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ADDENDA and CORRECTIONS

(ALL TIMES IN THIS BULLETIN ARE UTC)

ACCIDENT

Aircraft Type and Registration:	Aerospatiale SA365N Dauphin 2, G-BLUN	
No & Type of Engines:	2 Turbomeca Arriel 1C turboshaft engines	
Year of Manufacture:	1985	
Date & Time (UTC):	27 December 2006 at 1834 hrs	
Location:	Approximately 0·25 nm south of the North Morecambe platform, located within the Morecambe Bay gas field in the Irish Sea	
	Latitude Longitude	N 53º 57·361' W 003º 40·198'
Type of Flight:	Commercial Air Transport (Passenger)	
Persons on Board:	Crew - 2	Passengers - 5
Injuries:	Crew - 2 (Fatal)	Passengers - 4 (Fatal) 1 (Missing)
Nature of Damage:	Helicopter destroyed	
Commander's Licence:	Airline Transport Pilot's Licence	
Commander's Age:	52 years	
Commander's Flying Experience:	8,856 hours (hours on type unverified) Last 90 days - 97 hours Last 28 days - 29 hours	
Co-pilot's Age:	33 years	
Co-pilot's Licence:	Commercial Pilot's Licence	
Co-pilot's Flying Experience:	3,565 hours (of which 377 hours were on type) Last 90 days - 62 hours Last 28 days - 19 hours	
Information Source:	AAIB Field Investigation	

The investigation

The London Air Traffic Control Centre notified the Air Accidents Investigation Branch (AAIB) of the accident at 1906 hrs on 27 December 2006 and the investigation commenced the next day. The Chief Inspector of Air Accidents has ordered an Inspector's Investigation be conducted into the circumstances of this accident under the provisions of the Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 1996.

Because of the importance of helicopter operations in support of the offshore oil and gas industry it is considered appropriate to disseminate the results of the initial investigation as soon as possible. No analysis of the facts has been attempted and no safety recommendations are considered appropriate at this time.

History of the flight

The helicopter operator's base at Blackpool utilises SA365N (Dauphin) helicopters in support of offshore gas operations in the Morecambe Bay gas field. On the night of the accident, the helicopter departed Blackpool to complete a scheduled flight consisting of eight sectors in the Morecambe Bay gas field. The first two sectors were completed without incident. The helicopter then took off from the Millom West platform at 1826 hrs, and commenced a transit to the North Morecambe platform at a height of 500 ft.

The three-man helideck team on the North Morecambe platform saw the helicopter making its approach to the platform. They reported that the approach appeared normal and they assumed that the helicopter was going to fly a standard approach and land on the platform. They then saw the helicopter turn to the right and fly close to the platform without appearing to slow down. They were not aware of any strange noises or any sudden movements of the helicopter. They then saw the helicopter straighten briefly before it started to bank slightly as it continued descending at a steady rate. They lost sight of the helicopter and a few seconds later they heard it crash into the sea; the alarm was raised and the coastguard was contacted at 1835 hrs.

The fuselage disintegrated on impact and the majority of the structure sank. Two rescue craft were launched from a multipurpose standby vessel that was on station nearby and they arrived at the scene of the accident within 12 minutes. No survivors were recovered from amongst the five passengers and two crew.

Weather

A weather observation from the Central platform (located 7.5 nm south-south-east of the North Morecambe platform), recorded at 1700 hrs, reported the following conditions: surface wind from 150º at 22 kt, visibility 4 km in rain, sky obscured, temperature +5ºC, dew point +4ºC and the mean sea level pressure 1020 hPa. This information was passed to the helicopter operator for flight planning purposes.

A weather observation from the standby vessel, on station near to the North Morecambe platform recorded at 1810 hrs, reported a surface wind from 130º at 20 kt with a visibility between 3 to 5 nm (5.6 to 9.2 km).

The minimum weather conditions for flights at night between helidecks, when the over water sector is less than 10 nm, require a cloud base that allows a flight at 500 ft to remain clear of cloud with a visibility of 5 km.

Search and rescue

The search and rescue operation was co-ordinated by the Liverpool Maritime Rescue Co-ordination Centre. The first search and rescue helicopter arrived at the accident scene within 35 minutes of the accident and assisted the standby vessel's rescue craft that were already searching the area for survivors. Six bodies were recovered that evening; the search for the seventh occupant continued for a further two days without success.

Wreckage recovery

The tail boom and fenestron were found floating on the surface and recovered within the first few hours. The recovery of the remaining wreckage and the flight data recorder was hampered by persistent storms in the Irish Sea throughout early January. The location of the flight data recorder was identified on 5 January and wreckage was subsequently located in the immediate area. The next major elements of wreckage, consisting of the main rotor head, the main gearbox and both engines, were recovered on 10 January. The remaining major items, together with the flight data recorder, were recovered on 16 January.

Engineering

Despite the severely disrupted condition of the wreckage, it is estimated that more than 90% of the helicopter has been recovered including the tail rotor, the main rotor head, the main gearbox and both engines. Representatives of the airframe and engine manufacturers have completed an initial appraisal of the wreckage under the supervision of AAIB engineers.

The conclusion of this preliminary examination is that there are no signs of pre-impact malfunction of any major mechanical components, including the tail rotor and its drive shaft. Indications of torque delivery were observed on both the engines and the significant damage to the main rotor blades is consistent with normal operating rpm at impact with the sea. A more detailed strip inspection of the transmission, engines, flying control actuators and instruments will now commence.

Recorded data

The helicopter was fitted with a combined data and voice recorder. The recordings, which also covered previous flights, were successfully replayed. Initial analysis of the recordings indicates that the first two sectors, which were flown by the co-pilot, were completed without incident.

The recordings indicate that the helicopter departed Millom West with the co-pilot as the handling pilot. The approach to the North Morecambe platform was initially on a heading of 120º(M). During the later stages of the approach the helicopter slowly pitched nose down and commenced a slow roll to the right. At the same time the collective lever was raised, increasing power from the engines, and the indicated airspeed and altitude began to increase. The crew became unhappy with the approach and decided to abort the attempt to land.

A go-around was commenced during which the helicopter continued to roll to the right and pitch nose down. The co-pilot asked for assistance and the commander took control. The data indicates that one second later the helicopter had attained a maximum nose down pitch attitude of 38º, coincident with a bank angle of 38º to the right. The indicated airspeed was increasing through 80 kt, and the radio altitude was reducing through 300 ft with a rate of descent of approximately 1,400 ft per minute. Over the next two and a half seconds, the helicopter rolled level and the pitch attitude reduced to 13º nose down. The radio altitude indicated 170 ft, with an indicated airspeed in excess of 100 kt, and a rate of descent of about 1,400 ft per minute. During the next five and a half seconds, there was no significant change in the pitch attitude and the indicated airspeed continued to increase as the helicopter descended; over the same period, the helicopter commenced a slow roll to the right. The last recorded parameters indicate a radio altitude of 30 ft, a 12º nose down pitch attitude, an indicated airspeed of 126 kt, and an angle of bank of 20º to the right.

A review of the recorded data to date has not indicated any problems of a technical nature and no helicopter manoeuvres have been identified which were not in response to flight control inputs.

Further investigation

A detailed investigation of the wreckage is continuing, together with further analysis of the recorded data; the AAIB will also conduct a thorough assessment of the operational aspects of the accident.

Published January 2007

INCIDENT

Aircraft Type and Registration:	ATR72-202, G-BWDA
No & Type of Engines:	2 Pratt & Whitney Canada PW124B turboprop engines
Year of Manufacture:	1995
Date & Time (UTC):	23 May 2006 at 0829 hrs
Location:	Runway 27, Guernsey Airport
Type of Flight:	Public Transport (Passenger)
Persons on Board:	Crew - 4 Passengers - 40
Injuries:	Crew - None Passengers - None
Nature of Damage:	Wear to the tail bumper skid-shoe
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	43 years
Commander's Flying Experience:	8,510 hours (of which 1,430 were on type) Last 90 days - 143 hours Last 28 days - 72 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft bounced on touchdown due to insufficient landing flare being applied. In an attempt to cushion the second touchdown the co-pilot, who was the handling pilot, over-pitched the aircraft resulting in the tail bumper making contact with the runway surface. The co-pilot was relatively inexperienced, this being his first airline aircraft type, and he could not recall ever having received formal instruction in recovery techniques for bounced landings. One safety recommendation was made.

History of the flight

The aircraft departed Gatwick Airport at 0733 hrs for the short flight to Guernsey with the co-pilot acting as handling pilot. This was his first airline aircraft type; he had a total flying experience of 561 hours and 312 hours experience of flying the ATR72.

The ILS glideslope for Runway 27 at Guernsey was not in service at the planned time of their approach so during the cruise the pilots briefed for a visual approach to Runway 27. The weather reported by Guernsey ATIS for the period of their approach and landing was as follows: surface wind 240° at 13 kt, visibility 10 km or more, FEW cloud at 2,000 ft, air temperature 10°C and QNH 1018 mb.

The reference speed (V_{REF}) for the aircraft's predicted landing weight of 18.4 tonnes was 106 kt to which the crew added 5 kt, in accordance with their standard operating procedures (SOPs) and the prevailing wind conditions, to give an approach speed of 111 kt.

The co-pilot flew the approach using the runway PAPIs for glideslope guidance. Both pilots stated that these indicated two red and two white lights throughout the approach and that the aircraft was maintained at the correct approach speed. Indeed the commander, a line training captain, stated that the co-pilot had flown a particularly good approach. At about 10 ft agl the co-pilot closed the power levers and flared the aircraft. It touched down but then bounced back into the air.

The co-pilot instinctively tried to control the aircraft and was aware of it sinking back towards the runway. He stated that in an attempt to arrest the rate of descent, he pulled back on the control column. The aircraft touched down again and bounced once more, although this time to a lesser extent. The commander then immediately took control of the aircraft, landing from this second bounce before slowing the aircraft to taxiing speed and vacating the runway.

As the aircraft taxied to the parking apron ATC informed the crew that they believed the aircraft had struck its tail on landing. The crew continued to their stand, parking the aircraft and carrying out a normal shutdown. An engineering inspection then confirmed they had indeed struck the runway with the tail bumper.

Examination of the aircraft

Evidence of the tail strike was confined to the replaceable steel skid-shoe on the base of the tail bumper which was worn in two areas by approximately 3 mm. The skid-shoe is painted red to allow a tail strike to be identified by the erosion of paint.

The tail bumper is attached to a nitrogen-charged oleo allowing the bumper to be deflected upwards by a heavy contact. If deflected sufficiently, an angle indicator positioned either side of the bumper contacts the ground. If this occurs, further structural inspection is required. No contact was made with the angle indicators during this incident and repair necessitated simply re-painting the skid-shoe.

Runway inspection

Inspection of the runway revealed a scrape mark approximately 6 m in length and of a width consistent with that of the skid-shoe. It was positioned on the centreline approximately 650 m from the Runway 27 threshold.

Landing flare

Section 4.9.1 of the company Operations Manual describes the correct landing flare technique and states that the associated pitch attitude is:

> *'normally +2 to +3 degrees'.*

Page 43 of Section 3 of the same manual states:

> *'Tail strike may occur is (sic) the pitch attitude exceed (sic) 8° during the flare, depending upon vertical speed at touch down.'*

Bounced landing technique

The co-pilot cannot recall having being formally taught a bounced landing recovery technique during his flying training, either with this operator or earlier during his training on light aircraft. However, he had discussed it with instructors during his earlier training flights on light aircraft, normally as a result of having just bounced on touchdown.

When asked what he considered was the correct technique he stated that should the bounce be sufficiently severe, he would carry out a go-around. Where the bounce was less severe he would attempt to control it by applying slight forward pressure on the control wheel to limit the extent of the bounce, followed by once again, increasing the pitch attitude to cushion the landing whilst applying some power to arrest the rate of descent.

The company operating manuals contained no information on bounced landings.

National Transportation Safety Board (NTSB) Aircraft Accident Report NTSB/AAR-05/02

An accident in 2004 to an ATR72 resulting from a bounced landing was investigated by the NTSB. The report revealed that the operator involved did not, at that time, provide training or standardised guidance to its pilots on bounced landing recovery techniques. The NTSB considered that

> *'written company guidance on bounced landing techniques would have increased the possibility that the captain could have recovered from the bounced landings or handled the airplane more appropriately by executing a go-around'.*

An informal survey conducted as part of their investigation revealed that from a sample of six airlines, one aircraft manufacturer and one pilot training facility, only some (it did not state how many) included relevant information on the matter in their flight manuals, or discussed techniques during training. The NTSB was concerned that this lack of guidance could contribute to similar landing accidents in the future.

As a result the NTSB made the following recommendation to the Federal Aviation Administration:

> *'Require all 14 Code of Federal Regulations Part 121 and 135 air carriers to incorporate bounced landing recovery techniques in their flight manuals and to teach these techniques during initial and recurrent training'*

Analysis

The commander believes the bounce occurred due to insufficient flare being applied prior to touchdown. Neither pilot considered the initial bounce sufficiently severe to necessitate a go-around but the impression of an excessive sink rate back towards the runway led the co-pilot to instinctively apply nose-up pitch, in an attempt to reduce the heaviness of the second touchdown. The limited nature of the damage to the skid-shoe suggests that the pitch achieved at touchdown was only slightly in excess of 8º.

The investigation revealed that there is no formal requirement in the UK for pilots to receive training in bounced landing recovery techniques at any stage in their training. Rather, there is an assumption that this will be covered during basic pilot training with additional advice being given as appropriate by operators. Training for bounced landings on any type is problematic because it is inappropriate to bounce an aircraft simply in order to practise the recovery technique. Pilots, however, should already have sufficient knowledge to deal with a bounced landing should it occur, rather than gain such knowledge after the event. To ensure this knowledge is acquired, bounced landing techniques should form part of the formal training syllabus. This should apply not only to basic training but also to commercial and other operations, where different types of aircraft might require different recovery techniques.

In common with the investigation carried out by the NTSB, it is considered that the lack of formal guidance and training available to the pilot contributed to the accident. Therefore, the following safety recommendation was made:.

Safety Recommendation 2006-124

The UK Civil Aviation Authority and should require UK aircraft manufacturers, operators and training providers to issue appropriate guidance to pilots in the techniques for recovering from bounced landings.

ACCIDENT

Aircraft Type and Registration:	Beech BE58 Baron G-BTFT
No & Type of Engines:	2 Continental Motors Corp IO-520-CB piston engines
Year of Manufacture:	1979
Date & Time (UTC):	13 August 2006 at 1717 hrs
Location:	Denham Aerodrome, Uxbridge, Middlesex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 5
Injuries:	Crew - None Passengers - None
Nature of Damage:	Both propellers, right main landing gear, right wing, aileron and elevator
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	51 years
Commander's Flying Experience:	938 hours (of which 290 were on type) Last 90 days - 11 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft departed the paved runway surface during a landing in heavy rain. The investigation found that in the prevailing conditions there was probably insufficient runway available beyond the touchdown point for the aircraft to stop.

History of the flight

On the morning of the accident the aircraft departed Thruxton at 0908 hrs on the first leg of a day trip which included stops at Bristol Filton Airport, Kilrush in County Kildare, Eire, and Deauville in France. The commander was accompanied by another pilot who, although he had flown the aircraft in the past, played no part in the operation of this series of flights.

The aircraft arrived at Filton at 0927 hrs, embarked two passengers and departed again at 0959 hrs. When the aircraft arrived at Kilrush the two passengers who had boarded at Filton disembarked. The commander, accompanied by the other pilot, then flew the aircraft to Deauville, arriving in time for lunch. They were joined later by four passengers who boarded the aircraft for the flight to Denham, which departed Deauville at 1615 hrs.

As the aircraft approached Denham a line of thunderstorms was approaching the aerodrome from the north-east. Judging that his approach was too fast, the commander decided to go around and made a circuit of the aerodrome to position for another attempt. He stated that he then made what he considered to be a normal approach to land but, as the aircraft passed the threshold, it appeared to float more than usual and touched down further along the runway than he had planned. As the commander applied the brakes the aircraft began to slide, departing the left side of the runway and skidding with its right wing foremost through a hedge at the aerodrome boundary. It came to rest on a public road just beyond this hedge. There was no fire.

The arrival of the aircraft and its subsequent accident were witnessed by several people on the aerodrome. Some of them attended the scene in order to offer assistance but found the occupants uninjured and able to vacate the aircraft unaided. The AFISO alerted local emergency services and the aerodrome operator. Off-duty members of aerodrome staff attended with the aerodrome fire tender and were joined shortly afterwards by local fire and rescue services, who stood down after assessing the accident site.

Damage to the aircraft

Both propellers were bent, the right main landing gear was damaged by impact and side loads encountered during the skid, and the right wing, aileron and elevator were damaged. There was no evidence of any pre-existing fault which would have contributed to the accident.

Aerodrome information

Tarmac Runway 06/24 has negligible slope and a total length of 775 m. Runway 06 has an LDA of 706 m.

Meteorological information

At the time of the accident the AFISO recorded the surface wind was from 090° at 5 kt with heavy rain to the east and visibility between 10 and 20 km. The commander assessed the base of cloud to be broken at 2,500 ft. Rain began to fall at the eastern end of Runway 06 during the first approach and eyewitnesses who attended the scene shortly after the accident reported seeing standing water on much of the runway.

Aircraft performance

The basic weight of G-BTFT was 1,725 kg and the maximum authorised landing weight was 2,449 kg. The commander, who weighed 90 kg, estimated that the aircraft contained 250 kg of fuel and that the total weight of the other occupants and their belongings was 318 kg, resulting in a landing weight of 2,383 kg. The aircraft operating manual indicates that at this weight and in the reported wind conditions the type requires a landing ground roll of approximately 425 m on dry tarmac. Safety Sense Leaflet number 7 (SSL7) – '*Aeroplane Performance*', published by the CAA, recommends that for planning purposes the landing distance required (LDR) is increased by 15% when landing on a wet, paved runway. SSL7 also recommends that this increased distance should then be further increased by a factor of 1.43, to ensure that the LDR is no more than 70% of the landing distance available.

Analysis

The wet runway factor published in SSL7 applies to the total LDR, which includes the flightpath of the aircraft from 50 ft above the threshold to touchdown plus the ground roll itself. Consequently the ground roll on a wet runway required by G-BTFT was probably in excess of 490 m. Several eyewitnesses, including the front seat passenger, reported that the aircraft touched down with no more than two thirds, or 470 m, of the runway length remaining. Observers on the ground, including experienced pilots and flying instructors, reported that the aircraft appeared to be approaching faster than they would consider "normal" but it was not possible to establish the benchmark for that assessment, which must therefore be considered subjective. Nevertheless, even if the aircraft had maintained the runway centreline, there was probably insufficient runway remaining beyond the touchdown point for it to stop before the end of the paved surface.

Because published performance information is derived from tests undertaken by experienced pilots in new aircraft, the recommendation in SSL7 to apply a safety factor of 1.43 is intended to take account of variations in speed, technique and aircraft condition. In this case it would yield a required landing ground run of at least 700 m. The application of this factor would have been mandatory if the flight had been for the purposes of public transport.

Standing water can cause an aircraft to aquaplane or lose directional control, which may account for the aircraft sliding off the side of the runway. It is also conceivable that the pilot attempted to steer the aircraft off the runway centreline in order to increase the distance available before hitting the hedge. He did not state that this had been his intention.

Conclusion

The aircraft failed to stop on the runway in the prevailing conditions because there was insufficient paved surface remaining beyond the touchdown point.

INCIDENT

Aircraft Type and Registration:	i) DHC-6 Twin Otter Series 310, G-BVVK ii) Embraer EMB-145EU, G-EMBV
No & Type of Engines:	i) 2 Pratt & Whitney PT6A-27 turboprop engines ii) 2 Allison AE 3007/A1/1 turbofan engines
Year of Manufacture:	i) 1980 ii) 2001
Date & Time (UTC):	29 August 2006 at 0932 hrs
Location:	Glasgow Airport
Type of Flight:	i) Commercial Air Transport (Passenger) ii) Commercial Air Transport (Passenger)
Persons on Board:	i) Crew - 2 Passengers - 16 ii) Crew - 4 Passengers - 25
Injuries:	i) Crew - None Passengers - None ii) Crew - None Passengers - None
Nature of Damage:	i) None ii) None
Commander's Licence:	i) Air Transport Pilot's Licence ii) Air Transport Pilot's Licence
Commander's Age:	i) 45 years ii) 36 years
Commander's Flying Experience:	i) 5,796 hours (of which 2,130 were on type) Last 90 days - 146 hours Last 28 days - 55 hours ii) 4,200 hours (of which 3,300 were on type) Last 90 days - 210 hours Last 28 days - 70 hours
Information Source:	AAIB Field Investigation

Synopsis

A DHC6 Twin Otter aircraft was stationary at the Y1 holding point (see Figure 1), at Glasgow Airport. Its flight crew had correctly acknowledged a clearance from ATC to cross Runway 23, which was the active runway, after the landing Embraer 145. The DHC-6 crew having discussed some training issues, thought that the Embraer 145 had landed and began to taxi towards Y2. As they were about to cross Runway 23 the commander saw the Embraer 145 about to touch down and reversed the aircraft back towards Y1.

The RIMCAS (Runway Incursion Monitoring and

Confliction Alerting Sub-system) which was in use at the time of the incident did not provide an alert due to the operating mode selected.

History of the flight

The DHC-6 crew had reported for duty at 0810 hrs following a 14 hour rest period. They were scheduled for a six-sector 10-hour duty day and had completed the first and second sectors at the time of the incident.

The aircraft departed Campbeltown Airport for the return sector to Glasgow. The transit from Campbeltown was at FL050 in IMC with the co-pilot as the pilot flying (PF).

The weather at Glasgow was good with the 0920 hrs METAR giving a surface wind of 290°/09 kt, visibility in excess of 10 km, lowest cloud scattered at 2,200 ft, temperature +15°C, dew point +10°C and the QNH was 1005 hPa. The flight crew carried out a descent and when

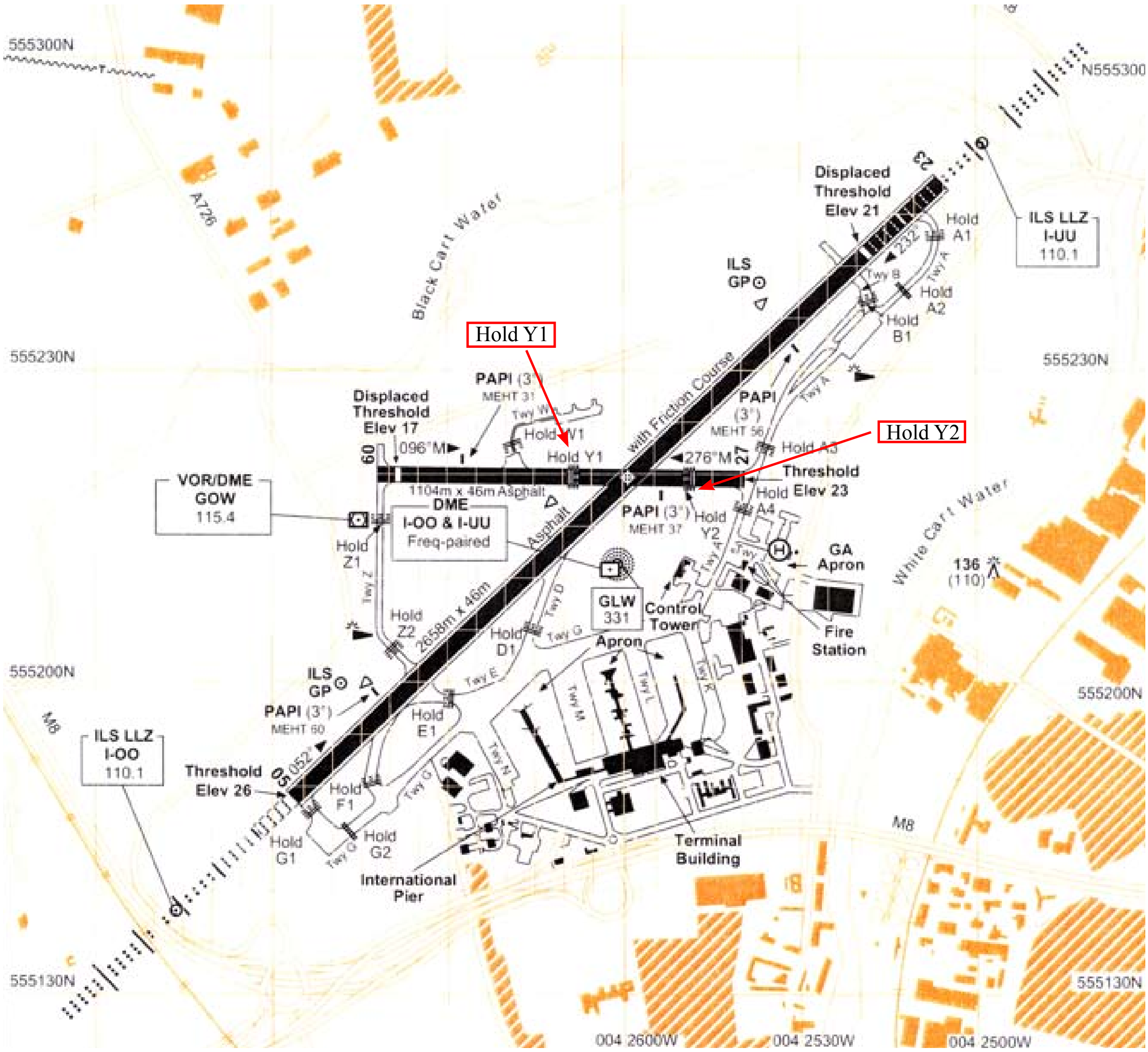


Figure 1

Glasgow International Airport

in good VMC, requested a visual approach to Runway 27. This was the normal practice in order to provide the most expeditious routing. When this was approved by ATC the crew positioned for a left base join to Runway 27. Having received the appropriate clearance a normal landing was made. The aircraft touched down to the east of the intersection with Runway 23 with the landing roll taking it west of the Y1 holding point. ATC cleared the aircraft to "BACKTRACK RUNWAY TWO SEVEN AND HOLD AT YANKEE ONE". The commander took control and taxied the aircraft, stopping at Y1. He did not apply the parking brake but held the aircraft stationary using the toe brakes.

The ATC clearance for the DHC-6 was "AFTER THE LANDING EMBRAER, YOU CAN CROSS RUNWAY TWO THREE YANKEE ONE TO YANKEE TWO", which was correctly read back by the co-pilot. Whilst waiting for the Embraer to land, the commander, who was a training captain, took the opportunity to explain some training points to the co-pilot. These required illustrating on a piece of paper which meant both pilots were looking inside the flight deck. Having completed the discussion, the commander thought that they had been stationary for some time. He could not see the Embraer and decided that it had probably passed him. In order not to delay operations he cautiously moved forward to cross Runway 23. As he approached the edge of the runway, he saw the Embraer 145 to his left, about to touch down. He immediately selected the power levers into the 'Beta' range and reversed the aircraft back towards the Y1 holding point.

The landing Embraer flight crew saw the DHC-6 just before touch-down but thought the aircraft was stationary. They did not identify it as a hazard and carried out a normal landing.

RIMCAS operation

At the time of the incident the DHC-6 was on the Tower frequency under the control of the Aerodrome controller. The controller had available a monitor which displayed the Surface Movement Radar (SMR). Overlaid on the SMR picture was the RIMCAS defined area which covered the surface area of Runway 05/23. Within the defined area, the movement of any aircraft or vehicles that might conflict or collide would activate an alert.

The controller was able to select either Runway 05/23 or 09/27, or both runways as the runway(s) in use. The dimensions of the defined area then varied depending on the operating mode selected. There are three RIMCAS modes available; 'Visual', 'Low Visibility Procedures' (LVP) and 'Cross Runway' operations.

With Visual mode selected for Runway 05/23, only the runway surface area is monitored as shown in Figure 2. When LVP mode for Runway 05/23 is selected the additional areas of the holding points to the runway edge as well as the runway(s) surface is monitored as shown in Figure 3. When both Runways 05/23 and 09/27 are in use, the Cross Runway operations mode should be selected. With Runway 05/23 and Cross Runway mode selected, an additional defined area covers the 09/27 runway surface between the Y1 and Y2 holding points as well as the Runway 05/23 surface area. This area is shown in Figure 4.

When a runway incursion or a potential conflict is registered by RIMCAS, a visual and audible alert is given in the Visual Control Room.

