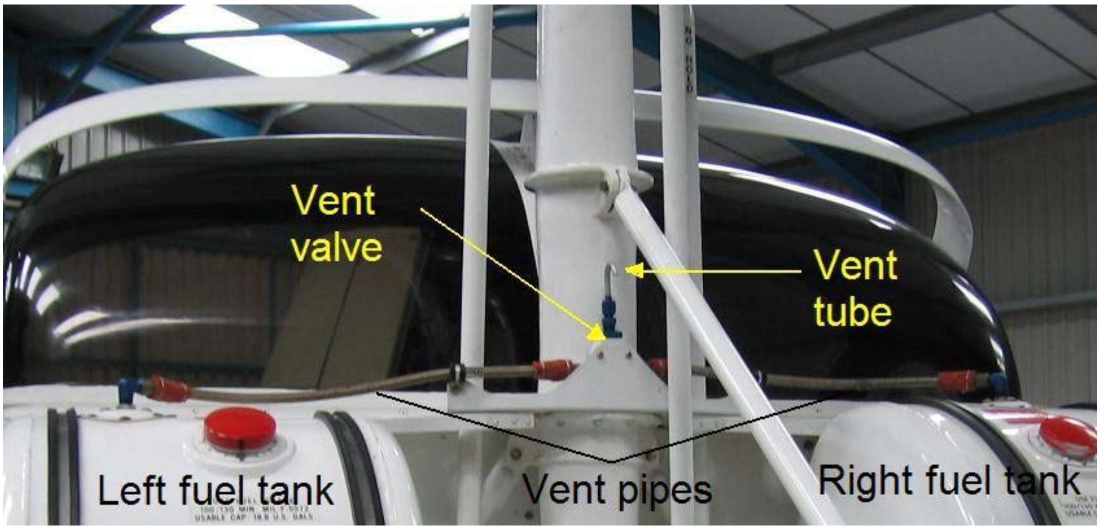

Figure 1
Location of fuel tanks vent

airspeed must be reduced to approximately 40 kt to achieve a similar rate of climb. The climb performance of G-OGOB was such that it reduced with increasing airspeed. It was reported by several Chief Flying Instructors who instruct on the type that, between 60 kt and 70 kt, dependant on its weight, the 269C has a restricted rate of climb in response to collective inputs.

Examination

General

After recovery to its hangar at Dunkeswell, the helicopter was examined by the engineer who usually carried out its routine maintenance. He reported that the engine showed no evidence of a significant failure and that the spark plugs were all free from oil fouling, were of a similar colour and visually appeared in good condition. The fuel filter was found to be free from contamination. A more detailed examination of the engine and its related fuel and airframe systems, also failed to reveal any faults which could explain the helicopter's reported loss of performance.

A further examination of the helicopter was carried out by the AAIB which confirmed that the engine had not suffered from any catastrophic failure. In addition, there was no evidence of any failures or disconnections within either the helicopter's flight controls or transmission system. The main rotor gearbox and fuel tank vent system were removed from the helicopter for further examination.

The main rotor gearbox was disassembled and inspected for any evidence of pre-existing damage or damage caused by the accident. The pinion and ring gears were found to be in good condition, with no evidence of adverse wear or cracking to the gear teeth. The pinion gear shaft was intact, and there was no damage to the drive belt or tail rotor drive splines.

Fuel tank vent system examination

On the Schweizer 269, the fuel tank vent connections are positioned on the upper left surface of each tank, Figure 1. In the event of a roll over, and depending on the fuel state of the helicopter, the possibility exists that fuel may flow from the higher tank to the lower tank.

The orientation of the connections means that the risk of a fuel tank becoming 'overfilled' is greater if the helicopter should roll onto its left side rather than its right. As fuel was reportedly seen leaking from the vent system after the accident, the fuel tank vent system was removed from the aircraft and taken to the AAIB for detailed examination and testing.

Vent system tests

The first series of tests allowed free fluid flow from a one gallon unsealed header tank through the vent system, whilst rotating the system to simulate the roll over, see Figure 2. This resulted in a few drops of fluid being released from the vent tube before the vent valve closed at approximately a 91º roll angle.

A second series of tests were conducted by closing the outlet pipe before the system was rolled to simulate the 'overfilling' of the lower fuel tank. In this condition, at roll angles greater than 45º, fluid flowed from the vent tube at a rate of 0.5 litres per minute until the system was rotated to 95º, when the flow ceased by the action of the valve closing. This series of tests was repeated after sealing the header tank, to simulate an airtight system. The maximum flow rate from the vent tube was reduced to 0.3 litres per minute, with the valve closing at 91º on the majority of occasions. During three of these tests, the valve failed to close completely, and could be clearly heard 'shuttling' in the valve body, with pressure pulses felt within the system. In this condition, a very rapid dripping flow of five drips per second was released from

