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SPECIAL BULLETINS

None

COMMERCIAL AIR TRANSPORT

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SPORT AVIATION / BALLOONS

ADDENDA and CORRECTIONS

(ALL TIMES IN THIS BULLETIN ARE UTC)

ACCIDENT

Aircraft Type and Registration:	1) Airbus A320-211, D-AIQA 2) Boeing 737-86N, EI-DKD
No & Type of Engines:	1) 2 CFM 56-5A1 turbofan engines 2) 2 CFM 56-7B26 turbofan engines
Year of Manufacture:	1) 1991 2) 2000
Date & Time (UTC):	5 August 2008 at 1223 hrs
Location:	Taxiway Juliet, Manchester Airport
Type of Flight:	1) Commercial Air Transport (Passenger) 2) Commercial Air Transport (Passenger)
Persons on Board:	1) Crew - 5 Passengers - 107 2) Crew - 6 Passengers - 180
Injuries:	1) Crew - None Passengers - None 2) Crew - None Passengers - None
Nature of Damage:	1) Right elevator and tail of the fuselage damaged 2) Right winglet damaged
Commander's Licence:	1) Airline Transport Pilot's Licence 2) Airline Transport Pilot's Licence
Commander's Age:	1) 42 years 2) 34 years
Commander's Flying Experience:	1) 10,820 hours (of which 7,912 were on type) Last 90 days - 128 hours Last 28 days - 54 hours 2) 4,652 hours (of which 3,483 were on type) Last 90 days - 257 hours Last 28 days - 82 hours
Information Source:	AAIB Field Investigation

Synopsis

An Airbus A320 had turned right off the main taxiway onto a link taxiway and stopped short of the runway prior to an intersection takeoff. It stopped 24.2 m short of the stop bar with its tail extending into the main taxiway. A following Boeing 737 was cleared to the holding point at the beginning of the runway, beyond the position where the A320 had stopped. That involved taxiing behind the A320, with an instruction to give way to the Airbus. The crew of the 737 believed that a clearance to the end of the taxiway meant that there were no obstacles to affect their aircraft. They also considered that there was sufficient clearance between their aircraft and the tail of the A320. As the 737 passed behind the A320, its right winglet struck the tail of the A320. Both aircraft were damaged.

History of the flights

Airbus A320, D-AIQA

D-AIQA pushed back from its stand at 1211 hrs, for a flight from Manchester to Frankfurt, and taxied towards Runway 23R via Taxiway Juliet (J). The crew requested Holding Point J1 (see Figure 1), so that they could use the full length of the runway, but were told by the Aerodrome Controller (ADC) that it would lead to a delay in their departure as another aircraft was already holding at J1. Instead, the ADC cleared the aircraft to hold at Holding Point JA1, the last taxiway link to the runway before J1. The commander, who was the handling pilot (PF), stopped the aircraft at JA1 and applied the parking brake. The nosewheel was later measured to be 24.2 m short of the stop bar. He subsequently stated that he was able to see the left side of the stop bar but not the right. Although he could have moved forward "a little" if asked to by ATC, he assessed that he had stopped in a reasonable position relative to the holding point.

At 1222 hrs, while holding for departure, the crew heard the ADC warn the crew of a Boeing 737, EI-DKD, that wingtip clearance was not assured. Almost immediately after the transmission they felt the aircraft "shaking around" and realised that there had been a collision.

The ADC instructed the crew of D-AIQA to "HOLD POSITION, AN AIRCRAFT BEHIND HAS CLIPPED YOUR AIRCRAFT FROM BEHIND" adding that fire vehicles were on their way. He subsequently told the crew that EI-DKD's winglet had detached in the collision but that no damage was observed on their aircraft and advised them to contact the fire vehicle crews. At 1229 hrs, the senior fire officer asked the crew to shut the engines down, which they did. The commander asked for permission to start the APU, which had been off at the time of the impact in preparation for departure. This was granted, after the senior fire officer had assessed the external damage to the tail of the aircraft.

The passengers subsequently disembarked the aircraft by steps positioned at the front left door and were taken back to the terminal by coach. There were no injuries.

Figure 1

(since this photograph was taken, the runway has been redesignated as Runway 23R)

Boeing 737, EI-DKD

EI-DKD was scheduled for a flight from Manchester to Tenerife. The aircraft pushed back from its stand at 1207 hrs and taxied via Taxiway J towards Holding Point J1 for Runway 23R. The commander was PF. When the crew changed to the Tower frequency, the ADC issued the clearance "GIVE WAY TO THE AIRBUS [D-AIQA] HOLDING ON THE RIGHT THEN HOLD J1". The crew read back "GIVE WAY TO THE AIRBUS AND HOLD SHORT J1". The commander stated later that he believed that a clearance to J1 meant that there were no obstacles to prevent him from taxiing that far. He also considered that the use of the phrase 'give way' had caused him some confusion, although he had not asked for clarification.

As EI-DKD was approaching JA1, the commander taxied the aircraft about 1.5 m left of the taxiway centreline, to increase its separation from D-AIQA, and continued to taxi slowly. He asked the co-pilot about the separation and was advised that, "with the aircraft moving left, it was ok". The crew thought that D-AIQA had increased power to move forward, as they approached, because they "saw ripples in puddles caused by the jet wash". The commander asked the co-pilot to apply some right aileron to stop the wing lifting as they passed behind D-AIQA's engines. Shortly after that the ADC advised the crew "GIVE WAY TO THE AIRBUS ON YOUR RIGHT, THE WINGTIP CLEARANCE IS UNDETERMINED". One second later, EI-DKD's right winglet struck the underside of D-AIQA's tail. The ADC instructed the crew of EI-DKD to hold position and subsequently told them that they should contact the fire crew. At 1227 hrs, the ADC instructed the crew to shut down their engines.

The passengers subsequently disembarked the aircraft from steps at the front left door and were taken back to the terminal by coach. There were no injuries.

Aerodrome controller

Manchester Airport was operating from a single runway as was usual for the time of day. The ADC was holding aircraft at both J1 and JA1 as it helped to increase runway utilisation. He believed that, by issuing an instruction for EI-DKD to 'give way' to D-AIQA, he had warned the crew to be careful. His expectation was that the crew of EI-DKD would not proceed past D-AIQA unless it was safe to do so. The view of the accident site from the Visual Control Room (VCR) was unobstructed. However, the distance and angle of the view made it difficult to assess the clearance between the aircraft and, although the ADC did pass a further warning prior to the collision, he was too late to stop it from happening.

Flight data recorder information

For most of the 20 seconds before the accident, EI-DKD's heading was constant at 055º ± ½º but it decreased to 054º two seconds before the collision. Right aileron was applied 16 seconds before the impact. The groundspeed 20 seconds before the collision was 13 kt and it decreased slowly until PF applied the brakes with eight seconds to go. The aircraft slowed to 4 kt, which it maintained for the remaining five seconds before the collision.

The collision caused the nose to swing right to 056º after which the heading decreased to 050º over four seconds. The speed decreased to 3 kt for five seconds before the aircraft was brought to a halt over two seconds.

Cockpit voice recorder

The CVR from EI-DKD was translated by a member of the accident investigation authority from the state of the operator.

In the 30 seconds before the collision, the crew of EI-DKD were doubtful about the clearance between their wingtip and D-AIQA's tail and the commander asked the co-pilot to confirm that there was sufficient room. Without waiting for an answer, he asked the co-pilot to maintain the position of the control wheel, to which the co-pilot answered "YES". This was when right aileron was applied. Next, in answer to the question about clearance, the co-pilot said "YES, I THINK THERE IS BUT…..I DON'T KNOW….PERHAPS….YES…..I CAN'T SAY". The last phrase could also be translated as "I'm not able to say" or "I don't know". The commander seemed to want a more definitive answer and, again, sought confirmation. After a short while the co-pilot decided that there probably was sufficient clearance. Although it was clear from his tone he was not absolutely certain, he seemed to have fewer doubts than before. Finally, he said: "YES, WE CAN PASS. YES. YES".

In discussions on the flight deck following the accident, the commander said he had not understood properly his clearance in relation to D-AIQA. He thought D-AIQA was going to move forward for takeoff before his aircraft passed behind it, because his clearance had been to "give way" to D-AIQA. If that was not the case, he thought his clearance should have been to "hold position".

Damage

The top 1.5 m of EI-DKD's right winglet had detached. It fell to the ground and was blown to the edge of the taxiway by the jet wash of D-AIQA.

On D-AIQA, the right elevator was bent and ripped and there was a 50 x 50 mm hole in the unpressurised section of the tail. The APU access panel was bent and the tail cone skin and structure near the access panel was deformed. There was also some scratching to the lower skin of the left stabiliser.

Procedures

The Rules of the Air Regulations regarding right of way on the ground, as contained in Civil Aviation Publication (CAP) 393, entitled *AIR NAVIGATION: THE ORDER AND THE REGULATIONS,* Rule 37(2)[1] stated:

> *'notwithstanding any air traffic control clearance it shall remain the duty of the commander of an aircraft to take all possible measures to ensure that his aircraft does not collide with any other aircraft'*

CAP 637, the *Visual Aids Handbook*, states that when reaching the taxi clearance limit the pilot should:

> *'stop the aircraft as close as possible to the taxi-hold position.'*

It also states:

> *'Taxi Holding Positions are normally located so as to ensure clearance between an aircraft holding and any aircraft passing in **front** of the holding aircraft, provided that the holding aircraft is properly positioned **behind** the holding position. **Clearance to the rear of any holding aircraft cannot be guaranteed.** When following a taxiway route, pilots and persons towing an aircraft are expected to keep a good lookout and are responsible for taking all possible measures to avoid collisions with other aircraft and vehicles.'*

The UK Aeronautical Information Publication (AIP) contains remarks for Manchester Airport which state:

Footnote

[1] Since the event this Rule has been amended and re-numbered.

> *'pilots are reminded of the need to exercise caution on wingtip clearances from other aircraft when manoeuvring in close proximity on the ground. Particular care should be taken in the runway holding areas and at runway crossing points.'*

CAP 493, the *Manual of Air Traffic Services* (MATS) - *Part 1*, contains statements on the responsibility of controllers and states:

> *'aerodrome control is responsible for issuing information.....to assist pilots in preventing collisions between.....aircraft and other aircraft on the manoeuvring area.'*

Controllers often discharge this responsibility by issuing pilots with instructions to follow, or give way to, another aircraft or by giving conditional clearances that begin with, for example, 'after the (aircraft type) crossing from left to right…..'.

CAP 168, *Licensing of Aerodromes*, includes instructions on the design of taxiways to ensure the largest aircraft to use a taxiway has clearance from fixed obstacles. No such provision is made in respect of clearance from other aircraft.

Analysis

Because it is difficult for pilots to assess accurately when the nose of their aircraft has reached a holding point, they regularly err on the side of caution by stopping slightly before the holding point. In this case, D-AIQA's (the A320) nosewheel stopped 24.2 m short of JA1's stop bar.

The crew of the Boeing 737, EI-DKD, had doubts about the meaning of their ATC clearance to Holding Point J1 and about the separation between their aircraft and D-AIQA. The commander's understanding was that he would not have been cleared to J1 unless wingtip clearance was assured - an understanding contrary to the warning in the UK AIP - and the instruction to 'give way' to D-AIQA caused some confusion in his mind. However, in making the decision to continue, the commander was also considering other information. He thought that D-AIQA was going to move forward, otherwise he surmised that he would have been instructed to 'hold position'. This view was reinforced when he saw ripples on puddles of water behind D-AIQA's engines, leading him to think that power had been increased, and the co-pilot confirmed that the wingtip was clear.

The ADC's expectation was that the crew of EI-DKD would not proceed unless safe to do so. Also, the distance and aspect of the ADC's view from the VCR made it difficult for him to intervene early enough to prevent the collision.

Follow-up action

Previously, a similar accident occurred at Manchester Airport in February 2007, at the same position on the aerodrome manoeuvring surface. Following the second event, as described in this report, the authorities at Manchester Airport, in conjunction with ATC, conducted a review of the local procedures and introduced the following changes:

1. The Ground Movement Controller would only clear an aircraft to the intermediate position at J4, the holding position on the taxiway prior to the holding position at JA1.

2. The Air Controller would give clearance beyond J4 but only when there were no

aircraft positioned at the intermediate holding position at JA1.

3. The use by ATC of the phrase 'give way' was withdrawn.

The airport authority reported that, since their introduction, these changes have proved effective.

Note: A report on the accident involving a Boeing 777, AP-BGY, and a DHC-8, G-JEDR, which occurred at Manchester Airport in February 2007, is also published in this Bulletin.

SERIOUS INCIDENT

Aircraft Type and Registration:	Airbus A321-231, G-MEDF
No & Type of Engines:	2 International Aero Engine V2533-A5 turbofan engines
Year of Manufacture:	2002
Date & Time (UTC):	14 October 2009 at 0545 hrs
Location:	North of Casablanca, Morocco
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 7 Passengers - 73
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	49 years
Commander's Flying Experience:	7,500 hours (of which 3,593 were on type) Last 90 days - 143 hours Last 28 days - 32 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

During a flight from Freetown, Sierra Leone to London Heathrow Airport, the commander was taken ill. Following an initial bout of sickness, he felt considerably improved and, after consultation with the crew, he decided to continue with the flight, with the co-pilot assuming the role of PF. Later in the flight the commander's sickness returned, requiring him to be vacant from the flight deck at more frequent intervals and for greater periods of time. One of the operator's cabin crew, who was positioning on the flight, was brought onto the flight deck jump seat to assist the co-pilot. The commander's condition eventually deteriorated to the extent that he was no longer able to play a role in the operation of the aircraft and he formally relinquished command to the co-pilot. From this point, a diversion was planned and initiated to Malaga and medical assistance was requested. The approach and landing were uneventful and, on arrival, the aircraft was met by an ambulance. The commander was taken to hospital and subsequently made a full recovery. Medical tests were unable to determine the precise cause of his illness.

ACCIDENT

Aircraft Type and Registration:	Avro 146-RJ100, G-BXAR
No & Type of Engines:	4 Lycoming LF507-1F turbofan engines
Year of Manufacture:	1997
Date & Time (UTC):	13 February 2009 at 1940 hrs
Location:	London City Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 5 Passengers - 67
Injuries:	Crew - None Passengers - 2 (Minor)
Nature of Damage:	Nose landing gear fractured, internal and external damage to lower forward fuselage
Commander's Licence:	Air Transport Pilot's Licence
Commander's Age:	35 years
Commander's Flying Experience:	4,730 hours (of which 2,402 were on type) Last 90 days - 73 hours Last 28 days - 21hours
Information Source:	AAIB Field Investigation

Synopsis

Following an uneventful ILS approach to Runway 27 at London City Airport, the nose landing gear collapsed as it was lowered onto the runway during the landing. The cockpit and cabin subsequently filled with dense smoke. After coming to a stop, all passengers and crew evacuated the aircraft on the runway. Three passengers were subsequently treated for minor injuries and two were kept in hospital overnight.

The nose landing gear had fractured due to the presence of a fatigue crack in the upper internal bore of the landing gear main fitting. The crack had formed as a result of poor surface finish during manufacture and the incomplete embodiment of Messier Dowty Service Bulletin SB 146-32-150, which the landing gear maintenance records showed as being implemented at its last overhaul in June 2006. CAA Airworthiness Directive 002-06-2000 mandated BAE Systems Service Bulletin 32-158, which referred to Messier Dowty SB 146-32-149; this required repetitive inspections of of the nose landing gear. As SB 146-32-150 was the terminating action for Service Bulletin SB 146-32-149, the operator was not then required to conduct any repetitive in-service inspections designed to detect the onset of fatigue cracks.

History of the flight

G-BXAR was on a scheduled flight from Amsterdam Airport, Holland, to London City Airport. The sector to London City and the ILS approach to Runway 27 were uneventful. After touching down on the main wheels the commander, who was the pilot flying, lowered the nosewheel onto the runway. As she did so, the aircraft continued to pitch down until the fuselage contacted the surface. She then applied the wheel brakes fully as smoke started to emanate from behind the instrument panel; this was followed by the illumination of the ELEC SMOKE warning. As smoke filled the cockpit, the co-pilot transmitted to ATC that they were stopping on the runway, following which the commander transmitted a MAYDAY to ATC which included the intention to evacuate once the aircraft had stopped.

Once the aircraft had come to a stop, the commander shutdown the four engines and ordered an evacuation of the passengers over the aircraft's public address (PA) system. The crew then donned their oxygen masks. The co-pilot operated the engine fire handles in the overhead panel but, due to the density of the smoke at this time, he could not see them and was only able to find them by feel. Having completed their evacuation drills, the commander tried to open the locked flight deck door, first by operating the electric unlock switch at the rear of the centre console then, manually, by attempting to slide the latch handle on the door. She was only able to reach the door by removing her oxygen mask, due to the restrictive length of the supply hose. The commander then leant out of her 'direct vision' (DV) window and saw the Purser who stated that all passengers had safely evacuated the aircraft. The crew then vacated the aircraft via the cockpit DV windows.

Evacuation

The evacuation was executed by the three cabin crew members on board. An analysis of questionnaires submitted to the passengers by the AAIB indicated that all bar one passenger left the aircraft via the rear slides. The Purser, who was seated by the front left door, stated that when she attempted to use the PA she found that it was not working. She subsequently shouted[1] "come this way undo your seat belts and get out" many times, and was surprised that only one passenger used the front left exit. As a result, numerous passengers commented in the questionnaires that there was a queue in the cabin aisle while they waited to exit the aircraft, although the cabin crew members reported that passengers queuing to exit was not an issue. The PA system was subsequently tested and found to be serviceable, but had ceased to operate as it had been deprived of generated electrical power after the engines were shut down, and as a result of damage to the forward fuselage causing the battery to disconnect.

The majority of the passengers who suffered minor injuries had grazed their hands as they came off the escape slide, and some suffered a slight sprain to an ankle or wrist. Two more seriously injured passengers spent a night in hospital.

Recorded information

The aircraft was fitted with a solid-state flight data recorder (FDR) and cockpit voice recorder (CVR). Both were recovered, successfully downloaded at the AAIB and captured the incident landing at London City Airport.

The FDR data confirms an uneventful approach with

Footnote

[1] The operator's Standard Operating Procedures require cabin crew to shout instructions in such an emergency situation.

main wheel touchdown at 19:39:33 hrs. Recorded peak normal acceleration at touchdown was 1.5g after which the aircraft de-rotated from a nose-up pitch attitude of 3.25° at approximately 5° per second. The nose leg squat switch registered that the nosewheel oleo had compressed after which the pitch attitude decreased to below 0° as the nose landing gear collapsed. The CVR recordings confirmed this with the commander issuing a Mayday call as the aircraft came to a stop.

Initial examination

The presence of scoring along the runway, together with a trail of hydraulic fluid, indicated that the nose landing gear had fractured shortly after the aircraft touched down. It came to rest on the runway centreline approximately 500 metres beyond the touchdown point. The landing gear had folded rearwards and penetrated the forward equipment bay. This allowed significant

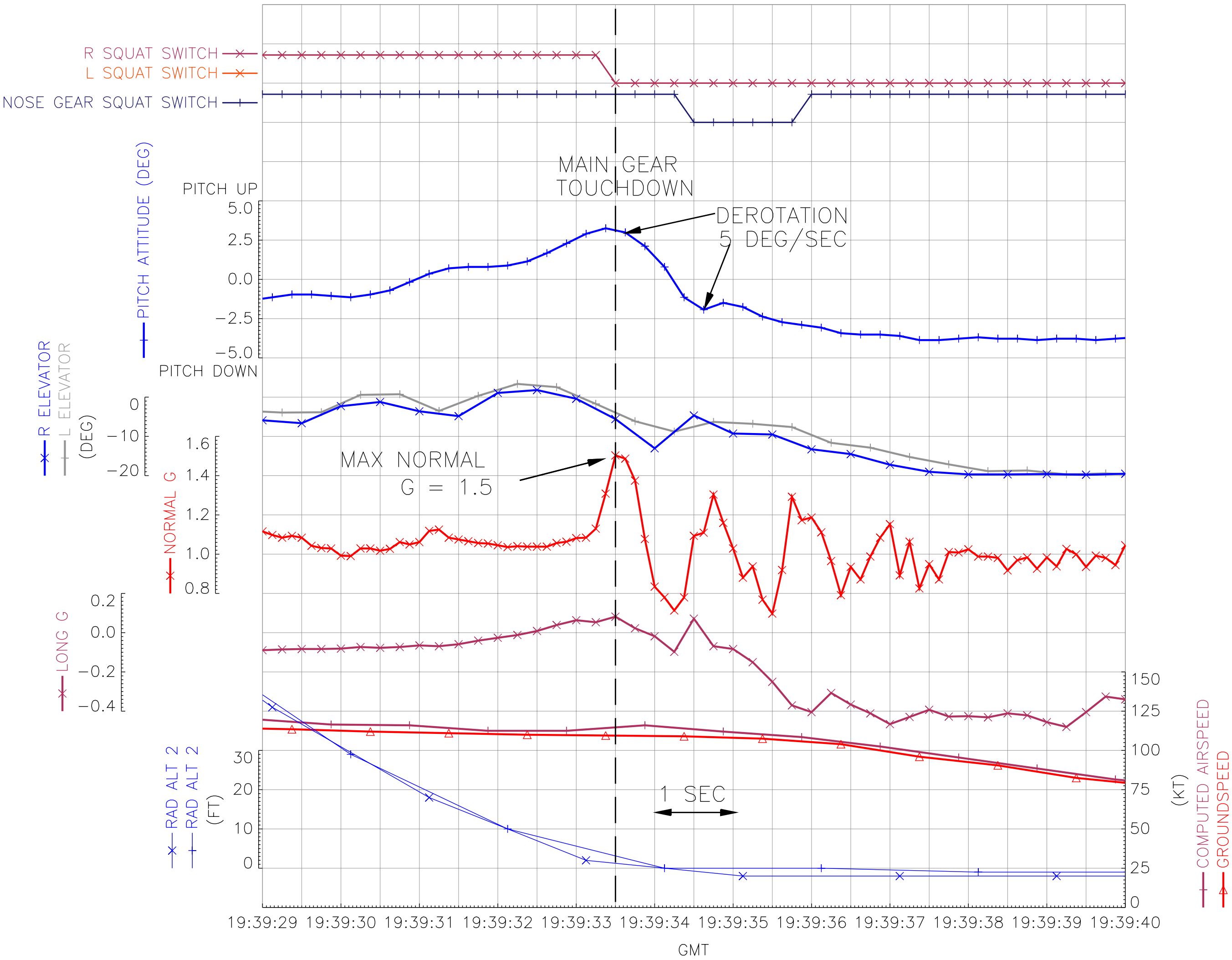

Figure 1

G-BXAR FDR Parameters

damage to be caused to the nose landing gear doors, the fuselage skin and structure immediately aft of the nose landing gear bay and severe abrasion to the forward face of the lower section of the nose landing gear, as the aircraft's lower fuselage scraped along the runway.

The floor of the equipment bay had been destroyed and the aircraft battery had been forced from its mountings, disconnecting one of the battery cables. After jacking up the nose of the aircraft, examination of the landing gear revealed that it had fractured at a point above its pivot and near to the top of the leg, which supports the down and up lock latch, Figure 2.

The retraction actuator and torque links had also broken. The upper portion of the landing gear main fitting was relatively undamaged and visual examination of the fracture surface indicated several relatively small areas of crack progression due to a fatigue mechanism, together with a large area characteristic of a failure in overload.

The nose landing gear was removed from the aircraft for detailed examination by the manufacturer in conjunction with the AAIB.

Figure 2

View showing failed nose landing gear and lower fuselage damage

Cockpit door

G-BXAR is fitted with a manufacturer's approved reinforced cockpit door. When locked, no means is provided to open the door from the passenger cabin. The door can be unlocked from the cockpit either manually, by directly releasing the lock on the door, or remotely, through the use of an electrically operated release switch located at the rear of the centre pedestal. Power for the remote cockpit door release is provided by the aircraft's AC electrical power supply and the loss of AC power renders this door release system inoperative. An examination of the door confirmed that the manual door release mechanism operated normally.

Nose landing gear main fitting

During the certification testing of the nose landing gear main fitting conducted by Messier Dowty, the test specimen completed 360,532 flight cycles without failure. However, a subsequent NDT inspection identified a fatigue crack in the upper section of the internal bore that had propagated partially through the radial wall. The surface finish (roughness) of the inner bore was confirmed as being within the limit specified at production of 3.2 microns. A second fatigue test specimen subsequently failed at 43,678 cycles without fracture before a fatigue crack was identified in the upper internal bore that had propagated fully through the radial wall section. Measurement of the inner bore showed that its surface roughness was 6.95 microns, which exceeded the production limit. Examination of the two test specimens revealed that the high value of surface roughness present in the second specimen had resulted in a significant reduction in the number of flight cycles required to initiate a fatigue crack in the material. As a result of these tests, the manufacturer issued Service Bulletin SB 146-32-149, in June 2000, which introduced a repetitive ultrasonic inspection of the main fitting bore every 2,500 flight cycles (once the main fitting exceeded 8,000 flight cycles since new), Figure 3. This inspection was mandated by CAA Airworthiness Directive AD 002-06-2000.

In addition, Service Bulletin SB 146-32-150 was published which introduced a maximum surface roughness value of 1.6 microns of the main fitting internal bore, together with a shot-peening process, to restore the fatigue life of the main fitting. Incorporation of SB 146-32-150 was introduced into future production and spares manufacture of main fittings, and was recommended to be retrospectively embodied at next overhaul for in-service main fittings. Incorporation of this SB terminated the repetitive inspections introduced by SB 146-32-149 and CAA AD 002-06-2000. The data plate attached to the fitting indicated that the failed unit had been modified in accordance with Messier Dowty SB 146-32-150.

The nose landing gear main fitting installed on G-BXAR had accumulated 18,299 flight cycles from entry into service prior to fracturing, and its maintenance records showed that it had been overhauled by Messier Services Inc. at their facility in Sterling, Va, USA[2] in January 2006, 3,302 cycles prior to failure. The records confirmed that SB 146-32-149 and -150 had been incorporated at that time. Therefore, after installation on G-BXAR, due to the declared incorporation of SB 146-32-150, the operator was not required to carry out further repetitive inspections of the main fitting in accordance with SB 146-32-149.

Footnote

2 This facility has since closed.

MESSIER-DOWTY

Messier-Dowty Ltd

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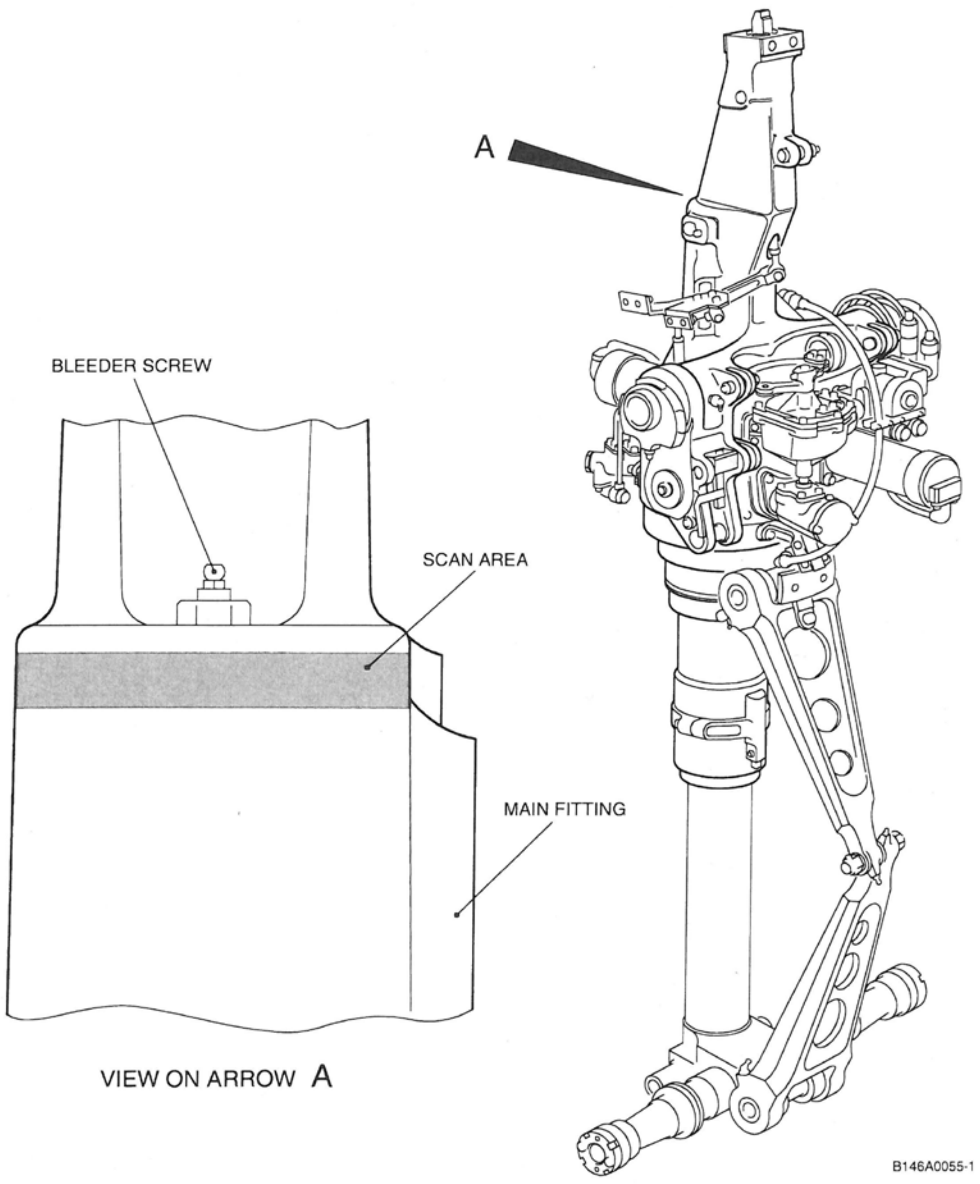
SERVICE BULLETIN



Main Fitting Inspection
Figure 1

Apr 17/2000

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Page 4

Figure 3

Messier Dowty SB 146-32-149 Inspection area

Detailed examination

Metallurgical examination of the main fitting confirmed that there were no material or microstructure abnormalities. However, examination of the main fitting fracture surface identified the presence of three fatigue cracks, which had become conjoined to form a single crack extending 23.2 mm around the circumference of the upper section of the internal bore, with a maximum depth of 2.21 mm, Figure 4. The location of the fatigue cracks was the same as found on the two fatigue tests.

A count of the striations within the fatigue cracks indicated that crack propagation had occurred for approximately 2,800 cycles prior to failure. The origin of these fatigue cracks was in the trough of a fine circumferential machining groove produced in the bore at the time the unit was manufactured. Smaller cracks were also found along the same groove and in adjacent grooves. Examination of the inner bore confirmed that the shot-peening process had been carried out, in accordance with the requirements of SB 146-32-150, but that the surface roughness close to the origin of the fatigue cracks was 9.5 to 10.1 microns, in excess of the finish specified in the service bulletin.

Examination of the landing gear actuator and torque link confirmed that they had both failed as a result of the failure of the main fitting.

Conclusions

Following a normal touchdown, the fracture of the nose landing gear main fitting allowed the nose gear to collapse rearwards and penetrate the lower fuselage, causing significant damage to the equipment bay and the battery to become disconnected. The penetration of the fuselage allowed smoke and fumes produced by the consequent release of hydraulic fluid to enter the cockpit and passenger cabin. With the battery

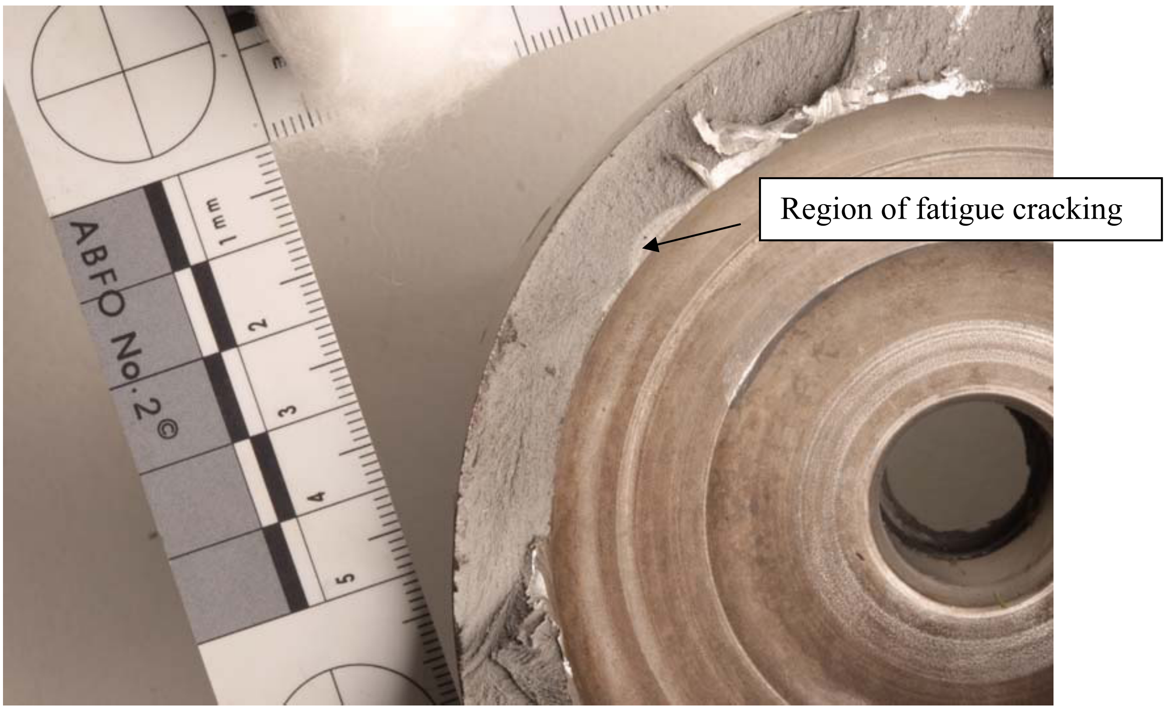


Figure 4

Fracture surface of main fitting

disconnected and after the engines were shut down, all power to the aircraft PA systems was lost and the remote cockpit door release mechanism became inoperative. No pre-accident defects were identified with the manual cockpit door release mechanism or the PA system.