The use of SMR and RIMCAS is only required during Low Visibility Procedures (LVPs). When Visual control operations are being carried out, RIMCAS is used as additional information only.

At the time of the incident visual operations were in progress and only Runway 05/23 was in use with the Visual mode selected on the RIMCAS. After the DHC-6 had landed, Runway 09/27 was being used as a taxiway and not as a runway so no Cross Runway mode was required. Without the Cross Runway mode selected, no alert was activated when the DHC-6 crossed the Y1 holding point towards the runway. The defined area covered by the Cross Runway operations mode, which would have created an alert when the DHC-6 crossed Y1 is shown at Figure 3.

The visual controller and ATCO colleagues were not aware that when only Runway 05/23 or 09/27 was in use with Visual mode selected, the areas between the holding points and the runway edge were not defined

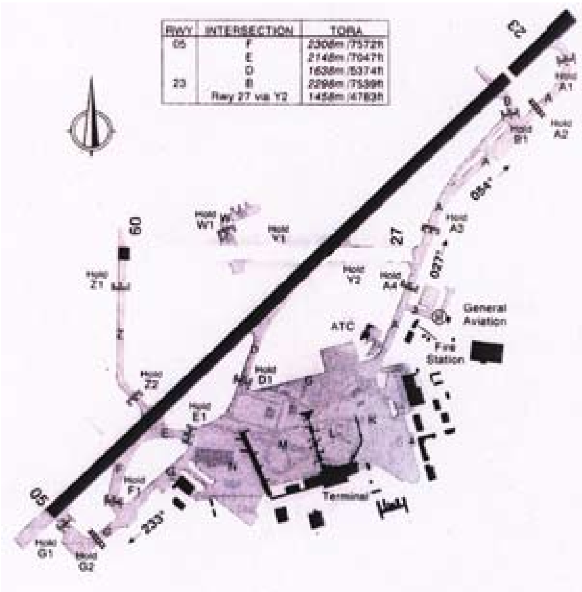


Figure 2

Visual mode

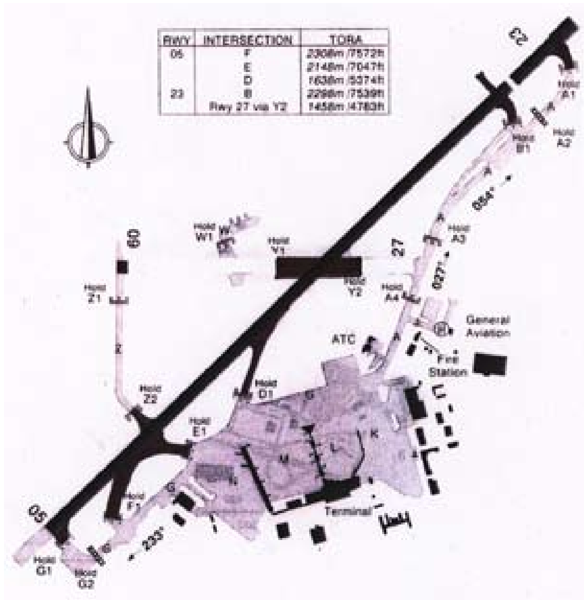
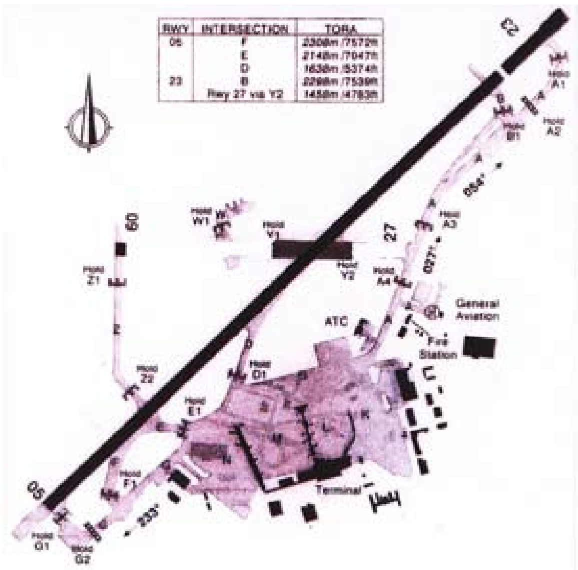


Figure 3

LVP mode



Dark areas indicate monitored surfaces

Figure 4

Cross Runway operations

areas. The actual defined area in the Visual mode is shown at Figure 2 but their perception of the defined area is illustrated at Figure 3.

RIMCAS procurement and training

During the procurement process, National Air Traffic Services (NATS) identified the RIMCAS defined areas to be covered by the selectable modes. These areas were in keeping with those normally supplied by the manufacturer and so the defined areas required by the client were those delivered by the manufacturer.

When the SMR and RIMCAS systems were installed, all Glasgow Airport ATCO's received training prior to its use. The initial training was provided by the manufacturer for six controllers who then cascaded the training down to their remaining colleagues.

During the introduction of RIMCAS at Glasgow Airport, the controllers had noted a significant number of spurious alerts. These were due partly to taxiways falling within the defined areas when certain runway/mode combinations were selected, and also partly to the ATCOs lacking familiarity with the system. This was especially the case when both Runways 05/23 and 09/27 were selected in the Visual mode or during LVP mode selection. Even when aircraft were moving in accordance with a safe clearance, aircraft taxiing on the different runways or on some taxiways which cross the runway thresholds initiated alerts. The main concern was that frequent spurious alerts may dilute the value of an alert when a real incursion or conflict was detected.

In order to minimise the number of spurious alerts, the use of the Cross Runway mode was initiated only whilst aircraft were operating from both Runway 09/27 and Runway 05/23. This mode was to be de-selected once an aircraft had landed or departed; this was the situation at the time of the incident.

Analysis

DHC-6

The runway incursion by the DHC-6 was caused by its flight crew diverting their attention from monitoring outside activity to discussing training matters. When the commander looked up he had a false sense of the length of time they had been at the Y1 holding point. Not wishing to delay airport operations he believed that the Embraer 145 must have landed and passed the runway intersection whilst he was debriefing. Consequently, the DHC-6 commander believed that he was following his ATC clearance to cross the active runway after the landing Embraer. His cautious move forward and his continued 'look out' meant that he was able to see the landing aircraft as it was about to touch down and he was able to stop his aircraft before it entered Runway 23. The capability of the DHC-6 to reverse allowed the commander to move away from Runway 23 and back towards holding point Y1.

Air Traffic Control

The Aerodrome controller was controlling traffic and issuing clearances by monitoring visually the activity on the airfield as required. RIMCAS was adjacent to the controlling position and selected to Runway 05/23 in the Visual mode. Cross Runway operations was not selected because once the DH-6 had landed, Runway 09/27 was serving as a taxiway.

The controller had seen the DHC-6 stop at the Y1 holding point and remain there stationary. When checking that Runway 23 was clear prior to issuing the landing clearance to the Embraer 145, the DHC-6 was still at the holding point. Although the Y1 holding point is clearly visible from the visual controller's position, the 'cautious' taxi forward probably had insufficient apparent movement to attract attention and because the aircraft did not fully encroach the runway, the runway appeared clear.

In keeping with colleagues, the controller would have expected a RIMCAS alert when the DHC-6 crossed the Y1 holding point. This did not occur because neither Cross Runway nor LVP modes were selected. As has been previously stressed, RIMCAS is only used to assist the controller during visual operations. Clearly, when Runway 05/23 only was selected, the level of protection afforded by RIMCAS in the normal Visual mode was not as comprehensive as that expected by the controllers.

Conclusion

Whilst holding on the north side of the active runway the DHC-6 commander sought to illustrate his training points to the co-pilot. By being 'head down' on the flight deck he became distracted and lost his sense of time and situational awareness regarding the landing Embraer 145. He concluded that if debriefing points needed to be illustrated, this was best conducted once the aircraft was parked and the engines shut down.

Safety action

NATS took immediate action to ensure that controllers had the correct understanding of the capabilities of the RIMCAS. This particularly included the defined areas covered by the various RIMCAS modes which were available. Shortly after the incident, NATS also extended the operational areas of the RIMCAS system to include an area beyond the runway edge towards each holding point. This action has not resulted in an increase in false or spurious alerts.

INCIDENT

Aircraft Type and Registration:	Dornier 328-100, TF-CSB
No & Type of Engines:	2 Pratt and Witney PW 119B turboprop engines
Year of Manufacture:	1997
Date & Time (UTC):	11 June 2006 at 1256 hrs
Location:	Near Sumburgh Airport, Shetland
Type of Flight:	Public Transport (Passenger)
Persons on Board:	Crew - 3 Passengers - 17
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	61 years
Commander's Flying Experience:	18,000+ hours (of which approximately 280 were on type) Last 90 days - 120 hours Last 28 days - 36 hours
Information Source:	AAIB Field Investigation

Synopsis

During a visual approach to Sumburgh Airport, the aircraft encountered worsening weather conditions and inadvertently flew into close proximity with the terrain. The crew were alerted to the situation by on-board equipment, but the commander did not respond to the 'PULL UP' warnings it generated. The approach was continued and a safe landing made at the airport. The investigation identified a number of organisational, training and human factors issues which contributed to the crew's incorrect response to the situation. Two recommendations were made, concerning crew training and regulatory oversight of the aircraft operator.

History of the flight

The aircraft was engaged on a return charter flight from Aberdeen Airport to Sumburgh Airport in the Shetland Isles. The flight crew, comprising a very experienced captain and a relatively inexperienced co-pilot in his first commercial flying position, reported for duty at 1100 hrs. During pre-flight preparations the flight crew noted that the wind at Sumburgh was forecast to be from 150º(M) at about 12 kt, so the possibility of a visual approach to Runway 15 was discussed. The main instrument runway at Sumburgh was Runway 09/27. The commander was familiar with Sumburgh Airport, although he had last operated there with a different company seven or eight years previously. The co-pilot had only been to Sumburgh once, about six months previously. The commander, who was to be the handling pilot, stated that he discussed with the co-pilot a route inbound to the airport which went further to the west than was necessary, in order to show him some of the local terrain features. However, the co-pilot's recollection was that the discussion was limited to the possibility of a visual approach, and did not extend to the routing or possible reasons for it.

The aircraft took off from Aberdeen at 1222 hrs. On board were the two flight crew, a cabin attendant and 17 passengers. During the cruise portion of the flight, the co-pilot obtained the Sumburgh ATIS report 'Juliet', timed at 1220 hrs:

> *"...Runway 09 in use, surface wind 150 degrees at 9 kt, visibility 7,000 metres, few clouds at 600 feet, temperature 13°(C), Dew point 11°(C), runway dry, No RVR available".*

The commander reported that he briefed for a visual approach to Runway 15, along the lines that had been discussed before the flight. He also briefed the Localiser/DME approach to Runway 09 in case the visual approach was not possible or not approved. The commander then entered a navigation waypoint into the Flight Management System (FMS); the waypoint was 5 nm to the west of the Sumburgh VOR/DME which was located at the airport. He briefed the co-pilot that he would fly towards this point and then towards the high ground of Fitful Head before turning right towards the airport and flying to a 'right base' position for Runway 15 (Figure 1). However, the co-pilot recalled that the commander briefed for the instrument approach to Runway 09, and added as a 'footnote' that they should request a visual approach to Runway 15. The co-pilot did not recall the commander briefing a route, configurations, speeds or altitude targets for a visual approach.

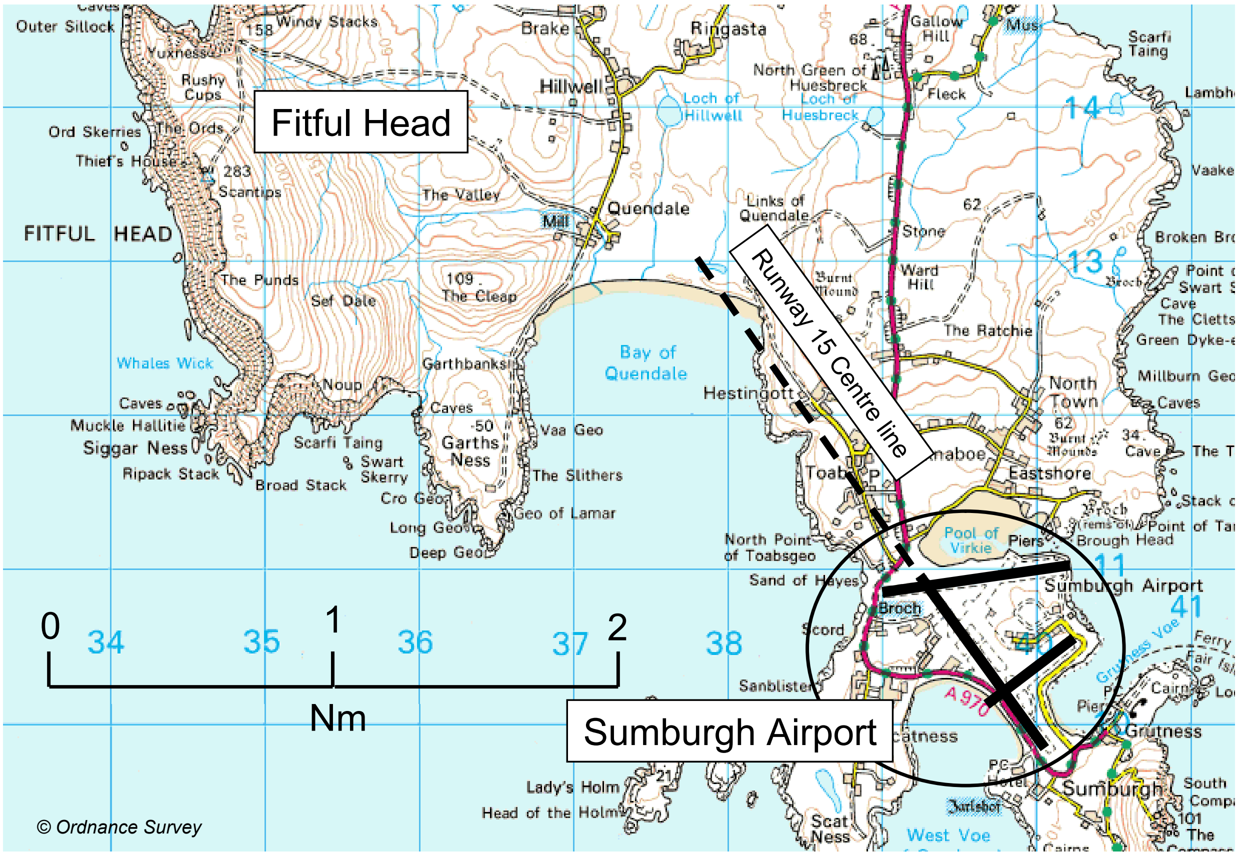


Figure 1

Area map

The commander later stated that, if the weather did not permit a visual approach, his plan was to turn right at the FMS waypoint, towards the VOR/DME, and from that point seek radar assistance for an instrument approach. This was not included in the briefing he gave the co-pilot.

On first contact with Sumburgh Approach Control, and in accordance with the commander's instructions, the co-pilot requested a visual approach to Runway 15, which was approved. At this stage the aircraft was routing towards the FMS waypoint but the crew were not visual with the airport. The co-pilot later reported that he was content with the plan for a visual approach, being aware that the commander had operated into Sumburgh many times beforehand.

Having approved the crew's 'own navigation', the Approach controller instructed them to reduce airspeed to 180 kt, as there was other traffic ahead, flying from left to right and following the Localiser/DME approach to Runway 09. The crew were cleared to descend to 2,100 ft altitude which was the Sector Safe Altitude (SSA) for aircraft approaching the airport from the south-west. The commander instructed the co-pilot to advise ATC that they were able to continue visually. The Approach controller then cleared the crew for a visual approach to Runway 15, with no further ATC descent restriction.

The co-pilot reported that he could not see the airport as it was obscured by cloud, but could see high ground ahead and to the right. He asked the commander if he intended to turn to the right before the high ground, and the commander said he would. At this point the co-pilot thought that the high ground he could see was Fitful Head, and recalled that, on his last visit to Sumburgh some six months previously, he had flown a visual approach which turned comfortably inside Fitful Head from a downwind position on Runway 15, having flown a published 'cloud break' procedure. The co-pilot later thought that the high ground he saw was that to the north of the airport, since Fitful Head was actually obscured by clouds at that stage.

As the aircraft descended below the selected altitude of 2,100 ft the altitude alert sounded, and the commander asked the co-pilot to silence the alert. The co-pilot momentarily selected a higher altitude which cancelled the alert, then reset the selector to 2,100 ft, which was also the 'missed approach' altitude. The commander did not specify which altitude he intended descending to, and the co-pilot did not query this. The commander later said that he had intended to descend to 1,000 to 1,200 ft, being a height appropriate to a downwind position.

The aircraft continued to descend whilst flying towards the high ground of Fitful Head (elevation 930 ft amsl). Neither the commander nor co-pilot were visual with the coastline or the headland itself, though both were in visual contact with the surface of the sea. As the aircraft descended the visibility decreased, in what the commander later described as "thickening haze". The commander thought that he had descended to about 1,000 ft, and was abeam the FMS waypoint, when he decided that conditions were not good enough for a visual approach. He therefore started a turn to the right, and later reported that his intention had been to position the aircraft for an instrument approach. The commander said that he was about to voice these intentions to the co-pilot when the crew received the first Enhanced Ground Proximity Warning System (EGPWS) alert, "CAUTION TERRAIN".

Neither crew member recalled looking at the EGPWS display (a small dedicated display on each pilot's instrument panel, which produces a graphic display of the surrounding terrain, based on the aircraft's position and an internal terrain database). The "CAUTION TERRAIN" alert was followed by a "TERRAIN TERRAIN PULL UP" warning. The co-pilot described looking up and seeing a cliff or steep hill ahead of the aircraft as the commander increased the bank angle to the right. The co-pilot thought that the aircraft was below the level of the highest terrain, and was aware of sea birds in the vicinity. Soon afterwards, the co-pilot heard the landing gear warning siren. This aural alert was accompanied by a flashing red light in the landing gear selector handle, which indicated that the aircraft was below 500 ft radio altitude with the landing gear not down.

The commander was aware of the "TERRAIN TERRAIN PULL-UP" warning, but was visual with the terrain and thought that his turn was taking the aircraft clear of it. He was also in sight of the sea surface and considered that the safety of the aircraft would not be jeopardised by continuing with the visual approach. He did not increase altitude, as he thought that to do so may cause him to lose visual contact with the terrain or the sea surface. Both crew members subsequently stated that they had the impression that the aircraft had been tracking towards the most southerly end of Fitful Head, and that the area to their right was clear of terrain.

The "TERRAIN TERRAIN PULL-UP" warning continued after the aircraft had turned right and was flying along the line of the cliff, still at about 400 to 600 ft and below the level of the cliff top. The landing gear warning siren was also sounding, making communications difficult between the two pilots and between the co-pilot and ATC. The co-pilot was alarmed by the situation and considered taking control from the commander. However, he thought that to attempt to do so whilst the aircraft was manoeuvring at low level might place the aircraft in a more hazardous situation, especially as communication between the two pilots was being hindered by the warning sounds.

As the aircraft turned eastwards and flew towards the airport the ground proximity warnings ceased, although the landing gear warning continued until the landing gear was lowered. The remainder of the approach and landing was uneventful. After landing the commander queried the broadcast weather conditions with ATC, expressing an opinion that they were poorer than the ATIS information suggested.

Recorded information

The incident was captured in part by the radar on Fitful Head itself, the output of which was recorded and available for analysis. Radio transmissions on the Sumburgh Approach and Tower ATC frequencies were also recorded. The Flight Data Recorder (FDR) and Cockpit Voice Recorder (CVR) were already in the possession of the AAIB at the time of notification, as the same aircraft had been involved in a later accident. However, the data for the incident flight had been over-written. The aircraft was equipped with an EGPWS which incorporated a memory module capable of storing triggered alerts and warnings, together with basic flight data. The EGPWS data was successfully downloaded by the manufacturer and was available for analysis.

Radar and R/T information

Figure 2 shows the aircraft's radar track and significant R/T exchanges. When the co-pilot contacted the Sumburgh Approach controller he was told that the aircraft would be radar vectored for the Localiser/DME procedure for Runway 09. The co-pilot acknowledged this, but requested a visual approach to Runway 15, if it was possible. The commander then transmitted "…WE'VE SET UP OUR NAV BOX TO PUT US ON A

FIVE MILE RIGHT BASE FOR ONE FIVE IF THAT'S OK WITH YOU"; the controller replied "… ROGER, YOUR OWN NAVIGATION".

As the aircraft tracked towards a point 5 nm west of the Sumburgh VOR/DME (which was the waypoint entered into the FMS), the crew was cleared by the Approach controller to descend to 3,000 ft and to reduce airspeed to 180 kt. The controller subsequently instructed the crew "…DESCEND TO ALTITUDE TWO THOUSAND ONE HUNDRED FEET AND REPORT WHEN YOU HAVE VISUAL".

On the commander's instruction, the co-pilot transmitted "…HAPPY TO CONTINUE, AND VISUAL". At this point the aircraft was at 2,100 ft, bearing 250º(M) from the VOR/DME at a range of 5.7 nm, and still tracking towards the FMS waypoint. The controller replied "…YOU'RE CLEARED VISUAL APPROACH RUNWAY 15 FOR THE RIGHT BASE AT 5 MILES, NO DESCENT RESTRICTION". As the controller began this transmission the SSR Mode C altitude indicated that the aircraft began descending below 2,100 ft, with an initial descent rate of between 1,500 ft/min and 2,000 ft/min.

As it approached the FMS waypoint, the aircraft commenced a gentle turn to the right. It passed about 0.2 nm to the east of the waypoint, whilst descending at about 1,500 ft/min through a Mode C altitude of 1,300 ft. The aircraft continued in a very gentle right turn towards the high ground of Fitful Head. The average descent rate reduced as the aircraft descended below 1,000 ft, to about 1,000 ft/min. When the aircraft was about 0.6 nm from the coastline as shown on the radar display, and at a Mode C altitude of 700 ft, the Approach controller asked "… JUST CONFIRM YOU ARE VISUAL WITH FITFUL HEAD?" The co-pilot replied with the single word "AFFIRM" and the subsequent radar returns showed the aircraft's turn rate to the right increased significantly until the aircraft had turned to track approximately

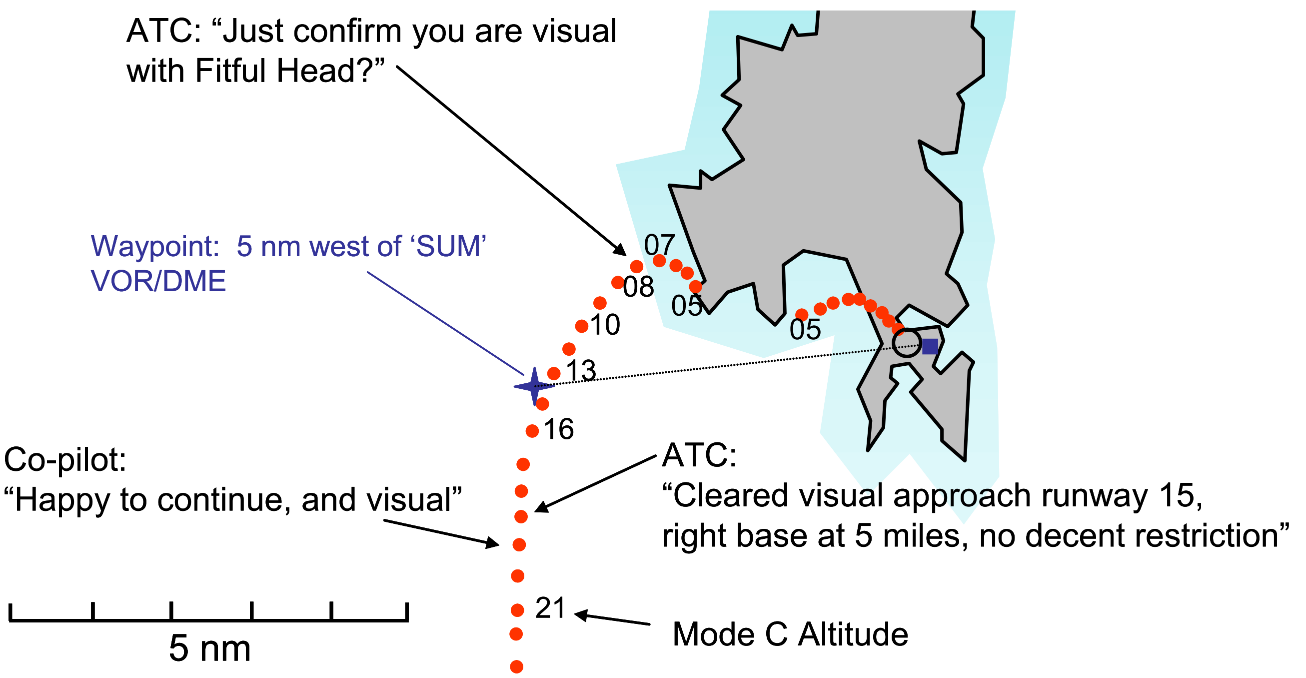


Figure 2

Radar plot and significant R/T exchanges parallel to the coastline. The indicated altitude remained at 700 ft initially, then reduced to 500 ft. At that point radar contact was lost, as the aircraft became masked by the high ground.

When the aircraft reappeared on radar it was about 1 nm from the runway threshold and still indicating 500 ft. The co-pilot contacted the Tower controller and was immediately cleared to land on Runway 15. After landing the commander transmitted to the Tower:

"…VISIBILITY WAS NOT AS GOOD AS WE'D LIKE SO WE HAD TO POSITION FOR THE OTHER RUNWAY, SORRY ABOUT THAT".

The controller said that this had not caused ATC a problem, just a measure of concern. The commander responded:

"…WE DIDN'T GET FITFUL HEAD TILL THE LAST MINUTE, THE VISIBILITY IS NOT AS – NEARLY AS GOOD AS REPORTED".

EGPWS information

The position of warnings and cautions generated by the EGPWS are depicted at Figure 3; values in red are radio altitudes. Figure 4 shows the aircraft's vertical profile for the same period. Flight data for each significant event, commencing with the start of the recorded data, is given in Table 1. Two recorded parameters were common to each event, these were: landing gear up and landing flaps not selected.

Meteorological information

At the time of the incident a moderate to fresh southerly airflow covered the northern Scottish Isles, with a weak cold front lying over the Orkney and Shetland area. The southerly flow generated extensive low stratus cloud over the area, though it is possible there were relatively large gaps in this cloud layer. Cloud was reported at the time as few at 600 ft, but it is quite likely that the cloud cover could have increased at any time.