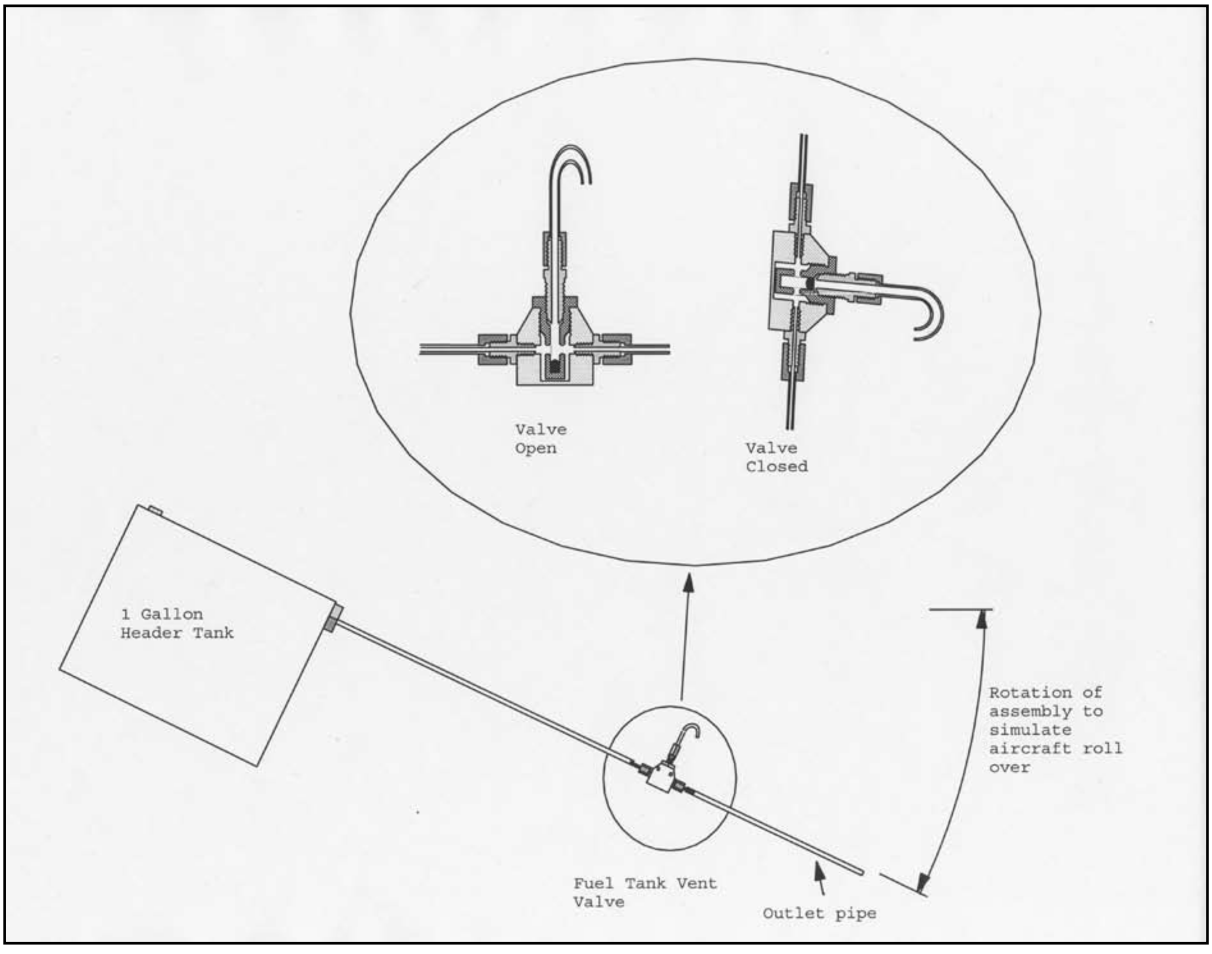

Figure 2

the vent tube for approximately 45 seconds, or until the roll angle had been increased to 99º.

A final series of tests were conducted, with the header tank sealed, at angles of roll small enough to prevent the vent valve closing. These showed that fluid flowed from the vent tube at an initial rate of 0.3 litres per minute, decreasing to a slow drip after 2 minutes, as hydrostatic equilibrium was reached in the header tank; the total fluid volume released was 0.53 litres.

Analysis

Prior to the accident, there were no reported signs of the engine running roughly, high vibration or unusual parameters, and no evidence to suggest that the engine had suffered from a major internal failure. No evidence was found to indicate that the fuel injection or ignition systems were defective, or that any restriction existed in the engine's fuel supply. Also, given that the helicopter was fitted with a fuel injection system and the absence of any reported rough running, it is considered unlikely that engine intake icing was a casual factor in this accident. In addition, examination of the helicopter's flight controls and transmission system revealed no evidence of any pre-existing defects which could have produced the symptoms of low power described by the pilot. In summary, no technical defects were discovered which could have been causal factors in this accident.

Calculations using the weight of the helicopter's occupants and the estimated fuel remaining at the time of the accident, show that the helicopter was operating at a weight of approximately 780 kg. At this weight, it is possible that the helicopter could have had a reduced climb performance at airspeeds over 60 kt.

It was considered possible that, during the descent into the field, the combination of the tailwind component and descent rate resulted in the helicopter descending into the downwash produced by its main rotor blades. This 'vortex ring state' results in a significant reduction of lift from the main rotor blades, the effect of which is a marked increase in the rate of descent, increased vibration, and general difficulties with control. If a helicopter remains in this state, any attempt to slow the rate of descent using collective pitch inputs would be ineffective and the descent would rapidly become uncontrollable. Although the pilot was reasonable certain that the rotor speed did not reduce during the descent to the field, the symptoms described could also be associated with a reduction of the speed of the rotor.

Although the testing carried out on the fuel vent system indicated that, at roll angles greater than 91º, the fuel tank vent valve regularly prevented the external release of fuel, they also showed that it was possible, in certain conditions, for the fuel vent valve to 'shuttle' which allowed the release of fuel at roll angles greater than 91º. The fuel system was tested using a small header tank of different rigidity to the helicopter fuel tanks and, as such, the duration of any valve 'shuttling', and the rate of fuel release on the helicopter, may differ from the test results.

The test also indicated that in the event of the helicopter rolling over to an angle of less than 91º there is the possibility, particularly with large quantities onboard, of fuel escaping from the vent tube if the lower fuel tank becomes full. Due to the arrangement of the fuel vent system this is more likely if the helicopter rolls onto its left side. The volume of fuel released in such a situation is dependant on how 'air tight' each fuel tank is, but the tests showed that, in this condition, a minimum of approximately 0.5 litres could be released. However, if hydrostatic equilibrium cannot be achieved in the higher of the two fuel tank, ie, air is able to enter the tank as fuel drains away, fuel could escape through the vent tube at a rate of 0.5 litres per minute,. The position of the fuel tanks and vent system on the airframe, in relation to the engine and exhaust manifold mean that any such fuel leakage from this area would provide a significant fire hazard, thus negating the reason for fitting the vent system modification in the first place.

Safety Recommendation

Tests have shown that despite the introduction of Schweizer Aircraft Corporation modification SA269K-101-1 significant quantities of fuel could escape from the fuel tank vent system in the event of the helicopter rolling over to less than 91º, which could provide a potential fire hazard. In some conditions it was demonstrated that the fuel may continue to flow from the vent system at roll angles up to 99º for a short time. The following safety recommendation is therefore made.

Safety Recommendation 2006-064

It is recommended that the Federal Aviation Administration require the Schweizer Aircraft Corporation to review modification SA269K-101-1, relating to the fuel tank vent system on the Schweizer 269 helicopter, to further reduce the possibility of fuel escaping from the fuel tank vent system in the event of the helicopter rolling over.

Conclusions

No technical defects were identified which could have explained the apparent loss of engine power. However, the possibility remains that an unidentified transient defect in the fuel or ignition systems may have prevented the engine from producing adequate power. The helicopter was operating at a weight which may have been sufficient to reduce its rate of climb from response to collective inputs, at high airspeeds.

In an attempt to avoid obstacles in the landing field, the pilot may have inadvertently entered a 'vortex ring state' or allowed the rotor speed to droop, resulting in an uncontrollable descent and subsequent hard landing and roll over.