The nose landing gear main fitting failed following the formation of multiple fatigue cracks within the upper section of the inner bore, originating at the base of machining grooves in the bore surface. These had formed because the improved surface finish, introduced by SB 146-32-150, had not been properly embodied at previous overhaul by Messier Services Inc, despite their overhaul records showing its incorporation. The operator had been in full compliance with the Service Bulletin relating to regular inspection of the main fitting, and embodiment of SB 146-32-150 at overhaul removed the requirement for these inspections by the operator.

Safety action

As a result of this accident the following safety actions have been taken:

BAE Systems Alert Service Bulletin A32-180, issued on 25 February 2009, reintroduced the repetitive in-service inspection requirements of Messier Dowty SB 146-32-149 on nose landing gear main fittings that had SB 146-32-150 embodiment claimed by Messier Services Inc. EASA Airworthiness Directive 2009-043-E, also issued in February 2009, mandated this Service Bulletin.

Messier Dowty published Service Bulletin SB 146-32-174 on 26 August 2009, which introduced an improved ultrasonic inspection technique and a shorter re-inspection interval for the affected nose landing gear main fittings, which superseded SB 146-32-149.

BAE Systems subsequently re-issued Alert Service Bulletin A32-180 (Revision 1), which introduced Messier Dowty SB 146-32-174 and canceled the requirements of Messier Dowty SB 146-32-149.

Messier Dowty issued Service Bulletin SB 146-32 173 on 30 September 2009, which required borescope inspection of nose landing gear main fittings overhauled by Messier Services, Sterling, Virginia, to verify the proper incorporation of Messier Dowty SB 146-32-150.

EASA Airworthiness Directive 2009-0197-E, published on 7 September 2009, mandated the requirements of BAE Systems Alert Service Bulletin A32-180 Revision 1, and Messier Dowty Service Bulletin SB 146-32-174.

As the foregoing safety actions have been implemented, no Safety Recommendations are made.

ACCIDENT

Aircraft Type and Registration:	BAC 167 Strikemaster Mk 80, G-UPPI
No & Type of Engines:	1 Rolls-Royce Viper 535 turbojet engine
Year of Manufacture:	1969
Date & Time (UTC):	26 April 2009 at 1543 hrs
Location:	Witheridge, near Tiverton, Devon
Type of Flight:	Private (Training)
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - 1 (Serious) 1 (Minor) Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	34
Commander's Flying Experience:	4,610 hours (of which 48 hours were on type) Last 90 days - 75 hours Last 28 days - 14 hours
Information Source:	AAIB Field Investigation

Synopsis

An instructor was carrying out a training flight with his student. This was the second flight of the day and as part of the sortie the aircraft was rolled inverted for approximately five seconds, which was within the permitted negative g time limitation. Shortly after the aircraft had been rolled back to the normal wings level attitude, the engine flamed out and, despite two attempts, it failed to relight. A forced landing was carried out into a field, during which the aircraft struck a substantial earth bank at the upwind end, sustaining severe damage. The instructor suffered a serious back injury and the student received a minor injury. There was no fire.

Background

The instructor was an experienced, serving military fast jet pilot who had conducted training and display flying on the Jet Provost aircraft, of which the Strikemaster is a variant. On 25 April 2009, he ferried a Strikemaster from RAF Church Fenton to Exeter Airport, arriving at 1355 hrs. He was due to conduct initial training for the co-owner of G-UPPI, another Strikemaster, who was new to the type. The afternoon was spent carrying out ground training, which included touch drills from the Flight Reference Cards (FRCs), discussion of the aircraft systems and some of the emergency procedures. The instructor's final task that afternoon was to prepare a brief for a three-aircraft formation sortie the following morning. Meanwhile, the student observed a ground run on G-UPPI.

The next day, the instructor carried out the formation brief before he and his student went out to their aircraft. The instructor demonstrated the pre-flight inspection to the student and noted that there was no emergency battery fitted to the aircraft. He checked if the battery was required for the flight and was informed that it was not. On this flight, he occupied the left seat, as the pilot flying, allowing his student to gain a better understanding of the aircraft by observing his actions from the right seat. The engine was started normally using a ground electrical power supply and the formation sortie was completed without incident. On the completion of the sortie, an after-flight inspection was carried out and the engine oil level was noted as full.

History of the flight

The instructor briefed his student that the second flight that day would involve general handling, throughout the aircraft's speed range, and a demonstration of some aerobatic manoeuvres, including inverted flight. The student would occupy the left seat and the commander the right. After completing the briefing, the pilots of the other two aircraft requested a short formation sortie before they departed for their home airfields. Based on the earlier briefing, the instructor agreed to this, with his aircraft occupying the number three position in the formation.

He carried out the pre-flight inspection, again noting that the emergency battery was not fitted, and joined his student in the cockpit. The engine was started using the aircraft's internal batteries and the start cycle was noticeably slower and hotter than normal. The normal operation of the igniters was clearly audible but the acceleration from 15% to 30% engine rpm (ERPM) was particularly slow. When the ERPM indicated about 18%, the Jet Pipe Temperature (JPT) rapidly increased through 500°C and the pilot prepared to close the HP cock. The rate of increase slowed and the JPT peaked at 610°C before dropping back within the normal temperature range. Despite the start being slower and hotter than normal it remained within permitted limits.

The After Start and Taxi checks were completed, which included confirming that the DC voltages were indicating in the green sector, and the aircraft was taxied as the number three aircraft for a formation departure from Runway 08. The 'After Line-Up' and 'After Takeoff' checks both included checking the Standard Warning Panel (SWP) for any illuminated captions. No captions or warnings were visible. The takeoff was carried out using 95% ERPM and the close formation element of the sortie was complete after approximately five minutes. For the next 40 minutes, the instructional part of the sortie was flown as briefed, using the large gaps in the weather over north Devon. Regular cruise checks were carried out and the wing tip fuel transfer was isolated at the appropriate time. Throughout the sortie, all the aircraft systems operated normally and no SWP captions or other warning lights illuminated. The voltage of the main busbar was normal and the GEN warning light did not illuminate, indicating that the generator was producing a voltage of at least 26 volts, enough to charge the batteries.

The weather was not suitable for aerobatics and a recovery back to Exeter Airport was initiated. The aircraft was decelerated to 140 kt at 2,400 ft on the Exeter QFE which, given their location, was approximately 2,000 ft agl. A clear horizon became visible, so the instructor took control to carry out the inverted flight check. He accelerated the aircraft to 200 kt, checked that his student's straps were secure and carried out the appropriate airmanship checks for the manoeuvre. The fuel remaining was 1,200 lbs; it was equally balanced and the tip tanks were isolated. The instructor selected

90% ERPM, pitched the nose up slightly and rolled the aircraft to the left adopting an inverted, wings level attitude, which he pointed out to his student whilst noting a small rate of descent. The aircraft was rolled to the left after approximately five seconds adopting the normal upright, wings level attitude. The time spent inverted was within the aircraft limits established for the engine lubrication and fuel systems.

The aircraft had been level for only a couple of seconds when the instructor noticed a change in engine note and the aircraft slowing down, accompanied by the nose pitching gently down. He checked the ERPM, which showed the engine slowly winding down through 50% ERPM. He informed the student that the engine had flamed out and initiated a 2g turn to the right in order to ensure a positive fuel supply. The throttle was closed and the relight button on the High Pressure (HP) fuel cock was pressed, to restart the engine. After about two seconds of pressing the relight button, the electrical systems failed. After some 30 seconds the engine had not restarted and the instructor released the relight button. The electrical systems recovered but when he tried to transmit a distress call the electrics faded again.

Without a successful relight, the instructor selected a large, open grass field which had its longest dimension approximately into the light south-easterly wind. He set up a forced landing pattern to the right and, with the aircraft trimmed for 130 kt, flew a constant sight line, angle approach while he attempted a cold restart from memory, without success. Once again the electrical systems failed and the instructor concentrated on executing the forced landing. Prior to the flight he had decided to eject only in the event of a loss of control or if a safe forced landing was not possible and had briefed his student to that effect. He selected mid-flap followed by full-flap, with the landing gear remaining up, and re-trimmed for an airspeed of 110 kt. The aircraft passed over some trees at the downwind end of the field with the IAS reduced to 100 kt and touched down positively. The aircraft did not appear to slow down on the wet grass surface as much as the instructor had expected and headed towards what appeared to be a substantial hedge at the end of the field. He had to shout to his student to brace, due to failure of the aircraft intercommunication system, and helped him to place his hands on the instrument coaming in a brace position. This resulted in the instructor not being properly braced when the aircraft impacted what turned out to be an earth bank, with a hedge on top. The aircraft struck the bank at approximately 50 kt and came to a rapid stop. The lack of bracing contributed to the instructor's back injury.

The instructor saw debris fly up and heard the rush of what he believed was fuel flowing. There was a significant pain in his back and he was concerned that the ejection seats may have been dislodged and might fire. He switched the Low Pressure (LP) and HP fuel cocks OFF, turned the battery OFF and checked for any signs of fire, of which there were none. Both crew made their seats safe, using the ejection seat pins, but realised they could not open the canopy manually. The instructor pulled the canopy emergency jettison handle and the canopy was blown up and backwards, allowing the pilots to exit the cockpit. They moved upwind of the wreckage and walked to a nearby farmhouse to summon assistance. The emergency services arrived shortly afterwards and both pilots returned to Exeter Airport. Later that afternoon, the instructor became increasingly aware of the pain in his back and attended the casualty department at the local hospital.

Recorded data

The aircraft was not, and was not required to be, equipped with any type of data recorder. Two GPS receivers were fitted; one was of a type that does not record a GPS track and the other relied on an internal battery to maintain the memory used to store a GPS track. However, the age of the internal battery had exceeded its recommended replacement period by 50% and did not have sufficient voltage to maintain the memory. A track was recorded by Burrington radar but it was limited to primary radar returns and did not record altitude information. It only covered part of the flight and no recorded data was obtained that was of benefit to the investigation.

Accident site

It was established that the aircraft had cleared an 8 m high line of trees before touching down in a level attitude, with the wheels retracted and flaps extended, 132 m into a field which was approximately 380 m in length. The aircraft skipped six times before it collided with an earth bank, approximately 2 m high, 3 m deep and covered with a mature hawthorn hedge, which was at the far boundary of the field. The field was the largest open space in the area and at the time of the accident the grass surface was damp and relatively slippery.

The tail skid had made an indentation in the last few ground marks, indicating that the aircraft struck the bank in a slightly nose high attitude. The aircraft's nose was extensively damaged, its back had broken aft of the cockpit area and the left wing had separated from the fuselage. Both wings had been extensively damaged and fuel had leaked into the local water course. The canopy was found lying upside down on top of the right wing. The ejection seat safety pins had been fitted to the seat-pan and face-blind firing handles on both seats but the guillotine sear, drogue gun and canopy jettison sear safety pins were still located in the storage panel in the cockpit.

Detailed examination of the aircraft

General

Whilst the wings and the structure forward and aft of the cockpit area were extensively damaged, there was little damage to the cockpit area. Both ejection seats were undamaged and one of the two cartridges in the canopy jettison system had operated – it is normal for only one of the cartridges to operate. The inertia (crash) switch, the fire extinguisher and its cockpit indicator had all operated. All the fuses in the DC electrical system were checked and found to be intact.

Batteries

The Strikemaster is designed to operate with a main and an emergency battery, with the latter providing power to essential services, such as the engine starting control and engine relight. The accident aircraft was fitted with two main batteries, connected in parallel, but an emergency battery had not been fitted. The main batteries were both 24 volt, twin cell, lead acid batteries that had last passed a capacity check[1] on 31 January 2009. Three days after the accident the open circuit voltage of the batteries was checked. A drop test, which is an indication of the battery's ability to provide a high load, was also carried out. One of the batteries failed the drop test and had an output voltage of 21 volts. On the second battery one of the two cells failed the drop test and the battery had an output voltage of 20.5 volts. The battery manufacturer advised the AAIB that, based on these test results, both batteries would have had approximately 30% of their capacity remaining and neither battery would be able to support a high electrical load.

Footnote

[1] Check carried out in accordance with Hawker Energy Products Manual 2602-0018 rev 2.

When an electrical load is applied across a battery it starts to discharge and the voltage drops. Once the load is removed the reaction of the acid on the battery plates causes a partial recovery of the voltage and the battery's capacity to provide electrical power. Most electrical equipment is voltage-sensitive and will cease to function when the voltage drops below a critical level.

The owners and the organisation who maintained the aircraft believed that an emergency battery was not required as the aircraft was only cleared for VMC operations. The CAA have since reviewed the records for Strikemaster aircraft and advised that the emergency battery is considered part of the approved configuration. They are unaware of any documentation authorising the removal of this emergency battery from the aircraft.

Aircraft fuel system

Each wing contains three flexible fuel tanks, one integral fuel tank and a tip tank feeding into a common collector tank situated in the centre fuselage. The fuel system is pressurised by air from the engine compressor which allows fuel to be transferred from the wing tanks to the collector tank, where an electrically driven low pressure fuel pump transfers fuel to the engine. During inverted flight, valves in the wing and collector tanks isolate the fuel system and fuel is provided to the engine by a fuel recouperator, which contains 2 gallons of fuel and is also pressurised by air from the engine compressor. The flight manual states that the duration of negative g is limited by the fuel recouperator, which for heights between 0 and 10,000 ft is 12 seconds.

The examination could find no evidence of a restriction in any of the fuel feed pipes and clean fuel was found in the collector tank, recouperator and the feed pipes to the engine. The electrical fuel pump and the inverted flight valves in the collector tank all operated normally. The flexible lining in the recouperator was found to be intact and there appeared to be no pre-impact damage to any of the fuel system pressurisation pipes.

Engine

The engine compressor and turbine rotated freely and there did not appear to be any damage to the compressor or turbine blades, nor had any debris been ingested into the engine. There was also no pre-impact damage to the engine controls. Fuel was found in all the fuel pipes and the fuel filter was found to be free of any debris.

An examination of the engine was carried out by the engine manufacturer who noted that there was a light dusting of carbon in the combustion chamber. This normally occurs when fuel is suddenly turned off whilst the engine is running at a relatively high power setting. It was also noted that whilst there was fuel in the main burner primer pipes, there was no fuel in the main burner feed pipes. All the fuel component drive shafts were intact and the gearbox turned freely. The blow-off valve, pressure ratio switch, barometric flow control unit, air/fuel ratio control unit and the high pressure fuel pump were all stripped and found to be serviceable, with no evidence of any debris that might have caused a fuel restriction.

Aircraft information

The aircraft was delivered to the Royal Saudi Air Force in 1969, where it remained in service until 1997. In May 2002, it was issued with a Permit to Fly in the UK and flown until 2004, when it was taken to South Africa. The wings were removed from the aircraft and it was shipped back, in a container, to the UK in July 2008. The aircraft next flew in December 2008 on a flight test which was required for the issue of a new Permit to Fly. During the flight test the aircraft was flown inverted for 12 seconds. The aircraft was next flown on the day of the accident.

Previous occurrence

The South African CAA reported that an in-flight electrical failure was considered to be a contributory factor to an accident which occurred on 28 October 2006, when the aircraft landed with its landing gear retracted. The report stated that the aircraft was started on main batteries and that during the flight a fuse blew causing the generator to go off-line. Following the accident both main batteries were found to be completely discharged: these batteries are believed to be the same batteries that were fitted to the aircraft during this accident flight.

Procedures and limitations

The FRCs provided information and the pilot actions in the event of engine flameout. These are shown in Figure 1.

The procedure for jettisoning the canopy states:

> ***'In Flight***
> *Fly the aircraft between 125-300 kts with the flaps up (320 kts extreme necessity only). Squeeze the jettison handle and pull firmly upwards.*
>
> ***On the Ground***
> *If possible, jettison whilst the aircraft is above 20 kts.*
>
> ***NOTE:*** *If the aircraft is stationary with the nose-wheel collapsed and any tailwind, there may be a danger of the canopy falling back into the cockpit.'*

Negative g limitation

The following limitation for negative g is set out in the Pilot's Notes:

> ***'Negative g***
> *Negative g conditions will cause the oil pressure to fall, usually to zero. Zero oil pressure is permitted for no longer than 30 seconds then normal g must be restored. Check that oil pressure builds up within 5 seconds of restoring positive g.'*

Analysis

The instructor had fully briefed his student on the sortie to be flown, including his decision to eject only in the event of a loss of control or if a safe forced landing was not possible. He was properly licensed and qualified to conduct the flight.

During the pre-flight inspection the instructor noticed that the emergency battery was not fitted to the aircraft. The inverted, negative g manoeuvre was of a short duration and less than the 30 second limitation for engine oil pressure and the 12 second below 10,000 ft for the fuel system limitation. Despite this, shortly after returning to normal flight the engine flamed out. Whilst the actions taken by the instructor during his two attempts to restart the engine were in accordance with the FRCs, the failure of the aircraft electrical system prevented the instructor transmitting a distress call and also prevented the use of the aircraft intercom.

The forced landing was made in the largest level field available, with the aircraft flaps fully lowered and the landing gear retracted. Despite the aircraft touching down at the earliest point in the field after clearing the trees, there was insufficient distance remaining for it to stop on the wet grass before it collided with the earth bank.

The light dusting of carbon in the combustion chamber, lack of fuel in the main burner fuel feed line and the

FLAME OUT

INDICATION

Reducing RPM/JPT, HYD/GEN captions may show. Loss of power, reducing engine noise.

ACTION Speed to Height

THROTTLE	**-- CLOSED**	
RELIGHT	**-- PRESS**	**(Hold for 30 secs, Check for RPM more than 40% JPT less than750°C)**
NO RELIGHT or JPTmore than 750°C		
HP COCK	**--OFF**	

UNDERWING TANKS	-- JETTISON
GLIDE	-- 130 KTS
GEAR, FLAP, S/B	-- UP AND IN
INSTRUMENTS	-- ERECT
IFF	-- EMERGENCY
RADIO	-- MAYDAY
ALTIMETER	-- SET QNH
NON-ESS ELECTRICS	-- OFF: (ADF, ILS, LIGHTS, PITOT, TACAN)

COLD RELIGHT (Below 30000')

THROTTLE	-- CLOSED
HP COCK	-- OFF
LP COCK	-- ON
SPEED	-- 120-140 KTS (Up to 200 KTS below 24000')
BATTERY	-- ON
START MASTER	-- ON
IGNITION	-- ON
TOP TEMP	-- OFF
PRESSURIZATION	-- UNPRESS
RAIN ICE	-- OFF
RELIGHT	-- PRESS AND HOLD BUTTON AS THE HP COCK IS OPENED (Hold for 30 secs or until RPM more than 40%)

After successful relight:

TOP TEMP -- ON

WARNING:

Do not select Top Temp Control ON if a failure of the system is suspected, but carefully monitor the JPT for the rest of the flight.

NO RELIGHT

HP COCK -- OFF

WAIT I MINUTE BEFORE TRYING COLD RELIGHT AGAIN

Figure 1

absence of debris in the compressor were all consistent with the engine having stopped in flight as a result of fuel starvation. Despite an extensive examination of the aircraft and engine fuel system, it was not possible to determine why the fuel interruption had occurred. The engine manufacturer informed the AAIB that, since the introduction of this engine variant, there had been a small number of unexplained engine flame outs where the engine had subsequently been restarted in flight. On this occasion, the accompanying electrical failure meant that the pilot was unable to achieve a relight of the engine.

It would appear that, following the engine failure, there was sufficient power in the battery to operate the intercom; however, once the instructor operated the relight button the battery voltage seems to have dropped below the critical level required to operate the radios and the engine relight system. His account of the electrical system recovering is consistent with a partial recovery of the battery voltage. The operation of the fire extinguisher and the cockpit indicator indicates that the inertia (crash) switches had operated and that there had been sufficient power remaining in the main batteries, to operate these systems, when the aircraft landed.

Whilst the batteries had previously passed a capacity check, following the accident they were found to be in a discharged state. Although the pilot commented that the engine took a long time to start, and it was 30 seconds before the engine was self sustaining, the aircraft then flew for approximately 45 minutes during which the generator should have been charging the batteries.

From the accident in South Africa, it is apparent that the batteries on this aircraft, one of which was 15 years old, appeared to take some time to recover their charge following an engine start and it is possible that they were reaching the end of their working life. It is also possible that there was an electrical short circuit on the aircraft which slowly drained the batteries. However, due to the disruption of the electrical system it was not possible to identify such a fault.

Conclusion

The cause of the engine run-down was not established but the loss of electrical power from the two main batteries and absence of an emergency battery meant that the engine could not be restarted. The aircraft was designed to be operated with an emergency battery and haad it been installed, it would have allowed the pilot the opportunity to attempt a relight of the engine.

The CAA subsequently investigated the UK fleet of Strikemaster aircraft and concluded that all the remaining aircraft of this type currently on the UK register had an emergency or third battery fitted, in accordance with the approved configuration.

INCIDENT

Aircraft Type and Registration:	Boeing 757-236, G-LSAA
No & Type of Engines:	2 Rolls-Royce RB211-535E4-37 turbofan engines
Year of Manufacture:	1988
Date & Time (UTC):	2 March 2009 at 1327 hrs
Location:	FL390, 30 nm north-east of Athens, Greece
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 9 Passengers - 183
Injuries:	Crew - None Passengers - 4 (Minor)
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	63 years
Commander's Flying Experience:	14,090 hours (of which 9,371 were on type) Last 90 days - 106 hours Last 28 days - 28 hours
Information Source:	Aircraft Accident Report Form submitted by the commander, and further enquiries by the AAIB

Synopsis

The flight crew carried out an en-route climb from FL370 to FL390. Shortly before the aircraft levelled at FL390 they heard a "popping" sound and felt a pressure change in their ears. The flight crew donned their oxygen masks and, with the cabin altitude seen to be rising and uncontrollable, executed a rapid descent. The aircraft subsequently diverted to Athens Airport. A number of the passengers complained of discomfort in their ears both during and after the event.

History of the flight

The aircraft was on a flight from Manchester Airport, UK, to Taba Airport, Egypt. There were three personnel on the flight deck, two pilots and a company maintenance engineer. In an area to the north of Athens the aircraft was climbed from FL370 to FL390 with a rate of climb of approximately 1,000 fpm.

Flight crew recollections

The first indication of a problem on the flight deck was a "popping" and "whooshing"sound. The three personnel felt a pressure change in their ears and the co-pilot observed that the cabin altitude was rising at a rapid rate; he thought he saw a rate of climb of approximately 4,000 ft/min. Also, the engineer noticed that the cabin differential pressure was about 9 psi. All three donned their oxygen masks.

The flight crew were not able to recall the exact sequence of events but made the following observations. The co-pilot attempted to control the cabin altitude by switching to the manual mode and closing the outflow valve; he considered that the valve had been in its normal position before it was closed. This action was not effective in controlling the cabin rate of climb, so the commander initiated a rapid descent to a lower level. The flight crew remembered seeing an Engine Indication and Crew Alerting System (EICAS) CABIN AUTO INOP caution message but could not recall exactly when it appeared. During the descent they also noticed that an EICAS CABIN ALTITUDE warning message was displayed but they observed that it ceased after a short time. A MAYDAY was transmitted to Athens ATC, in the descent, and a passenger announcement (PA) was made to advise the cabin crew and passengers. The initial memory actions for an emergency descent were carried out and, when the action '*passenger oxygen - ON*' was reached, the flight crew discussed whether or not this action should be performed. The cabin altitude was then below 10,000 feet so the commander decided not to deploy the oxygen masks. The maximum cabin altitude seen by the flight crew during the event was between 10,000 and 11,000 feet. The commander recalled that at 10,000 feet aircraft altitude the cabin altitude indicated zero feet.

The aircraft diverted to Athens Airport. After landing and parking on stand, the doors could not be opened until the outflow valve had been re-opened and the external and internal cabin pressures had equalised. The commander reported that it took some considerable time for this to be achieved. A number of the passengers complained of discomfort in their ears both during and after the event.

Recorded flight information

The flight data recorder (FDR) did not record cabin altitude but there was a discrete parameter, recorded once a second, that indicated when the cabin altitude exceeded 10,000 feet. This discrete (*CABIN ALTITUDE > 10,000 feet*) and other salient parameters recorded on the FDR are illustrated in Figure 1. The figure shows that the cabin altitude exceeded 10,000 feet for a period of 108 seconds, starting as the aircraft climbed through 38,700 feet and ending as the aircraft descended through 33,700 feet.

Technical investigation

Post-flight maintenance activity

During an investigation carried out after the incident by the operator, a post-flight maintenance inspection of the aircraft revealed that a cabin positive pressure relief valve (CPRV) had opened. A number of components of the pressurisation system were removed from the aircraft and tested. Several of them were found to operate marginally outside the required tolerances. The operator's investigation concluded that the reduction of cabin pressure was probably caused by the premature opening of a CPRV leading to a state in which the loss of cabin air exceeded the rate of inflow. This condition would have generated the CABIN AUTO INOP EICAS message, provided the outflow valve was closed at the time.

Examination and testing of components

Of the two CPRVs and the two Cabin Pressure Controllers (CPCs) which were removed from the aircraft and sent for investigation and testing, one of the CPRVs was found to have operating pressures 0.25 to 0.45 psi lower than specified. This could have caused it to operate at a lower pressure differential than intended. The cabin pressure sensor of the active CPC was found

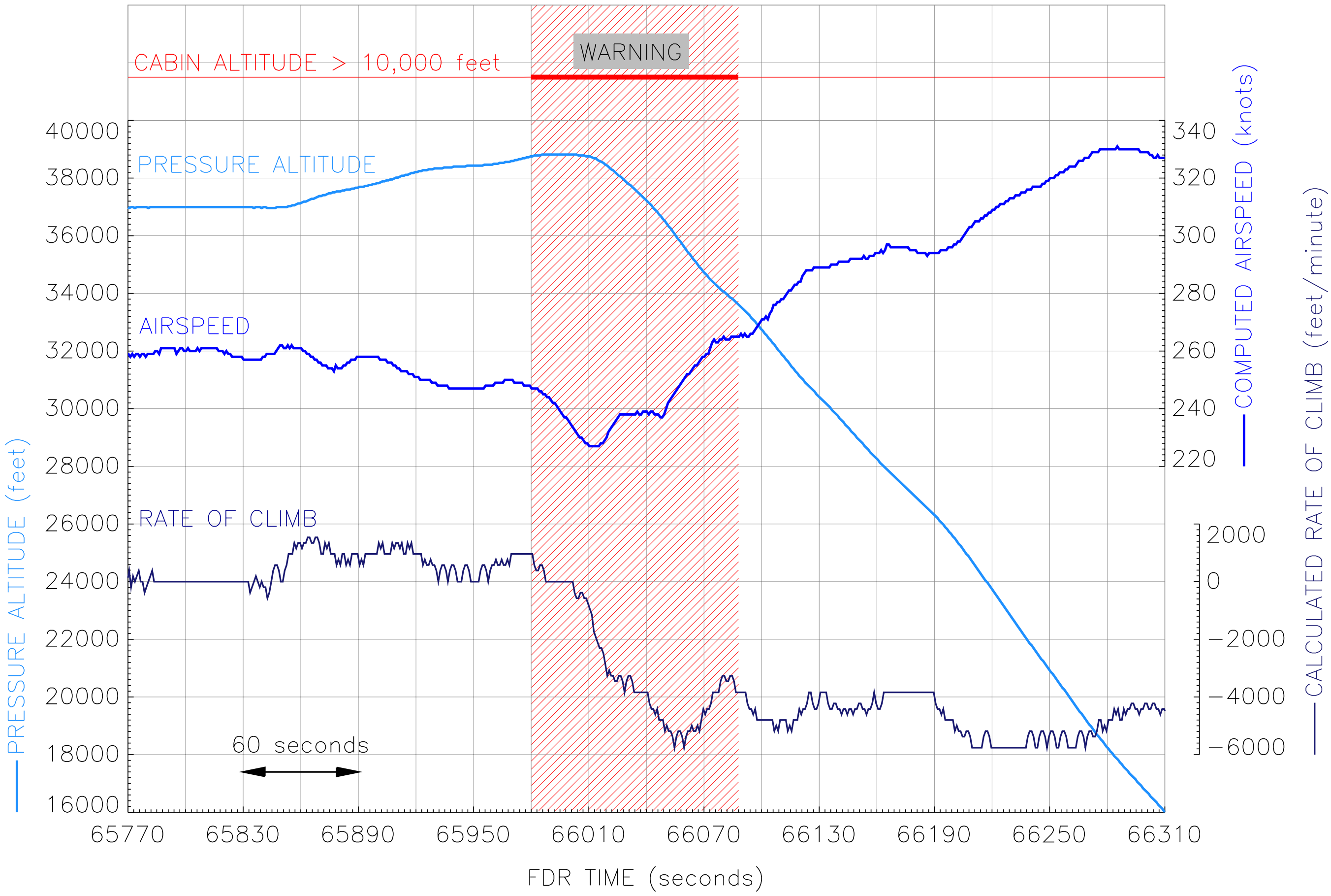


Figure 1

Salient FDR parameters

to be approximately 0.1 in Hg out of tolerance which may have raised the cabin pressure slightly higher than the 8.6 psi differential scheduled.

The manufacturer of the CPCs considered that the faults found with one CPC and a CPRV should not, individually, have caused a problem with maintaining the cabin pressure. However, it was possible that the combination of the faults caused the positive pressure relief valve to open too early which resulted in a rush of air from the cabin and caused the cabin altitude to increase.

A number of components were replaced on the aircraft and it was returned to service. No further problems with the pressurisation system have been recorded to date.

Aircraft information

A CABIN ALT discrete light and associated EICAS message are displayed when the cabin altitude exceeds 10,000 feet. There is a non-normal checklist in the Quick Reference Handbook (QRH) entitled '*CABIN ALTITUDE OR RAPID DEPRESSURISATION'*, the actions in which are all memory items.

The aircraft pressurisation system has both automatic (AUTO 1 and AUTO 2) and manual (MAN) operating modes. The EICAS caution message CABIN AUTO INOP displays when automatic control fails or when MAN mode is selected. When MAN is selected, all the automatic pressure control functions are locked out. The cabin pressure is then controlled in flight by repositioning the outflow valve manually and the cabin must be depressurised, before landing, by opening the outflow valve. There is a QRH checklist with reference items for the EICAS caution message CABIN AUTO INOP; this gives guidance about the management of the cabin pressure when using the manual mode.

The following information is included in the manufacturer's QRH:

> *'Consequential EICAS alert messages can show as a result of a primary failure condition .... The flight crew should do the checklists for consequential EICAS alert messages, unless the statement "Do not accomplish the following checklists:" is included.'*

Discussion

When the crew detected a loss of cabin pressure which they could not control, they carried out the QRH memory items, including the selection of manual mode, and initiated a rapid descent. The evidence suggests that the CPRV closed again as the aircraft descended and thus, with the outflow valve closed, the cabin re-pressurised. If the outflow valve is closed manually in flight and is not re-opened before landing, the fuselage will remain pressurised after landing, and consequently it will not be possible to open the external doors until the pressure has equalised. This seems to have been what happened in this incident.

The instructions in the manufacturer's QRH require the relevant checklists for all applicable EICAS alerts displayed to be carried out, unless there is a specific instruction not to do so. Had the *CABIN AUTO INOP* checklist been carried out, the cabin would have been depressurised before landing and the doors could have been opened.

Flight crews practise the management of pressurisation failures during recurrent simulator training. However, most often the scenario given is for a total or very rapid loss of cabin pressure, after which the cabin pressurisation remains unavailable for the rest of the flight. In this incident the circumstances were likely to be unfamiliar to the crew, in that the ability to control the cabin pressure was probably only lost for a short time; thereafter, the cabin could have been controlled manually.

ACCIDENT

Aircraft Type and Registration:	1) Boeing 777-240(LR), AP-BGY 2) DHC-8-402 Dash 8, G-JEDR
No & Type of Engines:	1) 2 General Electric GE90-110B turbofan engines 2) 2 Pratt & Whitney Canada PW150A turboprop engines
Year of Manufacture:	1) 2005 2) 2003
Date & Time (UTC):	15 February 2007 at 1220 hrs
Location:	Manchester Airport
Type of Flight:	1) Commercial Air Transport (Passenger) 2) Commercial Air Transport (Passenger)
Persons on Board:	1) Crew - 12 Passengers - 144 2) Crew - 6 Passengers - 37
Injuries:	1) Crew - None Passengers - None 2) Crew - None Passengers -None
Nature of Damage:	1) Minor scratches on right wingtip 2) Damage to the rudder
Commander's Licence:	1) Airline Transport Pilot's Licence 2) Airline Transport Pilot's Licence
Commander's Age:	1) N/K 2) 46 years
Commander's Flying Experience:	1) 14,000 hours (of which 180 were on type) Last 90 days - N/K Last 28 days - N/K 2) 9,873 hours (of which 2,000 were on type) Last 90 days - 150 hours Last 28 days - 50 hours
Information Source:	AAIB Field Investigation

Synopsis

A DHC-8-400 had stopped short of the runway, at intersection Holding Position JA1, prior to taking off. A following Boeing 777 was cleared to Holding Position J1, at the beginning of the runway, which involved taxiing beyond JA1. The crew of the B777 were cautioned about the presence of the DHC-8 as they continued towards J1. As the B777 passed behind the DHC-8, its right wingtip struck the DHC-8's rudder. The B777 suffered minor scratching to its wingtip. The DHC-8's rudder was damaged and required replacement.