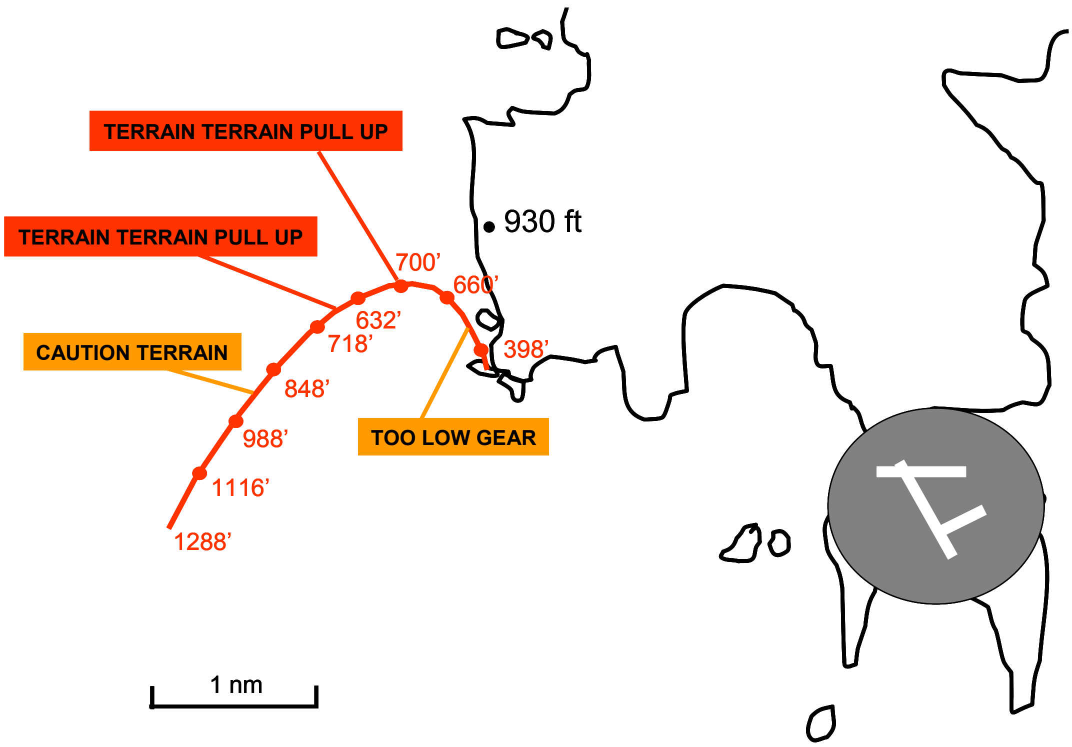


Figure 3

EGPWS record

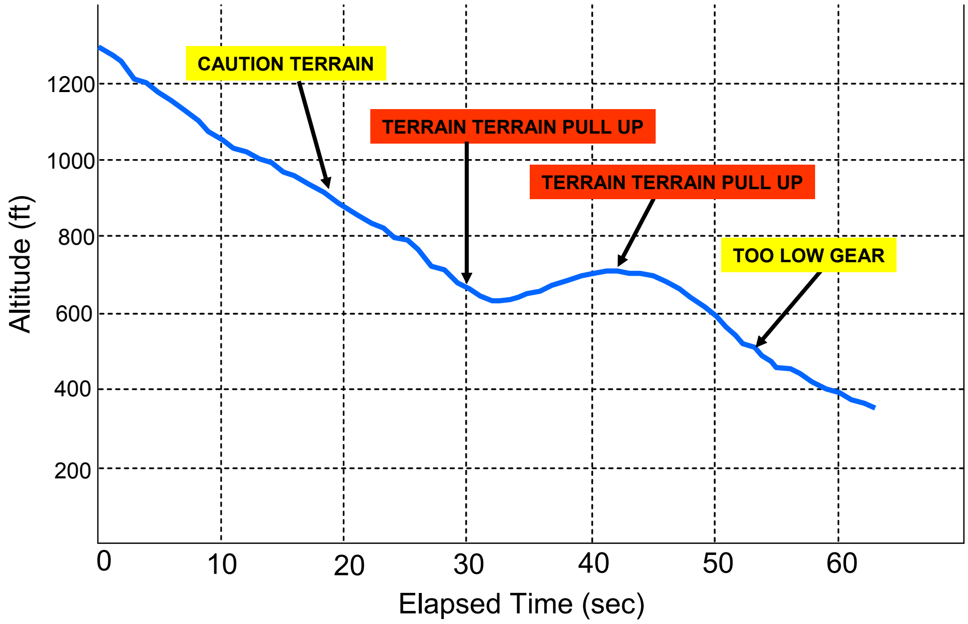


Figure 4

Aircraft vertical profile

To the north of the airport, the cloud cover was reported as broken or overcast at 100 to 200 ft. According to ATC personnel at Sumburgh, when south or south-easterly winds prevail, low stratus commonly affects the airport. On these occasions, Fitful Head is frequently obscured by low cloud.

The Sumburgh Terminal Area Forecast (TAF), issued at 0902 hrs on 11 June 2006 and valid for the period 1000 hrs to 1900 hrs, was:

> Surface wind from 150º(M) at 12 kt, visibility 3,000 m in mist, and broken cloud at 400 ft. Temporarily, the visibility may become 7 km, with broken cloud at 800 ft.

The Meteorological Aerodrome Report (METAR), issued at 1250 hrs, showed the following actual conditions:

> Surface wind from 140º(M) at 11 kt, visibility 7 km, few cloud at 600 ft, temperature 13º(C), dew point 11º(C), and QNH 1019 hPa.

Reporting action

The co-pilot sought to report the incident that evening on return to Aberdeen, but was unable to contact the company Flight Safety Officer (FSO), who was on a flying duty. Instead, the co-pilot discussed the incident with the FSO the next day, and suggested that the FDR and CVR be down-loaded to assist investigation into the incident. The FSO investigated the feasibility of removing the FDR (the CVR, with only a 30 minute recording history, would have been over-written by that time). As the aircraft would have been unable to continue to operate unrestricted without a FDR installed, the FSO decided against this course of action, believing that submission of an Air Safety Report (ASR) would meet the reporting requirements applicable to an incident of this nature. The co-pilot subsequently completed an ASR which the FSO sent by fax to the Icelandic Civil Aviation Administration (ICAA) on the evening of 14 June 2006. The ICAA reported the incident to the Icelandic AAIB on June 21 2006, which in turn notified the UK AAIB on 27 June 2006.

Elapsed time	Event and flight parameters
00:00	Start of recoded data Airspeed: 200 kt Groundspeed: 227 kt Radio altitude: 1263 ft Vertical Speed: -1,500 ft/min Heading (M): 028º Bank angle: 7º right
00:19	**Look ahead "CAUTION TERRAIN"** ***(note 1)*** Airspeed: 190 kt Groundspeed: 212 kt Radio altitude: 874 ft Vertical Speed: -1,079 ft/min Heading (M): 049º Bank angle: 4º right
00:30	**Look ahead "TERRAIN TERRAIN PULL-UP"** Airspeed: 187 kt Groundspeed: 197 kt Radio altitude: 644 ft Vertical Speed: -1,390 ft/min Heading (M): 067º Bank angle: 15º right
00:42	**Second look ahead "TERRAIN TERRAIN PULL-UP"** ***(note 2)*** Airspeed: 154 kt Groundspeed: 153 kt Radio altitude: 721 ft Vertical Speed: +12 ft/min Heading (M): 147º Bank angle: 37º right
00:53	**Mode 4 "TOO LOW GEAR"** Airspeed: 144 kt Groundspeed: 121 kt Radio altitude: 476 ft Vertical Speed: -1,609 ft/min Heading (M): 156º Bank angle: 12º right

Note 1: Typically generated at 40 to 60 seconds before terrain conflict, then repeated at 7 second intervals.

Note 2: When the aircraft enters the 'pull-up' warning envelope, a single aural warning is generated, together with the associated visual alerts. The system then remains silent for 12 seconds. If, after 12 seconds, the aircraft is still within the warning envelope, the warning is generated again and will continue to sound until the aircraft leaves the warning envelope.

Table 1

The commander had not sought to submit an ASR, but was asked by the operator to do so after the co-pilot had alerted them to the incident. The commander later stated that he was unaware that an EGPWS warning necessitated a safety report, and that he was not familiar with the reporting procedures as far as the Icelandic authorities were concerned.

Aerodrome information

Sumburgh Airport, elevation 20 ft, is situated 17 nm south of Lerwick, and just north of Sumburgh Head, which is the southernmost point of the Shetland Isles. The airport has two runways available for fixed wing aircraft. Runway 09/27 was the main instrument runway and was 1,180 metres long; Runway 15/33 was 1,426 metres long, with no associated approach procedures. Runway 09 was served by a localizer/DME approach, a VOR/DME approach and an NDB approach. An ILS approach was available on Runway 27 only. A cloud break procedure was also available for aircraft approaching from the south, based on an inbound course of 010º(M) to the Sumburgh VOR/DME.

Organisational information

General

The aircraft was operated by an Icelandic company which was based in Reykjavik, but which operated aircraft in both Iceland and the UK. The company's Aberdeen-based aircraft were registered in Iceland and operated under an Icelandic Air Operators Certificate, issued to the operator by the ICAA. Day-to-day operations in the UK were conducted from Aberdeen. Flight operations and commercial management positions were held by personnel in Iceland, who oversaw the activities of both the Icelandic and Aberdeen-based operations.

Safety management

The operator had been subject to an independent safety audit about one month before the incident which had highlighted a number of deficiencies in the company's safety management system. At that time the operator's Director Flight Operations (DFO) was solely responsible for flight safety matters, including handling of incident reports, disseminating safety-related information and chairing safety meetings. As a result of the audit, the FSO post had been created and had been filled by a line training captain at Aberdeen. The FSO had then received related aviation safety training (which had been completed only shortly prior to this incident), and the new post promulgated to company staff. However, at the time of the incident the Operations Manual had not been revised to reflect the change and there were no terms of reference established for the FSO post. For the reporting of accidents and incidents, the operator used a 'Flight Occurrence Report' form which was available in the crew area at Aberdeen and in a folder on board the aircraft.

Operational advice to flight crew

The company's Operations Manual (OM) conformed to the Joint Aviation Requirements (JAR) format, although the investigation found a number of deficiencies relating to aircraft operations.

Aerodrome categorisation

In accordance with JAR - Operations 1 (JAR-OPS 1)[1], the operator's OM included a method of categorisation of aerodromes, with Category A being the least demanding for flight crews and Categories B and C being progressively more demanding. The OM also included a list of aerodromes and their categories; Sumburgh Airport was listed as Category B, because of terrain and weather considerations.

Footnote

1 JAR-OPS 1 concerns Commercial Air Transportation.

Using wording taken directly from JAR-OPS 1, the OM stated that commanders should be briefed, or self brief, by means of 'programmed instructions' on Category B aerodromes, and that commanders should certify as having done so. However, the investigation established that there were no instructions available to commanders for *any* Category B aerodromes, including Sumburgh. Nor was there in place any method by which commanders could certify as having been so briefed. Additionally, the OM required that any airport 'special briefing' be included in the handling pilot's approach and landing briefing.

Descent below safety altitude

There was a discrepancy between the operator's OM Part A and another manual issued to flight crews, entitled '*D328 Standard Operating Procedures*'. The OM contained the following text concerning descent below safety altitude when not on a published procedure or under positive radar control:

> *" An aeroplane must not descend below the appropriate safety altitude except ... when in continuing visual contact with the ground and able to ensure adequate clearance from all obstacles affecting the intended flight path."*

The equivalent section in '*D328 Standard Operating Procedures*' states only that the aircraft must be:

> *"Maintaining VMC plus good contact with the ground".*

The operator's OM contained the weather minima for VMC flight, including the requirement for a minimum in-flight visibility of 5 km.

EGPWS

JAR-OPS 1 required that the OM contain information regarding response to GPWS warnings and limitations on high rates of descent close to the surface. The operator's Part A contained only a reference to the Airplane Flight Manual (AFM) in this respect. The AFM contained instructions regarding actions in the event of a GPWS "PULL UP" warning, though it was not on issue to flight crews and therefore the information was not available for self-study, as is also required by JAR-OPS 1. However, both crew stated at interview that they were familiar with the response required by this warning. The OM contained no reference to limitations on high rates of descent near to the surface.

Crew training

Both pilots underwent training for the Dornier 328-100 at a separate Type Rating Training Organisation (TRTO) in the United Kingdom; this training was completed in November 2005. The Computer Based Training (CBT) ground school course included a technical overview of the GPWS, its modes of operation and the types of warnings and cautions that could be generated. It did not include any of the predictive features of EGPWS.

The co-pilot's Type Rating Skill Test schedule (a UK Civil Aviation Authority form) recorded that practical training had been completed in the section titled *'Ground Proximity Warning System, weather radar, radio altimeter, transponder'*. The TRTO confirmed that the flight simulator used during training was capable of reproducing GPWS alerts and warnings (but not EGPWS predictive functions) but that practical exercises in GPWS responses were not included in the training syllabus; only normal and abnormal operation of the equipment itself would have been covered.

Regulatory requirements

The Joint Aviation Requirements stipulated that the aircraft be fitted with a GPWS system which included a predictive terrain hazard warning function. The EGPWS equipment met this requirement. Joint Aviation Requirements – Flight Crew Licensing 1 (JAR-FCL 1) contained the training, testing and checking requirements for the issue of crew licences and aircraft type ratings. The only requirement relating to GPWS was that flight crew were trained in the normal and abnormal operation of the system; there was no specific requirement for crew to be trained in, or demonstrate an understanding of, the correct response to GPWS alerts. Furthermore, there was no requirement for training or checking in the predictive or 'look ahead' functions which had been specifically required to be installed on aircraft such as TF-CSB from 1 January 2005.

Safety action by the operator

After interviewing the flight crew, the operator recognised that the advice to crews about GPWS warnings was not readily available and therefore issued a Flight Crew Notice (FCN). The FCN reproduced that part of the AFM dealing with GPWS warnings, including the following text:

> *"Whenever the aural announcements TERRAIN TERRAIN, SINKRATE SINKRATE, TOO LOW FLAPS, TOO LOW GEAR or GLIDESLOPE are heard, take appropriate action to correct the unsafe condition.*
>
> *Whenever the TOO LOW – TERRAIN or WHOOP WHOOP PULL UP announcements are heard, establish the power setting and attitude which will produce maximum climb gradient consistent with the airplane configuration."*

At the time of the incident, the operator was preparing a revision to the OM. The revision included responses to GPWS warnings, (as detailed in the AFM and reproduced in the FCN), though it did not include information on 'look ahead' alerts of the type received by the crew in this incident. In response to the incident, the operator undertook to distribute to all flight crews technical advice and operational guidance on the EGPWS.

The OM revision included a fully updated section on the handling, notifying and reporting of occurrences. A further revision, being prepared at the time of the investigation, was to address the discrepancy regarding decent below safety altitude, as well as including guidance regarding high decent rates close to the surface.

Safety action by the ICAA

The investigation highlighted possible shortcomings in the operator's Crew Resource Management training, as well as issues of crews' awareness of company procedures. The ICAA considered that these were issues associated with the operator's crew conversion training and checking programs. The ICAA has therefore added to its oversight program a special emphasis on the operator's conversion course.

Analysis

In this serious incident a serviceable public transport aircraft with 20 persons on board flew at low altitude and in poor visibility into close proximity with terrain, despite the availability of a suitable instrument approach aid and radar assistance. Mandatory equipment designed to prevent such an occurrence functioned correctly and may have averted an accident, though the crew's reaction to the alert it generated was not in accordance with established procedures.

The approach plan

It is not clear from the two pilots' differing accounts exactly how detailed the briefing for a visual approach was. During R/T exchanges and in their individual reports, both pilots refer to a 'right base' join for Runway 15, and it is this that was approved by the controller. Had the aircraft turned towards the airfield at the 5 nm waypoint, it would have been well placed to fly to a right base position, but it did not. The ATC clearance to descend without restriction was subject to the crew having reported "visual" with the airport. The co-pilot's account and subsequent events indicate that the crew were in fact not visual with the airport when the "visual" call was made.

The commander stated that he intended to fly towards the high ground with the intention of showing the terrain to the co-pilot (though the co-pilot was unaware of this). The commander also said that the 5 nm FMS waypoint would serve as a point beyond which he would not proceed if the weather or visibility was worse than expected. He thought the conditions were suitable to continue the visual approach, as he was in sight of the surface. However, to maintain surface contact he needed to descend the aircraft to an unusually low level, considering the aircraft's distance from the airport. If, as stated, the commander actually intended flying towards the highest ground in the vicinity, then it is remarkable that he continued to do so in conditions of poor and reducing forward visibility (almost certainly to less than the VMC minima of 5 km) and without informing ATC of the fact.

Human factors

The aircraft's radar track suggests that the commander, and probably the co-pilot, did not appreciate their position relative to the high ground of Fitful Head, thinking instead that the aircraft would fly to the east of the high ground on its way to a right base position. The co-pilot's question about whether the aircraft would turn inside the high ground, and the commander's response that it would, supports this view and may have served to reinforce in both pilots an incorrect mental model of the aircraft's situation. This is supported by the prompt, and initially rapid, final descent which began as soon as the Approach controller cleared the crew for a visual approach.

If the aircraft track was displaced only 2 nm further east, it would indeed have flown inside the high ground, and the vertical profile would then be more appropriate to the aircraft's position (had the crew been visual with the airport at that stage). The fact that both pilots thought the high ground they had seen to be the extreme southern end of Fitful Head also supports this hypothesis, as does the commander's statement that he intended to descend to a height appropriate to a downwind position. Furthermore, the commander described the incident as having taken place whilst turning on 'right base'. Because of this incorrect mental model of the situation, both crew thought that a turn to the right would take the aircraft into a clear area, when in fact, as the radar data shows, the aircraft actually turned towards the high ground. This would also account for the commander's incorrect reactions to the EGPWS alerts, and may have been a factor in the co-pilot's reluctance to assume control or order an immediate climb.

EGPWS reaction

The commander was aware of the high ground at Fitful Head, and when the 'CAUTION TERRAIN' alert sounded he probably thought it was triggered by ground he was turning away from, since otherwise his continued descent and gentle turn would be inexplicable. When the first 'TERRAIN TERRAIN PULL UP' warning sounded, the aircraft was descending through 644 ft radio altitude at a rate of 1,390 ft/min. The warning would not have agreed with the commander's probable mental model of the situation, but the EGPWS data shows that he did arrest the rate of descent and increase the turn rate slightly. However, he still did not carry out the prescribed manoeuvre, which would have been to level the wings and carry out a maximum performance climb.

It would have been at some point between the two 'TERRAIN TERRAIN PULL UP' warnings, probably about the point that ATC queried whether the crew were visual with Fitful Head, that the crew probably realised that high ground lay directly ahead of the aircraft. However, the commander still did not initiate the required maximum performance climb, but instead increased the turn rate to avoid the terrain. His action were probably based on his perception that the terrain he could see ahead was the extreme southerly tip of the headland, and that by turning the aircraft to the right he would be flying into a clear area. Although the commander stated that he was visual with the headland during this period, and did not consider that the terrain was a hazard, separation with the terrain continued to decrease and the aircraft actually flew over the extreme south-westerly point of the headland at less than 400 ft radio altitude.

When the first 'TERRAIN TERRAIN PULL UP' warning sounded, the aircraft was 1 nm from the highest terrain. Allowing for a reaction time of 5 seconds, and assuming constant groundspeed (ie no trade of airspeed for climb rate), the aircraft would only need to have achieved an initial climb rate of about 1,500 ft/min in order to clear the highest ground in the area by 50 ft. When the warning sounded a second time, the aircraft was 0.6 nm from the highest terrain, though turning away from it. A climb rate of 1,400 ft/min would have been required, allowing for a reaction time of 3 seconds. The climb rates required could comfortably have been achieved for the short duration required to clear the terrain, especially as excess airspeed was available.

Crew Resource Management (CRM)

The flight crew had very different backgrounds and experience. The commander had an extensive flying background and had accrued a large number of flying hours. In contrast, the co-pilot had joined the company less than a year earlier for what was his first commercial flying position. There was thus a very 'steep gradient' across the flight deck in terms of experience and authority.

The co-pilot was comfortable with the commander's initial decision to fly a visual approach, and although it may not have been briefed in any detail, had confidence in the commander. He admitted to feeling less comfortable as the descent progressed, but still trusted the commander's experience. The authority gradient, together with an erroneous mental model similar to the commander's, is probably the reason why the co-pilot did not seek further information about the visual approach during the briefing and did not question some of the commander's intentions during the descent, such as when the aircraft descended below the altitude target of 2,100 ft. The flight deck gradient appears to have been such a strong inhibitor for the co-pilot that, despite the EGPWS alerts and the ATC radio call, it was at a relatively late stage that the co-pilot considered taking control from the commander, at which point he decided that to do so would possibly place the aircraft in greater jeopardy.

There is a considerable onus on a commander to recognise the well-publicised problems of a steep authority gradient and to create an environment whereby a co-pilot feels able to question a commander's actions if he thinks them inadvisable or inappropriate. Similarly, for a two-pilot crew to operate most effectively, good communication between them is essential. In this case there appears to have been little effective communication, either regarding the approach plan or the developing situation, and it is probable that the co-pilot felt uncomfortable questioning the commander until the situation had clearly become very serious. However, the co-pilot's actions in bringing the incident to the attention of his company afterwards were commendable.

Organisational factors

The operator's OM clearly stated that Sumburgh was considered a Category B airport because of terrain and weather, both of which were factors in this incident. Had the operator met the requirements of JAR-OPS 1 and its own OM in regard of the provision of briefing material for Sumburgh Airport, the crew would have been reminded of the significant terrain and would probably have been reminded about the local weather effects that could affect Fitful Head. With this information fresh in their minds, the situation may have been avoided. Such a brief would also have raised the co-pilot's awareness of potential problems and may have prompted him to question the commander's intentions or actions before the situation became critical.

Crew training

The GPWS training received by both pilots during type rating training did not extend to practical handling exercises, nor was there a requirement for this under existing regulations. The crew received no training in the predictive functions of EGPWS, and there was no company information or guidance on such alerts. This was more significant for the co-pilot, as the commander had operated EGPWS equipment previously.

When the first 'CAUTION TERRAIN' alert sounded, the EGPWS display would have given a visual display of the terrain ahead of the aircraft which, had one of the crew seen it, would have alerted them much earlier to the true situation. Although the commander had experience of the system, the co-pilot's lack of training meant that he, as monitoring pilot, was not as well equipped to respond to the alert.

Although basic GPWS has been in use for many years, equipment with predictive functions has only recently been mandated in all large public transport aircraft (since 1 January 2005 in this case). However, there is no corresponding requirement that flight crews be trained in the enhanced functions of the system, or demonstrate an understanding of the correct responses to such alerts. It is recognised, however, that many modern simulators faithfully represent the latest GPWS standards and provide excellent training in this regard.

The situation regarding training may be compared to the carriage of Airborne Collision-Avoidance Systems (ACAS) which are also mandated and yet which carry a specific requirement that flight crews be trained in the interpretation of the ACAS display and the correct responses. Although GPWS warnings require less interpretation and handling finesse on the part of the pilot than ACAS alerts, accidents have still occurred due to incorrect crew responses. Had there been mandatory training in the predictive terrain hazard warning function of EGPWS, it is possible that this aircraft would not have come into such close proximity with terrain as it did.

It is therefore recommended that:

Safety Recommendation 2006-130

The Joint Aviation Authorities should review the training requirements for flights crews operating aircraft required to be equipped with a predictive terrain hazard warning function, with a view to ensuring that such crews are adequately trained in its use, interpretation and response.

Regulatory oversight

A number of organisational shortcomings were identified during the investigation, some of which have been addressed by the operator. At the time of the incident the operator's OM contained inadequate guidance to crews regarding responses to GPWS warnings, and no guidance or limitation on high rates of descent near to the surface, both of which were required under JAR-OPS 1. Furthermore, although the OM contained details of aerodrome categorisation, the system of briefing and certification of such was non-existent. Additionally, there was a discrepancy between the OM and another manual regarding the requirements for flight below safety altitude.

The ICAA was responsible for regulatory and safety oversight of the operator and, whilst acknowledging that the ICAA has already taken steps to increase its oversight of the operator's crew training programs, the following recommendation was made.

It was recommended that:

Safety Recommendation 2006-131

The Icelandic Civil Aviation Administration should conduct a safety audit of Landsflug ehf (City Star Airlines) in the light of the shortcomings identified during the investigation into this serious incident.

ACCIDENT

Aircraft Type and Registration:	Aeronca 7AC Champion, G-BVCS
No & Type of Engines:	1 Continental A65-8 piston engine
Year of Manufacture:	1946
Date & Time (UTC):	6 August 2006 at 1350 hrs
Location:	Leicester Airport, Leicestershire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers – N/A
Nature of Damage:	Underside of engine cowls and main landing gear
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	69 years
Commander's Flying Experience:	282 hours (of which 50 were on type) Last 90 days - 23 hours Last 28 days - 9 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquires by the AAIB

Synopsis

After takeoff, at approximately 100 ft aal, the aircraft's engine partially lost power. In response, the pilot retarded the throttle slightly before opening it fully. Full power was regained and the climb was continued. However, at approximately 300 ft aal the engine lost all power and stopped. The pilot flew a forced landing into a crop of wheat on the airfield. During the landing roll the aircraft's main landing gear collapsed.

History of the flight

The pilot reported that he was planning a local area navigation flight from Leicester Airport followed by visual circuits. Runway 28 was in use and its asphalt surface was dry. He added that the wind was from 330º at less than 5 kt, the visibility was 25 km and there was scattered cloud at 4,000 ft aal. The air temperature was 27ºC and the dew point was 14ºC.

After completing a water test of the fuel in the aircraft's tanks, using the under wing fuel drains, the pilot refuelled the tanks to full. He then completed his pre-flight checks, started the engine and taxied out to the holding point for Runway 28 where the carburettor heat and magnetos checks were completed satisfactorily before takeoff.

After an uneventful full power takeoff, at approximately 100 ft aal, the engine started to lose power without any signs of misfiring or rough running. The pilot momentarily retarded the throttle to about 60% power before fully opening it. The engine responded and full power was regained. He continued with a slow climbing turn and planned to land on Runway 10 because the wind was calm. Just after rolling out of the turn, the engine lost all power and stopped.

Having insufficient height to reach Runway 10, the pilot elected to land in a field of wheat straight ahead, short of and to the right of Runway 10. After touching down the aircraft rolled for approximately 60 ft during which the main landing gear collapsed. After coming to a stop the uninjured pilot selected the fuel selector, magnetos and radio to off before vacating the aircraft.

The pilot thought one reason for the engine failure may have been fuel starvation due to the high nose attitude after takeoff.

Carburettor icing

When the temperature and dew point are plotted on the Carburettor Icing chart in Safety Sense Leaflet 14 found in LASORS, their intersection falls within the *'serious icing – descent power'* area on the 50% humidity line. However, because the engine was at full throttle during the takeoff run, carburettor icing was unlikely. Additionally the pilot had carried out a satisfactory test of the carburettor heat for 30 seconds prior to takeoff. Had there been any ice present before takeoff it was likely to have melted during this test.

Engineering inspection

After the accident the repair agency inspected and tested the aircraft's engine and fuel system. This work revealed no pre-existing damage and no mechanical reason for the engine failure. The aircraft's magnetos were subsequently sent to an independent maintenance organisation for testing. Under test one magneto stopped when it reached operating temperature due to leaking insulation and the other showed signs of failure before stopping.

At the time of this report there was still some incomplete work. This includes the results of the full engine test which will be completed once the engine is re-installed on the airframe.

Discussion

The test results of the aircraft's engine, fuel system and magnetos, and discussion with the repair agency, suggest that the most probable cause of the engine failure was a double magneto failure. Given the high ambient temperature it is likely that the magnetos achieved a high operating temperature soon after takeoff and then failed in quick succession. The initial power reduction could be attributed to one of the magnetos showing signs of failure, as it achieved a high operating temperature, before they both subsequently failed.

ACCIDENT

Aircraft Type and Registration:	Cessna A152, G-BHAC
No & Type of Engines:	1 Lycoming O-235-L2C piston engine
Year of Manufacture:	1978
Date & Time (UTC):	11 September 2006 at 1611 hrs
Location:	Near Bethesda, Gwynedd, Wales
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Serious) Passengers - 1 (Fatal)
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	60 years
Commander's Flying Experience:	116 hours (of which 114 were on type) Last 90 days - 12 hours Last 28 days - 6 hours
Information Source:	AAIB Field Investigation

Synopsis

The pilot and his passenger flew from Shobdon to Caernarfon Airfield and planned to return late in the afternoon. On their first attempt to return, they chose a direct route back but encountered poor weather and returned to Caernarfon Airfield. After refuelling, they took off and embarked on an alternative return route via Colwyn Bay and the north Welsh coast. Eleven minutes after departing Caernarfon Airfield they struck a mountainside at 1,970 ft amsl, fatally injuring the passenger and seriously injuring the pilot.

History of the flight

The pilot and his passenger arrived at Shobdon on the morning of the accident, intending to fly to Caernarfon Airfield and return to Shobdon later the same day. This was the first time that the pilot had flown to Caernarfon Airfield although he had visited the airfield as a passenger three years previously. The weather was checked using the flying club's internet facilities and a flight log prepared for the route. The Minimum Safe Altitude (MSA) for the Colwyn Bay-Caernarfon leg of the route was noted as 4,900 ft on the flight log. On the pilot's chart a triangular route was drawn; Shobdon to Colwyn Bay to Caernarfon Airfield to Shobdon (see Figure 1). Wind corrected headings and timings were added to the chart for the first two legs of the route.

At approximately 1100 hrs they took off from Shobdon and flew to Caernarfon Airfield via Colwyn Bay and the Menai Straits, arriving at 1200 hrs. The pilot reported the

Planned route as drawn on pilot's chart

Radar recorded back

Figure 1

weather at their en-route cruising altitude of 2,500 ft amsl as *'good with little cloud, hazy visibility and no or little turbulence'*. They had lunch at the airfield and checked the latest weather forecasts for the local area and Shobdon, observing that there was now more cloud in the local area than on their arrival. They discussed the route home and decided that if the direct route back proved unsuitable, they would consider flying the reverse of the outbound route ie flying to Shobdon via Colwyn Bay. At 1505 hrs they departed from Caernarfon Airfield and climbed out on a southerly heading, intending to fly a direct route home.