ACCIDENT

Glider Type and Registration:	Glaser Dirks DG600 Glider, BGA 3445 (Tail No 656)
No & Type of Engines:	None
Year of Manufacture:	1988
Date & Time (UTC):	18 September 2005 at 1230 hrs
Location:	Ridgewell Airfield near Great Yeldham, Essex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Fatal) Passengers - N/A
Nature of Damage:	Glider destroyed
Commander's Licence:	FAI Gold C Certificate (August 1981) and 3 Diamonds completed July 1985
Commanders Age:	74 years
Commander's Flying Experience:	4,186 hours (estimated 2,000 on type)
Information Source:	AAIB Field Investigation with BGA assistance

Synopsis

At a height of approximately 350 ft during a winch launch, the glider was observed to be climbing at a slightly steeper than normal angle. The glider's airspeed was perceived to be abnormally slow and the winch engine lost rpm. The winch operator adjusted the winch throttle setting to allow the engine to accelerate but this had little effect. The glider stalled, yawed to the right and entered a right-hand spin; during this manoeuvre the cable separated from the glider. Height was insufficient for recovery and the glider struck the ground whilst spinning, fatally injuring the pilot.

History of the flight

The glider had been removed from its transportation trailer and assembled on the previous day by the pilot who, after an aerotow launch, carried out a flight of three hours. The glider was then left assembled overnight. Although no record was found of a Daily Inspection being completed, the pilot was known to be meticulous regarding the maintenance and inspection of the glider. It is therefore reasonable to assume that an inspection was carried out during the following morning, prior to the accident launch.

The accident flight was the pilot's only flight that day. Witnesses said that his behaviour before the flight was normal and he appeared to be in good spirits.

The glider's ground run and acceleration were normal. However, as the glider rotated into the full climb, its pitch attitude increased to an angle beyond that normally expected. During the full climb witnesses perceived that the glider's airspeed reduced. The load on the winch cable increased to the point where the winch rpm began to decrease so the winch operator reduced the throttle setting to allow the engine to recover. It was expected that the pilot, when feeling the reduction in pull from the cable, would reduce his climb angle, allowing the winch to accelerate, and then continue the launch. However, witnesses reported seeing the winch cable slacken at approximately 300 ft with the glider in a markedly nose-high attitude. The glider began to yaw to the right, the nose dropped and the cable separated from the glider. The glider's right wing dropped and it entered a right-hand spin from which it did not recover before it struck the ground.

An ambulance and an air ambulance both attended the scene but the pilot had not survived the impact with the ground.

Pilot information

The pilot was very experienced holding a full Gold 'C' FAI[1] Certificate with three diamonds that he had completed in July 1985. He had held a BGA Assistant Instructor's category but had allowed this to lapse in 2001. The pilot's logbook entries showed that he flew regularly, the flights being of long duration and were for the most part long-distance cross-country flights. He was also an authorised BGA glider inspector who serviced his own glider.

Meteorological information

At the time of the accident there was broken cloud with a base of 1,500 ft and good visibility. The surface wind was light and from the north-west.

Footnote

[1] Fédération Aéronautique Internationale – the world air sports federation.

Glider description

The DG600 is available with 15 m and 17 m wing spans and all variants make use of full-span flaperons. The larger wing span is achieved by the use of wing tip extension sections; these are secured to the wing's main spar with a metal tongue and shear pin. The accident glider was modified in Germany in 1998 and, at the time of the accident, was flying with longer wing tips, with built-in winglets, at a span of 18 m.

The wings and horizontal stabiliser/elevator can be removed to allow storage and transportation of the glider. When reassembled, the glider was considered to be 'self-connecting' in that the wing and elevator control circuits automatically engaged with the fuselage control circuits.

The 'self-connecting' features of this glider type make use of flared torque tubes in the fuselage flaperon and airbrake control circuits. These align and engage the wing control rods as the wings are slotted into the fuselage. The spars of the left and right wings form a tongue and fork joint, secured to one another by stainless steel pins at each end of the joint. The horizontal stabiliser and elevator also make use of a similar 'self connecting' feature.

The glider is fitted with three water ballast tanks, one 6 litre tank in the fin and one 90 litre tank in each wing. These are used to trim the glider in the cruise to improve its glide performance. All of these ballast tanks can by emptied in flight through the use of cable operated valves.

The DG600 glider makes use of a wing cross-section designed for high performance gliding. Trials during the introduction of this glider into the UK showed it to have 'sharp-edged' stall characteristics, giving little or no tactile warning to the pilot before stalling. In order to satisfy UK requirements for the issue of a Certificate of Airworthiness, the BGA raised a requirement to install an additional stall warning system. This modification did not change the stall characteristics of the glider; it provided the pilot with an audible warning to indicate that the glider was approaching a stall.

The stall warning system fitted to the glider consisted of two orifices on either side of the fuselage, one close to the wing leading edge and one at approximately mid-chord. The pressure readings from these orifices are fed into a cockpit mounted variometer. As the angle of attack of the glider's wing approaches the stalling angle, the airflow over the wing changes giving a differential pressure between the forward and mid-chord orifices. This produces a movement of the variometer needle, and an audible signal to warn the pilot of an impending stall.

Glider's maintenance history

The glider had been purchased from new by the pilot and another syndicate member and was operated by them until the accident date. All of the maintenance and inspection entries in the glider's log book were carried out by the pilot who was a BGA authorised inspector.

The glider was initially operated on a Permit to Fly until January 1992, when BGA approved modifications to the glider stall warning system were incorporated, allowing the glider to be granted a full Certificate of Airworthiness.

The glider's logbook confirmed that it had been maintained in accordance with current BGA requirements. The last airworthiness report was completed on 14 June 2005 and the last entry in the glider logbook, dated 13 June 2005, states that it had accumulated 2,274.5 flying hours and 804 winch launches.

Glider's flight characteristics

The manufacturer's flight manual for the glider gives the following information regarding winch launches:

> *'Set the wing flaps at +10º.*
>
> *Set the trim nose up for a winch launch.*
>
> *Use the normal winch launch procedure.*
>
> *After reaching 60 m (200 ft) gradually pull back some on the stick so that the glider will not pick up excessive speed'*
>
> *'Recommended winch launch airspeed 110-120 km/h (60-65 kts)'*
>
> ***'Caution**: Don't fly with less than 90 km/h (49 kts) and not more than 150 km/h (81 kts)'*

The flight manual states that with the flaps deployed, the glider will drop a wing when stalled; it also provides the following guidance regarding spin recovery:

> *'Height loss during recovery is 50-80m (160-260 ft), the max speed is 190 km/h (103 kts)'*

Airfield information

Ridgewell is an unlicensed grass airfield on the site of a former military airfield owned by the Essex Gliding Club. The airfield has two grass runways orientated 09/27 and 05/23. On the day of the accident, operations were being conducted from Runway 23.

Wreckage and impact information

The glider came to rest in a ploughed field 15 m beyond the left edge of Runway 23. The right wing spar had failed resulting in the separation of both the left and right wings from the fuselage. The forward fuselage was significantly disrupted and the aft fuselage had failed immediately ahead of the fin.