History of the flight

The Boeing 777, AP-BGY, and the DHC-8, G-JEDR, were both due to depart from Manchester Airport on scheduled public transport (passenger) flights. The two aircraft pushed back from their respective parking stands, in different parts of the airport, within 10 minutes of each other and taxied towards Runway 24R[1], which was in use for departures and arrivals. The weather was benign, with good visibility and a light southerly wind.

Complying with an instruction from the Ground Movement Control (GMC) controller, the commander of G-JEDR taxied his aircraft to Holding Position JA1 (see Figure 1) and stopped the aircraft "on the line" at about 1216 hrs. The flight crew prepared for an immediate departure and waited for clearance to enter the runway. They were aware that the Boeing 777, AP-BGY, was taxiing along Taxiway Juliet and would pass behind them.

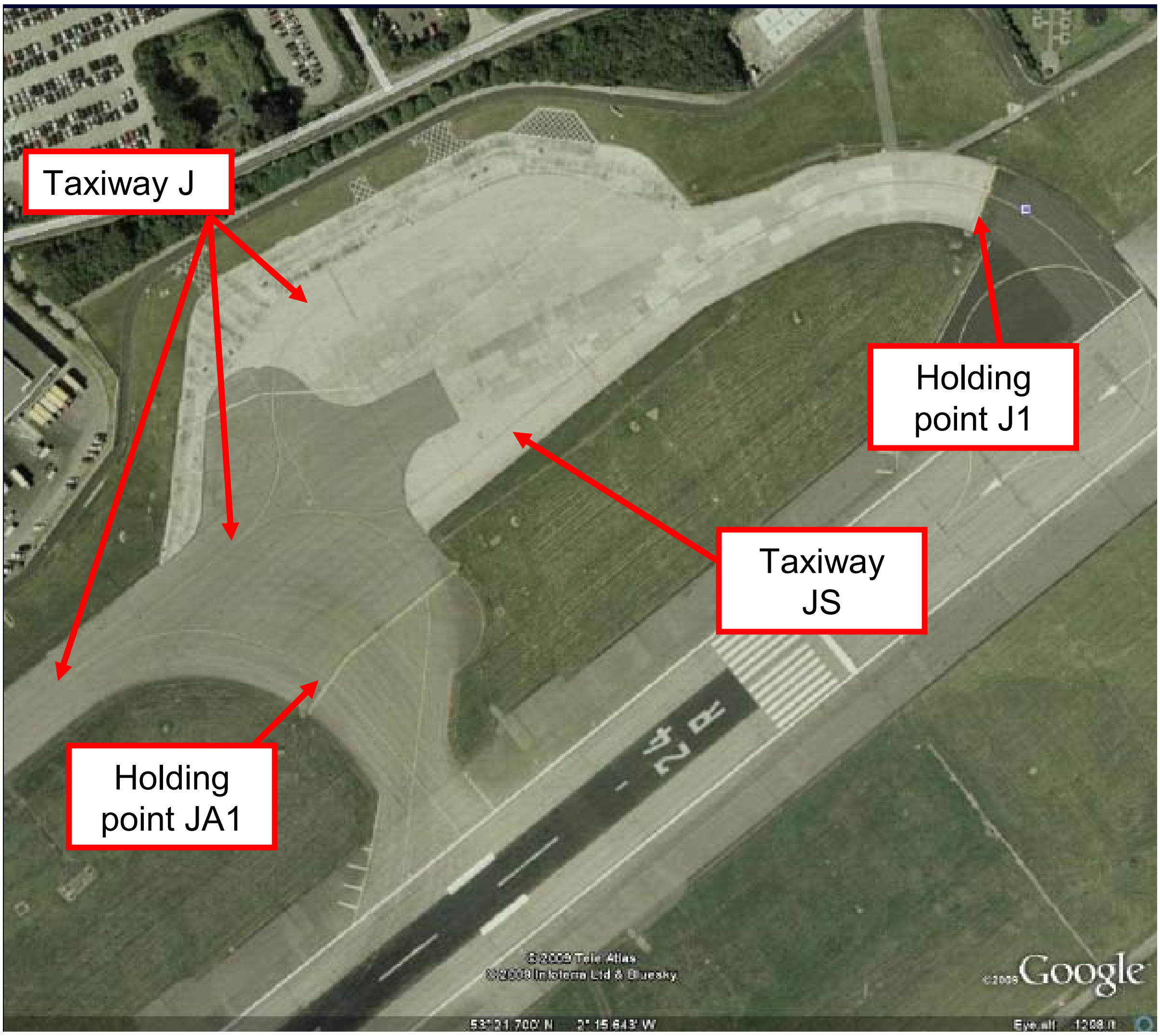


Figure 1

Footnote

1 Changes in magnetic variation since this event mean that the runways at Manchester Airport have been re-designated 23L and 23R.

The GMC controller cleared AP-BGY to taxi along Taxiway Juliet to Holding Position J1, and the co-pilot read back this clearance. The commander was the handling pilot.

At 1218 hrs, the GMC controller transmitted to AP-BGY "[CALLSIGN] JUST CAUTION THE TAIL OF THE [NAME OF DHC-8 OPERATING COMPANY] DASH EIGHT UP AHEAD OF YOU [BRIEF PAUSE] HOLD AT JULIET ONE CONTACT TOWER ONE ONE EIGHT DECIMAL SIX TWO FIVE". The co-pilot read back "ROGER JULIET ONE AND ONE EIGHT SIX TWO FIVE [CALLSIGN]". He then contacted the Tower controller, who replied "[CALLSIGN] HOLD AT JULIET ONE WHEN YOU'RE ABLE TO". The co-pilot replied "ROGER JULIET ONE [CALLSIGN]".

Approaching the point at which their aircraft would pass behind the DHC-8, the commander and co-pilot of AP-BGY discussed the position of G-JEDR. The commander stated that he believed that, in view of the ATC clearance and provided he taxied on the taxiway centreline, adequate space should exist between his aircraft and G-JEDR, otherwise the controller would have instructed him to stop. Nonetheless, the commander elected to deviate one or two metres to the left of the taxiway centreline, to increase the separation between the two aircraft.

At 1220 hrs, the right wing tip of AP-BGY struck the rudder of G-JEDR. The crew of AP-BGY were unaware of the collision, although they felt a very slight motion which the commander thought was a gust of wind. The flight crew of G-JEDR felt "a bump" through the rudder pedals and airframe. They discussed whether a collision had occurred or if they had been affected by a gust of wind. They dismissed this latter possibility as the aircraft was stationary, facing almost exactly into the wind. The commander concluded that a collision had occurred and informed ATC. The cabin crew had also felt the aircraft move but did not recognise that a collision had taken place.

The Tower controller informed the flight crew of AP-BGY of the collision. The commander of the B777 stopped the aircraft and asked the co-pilot to go into the passenger cabin to inspect the wingtip. There did not appear to be any significant damage. Meanwhile, ATC dispatched an Airfield Operations vehicle and the Airport Fire and Rescue Service (AFRS) to the accident.

Both aircraft were inspected by airport operations staff and damage to the DHC-8's rudder was discovered. The aircraft were then taxied back to parking stands at the terminal. After the collision neither aircraft's position was noted for the purposes of investigation.

GMC controller's recollection

The GMC controller recalled observing G-JEDR stationary at Holding Position JA1 and clearing AP-BGY to taxi to Holding Position J1. He had expected AP-BGY to wait until G-JEDR had moved forward from its position before continuing along Taxiway J to J1. However, he also stated that he had previously seen a B777 successfully taxi behind a DH8-Q400 which was holding at JA1, although the manoeuvre was "close" and "tight". Which variant of B777 was involved on that occasion is not known.

Tower controller's recollection

The Tower controller recalled that the GMC controller was directing some outbound aircraft to JA1, and others to J1, to provide flexibility in the outbound sequence. He recalled the flight crew of AP-BGY contacting him when G-JEDR was already holding at JA1 and instructing them to "[CALLSIGN] HOLD AT JULIET ONE WHEN YOU'RE ABLE TO", adding "WHEN YOU'RE ABLE

TO" to reflect his expectation that AP-BGY would hold before passing behind G-JEDR.

Aircraft information

The wingtips of the Boeing 777 are not visible from the flight deck. The flight deck is fitted with opening 'direct vision' windows at the sides, but the commander of AP-BGY reported that it would be most unusual for the windows to be opened during taxiing.

Engineering examination

Both aircraft had been moved after the collision so it was not possible to determine, from physical examination, precisely where they were at the time of the impact. However, the clearances between the two aircraft were simulated using a computer generated map, based on accurate survey data, on which scale representations of various aircraft types could be displayed (see Figure 2). This indicated that there would be a clearance of 2.0 m between the rudder of a DHC-8-400 (parked with its nose precisely at the stop line at holding point JA1 and on the taxiway centreline) and the right wingtip of a Boeing 777-200LR taxiing behind it along the centreline of Taxiway J. The gap between the wingtip of the B777 and the higher trailing edge of the DHC-8's left elevator would be less, at 1.4 m.

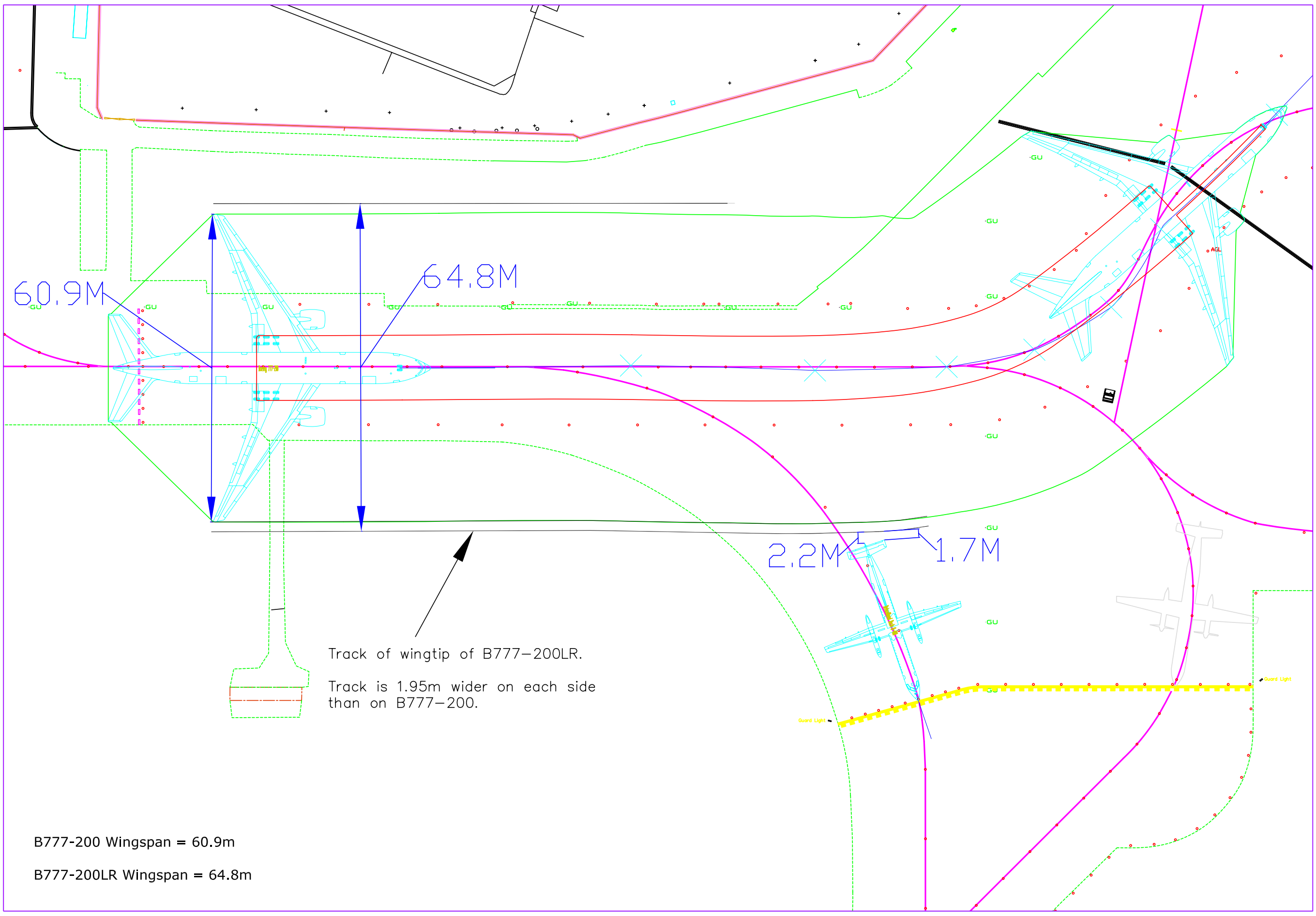


Figure 2

The trailing edge of G-JEDR's rudder had been struck just below the level of the horizontal stabiliser by AP-BGY's right wingtip. The impact had bent the trailing edge of the rudder at right angles over a length of about 80 cm. The damage was not repairable and the rudder was replaced.

There was little more than superficial scratching to the wingtip and outboard leading edge of AP-BGY's right wing which, after examination, was allowed to continue in service without requiring repairs.

Flight recorders

Introduction

Both aircraft were equipped with a Flight Data Recorder (FDR) and a Cockpit Voice Recorder (CVR), capable of recording a minimum of 25 hours of data and 120 minutes of audio respectively. Parameters recorded by AP-BGY included its heading and ground speed. A plot of the salient FDR parameters from both aircraft is provided in Figure 3.

FDR and CVR Data

The FDR and CVR were removed from both aircraft and successfully replayed.

When AP-BGY was about 100 metres from G-JEDR, it gradually decelerated (Figure 3, POINT A). There was some conversation between its flight crew about the position of G-JEDR, reflecting a concern that there would be little separation between the aircraft as they passed. As it closed to about 60 metres from G-JEDR, AP-BGY started to make a gradual turn to the left, with its ground speed reducing to about 6 kt (Figure 3, POINT B). As the turn continued, the collision occurred. There was a small oscillation of G-JEDR's rudder during the impact (Figure 3, POINT C), with associated lateral and longitudinal accelerations being recorded. There was no associated recording of an impact on AP-BGY and its flight crew made no mention of one. The flight crew in G-JEDR briefly discussed whether they had been struck, before they contacted ATC to advise "[CALLSIGN] I THINK THE AIRCRAFT BEHIND US HAS JUST CAUGHT THE BACK OF OUR WING…OUR TAIL RATHER " (Figure 3, POINT D). ATC responded by advising that they had noticed it as well and advised AP-BGY to hold position, which it did (Figure 3, POINT E).

The flight crew on both aircraft advised ATC that they would need to return to a stand to assess the damage. The commander of AP-BGY also advised ATC that "WE WERE MAINTAINING LEFT OF THE CENTRE LINE AND THEN I THINK IT CLIPPED". The commander of G-JEDR, in conversation with his co-pilot, had commented that they were "ON THE LINE". They were not sure, initially, if the aircraft had been struck, both agreeing that the rudder and aircraft movement may have been due to the jet blast from AP-BGY's engines as it passed behind them.

Manchester Airport

Manchester Airport has two parallel runways, 24L and 24R which are usually used simultaneously, with departures from one and arrivals on the other. However, only Runway 24R was in use at the time of the accident.

Air Traffic Control at Manchester

Prior to the incident, the Tower controller asked the Approach controllers to provide a mixture of gaps in arriving traffic, some of six miles and others of eight, at their convenience. He was endeavouring to achieve two departures in each eight mile gap, and one in each six mile gap. Where he planned two departures in the same gap, one would be a large aircraft using the full length of the runway, the other a smaller aircraft

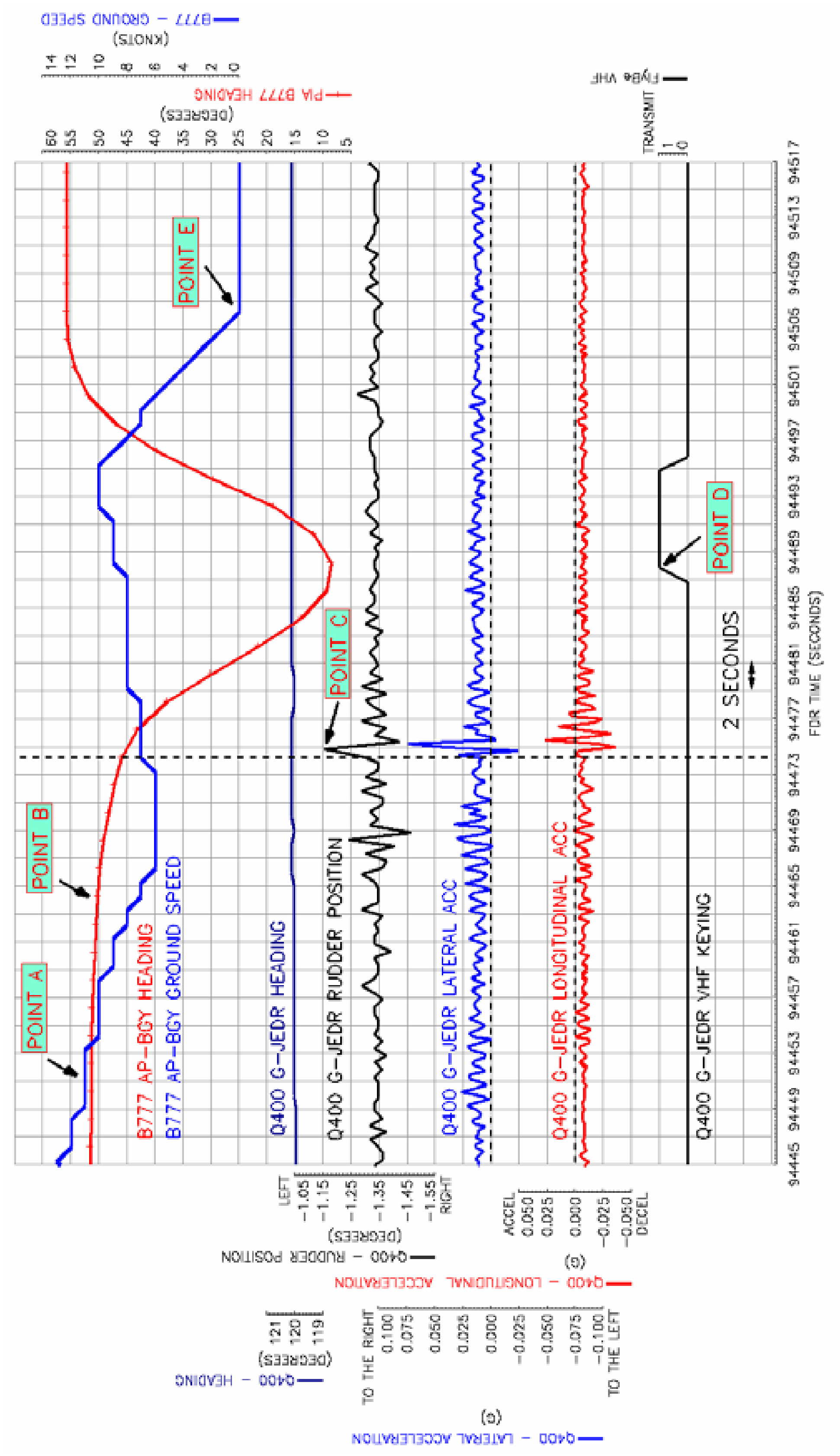

POINT A
POINT B
POINT C
POINT D
POINT E
B777 AP-BGY HEADING
B777 AP-BGY GROUND SPEED
Q400 G-JEDR HEADING
Q400 G-JEDR RUDDER POSITION
Q400 G-JEDR LATERAL ACC
Q400 G-JEDR LONGITUDINAL ACC
Q400 G-JEDR VHF KEYING
2 SECONDS
FDR TIME (SECONDS)

Figure 3

departing from an intersection. The smaller aircraft would depart first and fly on a different route from the larger, thus eliminating delays caused by separation considerations.

The GMC controller was aware of the technique being employed by the Tower controller and was using his own judgement to direct aircraft to Holding Positions J1 and JA1 to facilitate his colleague's plans.

The views from the GMC and Tower controllers positions in the Visual Control Room (VCR) are mainly unobstructed, but their distance and angle from Holding Position JA1 make it very difficult, if not impossible, to assess the clearance between the tail of one aircraft holding at JA1 and the wingtip of an aircraft on Taxiway J.

Air Traffic Control in the United Kingdom

Civil Aviation Publication (CAP) 493, the *Manual of Air Traffic Services* (MATS) - *Part 1*, gives guidance and instruction to air traffic controllers working in the United Kingdom. Under '*Aerodrome Control'*, it contains statements of responsibility for controllers undertaking various functions, including:

> *'2.1 Aerodrome control is responsible for issuing information and instructions to aircraft under its control to achieve a safe, orderly and expeditious flow of air traffic and to assist pilots in preventing collisions between:*
>
> .....
>
> *c) aircraft moving on the apron;*
> *d) aircraft and vehicles, obstructions and other aircraft on the manoeuvring area.'*

Aerodrome controllers were required to pass information to pilots as follows:

> ***'Information to Aircraft***
>
> *5.1 Aircraft under the jurisdiction of aerodrome control and in receipt of information critical to the continuing safe operation of the aircraft must be kept informed of any subsequent changes. For example:*
>
> *• changes in essential aerodrome information…*
>
> ***5.2 Essential Aerodrome Information***
>
> *Essential aerodrome information is that concerning the state of the manoeuvring area and its associated facilities that may constitute a hazard to a particular aircraft. It shall be issued to pilots in sufficient time to ensure the safe operation of aircraft… Essential aerodrome information shall include:*
>
> *e) aircraft parked close to the runways or taxiways and aircraft engaged in ground running of engines'.*
>
> ***9.3 Taxi Clearance***
>
> *'The importance of issuing clear and concise instructions to taxying aircraft cannot be over-emphasised. The visibility from an aircraft flight deck is limited and, when taxying, the pilot is dependent to a large degree upon aerodrome control to assist him in determining the correct taxi route to be followed. Essential aerodrome information is to be passed to the pilot to assist him in preventing collisions with parked aircraft and obstructions on or near the manoeuvring area.'*

Where there is a collision risk on the ground between two aircraft, controllers routinely instruct pilots to follow or give way to another aircraft, or issue conditional clearances such as 'after the (aircraft type) crossing from right to left…'.

Published instructions to pilots

CAP 637, the *Visual Aids Handbook*, states:

> *'At major aerodromes in the UK, taxiway width is determined so as to ensure a specified minimum clearance between the taxiway edge and the main undercarriage outer wheels of the largest aircraft that the taxiway is designed to accommodate. This minimum wheel clearance is assured in turns provided that the pilot keeps the 'cockpit' over the taxiway centreline.'*

And

> *'Upon reaching a Taxi Holding Position identifying a taxi clearance limit, the pilot should stop the aircraft as close as possible to the Taxi-Hold Position Marking, ensuring that no part of the aircraft protrudes beyond the marking.'*

Conflicting demands are placed on a pilot, to stop as close as practicable to the taxiway holding position marking and yet to avoid runway incursion by ensuring that no part of the aircraft protrudes over the marking. If an aircraft has been stopped with the foremost part of its structure exactly over a hold position marking, the flight crew may find it difficult or impossible to see any stop bar co-incident with the hold position. Therefore, it is normal practice to stop short of the marking.

CAP 637 also states:

> *'Taxi Holding Positions are normally located so as to ensure clearance between an aircraft holding and any aircraft passing in front of the holding aircraft, provided that the holding aircraft is properly positioned behind the holding position. Clearance to the rear of any holding aircraft cannot be guaranteed. When following a taxiway route, pilots and persons towing an aircraft are expected to keep a good lookout and are responsible for taking all possible measures to avoid collisions with other aircraft and vehicles.'*

UK Aeronautical Information Publication (AIP)

In the entry *Manchester Aerodrome - Textual Data* under *LOCAL TRAFFIC REGULATIONS, Ground Manoeuvring Restrictions,* it states:

> *'ATC instructions will normally specify the taxi route to be followed. This does not necessarily guarantee clearance from other aircraft, vehicles and obstructions on the manoeuvring area.*
>
> *Pilots are reminded of the need to exercise caution on wingtip clearances from other aircraft when manoeuvring in close proximity on the ground. Particular care should be taken in the runway holding areas and at runway crossing points.'*

CAP 393, *AIR NAVIGATION: THE ORDER AND THE REGULATIONS,* Rule 37(2)[2], entitled *'Right of way on the ground'* stated:

Footnote

[2] Since the event this Rule has been amended and re-numbered.

'Notwithstanding any air traffic control clearance it shall remain the duty of the commander of an aircraft to take all possible measures to ensure that his aircraft does not collide with any other aircraft or with any vehicle'.

CAP 168, *Licensing of Aerodromes*

CAP 168 includes instructions on the design of taxiways and the absence of fixed obstacles near them which, broadly, cause there to be a cleared area either side of each taxiway free of obstructions at least 20% wider than the wingspan of the largest aircraft which will use that taxiway. No similar provision is made in respect of mobile obstructions such as aircraft and vehicles.

Analysis

Whilst the crew of G-JEDR reported that they had stopped "on the line" at the holding position, analysis showed that if the aircraft had been stopped with its nose precisely above the relevant marking, and that AP-BGY had been following the taxiway centreline, the two aircraft would not have collided. Therefore, it is logical to conclude that G-JEDR had stopped a few metres short of the holding position, which was consistent with allowing the crew a view of the stop bar, as is normal aviation practice.

The decision by the commander of AP-BGY to deviate slightly from the taxiway centreline, as he passed G-JEDR, was to increase what he considered would be a small miss-distance between the two aircraft.

The method used by the GMC controller when directing departing aircraft for either full length or intersection departures, in order to present the Tower controller with opportunities to expedite the flow of traffic, was in accordance with normal ATC practice. Both controllers had expected AP-BGY to hold short of the link to JA1, until G-JEDR had moved forward. The clearances issued, for AP-BGY to taxi to J1, were correct. However, the cautions to the flight crew, which represented essential aerodrome information '*to assist him* [the pilot] *in preventing collisions with parked aircraft*', as described in MATS Part 1, were not understood by them as meaning that there was a risk of a collision if they taxied past G-JEDR. The commander of AP-BGY stated that he believed that the instruction to taxi past G-JEDR would not have been issued if a collision risk had existed.

The information provided by ATC and the entry for Manchester Airport in the UK AIP, which are intended to assist pilots in their responsibility for collision avoidance, did not do so on this occasion.

Note: A report on a similar accident, involving an Airbus A320, D-AIQA, and a Boeing 737, EI-DKD, which occurred at Manchester Airport in August 2008 is also published in this Bulletin.

SERIOUS INCIDENT

Aircraft Type and Registration:	BN2A Mk.III-2 Trislander, G-RLON
No & Type of Engines:	3 Lycoming O-540-E4C5 piston engines
Year of Manufacture:	1975
Date & Time (UTC):	2 September 2009 at 1657 hrs
Location:	Runway 14, Alderney Airport, Channel Islands
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 1 Passengers - 8
Injuries:	Crew - None Passengers - None
Nature of Damage:	Slight damage to right leg fairing
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	47 years
Commander's Flying Experience:	10,067 hours (of which 632 were on type) Last 90 days - 117 hours Last 28 days - 34 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

Having flown a go-around, due to the crosswind being out of limits on Runway 26, the pilot made an approach to grass Runway 14. As a result of turbulence and a sudden downdraft, the aircraft landed short of the marked threshold. It was subsequently discovered that the aircraft had struck a wire fence in the undershoot and a marker board. The aircraft suffered minor damage.

History of the flight

The pilot reported that he was on a scheduled service from Southampton Airport, Hampshire to Alderney Airport, Channel Islands. During the final approach to Runway 26 the pilot received a report from ATC, at approximately 200 ft aal, that the wind was from 180º at 36 kt. As this was outside the aircraft's crosswind limit of 25 kt the pilot flew a go-around. He then requested and received permission to make an approach to grass Runway 14.

The approach to Runway 14 was turbulent due to the wind and the nearby cliffs. On short finals, just prior to crossing the airfield boundary fence, the aircraft was subjected to a sudden strong downdraft; the aircraft then landed. The pilot believed, at the time, that the aircraft landed "slightly short" of the marked threshold. After shutdown a passenger informed the pilot that he believed he had "clipped" a marker board on landing. This was confirmed after an inspection by the Airfield Fire and Rescue Service. Additionally two 71 cm high fence posts had been dislodged after the aircraft clipped a wire fence, 67 m short of the threshold. The aircraft sustained a small amount of damage to the right leg fairing.

SERIOUS INCIDENT

Aircraft Type and Registration:	Raytheon 390 Premier I, G-FRYL
No & Type of Engines:	2 Williams International FJ44-2A turbofan engines
Year of Manufacture:	2004
Date & Time (UTC):	7 August 2008 at 1800 hrs
Location:	En route Copenhagen, Denmark to Farnborough, UK
Type of Flight:	Commercial Air Transport (Non-Revenue)
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	None
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	60 years
Commander's Flying Experience:	11,830 hours (of which 1,850 were on type) Last 90 days - 140 hours Last 28 days - 30 hours
Information Source:	AAIB Field Investigation

Synopsis

During descent the crew reported experiencing the loss of airspeed information followed by the loss of all three electronic flight instrument system (EFIS) displays. The investigation concluded that the loss of air data information was due to a blockage in the right pitot system caused by moisture ingress which subsequently froze. However, despite exhaustive testing, it was not possible to determine the cause of the loss of all three EFIS displays.

One Safety Recommendation is made.

History of the flight

The aircraft was returning to Farnborough having delivered a passenger to Copenhagen. The outbound flight had been uneventful except for the presence of three large thunderstorms south of the aircraft's route, around which there had been some short duration turbulence, characterised by the commander as "light to moderate". Engine anti-ice was selected ON during the descent into Copenhagen.

The aircraft was on the ground at Copenhagen for approximately one hour, during which it was refuelled. The crew remarked that passenger baggage, unloaded from the rear hold, felt damp and cold, whereas in their experience it usually felt only cold.

The commander was the pilot flying from Copenhagen to Farnborough. Approximately 20 mins after takeoff, whilst cruising at FL400 with an indicated outside air temperature (OAT) of -62°C, the aircraft encountered "significant" turbulence for about 10 mins. The commander estimated that the aircraft was 25 nm downwind of a thunderstorm in a layer of cloud that he did not consider to be cumulonimbus. Although he did not consider the Premier to have a specific turbulence penetration speed, he reduced thrust in an attempt to decelerate and achieve a more comfortable ride. Having done so, he was surprised at the high rate at which the indicated airspeed decreased. The airspeed indicated on his Primary Flight Display (PFD1) dropped quickly from 220 kt to 180 kt, which he considered excessive for the selected thrust reduction. He commented that the aircraft "felt different" but that there was no visible ice accretion on the airframe. The crew requested and were cleared to climb to FL410, where the aircraft was clear of cloud and turbulence and the OAT was -59°C. The commander noted that, when normal thrust was reselected, the speed increased "very slowly", estimating that acceleration to 220 kt took more than 10 minutes.

Cumulonimbus clouds were now visible across the route and the crew requested several heading changes to fly between the larger ones whose tops were at a similar level to the aircraft. During this time the commander was demonstrating to the co-pilot several functions of the Multi Function Display (MFD), including how to access fuel, navigation and diversionary information.

Shortly before commencing a planned descent, an amber IAS comparator message appeared on both PFDs, indicating a disagreement in IAS between the left and right air data systems of greater than 10 kt. The co-pilot's Primary Flight Display (PFD2) and the standby airspeed indicator (ASI) both indicated a steady 220 kt, which the commander interpreted as confirmation that PFD2 was indicating correctly. A lower and reducing airspeed was indicated on PFD1.

The commander recalled saying to the co-pilot that this indicated an Air Data Computer (ADC) failure. He therefore placed the ADC reversion switch in position '2' so that both PFDs would display information derived from ADC2. When so selected, IAS on PFD1 "jumped up" and PFD1, PFD2 and the standby ASI indicated the same airspeed.

Shortly afterwards the aircraft was cleared to descend to FL370. Immediately the descent commenced, both pilots noticed that the PFDs and the standby ASI indicated a reduction in airspeed. The commander also noticed that the rate of reduction of IAS varied with the rate of descent, "as if the ASI was acting like an altimeter"[1]. All three altimeters indicated the same altitude and he did not recall any discrepancy with geometric altitude derived from GPS data.

Before reaching the initial cleared level the aircraft was cleared for further descent and consequently did not level off. The crew advised ATC that they were experiencing "some airspeed difficulties". As IAS continued to reduce, the commander reselected the ADC switch to the normal position, whereupon PFD1 indicated an overspeed. However, the aural warning normally associated with an overspeed did not sound and, having retarded the thrust levers and hearing no increase in wind noise, the crew were content that airspeed was not excessive. Nevertheless the commander reverted to ADC2 and the IAS indication reduced once more.

Footnote

[1] If an airspeed indicator behaves like an altimeter it indicates that the associated pitot source may be blocked.

As IAS continued to fall, the commander opened the right STALL WARN circuit breaker (CB) to disarm the stick pusher[2]. IAS continued to reduce without activation of the stick shaker or aerodynamic buffet. The commander recalled that at approximately 60 kt IAS he heard a "click" from the vicinity of the instrument panel, reminiscent of a relay operating. Most of the information normally presented on the PFDs disappeared and the red IAS, HDG and ALT fail messages illuminated. The standby ASI indicated zero but the standby altimeter, attitude and heading indicators appeared to function normally. The commander used his experience of the aircraft to set thrust lever position and aircraft attitude appropriate to the phase of flight.

The central Multifunction Display (MFD) was now completely blank. The commander tried without success to restore the MFD presentation by selecting the DISPLAY/NORM reversion switch, first to PFD and then to MFD, then reselected the NORM position of this switch. He also selected each of the display reversion modes in turn without effect.

The co-pilot declared an emergency and stated that the crew intended to land at Manston, which they could see clearly. ATC advised that Manston was closed and that Ostend was available. As the aircraft descended below FL150, a combined PFD and MFD presentation appeared on the MFD[3]. The commander recalled that FL150 may have been the freezing level. The co-pilot then cancelled the 'MAYDAY', maintained the distress transponder code of 7770 and advised ATC that the crew now intended to leave controlled airspace and fly visually to Farnborough.