The pilot recalled getting airborne on this flight but, due to injuries sustained in the accident, subsequently remembered nothing else until several days afterwards. The following events are thus derived from recorded ground radar data and eye witnesses.

After taking off from Caernarfon Airfield, the aircraft was observed heading south by the airfield air/ground operator. Approximately 10 minutes after disappearing from view, the pilot transmitted that he was returning to Caernarfon Airfield as he was unable to penetrate the weather to the south. At 1530 hrs he landed back at Caernarfon Airfield and told ATC that he was now planning to return to Shobdon via the northern coast of Wales once the aircraft had been refuelled. The aircraft was refuelled to full tanks and prepared for departure. After ATC had passed the airfield information, the air/ground operator also added that he had received a weather update on their planned route from a recently departed aircraft. He reported that the Menai Straits were negotiable beneath the cloud until reaching Bangor where the cloudbase became 3,000 ft with unlimited visibility. At 1605 hrs, G-BHAC took off from Runway 26, turned right and tracked approximately 070°M, climbing to 1,800 ft amsl. The radar head situated at St Annes near Blackpool recorded the aircraft's track until 1612 hrs and this is shown in Figure 1. At 1611 hrs, G-BHAC called RAF Valley ATC to request a Flight Information Service (FIS). The controller offered the pilot a FIS and passed the Holyhead regional pressure setting of 1009 mb. The pilot replied 'QNH 1019, G-BHAC IS A CESSNA 152 ROUTING CAERNARFON SHOBDON VIA COLWYN BAY CURRENTLY TO THE EAST OF CAERNARFON HEADING 190° AT 1,800 FT VFR'. The controller corrected the inaccurately readback QNH and this was acknowledged by the pilot. Nothing more was heard from the aircraft.

Approximately five minutes later, a fell runner near Bethesda heard an aircraft flying close to her but was unable to see it due to the low cloud base. Initially, the engine sounded normal and then it seemed to rise in pitch for a couple of seconds before she heard a bang and then silence. She assumed the aircraft had impacted the mountainside and ran to the nearest telephone to alert the rescue services. At 1745 hrs, a Police Air Support Unit helicopter located the aircraft's wreckage and the pilot was flown to hospital by an RAF rescue helicopter. The passenger was fatally injured in the impact.

Meteorology

An aftercast was obtained from the Met Office which stated that at 1200 hrs on the day of the accident, a moist south-westerly flow covered the British Isles with a slow-moving frontal band covering Ireland and the south-west approaches. It was estimated that in the vicinity of the accident area, the wind at 2,000 ft agl was from 330° at 15 kt and that there was a broken strato-cumulus cloud base at 1,700 ft amsl which was likely to be more extensive over high ground due to the onshore wind. The surface visibility was estimated to be 15 to 20 km. The meteorological report from RAF Valley (20 miles west of the accident site) at 1550 hrs stated a surface visibility of better than 10 km and a broken cloudbase at 1,700 ft agl.

The Met Office also issued a Form 215 *'Forecast Weather Below 10,000 ft'* chart at 0930 hrs which provided guidance as to the conditions in Wales during the period 1400 to 2300 hrs. The pilot would have had the opportunity to study this chart whilst at Shobdon and Caernarfon Airfields. This chart forecast that visibility would generally be 15 km with widespread haze reducing this to 7 km. Occasionally the visibility could be expected to reduce to 3,000 m in mist and/or light drizzle on sea coasts with isolated sea and hill fog. The chart also forecast that there would be a broken strato-cumulus cloudbase between 1,500 and 2,000 ft amsl with occasionally a broken stratus cloudbase between 200 and 700 ft amsl. The TAF for RAF Valley issued at 1337 hrs and covering the period 1500-2400 hrs, forecast visibility in excess of 10 km and small amounts of cloud with a base at 2,000 ft amsl.

The fell runner witness was at an altitude of approximately 1,700 ft amsl when she heard the aircraft. She reported that the cloudbase was approximately 2,000 ft and that she could just see the other side of the Bethesda valley from her position (approximately 4 km). She also stated that the cloudbase had dropped significantly over the preceding two hours and there was very little wind.

Reports from other aircraft in the area suggest a cloudbase in the Menai Straits of approximately 1,000 ft amsl with 15 km visibility below the cloud. One aircraft flying over the Menai Straits reported that the mountains of Snowdonia were obscured by low cloud.

Pathology

The post mortem examination of the passenger revealed that he died due to aspiration of his stomach contents into his airways. The aviation pathologist's report states that:

> *"he had sustained a number of injuries in the crash but none of these would have been necessarily fatal, and indeed the pilot survived having sustained injuries of similar severity…No additional or alternative safety equipment would have been likely to make any difference to this unfortunate event".*

Impact conditions

The aircraft had struck gently rising ground at a point approximately 1,970 ft above sea level, close to the local summit of the hillside, on a track of approximately 070ºM. The distribution of ground impact features and the pattern of deformation suffered by the aircraft during the initial stages of the impact were consistent with it having been in substantially level flight, banked approximately 10° to the left and pitched slightly nose up relative to its flight path, which for all practical purposes was horizontal at the instant of impact.

During the main impact, the forward momentum of the mainplanes caused both to be moved forward in-plane and to swing downwards in an arc about the restraints offered by the lower ends of the wing struts, until the roof section of the cabin and both wings lay just above the level of the engine cowl and instrument coaming. Associated deformations of the cabin side structure, aided by concurrent forward and upwards swinging of the empennage and rear fuselage (also due to the aircraft's forward momentum), caused the rear part of the cabin, including the aft portion of the door apertures, to fold top-first towards the instrument panel. Additionally, the left wing rear spar attachment fittings failed in overload as a result of inertial in-plane loading of the mainplanes. Each of these structural deformations was indicative of a substantial impact velocity in the horizontal plane, consistent with the aircraft having been in substantially normal level flight at the time of impact.

Examination of the wreckage

A detailed inspection of the wreckage was carried out *in situ*. The fuel valve was selected ON. The fuel feed pipe from the left wing tank was broken between the inboard rib and the centre section, due to the in-plane rotational movement forward of the wing relative to the fuselage after the rear spar connection had failed. Both fuel tanks were cut open to permit access to their interiors: the right tank, which lay at a slightly higher level than the left, was empty; the left tank contained a small quantity of fuel, to the level of the outlet pipe. It was apparent that fuel had drained from the left tank directly via the fractured fuel pipe, and that the right tank had drained through the same fracture via the interconnecting pipework. The residue of fuel in the left tank was clean, free of visible water contamination, and its colour and odour were consistent with AVGAS.

The carburettor casing had fractured through the float chamber during the impact, and was empty of fuel. The gascolator housing, which lay in the wreckage at a higher level than the fractured carburettor bowl, was also empty. The gascolator bowl and its strainer, and the mesh fuel strainer at the float chamber inlet, were clean.

As found, the throttle plate was almost in the closed position and the throttle knob and its associated push-rod in the cockpit had been bent during the impact whilst at a partial throttle position. However, the throttle spindle lever at the carburettor was damaged in the impact. Its position, at the lowest point on the engine, was such that it would have been driven towards the throttle-closed end of its travel. It therefore could have potentially back-driven the operating cable and the throttle knob in the cockpit towards the throttle-closed position during the earliest stages of the impact sequence, thus pre-empting the impact damage to the push-rod. As a consequence, the setting of the throttle at the time of impact could not be ascertained. The mixture control lever at the carburettor and its associated control knob in the cockpit were both at the fully rich setting at impact. The hot air control knob in the cockpit was set to COLD at impact, and this setting was confirmed by the position of the valve plate within the hot air box at the carburettor inlet, which was also in the COLD position.

The alternator exhibited evidence of rotational scoring, indicating that the engine was running at impact. Significant impact damage to the propeller blades comprised heavy leading edge deformation and chordwise scoring of the tip region of one blade; circumferential scoring was also present in the tip region of the opposing blade. Overall, the propeller damage was consistent with the engine having been operating at a high power setting at impact.

Both of the wing flap slave cables, which run spanwise to the left trailing edge flap's actuating crank, and both of the aileron control cables in the wing were fractured in overload. This occured as a result of being stretched by the in-plane displacement of the left wing, following fracture of its rear spar attachment in the impact. The elevator and rudder control cables had been cut by the emergency services just aft of the cockpit, to allow removal of the complete aft fuselage and tail so as to give clearance for the extraction of the surviving occupant. Otherwise, the elevator and rudder cable circuits, and the elevator control circuit components located under the cockpit floor and comprising the push-pull rod and bellcrank and its connection to the lower end of the control column, were intact and connected. All control surfaces and their control system connections were intact; except for impact deformation of the rudder horn, all moved freely and without restriction on their hinges. The elevator trim tab was set to a neutral position.

Apart from the flap slave cable fractures and some impact bending of the left flap operating rod, the flap control system was intact and free of damage. The flap selector switch in the cockpit was in the flaps up position, but was potentially subject to post-impact disturbance and displayed no damage from which its position at impact could be ascertained. However, the electrical screw-jack flap actuator assembly and the right flap surface, to which it was still connected, were in the fully retracted position at impact.

All the evidence from the crash site suggests that G-BHAC was serviceable and flying essentially normally in level flight when it struck rising ground on a heading of approximately 070°M, banked approximately 10º to the left; possibly after having been pitched up slightly in the seconds before impact.

Discussion

The engineering investigation concluded that the aircraft was serviceable when the accident occurred, so it is likely that the causal factors were of an operational nature.

The pilot's first attempt to fly back to Shobdon would have alerted him to the generally deteriorating weather conditions and a decision was made to return to Caernarfon Airfield. When the pilot was on the ground at Caernarfon, he had the opportunity to study the latest TAFs and METARs as well as the F215 significant weather chart covering his intended route. This information suggested a cloudbase of 1,500 to 2,000 ft amsl which is below the height of much of the high ground in Snowdonia. However, a routing via the Menai Straits and Colwyn Bay would seem to have been feasible given these forecasts. The pilot would also have been aware from a recent airborne report that the Menai Straits were negotiable beneath the cloud and the weather conditions beyond Bangor were significantly better. This is likely to have encouraged an attempt to fly the 'northerly' route back to Shobdon, particularly as the pilot had already considered it a viable option should the direct route back be unsuitable.

After getting airborne the aircraft took up a track which diverged immediately from the stated routing towards the Menai Straits. The track followed was a direct line towards Colwyn Bay, which was also the routing transmitted to ATC at RAF Valley. The pilot's chart had a line drawn from Colwyn Bay to Caernarfon Airfield and the track followed back was coincident with this. The accident site was situated within one mile of this drawn line and its elevation (1,970 ft amsl) is only slightly higher than the height the pilot stated he was flying at (1,800 ft amsl) to ATC. The pilot, having no memory recall of this flight, was not in a position to say why this particular route was followed at a height below the minimum safe altitude into an area of cloud or low visibility. However, given his transmission to ATC that he was routing Caernarfon to Colwyn Bay, the line on his chart reflecting this routing and the radar recording showing that the flight actually proceeded along this route, it does appear that this route was the pilot's intention.

Conclusion

Although, due to the injuries sustained in the accident, the pilot has no recollection of the events surrounding the accident flight, it would appear that the aircraft was serviceable when it struck the ground and that it was proceeding along the pilot's intended route. His unfamiliarity with the area and the deteriorating weather conditions may well have disguised the danger that the rising terrain presented and led to this controlled flight into terrain. An early climb to MSA, which was accurately marked on the pilot's flight log or an accurately flown track over the Menai Straits, would almost certainly have prevented this tragic accident.

The CAA General Aviation Safety Sense leaflet 23 entitled '*Pilots: It's Your Decision*' states the following;

> *'Probably the single most important factor in General Aviation flight safety is the decision of a pilot to begin, or to continue with a flight, in unsuitable weather conditions. As you might expect, weather was a major factor in fatal accidents: over 80% of Controlled Flight Into Terrain accidents happened when the pilot either continues flying in adverse weather, or did not appreciate the actual effects of the weather conditions….Remember that weather does not stay constant, it doesn't always do what the forecast predicts, and it can deteriorate very fast. Respect the weather and the implications for flight safety.'*

ACCIDENT

Aircraft Type and Registration:	Cirrus SR22, N588CD
No & Type of Engines:	1 Continental IO-550-N piston engine
Year of Manufacture:	2006
Date & Time (UTC):	6 November 2006 at 1025 hrs
Location:	Chichester (Goodwood) Airfield, West Sussex
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to nose gear leg, main landing gear legs, left wing leading edge, fuselage underside and propeller
Commander's Licence:	Commercial Pilot's Licence (with Instructor rating)
Commander's Age:	38 years
Commander's Flying Experience:	8,055 hours (of which 150 were on type) Last 90 days - 195 hours Last 28 days - 55 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

The accident occurred during a takeoff attempt on the student pilot's second training flight, with an instructor. At 60 kt the student inadvertently closed the throttle instead of applying back pressure to the control stick. The instructor took control and decided to abort the takeoff. The wet grass reduced the aircraft's braking action and the aircraft overran the length of the runway and struck a tyre barrier at approximately 10 to 20 kt.

History of the flight

The student pilot was undertaking her second training flight, with an instructor, as part of a course to obtain an AOPA[1] Flying Companion's Certificate. The course is designed to enable those who fly regularly with a private pilot to be more involved in the flights and be able to take over and land the aircraft if the pilot were to become incapacitated. The course is conducted with the student pilot flying from the right seat and the instructor in the left.

The weather was good with a calm wind, but the grass runways were wet from heavy dew. The main runway, 14/32, was closed for grass cutting, so the intersecting Runway 24 was active. This runway had a takeoff run available and a takeoff distance available of 845 m. The instructor briefed the student pilot on how to carry out the takeoff run and explained that the aircraft would try to veer to the left when power was

Footnote

[1] Aircraft Owner's and Pilot's Association.

applied and this would need to be controlled with the rudder pedals. He also said that they would perform the rotation together.

The student taxied the aircraft and lined up on Runway 24. After a final briefing from the instructor, the student applied power. The aircraft veered to the left and the student stated that she was both distracted and alarmed by the extent to which this happened. She found that she could only concentrate on trying to control the aircraft's direction. At approximately 60 kt the instructor told her to pull back on the stick to initiate rotation. However, the student was so consumed with trying to maintain control with her feet that she confused the throttle lever in her left hand with the control stick in her right hand and inadvertently pulled back with her left hand, closing the throttle. At this point the instructor took control and he reported that, with the throttle closed and the speed already decaying, he decided to abort the takeoff. He applied the brakes but found no braking action on the wet grass. He released the brakes and reapplied them but still found no effect. He continued to pump the brakes, pulled the mixture lever to idle cut-off and switched off the electrics. The aircraft crossed over the motor circuit track at the end of the runway and hit the tyre wall on the other side. The instructor estimated the impact speed at between 10 and 20 kt. The aircraft came to an abrupt stop and both he and the student were able to evacuate safely. The airfield's fire service arrived within a minute but there was no fire (see Figure 1).

Eyewitness account

The airfield's flight information service officer (AFISO) on duty at the time, who was also a private pilot, observed the aircraft's takeoff run from the control tower. He reported that as takeoff power was applied the aircraft immediately yawed to the left but the turn was arrested. He then witnessed the aircraft making small turns from side to side as it continued down the runway while accelerating at a slower rate than he expected. The AFISO believed that he then heard a marked reduction in engine power which was followed by two separate slight increases but it did not sound like takeoff power to him. He estimated that at this point the aircraft was 200 to 300 m from the end of the runway and he became concerned that the aircraft would not be able to complete the takeoff. When the aircraft was just short of the runway intersection he heard a burst of power which sounded like takeoff power. As the aircraft passed the intersection he heard the power being cut, and by then he had his hand over the crash alarm. He thought the aircraft

Figure 1

Aircraft in its final resting position against the tyre barrier might still stop in time, but when it hit the tyre barrier he activated the crash alarm.

The instructor's recollection differed slightly from that of the AFISO. He has since stated that he thought the student maintained a fairly straight line down the runway without assistance from himself, although the student applied power slowly. The instructor also stated that after the student inadvertently reduced power he did not reapply power at any stage.

Takeoff performance

The aircraft's weight at takeoff was 1,326 kg, which was 219 kg below the aircraft's maximum takeoff weight. For the weather conditions of the day the aircraft's performance figures predict a takeoff ground roll of 229 m (this includes a 15% increment for dry grass) and a takeoff distance to 50 feet of 344 m. These figures assume a liftoff speed of 70 kt. The landing distance ground roll is given as 343 m for a dry paved runway and 478 m (40% more) for a dry grass runway. The aircraft's flight manual does not provide performance figures for wet grass runways. The CAA recommends in *Safety Sense Leaflet 7* on aeroplane performance that a factor of 15%+ should be used for dry grass runways and 35%+ for wet grass runways. However, it warns that very short wet grass may be slippery and may increase landing distances by up to 60%. (The CAA factors should be multiplied by the landing distance from a height of 50 ft so cannot be directly compared to the manufacturer's factors which are multiplied by the landing distance ground roll.)

Grass cuttings

The pilot expressed concern that the grass cuttings on the last third of the runway might have reduced the braking action on the wet grass. The CAA's Aerodrome Standards Department were consulted about the grass cuttings and were sent photographs of the cuttings that were in the path of N588CD. The CAA regarded the grass cutting clumps as small and stated that they would not have had an effect on braking action.

Analysis

If the takeoff had been carried out normally with no deviations and no delay in achieving takeoff power, then the aircraft should have reached 60 kt having used less than 229 m of runway. At this point there would have been 616 m of runway remaining. The aircraft's landing distance ground roll can be used to estimate the stopping distance required from 60 kt. Had the grass been dry it should have been possible to stop the aircraft within 478 m – which was less than the distance remaining. However, short wet grass can be significantly more slippery, as evidenced by the CAA's safety factor of 60%. It is therefore not possible to determine definitively if the aircraft would have stopped in the remaining distance available had the takeoff run been carried out normally.

The contributory factors in this accident were: the delayed application of full power during the takeoff run, the student pilot's apprehension and inadvertent closing of the throttle, and the slippery wet grass.

ACCIDENT

Aircraft Type and Registration:	Denney Kitfox Mk 2, G-BWHV
No & Type of Engines:	1 Rotax VL 582 piston engine
Year of Manufacture:	1997
Date & Time (UTC):	18 July 2006 at 1212 hrs
Location:	Treforest Industrial Estate, Pontypridd
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 Passengers - 1
Nature of Damage:	Aircraft destroyed
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	53 years
Commander's Flying Experience:	241 hours (of which 110 were on type) Last 90 days - 3 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft suffered a substantial loss of engine power and crashed into an industrial estate following an attempted forced landing into school playing fields.

History of the flight

The pilot and passenger, his wife, had planned a local flight and took off from Cardiff Airport at about 1145 hrs (UTC), departing to the north. Crossing the M4 motorway, clear of controlled airspace, they descended to 1,000 feet for a timed climb to 2,000 feet, their assigned height. The timed climb was satisfactory and the pilot turned up the Rhonda Valley towards Pontypridd for local flying.

Turning back for the return into Cardiff, the pilot retuned the radio for the Cardiff ATIS and was making a turn to the left when he and his passenger heard loud screeching sounds, and bangs, from the engine. The pilot throttled back and checked the engine instruments, which were normal. He found that the engine would run at about 4,000 rpm - he commented that, normally 5,000 to 5,500 rpm was needed to maintain height, with idle at about 3,000 rpm, so the aircraft was descending at this point.

The pilot looked for landing fields but could see nothing suitable in the upper valley. He decided that he could not clear the valley, towards Cardiff, so he selected the Hawthawn playing-fields, near the Treforest Industrial

Estate, as his only landing site. He set up for an approach over the open end of the playing-fields but, at the 'threshold' found himself still 2 to 3 metres high and much too fast. He managed to put the wheels on the grass twice but bounced each time and, assessing that the row of trees at the far end of the field was too close, opened the throttle.

The aircraft cleared the trees and the pilot was turning to the left, for another attempt into the same field, when the engine cut completely. The aircraft descended towards industrial buildings and the left landing gear leg struck a roof, spinning the aircraft around so that it fell next to the building it hit, chopping off the tail on a brick wall.

The crew compartment came to rest inverted on the A4054 road and the pilot told his wife to wait for him to help get her out. He released his harness and crawled out of the rear of the compartment, to reach the passenger side of the aircraft. Meanwhile his wife had released her harness and the pilot was able to help her out. Together they reached the grass at the side of the road and became aware of people coming to assist. There was no fire and the passenger and pilot were taken to hospital, although they assessed their injuries as minor. Both seats were equipped with full 'four-point' harnesses.

Examination

The Rotax 582 is a two-cylinder two-stroke engine driving the propeller, in this installation, through a simple reduction gearbox. In the case of G-BWHV, the engine was later modified with a factory-provided rotary hydrodamper unit, to reduce the level of vibration. The design of this damper is conventional, with a toroidal mass, enclosed within a cylindrical body, moving in a viscous fluid to provide rotary vibration damping.

The engine from G-BWHV was later examined at an overhaul agency. The major failure identified within the engine, before its impact with the ground, was in the hydrodamper, where the small outer flange of the cylindrical body had separated, resulting in the loss of the viscous fluid. It was not clear what mechanism had caused the subsequent loss of power but the engineer examining the engine considered it possibly due to contamination from the fluid released from the damper. Examination of the fracture surface by a metallurgist indicated the failure had been through a fatigue mechanism, starting with fatigue origin points on the inner surface of the flange.

The engine manufacturer was consulted on this flange failure and commented that they had not seen any similar cases.

Analysis

The pilot considered that the failure to make a satisfactory forced landing at the first attempt was at least partly due to a lack of recent practice of glide approaches to an actual landing: his most recent practice to a completed landing had been in September 2005, although he had done a practice, to 500 feet, the previous day. He assessed that, in the approach to the playing fields, he should have gone further downwind but was intimidated both by the state of the engine and the presence of the industrial buildings. He also considered that, to reduce energy on approach, a sideslip would have helped but that he did not realise he was too high and fast until it was too late.

ACCIDENT

Aircraft Type and Registration:	Europa, G-BWCV
No & Type of Engines:	1 NSI Propulsion Systems EA-81 piston engine
Year of Manufacture:	1997
Date & Time (UTC):	16 July 2006 at 1115 hrs
Location:	Near Portbury, North Somerset
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers -1
Injuries:	Crew - 1 (Minor) Passengers - 1 (Minor)
Nature of Damage:	Extensive damage to composite fuselage structure
Commander's Licence:	Private Pilot's Licence
Commander's Age:	46 years
Commander's Flying Experience:	977 hours (of which 31 were on type) Last 90 days - 30 hours Last 28 days - 14 hours
Information Source:	AAIB Field Investigation

Synopsis

Whilst cruising at 3,500 ft near the Severn Estuary, the aircraft suffered an alternator bearing seizure and smoke from the drive belts entered the cockpit. The engine stopped, but, due to its free-wheel mechanism, the propeller continued to rotate increasing the drag and causing a significantly higher rate of descent during the subsequent forced landing than for a propeller at idle or stopped.

The aircraft landed in a small field, struck a hedge and suffered major damage to the composite fuselage structure fore and aft of the cockpit. Both occupants suffered minor injuries.

History of the flight

The aircraft was cruising at 3,500 ft near the Severn Estuary with the engine at about 4,000 rpm, when, without warning, smoke entered the cockpit accompanied by a burning smell. The aircraft yawed and the nose dropped. The pilot then realised that the engine had stopped, although the propeller was still rotating.

The pilot, who also had approximately 1,000 hours gliding experience, reported that the aircraft attained an unusually high rate of descent as he manoeuvred it towards two adjacent fields which he had selected for the landing. He also reported a severe reduction in elevator effectiveness. He briefed the passenger and switched off the master switch, pulled the circuit breakers and turned off the fuel. He became aware of power lines running across the larger of the two fields so he made his approach to the smaller field, which was later measured to be 290 m diagonally. His workload was high as he had to avoid several trees and pylons in the vicinity, and the electric trim was unavailable as the master electric switch had been turned off. The smoke in the cockpit however, had cleared. The gear and flaps were lowered and the aircraft touched down. Once on the ground the pilot, drawing upon his gliding experience, elected to retract the single wheeled landing gear in an attempt to decelerate more rapidly. Whilst this probably reduced the risk of tipping the aircraft over, it caused the propeller to break off and the flaps to retract. The loss of drag from the free-wheeling propeller, the lack of flaps and the fact that the wheel still rotated[1] all combined to reduce the deceleration rather than to increase it. The aircraft then struck a dense hedge at the far end of the field causing major damage to the composite fuselage structure fore and aft of the cockpit. Both occupants suffered minor injuries and exited through the doors. The police, fire and ambulance services attended the scene.

Aircraft and engine information

The Europa is a two-seat aircraft sold in kit form. G-BWCV was a mono-wheel version, and these have a single main wheel gear (called the mono-wheel) supplemented with a tail wheel and outriggers. The mono-wheel partially retracts into a bay situated between the two occupants. The deployment/retraction mechanism for the gear and the flaps is linked such that the mono-wheel and the flaps are deployed together.

This aircraft was manufactured in 1997 and the engine airframe combination had accumulated 76 hours. The aircraft was operating on a Popular Flying Association (PFA) Permit-to-Fly. There are over 200 Europas on the UK register, the majority of which are fitted with Rotax engines, as per the manufacturer's recommendations. G-BWCV was fitted with an NSI EA-81 engine, which is also approved, and there are believed to be around 11 similarly powered Europas on the UK Register.

The NSI EA-81 is a 98 hp refurbished and modified Subaru car engine. According to the literature supplied by the UK distributor of this engine, NSI obtained used low mileage Subaru engine cores from Japan. As part of the refurbishment they chemically washed, inspected and reassembled the engines using new seals and bearings. The provision of new or refurbished alternator components is not noted in this literature. The alternator is mounted on the top rear of the engine. The alternator and water pump are both fitted with two pulleys and are driven by two parallel toothed belts. The use of two belts is thought to provide redundancy should one belt fail.

The engine has electronic ignition and can run without the alternator using battery power. It also has a gear reduction drive with a 'Linear Cam Device' to reduce torsional vibration. If the engine stops in flight, this device acts as a free-wheel mechanism allowing the propeller to rotate, or 'windmill'. A free-wheeling propeller can generate significantly more drag than a static propeller and, since the glide ratio for an aircraft is the same as the ratio of lift to drag, a free-wheeling propeller can significantly increase the aircraft's glide angle and therefore its rate of descent in a glide.

The Propulsion System Operator's Manual for the NSI EA-81 contains a section on handling instructions. There is no reference in this manual to the significantly higher rate of descent for a free-wheeling propeller.

Footnote

[1] In the retracted position approximately ¼ of the wheel is exposed beneath the fuselage. The pilot inspected the aircraft's ground marks and concluded that the wheel had continued to rotate when in its retracted position.

Wreckage examination

The AAIB did not attend the accident site. However the wreckage was subsequently recovered to the AAIB's headquarters in Farnborough for inspection.

Inspection of engine installation – drive belts

Black rubber deposits were found on the engine around the alternator. The two drive belts were removed and there was evidence of slippage and scorching on the belt surfaces. Whilst there was significant damage to the belts, they were not broken.

The engine cowling was vented on the lower surface, and directly aft of this was the well for the mono-wheel. Discussions with the pilot concluded that this was the likely route for smoke from the drive belts to have entered the cockpit.

Alternator

The alternator main bearing was found to have seized and was stripped for examination. The bearing was a sealed unit with caged balls. The cage was found to have failed; see Figure 1. A metallurgist with significant experience in investigating failed bearings concluded that the failure was due to lack of grease in the bearing. In addition to lubrication, grease dampens vibration between the balls and the cage pillars, and the lack of grease removed this damping, causing the cage to fail in overload. Typically such sealed bearings have a shelf-life since the grease can degrade with time. The pilot considered that the life of the grease might also have been adversely affected by elevated temperatures associated with the configuration of the installation.

Flight testing

The PFA were informed of the accident and initiated a flight test to quantify the rate of descent for a similar aircraft with a free-wheeling propeller; the rate of descent measured was 1700 ft/min, which is significantly higher than that encountered with the propeller turning and the engine at idle.