Ground marks showed that the first contact with the ground was made by the right wing tip on the runway, 10 m from the field boundary. Measurements indicate that the glider hit the ground 40° to 50° nose down and with 15° to 20° of right roll. The ground marks indicated that the right wing tip extension broke away from the wing shortly after the first impact mark. Approximately 2 m beyond the first impact mark, the main section of the right wing tip made contact with the ground. The right side of the forward fuselage hit the ground at the runway boundary; the force of this impact fractured the right side of the nose initiating the break up of the forward fuselage and canopy. It appears that at some point shortly after this impact, the right wing spar failed, allowing the right wing to separate and slide across the field. The fuselage and left wing continued into the field for a further 23 m before coming to rest. Sections of the forward fuselage outer skin, together with glider instrumentation and glider tools were scattered along the debris trail.

Before the pilot was extricated from the wreckage, it was noted that the seat harness lap straps were securely fastened. However, the shoulder straps were unfastened, the right strap being under the pilot and showing signs of being dragged across the surface of the field, and the left strap pinned under a section of cockpit internal structure. The emergency services and witnesses who were first on the scene confirmed that they had not removed the shoulder harnesses prior to the arrival of the AAIB investigators.

A substantial section of the glider instrument panel, containing a number of instruments including the ASI, was found in the wreckage trail. When examined, the ASI was reading 25 KIAS although it appeared to be undamaged.

Due to the detachment of the wings from the fuselage, continuity of the flaperon and air brake control circuits could not be confirmed on site; however continuity of the elevator and rudder circuits was verified prior to recovery of the glider.

The water ballast tank drains were exercised and all tanks were found to be empty. There was no evidence of water spillage at the accident site and it was concluded that no ballast had been carried on the accident flight.

Glider launching winch

Ridgewell Airfield is equipped with a motorised winch for launching gliders. The winch is fitted to a wheeled trailer and powered by a Ford V8 engine which has been converted to operate on LPG (Liquefied Petroleum Gas). The winch is operated from a cab at the front of the unit which is protected by a steel safety cage. The engine is equipped with a hand throttle and an automatic gearbox, the engine output being transmitted through dog clutches to two cable spools. The spools are fitted with guillotines to sever the cables if the glider fails to release the cable. The glider launch cables are fitted with a 'weak link' close to the eye end of the cable which is designed to fail and release the glider in if an excessive load is applied to the glider; the strength of the link required is dependent on the type of glider being launched. Examination showed that the cable used was free of visible defects. The 'weak' link fitted to the cable was intact and of the correct type for launching BGA 3445.

The LPG bottle used during the accident launch was found to weigh 28 kg. Full bottles typically weigh 38 kg, and bottles considered 'empty' weigh approximately 20 kg.

The winch operator was trained and experienced in launching gliders using the winch, and when interviewed reported that there were no abnormalities with the winch immediately before or during the launch of BGA 3445. The winch operator stated that the launch was initially normal, with the glider rotating into a steep climb. This increased the load on the winch cable and the winch operator attempted to increase the engine rpm by opening the throttle a little but this had no effect. As the glider reached a height of about 350 ft, the engine picked up speed and the operator noticed that the cable was slack, so he attempted to increase the engine speed to take up the slack. Some slack was taken up but the glider appeared to him to be stalling and it started to fall to the glider's right. The cable separated from the glider after it had turned through about 70º to the right. At that point the operator stopped the winch.

The winch was examined before its operation and was tested by towing calibrated loads along the runway. No abnormalities were observed during the examination, the testing or the subsequent launch.

Detailed examination

Examination of the ground marks and accident site showed that the glider was structurally intact immediately prior to impact. The wreckage was recovered to the AAIB and subsequent investigation concentrated on the glider's controls, cable release, instrumentation and seat harnesses.

Controls

The flaps and ailerons on the DG600 are combined to form a single moveable surface or flaperon on the trailing edge of each wing. The pilot's roll inputs and flap selections pass through a 'mixer' unit which transmits both inputs to the trailing edge control surface. (See Figure 1 below).

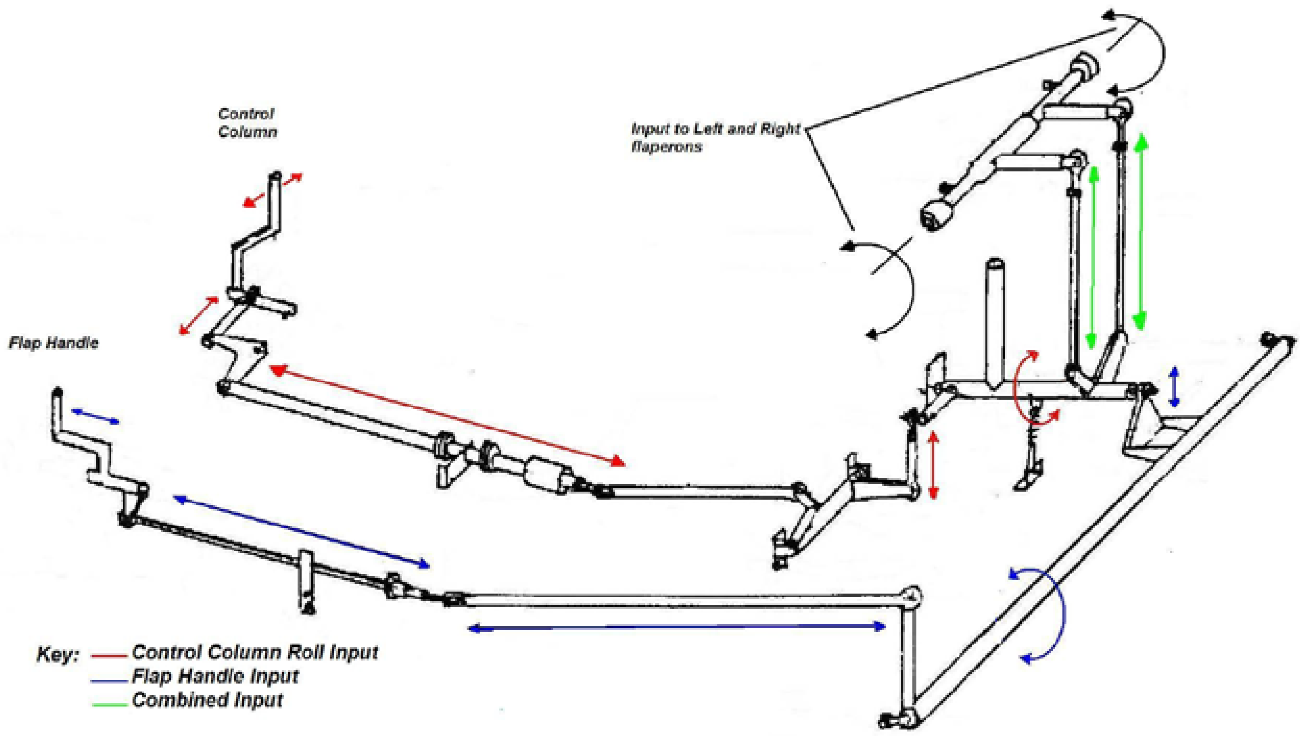

Figure 1

DG600 Flaperon control circuit
(Modification of manufacturers drawing)

The continuity of the primary control circuits from the cockpit to the wing joint and tail was verified; no evidence of restriction, jamming or pre-impact damage was identified in the flap, spoiler or elevator circuits. However, a connecting turnbuckle which transmitted aileron inputs into the 'mixer' unit had failed. Analysis of the fracture surface showed the characteristics of a single overload failure with no evidence of fatigue or pre-existing defect.