During the visual flight to Farnborough the commander reselected the ADC switch to the NORM position and returned the DISPLAY/NORM selector to NORM. The presentation of information on the two PFDs and the MFD was now normal in every respect and the remainder of the flight was uneventful, except that after landing the flight management system (FMS) showed an airborne time of 37 minutes, whereas the aircraft had been airborne for over 2 hours.

The following morning, after more rain, water was found in the front baggage bay and both pitot heads were damp when the pitot covers were removed.

Co-pilot's statement

The co-pilot's recollection of events broadly confirmed but differed in some detailed respects from that of the commander. Whereas the commander recalled that all three screens had immediately become blank except for the three red fail messages, the co-pilot recalled that the compass rose presentation and artificial horizon had remained visible on her PFD (PFD2) at first. She also stated that during the event the autopilot became disconnected and that the PITCH TRIM FAIL annunciator on the master warning panel was illuminated. She commented that the crew did not conduct any of the procedures contained in the abnormal and emergency sections of the pilot checklist because there were "no relevant annunciations."

While preparing the aircraft for the outbound sector the co-pilot noticed that although there had been heavy rain overnight and on the morning of the flight the aircraft did not appear particularly wet.

Footnote

2 The stick shaker is disabled by opening both stall warning CBs.

3 A combined presentation is shown on the MFD when the DISPLAY/NORM selector is in the MFD position, PFD1 is blanked.

Meteorological information

The Met Office provided a comprehensive report on the meteorological conditions prevailing along the route.

Synopsis

A complex region of surface low pressure prevailed along the flight path from Denmark to the United Kingdom, with several shallow but distinct low pressure centres over Denmark, Norway and southeast England. The flight mostly took place within a warm sector, later encountering a cold front as it approached the Kent coast.

Temperature

Before crossing the cold front, the coldest air temperature that the aircraft would have encountered was approximately -61° C at an altitude of 38,000 ft. The coldest air temperature over the southern North Sea was approximately -54° C.

Turbulence

AMDAR[4] reports from other aircraft indicated short range wind speed changes consistent with moderate or severe turbulence. A jetstream over the southern North Sea at the time was expected to generate moderate turbulence, possibly with areas of severe turbulence. It is also possible that turbulence was transported into the area from upstream thunderstorms over northeast France and the Netherlands.

Icing

The aftercast indicated that during most of the flight across the southern North Sea the aircraft would have been in clear air. However, cumulonimbus anvils, in which icing may have been significant, were moving northwards on the southerly upper winds. At temperatures below approximately -40° C, flight in cirrus cloud is normally considered to pose a negligible icing hazard, except if that cirrus cloud contains a cumulonimbus anvil. Cold soak of the airframe might intensify such effects.

Emergency and abnormal procedures

A *Pilot Checklist* handbook available in the cockpit included normal, emergency and abnormal procedures, shown in Table 1.

System description

Avionics system

The Premier 1 Model 390 is fitted with a Rockwell Collins Proline 21 fully integrated avionics system. It includes an Integrated Avionics Processor System (IAPS) which is designed to interconnect and manage the aircraft's various avionics sub-systems. There are eight sub-systems: an Electronic Flight Instrument System (EFIS), an Engine Indicating System (EIS), an Air Data System (ADS), an Attitude Heading Reference System (AHRS), a Flight Guidance System (FGS), a Flight Management System (FMS), a Radio Sensor System (RSS) and a Weather Radar System (WXR). The IAPS also contains a Maintenance Diagnostic Computer (MDC) module which monitors the sub-systems and stores diagnostic data in non-volatile memory.

The EFIS consists of three large colour displays, two Primary Flight Displays (PFD1 and PFD2) and a Multifunction Display (MFD), and two display control panels, one for each pilot's display (see Figure 1). The PFDs show attitude, navigation/compass, flight control, air data (altitude, airspeed and vertical speed), and TCAS advisory functions. Air data information is supplied

Footnote

4 The Aircraft Meteorological Relay (AMDAR) program collects temperature and static pressure data from commercial aircraft via a VHF downlink.

'AIRSPEED (IAS) COMPARATOR ILLUMINATED

Illumination of the Airspeed (IAS) comparator message indicates a disagreement between the left and right air data systems of greater than 10 KIAS.

If unable to determine reliable indication:

1. *At Higher Airspeeds .... USE HIGHER INDICATION*
2. *At Lower Airspeeds, Approach and Landing......................... USE LOWER INDICATION'*

'ELECTRONIC FLIGHT DISPLAY FAILURE

1. *Display Reversion Switch ....SELECT OPERABLE DISPLAY*

If all displays fail:

2. *Use copilot's (two display) or standby (three display) instruments'*

'SINGLE AIR DATA COMPUTER FAILURE

1. *ADC Reversion Switch .... SELECT OPERATING ADC*
2. *STALL WARN Circuit Breaker (Affected Side) .... PULL*

WARNING

The stick pusher is inoperative any time one or both STALL FAIL annunciators are illuminated.

NOTE

Failure of one ADC will render the following equipment inoperative: Autopilot; Flight Director; Pitch Trim (refer to PITCH TRIM FAIL) procedure in the Emergency Procedures section); Yaw Damp (refer to YAW DAMP FAILURE procedure in this section); Rudder Boost (refer to RUDDER BOOST FAILURE procedure in this section).

If the No.2 ADC has failed, also refer to the PRESSURIZATION CONTROLLER FAILURE procedure in this section.'

'DUAL AIR DATA COMPUTER FAILURE

1. *Use Copilot's (two display) or Standby (three display) Instruments.*

WARNING

The stick pusher is inoperative any time one or both STALL WARN[1] FAIL annunciator are illuminated.

NOTE

Failure of one ADC will render the following equipment inoperative: Autopilot; Flight Director; Pitch Trim (refer to PITCH TRIM FAIL) procedure in the Emergency Procedures section); Yaw Damp (refer to YAW DAMP FAILURE procedure in this section); Rudder Boost (refer to RUDDER BOOST FAILURE procedure in this section); Automatic Pressurization Controller (refer to the PRESSURIZATION CONTROLLER FAILURE procedure in this section).'

[1] (sic) The correct name for this annunciator is 'STALL FAIL' as in the procedure for single air data computer failure.

Table 1

by two identical Air Data Computers (ADCs) and the aircraft attitude and heading information is supplied by two Attitude Heading Computers (AHCs).

The MFD provides engine indicating displays, navigation/compass information, weather radar, Enhanced Ground Proximity Warning System (EGPWS) display, flight management, checklist, and diagnostic information. Engine information is supplied by the Engine Indicating System (EIS). The MFD also receives the same information as PFD1 and can act as a reversionary PFD. When reverted, a composite display showing combined information, normally presented on PFD1 and MFD, is shown on the selected PFD1 or MFD screen, and the other screen is blanked.

Display reversion

A series of display reversion/selection switches are located to the left of PFD1, in the pilot audio panel. These switches enable the pilot to select alternate display configurations or sources.

The 'display/norm' switch selects reversionary display on the PFD or MFD. When selected to NORM, PFD1 and the MFD display their own information, when selected to PFD, PFD1 displays the composite information and MFD is blanked, and when selected to MFD, the MFD displays the composite information and PFD1 is blanked. PFD2 is unaffected by the switch selection and displays its own information.

The AHRS switch selects attitude and heading source for the PFD and MFD displays. When selected to NORM, PFD1 displays AHC1 information and PFD2 AHC2 information. By selecting 1, both PFD1 and 2 use AHC1 information and AHC1 caption is displayed; selecting 2, both PFD1 and 2 use AHC2 information and an AHC2 caption is displayed.

Similarly, the ADC switch selects the air data source for the PFD and MFD displays. When selected to NORM, PFD1 displays ADC1 information and PFD2 ADC2 information. Selecting 1, both PFD1 and 2 use ADC1 information and 'ADC1' caption is displayed; selecting 2, both PFD1 and 2 use ADC2 information and an ADC2 caption is displayed.

Figure 1

Air Data System

The ADS includes two identical ADCs which output processed air data from pneumatic and temperature sensor inputs. The pitot/static system has two probes, one each side of the front fuselage, which connect via various tubes, connections and unions to the two ADCs and to the standby instruments. (See Figure 2). The left probe pitot connection supplies the left (No 1) ADC only and the right probe pitot connection feeds the right (No 2) ADC and the standby ASI. The left and right probe static lines are cross-connected and supply static pressure to the ADCs. The standby ASI and altimeter use the same static feed as ADC2.

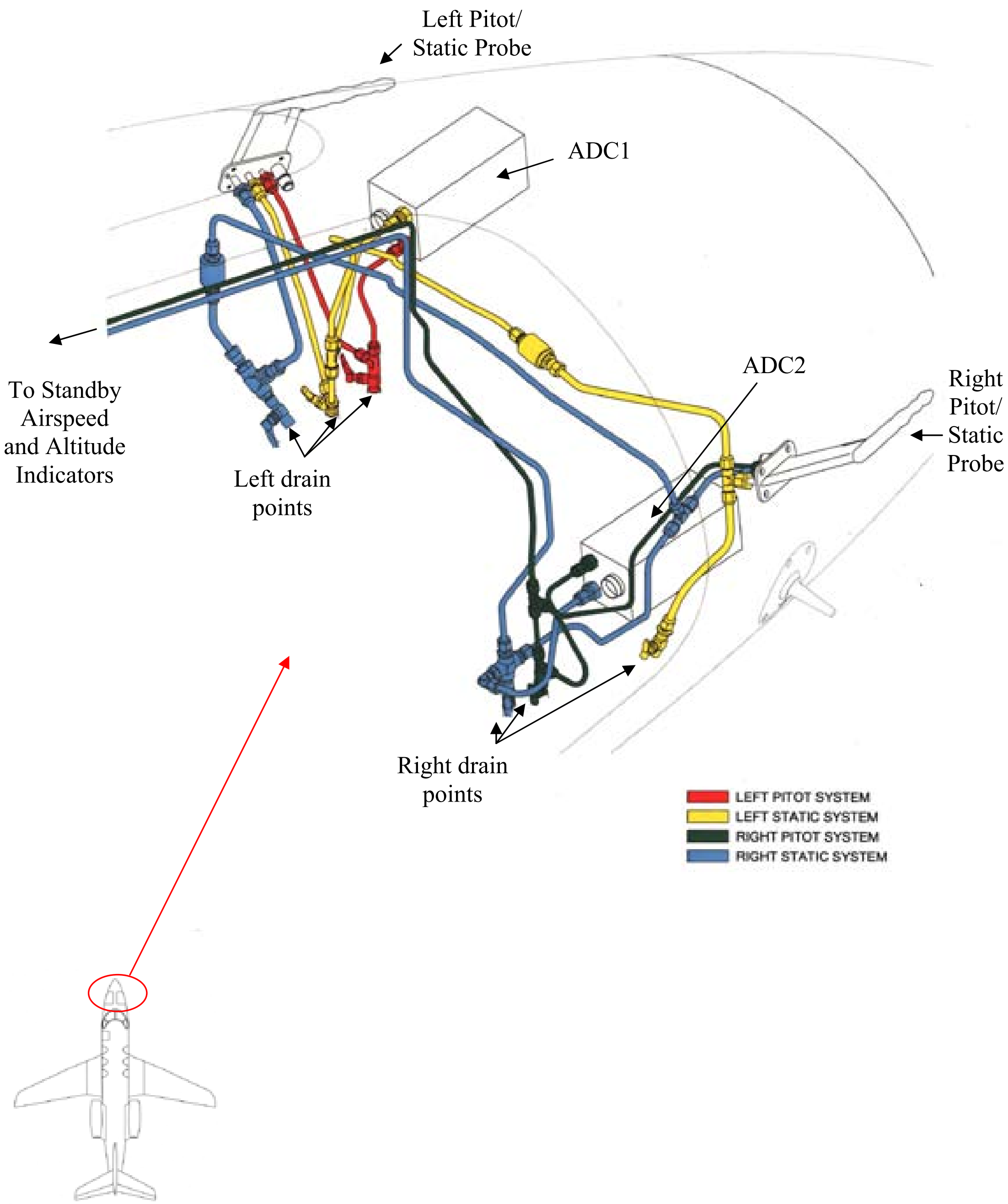


Figure 2

Pitot/static connections

Both left and right pitot/static systems have drain traps, located at the lowest point in the lines to collect any moisture, which can be drained by operating a spring loaded lever on the drain traps. The pitot/static probes are electrically heated.

G-FRYL was fitted with standby airspeed, altitude and attitude instruments, located above the central warning display in the centre of the instrument panel.

PFD warning and captions

Aircraft attitude and heading parameters are provided to the PFDs and MFD by the AHCs. A red HDG flag is displayed at the top of the compass presentation on the PFD if the heading sensor input fails.

When the difference between the ADC1 and ADC2 airspeed exceeds 10 kt, an airspeed comparator warning flag is displayed on PFD1 and PFD2 by means of a yellow boxed IAS caption adjacent to the airspeed tape. The caption flashes continuously until the master caution is reset.

If the air data information becomes invalid, red boxed IAS, ALT and VS captions appear instead of the airspeed, altitude or vertical speed tape on the PFD of the side affected. With these flags in view, all air data information is removed (see Figure 3),

Autoflight

The Flight Guidance System (FGS) provides an integrated Flight Director (FD), Autopilot, Yaw Damper and Automatic Pitch Trim system. If Automatic pitch trim is disabled a red boxed TRIM caption appears on the PFDs.

Figure 3

PFD display with air data information invalid

Electrical power

In flight, electrical power is provided by a DC electrical generation system consisting of two engine-driven starter/generators, two generator control units, a power distribution system, a main battery and a standby battery. Electrical power is distributed from the main 'power box' to the electrical services via relays and a busbar arrangement which is divided into the following buses: left main bus, right main bus, essential bus, non-essential bus, hot battery bus and standby bus. The right bus is normally supplied by the right generator and the left bus, normally supplied from the left generator, provides power to the essential bus and the standby bus. The bus connectors are located in the 'power box' which is in the right rear fuselage, behind the pressure bulkhead.

In normal operation, the left generator would supply power to the MFD, PFD1, AHRS1, and the CVR while the right generator would supply PFD2 and AHRS2.

Equipment location

Most of the Proline avionic system units, which were the subject of this investigation, are located in the right avionics bay in the nose of the aircraft. These include the IAPS, both AHS and ADC2. ADC1 is located in the left avionics bay.

The aircraft manufacturer reported that from certification test flying experience, temperatures within the forward avionics bay can drop below freezing and any moisture in the pitot/static tubes can freeze at altitude. Some avionics units will remain warm from internal heat generated, but others can become cold. The IAPS has an internal heater which will automatically operate if the temperature falls below -41 ºC and will only switch off again if the temperature rises above -35 ºC.

Pitot/static drain operation

The Aircraft Maintenance Manual (AMM) requires the operation of the pitot and static drains every 200 hours in order to remove moisture which may have entered the system. The process requires the removal of the blanking caps on the bottom of the drains and the turning of a red spring-loaded lever on each of the drain traps for the two independent (left and right) static and pitot systems (see Figure 2). This should allow any moisture to drain. The system must be leak-checked following the procedure. Figure 4 shows the location for the right system drains in the right avionics bay.

The AMM also details a separate procedure for purging the pitot and static systems to remove any foreign matter by attaching an external source of dry air to the pitot or static system. In order to purge the system, all the equipment, such as computers and instruments, must be disconnected. Each pitot/static system must be purged separately.

Recorded information

The aircraft was fitted with a 30-minute Cockpit Voice Recorder (CVR) which covered the period of the recovery of the aircraft to Farnborough. It had been replayed by the operator. However, when the incident was reported to AAIB, the recording of the incident flight had been overwritten during the ground testing. No flight data recorder was fitted to the aircraft and none was required.

The EGPWS memory was replayed and confirmed the failure messages which were logged on the Maintenance Diagnostic Computer (MDC) and were also downloaded. The relevant failure messages are shown in Table 2.

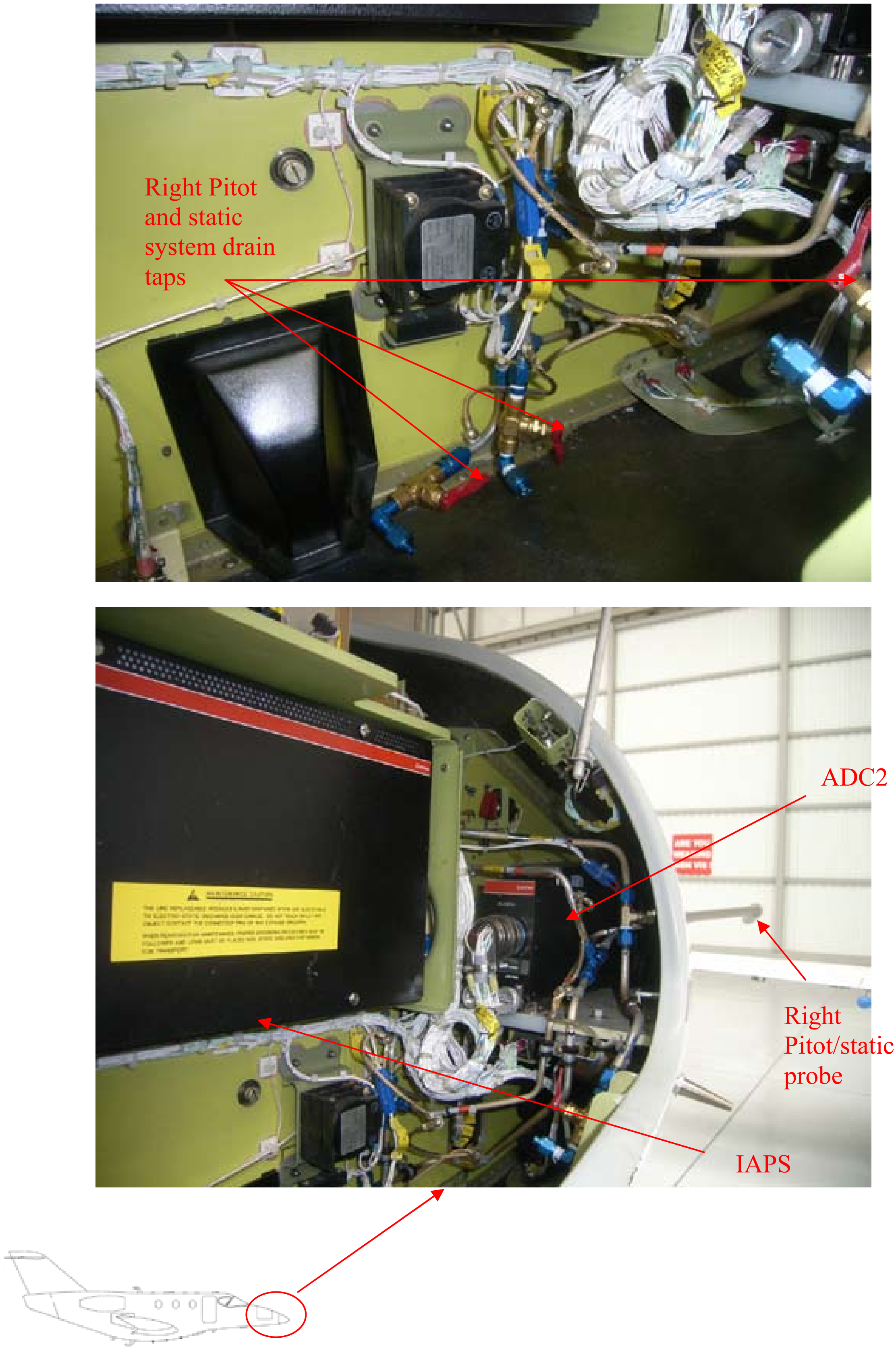


Figure 4

Right Avionics Bay

Time	LRU	Failure Message Code	Cause
18:03	FCG1	FCS CODE=AP DIS FCS CODE=YD DIS	AP disconnected due to roll equalization problem. YD disconnected due to a yaw equalisation problem
18:04	FCG2	FCS CODE=REPAIR	FCG2 repair code due to a pitch roll or yaw cutout
18:05	ADC2	VAR CIRCUITRY	ADC2 had an error bit set which indicates that the pitot pressure was less than or equal to static pressure. Manufacturer's experience is that often this fault is associated with the pitot tube becoming blocked. The ADC was operating as intended
18:05	TCAS	RA 1 DSPLY INVAL	Indicated a variety of faults, since the Vertical Speed Indicator would have been flagged following the ADC2 fault, the PFD would not be able to display Radar Advisories (RAs) from TCAS
18:09 18:10	PFD1 MFD1	NO OUTPUT NO OUTPUT	Both PFD1 and MFD1 are switched off. This could have been due to operation of the reversion switches
18:41	FCG1	FCS CODE=REPAIR	Pitch, roll or yaw equalization error. These errors occur when there are significant differences in the cross comparison of the autopilot command loop. This can be generated by a mis-compare between air data and/or altitude sources

Table 2

The Mode S radar recording data from Debden covered most of the flight from Copenhagen and included airspeed and altitude data in addition to positional information (see Figure 5).

The aircraft was cruising at FL410 before beginning a descent at about 1757 hrs. The Mode S IAS, which had been stable at 220 kt, then began to reduce. However, both the Mode S and radar groundspeeds, which had been around 390 kt, began to increase. Mode S IAS continued to reduce until 1804:30 hrs when, passing through approximately 33,000 ft, having decelerated to 50 kt, the recording suddenly reduced to zero. At the same time, the recorded groundspeed was about 430 kt. Approximately 30 seconds later, with the aircraft passing through 31,000 ft, the altitude indication also suddenly reduced to zero. The recorded groundspeed was 450 kt which then subsequently reduced to approximately 350 kt. About two minutes later the Mode S IAS and altitude information returned showing the aircraft passing 20,000 ft at 270 kt IAS. The airspeed and altitude information appeared normal for the remainder of the flight.

Heading and roll information from the Mode S recording indicated that the AHRS was operating correctly throughout.

Recent maintenance history

The last scheduled maintenance inspection was a 1,200 hour check carried out on 2 June 2008. Prior to the flight on 7 August 2008 the standby battery had been replaced.

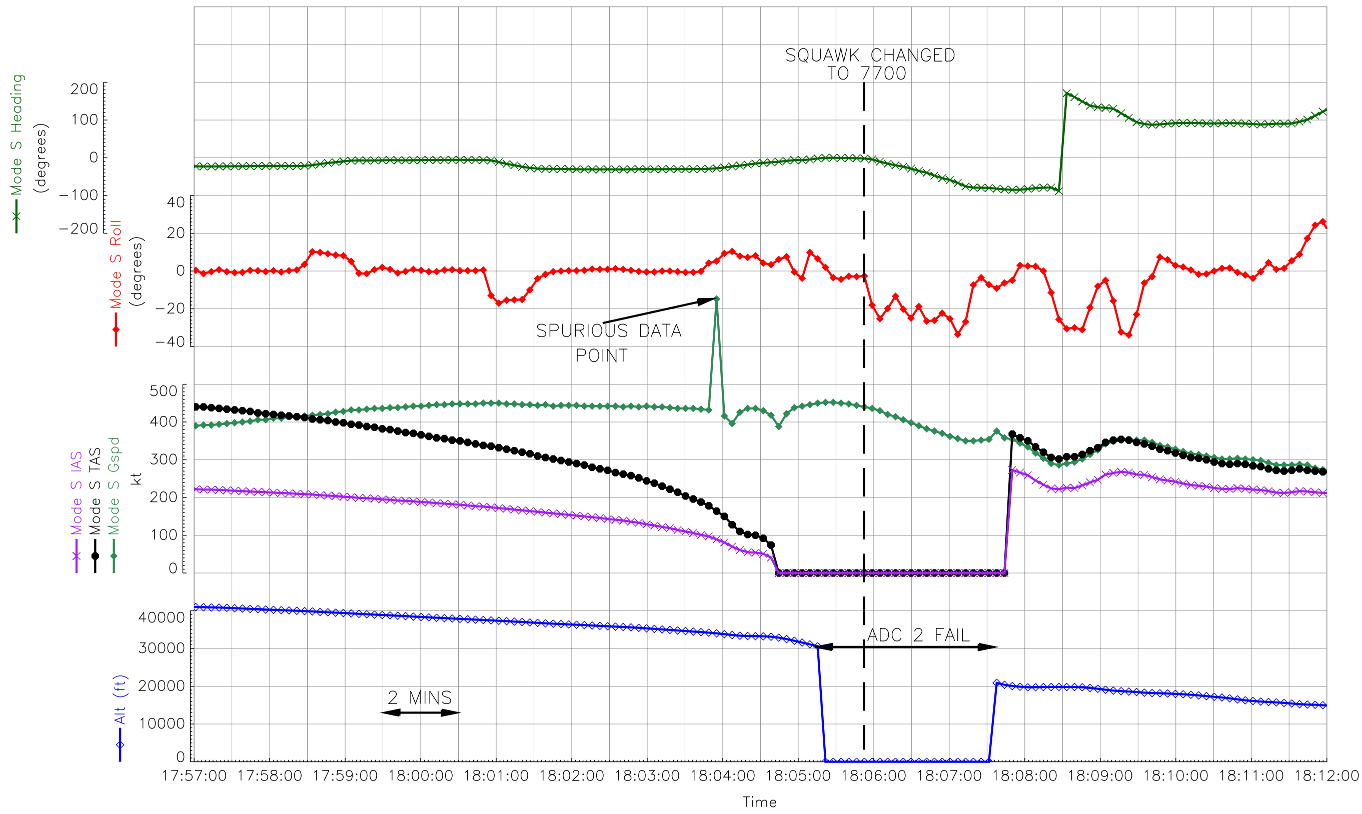


Figure 5

Modes S information

G-FRYL's operator's aircraft are mostly parked outside while on the ground. The aircraft last flew on the evening of 31 July and since then had been parked outside, facing south. Consequently its right hand side was more exposed to the prevailing westerly wind.

The standard pitot probe cover is a vinyl/fabric construction although the operator had been trialling a woven Kevlar pitot probe cover which is claimed to be water repellent. Prior to the incident flight one of the alternative Kevlar pitot covers had been fitted on the right pitot probe, while the left probe retained one of the standard covers (see Figure 6)

Aircraft examination and testing

When the AAIB was informed of this serious incident, extensive trouble-shooting by the maintenance organisation and multiple component removals had already taken place.

There had been three separate checks of the pitot/static drains. Firstly, the drain caps were removed and the drain cocks operated; no water came out. Subsequently, the maintenance organisation carried out a one-way purge of both systems with nitrogen; only one small drop of water came out. The system was then purged both ways with nitrogen and approximately one tablespoon of water (15 ml) was removed. The maintenance organisation also reported that when the pitot/static tubing was dismantled there was a small amount of water around some of the joints, described as "similar to condensation".

Left pitot probe and AOA vane below
Standard cover

Right pitot probe and AOA vane below
Kevlar cover

Figure 6
Types of pitot probe cover

All the avionics functioned normally during testing and a calibration was carried out on the ADS which was within limits.

A ground test was performed with separate pressure test sets connected to the left and right pitot probes, to simulate pitot and static pressures and a blockage in the right pitot line. A similar scenario to that on the incident flight was followed; at a stable altitude of 41,000 ft the 'blockage' was applied. The static pressure was then increased, to simulate a continuous descent of around 1,000 ft/min, and, although the pitot pressure from both test sets was not altered, it was noted that from a nominal start value of 220 kt, the airspeed indication from ADC2 and on the standby airspeed indicator began to reduce. As the airspeed indication passed through 50 kt the autopilot disengaged and at about 26,000 ft the ADC red IAS, HDG and ALT fail messages appeared on PFD2. The automatic pitch trim fail caption also illuminated. Similar fault messages to those from the incident flight were noted on the MDC.

It was also demonstrated that with the PFD1 selected to ADC2, the Mode S transponder altitude output is then supplied by ADC2. When ADC2 failed, the altitude information was lost and the FMS timer was reset.

Both ADCs and the right pitot/static probe, which supplies the standby instruments, were removed from G-FRYL for further examination.

The aircraft was returned to service with replacement ADCs, standby ASI and right pitot/static probe and a test flight carried out. During the test flight the stall 'tape' appeared on PFD2 and the stick shaker activated. The right stall system circuit breaker was pulled and the aircraft landed without further problem. During investigation following this incident the replacement ADC1 failed. This unit was replaced and the aircraft again returned to service without further problems.

Previous Occurrences

The commander commented that in the previous two years he had experienced 9 events involving unusual airspeed indications, most of which he believed were associated with ADC2. Some of these he attributed to flight in icing conditions. He noted that the indications he saw on this occasion were similar to those observed during a previous ADC failure on another company aircraft of the same type.

There were two previous instances of altitude indication anomalies on the Premier 1 reported on the CAA MOR database. There was an occurrence involving G-PREI, operated by the same company, which, in March 2007, experienced an altitude comparator warning. During investigation water was found in the pitot/static line. Secondly, also in March 2007, an occurrence on G-FRYL was reported when the No 2 altimeter was 'unstable and out of limits for Reduced Vertical Separation Minima (RVSM)'. Following investigation it was reported that a 'significant amount of water was drained from the right static line'.

As a result of these two MORs, the operator's maintenance organisation checked another four Premier 1 aircraft and found significant amounts of water in the pitot/static systems on each aircraft. It was noted that water could remain in the system after operating the drains and it was found necessary to purge the system with nitrogen for complete removal. The operator also chose to introduce the use of the alternative Kevlar pitot probe cover.

The aircraft manufacturer was aware of an event on another Premier 1, C-GYPV, in May 2006. At FL400, in the cruise, the pilot noted an altitude comparator flag displayed on PFD2 and an airspeed spilt between the No 1 and No 2 systems. He reported that the No 2 airspeed and altitude indications eventually went blank, and that the standby airspeed and altitude needles "quit moving". Shortly after this the No 1 airspeed and altitude information disappeared. The pilot declared an emergency and commenced a descent. Passing through FL040, valid information returned to the No 1 air data system. The aircraft landed safely. Water was removed from both the right and left pitot/static systems. Of significance was that the aircraft had remained on the ramp, prior to departure, in a rainstorm for approximately 2 minutes with the pitot covers removed.

The aircraft manufacturer has been unable to replicate the reported condition of water in the pitot/static system by any means other than directly injecting water into the pitot probe. Flight testing was conducted with pitot heat switched on and off, and in moderate to heavy precipitation. This did not result in any pitot/static anomalies or trapped water being found.

Further testing

Both ADCs from G-FRYL were returned to the manufacturer for examination and testing. A field performance test was performed on both units. This checked the accuracy of each unit's altitude and airspeed outputs and also performed a sensor leak test. No fault messages were recorded. Both units were also inspected internally, nothing abnormal was observed and there was no evidence of moisture ingress.

The right pitot/static probe was also returned to the manufacturer for examination and testing. Visual and X-ray examination showed that the probe was in good condition and no debris was found in the pitot inlet. The probe heater was tested and the heater current was in accordance with the requirements for the production acceptance test procedure; no faults were found.

Safety action

Since the incident the manufacturer has issued Premier I/IA Model Communiqué #23, dated June 2009, which references the manufacturer's Mandatory Service Bulletin (MSB) 34-3972, entitled *NAVIGATION - MODIFICATION OF #2 AIR DATA COMPUTER PLUMBING*. The MSB requires a modification to the right pitot/static system, which removes the plugs on both drain points and introduces cotter pins in both valves to prevent the valves from being locked open unintentionally.

In addition to the MSB, changes to the Airplane Flight Manual (AFM) have been introduced. They include a *LOSS OF ALL AIRSPEED INDICATION (ADC1, ADC2 AND STANDBY AIRSPEED)* procedure in the Section 3 *EMERGENCY PROCEDURES* and a revised *AIRSPEED (IAS) COMPARATOR ILLUMINATED* procedure in the Section 3A *ABNORMAL PROCEDURES*. There is also a *NOTE* in the *PREFLIGHT INSPECTION* in the Section 4 *NORMAL PROCEDURES* which calls for subsequent maintenance action when

> *'the airplane has been parked outside, exposed to visible moisture, and there is any suspicion one or both of the Pitot-Static Tube covers may have been dislodged or missing.'*

The *EXTERIOR INSPECTION* includes a requirement to drain and secure the standby pitot-static drains.

Analysis

Loss of airspeed information

The sequence of events during this incident began with the IAS comparator warning, indicating a mismatch in IAS sensed by the two ADCS. The loss of standby airspeed information, for which the only source is the right pitot/static system, indicated a problem with the right pitot system.

Subsequent testing on the aircraft reproduced the events which occurred during the incident. With a blockage introduced in the right pitot line, and the static pressure increased, with no change in pitot pressure, the difference between the static and the pitot pressure, ie the dynamic pressure and thus the indicated airspeed, reduced. The indications on the flight deck were a reduction in indicated airspeed data from ADC2 and the standby ASI. As the static pressure increased to a value greater than the blocked pitot pressure, ADC2 and the standby airspeed indicator would have sensed a negative airspeed. The ADC would identify this as an invalid input and would 'fail' at this point, displaying the three red flags on the EFIS. The faults recorded in the MDC during the test replicated those recorded during the incident.

The return of valid air data information as the aircraft descended supports the theory that the blockage was caused by ice, which then melted as the outside air temperature rose. Subsequent investigations found no faults within either of the ADCs or the right pitot/static probe.

There have been previous incidents on the Premier 1 of moisture ingress leading to loss of air data information, and temperatures in the right avionics bay can be sufficiently low to allow any moisture present to freeze. This operator has reported that the operation of the pitot and static drains is not always sufficient to clear moisture, and that the systems can require purging to ensure that all moisture is removed. This was the case following this incident, where no water was found in the pitot and static lines by operating the drains; however, some water was found by purging.

The manufacturer's Communiqué #23, issued in June 2009, introduced a pre-flight check to operate the standby pitot-static drains. However, operation of the drains is not always sufficient to clear the moisture. Therefore, the following Safety Recommendation is made:

Safety Recommendation 2009-109

It is recommended that the Federal Aviation Administration should require Hawker Beechcraft Corporation to review and modify, if necessary, the design of the pitot and static drainage on the Premier 1 aircraft in order that its pitot/static systems cannot become blocked as a result of trapped moisture.