Belt strength

The twin belts used were Super HC belts manufactured by the Gates Corporation. This organisation has a policy of not recommending the use of its power transmission products on aircraft, including home-built and FAA certified types.

This type of belt is suitable for multiple drive systems. The engine is rated at 98 hp at 5,800 rpm and the failure occurred in cruise at around 4,000 rpm and approximately 60 hp. The opinion from an engineer from the Gates Corporation was that the belts would slip at these conditions if the alternator seized.

Figure 1

A simple estimate of the load in one belt at this cruise condition made by the AAIB was 150 lbf. The ultimate strength of the belt was not available from the manufacturer, but with such a load the strength of the belts may well have been sufficient to stop the engine without the belts failing.

Previous incident

An incident occurred several years ago to an NSI powered Europa. The aircraft was in the cruise when the alternator seized. The belts were damaged but did not fail; smoke filled the cockpit and the pilot switched the engine and fuel off. The cockpit cleared of smoke and the pilot made a satisfactory forced landing. The pilot minimised the drag penalty of the free-wheeling propeller by adjusting the propeller pitch (NB the propeller on G-BWCV was fixed-pitch). The pilot also trimmed for 80 kt to increase the control effectiveness. The reason for the alternator failure was not determined.

Analysis

The main bearing of the alternator had seized due to lack of grease. This engine was refurbished approximately 10 years ago as part of its conversion to an aircraft unit and it was not possible to determine the history of the alternator components.

The pilot's account was consistent with the alternator seizing, causing the belts to slip and generate the smoke, and causing the engine to stop. There is evidence from the belt manufacturer and AAIB engineering estimates that this could have occurred.

If only one belt had been fitted, the single belt might have failed after the alternator seizure, and hence the engine might have continued running. However more detailed analysis is required to determine if this would be a better option. Therefore the following safety recommendation is made:

Safety Recommendation 2007-033

It is recommended that the Popular Flying Association review the use of dual belts on NSI EA-81 engines to minimise the consequences of an alternator seizure.

The greater concern with this incident, however, is the unexpected and abnormally high rate of descent in the glide after the engine stopped. In order to advise owners and pilots of this situation, a further safety recommendation is made:

Safety Recommendation 2007-034

It is recommended that the Popular Flying Association (PFA) advise all owners and operators of PFA Permit-to-Fly aircraft which have a free-wheeling fixed pitch propeller, that such aircraft may have a high rate of descent if the propeller free-wheels following an engine failure.

As a result of these two Safety Recommendations, and shortly before publication of this report, the PFA has advised that it is in the process of issuing two PFA Airworthiness Information notices. The first informs all operators of the NSI EA-81 engine (as well as operators of any other engine with a free-wheeling propeller) of the high rate of descent which may result if the engine stops. The second requires all aircraft fitted with the NSI EA-81 to have the alternator bearings inspected every 50 hours or at least annually. In the meantime the PFA intend to review the option of removing one of the two belts. In view of these safety actions the AAIB is satisfied that the PFA have already responded appropriately to the two Safety Recommendations 2007-033 and 2007-034.

ACCIDENT

Aircraft Type and Registration:	Europa, G-PTAG
No & Type of Engines:	1 Jabiru Aircraft PTY 3300A piston engine
Year of Manufacture:	2000
Date & Time (UTC):	27 May 2006 at 1545 hrs
Location:	Wickenby, near Market Rasen, Lincolnshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to fuselage, nose gear leg, propeller and main gear fairings
Commander's Licence:	Private Pilot's Licence
Commander's Age:	66 years
Commander's Flying Experience:	555 hours (of which 532 were on type) Last 90 days - 14 hours Last 28 days - 5 hours
Information Source:	AAIB field investigation

Synopsis

After a normal touchdown, on both main wheels followed by the nosewheel, the nosewheel shimmied and departed the aircraft, together with the nosewheel fork. The lower cowl, propeller, nose gear leg, nose gear mount and main gear fairings were all subsequently damaged. The pilot and the passenger were uninjured.

A scroll pin which retained the nosewheel fork assembly had failed, although the precise cause of this failure could not be determined. One recommendation is made.

History of the flight

The aircraft was returning to Wickenby, having previously flown to Shobdon. The pilot reported a smooth touchdown on Runway 34 at Wickenby but, shortly after the nosewheel settled on the runway, it shimmied and detached, together with the nosewheel fork, and the propeller struck the tarmac. During the subsequent ground roll the nose gear leg, which is swept forward on this aircraft type, became angled rearwards thus allowing the aircraft to adopt an extreme nose down attitude, and the forward underside of the spats of the main wheels contacted the runway. The pilot recalled a long taxi on grass at Shobdon prior to the incident flight, with no problem.

The lower cowl, propeller, nose gear, nose gear mount and main gear fairings were all damaged. The pilot and the passenger were uninjured.

Description

The Europa is a two-seat aircraft sold in kit form. G-PTAG was a tri-gear version. The main component of the nose gear leg comprised a length of steel tube attached to the aircraft structure behind the engine compartment. The geometry was such that the leg was swept forward making an angle of approximately 30° to the horizontal, see Figure 1.

The nosewheel fork assembly was supplied as a pre-assembled unit and consisted of a pivot shaft and an aluminium alloy fork unit. The upper end of the pivot shaft fitted into a cylindrical housing welded to the lower end of the nose gear leg, see Figure 2.

The lower end of the pivot shaft fitted into a hole in the fork unit. The tolerances on the pivot shaft and the hole in the fork were such that for within-tolerance components there could be, at one extreme, a gap of 0.0016”, and at the other extreme 0.0002” interference. Loctite adhesive was used to bond the two components. A 6 mm diameter scroll pin[1] was inserted into a hole through both the fork and the lower portion of the pivot shaft to locate the components positively and to take the relatively small load from tightening the shimmy damper nut, see Figure 3.

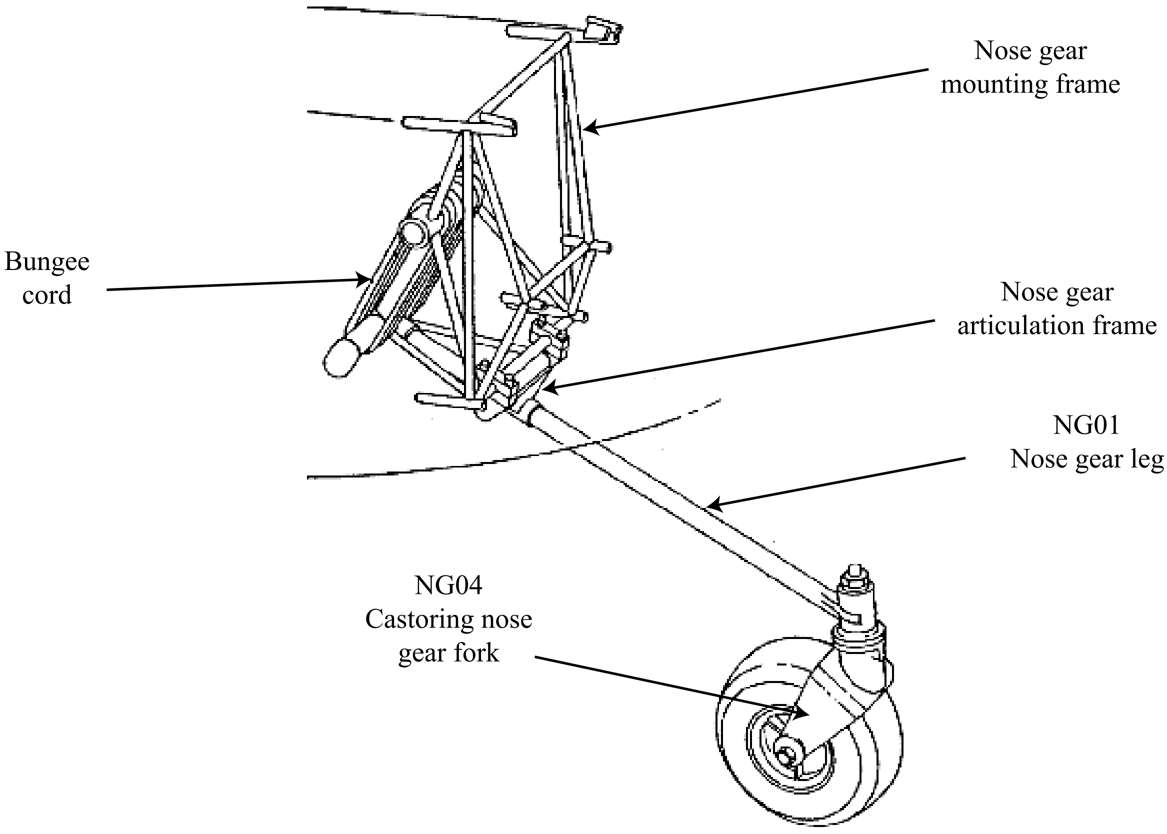


Figure 1

General arrangement of nose gear

Footnote

[1] A pin made from rolling a flat piece of metal with the appearance of a paper scroll

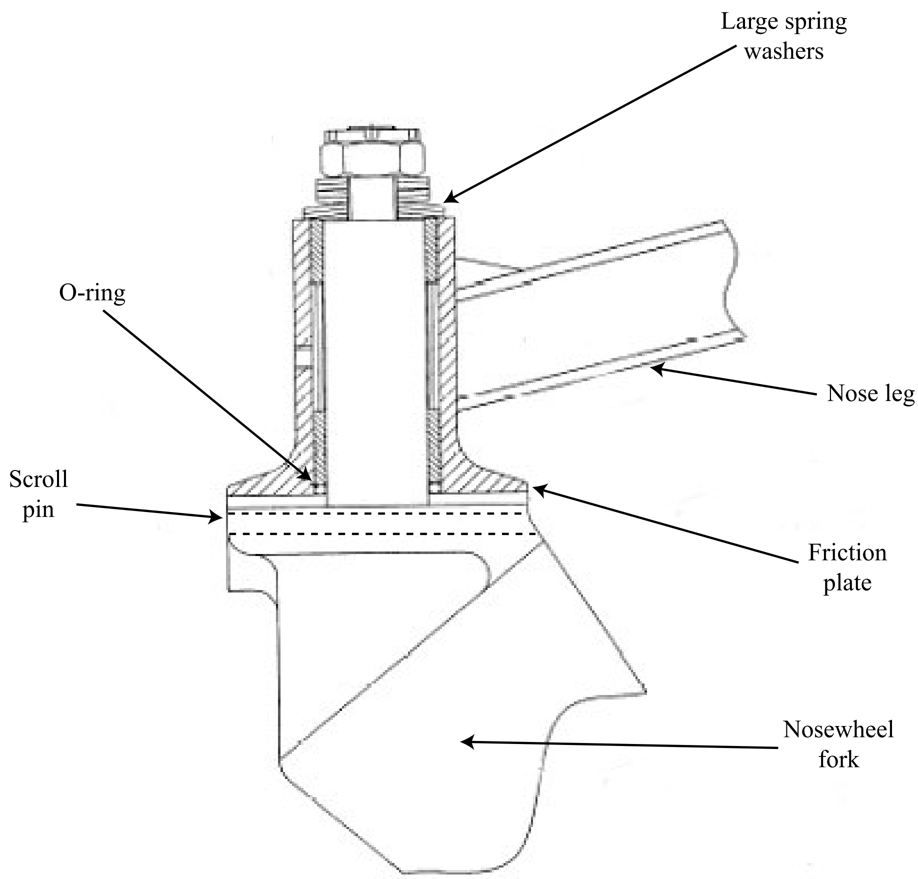


Figure 2

Details of attachment of nosewheel fork to leg

The threaded upper end of the pivot shaft was inserted through a bushed hole within the cylindrical housing and was secured by means of a nut, which tightened down onto a stack of spring washers. These, in conjunction with a friction plate between the fork and the housing, allowed the nosewheel to castor. The spring washers provide shimmy damping, with the level of damping being adjusted by tightening or loosening the nut.

Recent maintenance on the nose gear

The owner, who was also the pilot, had adjusted the shimmy-damper nut on 4 April 2006. Fifteen flights were made between then and the incident flight.

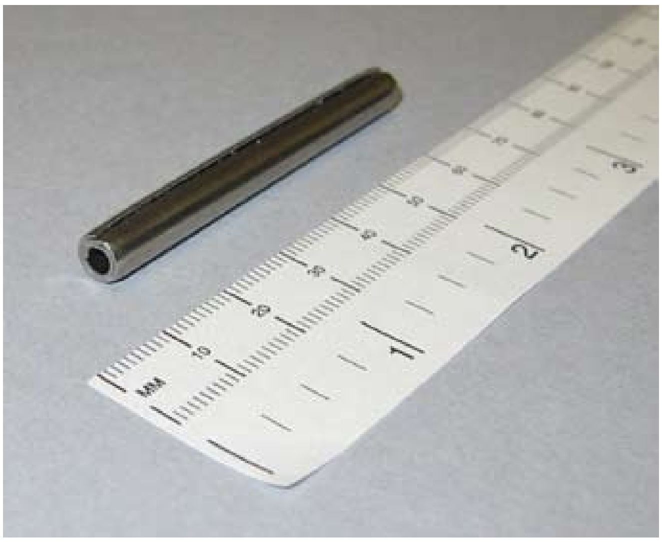


Figure 3

Detail of a scroll pin

Runway marks

The pilot took a series of photographs after the incident to record the ground marks on the runway. There was good physical evidence of the following having taken place (in chronological order):

a) the nosewheel shimmied, approximately 20 m after the nosewheel touched down;

b) the nosewheel fork departed the airframe;

c) the propeller struck the runway, approximately 30 m after the nosewheel touched down;

d) approximately 45 m after the nosewheel touched down, the nose gear leg scraped along the runway for a further 45 m;

e) the nose gear leg entered a small, pre-existing pot hole on the runway;

f) at the same distance along the runway as e), the front underside of the main wheel fairings scraped along the runway;

g) the aircraft stopped 105 m along the runway from the start of the shimmy marks.

The aircraft remained within a few metres of the runway centre line throughout its ground roll.

Examination of the nose gear

The nose gear leg and fork assembly were transported to the AAIB headquarters for detailed inspection. A consultant metallurgist examined the damaged surfaces.

The nose gear leg had deformed plastically downwards, in the opposite direction to that which would normally be expected from loads applied during landing (which, due to the forward rake of the nose leg, would normally deflect the leg forwards and upwards). This deformation probably occurred when the nose gear leg struck the pot hole, causing the gear leg attachment structure in the fuselage to fail and the leg to then rotate rearwards. This is supported by the runway marks near the pot hole which indicated that the aircraft had nosed forward causing the forward underside of the main gear fairings to contact the runway.

The underside of both the pivot shaft and the front of the pivot shaft housing had worn to a 'chisel edge', see Figure 4. This was consistent with the aircraft having rolled along the runway without the nosewheel and nosewheel fork, but with the gear leg swept forward in its normal position.

Figure 4
Pivot shaft housing and nose gear leg

The scroll pin in the pivot shaft had failed in shear due to overload, see Figure 5. The hole in the pivot shaft for the scroll pin had not been drilled accurately across a diameter, see Figure 6. There were also burrs present on the internal surface of the pivot shaft next to the hole for the scroll pin. The hole was not perpendicular to the axis of the pivot shaft, hence the scroll pin was aligned slightly nose down. The off-centre and

Figure 5

Pivot shaft
Note failed scroll pin

Figure 6

Detail of failed scroll pin in pivot shaft

non-perpendicular hole for the scroll pin, and possibly the presence of the burrs, would have compromised the effective strength of the scroll pin.

The lower end of the pivot shaft had expanded the upper part of the hole in the fork by working within it. This probably occurred during the ground roll after the scroll pin had failed. Thus it was not possible to determine the precise dimensions of the diameter of the pivot shaft and the hole in the fork due to damage sustained in the accident.

The spring washers from G-PTAG were inspected and compared with a set of new parts supplied from the manufacturer. Wear on the faces of the washers from G-PTAG was found. The washers were stacked in pairs and their respective heights measured. The height of both the large and small pairs of washers from G-PTAG were over 10% lower than the respective pairs of new parts. This could have been due to overloading of the spring washers.

The metallurgist concluded that the scroll pin had fractured in overload in shear and that the load was applied by tightening the pivot shaft nut during adjustments made to prevent nosewheel shimmying.

Manufacturer's testing

As a result of the incident the manufacturer tested a nosewheel assembly to determine if a scroll pin could fail under the typical loads encountered during maintenance. They reported that 17 ft lbs of torque completely compressed the washers (ie a much higher torque than that required to prevent shimmy), and that the scroll pin withstood 40 ft lbs of torque without being marked.

Previous heavy landing

The aircraft had landed heavily, nosewheel first, approximately three years ago. The nose gear leg was deformed downwards and was subsequently replaced. The fork was inspected by the owner and a PFA inspector, and subsequently fitted to the new gear leg.

Other incidents

On 7 June 2005 a tri-gear Europa, registration G-PUDS, suffered a failure of the scroll pin in shear; ie in overload from a load vertically downwards (see AAIB Bulletin 11/2005). Whilst the pivot shaft was recovered, the investigation was hindered since the nosewheel and nosewheel fork were never found. Such was the distortion in the lower end of the pivot shaft that an overload from a heavy landing or striking an obstruction was considered to be the most likely cause. Also of note was that the lower end of the pivot shaft had an additional hole which would indicate that the pivot shaft had been removed from the fork at some stage.

Analysis

The scroll pin in both this accident and the accident to G-PUDS failed in shear from a load applied downwards on the fork, relative to the pivot shaft.

The source of such a load could be from:

a) Over-tightening of the anti-shimmy nut. The manufacturer's tests indicated that over-tightening of the nut would be unlikely to fail a scroll pin. However the hole for the scroll pin was significantly off-centre, which would have introduced some degree of asymmetric loading;

b) A heavy nosewheel first landing, possibly combined with an uneven surface dragging the nosewheel rearwards (as was probably the case with G-PUDS). G-PTAG had a nosewheel first landing approximately three years ago and this could have caused some damage to the scroll pin;

c) Nosewheel shimmy, and hence high loads in the nose gear components.

The pilot reported that the landing was normal, with no abnormal forces on the nose leg prior to the nosewheel shimmy. The nosewheel shimmy could have been as a result of the nosewheel fork rotating about the pivot shaft, and this could happen if the scroll pin had failed prior to or during the incident landing.

The precise cause of the failure of the scroll pin could not be determined. However there is evidence from this and the G-PUDS incident that the design and manufacture of the fork assembly could be more robust, particularly when the three possible sources of downwards loads described above are considered. As a result of this a recommendation is made to prevent reoccurrence:

Safety Recommendation 2006-146

It is recommended that Europa Aircraft Limited review the design, manufacture and recommended maintenance of the nose gear fork assembly of the tri-gear Europa to improve the integrity of the nosewheel fork attachment.

Safety actions

Prior to finalising this report for publication, and following the distribution of a draft to various parties, including Europa, for comment, Europa has advised the AAIB that the design of the pivot shaft has been revised. It has been modified to increase the length of insertion in the casting and thereby reduce the load on the scroll pin. Also, the tolerances of the shaft and casting bore will be reviewed, and a new material has been specified for the casting. No change to the maintenance requirements was considered necessary by Europa.

In view of this response to the draft report, the AAIB considers that the intent of Safety Recommendation 2006-146 has now been met.

ACCIDENT

Aircraft Type and Registration:	Grob G115E, G-BYWC
No & Type of Engines:	1 Lycoming AEIO-360-B1F piston engine
Year of Manufacture:	2000
Date & Time (UTC):	21 September 2006 at 1555 hrs
Location:	Colerne Airfield, Wiltshire
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to nose and right landing gear, right aileron and wingtip
Commander's Licence:	Military
Commander's Age:	63 years
Commander's Flying Experience:	4,900 hours (of which 411 were on type) Last 90 days - 20 hours Last 28 days - 6 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft landed heavily on the right wheel in gusty crosswind conditions, causing damage to the landing gear and right wing.

History of the flight

The aircraft had carried out a gliding approach to Runway 19 during a practice forced landing, in a recorded wind speed of 150º/18 kt, gusting 25/30 kt. Having flown the final approach at 80 kt, the pilot encountered a gust of wind in the flare and was unable to arrest the rate of descent. The aircraft landed heavily on the right main wheel. He brought the aircraft to a stop, and then cleared the runway and shut down. Damage had been caused to the nose and right main landing gear, the trailing edge of the right aileron and right wing tip.

ACCIDENT

Aircraft Type and Registration:	Gulfstream AA-5B, G-BTII
No & Type of Engines:	1 Lycoming O-360-A4K piston engine
Year of Manufacture:	1979
Date & Time (UTC):	14 January 2007 at 0945 hrs
Location:	Biggin Hill Airfield, Kent
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to both wings of G-BTII and to left wing of an adjacent aircraft
Commander's Licence:	Private Pilot's Licence
Commander's Age:	38 years
Commander's Flying Experience:	108 hours (of which 7 were on type) Last 90 days - 8 hours Last 28 days - 0 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The pilot started the engine and the aircraft began to move forward. Despite the pilot repeatedly operating the toe brakes, the aircraft swung round, resulting in its left wing contacting the left wing of an adjacent aircraft, and its right wing striking the wall of a shed.

Sequence of events

When the pilot boarded the aircraft, it was parked immediately to the right of a Piper PA-28. A small concrete shed was located behind the aircraft, whilst in front, across the apron, were two aircraft hangars.

The pilot completed the internal checks, which included setting the parking brake to ON, before starting the engine. Whilst he did so, he kept his feet on the toe brakes and, after the engine started, he monitored the instruments for several seconds. However, on looking up, he noted that the aircraft was moving and heading towards one of the hangars. He attempted to halt the aircraft by repeatedly applying the brakes, but this only resulted in a 90º turn to the left. Whilst this avoided a collision with the hangar, the aircraft was now heading towards the perimeter fence. The pilot, by now very alarmed, quickly glanced inside the cockpit to locate the throttle and mixture controls, whilst still attempting to brake. The aircraft continued to turn to the left so that it was heading towards the parked PA-28 aircraft, and as it did so, he pulled both control levers fully back, which eventually stopped the engine. Realising that a collision was inevitable, he decided to refrain from additional braking, as any further turn to the left would have resulted in striking the other aircraft with the nose and propeller of his own aircraft. The collision occurred with the left wing of G-BTII sliding under the left wing of the parked aircraft, and the right wing striking the wall of the shed. The pilot vacated the aircraft uninjured.

Examination of the aircraft

Following the accident, one of the co-owners, together with the pilot, took the aircraft onto the apron in order to test the brakes. It was found that the right wheel brake was marginally less effective than the left, although the aircraft could be steered and braked normally at fast and slow speeds. The pilot commented that the aircraft had not flown for a month and that, as it had been parked outside in wet weather, it was possible that the right brake calliper piston had temporarily stuck.

Other information

The pilot supplied video footage from one of the airfield CCTV security cameras that had captured the incident. This took the form of time lapse photographs, taken approximately two seconds apart. The quality was such that it was not possible to discern the point at which the propeller started to rotate during the engine start. However, a sudden, nose-down change in the aircraft attitude was apparent, consistent with the engine starting up and running at a relatively high speed. Two seconds later, the first forward movement could be seen, albeit only a matter of inches. After a further ten seconds, the aircraft had made its 90° turn towards the perimeter fence and the collision with the adjacent aircraft occurred after an additional three to four seconds. Thus the total time, from the first observable movement to the collision took approximately 13-14 seconds.

Pilot's comments

In a candid statement, the pilot noted that the engine was almost certainly running faster than the 1,200 rpm at which it should be set following start. However he did not have a chance to reset the power due to his preoccupation with attempting to avoid a collision. He also commented that when he was pushing on the brake pedals, in his panic, he may have inadvertently applied a combination of brake and rudder. Furthermore, as the parking brake was still set in the ON position, the design of the hydraulic brake system is such that this should have locked out the toe brakes. Nevertheless, the fact that sharp left turns were made during the sequence suggests that the park brake was not fully on, with some left brake pressure being generated by the toe brakes.

Finally, the pilot commented that although, with hindsight, he ought to have cut the engine power a lot earlier, he was reacting to what he perceived to be the immediate priorities of avoiding the hangar and the fence.

ACCIDENT

Aircraft Type and Registration:	Piper PA-28-140, G-BAHF
No & Type of Engines:	1 Lycoming O-320-E2A piston engine
Year of Manufacture:	1971
Date & Time (UTC):	17 December 2006 at 1330 hrs
Location:	Coventry Airport
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Minor damage to outer wings; damage to left hand flaps, door and tail cone of an adjacent Piper Seneca
Commander's Licence:	Commercial Pilot's Licence, with IMC and Instructor ratings
Commander's Age:	49 years
Commander's Flying Experience:	780 hours (of which 127 were on type) Last 90 days - 111 hours Last 28 days - 33 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

On starting the engine, the commander failed to notice that the parking brake had not been set, and the aircraft began to move. The aircraft was not fitted with toe brakes and the brake handle was obscured by the right leg of the student pilot, so he stopped the engine by pulling the mixture control. However, there was insufficient time to prevent a low speed collision with an adjacent aircraft.

History of the flight

The commander briefed his student and a passenger for what was intended to be a trial lesson, before escorting them to the aircraft, which he had earlier pulled out of the hangar. As he was assisting the two people into the aircraft, he observed that the windscreen was rapidly fogging; he then advised them that he would keep the door open until after starting the engine, in an attempt to assist the demisting process.

During engine start, the commander held his feet on the rudder pedals, covering the brakes. After the engine was running, he turned to latch the door, before noticing that the aircraft was moving. He re-applied pressure to the rudder pedals, at which point he realised that this aircraft was not fitted with toe brakes. He then reached for the brake handle with his left hand, but was unable to locate it. In fact the student was blocking access to the handle with his right leg as a result of keeping his feet away from the rudder pedals, as briefed by the commander. In the short time available, the commander stopped the engine by moving the mixture control to the idle cut-off position, but was unable to prevent a low speed collision with an adjacent Piper Seneca.

The pilot summed up the cause of the incident as a combination of the park brake not being set, his inability to locate the park brake handle quickly due to it being obstructed by the student's leg, and the restricted forward vision due to the misted windscreen.

ACCIDENT

Aircraft Type and Registration:	Piper PA-28-140, G-BOSU
No & Type of Engines:	1 Lycoming O-320-E3D piston engine
Year of Manufacture:	1973
Date & Time (UTC):	8 September 2006 at 1615 hrs
Location:	Boughton, private airstrip near Thetford
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 Passengers - None
Nature of Damage:	Damage to right wing and nose leg
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	30 years
Commander's Flying Experience:	318 hours (of which 177 were on type) Last 90 days - 65 hours Last 28 days - 24 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During an attempted departure from a private airstrip the pilot rejected the takeoff and the aircraft ran into a hedge.

History of the flight

The aircraft was being operated from Boughton, a private airstrip near Thetford. The grass runway, 08/26, was 520 m long with a 6 ft hedge at each end and the pilot considered that the grass was short and dry. He had flown the aircraft into the strip but this was his first attempt at a takeoff from it.

The pilot elected to use Runway 08 as the airstrip did not have a significant slope and the wind was almost calm, with a very slight headwind. He was careful to use the full length of the runway as he was aware that the aircraft's nominal performance gave only a small margin for takeoff.

The pilot reported that, about half-way through the takeoff roll, the aircraft seemed to stop accelerating and it felt "as if there was something dragging". He made the decision to reject the takeoff rather than get airborne and risk stalling; as a result, the aircraft ran off the end of the runway and into the hedge. On making the decision to reject the takeoff, the pilot was able to shut down the engine and turn off the fuel before the impact with the hedge.

The pilot reported that the pre-flight checks and pre-takeoff power checks had been normal. He could not positively identify a cause of the lack of acceleration during the takeoff roll, although he considered it possible that the nose tyre had suffered a puncture. The extensive damage to the nose landing gear prevented a positive determination of this.