The 'self connecting' mechanisms on the 'mixer' unit and the wings were examined and no evidence of incorrect connection or a mechanical disconnect in flight was identified. The wing control surfaces were operated through their full range of movement from the wing root connection points and no binding or jamming of either the flaperons or the spoilers was identified. The position of the flap lever prior to impact could not be determined.

The glider was fitted with an automatic pitch trimming system operated either by a lever on the control column or a handle on the left cockpit wall. In order to set the trim, the pilot pulls the lever. This engages a rack and pinion arrangement in the elevator circuit. The control column is then moved to the position for the desired flight speed and the lever is released setting the trim. Examination of the system showed that all systems tensions and dimensions were within the manufacturer's limitations. Witness marks on the rack and pinion within the system indicated that the glider had been trimmed in a nose-down position at impact, corresponding to the recommended setting specified in the manufacturer's Flight Manual, when launching the glider.

Cable Hook and Release Mechanism

BGA 3445 was fitted with a single cable hook positioned at the C of G and located below the cockpit. The hook mechanism is designed to release the cable automatically if the launching/towing cable becomes angled to the rear of the perpendicular to the longitudinal axis of the fuselage. This is known as 'back releasing'. Back releasing can occur at the top of a winch launch or at any stage if the cable becomes slack and is dragged rearwards relative to the glider. The launching/towing cable is normally released manually by the pilot.

The cable hook recovered from the wreckage was found to be in good working order; both the manual and automatic cable release mechanisms worked and no defects were observed with the hook assembly.

Instrumentation

The glider was equipped with primary flight instrumentation consisting of an ASI, artificial horizon, altimeter, compass and a turn and slip indicator. In addition the glider was fitted with two variometers and a gliding computer with integral GPS. One of the variometers was used in conjunction with pressure tappings close to the wing roots to provide a stall warning system for the glider.

The glider was fitted with a nose mounted pitot orifice which provided a 'total' (pitot) pressure supply to the instruments; this was blocked by a very tightly packed accumulation of earth which appeared to have been driven into it during the impact sequence. Two static ports were provided, one on each side of the forward fuselage supplying static pressure to the primary flight instruments.

BGA 3445 was also fitted with a fin mounted receptacle for an additional probe which provided independent pressure readings to gliding computers and variometers. Two types of probe were available, a 'multi-probe' and a 'total energy' probe. The 'multi-probe' provided pitot, static and 'total energy'[2] pressures through three concentric tubes, the 'total energy' probe provides only a 'total energy' pressure through a single tube. To accommodate both types of probe, the fitting has three outlets, each connected to a different coloured tube, red, green and transparent.

BGA 3445 was fitted with a 'total energy' probe. The red and green tubes were blanked with tape, leaving the clear tube open to provide the 'total energy' pressure. The probe consisted of a 60 cm long pipe with a 'Y' shaped end piece as illustrated in Figure 2.

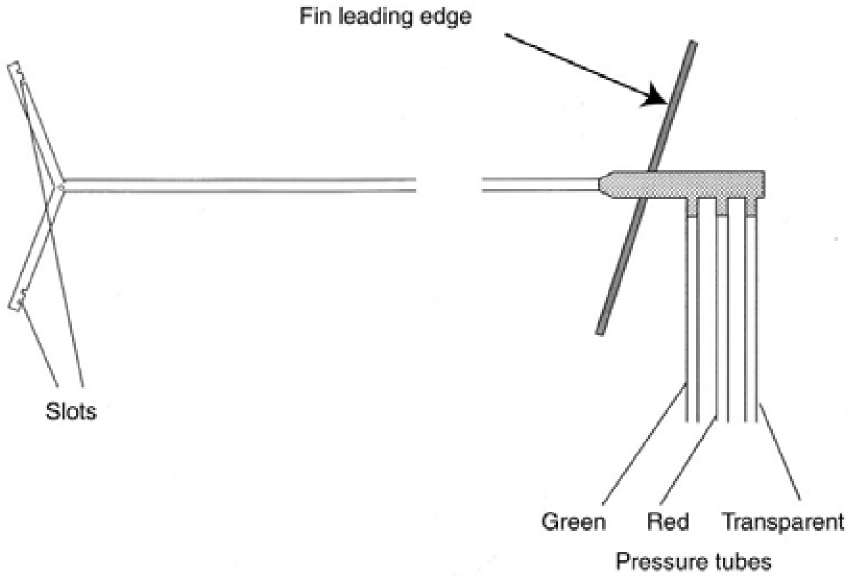

Figure 2

BGA 3445 Total Energy Probe Installation

Two slots were cut in the aft face of each side of the 'Y' shaped end piece allowing the 'total energy' pressure to be transmitted through the probe.

Anecdotal evidence suggests that the pressures obtained from a 'total energy' probe may be affected by the attitude of the glider but they are sufficiently stable to be used by variometers and gliding computers.

A reconstruction of the pitot static system showed that the gliding computer, flask variometer and the primary flight instruments were connected to the same pitot and static sources, including a static pressure input from the tail mounted total energy probe, see Figure 3.

During the reconstruction it was not possible to identify a connection to the separate total energy input of the gliding computer. However, it was found that the computer fitted to this glider was capable of being programmed to generate an equivalent total energy signal using pitot and static pressure inputs. Therefore, it is possible that there was no total energy input to the gliding computer.

In order to determine what effect, if any, this would have on the accuracy of the ASI, the glider's pitot static system and instrumentation were replicated and subjected to dynamic testing through a range of 0º to 75º Angle of Attack (AOA). The test results showed that at steady speeds of 40 kt and 50 kt the indicated airspeed remained constant as the 'total energy' probe was moved through the measured AOA range.

Due to disruption of the forward fuselage and severe damage to the variometer used for the stall warning system, the pressure tappings and associated piping could not be tested.

Footnote

2 *'Total energy'* is a term used to describe a pressure produced by a *'total energy'* probe. Its properties are such that it eliminates the effects of airspeed changes on variometers which indicate a glider's rate of climb or descent.