Loss of EFIS displays

During the testing it was not possible to recreate that part of the sequence of events in which the pilots reported the blanking of all three displays.

At 1803 hrs the Autopilot and Yaw damper disengaged. Analysis of the fault codes recorded by the MDC indicates that this was probably due to the difference in the airspeeds sensed by the two ADCs. The failure of ADC2 at 1805 hrs, which was supplying air data to both PFDs by that time, would have resulted in the three red flags being displayed on both PFDs and the loss of all air data information. The Mode S data indicated that there was no loss of altitude information, which should have continued to be displayed on the PFDs. The co-pilot recalled that, initially, the compass rose presentation and artificial horizon remained visible on both PFDs.

Use of the reversionary display control would have resulted in the momentary blanking of PFD1 and MFD, as the displays were interchanged. This was recorded on the MDC at 1809 hrs as PFD NO OUTPUT and at 1810 hrs as MFD NO OUTPUT. When the displays reappeared, during the descent, the commander reported that the composite PFD/MFD presentation appeared on the MFD, indicating that the DISPLAY/NORM reversion switch was selected to MFD. This would have resulted in a blank screen on PFD1. PFD2, which is unaffected by operation of the display reversion switch, should have been displaying information throughout.

All three displays are supplied from different electrical buses supplied by two electrical generators, a main battery and a standby battery. A single electrical failure could not cause the loss of all three displays and would have resulted in additional warnings being evident to the crew, with related failure messages being recorded on the MDC. The Mode S recording shows that AHC1 was operating normally throughout the incident, thus indicating that there was no power loss on the left electrical bus.

Abnormal procedures

Following the loss of information on all three electronic flight displays the flight crew used the standby instruments to conduct the flight safely until this information was restored, and they did so without the use of the *Pilot Checklist*. The checklist included several relevant procedures. The item entitled *'Airspeed (IAS) Comparator Illuminated'* provided information about the initial amber IAS annunciation on both PFDs. The following procedures are relevant to the subsequent loss of information from both PFDs and the MFD:

1. *'Electronic Flight Display Failure'*
2. *'Single Air Data Computer Failure'* or
3. *'Dual Air Data Computer Failure'*

Procedure (1) refers to failure of the screen itself, where the display is entirely blank. In this event, however, some information, such as failure flags, was presented on each of the screens. Having identified an ADC failure as a possible cause of the airspeed anomaly the crew carried out both actions in (2), namely operating the ADC reversion switch and opening the STALL WARN CB. However, by not consulting the checklist they missed an opportunity to prepare for the associated failures, such as loss of flight control functions and pressurisation. In the event, pressurisation was not lost.

Meteorological considerations

The commander believed that, at all times, the flight remained clear of cumulonimbus cloud. The report from the Met Office suggests, however, that the layer of cloud in which the aircraft flew immediately prior to the event may have contained an embedded cumulonimbus anvil. The Met Office report also highlighted the risk of encountering severe turbulence downwind of cumulonimbus.

Summary

The loss of airspeed information was caused by a blockage in the right pitot system due to an ingress of moisture, which then froze. Similar incidents had been reported previously. The flight crew also reported the loss of all information from the three EFIS displays. It was not possible to recreate this situation during subsequent tests on the aircraft and the loss could not be explained.

ACCIDENT

Aircraft Type and Registration:	Aero AT-3 R100, G-SYEL
No & Type of Engines:	1 Rotax 912-S2 piston engine
Year of Manufacture:	2006
Date & Time (UTC):	24 September 2009 at 1150 hrs
Location:	Runway 23, Sywell Aerodrome, Northamptonshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Lower engine cowling, nosewheel, propeller
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	73 years
Commander's Flying Experience:	20,300 hours (of which 3 were on type) Last 90 days - 9 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft bounced on touchdown after a normal approach to the grass Runway 23 at Sywell in conditions of light wind and good visibility. The pilot applied power and continued the approach but the second touchdown was "a little heavy". Witnesses saw the aircraft land on its nose landing gear, which collapsed allowing the propeller to strike the ground. The aircraft stopped very quickly but there was no fire and the uninjured pilot was able to vacate the aircraft without assistance.

The aircraft operator's maintenance organisation found no evidence of any mechanical defect that might have contributed to failure of the nose landing gear. The pilot commented that he should have executed a go-around after the bounce.

ACCIDENT

Aircraft Type and Registration:	Auster J5F Aiglet Trainer, G-AMZU
No & Type of Engines:	1 De Havilland Gipsy Major 1F piston engine
Year of Manufacture:	1953
Date & Time (UTC):	19 September 2009 at 1430 hrs
Location:	Bicester Airfield, Oxfordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Serious) Passengers - 1 (Minor)
Nature of Damage:	Left wing broken, landing gear, propeller and right wing very badly damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	61 years
Commander's Flying Experience:	870 hours (of which 705 were on type) Last 90 days - 3 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

During the takeoff run the aircraft was slow to accelerate and, once airborne, it was slow to climb. As it passed over some trees, the aircraft appeared to stall at such a low level that recovery was impossible and it descended into the trees. A combination of factors contributed to a lift-off point that was further along the runway than expected. It is possible that the high density altitude contributed to degraded climb performance thereafter.

History of the flight

The aircraft, with two people on board, taxied out for departure from a grass airfield and the pilot decided that he would takeoff on Runway 36. The weather, obtained later from the Met Office, was a light and variable wind, visibility 15 to 20 km, few clouds between 3,500 and 4,000 ft, a temperature of 25°C and a dew point of 13°C. The pilot taxied onto the runway and stopped to carry out the engine power checks. Shortly afterwards, the aircraft began its takeoff run from a position which was estimated to be approximately 150 to 200 m from the start of the 1,000 m long runway.

The aircraft was thought by witnesses to be slow to accelerate but then it "lurched upward" as if the pilot was trying to "haul the aircraft into the air". The aircraft began to climb but only gently and once again it was seen to "lurch" upward as it approached a line of trees. As it passed low over the trees, the left wing and the nose dropped and the aircraft descended into the trees and came to rest in the corner of a small industrial site approximately 380 m beyond the end of the runway. The passenger was helped from the wreckage soon after the impact but the pilot had to be cut free before being flown to hospital.

Witness information

A witness saw the accident from close to the start of the takeoff run and saw the aircraft "accelerate rather slowly" and lift off approximately ⅔ of the way along the runway. When it lifted off the ground, it "pitched very nose-up, as if [the pilot] had pulled back hard on the stick". Immediately afterwards "the tail flicked up very quickly indeed, as if he had pushed the stick forward rapidly". As the aircraft approached the trees, it "pitched nose-up and then levelled out again". The aircraft began to descend slowly while turning gently to the right but, just before it disappeared below the tree line, the right wing "went up a bit". The witness estimated that the aircraft was never more than 10 to 15 ft above the trees.

Another witness, who was an experienced Auster pilot, saw the accident from a similar location. He recalled that the aircraft used a lot of runway during the takeoff and was in a slightly nose-down attitude rather than level or slightly tail-down as he would have expected. The witness estimated that the aircraft lifted off approximately ¾ of the way along the runway. As the aircraft left the ground the nose "pitched up noticeably" and he saw some "pilot induced oscillations" in pitch. The aircraft settled into quite a nose-high attitude but was only climbing slowly and it began to turn right gently. The witness then saw the "left wing drop and the nose yaw left". The aircraft was only "a few feet above the trees when it rolled approximately 60° left and the nose pitched down".

This witness was one of the first people to reach the aircraft after the accident. He reported that the elevator trim was in the full nose-up position rather than neutral, which would be the norm for takeoff. He also noticed that the flaps were set to the second position whereas they would usually be at the first position for takeoff.

Information from the pilot

The pilot survived the accident and was able to remember some of the events leading up to the takeoff. Before taxiing out, the pilot noticed that the windsock near the southern end of the airfield was showing a very light southerly wind, which he estimated to be approximately 2 kt. The windsock near the eastern boundary showed a very light easterly wind. He decided not to take off towards the east because he would cross the takeoff run being used by gliders operating at the airfield. He assessed that the very slight tailwind at the southerly end of the airfield would become a crosswind as he approached the mid-point. He decided not to use the full length of the airfield to avoid activity near the southern boundary, which included cars, gliders and people. He estimated that he began his takeoff run approximately 150 m from the southern boundary and he considered at the time that the remaining distance available (approximately 850 m) would be sufficient.

The pilot commented that, although he could not remember the actual trim position, full nose-up trim would have required more force than normal to raise the tail which might have prompted him to reject the takeoff. He stated that he had never before used two stages of flap to take off and it was highly unlikely that he did so on this occasion. He thought it unlikely that the flap lever moved during the impact sequence and wondered whether he had lowered the flap in an attempt to clear the trees although he did not remember doing so.

Information from the passenger

The passenger in the aircraft was also an Auster pilot. He remembered the winch operator discussing whether to change the takeoff direction for the gliders but deciding that the wind was so light that it was not necessary. He remembered that the aircraft "bounced" into the air at about 60 mph and, once airborne, flew normally with the engine running well. He did not think that the pilot adjusted the flap setting as the aircraft approached the first line of trees.

Analysis

The airfield is at an altitude of 267 ft amsl but in the conditions of the day its density altitude was approximately 1,270 ft. The aircraft started its takeoff run approximately 150 to 200 m inset from the start of the runway although there was approximately 800 to 850 m still available. It is possible that there was a very slight tailwind during the early part of the takeoff run. The nose-down attitude of the aircraft would have resulted in a greater down force on the tyres than usual, which was likely to have reduced the acceleration. The higher density altitude would also have led to an acceleration that was less than usual. The combination of factors contributed to a longer ground run, and a lift-off point further along the runway, than would otherwise have been expected.

Once airborne, the aircraft's climb performance would probably have been reduced by the high density altitude and the aircraft might not have accelerated at its usual rate. There was no evidence that the aircraft hit the trees before the loss of control but its clearance from them was marginal. It is possible that the "lurch" upwards as the aircraft approached the trees represented an attempt by the pilot to clear the tree line, perhaps by lowering a stage of flap. The evidence suggested that the aircraft stalled with an accompanying wing drop at such a low height above the trees that recovery was impossible. It was not possible to positively determine the flap or trim setting during the takeoff ground roll.

ACCIDENT

Aircraft Type and Registration:	Bolkow BO 208A2 Junior, G-CLEM
No & Type of Engines:	1 Continental Motors Corp O-200-A piston engine
Year of Manufacture:	1964
Date & Time (UTC):	12 September 2009 at 1620 hrs
Location:	Lee-on-Solent Airfield, Hampshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Canopy destroyed and slight damage to leading edge of fin
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	37 years
Commander's Flying Experience:	1,020 hours (of which 11 were on type) Last 90 days - 65 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The canopy detached just as the pilot rotated the aircraft during takeoff. He abandoned the takeoff and vacated the runway.

History of the flight

The pilot completed his pre-flight checks and taxied onto Runway 05 for departure. The weather conditions were good, with a surface wind from 060° at 12 kt, gusting to 18 kt. The pilot began the takeoff and at an airspeed of about 55 kt he started to rotate the aircraft. As he did so, he heard a "crack" and noticed an increase in wind noise from the right hand side of the cockpit. There was then a loud bang and the canopy opened. He felt the aircraft decelerate and heard another bang as the hinges failed and the canopy folded back over the rear fuselage, destroying the canopy and causing damage to the rear window. The pilot closed the throttle, aborted the takeoff and taxied off the runway.

Discussion

When the aircraft's canopy is closed, the main central latch engages automatically. Two supplementary over-centre latches, either side of the cockpit, should then be closed by the pilot.

Following inspection, the pilot concluded that the main latch had been ineffective. He considered that this was due to the design of the main latch and subsequent wear which had affected its operation. The right-hand side over-centre latch was distorted and had detached, while the left-hand side over-centre latch had remained intact. The pilot thought that the left latch had released, due to the distortion of the canopy, or that he might have forgotten to secure it.

Another Bolkow Junior aircraft has previously been landed successfully after its canopy had detached in flight.

INCIDENT

Aircraft Type and Registration:	CAP 10B, G-CPXC
No & Type of Engines:	1 Lycoming AEIO-360-B2F piston engine
Year of Manufacture:	2002
Date & Time (UTC):	28 August 2009 at 0930 hrs
Location:	Old Sarum Airfield, Wiltshire
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Tailwheel mounting broken and bottom of rudder damaged
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	53 years
Commander's Flying Experience:	11,500 hours (of which 2 were on type) Last 90 days - 90 hours Last 28 days - 40 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft was on a dual instructional sortie and had been landed by the student on Runway 24. The instructor stated that the student was having difficulty in the gusty conditions (reported surface wind 260° at 15 kt, gusting to 25 kt) so he took control to stabilise the aircraft during the landing roll. Retaining control, he slowed the aircraft to taxi speed and turned about 45° to the right but, with taxi power applied, the tail suddenly lifted. Fearing that the propeller was about to strike the ground, he reduced power and the tail dropped heavily, breaking the tailwheel mounting and causing damage to the bottom of the rudder.

The instructor could only surmise that the aircraft had caught a "freak" gust. Although he believed he had been holding the control column aft at the time, he concedes that it may not have been fully back.

ACCIDENT

Aircraft Type and Registration:	1) Cessna 172S Skyhawk, G-SHSP 2) Enstrom 480, G-LADZ
No & Type of Engines:	1) 1 Lycoming IO-360-L2A piston engine 2) 1 Allison 250-C20W turboshaft engine
Year of Manufacture:	1) 1999 2) 1993
Date & Time (UTC):	31 October 2009 at 1400 hrs
Location:	Sleap Airfield, Shropshire
Type of Flight:	1) Private 2) N/A
Persons on Board:	1) Crew - 1 Passengers - None 2) Crew - None Passengers - None
Injuries:	1) Crew - None Passengers - N/A 2) Crew - N/A Passengers - N/A
Nature of Damage:	1) G-SHSP: Inboard leading edge of wings 2) G-LADZ: Fuselage and rear fin
Commander's Licence:	1) National Private Pilot's Licence 2) N/A
Commander's Age:	1) 88 years 2) N/A
Commander's Flying Experience:	1) 1,920 hours (of which 4 were on type) Last 90 days - 2 hours Last 28 days - 1 hour 2) N/A
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot had just refuelled G-SHSP following an uneventful flight in the local area. The parking brake was off during the refuelling and remained off whilst the engine was started. However, for the engine start, the pilot stated that he held his feet on the rudder pedals and toe brakes. Once the engine was running, the pilot completed the engine-start-checklist items before noticing that the aircraft was moving forward. He applied further pressure to the pedals but the aircraft continued to move so he repositioned his feet and reapplied pressure to the brake pedals. The aircraft responded immediately but only came to a stop as it hit an Enstrom 480 helicopter parked 20 metres from the refuelling location. The collision caused damage to both wing leading edges of the aircraft and damage to the rear fuselage and fin of the helicopter.

The pilot's assessment of the cause of the accident was that his first reaction had been to apply the brakes in the way he was used to from his relatively longer experience of flying Piper PA-28 aircraft (70 hours) rather than the Cessna C150 or C172 (14 hours total). It should be noted that the Piper and Cessna aircraft referred to above both have toe brakes as part of the rudder pedal installation that require pressure to be applied to the top of the pedals to operate. However, the rudder pedal and toe brake assemblies differ in that the Piper has rudder pedal pads for rudder control with toe brake pedals attached above the rudder pedals, whereas the Cessna uses a one-piece pedal. Both pedal assemblies are hinged to allow toe brake operation.

ACCIDENT

Aircraft Type and Registration:	Cirrus SR22, N192SR
No & Type of Engines:	1 Teledyne Continental Motors I0-550N piston engine
Year of Manufacture:	2007
Date & Time (UTC):	28 July 2009 at 1945 hrs
Location:	Goodwood Aerodrome, Chichester, West Sussex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to the propeller blade tips and nose landing gear
Commander's Licence:	Private Pilot's Licence
Commander's Age:	54 years
Commander's Flying Experience:	804 hours (of which 28 were on type) Last 90 days - 9 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

After a smooth touchdown in good weather conditions, the pilot applied a forward input on the side stick controller, commensurate with the landing technique he employed on another type of aircraft which he had recently flown. Following the landing the aircraft adopted a lower nose down attitude than usual. Subsequently, the pilot discovered damage to the propeller and the nose landing gear.

History of the flight

The aircraft was returning to Goodwood Aerodrome after an uneventful local flight around the Isle of Wight. The weather was good, with a calm surface wind, CAVOK and an OAT of 18°C. The aircraft joined overhead the aerodrome and entered the downwind leg of the right hand circuit for grass Runway 24, which is 855 metres in length and 44 metres wide.

Having established the aircraft on the final approach with landing flap selected and an approach speed of 80 kt IAS, the pilot flared the aircraft at the normal height and it touched down smoothly with the throttle closed. He then applied forward side stick controller which lowered the nose landing gear onto the runway. (The Cirrus has a side stick controller linked to the elevator and ailerons instead of a conventional control column.) The aircraft adopted an untidy and lower than usual nose-down attitude but the pilot heard no unusual noises or change in the engine rpm. He then taxied the aircraft to the parking area and shut it down. As he was inserting the nosewheel chocks, he noticed that there was damage to the tips of the propeller. Further inspection of the aircraft revealed damage to the nose landing gear oleo.

Prior to flying the Cirrus, the pilot's last four flights had been in a Piper Aztec. His landing technique on that aircraft involved moving the control column fully forward on touchdown in order to enable the nosewheel steering. The pilot considered that his application of excessive forward side stick controller during this landing, rather than allowing the nose to lower on to the runway, had led to the damage.

ACCIDENT

Aircraft Type and Registration:	CZAW Sportcruiser, G-CZSC
No & Type of Engines:	1 Rotax 912 ULS piston engine
Year of Manufacture:	2009
Date & Time (UTC):	17 August 2009 at 1420 hrs
Location:	Priory Farm Airstrip, Norfolk
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Significant damage to both wings and fuselage
Commander's Licence:	Private Pilot's Licence
Commander's Age:	56 years
Commander's Flying Experience:	112 hours (of which 15 were on type) Last 90 days - 35 hours Last 28 days - 9 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During the landing roll, a gust of wind caused the aircraft to turn to the left towards a hedge and ditch. The pilot corrected the turn but the wingtip contacted a substantial branch in the hedge, rotating the aircraft 180° into the ditch. The pilot and passenger exited the aircraft uninjured.

History of the flight

The aircraft took off from Runway 19 at 1210 hrs for a local flight, returning at 1420 hrs. The weather at departure was fine with an 8 kt breeze from the south-west. Upon return the pilot executed an overhead join, making 'blind' radio calls as required. He noted that the windsock was showing the wind had veered to become a north-westerly, so he elected to turn downwind for Runway 01. After flying an uneventful circuit, the pilot landed on the main gear and continued the landing roll. At a point about halfway down the runway, prior to the nose gear touching down, the aircraft turned sharply left and was heading for a hedge and ditch, which ran the length of the left side of the runway. The pilot immediately countered the turn and straightened the aircraft but the left wingtip was now in contact with the hedge. Before he could move the aircraft away from the hedge the wingtip struck a more substantial branch and the aircraft spun 180°, coming to rest in the ditch. The pilot and passenger exited the aircraft normally, uninjured.

The pilot noted, whilst waiting for assistance, that the windsock was veering between north-west and south-west and the wind was gusting up to 15 kt. He reported that each time he had checked the windsock during the approach it had shown the wind was from the north-west.

Discussion

The pilot reported that this was only the third time he had landed on Runway 01 and consequently he was not familiar with the approach. He considered that the sudden gust of wind acting on the tail, and turning the aircraft, had taken him by surprise. The hedge along the runway is several feet high but not continuous, which may account for the aircraft's sudden reaction. Of note, the entry for Priory Farm Airstrip in Pooleys Flight Guide, which is replicated on the airfield's website, warns of buildings and trees on the approach to Runway 01. It also highlights the ditch along the runway, though not the hedge, and suggests use of Runway 19 in crosswinds.

INCIDENT

Aircraft Type and Registration:	Druine D.62B Condor, G-AWST
No & Type of Engines:	1 Continental Motors Corp O-200-A piston engine
Year of Manufacture:	1969
Date & Time (UTC):	25 August 2009 at 1910 hrs
Location:	Haverfordwest Airfield, Pembrokeshire
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to left rear wing spar attachment
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	12,000 hours (of which 14 were on type) Last 90 days - 13 hours Last 28 days - 7 hours
Information Source:	Aircraft Accident Report Form submitted by the commander and aircraft owner

The aircraft owner, who had 106 hours total flying experience including 11 hours on tailwheel aircraft, was undergoing instruction. He had successfully flown seven circuits, but on the next he over-rotated during the flare. The instructor was unable to correct in time and the aircraft landed very firmly on all three wheels, which resulted in damage to the left rear spar attachment. There had previously been a repair to this rear spar attachment, but it is not known whether this was a significant factor.

ACCIDENT

Aircraft Type and Registration:	Extra EA 300, G-SIII
No & Type of Engines:	1 Lycoming AEIO-540-L1B5 piston engine
Year of Manufacture:	1994
Date & Time (UTC):	12 September 2008 at 1825 hrs
Location:	On the runway at White Waltham Airfield
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to the propeller, left hand landing gear strut, left wing and the fuselage
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	43 years
Commander's Flying Experience:	9,500 hours (of which 25 were on type) Last 90 days - 130 hours Last 28 days - 28 hours
Information Source:	AAIB Field Investigation

Synopsis

During the landing roll the left landing gear leg fractured, which caused the wheel assembly to detach from the leg. Examination of the failure revealed that the lower area of the composite leg had weakened over a period of time, due to the brake calliper abrading the paint and outer layer of the glass fabric reinforced composite material. This caused cracks to develop and propagate in the cotton flock-filled composite material in the area of the metal flange plate, as a result of lateral flexing of the leg. This abrading and cracking of the composite material allowed contaminants into the plywood core and, over time, caused the plywood to swell. This swelling caused further cracking of the composite material, weakening the lower leg in the area of the wheel attachment, which resulted in a lateral failure.

History of the flight

Following a normal approach, touchdown and landing roll the aircraft veered uncontrollably to the left, pitched nose down and swung through approximately 180° before coming to rest. The pilot switched off all the aircraft services and quickly exited the aircraft with his passenger; neither suffered injuries.

Description of the main landing gear

The Extra 300 is designed as a conventional tailwheel aircraft with a fixed main landing gear. The main landing gear wheels are attached to a single U-shaped composite-constructed carrier, which tapers towards the wheel axle attachment points and is attached to the underside of the fuselage. This composite carrier incorporates the spring and damping for the wheels.

The carrier is constructed from a mixture of glass fibre rovings, glass fabric and cotton flock infused with a epoxy resin. At either end of the composite carrier, where the wheel axles are attached, the composite has a construction consisting of a plywood core overlaid with glass fibre composite. Further up the landing gear legs the construction changes to a sandwich structure, with glass fibre rovings and glass fabric over-wrapping of a foam core. The composite beam is constructed in two sections with the join running longitudinally down the centre line. Following construction, the U-shaped carrier has a number of coats of paint applied.

The aircraft manufacturer redesigned the main landing gear composite U-shaped carrier, which included reinforcing and reshaping the wheel attachment area and strengthening the upper area of the main carrier by wrapping glass fibre fabric round the two sections of the composite beam. This redesigned carrier replaced the original design, which was fitted to G-SIII at the time of the accident, on new-build aircraft and on an attrition basis for existing aircraft.

Engineering examination

On G-SIII the lower part of the composite left landing gear, with the wheel, brake disc, calliper and the wheel spat, had broken away from the leg. The complete main landing gear was taken to QinetiQ for a detailed examination.

Examination of the left landing gear leg showed that the failure appeared to have occurred due to two separate events. One was the abrading of the paint and the outer layer of the glass fabric reinforced composite material at the lower rear area of the leg, which exposed the glass fibre fabric and resulted in local cracking. The other was cracking of the paint and the epoxy-infused cotton composite material around the metal flange plate mounted on the lower inboard surface of the leg. These breaches of the composite material allowed the ingress of contaminants, both solids and liquids. Over time the liquid contaminants penetrated to the plywood core and, when absorbed, increased the volume of the plywood. This increase in volume caused cracks to develop in undamaged areas of the outer layer of the cotton-flock filled composite material which, in turn, allowed an increased ingress of contaminants. Over time this weakened the structure of the lower leg in the area of the wheel attachment, leading to failure. One of the contaminants was identified by smell as being oil-based, most likely hydraulic fluid, which may have a detrimental weakening effect on the resin that binds together the glass fibre fabric.

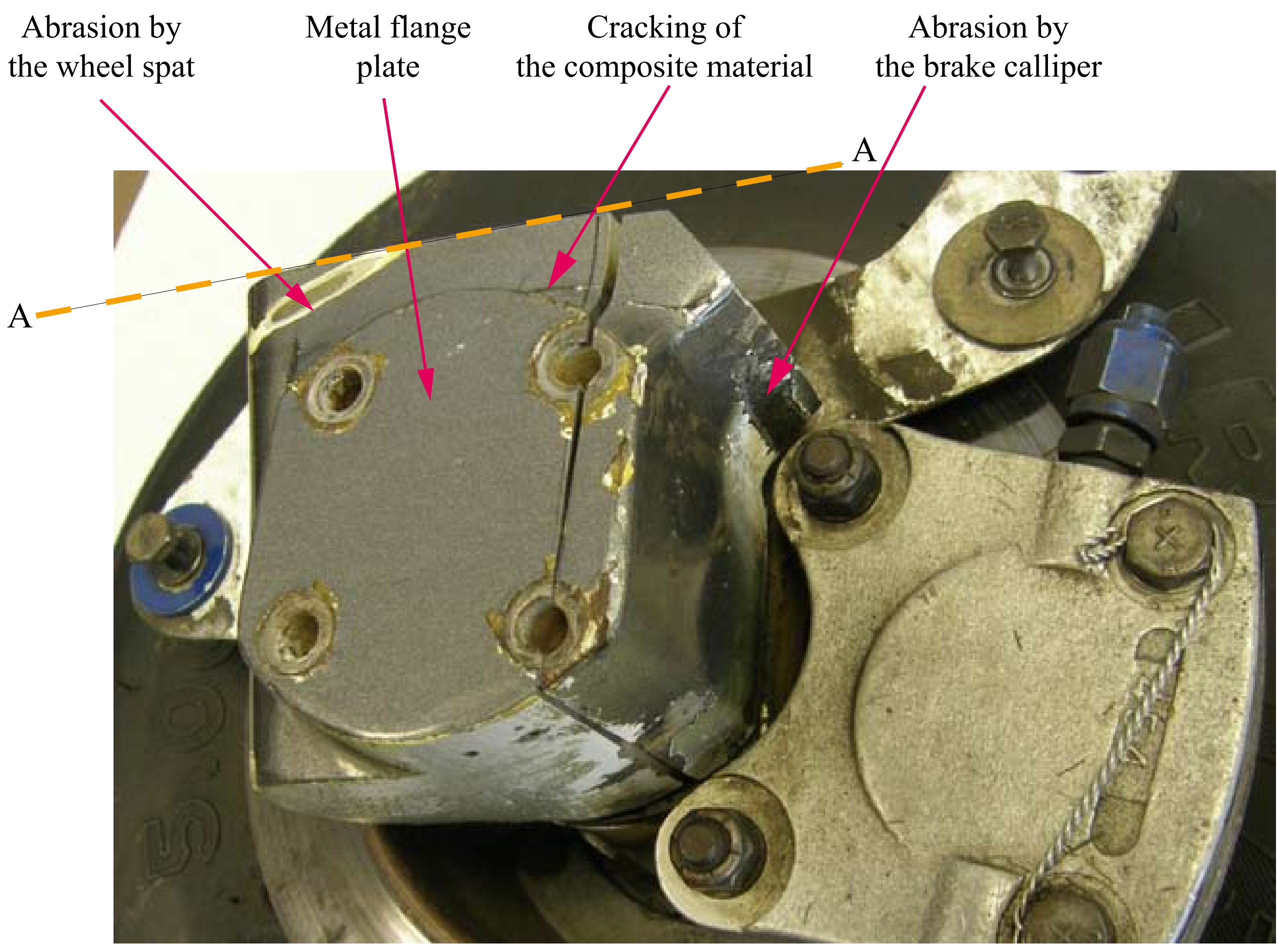
The cracking of the composite material in the area of the metal flange plate was as a result of lateral flexing of the composite U-shaped carrier during taxiing, takeoff and landing. The final failure of the leg was in a lateral loading direction.

A study of the right landing gear leg in the area of the wheel attachment, which had not failed, revealed the presence of composite material abrasion and cracking in similar locations to those identified on the left side. In common with the left side fractures, the cracks on the right side also showed signs of staining, indicating a progressive accumulation of damage, although in both cases the time period could not be determined. The similarity between the damage in the right and left landing gears suggests that both were subject to the same failure mechanisms, with the left failing first due to a single high load. The damage accumulating on the inboard and aft surfaces would have significantly weakened the composite material around the wheel attachment, leading to failure.

As a result of the findings of the QinetiQ examination the right wheel, wheel spat and wheel brake assembly were refitted to the composite landing gear (Figure 1) and it was found that the inner upper corner of the brake calliper had abraded the composite material to the extent that it exposed the glass fibre fabric. This allowed contaminants such as moisture, brake dust and hydraulic fluid to penetrate the inner structure of the composite leg. The abrading of the outer layer of the cotton-flock filled composite material was deeper on the failed left landing gear leg than the right.

Manufacturers' maintenance requirements

The manufacturers' Service Manual calls for a visual inspection at 1,000 hrs of the main landing gear spring for dents, cracks and delaminations, especially at the wheel axle attachment and the centre bushing, for wear and looseness. There are no specific requirements to inspect for abrasion of the outer layer of the glass fabric reinforced composite material. The aircraft had achieved 1,201 hrs since manufacture.



Courtesy of QinetiQ

Figure 1

The reassembled 'original design' right landing gear from G-SIII
(wheel and brake mounting cut from main U-shaped carrier along line A - A)

Other information

A number of other Extra 300 model aircraft were examined, some with and some without the redesigned composite U-shaped carrier. All of them showed varying degrees of abrasion of the composite material by the brake calliper and, to a lesser degree, the wheel spat. Cracking of the composite material in the area of the metal flange plate was only seen on the 'original design' composite U-shaped carrier.

Safety action

There is continuing discussion on the mode and cause of the technical failure and the aircraft manufacturer has introduced an additional inspection requirement:

> *'Visually inspect complete main landing gear spring for dents, cracks and deformations, especially in the area of the mounting clamps and the axle attachments, when wheels and brake callipers are removed.'*

In addition, as airworthiness oversight of this category of aircraft remains the responsibility of the National Aviation Authority of the State of Design:

Safety Recommendation 2009-108

It is recommended that the Luftfahrt-Bundesamt (LBA) review the continued airworthiness of the main landing gear fitted to Extra EA 300 aircraft to ensure the integrity of the outer layer of the cotton flock filled composite material.

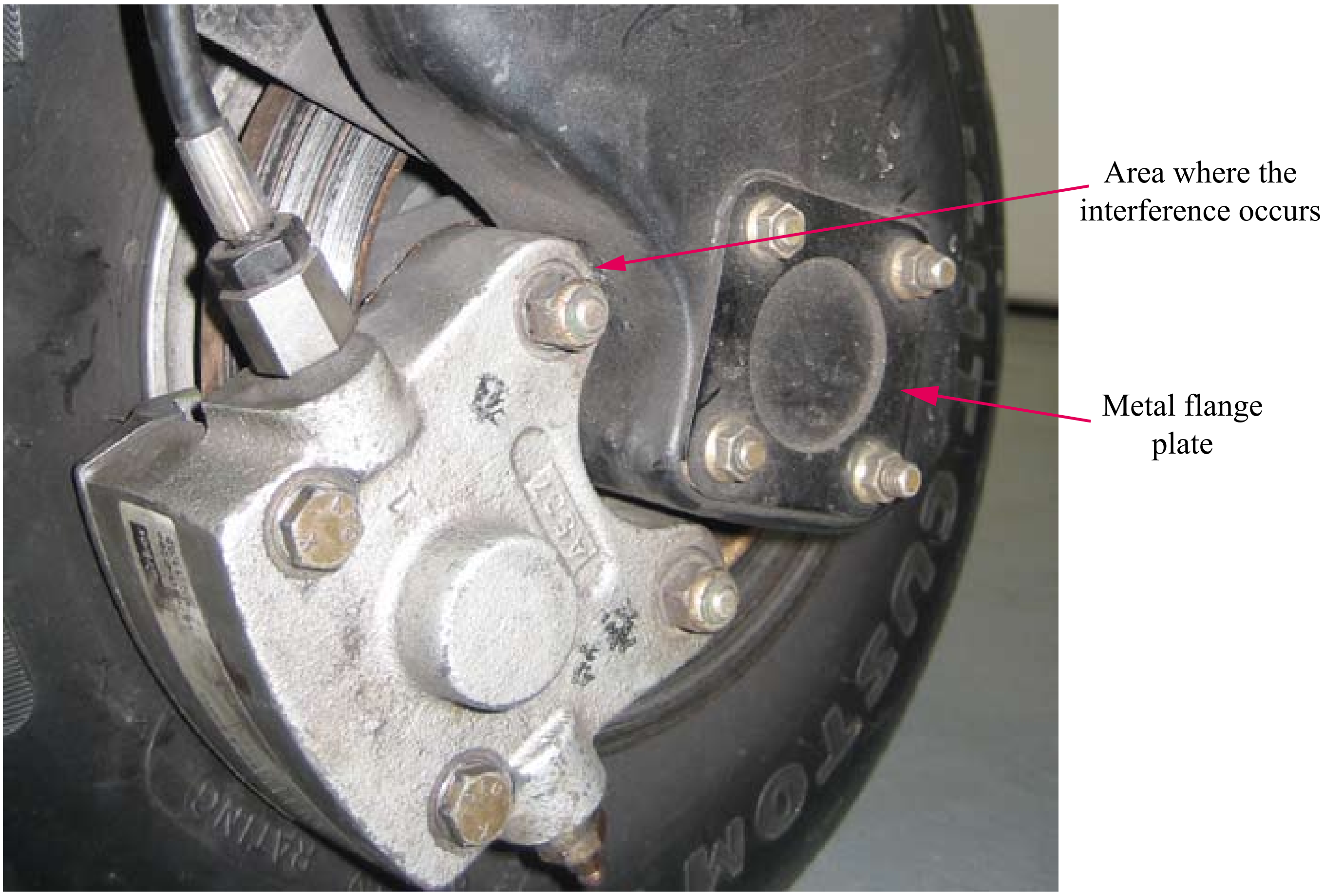


Figure 2

Interference between the brake calliper and the 'redesigned' landing gear leg

ACCIDENT

Aircraft Type and Registration:	Glasair RG, G-BKHW
No & Type of Engines:	1 Lycoming O-320-D1A piston engine
Year of Manufacture:	1989
Date & Time (UTC):	26 April 2009 at 1706 hrs
Location:	Cranwell Airfield, Lincolnshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to engine cowling, propeller and landing gear
Commander's Licence:	Private Pilot's Licence
Commander's Age:	66 years
Commander's Flying Experience:	339 hours (of which 47 were on type) Last 90 days - 15 hours Last 28 days - 9 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft developed a pilot-induced yaw oscillation during the takeoff roll. Shortly after becoming airborne the left wheel touched the ground and the right wheel reportedly struck a runway edge light. The right landing gear was damaged and became jammed in the wheel well during gear retraction. A hydraulic fitting on the right landing gear also failed, causing further difficulties in lowering the landing gear. Following an attempted free-fall emergency extension of the landing gear, the right gear remained jammed in the wheel well and the nose gear failed to lock down and collapsed on landing. Both occupants were uninjured.