ACCIDENT

Aircraft Type and Registration:	Piper PA-28-181 Archer II G-BNVE
No & Type of Engines:	1 Lycoming O-360-A4M piston engine
Year of Manufacture:	1984
Date & Time (UTC):	12 July 2006 at 1800 hrs
Location:	Maritime and Coastguard Agency (MCA) Daedalus, Lee-on-Solent, Hampshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 2
Injuries:	Crew - None Passengers - None
Nature of Damage:	Impact damage to left wing and fuselage
Commander's Licence:	Private Pilot's Licence
Commander's Age:	70 years
Commander's Flying Experience:	528 hours (of which 351 were on type) Last 90 days - 18 hours Last 28 days - 6 hours
Information Source:	AAIB Field Investigation

Synopsis

Construction work at the airfield formerly known as HMS Daedalus and Lee-on-Solent, now known as MCA Daedalus, resulted in the erection of a perimeter fence incorporating various gateways for use by aircraft and vehicles. A pilot, unable to find a new grass taxiway, continued to taxi on a metalled perimeter taxiway until coming to one of the gateways, which was only just wide enough for the aircraft. In attempting to pass through the gateway, the aircraft's left wing struck the gate. Although information was available to the pilot about the gate and the new grass taxiway, the entrance to the taxiway was not obvious. Moreover, there was no readily available diagrammatic plan of the airfield illustrating its layout and the positions of obstructions.

History of the flight

The pilot, who had flown from MCA Daedalus in the past, hired an aircraft from one of the clubs based at the airfield for a private flight to Guernsey. Later that day the pilot and his two passengers returned from Guernsey and landed at MCA Daedalus on Runway 23. The pilot taxied the aircraft, which had a wingspan of 11.05 metres, to the end of the runway, vacating to the right onto the airfield's perimeter taxiway. The pilot taxied along the taxiway to the north, looking for a grass taxiway he knew existed but, unable to find it, he continued on the perimeter taxiway. Shortly after passing a hangar used by the SAR helicopter, the pilot became aware of an open set of metal gates with the gateway set at an angle across the taxiway. The pilot attempted to taxi through the gateway but the aircraft's left wing struck the gate to the left of the taxiway, slewing the aircraft around. The pilot stopped the aircraft and shut it down before he and the passengers disembarked.

Airfield details

Part of the ex-government airfield is now owned by the Maritime Coastguard Agency (MCA). It is operated as an unlicensed airfield, primarily for use by the Coastguard Search And Rescue (SAR) helicopter and the Hampshire Police Air Support Unit (PASU), who operate a fixed wing aircraft. There were also two civilian flying training organisations, a gliding club, some aircraft maintenance organisations, and a number of private aircraft based at the airfield. Normally it is only available for use by aircraft based there or visiting for maintenance.

Other parts of the old airfield are being redeveloped as an industrial estate and a fence has been constructed protecting the area still used as an airfield. The position of this fence had not been finalised due to the progressive nature of the construction work. Completion of the fence was anticipated early in 2007.

Because the new industrial estate still had some aircraft related activity, a means for aircraft to cross from the industrial estate to the airfield had been devised. At the time of the accident the fence crossed taxiways at various points and gateways had been installed to allow access to the operational part of the airfield. The purpose of one gateway was to allow access to the airfield by aircraft that were, at the time, kept on an area outside the perimeter fence. A mown grass taxiway was created to allow aircraft to bypass a gateway on the eastern side of the airfield in the area of the Coastguard hangar. The taxiway was unmarked except where it crossed a road approximately half way along its length. The mown area had been extended in the vicinity of the Coastguard hangar to facilitate helicopter operations.

Day to day operation of the airfield is the responsibility of the PASU which has provided organisations using it with information about the fence and gateways. This information included photographs of the airfield with the positions superimposed. An airfield description document, (locally called the airfield manual), was also amended early in 2006 with relevant written information, although the plan of the airfield was not updated to show positions of the fence, gates or grass taxiway. The amendment was dated April 2006 and the document stated that the gate, subsequently struck by the aircraft, was '*only 12 metres wide*'. It also stated that it is '*the pilot's responsibility to ensure that his/her aircraft can safely negotiate this gate*'.

The Airfield Manager reported that the gate had also been hit on two occasions by another pilot when trying to pass through it in the opposite direction to this event, scraping the wing tip on each occasion. As a result of this accident and these other incidents, the airfield manual has been further amended to prohibit aircraft from using the gateway involved. This amendment is also dated April 2006, although it was published after the previous amendment bearing the same date.

The airfield description document states that visiting aircraft are accepted only when specifically authorised by the Airfield Manager (the civilian pilot in the PASU) or the Airfield Duty Officer (also a PASU staffed position) and only when pilots have been briefed by their sponsoring organisation. However, the AAIB investigator was unable to obtain a plan of the airfield illustrating the position of the fence, gateways or grass taxiway from the MCA, the PASU or the organisation from which the aircraft had been hired. The only plan that could be obtained, on the advice of the PASU, was from the local council's planning department showing the position of the fence as part of a planning application.

Safety standards at unlicensed airfields

The Civil Aviation Authority has issued guidance to owners and operators of unlicensed airfields in CAP 428 '*Safety Standards at Unlicensed Airfields*.' Being unlicensed, MCA Daedalus does not feature in the UK Aeronautical Publication but Chapter 3 of CAP 428 invites unlicensed aerodrome owners to consider publishing aerodrome details in one of several commercially produced airfield guides. Moreover, paragraph 5.4 of Chapter 4 states:

> *'If the aerodrome does not feature in any aeronautical publications, a procedure should be developed whereby visiting pilots are warned of hazards prior to arrival'.*

The Airfield Manager stated that there was no intention of publishing details of the airfield in any guide until work on the airfield is complete in 2008. To do so any earlier would result in published information not necessarily reflecting the true state of the airfield. Instead, visiting pilots are verbally briefed by the duty officer as part of the process for obtaining the required prior permission to land before leaving their aerodrome of departure.

Analysis

Information was available to the accident pilot describing the position of the gate and the limited width of the gateway. There was also a picture showing the position of the gate and the grass taxiway in the briefing area of the organisation from which the aircraft was hired.

The pilot was aware of the existence of the grass taxiway but it is likely that he failed to find it due to a lack of any obvious marking at its entrance. It is also possible that the entrance was disguised by the widely mown area at its junction with the perimeter taxiway, next to the Coastguard hangar. Having missed the taxiway, the pilot continued towards the gate but misjudged the position of the aircraft in relation to the gateway, partly due to the staggered nature of the gate. The wingspan of the aircraft was only 0.95 of a metre narrower than the gateway so any small error in the positioning of the aircraft would result in a collision. The nature of the aircraft damage also suggests the aircraft had not been slowed to a speed commensurate with the manoeuvre being attempted.

Although the use of MCA Daedalus is largely restricted to locally based aircraft, there is significant flying activity at the airfield. There are also likely to be a small number of visitors to the Daedalus-based maintenance organisations who are not familiar with the airfield layout.

Safety action

The prohibition placed on aircraft using the gate involved in the accident places an enhanced requirement on the airport management to ensure that the grass taxiway is clearly marked for those now required to use it. This requirement was suggested to the PASU whose representative stated that it was not possible to mark the taxiway due to the problems of helicopter operations in the vicinity. Nevertheless, if the grass taxiway is an important part of the manoeuvring area of the airfield, an acceptable means of clearly marking its presence should be provided in order to minimise ground collisions with obstacles.

The Airfield Manager considered that, due to the constantly changing nature of the work, it was not practical to publish a plan. This was because anything that was published was likely to remain valid for only a few days at most. Instead, the frequent changes to the airfield layout were communicated to the relevant parties by e-mail. The date of the e-mail served as the date of the amendment. Finally, it was intended to produce a final airfield document once the construction work was completed. In view of these issues the following safety recommendation was made:

Safety Recommendation 2007-035

The Maritime Coastguard Agency should require its airfield operator at MCA Daedalus to take the following actions:

a. Apply appropriate markings to the grass taxiway in the vicinity of the Coastguard hangar to delineate its boundaries for the safe manoeuvring of aircraft.

b. On completion of the fence construction work, publish an up-to-date plan of the airfield that includes the position of the new perimeter fence, gateways and grass taxiways.

ACCIDENT

Aircraft Type and Registration:	Piper PA-28R-200 Arrow II, G-ELUT
No & Type of Engines:	1 Lycoming IO-360-C1C piston engine
Year of Manufacture:	1974
Date & Time (UTC):	17 September 2006 at 1202 hrs
Location:	Old Sarum Airfield, Wiltshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to fuselage underside and propeller tips
Commander's Licence:	Private Pilot's Licence
Commander's Age:	57 years
Commander's Flying Experience:	423 hours (of which 203 were on type) Last 90 days - 14 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

The aircraft landed on its belly and slid along the grass runway because the pilot omitted to extend the landing gear.

History of the flight

The aircraft was on a cross-country flight from Goodwood to Old Sarum. The weather was good with no cloud and visibility greater than 10 km. The pilot joined the Old Sarum circuit by descending on the 'deadside' (non-active part of the circuit) and joining on the crosswind leg for a right-hand circuit to land on Runway 24 (grass). Once established 'downwind' he carried out his normal 'downwind' checks but forgot to lower the landing gear. There was one aircraft ahead of him in the circuit and he was aware of another aircraft behind him. Once established on 'final' he carried out his 'final' checks which included confirming: fuel pump ON, landing light ON, propeller rpm 'full forward' and full flaps, but he forgot to check for three green 'landing gear down and locked' lights. At this point the aircraft ahead of him had landed and vacated the runway.

At a height of approximately 50 feet the pilot heard "GO ROUND" over the radio, followed shortly thereafter by another call of "GO ROUND, GO ROUND". The pilot checked the runway ahead and it was clear so he assumed the call was for the aircraft behind him. He proceeded with the landing and the aircraft touched down gently on its belly, slid across the grass surface, and then left the runway to the right before coming to rest. The pilot and his passenger were able to exit the aircraft normally. There was no fire.

Report from the airfield radio operator

The radio operator on duty, who was in the tower of the airfield at the time of the accident, reported that the accident occurred on a busy day. He heard the pilot of G-ELUT report on 'final' but when he looked up at the aircraft and noticed no visible landing gear legs, the aircraft was already very close to the ground. He called for the aircraft to "GO ROUND" and when he saw no change in its flight path he repeated "GO ROUND, GO ROUND", but at this point the aircraft was just 30 feet from touchdown. He reported that if he had had another 10 seconds to react, he could have looked down at his data strip for the aircraft's registration and said "UNIFORM TANGO GO ROUND". He also reported that when he knows that there is a retractable-gear aircraft in the circuit, he has a practice of looking for the landing gear when the aircraft is on final. In this case he was not aware that G-ELUT had retractable landing gear because the aircraft's full type designation PA-28R-200 was not given by the pilot during his initial call to the airfield (the 'R' in 'PA-28R' indicates 'retractable').

Discussion

The accident occurred as a result of the pilot omitting to lower the landing gear and forgetting to check for three green 'down and locked' lights and an opportunity to avoid the accident was missed when the pilot believed that the "GO ROUND" call from the radio operator did not apply to his aircraft. However, responsibility for ensuring that the landing gear is down and locked rests with the commander of the aircraft.

The aircraft's automatic gear extension system in G-ELUT had been disabled and the pilot did not recall hearing the gear warning horn. The pilot stated that it was his normal practice to say "THREE GREENS" over the radio when he made his 'final' call, but on this occasion he omitted this check as well. Routinely saying "THREE GREENS" when making the "final" call can serve as a reminder to the pilot to check for 'three greens'; it also alerts the radio operator or tower controller that the aircraft has retractable landing gear. Workload permitting, they can then visually check that the landing gear is extended.

ACCIDENT

Aircraft Type and Registration:	Pulsar, G-BUDI
No & Type of Engines:	1 Rotax 582 piston engine
Year of Manufacture:	1994
Date & Time (UTC):	13 October 2006 at 1328 hrs
Location:	Popham Airfield
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to propeller, nose landing gear and engine mountings
Commander's Licence:	Private Pilot's Licence
Commander's Age:	60 years
Commander's Flying Experience:	228 hours (of which 111 were on type) Last 90 days - 3 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and metallurgical examination of the failed component

Synopsis

After a normal touchdown the nose landing gear failed. The separation resulted from fatigue damage induced by cyclic bending due to normal operating loads on the landing gear.

History of the flight

The pilot carried out a standard approach and landing onto Runway 08 at Popham. During the flare he continued to apply back pressure on the control column to allow the nosewheel to lower gently onto the grass. As the nose landing gear touched down the aircraft pitched down and came to rest on the propeller. The sole occupant exited the aircraft without injury.

Description of the nose landing gear

The nose landing gear strut on this type of aircraft consists of a thick-walled square tube, with a castoring nose wheel assembly attached to the lower end (see Figure 1). Near the top of the strut a drag brace is attached, which runs forward to the central longitudinal member of the engine mount assembly. This longitudinal member is welded to lateral bracing tubes. Some aircraft, including G-BUDI, have a damper incorporated with the drag brace.

Metallurgical examination

The longitudinal engine mount tube had failed at the location of the weld attaching it to the rear lateral

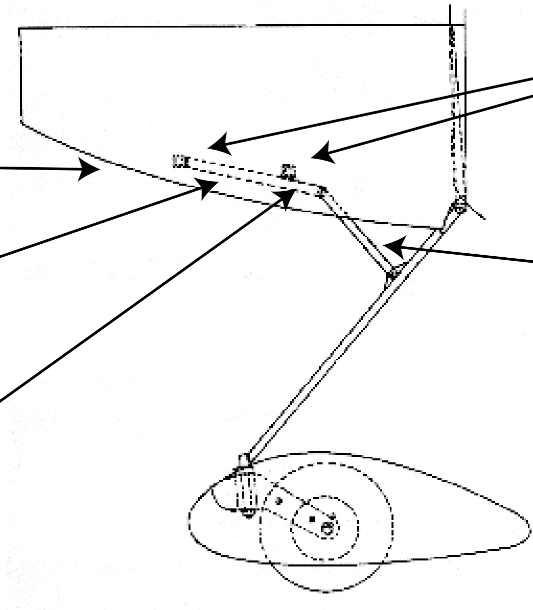


Figure 1

Nose landing gear and engine mount assembly

bracing tube. The engine mount, together with the drag brace, was returned to the AAIB for metallurgical examination (see Figure 2).

Magnetic tests on the tubing showed that it had been manufactured from ferro-magnetic steel. The failure had developed from multiple fatigue initiations across the majority of the tube face. The face had been extensively mechanically damaged during and after separation (see Figure 3) but it was evident that multiple, relatively low-cycle, fatigue initiations had occurred along the top edge where the weld had been located. It was concluded that the separation resulted from fatigue damage induced by cyclic bending due to normal operating loads on the landing gear.

Aircraft information

G-BUDI was built in 1994, since when it had accumulated 114.55 hours. The aircraft has been flown by the current owner since it was built and is operated from the grass airfield at Popham. It had previously been operated from a paved runway and taxiways at Blackbushe.

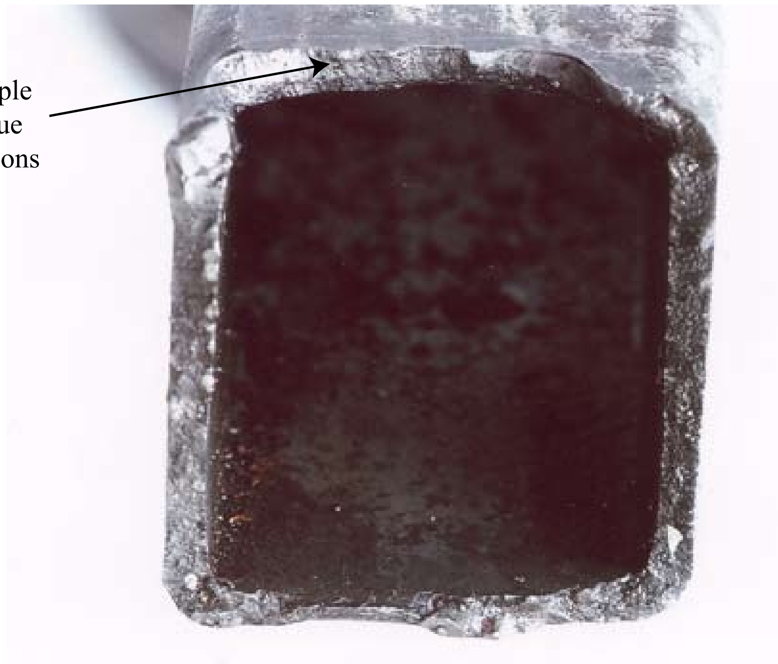
(Photo: H T Consultants)

Figure 2

Failed engine mount tubing for G-BUDI

Previous accident

A previous accident occurred to a Gill SA Pulsar, G-BSFA on 14 August 2002 at Staverton, which resulted from the loss in flight of the nosewheel. The AAIB report, EW/G2002/08/13 published in AAIB Bulletin 2/2003, described a fatigue failure of the nosewheel pivot pin. Examination of the failed pin indicated that the failure was the result of a fatigue process, with multiple initiation sites. There was thus no evidence to suggest that a single event, such as a heavy landing had been responsible for the initiation. The report concluded:



(Photo: H T Consultants)

Figure 3

End-on view of fracture face from G-BUDI

> *'In the absence of any evidence indicating that this aircraft had been operated in a radically different way to others in the UK, it was concluded that the failure resulted from typical in-service loads. This posed the question of whether the design was suitable for operation from all but the smoothest of surfaces and, as a consequence, whether a 'safe life' should be imposed on the nose landing gear. It should be noted that the nature of the installation is not conducive to a reliable inspection method for discovering cracks in the pin.'*

G-BSFA had achieved more than 300 flying hours, which was high relative to the other 20 or so aircraft on the UK register. Although at the time of the accident the aircraft was based at Staverton, which has paved runways and taxiways, it was previously operated as a demonstration machine from a grass airfield.

The following Safety Recommendation was made as a result of the investigation:

> ***Safety Recommendation 2003-06***
>
> *It is recommended that the Popular Flying Association conduct a design review of the nose landing gear as fitted to Pulsar aircraft on the UK register and liaise with the Experimental Aircraft Association (EAA) in the USA on this matter.*

No response to this recommendation was received.

Safety action

The PFA Type Acceptance Data Sheet (TADS) 202 has now been re-issued, dated 02/02/07, with the addition of a reference to the problems experienced with Pulsar noseleg failures. The salient information from Section 12 is reproduced below:

> *'Noseleg failures have occurred due to failure of early type 5/8" diameter noseleg castor pivot pins. As a result, improved pivot pins were introduced by Aerodesigns with diameter increased to 3/4".*

Aerodesigns manufactured 3/4" diameter pivot pins were made removable from the leg, whereas the earlier 5/8" diameter pins by Aerodesigns, and the later Skystar produced 3/4" diameter pins were welded integral with the noseleg. Check carefully for signs of bending/cracking of noseleg pivot pins particularly if they are of the earlier 5/8" diameter design and particularly following any heavy landing.

Noseleg failures have occurred due to the square steel tube support stub for the front noseleg suspension strut failing through fatigue where it is welded to the forward engine mounting cross-beam. The tube concerned is the one which runs fore and aft on the aircraft centre line, linking the front and rear cross beams, and projects aft to provide a mounting for the front noseleg strut. Check carefully for signs of bending or cracking of this square tube where it passes underneath the forward cross beam, especially following any heavy landing and especially if the early type fixed-length support strut is used rather than the later suspension spring link. This does not apply to the Pulsar XP which has a different noseleg suspension strut mounting arrangement'.

The PFA intend to issue a bulletin to Pulsar owners calling for a reinforcement of the nose leg support stub. This will be mandatory for the issue or renewal of a Permit-to-Fly.

ACCIDENT

Aircraft Type and Registration:	Rans S10, G-OEYE
No & Type of Engines:	1 Rotax 582 piston engine
Year of Manufacture:	1991
Date & Time (UTC):	15 October 2006 at 1705 hrs
Location:	Otherton airfield, Staffordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Minor) Passengers - 1 (Minor)
Nature of Damage:	Severe damage to wings and tail, beyond economic repair
Commander's Licence:	Private Pilot's Licence
Commander's Age:	47 years
Commander's Flying Experience:	934 hours (of which 125 were on type) Last 90 days - 15 hours Last 28 days - 12 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

Whilst taking off from a grass airstrip, the aircraft's engine failed just as it became airborne. The pilot failed to maintain airspeed and the right wing dropped, resulting in a 'cartwheel'.

History of the flight

The aircraft was taking off on grass Runway 07 for a local flight. Although the pre-takeoff checks had been normal, a few seconds after rotation, approximately halfway along the runway, the engine lost power and then stopped. The pilot admits that he then did not manage his airspeed properly, resulting in a stall and dropping of the right wing. As the wingtip touched the ground it swung the aircraft through more than 90° in a 'cartwheel' to the right before coming to rest. The pilot suffered a broken ankle, the passenger cuts to the head and bruising, and both were taken to hospital. Despite the extensive damage to the flying surfaces, the cockpit was "remarkably undamaged" according to the pilot.

No reason for the engine stopping has been found but the pilot believes that his lack of preparedness for the engine failure, and consequently having no plan what to do should it happen, was a major factor in the accident.

ACCIDENT

Aircraft Type and Registration:	Van's RV-9A, G-CCZT
No & Type of Engines:	1 Lycoming O-320-E2A piston engine
Year of Manufacture:	2004
Date & Time (UTC):	16 April 2006 at 1525 hrs
Location:	Bicester Airfield, Oxfordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to the nose landing gear, propeller and the engine area
Commander's Licence:	Private Pilot's Licence
Commander's Age:	62 years
Commander's Flying Experience:	137 hours (of which 45 were on type) Last 90 days - 1 hour Last 28 days - 1 hour
Information Source:	AAIB field investigation

Synopsis

Whilst initiating the landing flare the dual cockpit control stick became disconnected from the flying control system and the aircraft pitched nose down. It impacted the grass runway damaging the nose landing gear, propeller and engine mountings and cowling.

History of the flight

The aircraft was being handled by the 'passenger' (who also held a Private Pilot's Licence and had nearly completed construction of his own Van's RV-9A) from the right-hand seat. After a normal approach and finals, which were flown at approximately 65 kt, he started to flare the aircraft when the control stick became disconnected from the flying control system. The aircraft, which was trimmed for the approach, pitched to a nose-down attitude. The nose landing gear struck the ground causing it to collapse and dig into the surface of the grass airfield. This allowed the propeller to strike the ground and the aircraft to pitch forward onto its nose. The aircraft stopped abruptly and then fell backwards onto its main landing gears. Both occupants evacuated the aircraft with no injuries.

Engineering investigation

The right-hand control stick, also known as the dual control stick, was attached to the flying control system by the lower section of the tubular stick sliding into the inside of a tube (protruding upwards from the forward seat area) connected to the flying control system (Figure 1). The control stick was held into the protruding tube by the friction associated with the 'push fit' between the two tubes. There was no positive secure connection, such as, for example, a bolt between the control stick and the tube of the flying control system.

The aircraft manufacturer's drawings did not specify any positive secure connection between the dual control stick and the aircraft's flying control system.

Safety action taken

The Popular Flying Association (PFA) is the organisation authorised to oversee homebuilt aircraft in the UK, covering design assessment, build standard, recommendation for the issue of the Permit to Fly and continued airworthiness. The PFA issued mandatory airworthiness information MOD/320/002 on 19 May 2006 requiring a nut and bolt to be installed at the junction of the dual control stick and the aircraft's flying control system on all Van's RV-9/9A aircraft. During the PFA's research they found that the Van's RV-7/7A aircraft had a similar arrangement for the attachment of the dual control stick as that of the RV-9/9A. On 19 May 2006 the PFA issued mandatory airworthiness information MOD/323/001 requiring a nut and bolt to be installed at the junction of the dual control stick and the aircraft's flying control system on all Van's RV-7/7A aircraft.

The PFA has added a note regarding this accident and the mandatory airworthiness information in the Van's aircraft incidents and defects section of SPARS, which is the 'Note**S** to **P**FA **A**irc**R**aft In**S**pectors'. The PFA has also issued a PFA Safety Alert regarding the security of control columns in all PFA aircraft which will be published in the PFA magazine.

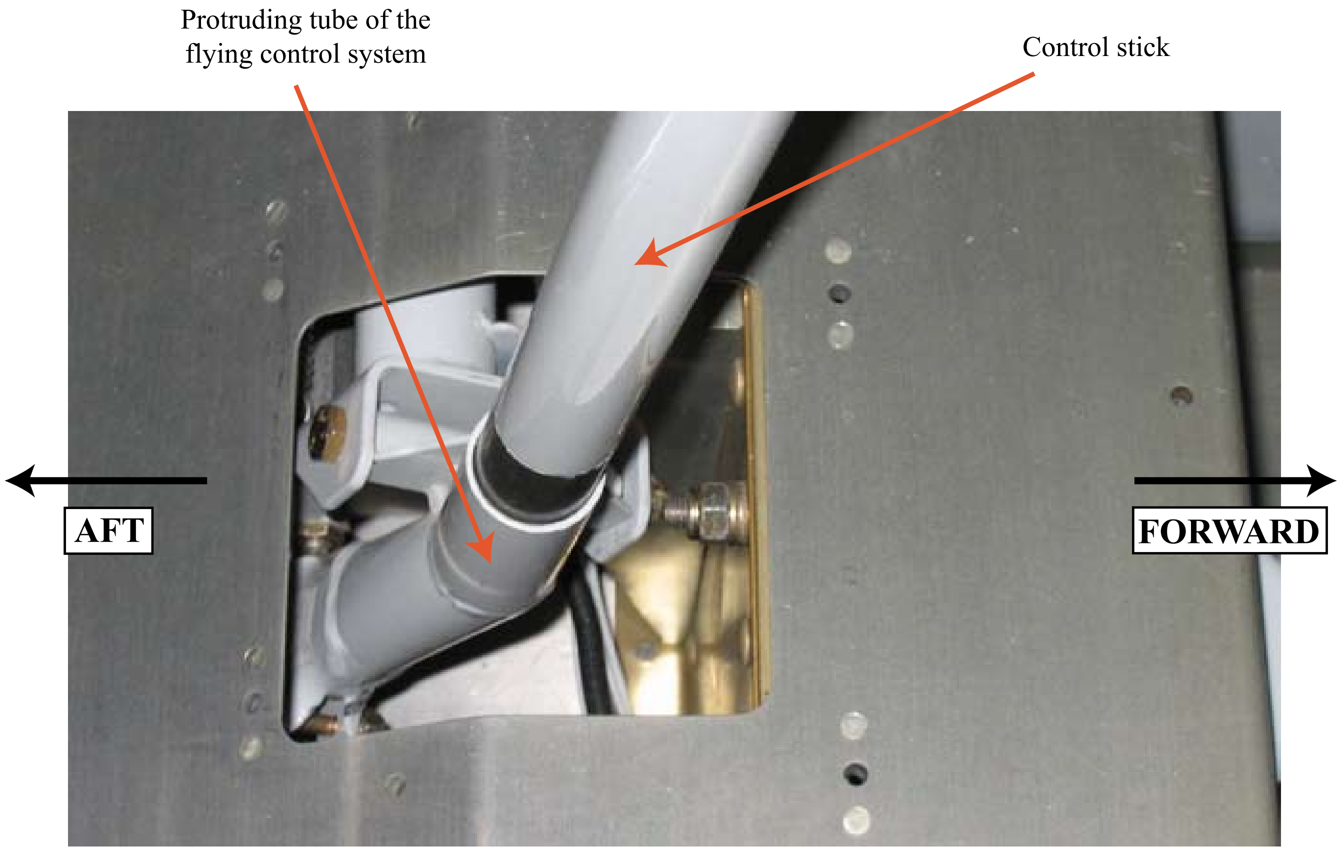


Figure 1

Safety Recommendations

Safety Recommendation 2006-110

It is recommended to Van's Aircraft, the producer of the drawings and aircraft kits, that they modify their drawings for the RV-7, -7A, -9 and -9A models to introduce a positive attachment of the dual cockpit control stick to the aircraft's flying control system.

Safety Recommendation 2006-111

It is recommended to Van's Aircraft, the producer of the drawings and aircraft kits, that they issue a Service Bulletin recommending to all owners of RV-7, -7A, -9 and -9A aircraft that they positively attach the dual control stick to the aircraft's flying control system.

ACCIDENT

Aircraft Type and Registration:	Robinson R22 Beta, G-OLIZ
No & Type of Engines:	1 Lycoming O-320-B2C piston engine
Year of Manufacture:	1988
Date & Time (UTC):	30 October 2006 at 1439 hrs
Location:	Falhouse Lane, Whitley, Dewsbury, West Yorkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Extensive
Commander's Licence:	Private Pilot's Licence
Commander's Age:	41 years
Commander's Flying Experience:	103 hours (of which 20 were on type) Last 90 days - 8 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During the initial climb at slow speed, the pilot was aware of the engine seeming to "splutter" and he increased the collective input. The low rpm horn then activated and, assuming an engine failure, the pilot lowered the collective and carried out a forced landing into some trees. The helicopter was extensively damaged during the landing. No malfunction was subsequently identified with the engine and the pilot considered that the apparent engine problem may have been the result of carburettor icing.