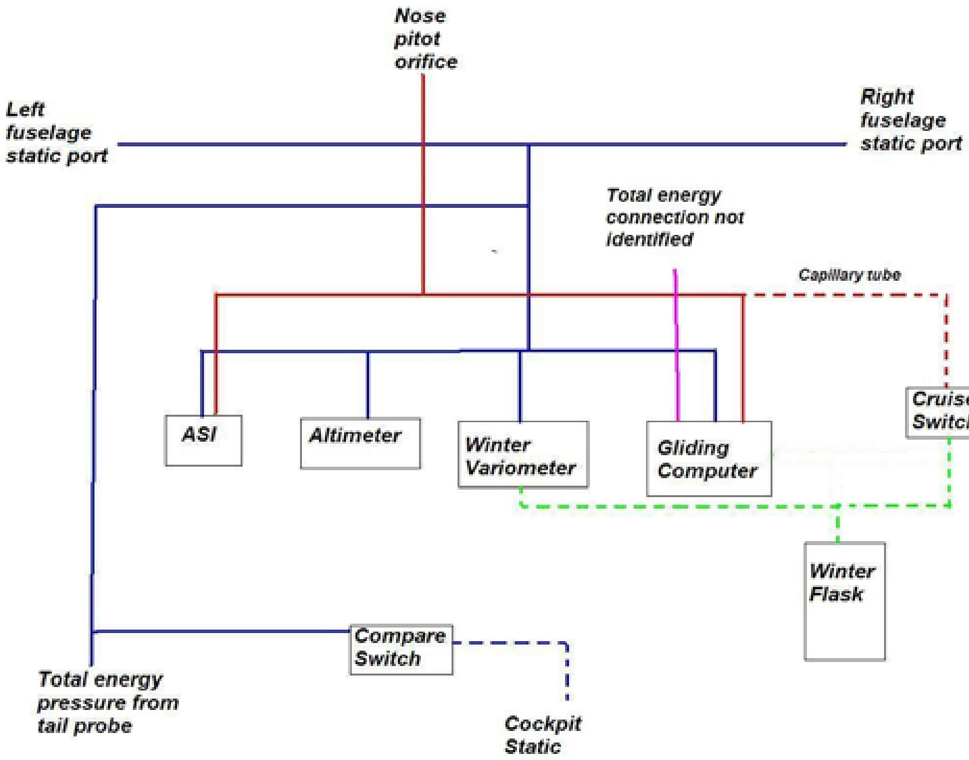

Figure 3

BGA 3445 Pitot static system schematic diagram

Harness

The glider was fitted with a four-point nylon harness consisting of two shoulder straps and two lap straps. The harness buckle was attached to the right lap strap. The shoulder and left lap straps were released from the buckle by turning the release mechanism on the front of the buckle through 45º in either a clockwise or anticlockwise direction. The buckle was also fitted with a shoulder strap release tab behind the shoulder strap slots (see Figure 4),

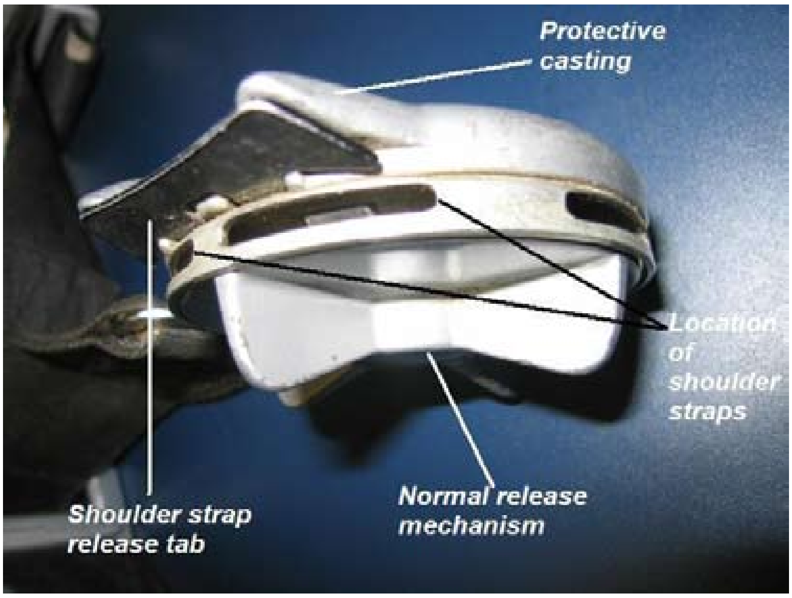

Figure 4

BGA 3445 Seat harness buckle

Pushing the tab forward would release both shoulder straps but leave the lap straps secure. The tab requires a force of 19.6 Newtons to operate it and is protected from inadvertent operation by two projections on the rear of the buckle casing. During the impact, the seat structure failed but the harness attachments remained intact. The straps were free from tears or damage; the buckle was also free from damage and functioned normally. Evidence of soil was found on both the inner and outer faces of the right shoulder strap but not on the other straps. Both lap straps showed some degree of 'hardening' of the webbing where it passed through the adjustment points. This is typical of the nylon material subjected to a high load. The shoulder straps did not exhibit this 'hardening'.

The seating position in the DG600 is semi-reclined, (see Figure 5), with a smoothly curved backrest. Typical fuselage pitch attitudes during a winch launch are between 35º and 45º; this results in the pilot's torso effectively lying flat on the seat back with his hips and legs raised. In this position the mass of the pilot's hips and legs would exert a force on the pilot's torso which would tend push the pilot 'up' the seat back. Acceleration of the glider in the initial stages of the launch can also contribute to this effect. Any tendency for the pilot to move in this direction would normally be restrained by the harness shoulder straps.

Load and Balance

After taking into account the mass of the pilot and the tools carried on board the glider, calculations show that it was being operated within its established centre of gravity limitations.

Witnesses

Statements were taken from a number of witnesses and the majority have confirmed that after the initial part of the winch launch, which was normal, the glider was seen to be climbing very steeply and appeared to be slower than 'normal'. It is difficult to assess quantitively the pitch attitude of a glider during a winch launch, but witnesses generally concluded that this was of the order of 45º.