History of the flight

The aircraft, a Glasair RG (Figure 1), was being flown from Humberside to Cranwell. The pilot flying was a PPL-holder with a total flying experience of 236 hours, of which 2 hours were on type. During the takeoff roll at Humberside the aircraft started to oscillate in yaw before becoming airborne. The more experienced pilot, who was the aircraft's owner, took control but was unable to prevent the left wheel from contacting the runway and the right wheel from reportedly striking a runway edge light. Landing gear retraction after takeoff appeared normal.

Whilst en-route, the landing gear in transit indication illuminated. In the circuit at Cranwell, the pilot was only able to obtain two green indications (for the nose and

Figure 1

left gear legs) after selecting the gear down. The failure of the right gear to deploy was confirmed by ATC. The pilot then recycled the landing gear, following which only the left gear locked down. A flying instructor in another aircraft provided confirmation that the right landing gear and nose gear were not fully down.

The pilot flew two circuits and liaised with ATC to ensure that the emergency services would be in attendance for the landing. He switched the alternator, battery and magnetos to off, and set the mixture to lean prior to touching down on Runway 19, close to the intersection with Runway 27. During the rollout the right wing dropped, the aircraft slewed to the right, and the nose gear collapsed. The aircraft came to a halt on the grass close to the runway.

Aircraft inspection

The aircraft was inspected by the owner and an engineer. The right gear leg was bent backwards by about 2°, so that the tyre overlapped the wheel well by approximately 2 mm, and the elbow fitting connecting the hydraulic pipe to the right landing gear actuator had fractured. The reason for this was not conclusively established. Once the hydraulic fluid was lost, the normal landing gear operating system would have been rendered inoperative.

Also of concern was the failure of the emergency nose gear deployment system to operate. The nose gear is equipped with a gas spring that is designed to force the gear down during emergency deployment. On inspection, the gas spring was found to have become ineffective due to corrosion of the chromed piston and chafing of a seal, which had allowed gas to leak out. The owner has informed the Light Aircraft Association (LAA) of these findings.

Pilot's comments

The pilot, with the benefit of hindsight, considered that the takeoff should have been aborted during the takeoff roll before the oscillation was allowed to develop. The owner has included supplemental information in the Flight Manual to highlight the dangers of Pilot Induced Oscillation during takeoff and to caution that in the event of the aircraft touching the runway abnormally, the landing gear should not be retracted until a ground check of the system has been made.

ACCIDENT

Aircraft Type and Registration:	Grob G115E Tutor, G-BYXD
No & Type of Engines:	1 Lycoming AEIO-360-B1F piston engine
Year of Manufacture:	2001
Date & Time (UTC):	15 September 2009 at 1105 hrs
Location:	Boscombe Down, Wiltshire
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to main and nose landing gear, cracked engine mounting frame and damage to firewall in area of nose leg attachment
Commander's Licence:	RAF Flight Instructor
Commander's Age:	43 years
Commander's Flying Experience:	Approx 9,000 hours (of which 440 were on type) Last 90 days - 54 hours Last 28 days - 20 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

Whilst a student pilot was landing on the runway during a practice forced landing exercise, a high rate of descent developed during the flare, so the commander/instructor took control and landed the aircraft from the subsequent bounce. During the landing the aircraft sustained significant damage, 6.5g having been recorded by the on-board meter.

History of the flight

The aircraft was operated by a University Air Squadron, and was on a training flight which was planned to include a practice forced landing (PFL). The forecast wind was 20 kt, from 010°, gusting at 26 kt.

The student was briefed to carry out the PFL on Runway 35; the pattern was flown normally and the student lined up the aircraft with the runway, with land flap selected, at a height of about 500 ft. The commander encouraged the student to lower the nose in order to maintain an airspeed of 75 kt, and a final check of the speed was made just below 100 ft, when it was observed to be slightly over 75 kt. At the appropriate position, the student flared the aircraft to the correct attitude. However, the rate of descent increased suddenly, causing the aircraft to impact heavily on the runway surface. The commander took control and landed the aircraft from the subsequent bounce. He decided to taxi to the end of the runway, but it became apparent that the wheel brakes and nosewheel steering were not available, these most probably having failed during the hard touchdown. It was later established that the on-board meter had registered a peak normal load factor of 6.5 g during the landing. The commander informed ATC of the situation and brought the aircraft to a halt on an area of grass beyond the end of the runway.

The actual wind was reported as 5 kt higher than forecast. The commander subsequently commented that, given these conditions, he believed that wind shear was a probable cause of the event.

ACCIDENT

Aircraft Type and Registration:	Grumman AA-5B Tiger, G-ROWL
No & Type of Engines:	1 Lycoming O-360-A4K piston engine
Year of Manufacture:	1977
Date & Time (UTC):	16 September 2009 at 1154 hrs
Location:	Cotswold Airport (Kemble), Gloucestershire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Nose landing gear and propellor damage
Commander's Licence:	Private Pilot's Licence
Commander's Age:	53 years
Commander's Flying Experience:	110 hours (of which 4 were on type) Last 90 days - 6 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot, ATS occurrence report and AAIB enquiries.

While landing on Runway 08, which has an LDA of 1,778 m, the aircraft touched down about 140 m beyond the threshold, bounced and touched down again, nose landing gear first, about 200 m further on. The aircraft then became airborne a second time and the pilot conducted a go-around, requesting a low level circuit to land. During climb out, the aircraft's poor rate of climb led the pilot to suspect that the aircraft had sustained some damage. While on the base leg, he requested a visual inspection of the landing gear from the Control Tower. No landing gear damage was evident and the aircraft landed without further incident at 1202 hrs.

A runway inspection revealed propeller strike marks and the aircraft maintenance organisation reported that the aircraft damage resulted in a replacement propeller, engine shock-load inspection and replacement of the nose landing gear torque tube.

The pilot considered that the initial landing flare may have been too high and conducted at a slightly slow airspeed.

ACCIDENT

Aircraft Type and Registration:	Luton LA4A Minor, G-ASEB
No & Type of Engines:	1 Lycoming O-145-A2 piston engine
Year of Manufacture:	1963
Date & Time (UTC):	17 September 2009 at 1740 hrs
Location:	1 mile north-east of Thatcham, near Newbury, Berkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to fuselage, landing gear and propeller
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	62 years
Commander's Flying Experience:	376 hours (of which 150 were on type) Last 90 days 12 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

Shortly after takeoff, at a height of approximately 100 feet, the engine stopped. The pilot carried out a forced landing and, in an attempt to avoid a high hedge, he landed with a high descent rate and low forward speed. The aircraft sustained damage but the pilot was uninjured. The pilot's post-accident examination of the engine and fuel system did not reveal any faults, so the pilot concluded that the engine may have suffered from carburettor icing.

History of the flight

The Luton LA4A Minor is a homebuilt high-wing single-seat aircraft with a tailwheel landing gear configuration (see Figure 1). G-ASEB was powered by a 4-cylinder 55 hp air-cooled Lycoming O-145-A2 piston engine. The aircraft was operated on a Permit to Fly and maintained by the pilot/owner.

After completing his pre-takeoff checks, the pilot departed from Seige Cross Farm airstrip. The takeoff and initial climb were normal, but after about 15 seconds he noticed that the aircraft's climb rate was lower than usual. The airspeed was indicating about 10 kt lower than normal and the engine speed was about 100 rpm below normal and fluctuating slightly. The oil pressure indication was in the normal range. The pilot lowered the nose of the aircraft and, as he was about to select the carburettor heat on, the engine stopped. He estimated

Figure 1

Luton LA4A Minor, G-ASEB
(photo courtesy CAA database G-INFO)

that this occurred at a height of about 100 feet above the ground. He committed to make a forced landing and banked to the left to avoid a barn that was straight ahead. He then saw a hedge ahead that was about 15 to 20 feet high which he did not think he could clear, so he pulled the stick back in order to slow the aircraft down towards the stall, and hit the ground with a high vertical speed and low forward speed, just short of the hedge. The aircraft came to rest in a very short distance and the pilot was able to vacate the aircraft uninjured.

Pilot's assessment of the cause

The pilot carried out an examination of the engine and fuel system after the accident. He reported that there was sufficient fuel onboard and a check for water was negative. He carried out a fuel flow test, which was normal. He removed the carburettor and an internal inspection revealed no evidence of water or foreign debris, and the main carburettor jet was clear. Both magnetos had been refurbished with new coils, condensers and points in the previous six months. The spark plugs were slightly sooted but otherwise in satisfactory condition. The engine had not suffered from any mechanical failure, so the pilot concluded that the engine may have suffered from carburettor icing. The temperature and humidity at the time were 14°C and 54%, which placed the risk of carburettor icing on the borderline between '*Serious icing – any power*' and '*Moderate icing – cruise power*' based on the CAA's carburettor icing probability chart (see Figure 2).

The pilot said that most of the time he taxied his aircraft with the carburettor heat on. On this particular occasion he had not taxied with the carburettor heat on, because the air had felt dry and the grass was dry. He did, however, operate the carburettor heat for 5 to 10 seconds during the engine run-up checks. The only previous occurrence of possible carburettor icing he had experienced on this aircraft occurred at 1,500 ft while cruising below a layer of cloud, when the engine "hiccupped". He had immediately applied carburettor heat and the engine had returned to normal operation.

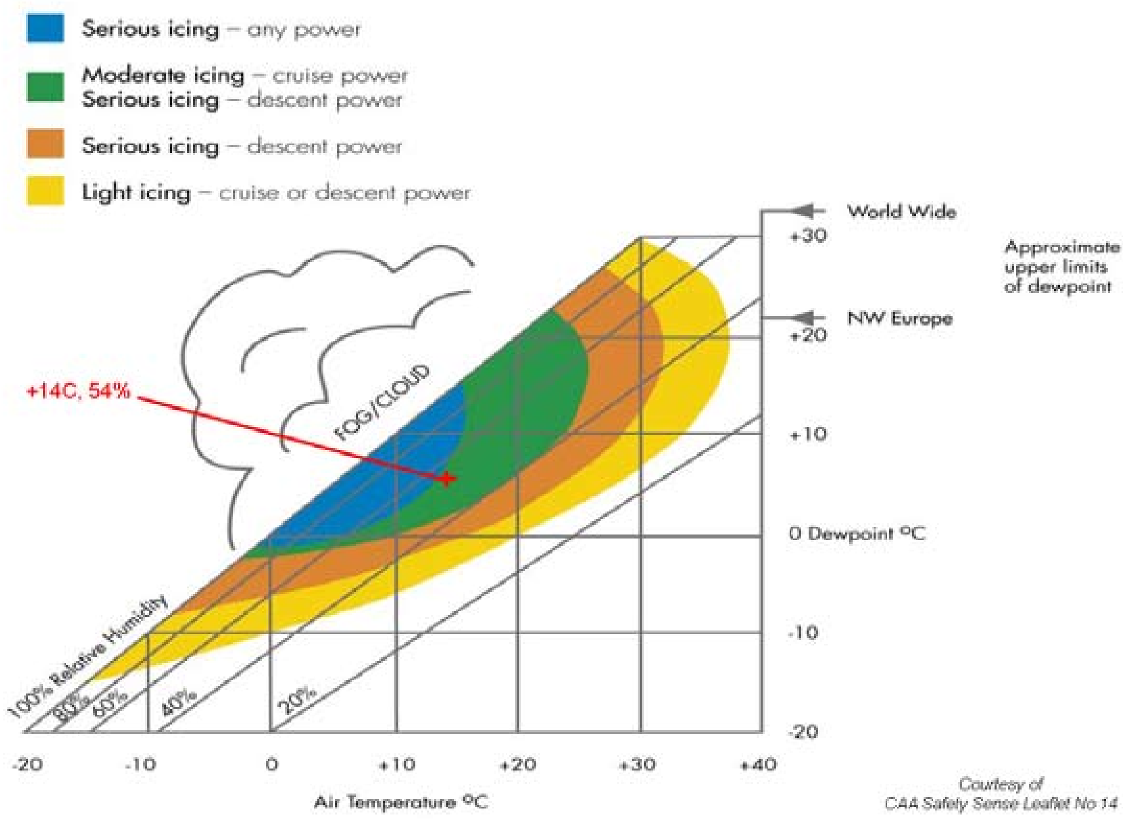


Figure 2

Carburettor icing probability chart from CAA Safety Sense Leaflet 14

ACCIDENT

Aircraft Type and Registration:	Morane Saulnier MS.880B Rallye Club, G-AWOA
No & Type of Engines:	1 Continental Motors Corp O-200-A piston engine
Year of Manufacture:	1968
Date & Time (UTC):	23 October 2009 at 1515 hrs
Location:	Holmbeck Farm Airfield, Leighton Buzzard, Bedfordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Wire entangled propeller, dents to underside of fuselage, spats fractured and possibly engine shock-loaded
Commander's Licence:	Private Pilot's Licence
Commander's Age:	63 years
Commander's Flying Experience:	200 hours (of which 46 were on type) Last 90 days - 22 hours Last 28 days - 8 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

During the later stages of approach to the airstrip, the pilot corrected for a wing drop and shortly thereafter recalled being thrown forward as the aircraft decelerated and came to an unexpected stop. The aircraft's fixed landing gear had made contact with a wire mesh boundary fence supported by 1 m high wooden posts positioned approximately 20 m from the runway numbers. This fence subsequently became entangled around the propeller. The deceleration was relatively benign due to the uprooting of several of the fence posts and neither occupant suffered injuries. The pilot considered that his approach had been too shallow, leaving insufficient clearance between the landing gear and the fence.

ACCIDENT

Aircraft Type and Registration:	Pierre Robin HR200/120B, G-BYLH
No & Type of Engines:	1 Lycoming O-235-L2A piston engine
Year of Manufacture:	1999
Date & Time (UTC):	13 June 2009 at 1641 hrs
Location:	Leeds Bradford Airport
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Minor damage to nosewheel spat
Commander's Licence:	Student pilot
Commander's Age:	45 years
Commander's Flying Experience:	35 hours (of which 25 were on type) Last 90 days - 25 hours Last 28 days - 12 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The student pilot was flying his second solo flight, a circuit consolidation exercise which included visual circuits using Runway 32. The weather was fine, with a light westerly wind. The pilot completed four 'touch-and-go' landings without incident, and was landing from his fifth approach when the accident occurred. As the aircraft nosewheel was lowered to the runway, the aircraft veered to the left; the pilot was unable to correct the deviation with rudder and the aircraft left the paved surface at the side of the runway. The pilot was uninjured and the aircraft suffered only minor damage.

The pilot's instructor remarked that other students had experienced problems with directional control on this type of aircraft. The operator was unable to find any fault on the aircraft and commented that the manufacturer had advised reducing the tyre pressure in the nosewheel to aid directional control on hard runways. Since the incident, the aircraft has flown without a repetition of this occurrence.

ACCIDENT

Aircraft Type and Registration:	Piper J3C-65 Cub, G-NCUB
No & Type of Engines:	1 Continental Motors Corp C85-12F piston engine
Year of Manufacture:	1944
Date & Time (UTC):	8 October 2009 at 1430 hrs
Location:	4 miles NW of Ledbury, Herefordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damaged beyond economic repair
Commander's Licence:	Private Pilot's Licence
Commander's Age:	61 years
Commander's Flying Experience:	164 hours (hours on type not known) Last 90 days - not known Last 28 days - not known
Information Source:	Aircraft Accident Report Form submitted by the pilot and meteorological aftercast report from the Met Office

After conducting a practice landing at a farm strip the pilot put the aircraft into a climb. At approximately 800 ft the engine had a partial loss of power. The pilot immediately selected carburettor heat but there appeared to be no response from the engine, so she decided to carry out a forced landing. She chose a field but at the last minute decided not to land there as it appeared to be too small. The pilot stretched the glide into another more suitable field and landed heavily, damaging the propeller and landing gear.

No detailed examination of the engine or engine systems was carried out. An aftercast, for the Ledbury area on 8 October obtained from the Met Office, gave air temperature, dew point and humidity from the surface to 920 ft. When these figures were plotted on the Civil Aviation Authority's Carburettor Icing Prediction Chart, published in Safety Sense Leaflet No 14, it gave a prognosis that serious carburettor icing could occur at any power setting between the surface and 920 ft above sea level (see Figure 1).

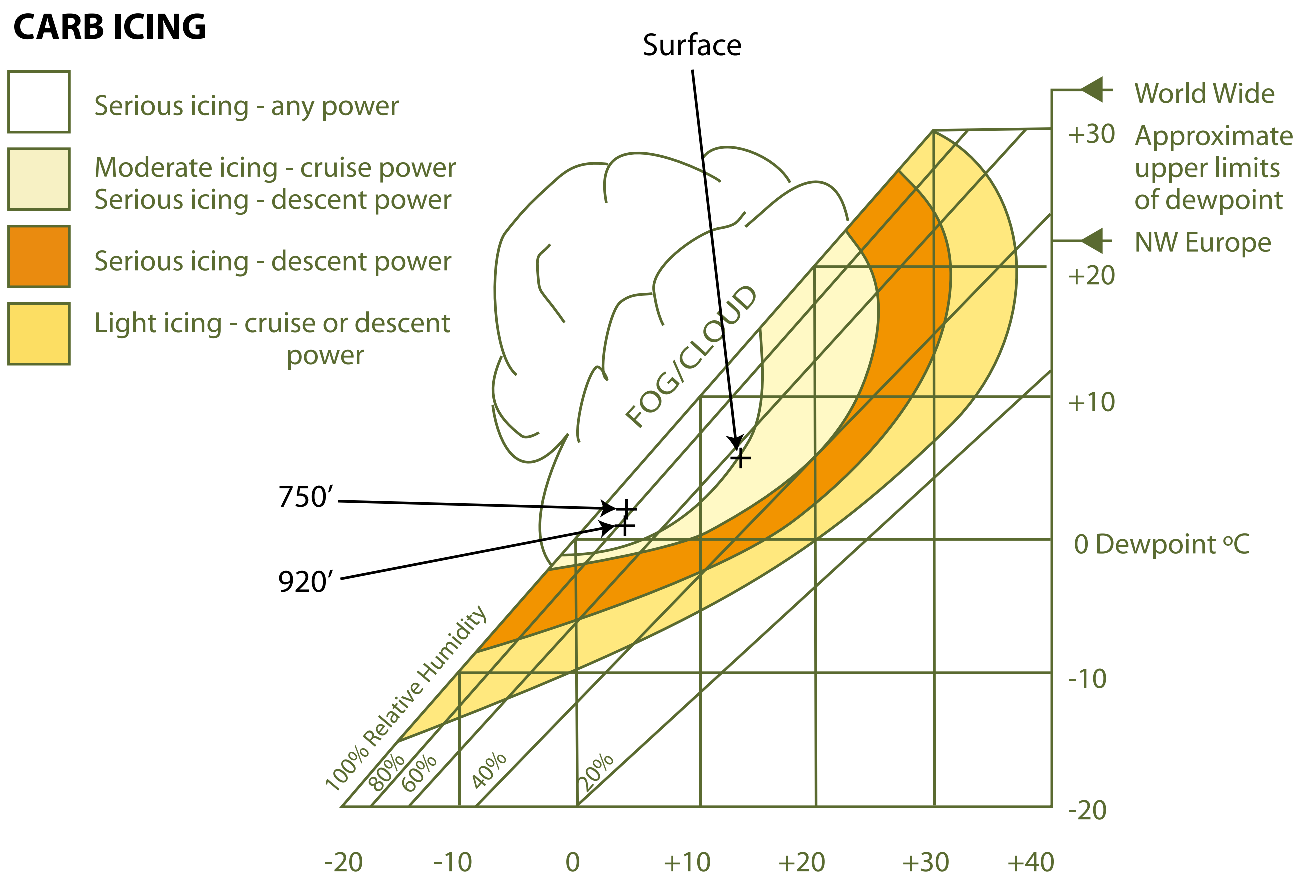


Chart taken from:
CAA Safety Sense Leaflet No 14

ACCIDENT

Aircraft Type and Registration:	Piper PA-28-161 Cherokee Warrior II, G-LACB
No & Type of Engines:	1 Lycoming O-320-D3G piston engine
Year of Manufacture:	1982
Date & Time (UTC):	20 November 2009 at 1420 hrs
Location:	Barton Aerodrome, Manchester
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Substantial to propeller and wing root
Commander's Licence:	Student pilot
Commander's Age:	38 years
Commander's Flying Experience:	48 hours (of which 47 were on type) Last 90 days - 4 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

G-LACB was parked near the fuel pumps with the parking brake off. The student pilot (who had flown solo several times) decided to taxi G-LACB closer to the fuel pumps before re-fuelling; his instructor was not present. He started the engine and the aircraft began to move forward. He reported that because of his seating position, he could not apply the brakes. In attempting to stop the aircraft, he depressed the left rudder pedal, causing the aircraft to turn to the left. The aircraft accelerated towards and collided with a parked aircraft, causing substantial damage to both aircraft.

ACCIDENT

Aircraft Type and Registration:	Piper PA-28-161 Cherokee Warrior III, G-CEMD
No & Type of Engines:	1 Lycoming O-320-D3G piston engine
Year of Manufacture:	2006
Date & Time (UTC):	9 November 2009 at 1620 hrs
Location:	Llanbedr Airport, Gwynedd
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Propeller, left wing outer leading edge skin and wing tip damaged; engine shock-loaded and engine mount/nose landing gear frame bent
Commander's Licence:	Student
Commander's Age:	51 years
Commander's Flying Experience:	55 hours (of which 55 were on type) Last 90 days - 15 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The student was flying the final leg of a Caernarfon-Haverfordwest-Aberporth-Caernarfon solo qualifying cross-country flight. As the aircraft passed the town of Barmouth and, with a lowering cloudbase, forward visibility reduced to the extent that she could no longer see her next checkpoint at the town of Criccieth nor the familiar landmark of the Nebo mast. The pilot declared a PAN, set 7700 on the transponder and advised ATC of her intentions to carry out a precautionary landing on Runway 35 at the disused aerodrome at Llanbedr. Following an initial bounce, she braked and the aircraft veered to the right, departed the runway surface and entered an area of soft ground. About 10 metres from the runway edge the aircraft tipped onto its nose and came to a stop. The uninjured pilot shut down the aircraft, released her lap and diagonal harness, and exited through the cabin door. The aircraft sustained damage to the propeller, engine, landing gear structure and the leading edge of the left wing.

ACCIDENT

Aircraft Type and Registration:	Piper PA-28-180 Cherokee, G-ASIJ
No & Type of Engines:	1 Lycoming O-360-A3A piston engine
Year of Manufacture:	1963
Date & Time (UTC):	31 July 2009 at 1325 hrs
Location:	Andrewsfield Airfield, Stebbing, Essex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to left wing tip, lower engine cowling, nosewheel and propeller
Commander's Licence:	Private Pilot's Licence
Commander's Age:	52 years
Commander's Flying Experience:	102 hours (of which 27 were on type) Last 90 days - 10 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot reported that the weather was good but that the wind was variable in direction. She had departed from Runway 09 at Andrewsfield and on her return to the airfield the wind favoured Runway 27. During the landing on Runway 27 (grass) the aircraft bounced and the left wing rose. The left wing then dropped and the left wing tip struck the ground. The nose gear also struck the ground, heavily, before the aircraft came to rest. The pilot assessed that the accident might have been initiated by a sudden gust of wind. She noted that a line of trees running along the south side of the runway could, in some circumstances, cause a disturbance of the wind. The wind at the airfield was recorded to be from 210° at 8 kt, 35 minutes before the accident, and from 170° at 7 kt, 25 minutes after the accident.

ACCIDENT

Aircraft Type and Registration:	Piper PA-28-180 Cherokee, G-LFSG
No & Type of Engines:	1 Lycoming O-360-A4A piston engine
Year of Manufacture:	1970
Date & Time (UTC):	16 October 2009 at 1426 hrs
Location:	Caernarfon Airport, Gwynedd
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 3
Injuries:	Crew - None Passengers - None
Nature of Damage:	Dents in right aileron, lower wing surface and horizontal stabiliser, both wheel spats damaged
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	80 years
Commander's Flying Experience:	6,866 hours (of which 1,608 were on type) Last 90 days - 3 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot had expected to land on Runway 02 at Caernarfon Airport but on establishing radio contact he was informed that due to an incident, the active runway had changed to Runway 08. This would entail landing with a crosswind of approximately 12 kt and he therefore decided to carry out a flapless landing. The aircraft was approximately 40 kg below the Maximum Landing Weight. The pilot had to extend the downwind leg in order to provide sufficient separation with a light aircraft ahead and consequently, the approach over the sea was long and flat. As he reached the coast, the aircraft encountered some sink. Despite the pilot applying power and raising the aircraft's nose, the landing gear brushed the top of a shingle bank and the aircraft then struck a barbed wire airport boundary fence. The aircraft landed on the runway safely, but the damage incurred made it unfit for further flight.

ACCIDENT

Aircraft Type and Registration:	Piper PA-32R-300 Cherokee Lance, G-BTCA
No & Type of Engines:	1 Lycoming IO-540-K1G5D piston engine
Year of Manufacture:	1977
Date & Time (UTC):	23 August 2009 at 1330 hrs
Location:	Alderney Airport, Channel Islands
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 3
Injuries:	Crew - 1 (Minor) Passengers - 3 (Minor)
Nature of Damage:	Impact damage and severe fire damage to left wing
Commander's Licence:	Private Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	875 hours (of which 640 were on type) Last 90 days - 12 hours Last 28 days - 6 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and additional AAIB inquiries

Synopsis

On approach to Alderney, the pilot temporarily lost sight of the airfield due to a bank of sea fog rolling in from the south. Having passed through the runway centreline, the angle of bank was seen by witnesses to increase to the left, following which the aircraft descended and struck the ground, just before and slightly to the left of the runway threshold. The pilot attributed the accident to the aircraft having been caught by a sudden gust of wind, or maybe a thermal. Warnings are published in the UK AIP and various flight guides to exercise caution due to turbulence caused by nearby cliffs.

History of the flight

The aircraft took off from Jersey with the pilot and three passengers on board, bound for Alderney. It turned onto a northerly heading and levelled out at around 950 ft on the QNH, having been instructed by Jersey Tower to remain below 1,000 ft. The aircraft was then handed over to Guernsey ATC. The presence of some stratus cloud obscured Alderney until the aircraft was at a range of approximately 5 nm; the pilot reported visual contact with the island and was passed to Alderney Tower, who requested that the aircraft join on a left base for Runway 26. The pilot slowed the aircraft to 129 kt and lowered the landing gear. As the aircraft passed over the coast, he increased the engine power to 20 inches of manifold pressure, before reducing the airspeed to 120 kt and lowering two stages of flap. He started a descending left turn and applied a degree of back pressure to the controls in order to reduce the rate of descent. However, at this point the right wing suddenly lifted and the nose raised to a higher angle than the pilot expected. The stall warning horn then sounded and he noted that the airspeed indicator was showing 60 kt. He lowered the nose and applied power; this stopped the warning horn but the controls still felt "sloppy". The stall warning then sounded once more and the pilot responded by pushing the nose further down and applying full power. However, the aircraft continued to turn to the left. The pilot regained partial control and pulled the nose up just before the aircraft struck the ground, short and slightly to the left of the runway threshold.

After the aircraft had come to rest, one of the rear seat passengers called out that there was a fire on the left side of the aircraft. The pilot looked out and saw two small fires, one close to the left wing root and the other immediately outboard of the outer tank. The passengers in the rear of the aircraft exited via the rear door, which was on the left side. The front seat passenger left the aircraft via the forward door on the right hand side. One of the rear seat occupants, who had sustained a knee injury, had to be assisted from the aircraft by the other passengers. The pilot turned off the fuel and the electrical services and, after checking that everyone else had left, collected the fire extinguisher and evacuated the aircraft. He noted that the landing gear had collapsed and that the left wing had broken into two parts. He extinguished the fire but it reignited after the extinguisher was exhausted. The flames spread and the aircraft was largely burnt out before the arrival of the fire and rescue services.

Other information

The weather on the day of the accident, according to the airfield log, indicated wind conditions of 190° at 6 kt. In addition there were FEW clouds reported at 500 ft. However, as the aircraft approached the island, the cloud conditions were revised to SCATTERED at 200 ft, due to a bank of sea fog rolling in from the south which temporarily obscured the pilot's view of the airfield. Witnesses on the airfield noted that the aircraft passed through the runway centreline as it turned onto final approach and the bank angle was seen to increase, as the pilot apparently tried to regain the correct track.

The UK Aeronautical Information Publication (AIP) chart for the airfield, which is 290 ft amsl, carries a warning to exercise caution due to turbulence caused by nearby cliffs. This warning was also included on the airfield guide used by the pilot who had flown on many occasions to Alderney over a period of around fifteen years.

Discussion

In his narrative, the pilot attributed the accident to the aircraft having been caught by a sudden gust of wind, or maybe a thermal. However, when the aircraft was on base leg, the presence of the scattered low cloud caused a temporary loss of visual contact with the runway, possibly causing the aircraft to pass through the extended centreline. It is additionally possible that the pilot's response was to tighten the turn, thus raising the stalling speed to the point where a gust may have precipitated a stalled condition.

ACCIDENT

Aircraft Type and Registration:	Piper PA-38-112 Tomahawk, G-BOMO	
No & Type of Engines:	1 Lycoming O-235-L2C piston engine	
Year of Manufacture:	1981	
Date & Time (UTC):	24 September 2009 at 1052 hrs	
Location:	Swansea Airport	
Type of Flight:	Training	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Damage to front of fuselage, engine, propeller and nosewheel	
Commander's Licence:	Student pilot	
Commander's Age:	56 years	
Commander's Flying Experience:	59 hours (of which 20 were on type) Last 90 days - 9 hours Last 28 days - 5 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

Whilst flying a consolidation solo circuit, the student pilot had to execute an 'S-turn' on final to maintain separation from the aircraft ahead. This destabilised her approach, resulting in her aircraft being higher than planned as she neared the runway. The pilot reduced power to achieve a steeper glide angle, but she considered that the aircraft was still too high as she passed over the runway threshold. The aircraft then touched down heavily on the runway and bounced. The pilot applied power again, but this failed to prevent a further heavy bounce. As the aircraft touched down for a third time, the nosewheel collapsed and the aircraft skidded to a halt at the edge of the runway. The pilot felt, in retrospect, that she had not applied sufficient power to recover the landing following the initial bounce.

ACCIDENT

Aircraft Type and Registration:	Reims Cessna F152, G-BJKY
No & Type of Engines:	1 Lycoming O-235-L2C piston engine
Year of Manufacture:	1981
Date & Time (UTC):	16 October 2009 at 1320 hrs
Location:	Caernarfon Airport, Gwynedd
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to nose landing gear, propeller, firewall, lower fuselage and starboard wing
Commander's Licence:	Student pilot
Commander's Age:	45 years
Commander's Flying Experience:	44 hours (of which 44 were on type) Last 90 days - 6 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft bounced twice during landing and then touched down on the nosewheel causing the nose landing gear to collapse. The pilot was a solo student carrying out a cross-country navigation and land away exercise.

History of the flight

The student pilot was on a cross-country qualifying flight from Blackpool, landing at Hawarden and Caernarfon before returning to Blackpool. The weather conditions for the flight were fine. The pilot landed successfully at Hawarden, where it was commented that his overall standard was "very good".

The pilot then flew to Caernarfon and made an approach to Runway 02, which has an asphalt surface and a Landing Distance Available (LDA) of 1,000 m. The surface wind was from 040ºat 17 kt. The initial touchdown was heavy and the aircraft bounced back into the air. The student recalled holding the control column back and allowing the aircraft to land again. It bounced once more and adopted a nose-high attitude. The student released some of the back pressure, to lower the nose so that he could see ahead, but the aircraft pitched down and landed on its nosewheel. The nose landing gear collapsed and the aircraft slid along the runway before coming to rest on its nose and starboard wheel. The pilot was not injured and was able to vacate the aircraft without assistance. There was no fire.