History of the flight

The pilot had planned a local flight from his private helicopter site. The weather was good with an air temperature of 14ºC. Using a windsock positioned on top of a hangar adjacent to the site, the pilot assessed the surface wind as north to north-westerly at less than 10 kt.

Engine start was normal and the pilot allowed the engine to warm up for approximately 10 min. He then checked the carburettor heat function and applied partial carburettor heat before hover taxiing G-OLIZ backwards to maximise his takeoff run. In accordance with his normal procedures, the pilot planned to avoid some neighbouring properties and so he used a north-easterly departure direction. For the departure, the pilot used almost maximum rated power in order to clear a line of trees, which were approximately 25 ft high. He was aware that the helicopter was close to the tops of the trees as he cleared them with the airspeed at about 25 kt. As he crossed the trees, the pilot heard the engine “splutter”. He immediately pulled on the collective control, while also switching off the rpm governor and pulling the carburettor heat control to maximum. He was then aware of hearing the low rpm horn sounding together with the helicopter yawing to the right. He assumed the engine had failed and so he responded by lowering the collective control. At an estimated height of 30 to 40 ft agl, the pilot had no option other than to prepare for a forced landing and he aimed for some trees in an attempt to cushion the ground impact. The helicopter struck a large tree, turned through about 180º and landed on its right side. The pilot was able to get out through the passenger door. Once outside, there was a strong smell of fuel and so he reached back into the cockpit to close the fuel shut-off valve and turn off the electrics master switch.

Post accident assessment

The helicopter was extensively damaged but no pre-impact engine malfunction was identified. On reflection, the pilot considered that the initial engine problem probably resulted from carburettor icing. His subsequent action of increasing collective input would have caused a reduction in rotor rpm. At the time, the combination of low airspeed and low height meant that G-OLIZ was in the avoid area of the height/ velocity diagram with little possibility of a successful forced landing.

Since the accident, the pilot has cut off the tops of the trees in the area surrounding his helicopter site. He has also increased the height of his windsock to give a more accurate indication of the surface wind.

ACCIDENT

Aircraft Type and Registration:	Robinson R44 Raven, G-GGRH
No & Type of Engines:	1 Lycoming O-540-F1B5 piston engine
Year of Manufacture:	2006
Date & Time (UTC):	16 September 2006 at 1016 hrs
Location:	Burnwynd Farm, Strathaven, Lanarkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Minor) Passengers - 1 (Minor)
Nature of Damage:	Aicraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	41 years
Commander's Flying Experience:	172 hours (of which 172 were on type) Last 90 days - 42 hours Last 28 days - 14 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

The pilot had been waiting for fog to clear at his private site so that he could depart on his intended flight. Having assessed that the visibility had improved and was suitable for the flight, the pilot and his passenger took off but the helicopter quickly entered cloud. The pilot managed to regain visual flight references and attempted to make a precautionary landing but the helicopter collided with some trees which he had not seen due to the impaired visibility.

History of the flight

The pilot was due to fly with a passenger from a private site near Strathaven to the Mull of Kintyre, some 60 nm to the west. The pilot's intended route took him close to Prestwick Airport which was about 20 nm west of the departure site.

The private site had been affected by fog early in the morning but the pilot reported this had cleared by about 0945 hrs. Having checked the weather forecast and made a visual assessment of the local weather shortly after this time, the pilot believed the weather was suitable for the proposed flight. He took off with his passenger at about 1000 hrs, climbing to the west. On climbing through about 500 ft agl the helicopter entered cloud and so the pilot began a descent to regain visual references. He was able to regain visual contact with the ground but because the local visibility was considerably reduced, he decided to make a forced landing in a field, about 2 nm from his point of departure. The pilot made a run-on landing in the field, but due to the poor visibility, he was unaware of a hedgerow containing some trees ahead of the helicopter. The fuselage passed between two of these trees but the main rotor blades struck both trees, destabilising the helicopter and starting a process of structural disintegration. The severely damaged helicopter came to rest on its side in the field about 50 m beyond the trees. The two occupants were able to climb out, unassisted, having sustained only minor injuries.

Weather

On the morning of the accident the pilot checked the weather for his flight and stated that shortly before takeoff, Prestwick Airport was reporting variable light winds, visibility in excess of 10 km and no cloud below 10,000 ft. The pilot also made a local assessment of the weather and was able to see some hills to the south-east which were about 15 km away.

The forecast (TAF) and actual (METAR) weather conditions for Prestwick Airport, available to the pilot, were as follows:

TAF: EGPK 160906Z 161019 VRB05KT CAVOK=
METAR: EGPK 160920Z VRB 02KT CAVOK 16/11 1014=
EGPK 160950Z 01004KT CAVOK 16/12 1013=

These describe both the forecast and actual visibility for the period of the flight as 10 km or more and no significant cloud below 5,000 feet.

A subsequent Met Office aftercast for the area stated the following:

'Close inspection of the synoptic charts and actual reports between 0600 and 1000 UTC show a moist low level easterly flow covering the Scottish Borders and the Forth-Clyde valley area. This was feeding much low cloud, mist and hill fog into eastern Scotland, northern England, the Scottish Borders and the Forth-Clyde valley areas. It is likely, however, that in the far west of the Borders around Strathaven/Prestwick area, that there were some good breaks in this lower cloud and the 'line' between the good/bad weather could well have been over, or very close, to the launch site. To the east of Strathaven, there was much low cloud and this will have advected towards the Strathaven area during the hours prior to the accident.'

Analysis

The pilot relied upon his own observations of the local area for assessing the suitability of the weather for his departure. The reported weather conditions at Prestwick reinforced the pilot's view that the visibility and cloud base along his route were suitable for the flight at the time he took off. Prestwick was, however, some 20 nm away and his personal observations would have been unable to determine whether fog or low cloud remained to the west, outside the immediate area of his departure point.

Without suitable training to fly under instrument flight conditions, once the aircraft entered cloud the pilot tried to regain visual flight conditions by descending. He was then aware that the weather was unsuitable to continue the flight so he decided to make a precautionary landing without delay. The fact that he was unaware of the hedge until it was too late to stop is indicative of insufficient visibility for flight by visual references.

Conclusion

This accident highlights the difficulty in accurately judging local weather conditions without suitable equipment. This is particularly so when considering fog, which may be patchy in nature, or low cloud with a base height that is difficult to determine. Due caution should be exercised when such conditions exist.

ACCIDENT

Aircraft Type and Registration:	Cameron Z-350 Balloon, G-CCSA
No & Type of Engines:	Burners: Quad Shadow CB 2256-2
Year of Manufacture:	2004
Date & Time (UTC):	10 May 2006 at 1947 hrs
Location:	Talywain, Pontypool, Wales
Type of Flight:	Public Transport (Passenger)
Persons on Board:	Crew - 1 Passengers - 14
Injuries:	Crew - 1 (Serious) Passengers - 1 (Serious) 13 (Minor)
Nature of Damage:	Damage to basket
Commander's Licence:	Commercial Pilot's Licence (Balloons)
Commander's Age:	50 years
Commander's Flying Experience:	1,133 hours (963 on type) Last 90 days - 12 hours Last 28 days - 12 hours
Information Source:	AAIB Field Investigation

Synopsis

Although the forecast included a 30% probability of thunderstorms, the local weather conditions were fine when the balloon launched from a field outside the town of Monmouth. About 40 minutes into the flight some of the occupants of the balloon basket observed lightning to the south and east. Approximately 15 minutes later, prompted by the sound of thunder, the pilot made an approach to land in the area that he had previously selected for the end of the flight. This approach was abandoned because of fluctuating winds and the presence of wires across the landing path. Another attempt to land was aborted before the pilot made an emergency landing in gusty wind conditions onto uneven ground. During the hard landing the pilot and one passenger received serious injuries and the other 13 passengers sustained minor injuries. Following the accident the operator reviewed their decision-making procedures prior to take off. Two recommendations regarding the operator's procedures and safety equipment have been made.

History of the flight

The balloon took off from a field next to the town of Monmouth at 1830 hrs. The pilot reported that the meteorological forecast had predicted a 30% probability of thunderstorms in the area but that the sky was clear with no thunderstorms visible when they took off. During the journey to the launch site he had discussed the weather with the operator's chief pilot, who was watching its development on weather radar imagery on the Met Office's website and, on arrival at the launch site, the pilot decided that the flight would go ahead. It was planned to last one hour and the wind velocity was such that he expected to land in the vicinity of Betts Newydd, which is 9 nm to the west-south-west of Monmouth and 5 nm to the north-east of Pontypool.

The pilot told the passengers that there were storms in the vicinity of Swindon and Swansea but they all remembered the weather being fine when they took off. About 40 minutes into the flight some of the passengers recalled seeing lightning to the south, in the direction of the Bristol Channel, and to the east.

The flight was reported to have been uneventful for the first 55 minutes and the pilot then made an approach to land in a position 1 nm to the west-south-west of Betts Newydd. Afterwards, he recollected that he had been prompted to make preparations for this attempt to land, which included briefing the passengers, when he heard the sound of thunder. During the approach the wind veered and increased and the balloon became more difficult to control. In addition, there were power cables ahead, across the balloon's intended track, so the pilot aborted the landing and initiated a climb. Some of the passengers reported that during the climbout the balloon basket clipped the tops of some trees.

Over the next 15 minutes the weather conditions deteriorated rapidly. The pilot made another attempt to land but, again, had to abort it because of rapid changes in the wind direction and more power cables. By this stage the balloon had reached the northern end of Pontypool, the wind was very gusty. There was a steep ridge of hills ahead, over which the pilot was concerned that the wind might increase still further. Consequently, he decided to make an emergency landing on uneven land on the north-west side of Pontypool.

The pilot instructed the passengers to adopt the landing position, which involved sitting on their bench seats holding on to a rope handle, with their heads back against the side of the basket and nothing around their necks. He recalled the final part of the approach being made in very turbulent conditions, at a speed of 15 to 20 kt across the ground. The balloon's burners were used to control the rate of descent, which the pilot reported as being between 300 and 400 fpm. Just prior to the landing the balloon basket struck a tree and one of its branches struck a passenger, causing a laceration above his left eye. The basket then landed hard on uneven ground, rolled on to its side and was dragged across the surface on to more level ground before stopping. The passengers remained in the basket, which was damaged, but were in distress.

During the landing the pilot sustained a broken ankle. He had difficulty walking and remained with the basket. Initially, he thought that he was the only one who was injured and that a few of the passengers were dazed and shaken. After being cleared to exit the basket, some of the passengers helped to gather in the balloon canopy, while others sat and then lay down. It was reported by some of the passengers that two of their number were rendered temporarily unconscious.

In the meantime, one of the passengers had called the emergency services. Their arrival, after about 10 minutes, coincided with a heavy downpour of rain and some of the passengers were taken to local houses for protection. Subsequently, the pilot and all of the passengers were taken to hospital for examination. One of the passengers had suffered cracked ribs and all the other passengers sustained a variety of neck and back strains and bruising. Also, a number of them complained of headaches following the accident.

Local residents, who had observed the balloon landing, were some of the first on the scene to assist the pilot and passengers, before the emergency services were able to arrive. The retrieval crew were in the vicinity of the landing site, liaising with the land owners, and arrived at the scene very shortly after the emergency services.

The balloon was equipped with portable GPS navigational equipment but subsequent examination by the AAIB found no record of the flight in its memory.

Weather

The investigation reviewed the Terminal Area Forecast (TAF) at 1520 hrs for Cardiff Airport, 25 nm to the south-west of the balloon's intended landing site. For the period from 1600 hrs on 10 May to 0100 hrs on 11 May it predicted a variable wind of 5 kt; 7,000 metres visibility; a few clouds with a base at 4,000 ft and temporary spells during the period with visibility in excess of 10 km and no cloud below 5,000 ft. This forecast was revised at 1805 hrs to include a 30% probability of a temporary change, between 1800 hrs and 2100 hrs, with thunderstorms and scattered cumulonimbus clouds with a base at 4,000 ft amsl. At 1819 hrs the TAF was amended once again, forecasting a temporary change between 1900 hrs and 2300 hrs with 4,000 metres visibility, thunderstorms and broken cumulonimbus clouds with a base at 3,500 ft amsl.

These TAFs reflected the forecasts at Bristol Airport, Bristol (Filton) and Gloucester Airport, which were to the south and east of the balloon's track. Bristol Airport's TAF was also changed at 1819 hrs, from a 30% probability of thunderstorms during the evening to temporary thunderstorms after 1900 hrs.

Uncertainty in forecasts is unavoidable, and it is often useful to provide a forecast in terms of a probability of occurrence, particularly when referring to significant phenomena such as thunderstorms. When there is a probability of thunderstorms occurring, a 30% or 40% probability is used. If the probability is judged to be less than 30% it is not considered sufficiently significant to be included, and if the probability is 50% or more then is no longer considered to be a probability but is indicated by use of one of the change indicators 'BECMG' or 'TEMPO'.

Also during the investigation an aftercast was obtained from the Met Office. The synoptic situation at 1800 hrs on the evening of the accident showed a high pressure covering the British Isles with a thundery trough lying over South Wales and the Bristol area.

It was clear, from tephigrams and the general state of the atmosphere from surface charts, that significant instability was possible, with cumulonimbus cloud tops up to between 30,000 and 35,000 ft.

Recorded radar images, which indicate the presence of rain droplets in the atmosphere, showed a build-up of rain returns over South Wales from 1745 hrs onwards. The heaviest rain appears to have arrived in the Pontypool area between 1930 hrs and 2000 hrs and was, according to the colour of the returns, particularly heavy, possibly including hail.

Satellite imagery revealed that a number of convective cells were generated over South Wales during the early evening. Also, there was a large area of cumulonimbus cloud situated over Wiltshire at 1700 hrs, which moved west towards south Wales at 10-15 kt, possibly generating further cumulonimbus cells along its leading (western) edge by picking up moisture from the Bristol Channel.

Cumulonimbus cloud began to develop over South Wales and around the Bristol Channel/Severn estuary area during the period between 1700 hrs and 1800 hrs and moved in a west-north-westerly direction towards the site of the accident. It is likely that cumulonimbus cloud was over, or very close to, the area of the accident at the time it occurred.

The aftercast estimated the surface visibility to be 10-15 km in haze and it was considered possible that, in the prevailing visibility, any cumulonimbus cloud would not have been seen until it was quite close to the observer.

The wind at 2,000 ft agl was estimated to be from 060º at 10 kt, veering to 110º at 10 kt; with the surface wind from 080º at 5 kt, veering to 110º at 10 kt. It was possible that in and near thunderstorms the surface wind was from the east-north-east at 15 to 20 kt, gusting to 30 kt.

The 'Afternoon ballooning forecast - South-West' for the period from midday to dusk was consistent with the general forecast and referred to isolated wind gusts of 30 kt in and near to thunderstorms.

The departure weather recorded by the pilot, based on an observation at 1750 hrs at Cardiff, indicated a surface wind from 080º at 5 kt, 10 km visibility, a few clouds at 3,400 ft and a temperature of 19ºC.

Sunset at Cardiff, was at 1952 hrs.

Photographic evidence

Photographs taken from the balloon basket during the flight reveal that for much of the flight the weather was fine and hazy. Two other photographs taken from a residential property in Pontypool shortly before the balloon landed, showed it beneath the western edge of cumulus type cloud in a position assessed as being over the north-western side of Pontypool.

Procedures and limitations

Weather and flight planning

The operator's Operations Manual states that:

> *Before flying a balloon the captain shall satisfy himself that .... in the forecast wind conditions the balloon will reach an area suitable for landing within the planned flight time.*

and in APPENDIX Y it stipulates:

> ***Wind Speeds.*** *Pilots are reminded they must not fly if the ground speed is expected to exceed 15 knots.*

The Operations Manual also states that the CAA approved Flight Manual is part of the Operations Manual.

That approved Flight Manual specifies the following weather limitations:

> *1. Balloon must not be flown free in surface winds greater than 15 knots (7.7m/sec).*
>
> *2. The balloon must not be flown in meteorological conditions which could give rise to erratic winds and gusts of 10 knots (5.1m/sec) above the mean wind speed.*
>
> *3. The balloon must not be flown if there is extensive thermal activity or any cumulonimbus (thunderstorm) activity.*

With regards to flight planning, the Flight Manual advises that the following should be considered;

> ***Severe weather*** *A balloon flight should never be attempted around thunderstorm activity, ahead of approaching frontal systems or near severe weather of any kind.*

and ….

> ***Wind Direction*** *The wind direction should not carry the balloon into ..... areas unsuitable for landing (mountains, lakes or large built-up areas) unless sufficient fuel is carried to overfly such areas safely.*
>
> *The pilot should visually assess the weather both before take-off and during the flight and be prepared to modify flight plans accordingly.*

Landing site selection and procedures

On the subject of landing site selection, the Flight Manual states:

> *For landing, a field must be chosen in the line of flight, containing a sufficiently large clear area in which to land the balloon. The intended landing area should be free of animals, crops, telephone wires and power cables, and there should be no high obstacles in the approach or overshoot. A larger landing area will be needed in stronger winds.*

The Flight Manual also contains a list of Pre-Landing Checks which includes repeating the landing part of the passenger briefing; that briefing having been given when the passengers first embark, before takeoff. For partitioned baskets, as in this case, the landing part of the briefing states:

> *Before landing, stow all loose items, cameras etc.*
>
> *On landing face away from the direction of travel. Knees should be together and slightly bent. Push backwards against the leading edge of the passenger compartment. Hold on to the rope handles in front of you with both hands. After touchdown the basket may fall on its side and drag along the ground.*
>
> *After landing do not leave the basket without the pilot's permission.*
>
> *The passenger's landing position may be rehearsed before take-off to ensure that they are taking up the correct position. It is important that the passenger's knees are only slightly bent, and that they are not squatting or sitting on their heels.*

The Flight Manual Emergency Procedures contain guidance on *PREPARATION FOR A HARD LANDING.* It states:

> *.... a weather emergency may cause a 'fast' landing where the speed is mostly horizontal....*
>
> *In a fast landing the basket may tip forward violently on impact, tending to throw the occupants out. The occupants should adopt a low down position (knees well bent) with their back or shoulder pressed against the leading edge of the basket, head level with basket edge and rope handles or cylinder rims held firmly.*

Safety equipment and procedures

The Flight Manual states in its *Limitations* section:

> *There must be at least one restraint, e.g. hand hold, for each basket occupant.*

Under the heading *Passenger Handling,* the Operations Manual states:

> *Protective helmets must be provided for the use of passengers if it is likely that other than normal conditions could be encountered during the course of a flight, for example a landing on steep or rocky terrain or at a high ground speed.*

However, later in the Operations Manual a Notice to Pilots (APPENDIX Y) states:

> ***Protective Helmets.*** *I do not consider that we fly over steep or rocky terrain or at high ground speeds. Protective Helmets are not issued by this company and flying over steep or rocky terrain or at high ground speeds is prohibited.*

The Manual specifies that the minimum equipment required to be carried for public transport includes a First Aid Kit. The Manual also stipulates that pilots must complete first aid training every three years and it advises that

> *ground based personnel should have adequate training in first aid because, in the event of a serious accident, it is possible that the pilot may be incapacitated and the retrieve crew would be first to attend the scene.*

It was confirmed that the pilot had received his first aid training and that a first aid kit was carried in the balloon basket and in the retrieve vehicle.

Civil Aviation Authority advice

The UK CAA General Aviation Safety Sense Leaflet 16a, entitled *Balloon Airmanship Guide,* gives guidance on obtaining weather information and landing area planning. It states:

> *Plan to land in an area which provides a choice of suitable sites. Avoid being committed to land in an area which does not offer any alternatives if an initial approach has to be abandoned.*

Fuel

The balloon departed with 148 kg of fuel, the amount specified in the operator's Operations Manual for a flight lasting one hour. This provided 30 minutes of reserve fuel.

Discussion

The balloon was beneath the western edge of a cumulonimbus cloud when it made an emergency landing. It was not possible to establish the balloon's ground speed or the surface wind velocity during the landing, but the weather forecast for the period indicated that the wind speed could gust to 30 kt in, and near to, thunderstorms.

The pilot had earlier made two attempts to land but was unable to do so due to obstacles and insufficient control of the balloon. The weather then deteriorated rapidly. The initial attempt was made in the vicinity of Betts Newydd, the planned landing area. As the balloon flew further west, the weather worsened and suitable landing sites did not present themselves as the balloon travelled over difficult landing terrain. When the pilot decided to make an emergency landing he was faced with a combination of a strong surface wind, which was probably in excess of the manufacturer's limiting surface wind for a landing, and an uneven landing surface. These conditions, which were not foreseen and fell outside the operator's operating limitations, fell within the criteria for passengers to wear protective helmets.

The meteorological aftercast reflected the conditions that the pilot observed before the balloon took off and during the first half of its flight. The aftercast also indicated that any cumulonimbus cloud would not have been visible until it was quite close to the observer.

However, there was evidence of developing convective cloud activity over South Wales on the radar imagery, which the operator reported having access to, in the 45 minutes before the balloon launched. There were also visible signs of thunderstorm activity to the south and east of the balloon about 15 minutes before the first attempt to land. The pilot recalled hearing the sound of thunder during that 15 minute period and that prompted him to prepare for a landing.

The advice in the Flight Manual, that

> *the balloon must not be flown if there is extensive thermal activity or any cumulonimbus (thunderstorm) activity,*

arguably warranted a cancellation or a postponement of the flight on the basis of the weather radar imagery and the forecast. However, it was understandable that the balloon took off, in the light of the local conditions at Monmouth and bearing in mind that a 30% probability is the minimum level of probability that will be included on a TAF.

By the time the balloon was making its first approach to land, the combination of the wind and local obstructions was such that the pilot decided to abort the landing. Thereafter there was a lack of suitable landing sites and, ultimately, the pilot elected to make an emergency landing in unsuitable conditions.

The pilot's passenger briefings were appropriate. With bench seats fitted, the passengers' seating position was the same for an emergency high speed landing as for a normal one. However, the provision of protective helmets was merited. Following the accident, the Civil Aviation Authority undertook to review the use of protective helmets in public transport balloons and, as an interim measure, to issue a Balloon Notice reiterating previously published advice regarding the provision of protective helmets for balloon flights over areas close to steep or rocky terrain. The Notice would also give greater guidance to operators on when helmets should be used.

Although first aid kits were provided, the pilot was incapacitated and the retrieve crew arrived after the emergency services, who administered first aid treatment before the pilot and passengers were taken to hospital. The proximity of the landing site to a residential area meant that local residents were some of the first to assist the occupants of the balloon in the immediate aftermath of the landing.

Safety Recommendation 2006-132

It is recommended that Ballooning Network Ltd review their procedures to ensure that suitable alternative landing areas are identified in their spheres of operation in the event that a planned landing area cannot be used.

Safety Recommendation 2006-133

It is recommended that Ballooning Network Ltd review their safety equipment, particularly with regards to the provision of protective helmets, to cater for possible emergencies

ACCIDENT

Aircraft Type and Registration:	Slingsby T.51 Dart 15 Glider, BGA1166
No & Type of Engines:	None
Year of Manufacture:	1964
Date & Time (UTC):	30 August 2006 at 1750 hrs
Location:	Sutton Bank, near Thirsk, Yorkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Fatal) Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Silver C gliding certificate
Commander's Age:	54 years
Commander's Flying Experience:	412 hours (of which 1:17 were on type) Last 90 days - 3:56 hours / 23 flights Last 28 days - 1:04 hours / 4 flights
Information Source:	AAIB Field Investigation, assisted by the British Gliding Association

Synopsis

During a local flight from a hill-top gliding site, the glider descended in weak ridge lift until it was too low to land safely back at the airfield. However, the pilot appears to have made an attempt to do so and, whilst turning at low height and low speed, lost control of the glider. It crashed on the steep slope just below the ridge line, and the pilot sustained injuries from which he later died.

History of the flight

The pilot was a member of a club which flew vintage gliders and which was visiting Sutton Bank gliding site as part of an annual event. The pilot had flown the glider on a twenty minute flight on the afternoon of the accident, and planned to fly a further flight that day. This later flight was originally intended to be a cross-country flight, but had been changed to a local flight for weather considerations.

The glider was launched by 'aerotow' at 1630 hrs and remained close to the airfield for the duration of the one hour and twenty minute flight. Towards the latter stages of the flight, onlookers became concerned that the glider was flying very low along the ridge line which is immediately adjacent to the gliding site. The glider was seen to descend to a height only just above the ridge line, apparently flying at an unusually slow speed. Witnesses saw it initiate a turn to the left, away from the ridge. However, it then began a turn to the right, back towards the gliding site and, as it did so, rolled rapidly to the right and the nose pitched down. The glider appeared to be entering a spin but quickly disappeared from view and crashed into trees on the steep slope, a short distance below the top of the ridge. Onlookers were quickly on the scene and found the glider severely damaged, with the disrupted cockpit suspended nearly vertically from the trees. The pilot was unconscious and was prevented from falling from the wreckage by his four point harness.

The emergency services attended some 10 minutes after the accident. The pilot, who remained unconscious throughout, was extricated from the wreckage, though this process was protracted as it was made difficult by the steep slope and vegetation. He was airlifted to York General Hospital by an RAF Search and Rescue helicopter and subsequently underwent surgery for his injuries. Despite this, the pilot did not regain consciousness and died on 19 September 2006, 20 days after the accident.

Aircraft information

BGA1166 was one of the early Slingsby T.51 Dart 15s to be built, being of all wood construction, and was manufactured in 1964 at Kirkbymoorside, near to Sutton Bank. This version had a 15 m span wing but later versions had a 17 m span wing, with wood and metal bonded spars, metal tailplanes, and an optional retractable main landing gear. The primary flight controls are a rudder, ailerons and an 'all-flying' tailplane. Pitch trim is achieved by trim tabs situated at the trailing edge of both the left and right side of the tailplane, and these are actuated by moving a control handle in the cockpit. Two airbrake paddles deploy from the upper and lower surface of both wings, making four in total, and are also operated by moving a control handle in the cockpit.

The aircraft had flown for a total of 2,148 hours over 1,381 flights. The glider's Certificate of Airworthiness was valid until 5 June 2007.

Wreckage information

The wreckage was located some 50 ft below the ridge line, to the west of the gliding site, in an area of soft ground where the slope was approximately 1:2, and which was covered by birch trees and heather. The forward fuselage was aligned 175°(M), pitched almost vertically down and had sustained severe disruption to the nose. The rear fuselage structure had broken away from the forward fuselage, aft of the wings. The vertical and horizontal tail surfaces were intact, attached to the rear fuselage, and had sustained little damage. A 10 cm diameter branch had become detached from the tree; the geometry and fresh fracture surfaces were such that it was likely the branch had been struck by the forward fuselage and canopy during the impact.

Both wings were still attached to the forward fuselage and both were broken outboard of the inboard end of their respective ailerons; the right wing was supported 2 m above the ground by a tree. Above the wreckage there were freshly broken branches and twigs that were consistent with the right wing having struck the tree with the glider at an attitude of 70º to 85º nose down. The outboard part of the left wing was lying on the ground, and had sustained only minor damage, consistent with the left wing tip striking the ground at low speed.

The airbrake paddles on the upper and lower surfaces of both wings were partially deployed, and foliage was lodged on the forward side of the airbrake on the upper surface of the right wing.

On-site checks were made of the continuity of aileron, all-flying tailplane, rudder and airbrake controls with no discontinuities being found. It was not possible to check the continuity of the pitch trim system at the accident site.

Engineering investigation

The glider was transported to the AAIB headquarters at Farnborough for detailed examination.

Flight controls

The continuity of aileron, all-flying tailplane, rudder and airbrake controls were all confirmed, and the pitch trim system was found to have been serviceable. No evidence of any pre-accident control jams or restrictions was found in any of these systems.

Air speed indicator (ASI) system

The ASI system featured a 'pot' pitot mounted in the glider's nose, a static port mounted on the left forward fuselage and the ASI instrument mounted in the instrument panel. The ASI was removed and taken to an engineering organisation experienced with testing similar units. The unit was tested in the range from 30 kt to 100 kt and then back to 30 kt using appropriately calibrated test equipment. All the readings were within 2 kt of the calibrated values. A general inspection of the pitot/static system failed to determine with any certainty if any leaks had been present prior to the accident, due to the disruption of the forward fuselage.