Medical and pathological information

The pilot's medical certificate, valid until 4 April 2006, was a self-declared certificate countersigned by his General Practitioner. A post-mortem examination determined that the pilot had died of multiple injuries

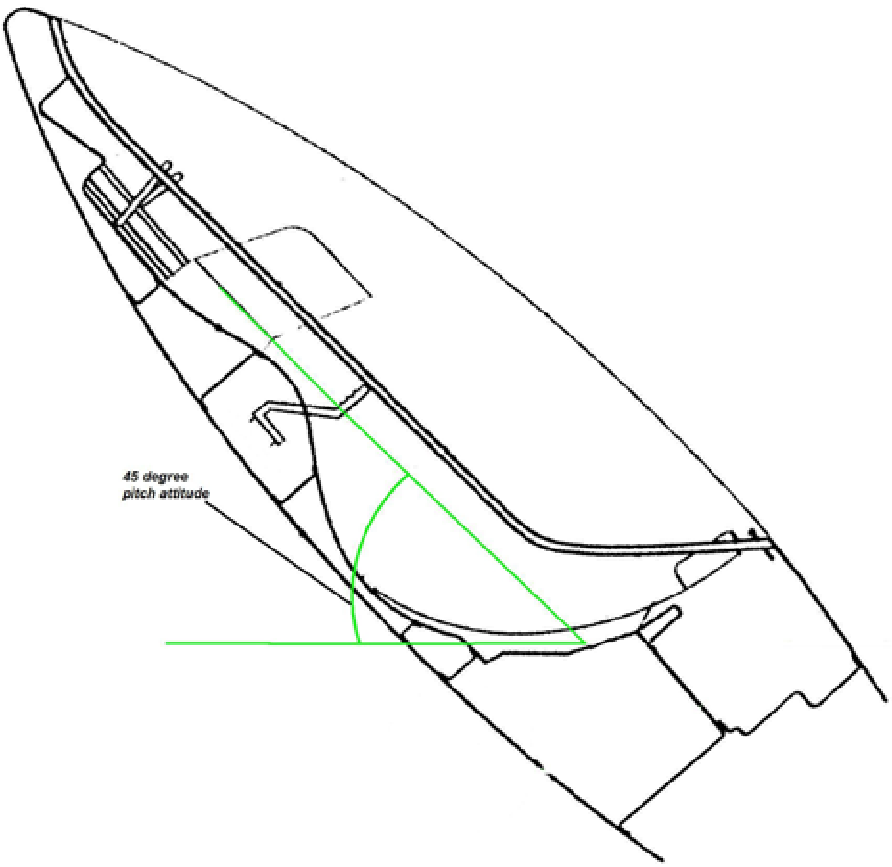

Figure 5

DG600 Cockpit sectional diagram
(Modification of manufacturers drawing inclined to represent a 45º pitch attitude)

sustained in the accident and confirmed that it was not survivable. Injuries to the pilot's left hand suggested that he had not collapsed prior to ground impact. Moreover, there were no medical conditions which were likely to have contributed to this accident but it was not possible to determine from his injuries whether or not the pilot's shoulder straps had been fastened during the ground impact sequence.

Analysis

The launching winch and cable were both serviceable at the time of the accident. The winch operator was suitably trained on the use of the equipment and the launch of BGA 3445 appeared normal until the glider's attitude produced an excessive load on the winch engine.

Analysis of the accident site and detailed examination of the glider showed that it was structurally intact immediately prior to impact. The rudder, elevator and spoilers were correctly connected and free from any restrictions or malfunction and the glider was trimmed correctly. The failure of the aileron turnbuckle was caused by a single overload event occurring at impact. There was no evidence of a restriction in the aileron control circuit or of pre-existing damage.

The ASI was serviceable and probably accurate immediately before the accident. Although the 'total energy' probe was connected to the primary flight instrument static system, it is considered very unlikely to have introduced errors in airspeed indication during the winch launch.

Calculations based on the weight of the glider, equipment and pilot show that the glider's level flight (1g) stall speed on the accident flight was approximately 35 kt with the manufacturer's recommended flap setting (10º) selected. In the event of a winch launch problem at medium height, published calculations show that, unless immediate and correct recovery action is taken, the glider will decelerate rapidly. For a 45º nose high pitch attitude, this is typically in the order of 14 kt per second.

The glider had been estimated by several witnesses to be flying slower than expected. It was therefore probable that it was flying below the recommended 60 to 65 kt. A 'normal' speed for winching operations with most gliders is approximately 55 kt with higher speeds only being achieved further into the launch path.

It was not possible to quantify the actual speed of this glider at the point of cable release; however in view of the witness reports and 'normal' winch speeds, it is probable that the glider's airspeed was no higher than 50 kt. A cable release in this speed range, if immediate recovery action was not taken, would cause the glider to decelerate below the 1g stalling speed within one second. It is therefore probable that a reduction in airspeed would result in an almost immediate and possibly abrupt stall. If the glider had been operated with a positive flap setting, as recommended in the Flight Manual, it would have 'dropped' one wing as it stalled, rotating the glider and causing entry into a spin.

It was not possible to test the stall warning system for the glider, and therefore no estimation of the interval between the system producing a warning of impending stall, and the glider reaching the stall could be made. Based on the glider's maintenance records and its pilot's qualifications, it is considered likely that the stall warning system was serviceable prior to the accident and would have provided an audible warning of the impending stall if it was switched on. However, the time between the warning and decelerating to the stall speed would have been short.

Examination of the seat harness shows that the shoulder straps were not subject to the same magnitude of loading as the lap straps. The position of the shoulder straps in the wreckage and the soil contamination of the right shoulder strap suggests that they were not secured when the glider hit the ground. There are two likely explanations for this apparent insecurity: either the shoulder straps had not been fastened properly or the dynamics of the ground impact released them very early during the impact sequence.

If the pilot was unrestrained by the shoulder straps during the flight, it is possible that during the launch his body slipped 'up' the seat. The cockpit of the DG600 does not offer any obvious hand holds, with the exception of glider control levers. It is possible, therefore, that the pilot inadvertently pulled back further on the control column before finding a suitable hand-hold for his free hand. This would result in an increase in pitch, an increasing in the load on the winch and a decrease in the glider's airspeed, bringing it closer to its stalling speed. It may also have decreased the pilot's ability to lower the nose sufficiently rapidly to prevent the glider stalling and entering the spin.

Alternatively, the pilot had a reputation for meticulous pre-flight preparation and not to have fastened his shoulder straps would have been out of character. Furthermore, his normal practice whilst boarding the glider was to drape the shoulder straps over the sides of the fuselage, thus preventing the canopy from closing until the straps were brought inboard. There was no suggestion that the launch had taken place with the canopy unfastened. Consequently, it is possible that the shoulder straps were properly fastened in flight but the release tab was moved forwards due to inertial forces as the glider hit the ground and whilst the straps were off-loaded by simultaneous deformation of the cockpit structure.

Survivability

An investigation into the protection offered by glider cockpits during crashes was carried out in 1994 by the TUV Rhineland Group. The investigation carried out laboratory crash simulations using fuselage sections very similar to that of the DG600 with crash test dummies strapped into the cockpit seat. The final test scenario, used by the investigation team, involved a simulated crash from a spin, at high speed and at 45º nose-down attitude.

The results of this test showed that during the impact, there was significant upward deformation of the forward fuselage, which, coupled with the momentum of the structure immediately behind the cockpit, resulted in the cockpit folding upwards crushing the dummy between the seat back and the forward section of the cockpit. As the structure behind the cockpit decelerated, the cockpit sprang back into a nearly normal position with the dummy apparently unharmed. An analysis of the forces involved in the test showed that the impact was not survivable despite the apparent lack of post-test damage to the cockpit.