ACCIDENT

Aircraft Type and Registration:	Robin R2160I, G-WAVT
No & Type of Engines:	1 Lycoming AEIO-320-D2B piston engine
Year of Manufacture:	2002
Date & Time (UTC):	19 September 2009 at 1310 hrs
Location:	Wellesbourne Mountford Airfield, Warwickshire
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to the propeller, engine and nose landing gear
Commander's Licence:	Student pilot
Commander's Age:	16 years
Commander's Flying Experience:	30 hours (of which 4 were on type) Last 90 days - 5 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The student pilot had completed two satisfactory dual circuits with his instructor to Runway 36, in good weather conditions and light winds. The instructor then briefed him to fly two more circuits on what would be his second solo flight. The first circuit was uneventful but during the landing after the second circuit the student flared too early and levelled the aircraft several feet above the runway. The subsequent landing was hard and the aircraft bounced back into the air. The aircraft bounced twice more before finally touching down and departing the runway, coming to rest on the grass to the left of the paved surface. The student pilot was unhurt and was initially unaware that the aircraft had suffered any damage. On instructions from the fire crew who attended the scene, he shut the aircraft down and vacated it normally. The nose landing gear and propeller had been damaged and the engine had been shock-loaded. There was no fire.

SERIOUS INCIDENT

Aircraft Type and Registration:	Rockwell Commander 112TC, G-BLTK
No & Type of Engines:	1 Lycoming TO-360-C1A6D piston engine
Year of Manufacture:	1976
Date & Time (UTC):	19 August 2009 at 1046 hrs
Location:	Blackbushe Airport, Surrey
Type of Flight:	Private
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to propeller and possible engine shock-loading
Commander's Licence:	Private Pilot's Licence
Commander's Age:	53 years
Commander's Flying Experience:	805 hours (of which 136 were on type) Last 90 days - 0 hours Last 28 days - 0 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

While returning to land the pilot discovered that the nose gear leg would not extend. He carried out a series of manoeuvres to try and free the nose gear leg, but the nose gear remained retracted. After declaring an emergency the pilot carried out a landing and held the nose of the aircraft off as long as possible until the propeller finally struck the ground and the aircraft came to rest. The fault was attributed to the right nose gear door jamming on its hinge.

History of the flight

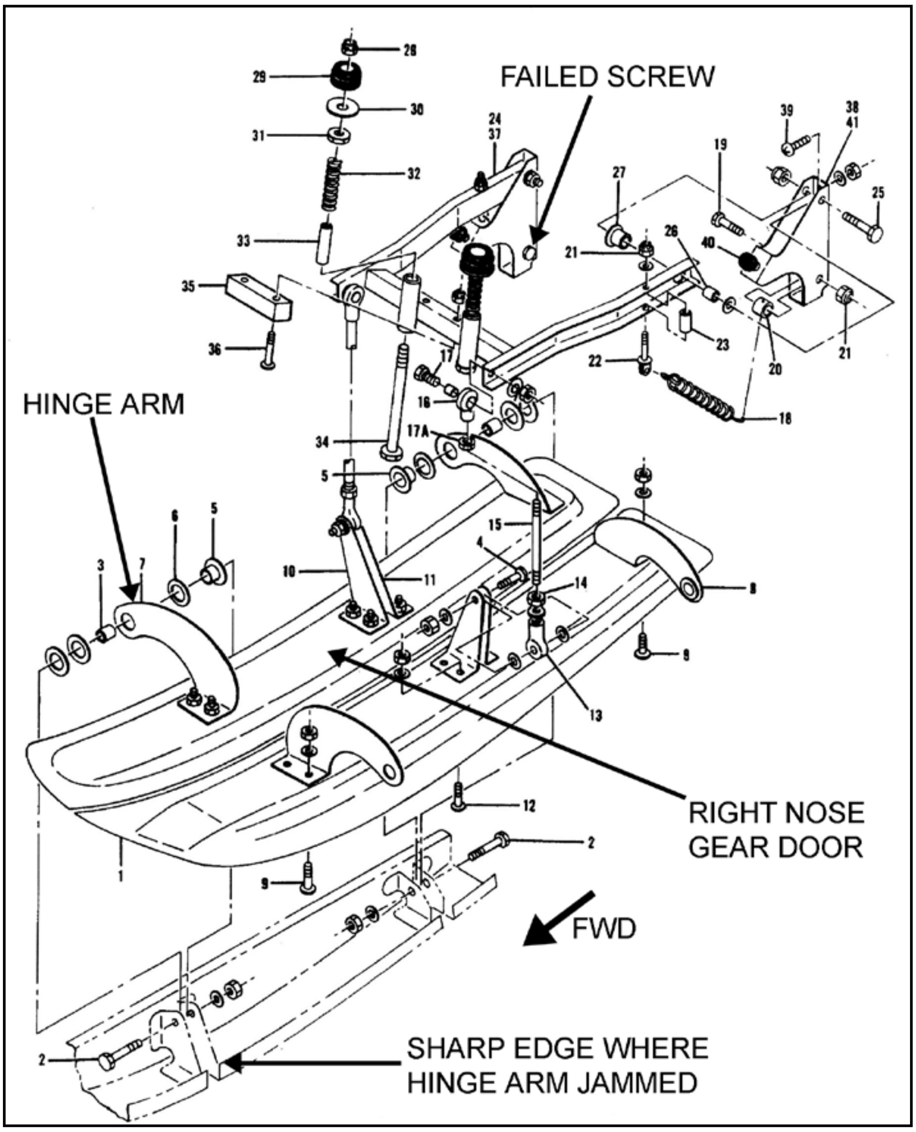
Following a local flight the aircraft returned to the circuit. While joining crosswind the landing gear was selected down at about 110 kt. During the downwind checks the pilot noticed that the two green 'down and locked' lights for the main landing gear legs were illuminated, but that the green light for the nose gear leg was not. The bulb was checked and found to be operational. The pilot informed the Blackbushe AFIS(O) of the problem and then carried out a low approach past the control tower. The AFIS(O) reported that the main gear legs were extended, but the nose gear leg was retracted and the nose gear doors were closed.

The pilot departed the circuit and then carried out a series of manoeuvres, at varying levels of 'g', to try and force the nose gear leg to extend. These manoeuvres were attempted while cycling the gear using both the normal hydraulic extension system and the manual gravity drop system. A second fly-past of the Blackbushe tower was carried out, but this confirmed that the nose gear leg was still retracted. The pilot declared a MAYDAY and then planned for his emergency landing while waiting for the emergency services to position themselves.

The pilot carried out his approach using full flap at a speed slightly above the minimum approach speed. Prior to touchdown the fuel selector was turned off, the mixture was set to LEAN and the battery master switch was turned off. The aircraft touched down normally on the main gear legs with the propeller windmilling. The pilot gradually increased back pressure on the controls to keep the nose of the aircraft and propeller clear of the ground for as long as possible. The nose eventually dropped and the 3-bladed propeller hit the ground and stopped after a few rotations. The aircraft came to a stop with its nose resting on two of the propeller blades.

Aircraft examination

A Licensed Aircraft Engineer examined the aircraft and determined that the nose gear had failed to extend because the right nose gear door had jammed near its hinge. He also discovered that a screw which attached the right lower engine cowling to the nose gear structure had failed in shear (see Figure 1). This would have caused the engine cowling to drop slightly and to move the right nose gear door. The door hinge operates in a narrow slot with sharp edges (see Figure 1) and a slight movement of the door could cause it to jam at the hinge. The engineer could not determine what had caused the screw to fail, but said that it was also possible that the screw had failed as a consequence of the door not opening, and the force of the nose gear actuator sheared the screw.

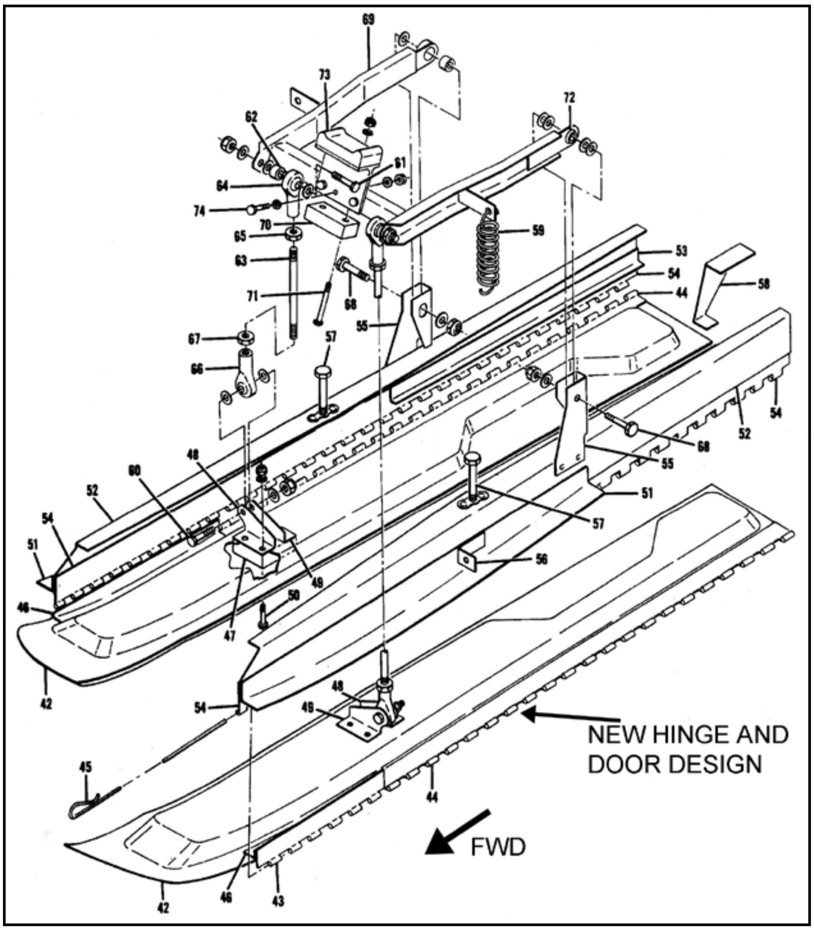


Courtesy of Commander Premier Aircraft

Figure 1

Nose gear door installation on G-BLTK

Later models of the Rockwell Commander 112 were fitted with nose gear doors that had a 'piano-wire' hinge (see Figure 2). This type of hinge would not have jammed in the same manner as the original design.



Courtesy of
Commander Premier Aircraft

Figure 2

Modified Nose gear door installation fitted to Model 112B-500 and subsequent serial numbers and
Model 112TCA-13150 and subsequent serial numbers

ACCIDENT

Aircraft Type and Registration:	Rockwell Commander 114 Commander, G-BDYD
No & Type of Engines:	1 Lycoming IO-540-T4A5D piston engine
Year of Manufacture:	1976
Date & Time (UTC):	31 May 2009 at 1218 hrs
Location:	Ballynakilly Road, Cookstown, Northern Ireland
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Serious) Passengers - 1 (Serious)
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	51 years
Commander's Flying Experience:	526 hours (of which 145 were on type) Last 90 days - 6 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and subsequent AAIB examination of the aircraft

Synopsis

The aircraft suffered an in-flight engine failure as a result of a total oil loss; the subsequent forced landing was made into a cultivated field, but the aircraft failed to stop before encountering a ditch and hedge at its far end. The aircraft was damaged substantially as it came to an abrupt halt.

The oil loss was caused by the failure of a gasket on the oil filter converter plate, mounted on the rear of the engine. The gasket was the subject of an Airworthiness Directive (AD) which required gasket renewal at 50 hour intervals. This requirement was terminated when an improved design of gasket was fitted. The aircraft's maintenance records indicated periodic replacement of the gasket for a time following the issue of the AD. However, the aircraft was subsequently transferred to a different maintenance organisation, which concluded that the new type of gasket had been fitted and that the AD was no longer applicable.

History of the flight

The aircraft was on a flight from Oban to Abbeyshrule, in the Irish Republic. It was in the cruise at 2,000 ft close to Cookstown, when there was a sudden vibration followed by a rapid increase in propeller speed. This was followed by a loud rattling sound from the engine, which then stopped. The pilot reported that the entire sequence lasted approximately 10 to 15 seconds. He also noted that the engine oil pressure had dropped to zero prior to the engine failing completely. He transmitted a MAYDAY call to Scottish Information before looking for a field in which to carry out a forced landing. However, all the fields he could see were small and uneven. The pilot lowered the landing gear and turned off the fuel and battery master switch, before landing downhill in a cultivated field, at the far end of which was a ditch and a hedge. The combined effect of the nose striking the hedge and the main landing gear entering the ditch caused the aircraft to come to an immediate halt. Despite considerable disruption to the fuselage, the lap and diagonal harnesses held on impact. The occupants, who had sustained minor fractures, vacated the aircraft via the left door, having been unable to open the right door.

The pilot stated that prior to the flight, he had checked the engine oil level, which was showing just below maximum, and noted that the indication had not changed from the previous flight.

Examination of the aircraft

The wreckage of the aircraft was recovered to the UK mainland where it was subsequently examined by the AAIB. It was apparent that oil had been lost from the engine, although there were no holes in the engine casing or accessories and the drain plug was present. Attempts to rotate the engine by hand using the propeller revealed the presence of severe internal damage, with at least one broken connecting rod. After removing the oil drain plug, less than half a pint of oil was drained out; it was noted that the oil contained a quantity of metallic debris.

It was observed that the accessory gearbox at the rear of the engine was covered in oily deposits, whereas the rest of the engine was relatively clean. After removing the oil filter from its threaded boss, it was apparent that a seal on the converter plate within the filter mount, Figure 1, was in a deteriorated condition. The converter plate was removed from the mount after unscrewing the boss, which is shown at Figure 2. It can be seen that there is a breach in the circumference of the seal, which has also been 'extruded' between the converter plate and the accessory housing. It was established that the filter was the correct type for use with this particular engine.

Converter plate gasket history

The converter plate gasket was the subject of Lycoming Service Bulletin (SB) 543B, issued on 1 July 2003. This superseded an earlier version that had been mandated by Federal Aviation Administration (FAA) Airworthiness Directive (AD) 2000-18-53. This AD stated that swelling or extrusion of the gasket allowed engine oil to leak from between the converter plate and the engine accessory housing. The AD requires inspection of the oil filter base for evidence of oil leakage and/or gasket extrusion, together with replacement of the gasket at intervals not exceeding 50 hours. These actions were intended

> *'…to prevent the complete loss of engine oil and subsequent seizing of the engine and possible fire…'*

AD 2000-18-53 was amended in July 2002, when it became AD 2002-12-07. This took account of an improved design of gasket which, when fitted, constituted terminating action for the repetitive replacements.

SB 543B additionally stated that some gaskets, with the Part Number LW-13388, had been manufactured from incorrect material, which was given as the reason

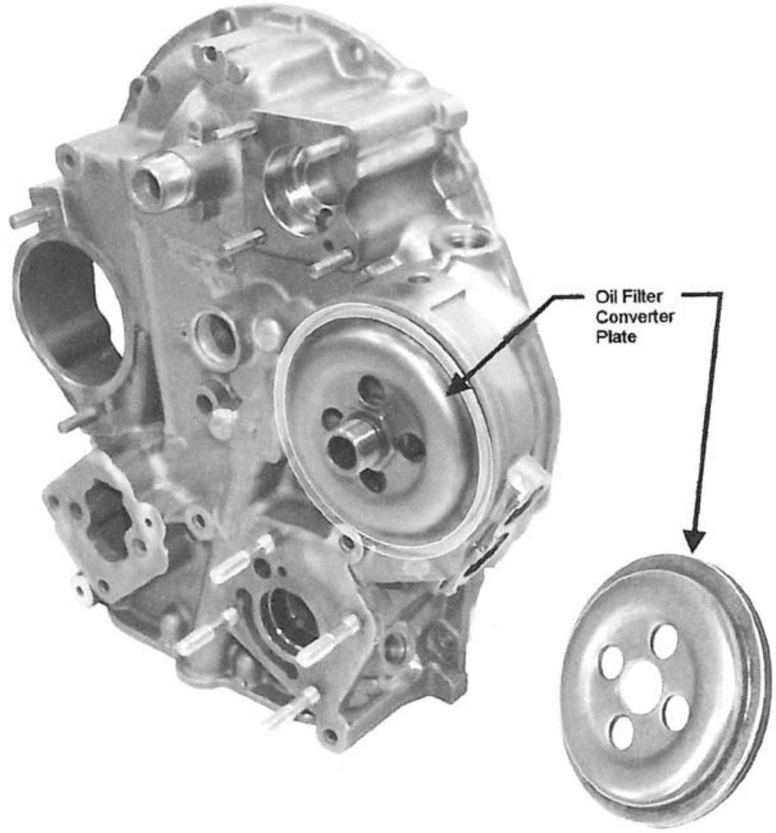


Figure 1

Oil filter converter plate location on the accessory drive housing

Figure 2

View of filter and converter plate, showing damaged gasket why gaskets become extruded during service. The new gasket has the Part Number 06B23072, and this number is identified on the component. After bonding the new gasket in place, the SB requires the number 543 to be 'vibro-etched' on the outer surface of the converter plate.

Examination of the converter plate gasket

Examination of the converter plate revealed that it had not been marked with the number 543, in accordance with the requirements of the SB, which led to an initial conclusion that the gasket may have been of the old type. A new, correctly identified, gasket was obtained and this, together with the filter canister, converter plate and failed gasket, were subjected to detailed examination. The analysis of the gaskets did not establish the material compositions; however differential scanning calorimetry values were significantly different for the two types, meaning that they had not been manufactured from the same base polymer. This reinforced the view that the failed gasket was an example of the old type. The engine manufacturer stated that the material used for the old gasket was ethylene propylene rubber, which is not recommended for use with petroleum based oils.

The failed gasket had sustained considerable damage, as shown in the photographs at Figure 3a and 3b. It was concluded that this was partly the result of high temperatures generated within the engine following the loss of lubrication.

Aircraft maintenance records

Copies of the aircraft engine log book pages were obtained, which contained dates of compliance with the various Service Bulletins and Airworthiness Directives that applied to G-BDYD. It was apparent that AD 2000-18-53 was first complied with in September 2000, when the engine had achieved 36.5 hours since overhaul. The next recorded gasket replacement occurred in September 2001, at 122 engine hours, which was clearly in excess of the stipulated 50 hour interval but it was apparent that a 50 hour and an Annual Inspection had been carried out in the intervening period. The last recorded compliance with the AD was in March 2003, at 184 engine hours. There was no record of complying with SB 543B, which introduced the new gasket and which terminated the requirement for its replacement every 50 hours.

The aircraft was subsequently transferred to the organisation responsible for its maintenance at the time of the accident. Their first task was a 50 hour check, carried out in May 2004 at 215 engine hours. It is usual for a maintenance organisation to conduct an audit of modifications, Service Bulletins and Airworthiness Directives to establish which are applicable to a newly 'acquired' aircraft, and whether they have been implemented. In this case, the maintenance organisation stated that AD 2000-18-53 had been raised on their paperwork, but was identified as not applicable due to previous compliance, ie, a new type of gasket had been fitted, thus negating the requirement for subsequent gasket replacements. However, they could not produce any item of the paperwork that led them to this conclusion.

The most recent maintenance conducted on the aircraft by this organisation was an Annual Inspection, which occurred on 16 January 2009, at 280 engine hours. This was five hours prior to the accident.

Conclusion

The available evidence strongly indicated that the engine failed as a result of a complete loss of oil following the failure of the gasket on the oil filter converter plate. Loss of oil was consistent with the reported symptom

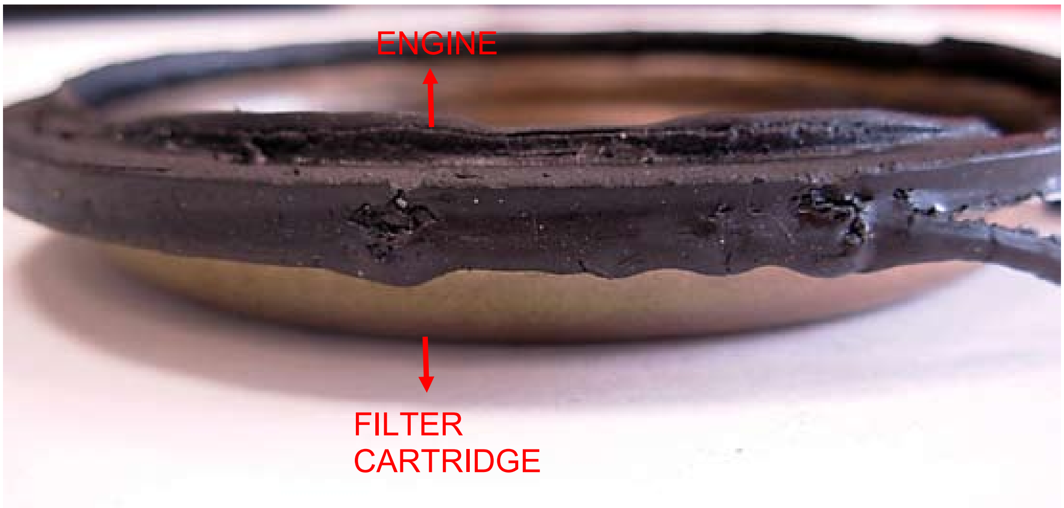


Fig 3a

Fig 3b

Figure 3

Views of damaged gasket

of high engine speed, as oil pressure is used to oppose the aerodynamic forces acting on the propeller blades which, in conjunction with the blade counterweights, act to move the blades towards the fully fine pitch position. Thus, loss of oil pressure would result in the propeller hub piston moving in the fine pitch direction, reducing the load on the engine, with a consequent uncommanded rise in speed.

The forensic examination indicated that the converter plate gasket was likely to have been of the old type, which required replacement at 50 hour intervals. The current maintenance organisation had mistakenly concluded that FAA AD 2000-18-53 was no longer applicable, with the result that the gasket had not been changed for approximately 100 engine operating hours by the time of the accident.

ACCIDENT

Aircraft Type and Registration:	Vans RV-7A, G-MROD
No & Type of Engines:	1 Superior XP-IO-360-A1A2 piston engine
Year of Manufacture:	2007
Date & Time (UTC):	8 November 2009 at 1545 hrs
Location:	Sittles Farm Strip, Lichfield, Staffordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Nosewheel bent and spat broken
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	62 years
Commander's Flying Experience:	975 hours (of which 315 were on type) Last 90 days - 25 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

Just prior to touchdown the aircraft's left wing dropped. The left main wheel touched the ground causing the aircraft to yaw left and leave the grass strip into some short standing crops. The nose wheel subsequently dug into soft ground causing the leg to bend as the aircraft came to an abrupt halt. The aircraft had probably stalled.

History of the flight

The pilot stated that he was coming into land "a little slow" on Runway 35 at Sittles Farm, Lichfield, Staffordshire where his aircraft is based. Runway 35 is a 450 m long grass strip from which he was used to operating. His normal approach speed is 80 mph but he flew this approach at 70 mph due to the short length of the strip. The stalling speed of this aircraft at maximum weight is approximately 58 mph.

At approximately 2 ft agl, 20 m from the start of the strip, the left wing dropped causing the left main wheel to touchdown with the aircraft in a nose-high attitude. This caused the aircraft to yaw left off the strip into a field of short standing crops. Although the pilot corrected the yaw the aircraft continued to parallel the runway for about 70 m before the nosewheel dug into soft ground causing it to stop abruptly. The aircraft suffered a bent nose leg and a small nick to the propeller. The pilot and passenger vacated the aircraft uninjured. The aircraft had probably stalled.

The pilot stated that the accident was caused by him flying the approach too slowly and added that although the audio stall warning was serviceable, he does not remember hearing it. He considered that had he been quicker applying rudder to counter the yaw he would have been able to keep the aircraft on the grass strip.

ACCIDENT

Aircraft Type and Registration:	Vans RV-8, G-XSEA
No & Type of Engines:	1 Superior XP-IO-360-B1AA2 piston engine
Year of Manufacture:	2005
Date & Time (UTC):	7 November 2009 at 1605 hrs
Location:	High Easter Airfield, Essex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Damage to left landing gear, left wing, propeller, engine cowling and fuselage
Commander's Licence:	Private Pilot's Licence
Commander's Age:	48 years
Commander's Flying Experience:	1,044 hours (of which 110 were on type) Last 90 days - 15 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and subsequent AAIB inquiries

Synopsis

Whilst performing an aerobatic manoeuvre, the shuttle valve in the engine oil system became stuck in the inverted position causing a reduction in the engine oil pressure. During the subsequent precautionary landing, the left landing gear ran off the grass strip and sunk into a cultivated field, resulting in the left wingtip and propeller striking the ground.

History of the flight

The pilot was carrying out an aerobatic manoeuvre when the engine oil pressure warning light illuminated, the oil pressure dropped to between 4 and 7 psi, and shortly after the engine started to run roughly. At this point, the aircraft was approximately 3 nm from its home strip and at a height of between 1,200 and 1,500 ft. The pilot decided it would be safer to return to his strip rather than land in a field and positioned the aircraft for a downwind glide approach, to land uphill with a tailwind of approximately 2 kt. The aircraft crossed the hedge at the threshold of the runway approximately 15 kt above the normal approach speed and did not touch down until approximately 180 m into the 450 m long strip. Aware that he would not be able to stop on the runway, and not wishing to risk a go-around, the pilot manoeuvred the aircraft in an attempt to avoid colliding with a hedge and ditch at the end of the runway. In doing so, the left landing gear ran off the grass strip, sunk into a cultivated field and broke away from the aircraft. The left wingtip and propeller dug into the ground and the aircraft came to a halt. The pilot, who was wearing a five-point harness and safety helmet, sustained minor bruising.

Engine oil system

The engine was equipped with an oil system designed to permit unlimited inverted flight. The principal element of the system is a gravity-operated shuttle valve which controls the location from which oil is drawn into the high-pressure engine-driven oil pump. During normal flight, oil is drawn from the sump through the shuttle valve to the oil pump. However, during inverted flight the oil is drawn from the top of the crankcase, which is now lowermost, through the breather port and shuttle valve to the oil pump.

Engineering examination

The owner's maintenance organisation reviewed the data stored in the electronic flight and engine instrument system and established that during the first part of the flight the engine oil pressure was between 62 and 66 psi. The oil pressure then reduced to between 19 and 12 psi for approximately 12 seconds and then fluctuated between 3 and 7 psi for the remainder of the flight. When the oil pressure dropped to 19 psi the airspeed was 26 kt and the ground track changed from 016° to 302°.

An examination of the engine revealed that all the engine oil was in the sump and there was no evidence of any oil having leaked out of the engine. The crankcase breather vent was clean and free from oil and emulsion.

Comment

The drop in oil pressure occurred whilst the aircraft was undertaking an aerobatic manoeuvre and it is likely that the shuttle valve in the engine oil system became stuck in the inverted position for the remainder of the flight. It is also probable that the drop in oil pressure would have caused the hydraulic valve lifters to deflate, which would have affected the dynamic range of movement of the inlet and exhaust valves and caused the engine to run roughly.

ACCIDENT

Aircraft Type and Registration:	Robinson R44 Clipper, G-DBUG
No & Type of Engines:	1 Lycoming O-540-F1B5 piston engine
Year of Manufacture:	2002
Date & Time (UTC):	9 July 2009 at 1045 hrs
Location:	Welshpool Airport, Powys
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damaged beyond economic repair
Commander's Licence:	Private Pilot's Licence (Helicopter)
Commander's Age:	61 years
Commander's Flying Experience:	135 hours (of which 6 were on type) Last 90 days - 18 hours Last 28 days - 7 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and inspections by maintenance organisation

Synopsis

Shortly after lifting into the hover, the cyclic control became heavy and the pilot had difficulty controlling the helicopter. During the attempted run-on landing, the helicopter struck the ground in a nose-down attitude and rolled onto its side. The two occupants were uninjured. The pilot had recently converted from the R22, which does not have hydraulically-powered flying controls, to the R44. Post-accident inspection did not identify any defects which could have caused the reported control difficulties. It was considered that the pilot might have inadvertently switched off the hydraulic system during the flight.

History of the flight

The pilot had recently converted from the two-seat Robinson R22 to the larger, four-seat Robinson R44. He had intended to position the helicopter from the north apron to the fuel bay, at Welshpool Airport. Having completed the ground and start-up checks, which included momentarily switching the hydraulics off to check that the cyclic control became heavy, the pilot lifted the helicopter into the hover. He turned to the left with the intention of hover-taxiing past an air ambulance, and then became aware of the cyclic control becoming heavy. Almost immediately, he felt the helicopter become laterally unstable and it started drifting towards the air ambulance. The pilot raised the collective and applied forward cyclic control to avoid the other aircraft, and decided to perform a run-on landing. He lowered the collective, but was unable to raise the nose sufficiently and the helicopter struck the ground in a nose-down attitude before rolling over onto its right hand side. Both the pilot and passenger were uninjured and exited via the passenger door.

Aircraft inspection

The first person to arrive at the scene was an instructor, who noticed that the hydraulic switch was in the OFF position.

An engineer subsequently inspected and tested the helicopter's hydraulic system. This included a visual inspection of the system, an operational check using a slave hydraulic pump driven by an electric motor, and an operational check of the hydraulic pump. He concluded that the hydraulic system had functioned normally.

Aircraft information

The R44 has a Press-To-Talk (PTT) switch in the pistol grip on the cyclic control, which is activated by the index finger. The hydraulic switch is located on the front of the cyclic stick.

The pilot had recently converted from the smaller R22, which does not have a hydraulic system. The PTT switch on the R22 is located on the front of the cyclic stick, in a similar position to the hydraulic switch on the R44.

Discussion

The lack of any apparent defect in the hydraulic system, the hydraulic switch being found in the OFF position and the pilot's account of the handling difficulties all seem consistent with the pilot having inadvertently switched off the hydraulics. The similar positions of the hydraulic switch on the R44 and the PTT switch on the R22 might have been a factor, although the pilot did not recall any intention to use the radio at the time that the controls became heavy.

ACCIDENT

Aircraft Type and Registration:	Robinson R44 Raven, G-EKKO
No & Type of Engines:	1 Lycoming O-540-F1B5 piston engine
Year of Manufacture:	2000
Date & Time (UTC):	29 March 2009 at 1314 hrs
Location:	Swansea Airport
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Minor) Passengers - 1 (Serious)
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	62 years
Commander's Flying Experience:	984 hours (of which 40 were on type) Last 90 days - 50 hours Last 28 days - 4 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft was about to depart when it began to rotate to the left whilst still on the ground. It rotated through about five complete revolutions before the rotors struck the ground and the aircraft rolled onto its side. The removable left seat flying controls were found fitted and engineering evidence indicates that either one or both of the left yaw pedals had been applied at the time of the accident.

Background

The owner of the aircraft had gained a private pilot's licence on fixed wing aircraft in 1991 and helicopters in 1993. His only helicopter rating was on the R22 but this had lapsed about three years prior to the accident. He had previously owned a R22 and had accumulated about 600 hours on type. He had recently purchased G-EKKO and was intending to become rated on the R44 so that he could fly it himself. On the day of the accident he had planned a local flight with a friend, who was a qualified private pilot with a valid rating on both the R22 and R44 helicopter.

History of the flight

The pilot and owner were seen completing a walk-round check of the aircraft, which was positioned on the airport apron. They then boarded the aircraft, the pilot occupying the front right seat and the owner the front left. Shortly afterwards the aircraft was heard to start and, with the rotors running, the owner requested departure instructions over the radio for a VFR flight to the west. The weather at the time was reported as good with a wind of 160 degrees at 8 kt.

The owner then called "LIFTING". The engine noise was heard to increase and, with the aircraft still on the ground, it began to rotate to the left. It continued to rotate at an increasingly rapid rate, completing approximately five rotations. The aircraft then pitched forwards until the main rotor blades came into contact with the tarmac and the aircraft rolled onto its left side, the tail rotor and empennage separating from the fuselage.

The pilot was able to climb out of the aircraft through his door and he assisted the owner out of the aircraft through the broken windscreen. Both men were injured, the owner receiving serious injuries. The airfield fire and rescue service was quickly in attendance and spread foam on fuel that had leaked from the aircraft.

During the accident sequence pieces of the rotor blades were projected over 100 m from the main wreckage. Despite several people being in the vicinity of the aircraft, no third party was injured.

Aircraft information

The Robinson R44 is a four-seat, single-engined helicopter. It can be fitted with dual controls, which consist of dual sets of yaw pedals, dual collective sticks and a T-bar cyclic stick which has a left and right grip. This T-bar cyclic has a removable grip assembly for the left hand pilot which is marked with a decal *"Solo from right seat only"*. The left collective lever and yaw pedals are also removable. There is a note in the *"daily or preflight checks*" on page 4-5 of the R44 Pilot's Operating Handbook that states:

> *'CAUTION*
>
> *Remove left seat controls if person in that seat is not a rated helicopter pilot.'*

The main rotor blades on an R44 rotate anti-clockwise (when viewed from above). To counteract the nose-right torque of the main rotor blades the tail rotor provides thrust that acts in an anti-clockwise direction in the hover. An input on the left yaw pedal is required on takeoff to maintain directional control. The amount required will depend on various factors including wind strength and direction, and aircraft weight.

Engineering examination

The aircraft was inspected with particular attention being paid to the yaw controls, the tail rotor, and tail rotor drive systems.

The inboard end-plate on the left rudder pedals for the left-hand seat were bent, almost certainly as a result of the impact sequence. Such was the deformation to the end plate that the pedals were stuck in a 'left pedal input' position since it was not possible for the pedals to cross beyond the neutral position . This was consistent with the yaw pedals being in the left pedal forward position when the damage occurred, which might have been a result of an action by either one, or both, of the occupants.

All the damage to the yaw controls, the tail rotor, and tail rotor drive systems were consistent with overload from the impact sequence, and nothing significant was found with these and other aircraft systems that might have contributed to the accident.

All the removable left seat flying controls were found fitted to the aircraft with the *"Solo from right seat only"* decal in place and clearly legible.

Comment

Neither the pilot nor the owner had any recollection of the events leading to the accident. The existing evidence indicates that the accident was caused by either one, or both, of the occupants applying excessive left yaw, probably as the aircraft became light on its skids, when attempting to takeoff.