Glider structure

There was no evidence of any structural failure prior to the accident. However, evidence of corrosion was found on the bolts that attach the wing root attachment fittings to the wooden spars, in both wing roots. Whilst this was not causal to the accident, the British Gliding Association (BGA) was informed and undertook to consider the findings with a view to issuing advice to their inspectors regarding the inspection of vintage and ageing gliders.

Pilot information

The pilot had begun flying gliders in 1995, and had joined the flying group in 1996. His total flying experience of 412 hrs was gained almost exclusively on gliders, with the occasional flight as a passenger in a self-launching motor glider. Although the pilot had learnt to fly at a gliding site located at the base of the ridge at Dunstable, Bedfordshire, the majority of his experience had been gained at flat sites. His flying logbook recorded only 17 flights, over 10 years, which contained an element of hill soaring. Only two (total 43 minutes flight time) were solo flights. One of these solo flights was during the pilot's only other visit to Sutton Bank, in 2005. The second was the pilot's penultimate flight on the day of the accident. In the year leading up to the accident, the pilot's only experience of hill soaring had been during a dual 'site check' the previous day, and on the day of the accident itself.

The majority of the pilot's gliding had been done in a mix of older gliders that were operated by his flying group. His experience on the Dart 15 was limited; he had flown it twice in June 2005 and not again until the day of the accident - a total recorded time of one hour and 17 minutes. The pilot had qualified to the Bronze gliding certificate level, with cross country endorsement, in 1996, and had further qualified to Silver C certificate standard in 1998.

Airborne photographs

The pilot was known to have been a keen photographer and to have frequently taken photographs whilst airborne. Two cameras were recovered from the glider wreckage: a digital camera and a compact 'wet-film' type. The 'wet-film' camera was in its case when found, while the digital camera was found with its zoom lens extended. Damage to the lens indicated that the camera had been switched on at the time of the accident.

Aerial photographs had been taken with both cameras, and recorded information showed that they had been taken on the day of the accident. The digital camera images also had an associated time stamp which indicated that 27 images had been taken during the accident flight, with recorded times between 1738 hrs and 1845 hrs local time. Of these, 15 images were of other gliders in flight. As it was nearing the end of the gliding day, very few other gliders were airborne, and it was possible to identify the gliders in the photographs as being two that were airborne at the time of the accident. These were also ridge soaring, though were higher than the accident glider when the photographs were taken.

Earlier in the flight (probably soon after release from the aerotow) the pilot had captured a portion of the instrument panel in the first photograph, which showed the ASI reading 45 kt. This speed was in the normal operating range for the glider, although the group's Chief Flying Instructor (CFI) recommended a minimum airspeed of 50 kt for non-turning flight.

Medical and pathological information

As required by BGA regulations, the pilot held a valid medical declaration form which was countersigned by his General Practitioner. A post-mortem examination did not identify any disease or existing medical condition that may have contributed to the accident, but confirmed that the pilot had died as a result of head injuries sustained during the impact sequence.

Gliding site information

The Sutton Bank Gliding Site has been used for gliding since 1933. The site forms part of the western edge of an extensive plateau, effectively forming a corner at the junction of the steep escarpments along the western and southern edges of the North York Moors. The ridge on which the glider was soaring was at a mean 940 ft amsl, rising higher to the north. The site is some 650 ft higher than the low ground to the west, with the slope of the ridge varying between 1:4 and vertical.

On the day of the accident the site was operating to a standard configuration of takeoffs and landings, according to the prevailing wind. This configuration was promulgated at a routine briefing, given by the club duty instructor on the morning of the accident. In this configuration, launches and landings were both being made on the 'short run', with a secondary landing area available on the 'long run', see Figure 1.

Witness information

The accident was seen by a number of witnesses, many of whom were experienced glider pilots and familiar with gliding operations at the site. They reported that the glider had been at an unusually low height on the ridge for a considerable time before the accident, and appeared to be gradually losing height with each traverse of the ridge line. It was the glider's low height (generally reported as between 100 ft and 300 ft above the ridge when most witnesses first became aware of the glider) which alerted them to the fact that the pilot may have been getting into difficulties. They also described the glider as flying unusually slowly.

Witnesses considered that there had been ample opportunity for the pilot to land the glider on the secondary landing area, even after it had become too low to land

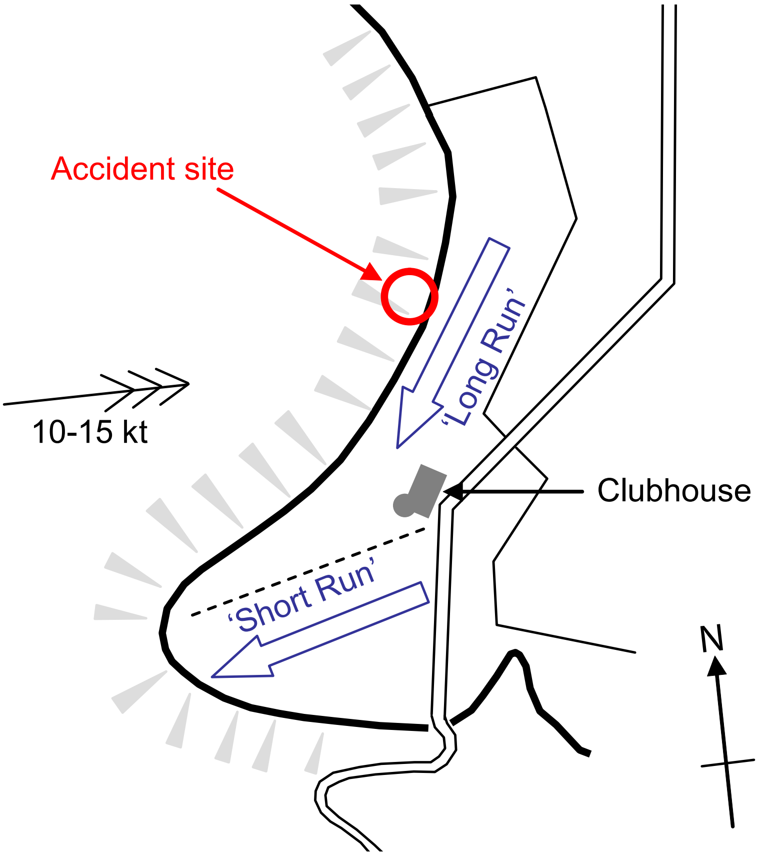


Figure 1

Gliding site showing main and secondary landing areas

the glider appearing to enter a spin or spiral dive and descending steeply, disappearing from view below the ridge line.

Some witnesses described a 'wallowing' once the glider was very low and clearly flying slowly, or that there was a period just before the accident when the glider's motion became erratic. It was also reported that the glider was flying shallow turns in the latter stages of flight (presumed to be because of its low height), and that the pilot was applying excess rudder, producing a skidding turn. Witnesses who expressed an opinion about the airbrakes thought they remained retracted.

on the main landing area. On the penultimate traverse southwards, the glider flew approximately down the centre of the secondary landing area at between 100 and 150 ft; witnesses were surprised and concerned when the glider did not land, but instead turned northwards again on its final traverse along the ridge line. During this time the glider descended to a very low height, probably less than 50 ft above the ridge, and appeared to be flying very slowly with an unusually nose-high pitch attitude.

Just before the accident, the glider turned left, away from the ridge, and witnesses initially assumed that the pilot was committing to a landing in one of many suitable fields in the valley below. However, the glider then began a turn to the right, and as it did so the right wing dropped and the glider rolled rapidly to the right as it departed from controlled flight. Witnesses described

Meteorological information

At the time of the accident, Met Office information indicated that a ridge of high pressure was moving eastwards away from the area, with frontal rain moving into western and central areas of the country. At the time of the accident the weather was generally fine, with small amounts of cumulus cloud at 3,500 ft and broken cloud layers at higher levels. The wind at Mean Sea Level would have been from 240º(T) at 11 kt and the wind at 1,000 ft amsl would have been from 270º(T) at 15 kt. The Met Office data corresponds with the recall of witnesses, most of whom stated that the wind was westerly or south-westerly at about 10 kt.

Gliding site operations

A document held at the local gliding club, titled '*Gliding at Sutton Bank*' contained details of the various site configurations. Concerning operations in a westerly wind, the document stated:

'A wind strength of at least 12 kts is needed for the hill to work, although much depends upon the glider and its pilot. The area of best lift in the bowl will depend upon wind direction. If it is insufficient to maintain 400 ft you should land.'

Gliders positioning for an approach to the 'short run' would generally fly a downwind leg to the north of the site before turning right to position onto final approach. Club members stated that a comfortable minimum height for crossing the ridge downwind was 700 to 800 ft. The '*Gliding at Sutton Bank*' document also stated:

'400 ft is the minimum safe height for crossing the ridge on an approach to the Short Run. If you cannot ensure this, use the Long Run'.

The local gliding club, which was hosting the event, had no formal arrangements for briefing visiting pilots about site operations. However, the club did require that all visiting pilots undergo a flying 'site check' with an appropriately qualified pilot before being allowed to fly solo. As well as weather information, the morning flying briefing included the site configuration and any special requirements or issues particular to the day. Additionally, it was a club requirement that all pilots not holding a Silver C qualification were briefed by an instructor prior to every flight.

On this occasion, and because of the large number of visitors attending the event, the responsibility for the accident pilot's site check was delegated by the club duty instructor to the group's CFI, once he himself had flown a check flight with the duty instructor. The accident pilot's check flight had been carried out on the day before the accident, in a relatively modern, two-seat training glider. During the 34 minute flight, salient features of the site were covered by the CFI, who was satisfied that the pilot was competent to fly solo. The document '*Gliding at Sutton Bank'* was not required reading and it is not certain whether the pilot was fully aware of the cautionary information it contained regarding minimum heights.

Glider handling qualities

The handling qualities of most gliders are such that the rudder is used to a greater extent when turning, in comparison with many powered aircraft. However, the use of too much rudder in a turn can lead to a well-recognised scenario in which the glider may depart from controlled flight and possibly enter a spin. Typically, this is likely to occur at a low height (during the final turn is a frequently quoted scenario), when the pilot is reluctant to use large angles of bank to turn the glider. Instead, a shallow angle of bank is used but, as this leads to a relatively poor turn rate, the pilot is tempted to apply more rudder in the direction of the turn.

Although the increased rudder deflection increases the turn rate by a small amount, it has the affect of markedly increasing the glider's drag. If the glider is already flying too slowly, it may stall. Because of the yawing motion, the 'inside' wing will stall first and the glider enters an autorotative manoeuvre in which it rolls rapidly in the direction of the turn.

The situation may be triggered or aggravated if the ailerons are deflected near the point of stall. The extra applied rudder will cause a rolling tendency which requires opposite aileron to correct. The down-going aileron on the 'inside' wing increases the effective angle of attack of the wing tip, either causing it to stall or ensuring that the wing remains stalled.

It is also possible for a pilot to apply an inappropriately large rudder input at low heights because of a visual illusion. As a glider turns at normal operating heights the 'inside' wing tip appears to the pilot to move backwards relative to the distant ground. However, at low heights, the glider's forward speed is much more apparent when looking at the ground, and hence the wing tip appears to move forwards relative to the ground (though the glider is still turning). This creates a perception that the glider is not turning as expected, and the temptation for the pilot is to apply more rudder to increase the turn rate.

The Dart 15 glider belonged to a generation of gliders which, in some cases, were less forgiving in their handling qualities than many modern gliders. The Pilots' Notes for the Dart 15 included the following comment, in relation to a 30º banked turn:

> *'The minimum speed in a 30º banked turn is between 38 and 40 knots depending on C.G. position. Airframe buffet tends to be present and opposite aileron is required to hold off bank. Any additional "bottom rudder" causes the inner wing to drop; followed by the nose; and a spiral dive ensues, from which recovery is rapid on easing the control column forward.'*

Analysis

The engineering investigation concluded that there was no failure of the glider's structure before impact, and that the glider's flying controls were capable of being operated normally. Foliage in the airbrakes indicated that they were probably partially deployed at or during the impact. No witnesses reported seeing the airbrakes extended, nor would it have been appropriate for them to be used. Airbrake operation is normal when landing a glider and it is not unknown for pilots to select them inadvertently prior to landing when the situation does not warrant their use, particularly if under stress. It is perhaps more likely that the airbrakes extended as a result of an instinctive action by the pilot just before impact, but the reason for their partial extension remains unexplained.

The satisfactory calibration of the ASI supports the photographic evidence that the instrument was working normally during the flight. A leak in the pitot line would have caused the ASI to under-read (ie the aircraft would be flying faster than the indicated speed), and a leak in the static line would produce only a small error at the altitude at which the glider was flying. Hence it is very unlikely that the ASI would have been over-reading the actual airspeed.

Although the pilot had a reasonable experience level, he had only very limited experience of hill or ridge soaring, and was inexperienced in the type of glider he was flying at the time of the accident. Although the pilot had demonstrated his ability to fly safely from the site on the day before the accident during the site check with his CFI, this check flight was made in a relatively modern, two-seat training glider, which has less demanding handling characteristics than the Dart 15 glider.

The pilot had been soaring on the ridge for some time before his glider became low enough to cause onlookers concern. It is possible that the wind strength or direction may have changed subtly whilst he was airborne, and reduced the amount of lift the ridge was capable of producing. The pilot may not have been aware of the recommended minimum height of 400 ft on the ridge to commence a landing pattern to the 'short run'. However, it should be expected that he would have had a minimum height in mind; it is likely this would have been higher than 400 ft, which was considered an absolute minimum by most club members. Even when below 400 ft, when it should have been apparent that a landing on the 'short run' was not possible, there were several opportunities for the pilot to land safely on the secondary 'long run', though he did not. It is not known why the pilot remained on the ridge when it was producing inadequate lift. Apart from the increasing difficulty in landing, a well-used public footpath ran along the ridge line which made soaring at low height inadvisable (notwithstanding that ridge-soaring gliders are exempt from the minimum height requirements of the Air Navigation Order).

The photographic evidence does indicate a potential source of distraction. The date/time stamp on the digital photographs show that the pilot had been taking air-to-air photographs until the last minutes of the flight, and it is known that his camera was switched on at the time of the accident. From the times of launch and accident, it was possible to determine that the camera time was accurate to within 4 minutes, and the pilot's keen interest in photography would also suggest that the camera time was set reasonably accurately. It follows that the pilot had been taking photographs of gliders above him at the same time that his own glider's height was causing onlookers concern. Given that opportunities to land were not taken, it is possible that the pilot allowed himself to become distracted from his prime task of piloting the glider, and descended to a lower height than he had intended. Witness accounts of the glider's speed and behaviour just before the accident suggest that the glider was flying at just above its stalling speed as it flew northwards on its final traverse. This is indicative of the pilot attempting to minimise the descent rate, although the gently up-sloping ridge line ahead of him may have produced an incorrect perception of the true horizon, leading the pilot to select a higher pitch attitude than was required.

From a position only just above the ridge line, and with minimal flying speed, the pilot's only safe option was to fly out into the valley and land there. The initial turn away from the ridge line just before the accident lead witnesses to think this was the pilot's intention. As all turns whilst ridge soaring should be made away from the ridge, into the prevailing wind, the only plausible reason for him to reverse the turn at that point would have been to try to land back at the airfield. It is reasonable to assume that this was the pilot's intention, in which case the initial turn to the left may have been an attempt to gain some separation from the ridge (and thus gain separation from the steeply sloping ground), prior to turning back to the landing area. It should have been clear to the pilot that there was insufficient height to achieve a normal landing on the 'long run' but he may have thought he could land diagonally across it.

The final manoeuvre, as seen by many witnesses, is consistent with the inner (right) wing stalling first, leading to an uncontrollable right roll and departure from controlled flight. The departure may have been solely due to the aircraft's airspeed being too low for the manoeuvre, or may have been as a result of an inappropriate rudder input. Recovery from such a departure is possible, and the pilot would have had considerable practice of such recoveries. However, recovery would initially involve moving the control column forward to unstall the wings. Faced with such a situation unexpectedly and at very low height, the pilot's probable instinctive reaction would be to use aileron to correct the roll, and possibly aft stick movement to arrest the descent. Both of these actions would ensure that the aircraft would not recover and would enter a spin or spiral dive, given sufficient height. The glider's situation was such that, once it had begun to depart from controlled flight, it is not certain that even prompt and positive actions would have prevented the glider from striking the ground, although such actions may have reduced the extreme nose down attitude at impact.

The head injuries suffered by the pilot were probably caused by a section of tree branch which penetrated the glider's canopy. As was common practice, the pilot was not wearing a helmet, although it is not certain that a helmet would have afforded sufficient protection to the front of the pilot's head to alter the fatal outcome. The BGA has previously reviewed the issues surrounding the wearing of helmets in gliders. It was determined that wearing a helmet in the confined space of a glider's cockpit represented a significant hazard in terms of restricted head mobility, and therefore of lookout, as well as raising possible issues of reduced auditory reception.

Safety action

Although the local gliding club at Sutton Bank required a site check for visiting pilots, there was no requirement that such pilots be briefed or self-brief on the local procedures and guidance, such as was included in the *'Gliding at Sutton Bank'* document. Prior to this accident the local club had produced a draft document containing Standard Operating Procedures (SOPs), which was subsequently issued in hard copy and also placed on the club's web site. The SOPs contain rules and procedures pertaining to all aspects of flying operations at Sutton Bank, and detail the requirements for flying currency and check flying. In addition to specific daily and site briefings, all pilots at Sutton Bank are now required to sign as having read the SOPs on joining the club and annually at membership renewal.

Safety Recommendations

For some years, the BGA has been encouraging its associated clubs to use documents such as SOPs as a means of passing essential information to their members and visitors. Despite this, there was no demonstrated requirement for ground briefing of visiting pilots in force at the Gliding Club at Sutton bank at the time of the accident.

The following safety recommendation is therefore made:

Safety Recommendation 2007-001

The British Gliding Association should review the guidance it gives to its associated gliding clubs in respect of the briefing requirements for visiting pilots, with a view to ensuring that such pilots are adequately briefed on all aspects of site operations.

Conclusion

The pilot continued to fly on the ridge line in conditions of reduced lift, despite earlier opportunities to land his glider safely. The accident occurred when the pilot attempted to turn his glider at low height and low airspeed, probably in a late attempt to land. The glider's right wing stalled first, and the glider departed from controlled flight with insufficient height for the pilot to make a recovery.

ACCIDENT

Aircraft Type and Registration:	Ultramagic N-250 balloon, G-BZJX
No & Type of Engines:	None
Year of Manufacture:	2000
Date & Time (UTC):	21 July 2006 at 1815 hrs
Location:	Henley on Thames, Oxfordshire
Type of Flight:	Passenger Transport
Persons on Board:	Crew - 1 Passengers - 10
Injuries:	Crew - None Passengers - None
Nature of Damage:	No damage to G-BZJX. Damage to canopy of G-CBFY
Commander's Licence:	Commercial Pilot's Licence (Balloons)
Commander's Age:	58 years
Commander's Flying Experience:	3,686 hours (of which 1,800 were on type) Last 90 days - 26 hours Last 28 days - 10 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The balloon was caught by a gust of wind during takeoff, went in a direction approximately 70º to that which was expected. The pilot was unable to increase the rate of climb sufficiently to avoid another balloon that was about to launch. The basket of G-BZJX brushed against the canopy of G-CBFY causing the latter's canopy to tear and deflate. Nobody was injured in the accident.

History of the flight

At 1730 hrs the crews arrived at the launch site to discuss the launch of five balloons. The site was a large school sports field and balloon rides were part of a corporate entertainment event. A meteorological balloon was launched which drifted off towards 290º before slowly turning right as it gained height and settling at 020º at about 5 kt. This latter wind speed and direction were consistent with the forecast of the wind coming from 200º at 5 kt. The five balloons were then prepared at their respective launch positions. The passengers arrived at about 1745 hrs and at 1815 hrs all five balloons were inflated and the passengers were on board.

Of the five inflated balloons, G-BZJX was positioned the furthest upwind of the forecast wind direction. One balloon was positioned directly downwind of G-BZJX. The pilot of G-BZJX called the pilot of the downwind balloon on his radio twice and received no reply. However he could see that the pilot of the downwind balloon was not ready for takeoff. Another balloon was situated 150 m away on a bearing approximately due east of G-BZJX, ie some distance upwind of G-BZJX and not on the path that G-BZJX would be expected to take after takeoff, and this balloon took off in the expected direction of 020º. G-CBFY was situated midway between G-BZJX and the balloon that had taken off ie about 75 m away, slightly upwind and about 70° to the right of G-BZJX's expected path (see Figure 1).

The pilot of G-BZJX decided to take off. A gust of wind then blew G-BZJX towards G-CBFY and the pilot of G-BZJX promptly applied maximum heat in an attempt to increase the rate of climb to avoid the stationary balloon. The basket of G-BZJX then brushed against, and tore, the canopy of G-BCFY before climbing clear. The initial contact of the basket was about 20 ft below the top of the canopy of G-BCFY.

The subsequent flight of G-BZJX was uneventful and the flight of G-CBFY was aborted. Nobody was injured in the accident.

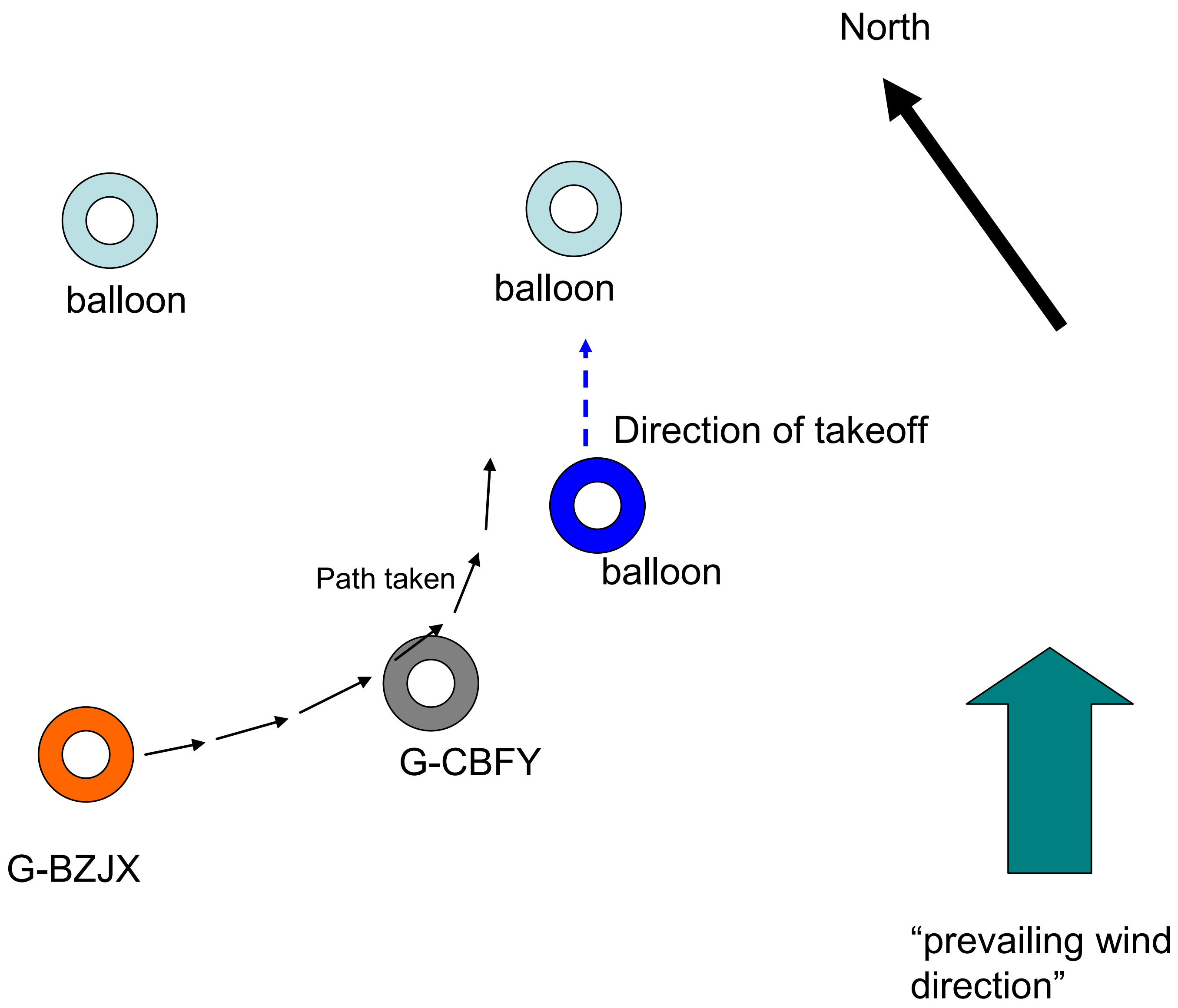


Figure 1

Pilot's comments

The pilot attributed the accident to the unexpected direction of the gust of wind at a critical time during the takeoff. He also noted that his future takeoffs would have a faster rate of climb to minimise the risk of hitting an obstacle.

Metrological information

The Met Office provided the AAIB with forecast and reported wind information. The forecast winds at Farnborough, Heathrow and Northolt were 5 kt at 210°, 7 kt at 200º and 8 kt at 200º respectively. The reported winds at 1820 hrs for Farnborough, Heathrow, Benson and Northolt were 5 kt at 250º, 8 kt at 200º, 7 kt at 200º and 6 kt at 210º respectively.

The only relevant recorded information regarding gusts was at High Wycombe at 1800 hrs which was 5 kt at 240º gusting to 12 kt.

CAP 403

CAP 403 '*Flying Displays and Special Events: A Guide to Safety and Administrative Arrangements'* is published by the UK CAA. This document is intended *as 'a code of practice and an indicator of best practice*' for such events.

The following are extracts from chapter 8 '*Balloon Events*' in the document:

> *a) Mass takeoffs should only take place in winds of less than 8 kts*

> *b) Prior to takeoff, pilots must ensure that their projected track out of the site is clear of balloons either on the ground or in the air*
>
> *c) If the wind speed exceeds 5 kts the crowd should be separated from the balloons in such a way that in the event of a change of wind direction prior to launch no part of the balloon will come into contact with the crowd*

Analysis

The pilot of G-BZJX was experienced and the preparation prior to the takeoff appeared to be appropriate.

Based on the forecast winds and the winds observed prior to the takeoff of G-BZJX, the pilot's actions were in accordance with the CAP 403 guidelines. However, the balloon was caught by a gust in an unexpected direction that the pre-flight planning did not envisage. The reported wind directions, particularly from High Wycombe, confirmed that there was some variability in the wind direction and some gusting.

Mass takeoffs such as this necessitate the implementation of an appropriate assessment of risks. It is not uncommon for the canopies of balloons to touch during such an event; however it is more important to avoid a basket touching a canopy. Whilst the probability of such an accident occurring is not negligible, the outcome is usually minor.

BULLETIN CORRECTION

AAIB File:	**EW/G2006/07/27**
Aircraft Type and Registration:	Mainair Blade, G-MZIW
Date & Time (UTC):	17 July 2006 at 1950 hrs
Location:	Nightfield Lane, Balderstone, Lancashire
Information Source:	Aircraft Accident Report Form

AAIB Bulletin No 1/2007, page 105 refers

The Bulletin incorrectly stated that the pilot held a National Private Pilot's Licence. The pilot in fact held a CAA Private Pilot's Licence (Microlights) with a National Private Pilot's Licence Declaration of Medical Fitness to Fly.

The report stated that the pilot experienced a 'jolt' through the airframe and controls, and that the cause of this jolt could not be determined. The pilot has advised the AAIB that the radiator cowl was not found at the scene of the accident, and that in his opinion this may have detached and struck the propeller, causing the unexpected jolt.

FORMAL AIRCRAFT ACCIDENT REPORTS ISSUED BY THE AIR ACCIDENTS INVESTIGATION BRANCH

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.

2/2006 Pilatus Britten-Norman BN2B-26
Islander, G-BOMG, West-north-west of
Campbeltown Airport, Scotland
on 15 March 2005.

Published November 2006.

3/2006 Boeing 737-86N, G-XLAG
at Manchester Airport
on 16 July 2003

Published December 2006.

2007

1/2007 British Aerospace ATP, G-JEMC
10 nm southeast of Isle of Man
(Ronaldsway) Airport
on 23 May 2005.

Published January 2007.

AAIB Reports are available on the Internet
http://www.aaib.gov.uk