In the case of BGA 3445, the glider appears to have struck the ground at between 40º and 50º nose down at high speed. Due to the significant disruption of the fuselage observed at the accident site, it was apparent that BGA 3445 was subjected to higher forces than those experienced during the TUV Rhineland Group tests and in view of this, it is considered that the crash of BGA 3445 was not survivable, regardless of whether or not the pilot had fastened his shoulder straps.

Conclusion

The glider was structurally intact; the control circuits appear to have been connected and without restriction or damage, and the ASI was functional prior to the accident.

During the launch the glider adopted a slightly steeper than expected climb angle and its airspeed reduced to the point at which it stalled. The load on the winch cable was such that the winch operator was unable to accelerate the winch and restore airspeed to the glider. As the glider stalled and yawed to the right, the load on the cable reduced and the winch engine accelerated but slack in the cable probably allowed it to automatically 'back release' from the glider. The glider then entered a right hand spin with insufficient height for recovery and impact with the ground was not survivable.

It is possible that the harness shoulder straps were not securely fastened. However, it is also possible that the shoulder straps unlocked during ground impact due to an ill-defined and very unusual sequence of applied forces and possibly fuselage deformations.

If the shoulder straps had been insecurely fastened, the pilot could have slipped rearwards in the seat during the initial acceleration and climb, and thereby applied additional and unwanted aft movement to the control column. The inadvertent pitch input would have resulted in an excessive nose-high attitude and a significant increase in the load on the winch. This in turn would result in the winch being unable to provide adequate power to maintain the launch. If immediate and correct recovery action could not be taken because of the rearward position of the pilot, the glider would decelerate rapidly, leading to it stalling and entering a spin.

Safety Recommendation

Evidence that the pilot's shoulder harness may not have been secured during the winch launch has given rise to the possibility that he may have slid rearwards and upwards relative to the seat pan and inadvertently moved the control column aft increasing the pitch angle of the glider. He may also have been restricted in his ability to move it forward again for recovery action. Because of these potential causal factors it was recommended by the BGA investigator that:

BGA Recommendation BGA 01/06

The BGA remind all glider pilots of the importance of ensuring that glider harnesses correctly fit the user of the glider and that that harness is fully secured before flight.

Safety action taken

The procedures and problems of winch launches have been adequately covered by the recent work conducted by a BGA Safety Initiative. Their conclusions and recommendations have been circulated to all BGA affiliated clubs and thence will be circulated to all BGA associated glider pilots within the United Kingdom. Therefore, it is not considered necessary for the AAIB to make any additional recommendations.

ACCIDENT

Aircraft Type and Registration:	Medway Microlights Eclipser, G-BZGE
No & Type of Engines:	1 Jabiru Aircraft PTY 2200A piston engine
Year of Manufacture:	1998
Date & Time (UTC):	19 February 2006 at 1430 hrs
Location:	Woore, Shropshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Extensive damage to wing
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	38 years
Commander's Flying Experience:	349 hours (of which 81 were on type) Last 90 days - 45 minutes Last 28 days - 45 minutes
Information Source:	Aircraft Accident Report Form submitted by the pilot and AAIB enquiries

Synopsis

The aircraft lost power in the cruise and the pilot carried out a forced landing. During the landing flare the pilot could not reduce the power to idle and the aircraft landed long, running into trees. The pilot suggests that the initial power loss was due to carburettor icing.

History of the flight

The pilot had flown for 45 minutes in the previous 24 hours, but had otherwise not flown for a number of months. Whilst in the cruise at 1,200 ft, with normal cruise power of 2,300 rpm set, the engine began to loose power, dropping to approximately 1,900 rpm. The aircraft was equipped with both a hand throttle, normally used in the cruise, and a foot throttle, and the pilot tried to regain power using the latter without success. He therefore chose a field for a forced landing. As he approached the field he saw deep ruts at the approach end, and so he extended the landing further into the field. During the landing flare he retarded the throttle to idle but the engine power did not reduce and the aircraft landed long, running into some trees and a barbed wire fence.

Discussion

This particular engine has had problems with overheating, and new cylinder heads had been fitted as a result. However, in his report the pilot suggests that the initial power loss was due to carburettor icing. The carburettor has a spring loaded slide which, if induction ice is present, can freeze and can prevent the power from being reduced. Alternatively the pilot suggests that he may not have fully closed the hand throttle.

ACCIDENT

Aircraft Type and Registration:	Pegasus Quik microlight, G-FLEX
No & type of Engines:	1 Rotax 912 ULS piston engine
Year of Manufacture:	2003
Date & Time (UTC):	11 June 2006 at 1100 hrs
Location:	Lower Boddington, Northamptonshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to fuselage fairings and kingpost
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	28 years
Commander's Flying Experience:	79 hours (of which 24 were on type) Last 90 days - 11 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

After landing deep into a field, the pilot attempted to both brake and steer the aircraft at high speed, which caused it to skid and tip onto its wing.

History of the flight

The pilot had flown from Hanney, Oxon to Lower Boddington with the intention of landing in a friend's field. After completing a normal circuit and approach the aircraft landed further into the field than intended. With insufficient speed to carry out a go-around, and when approaching an area which sloped down, the pilot braked hard and attempted to steer towards the corner of the field. As a result, the aircraft began to skid, tipped over and finally come to rest on its wheels.

The pilot attributed the incident to both his failure to go-around immediately from the late touch down, and then not allowing the aircraft to slow sufficiently before trying to simultaneously brake and steer the aircraft towards the corner of the field.

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2004

1/2004 BAe 146, G-JEAK
during descent into Birmingham
Airport on 5 November 2000.

Published February 2004.

2/2004 Sikorsky S-61, G-BBHM
at Poole, Dorset
on 15 July 2002.

Published April 2004.

3/2004 AS332L Super Puma, G-BKZE
on-board the West Navion Drilling Ship,
80 nm to the west of the Shetland Isles
on 12 November 2001.

Published June 2004.

4/2004 Fokker F27 Mk 500 Friendship,
G-CEXF at Jersey Airport,
Channel Islands on 5 June 2001.

Published July 2004.

5/2004 Bombardier CL600-2B16 Series 604,
N90AG at Birmingham International
Airport on 4 January 2002.

Published August 2004.

2005

1/2005 Sikorsky S-76A+, G-BJVX
near the Leman 49/26 Foxtrot Platform
in the North Sea on 16 July 2002.

Published February 2005.

2/2005 Pegasus Quik, G-STYX
at Eastchurch, Isle of Sheppey, Kent
on 21 August 2004.

Published November 2005.

3/2005 Boeing 757-236, G-CPER
on 7 September 2003.

Published December 2005.

2006

1/2006 Fairey Britten Norman BN2A Mk III-2
Trislander, G-BEVT
at Guernsey Airport, Channel Islands
on 23 July 2004.

Published January 2006.

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