Accidents to helicopters such as this can be particularly dangerous as a consequence of flying aircraft debris. A recent accident to a Robinson R44 at Goodwood Airfield (AAIB Report EW/G2009/05/26) resulted in a member of the public losing part of a leg. They had been struck by a piece of the aircraft's main rotor which became detached when the aircraft rolled onto its side on the airfield apron.

SERIOUS INCIDENT

Aircraft Type and Registration:	Aerotechnik EV-97 Eurostar, G-SDFM
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	2002
Date & Time (UTC):	31 July 2009 at 1733 hrs
Location:	Broomhill Grange, Edwinstowe, Nottinghamshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Canopy shattered, tailplane leading edge and right wing upper surface damaged
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	51 years
Commander's Flying Experience:	2,545 hours (of which 7 were on type) Last 90 days - 78 hours Last 28 days - 27 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft was level at 3,000 ft to the north of Mansfield when the canopy suddenly shattered. Loose items within the cockpit began moving about and some of these, including the pilot's rucksack, fell overboard. The pilot suffered lacerations to the head which caused profuse bleeding, impairing the vision in her right eye. Despite these difficulties, she was able to identify a suitable field and carried out a successful forced landing. It was concluded that the most likely reason for the canopy shattering was a bird strike.

ACCIDENT

Aircraft Type and Registration:	Gemini Flash 2A, G-MWMS
No & Type of Engines:	1 Rotax 503 piston engine
Year of Manufacture:	1990
Date & Time (UTC):	1 July 2009 at 1229 hrs
Location:	Park Hall Country Park, near Weston Coyney, Stoke-on-Trent, Staffordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Serious) Passengers - N/A
Nature of Damage:	Extensive
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	58 years
Commander's Flying Experience:	180 hours (of which 0 were on type) Last 90 days - 0 hours Last 28 days - 0 hours
Information Source:	AAIB Field Investigation

Synopsis

The pilot was on his first flight in a flexwing microlight. Shortly after takeoff the microlight crashed, seriously injuring the pilot.

The pilot had three-axis microlight flying experience but had not completed any differences training for a flexwing microlight as required by Licensing Administration Standardisation Operating Requirements Safety (LASORS). His fixed wing recency had also expired.

History of the flight

Having been given access to a friend's recently mown field the pilot assembled the microlight with the assistance of the friend. The friend stated that the pilot's intention was just to taxi around the field a few times. Once the microlight was assembled the pilot donned his flying clothing and strapped in. The friend then pulled the rope to start the engine and it started on the second pull. The pilot taxied the microlight in a diagonal/easterly direction down the field, turned around halfway down the field and taxied back to where he had started. He set off again in the same direction but this time closed the throttle just less than halfway down the field. He re-opened the throttle and the aircraft accelerated, becoming airborne about halfway down the remaining part of the field.

The microlight initially climbed steeply and straight ahead before turning right onto a southerly heading towards Park Hall Country Park. It turned further right, using about 45° of bank, towards a golf course (accident site) and descended. The friend lost sight of the microlight as it went below the horizon.

The aircraft subsequently impacted the golf course 700 m from the departure site. Eyewitnesses on the golf course assisted the pilot before he was taken to hospital by an air ambulance. He remained in hospital with serious injuries for six weeks.

Pilot's details

The pilot held a 'three-axis' National Private Pilot's Licence (NPPL) with a current medical declaration.

The last flight entry in his log book was 18 October 2007. Prior to this he had maintained reasonable recency and had revalidated his licence skills test whenever it had expired.

Pilot's comments

The pilot was interviewed seven weeks after the accident after being released from hospital.

He stated that he had no recollection of the accident or any of his activities during the morning before the accident. He added that he did not believe it was his intention to fly that day. Previously he had flown in the rear seat of a flexwing microlight and flown the takeoff and landing, but this was not on an instructional flight.

Although he did not understand why he had become airborne, he added that it was an "act of stupidity" to do so and to start the takeoff run from half way down the field. He said he had checked the manufacturer's manuals to calculate a takeoff distance required and paced out the field believing it to be 230 m along the takeoff direction.

The pilot added that while he was aware of his lack of recency, he had not renewed his skills test as he had been occupied with a new business. He stated that although the fuel selector needed to be reachable in flight, he would never turn it off.

Although he had been advised to take lessons in a flexwing microlight he does not know why he had not done so.

Aircraft information

The Gemini Flash is a two-seat flexwing microlight aircraft. As with other flexwing microlights they are controlled by moving the control bar of the aircraft. The sense of the controls for this type of aircraft is different from that of conventional three-axis aircraft. For example to turn left in a flexwing the control bar is moved to the right, as opposed to moving the control stick to the left or applying left rudder pedal on a three-axis aircraft. Similarly, pulling the control bar rearwards results in pitching the nose down in a flexwing aircraft, whereas pulling the stick rearwards in a three-axis aircraft results in pitching the aircraft nose up.

The aircraft was manufactured in 1990 and was powered by a two-cylinder two-stroke Rotax 503 engine driving a three-bladed pusher propeller. This engine is air-cooled and has a fan mounted in a shroud near the cylinder heads to increase the airflow around the cylinders, and to provide warmed air to the air intake. The fuel selector lever was located close to the engine in a position that required the pilot to reach over his shoulder to reach it in flight.

The pilot bought the aircraft in August 2008 and sent the wing to the manufacturer for a strip and rebuild in April 2009. The BMAA issued a Certificate of Validity for the aircraft on 29 May 2009 which was valid for 12 months and included a flight test by a BMAA inspector.

Field suitability

In the BMAA Code of Good Practice for Microlight Clubs it states in the section titled BMAA Minimum Criteria for a Microlight Flying Site the following:

> ***BMAA Site Recommendations For Private Sites***
>
> 1. *Permission for use must be obtained from the landowner*
> 2. *Location should be outside controlled airspace. If not, permission from the Senior Air Traffic Controller responsible for such airspace must be ontained.*
> 3. *The site should be smooth, reasonably level and well drained when in use.*
> 4. *The take-off/landing criteria are as follows-*
>   - *The runway should be a minimum length of 250 metres and a minimum width of 10 metres.*

The manufacturer agreed with this minimum runway length assuming there were no obstacles. They added that the takeoff roll was likely to be approximately 100 m.

Airfield information

The field from which the aircraft departed had been recently mown, and measured approximately 200 by 100 m, see Figure 1. It was surveyed by

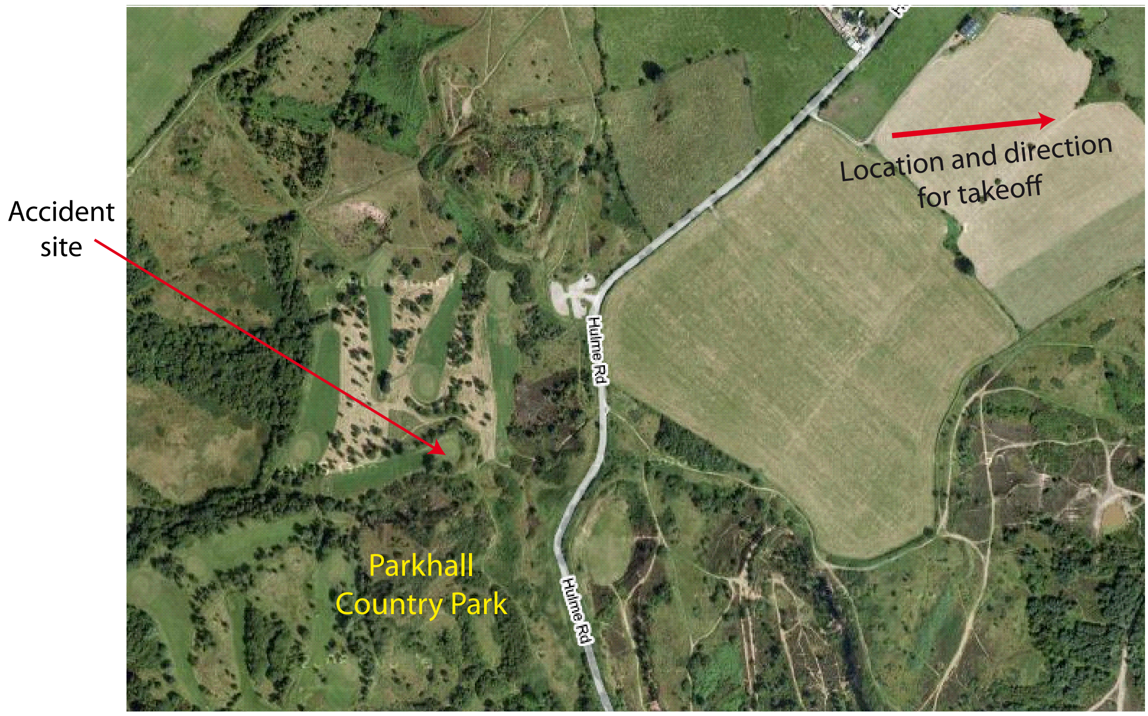


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Figure 1

the Staffordshire Police Collision Support Unit. The aircraft had taken off in a direction that had 180 m of field available on a downward slope of approximately 6%.

LASORS

The General Information section of LASORS 2008 states in Section 3, National Private Pilot's Licence (Aeroplanes), under the title Differences Training the following:

> *'He shall not fly as pilot in command of such a microlight aeroplane where the aeroplane has flexwing controls and his previous training and experience has only been in an aeroplane with 3 axis controls unless appropriate training has been completed and recorded in his personal flying logbook.'*

It was, however, noted that there was no such requirement for holders of Private Pilot's Licences (PPL) in LASORS. Schedule 8 of the Air Navigation Order (ANO), states the following:

> ***'Section 2 – Aircraft and instructor ratings which may be included in United Kingdom Licences, JAR-FCL Licences and National Private Pilot's Licences (Aeroplanes)***
>
> *(1) The following ratings may be included in a United Kingdom pilot licence, a JAR-FCL pilot licence or a National Private Pilot's Licence (Aeroplanes) granted under Part 4, and, subject to the provisions of this Order and of the licence, the inclusion of a rating in a licence has the consequences respectively specified as follows-*
>
> *Microlight class rating*
>
> *(2) (a) Where the current certificate of revalidation for the rating is endorsed "single seat only" the holder is only entitled to act as pilot in command of any single seat microlight aeroplane.*
>
> *(b) Where:*
>
> *(i) the aeroplane has 3 axis controls and his previous training and experience has only been in an aeroplane with flexwing/weightshift controls;*
>
> *(ii) the aeroplane has flexwing/weightshift controls and his previous training and experience has only been in an aeroplane with 3 axis controls;*
>
> *before he exercises the privileges of the rating, appropriate differences training, given by a flight instructor entitled to instruct on the aeroplane on which instruction is being given, must have been completed, recorded in his personal flying logbook, and endorsed and signed by the instructor conducting the differences training.'*

The CAA commented that the ANO requires both PPL and NPPL holders to do differences training if they intend to convert from a flex-wing to a three-axis aircraft, or vice versa, and the next edition of LASORS will include the requirement in the section on PPLs.

To keep his NPPL current a pilot is required to revalidate by either a certificate of experience (requiring a minimum number of hours flying experience in the previous two years), or by a certificate of test which involves passing a skills test with an examiner.

Wreckage site

The wreckage was located approximately 700 m from the field from which the pilot had taken off (Figure 1). The nose of the aircraft had struck a steep embankment a few metres from the third green on a municipal golf course. No damage or witness marks were found on the trees that were growing on the top of the embankment and it was concluded that the aircraft had struck the ground in a slightly nose-down attitude, without excessive roll, having been flying in approximately the same direction as the third fairway and towards the green, possibly attempting a forced landing.

The throttle lever was found in a half-open position, the fuel valve was in the OFF position and the ignition switch in the ON position.

The airframe was inspected and there was no evidence of a structural failure or incorrect rigging.

Weather

A complex front lay over the Western Isles of Scotland and the West of Ireland. An area of high pressure centred over the North Sea gave a light but unstable southerly flow over the Stoke-on-Trent area.

The nearest full observation available was from RAF Shawbury approximately 24 nm south-west of the accident site. Estimated values for the accident site, at the time of the accident, are temperature 25ºC, dew point: 19ºC, visibility 28 km, scattered convective cloud with bases between 3,000-3,300 ft agl, with broken altocumulus with bases between 7,000 ft and 12,000 ft agl. The surface wind was south to south-easterly at 5 kt and the 2,000 ft wind was southerly at 10 kt.

Engine inspection and test

The engine was inspected. The shroud for the cooling fan had been penetrated, almost certainly when the aircraft struck the ground. All the blades of the cooling fan had broken away from the hub in a similar way and this was evidence that the engine was rotating when it struck the ground.

The engine was taken to an engineering organisation with significant experience of this type of engine. The engine was mounted on a test rig along with all the engine controls, the fuel tank and the fuel taken from the wreckage. A replacement cooling fan was fitted and the engine ran satisfactorily and all the controls operated normally. With the engine running the fuel selector was switched to OFF and the engine ran for about 10 seconds at full power and about 15 seconds at cruise power.

Analysis

It appears that the pilot had been careful with his previous fixed wing flying ensuring his recency and skills tests were current before he flew unsupervised. The microlight's paperwork was also in order before the accident.

No engineering deficiencies were found to the microlight or its engine although the pilot was unable to recall if there was a technical problem during the flight. The engine ran satisfactorily on the test rig and there was good evidence that it was running when the aircraft struck the ground. The engine ran for only a short duration on the rig once the fuel was selected off and comparing this to the likely duration of the flight, it is unlikely that the pilot took off with the fuel selector in the OFF position. The fuel selector was probably selected off by the emergency services.

The pilot had not completed any differences training. Given his lack of experience and recency, it is likely that he would have found controlling the flexwing microlight demanding and this may have led to the subsequent ground impact.

While it appears the pilot did not intend to avoid the differences training, this accident highlights the possible consequences of not completing differences training as required by the ANO.

ACCIDENT

Aircraft Type and Registration:	Jabiru UL-450, G-BZSZ
No & Type of Engines:	1 Jabiru Aircraft PTY 2200A piston engine
Year of Manufacture:	2001
Date & Time (UTC):	6 September 2009 at 1300 hrs
Location:	Clipgate Farm, Barham, Kent
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to wings, wing strut, propeller and nose gear leg
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	60 years
Commander's Flying Experience:	312 hours (of which 237 were on type) Last 90 days - 4 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

After returning from a local flight the pilot lined up for an approach to Runway 20 (grass). He reported that the wind was from 200° at 8 to 10 kt. Just prior to touchdown, while the pilot was reducing power, the aircraft was struck by a gust of wind from the right. The pilot reported that he had insufficient time to stop the aircraft from drifting to the left. After touchdown the left wing clipped some hedges and spun the aircraft around until it came to rest. The pilot was uninjured.

ACCIDENT

Aircraft Type and Registration:	Rans S6-ESD XL Coyote II, G-MZBD
No & Type of Engines:	1 Rotax 503 piston engine
Year of Manufacture:	1996
Date & Time (UTC):	22 August 2009 at 1615 hrs
Location:	Runway 15, Felixkirk Airfield, North Yorkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Extensive
Commander's Licence:	Private Pilot's Licence
Commander's Age:	65 years
Commander's Flying Experience:	344 hours (of which 3 were on type) Last 90 days - 4 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot reported that he was making a full-flap approach to Runway 15, which is 500 m long, with a grass surface. The wind was variable between 220°/270° at 5-10 kt. He landed long and was unable to prevent the aircraft from colliding with a boundary hedge and fence. He considered that his lack of familiarity with the aircraft type and the airfield were contributory to the accident.

BULLETIN CORRECTION

AAIB File:	EW/G2009/03/06
Aircraft Type and Registration:	Airbus A320-233, HA-LPJ
Date & Time (UTC):	12 March 2009 at 0902 hrs
Location:	Stand 40, London Luton Airport
Information Source:	Aircraft Accident Report Form

AAIB Bulletin No 10/2009, page 4 refers

This event has been reviewed and is now classified as a **Serious Incident**.

BULLETIN CORRECTION

AAIB File:	EW/C2008/11/04
Aircraft Type and Registration:	Boeing 737-8AS, EI-DLR
Date & Time (UTC):	13 November 2008 at 1920 hrs
Location:	Stand D 61, London Stansted Airport, Essex
Information Source:	AAIB Field Investigation

AAIB Bulletin No 12/2009, page 1 refers

The introduction of this report it was incorrectly stated in the **Persons on Board** section there were 4 crew and 164 passengers on board the aircraft.

This should have read **6** crew and 164 passengers.

AIRCRAFT ACCIDENT REPORT No 1/2010

This report was published on 9 February 2010 and is available on the AAIB Website www.aaib.gov.uk

REPORT ON THE ACCIDENT TO BOEING 777-236ER, G-YMMM, AT LONDON HEATHROW AIRPORT ON 17 JANUARY 2008

Registered Owner and Operator	British Airways PLC
Aircraft Type	Boeing 777-236ER
Serial No	30314
Nationality	British
Registration	G-YMMM
Place of Accident	London Heathrow Airport
Date and Time	17 January 2008 at 1242 hrs All times in this report are UTC

Synopsis

The Air Accidents Investigation Branch (AAIB) was notified at 1251 hrs on 17 January 2008 of an accident involving a Boeing 777-236ER aircraft registration G-YMMM at London Heathrow Airport. The investigation commenced immediately and the AAIB team consisted of:

Mr R Tydeman
  Investigator-in-Charge January 2008 - October 2008
Mr R D G Carter
  Investigator-in-Charge from November 2008
Mr P A Sleight
  Engineering - Deputy IiC & Lead Engineer
Ms A Evans
  Engineering - Chair Crashworthiness Group
Mr B D McDermid
  Engineering - Chair Fuel and Fuel System Group
Mr S W Moss
  Engineering - Chair Powerplant Group
Mr R Parkinson
  Engineering - Chair Aircraft Group
Mr M W Ford
  Flight Data Recorders - Chair Data Group
Mr A Severs
  Operations - Lead Operations
Mr P E B Taylor
  Operations - Chair Evacuation Group

In accordance with established international arrangements, the National Transportation Safety Board (NTSB) of the USA, representing the State of Design and Manufacture of the aircraft, appointed an Accredited Representative and was supported by a team which included additional investigators from the

NTSB, the Federal Aviation Administration (FAA) and Boeing; Rolls-Royce, the engine manufacturer, also participated fully in the investigation. The operator co-operated with the investigation and provided expertise as required. The Civil Aviation Authority (CAA) and the European Aviation Safety Agency (EASA) were kept informed of developments.

On 28 November 2008, a Boeing 777-200ER suffered an in-flight engine rollback; an investigation by the NTSB was initiated with Mr P A Sleight, from the AAIB, assigned as the UK accredited representative.

Prior to this Final Report the AAIB published an Initial Report, on 18 January 2008, a subsequent update on 23 January 2008, Special Bulletins on 18 February 2008 and 12 May 2008, and Interim Reports on 4 September 2008 and 12 March 2009.

Eighteen Safety Recommendations have been made.

Whilst on approach to London (Heathrow) from Beijing, China, at 720 feet agl, the right engine of G-YMMM ceased responding to autothrottle commands for increased power and instead the power reduced to 1.03 Engine Pressure Ratio (EPR). Seven seconds later the left engine power reduced to 1.02 EPR. This reduction led to a loss of airspeed and the aircraft touching down some 330 m short of the paved surface of Runway 27L at London Heathrow. The investigation identified that the reduction in thrust was due to restricted fuel flow to both engines.

It was determined that this restriction occurred on the right engine at its Fuel Oil Heat Exchanger (FOHE). For the left engine, the investigation concluded that the restriction most likely occurred at its FOHE. However, due to limitations in available recorded data, it was not possible totally to eliminate the possibility of a restriction elsewhere in the fuel system, although the testing and data mining activity carried out for this investigation suggested that this was very unlikely. Further, the likelihood of a separate restriction mechanism occurring within seven seconds of that for the right engine was determined to be very low.

The investigation identified the following probable causal factors that led to the fuel flow restrictions:

1. Accreted ice from within the fuel system[1] released, causing a restriction to the engine fuel flow at the face of the FOHE, on both of the engines.

2. Ice had formed within the fuel system, from water that occurred naturally in the fuel, whilst the aircraft operated with low fuel flows over a long period and the localised fuel temperatures were in an area described as the 'sticky range'.

3. The FOHE, although compliant with the applicable certification requirements, was shown to be susceptible to restriction when presented with soft ice in a high concentration, with a fuel temperature that is below -10°C and a fuel flow above flight idle.

4. Certification requirements, with which the aircraft and engine fuel systems had to comply, did not take account of this phenomenon as the risk was unrecognised at that time.

Footnote

[1] For this report 'fuel system' refers to the aircraft and engine fuel system upstream of the FOHE.

Findings

Conduct of the flight

1. The crew were properly licensed and rested to conduct the flight.

2. The aircraft had been loaded with 71,401 Kg of Jet A-1 fuel at Beijing and the total fuel load at the start of the accident flight was 79,000 kg. This was sufficient fuel to complete the flight.

3. The left main fuel tank temperature at takeoff was -2°C, this was not unique and data mining revealed that a small percentage of B777 flights had a fuel temperature below 0°C at takeoff.

4. During the flight from Beijing the fuel temperature reached a minimum of -34°C and the minimum TAT reached was -45°C. These temperatures experienced during the flight were unusual but were within the operating envelope of the aircraft and were not unique.

5. During the flight two step climbs were completed in VS mode which required relatively low fuel flows and contributed to low average fuel flows for the flight.

6. Data mining showed that the accident flight was unique amongst 175,000 flights as having a low cruise fuel flow and a high fuel flow during approach while at a low fuel temperature.

7. The flight from Beijing had been uneventful until the final approach to Runway 27L at London Heathrow.

8. The co-pilot took control of the aircraft from the commander at 800 ft in accordance with the operator's procedures.

9. At 720 ft agl the right engine suffered an uncommanded reduction in engine power to 1.03 EPR and seven seconds later the left engine suffered an uncommanded reduction in engine power to 1.02 EPR.

10. The right engine fuel flow reduced to 6,000 pph and the left engine fuel flow reduced to 5,000 pph, levels above those required by an engine at flight idle.

11. Both the left and right engine FMVs moved to full open and the EECs entered LIC 17, with no effect on the fuel flow.

12. Data mining did not reveal any flight, other than the G-YMMM accident flight and the N862DA incident flight, that had indicated an EEC LIC 17 or had a genuine FMV position versus fuel flow mismatch.

13. The fuel temperature at the time of the engine rollback was -22°C. This was also the fuel temperature at which the rollback occurred on the N862DA incident flight.

14. The flight crew became aware of a possible problem with the thrust 48 seconds before touchdown.

15. The co-pilot intended to disconnect the autopilot at 600 ft but became distracted by the engine rollback, so the autopilot remained engaged.

16. The loss of engine power led to a reduction in airspeed as the autopilot attempted to

follow the ILS glideslope, leading to a nose-high pitch attitude.

17. Thirty-four seconds before touchdown the flight crew became concerned about the reduction in airspeed below the target approach speed and attempted manually to increase engine thrust to compensate; there was no response from the engines.

18. At 240 ft agl the commander retracted the flap from FLAP 30 to FLAP 25 which increased the distance to touchdown by about 50 metres; if left at FLAP 30 the touchdown would have still been within the airfield boundary.

19. At 200 ft agl the stick shaker activated and as a touchdown short of the runway was inevitable the commander transmitted a 'MAYDAY' call three seconds before touchdown.

20. At the operation of the stick-shaker, the co-pilot pushed forward on the control column and the autopilot disconnected.

21. The aircraft struck the ground within the airfield boundary at a recorded normal peak load of 2.9g, and a descent rate of about 1400 fpm (~25 ft/s), at 1242:09 hrs, 330 m short of Runway 27L and slid 372 m before coming to rest.

22. During the latter stages of the approach the commander attempted to start the APU, but the start sequence was not completed.

23. The landing gear attachments were disrupted during the initial impact, the left MLG collapsed and the right MLG separated from the aircraft.

24. The nose landing gear collapsed and the lower side of the aircraft and engines were severely disrupted during the ground slide.

Evacuation and survivability

25. There was insufficient time for the flight crew to brief the cabin crew or issue a 'brace brace' command.

26. The evacuation alarm was perceived by the cabin crew as sounding 'faint' in the cabin.

27. The evacuation alarm was later found to operate satisfactorily, except at Door 1L which was silenced due to a stuck reset switch.

28. There is no minimum performance specification for the evacuation alarm as it is an optional fit to the aircraft. However, sound level checks met BS EN 1SO 7731.

29. The commander initially announced his evacuation call over the VHF radio, but when ATC informed him of this, the call was repeated over the cabin PA system.

30. The cabin crew initiated the evacuation, all the escape slides deployed satisfactorily and all the passengers evacuated the aircraft.

31. The passenger in seat 30K suffered a broken leg as items from the right MLG penetrated the fuselage during the ground slide.

32. 34 passengers and 12 cabin crew suffered minor injuries, mainly to the back and neck.

33. The evacuation was conducted efficiently with clear instructions from the cabin crew.

34. Some passengers attempted to retrieve personal items during the evacuation.

35. There was no fire; however there was a significant fuel leak and an oxygen leak from disrupted passenger oxygen bottles. The AFS were on site within 2 minutes of the initial touchdown.

36. The operator's evacuation check list split the actions between the commander and co-pilot and was on a placard on the control column. The commander operated the engine run/cutoff switch and the co-pilot the engine fire switches. The engine fire switches were operated first.

37. The evacuation check list from the aircraft manufacturer required the operation of the engine run/cutoff switch to CUTOFF prior to pulling the fire switch.

38. The spar valves remained OPEN following the accident despite the operation of the fire switches and engine run/cutoff switch to CUTOFF. This allowed 6,750 kg of fuel to leak out of the engines until the valves were manually closed.

39. The spar valves remained OPEN due to the wiring damage caused by the separation of the MLGs, which also caused the left spar valve circuit breaker to trip.

40. The wiring to the right spar valve from the engine run/cutoff switch remained intact. Pulling the fire handle isolated the run/cutoff relay and removed the ability of the run/cutoff switch signal to CLOSE the spar valve.

41. SB 777-28-0025 introduced a means of shutting the spar valve from the engine run/cutoff switches, even if the fire switch has been pulled. This SB had not been embodied on G-YMMM.

Crashworthiness - cabin

42. Exit sign lenses at Doors 3L and 3R detached during the accident due to the lack of positive retention.

43. Glass fragments from the indirect ceiling fluorescent tubes were found on the cabin floor.

44. The light fittings met the regulatory requirements for emergency landing loads, but these requirements did not allow for flexing of the surrounding structure.

45. Nine of the 32 Business economy video monitors detached from the seat backs, in the impact, due to wear of the support detent and spring.

Crashworthiness – structure

46. Both MLGs partially separated at initial impact with a vertical descent rate of 25 ft/s.

47. The left MLG attachments separated as designed.

48. On the right side a section of rear spar web ruptured during the detachment of the right

MLG and thus left a large breach in the right wing rear spar and centre fuel tank.

49. The right MLG had moved aft, causing the shock strut to contact the truck beam leading to the separation of the forward truck beam and two front wheels.

50. Two of the right MLG inboard wheels contacted the fuselage behind the MLG bay, disrupting the RAT and the passenger oxygen bottles, leading to an oxygen leak.

51. Simulation of the accident showed different behaviour depending on the type of impact surface.

52. Certification requirements for landing gear design do not specify differing impact surfaces.

Aircraft examination

53. The aircraft had been adequately maintained and had a valid certificate of airworthiness.

54. There were no recorded technical defects with the aircraft, prior to departure from Beijing, that would have contributed to the accident.

55. The left engine fuel valve circuit breaker had tripped due to the wiring disruption to the underside of the engine during the ground slide.

56. The Ram Air Turbine had not deployed prior to the initial impact.

57. The forward cross-feed valve was found OPEN and the switches for the cross-feed valves on the overhead fuel panel were also in OPEN.

58. The operation of the forward cross-feed valve was after the power had been lost to the DFDR during the accident ground slide. Prior to this point it was CLOSED.

59. The loose fuel scavenge union in the left fuel tank was not a factor in this accident.

60. The manufacturing debris found in the fuel tanks was not a factor in this accident.

61. The right suction check valve was found to stick OPEN, but was not a factor in this accident.

62. There was no evidence that HIRF or EMI were factors in this accident.

63. There were no pre-existing defects with the engines and the engine control systems operated correctly.

Fuel

64. There was 10,500 kg of fuel remaining on the aircraft at the time of the engine rollback, 5,100 kg in the left main fuel tank and 5,400 kg in the right main fuel tank.

65. The fuel onboard G-YMMM was consistent with Jet A-1 and met the Defence Standard 91-91 and ASTM D1655.

66. The fuel sampled from G-YMMM contained 35 to 40 ppm of water, which was similar to that found on other aircraft that had flown similar routes.

67. The fuel had not, at any time during the flight, cooled to a temperature at which it would suffer from fuel waxing.

68. The operator had the highest practicable frequency of fuel sumping for the Boeing 777. The frequency and efficiency of the fuel tank sumping was not a factor in this accident. The aircraft had been last sumped on the 15 January 2008.

69. The centre tank water detection messages, recorded during taxi in Beijing, were most likely 'nuisance' messages.

70. The centre tank fuel scavenge system was not a factor in this accident.

71. The water scavenge system was not a factor in this accident.

Recorded data

72. The DFDR did not record FMV position; however it was recorded on the non-protected QAR.

73. The QAR buffer caused the loss of 45 seconds of data prior to the accident.

Restriction to fuel flow

74. The FMV positions and the recorded fuel flows showed that both engines had suffered restrictions in the fuel delivery system to the engine.

75. The left and right HP pumps had signs of fresh cavitation, indicating that the restriction was recent and upstream of the pump.

76. The aircraft fuel boost pump had not indicated a low pressure during the flight.

77. Testing and analysis of the engine response has shown that aeration of the fuel had not occurred.

78. The restriction was downstream of the forward boost pump connection into the fuel manifold and upstream of the HP pump.

79. There was no remaining evidence of a physical restriction in the fuel system.

80. The fuel spar valves had remained open throughout the flight and there was no indication of an uncommmanded movement of a spar valve, either recorded or reported by the flight crew.

Engine testing

81. Engine tests and analysis suggested that a restriction could have been in place prior to the final series of four acceleration/deceleration cycles, during the approach, if the restriction was sited 25 feet or more from the strut interface.

82. The engine tests used fixed restrictor plates, warm, unweathered fuel and did not consider the dynamics or properties of ice in the system.

83. It was concluded that the restriction most probably occurred at the face of the FOHE just prior to the final acceleration cycle.

Fuel system testing

84. Ice can form within the fuel system feed pipes with normal concentrations of dissolved and entrained water present in aviation turbine fuel.

85. Ice can form on the inside of fuel pipes when warm fuel at a temperature of +5°C flows through cold pipes.

86. There is a 'sticky range' between -5°C and -20°C, when ice crystals in aviation fuel are most likely to adhere to their surroundings.

87. The ice is most 'sticky' at -12°C.

88. Ice does not appear to stick to the inside of the fuel pipes when the fuel temperature is at -35°C or below.

89. Ice that accumulated in the fuel system, during testing, was always soft and mobile.

90. The properties of the ice generated during testing may not be the same as the properties of the ice generated in flight.

91. Increasing the fuel flow can cause accreted ice to be released from the walls of the fuel pipes.

92. Ice released from within the fuel pipes could form a restriction at the face of the FOHE.

93. Tests demonstrated that water when injected into a cold fuel flow at concentrations of the order of 100 times more than certification requirements could form a restriction at the face of the FOHE.

94. Sufficient ice can accumulate in the Boeing 777 fuel system, which, when released, could form a restriction on the face of the FOHE.

95. It was not possible to restrict the fuel flow through the FOHE when fuel temperature in the main tank was warmer than: -15°C at a flow of 6,000 pph, and -10°C at a flow of 10,000 pph.

96. Reducing the fuel flow to idle always cleared any ice restriction on the face of the FOHE and therefore restored full fuel flow capability.

97. The FOHE was the only component in the fuel system that could be demonstrated to collect sufficient ice to cause the fuel restrictions observed during the accident flight.

98. The minimum fuel temperature of -34°C was not critical to the formation of ice in the fuel system.

99. A temperature below 0°C at takeoff has little effect on ice accumulation compared to during flight.

100. FSII is a means of preventing ice formation in fuel systems.

101. Research from the 1950s identified the problem of ice formation in fuel systems from dissolved or entrained water, but did not identify the scenario of accumulated ice release and subsequent restriction to fuel flow.

102. There are no published guidelines on environmental conditions or fuel rig size required to accomplish tests on the susceptibility of a fuel system to ice.

103. Current certification requirements do not address the scenario of ice accumulation and release within fuel systems.

The engine rollbacks

104. Ice probably began to accumulate in the fuel feed pipes whilst the warm centre tank fuel flowed through cold fuel pipes that pass through the main fuel tank at the start of the flight.

105. Ice would have continued to accumulate in the fuel feed pipes as the fuel was later fed from the main fuel tanks, but the rate of ice accumulation reduced as the fuel temperature dropped from -20°C down to its minimum temperature of -34°C.

106. The rate of accumulation of ice in the fuel pipes in the strut area may have been greater due to the warmer environment, whilst the localised fuel temperature was in the 'sticky range'.

107. Ice accumulation rates changed as the fuel temperature and TAT rose toward the end of the flight.

108. During the later stages of approach, the accumulated ice in the fuel system was probably released due to the final set of engine accelerations and possibly a combination of turbulence, aircraft pitch changes and an increase in strut temperature.

109. The ice would have travelled through the fuel feed system and formed a restriction on the face of the FOHE sufficient to cause the subsequent engine rollbacks.

110. The recorded drop in oil pressure on the right engine, which occurred close to the start of the final acceleration, was consistent with a restriction of the fuel flow at the face of its FOHE.

111. The recorded oil pressure data for the left engine ceased before it could provide any meaningful data for a positive determination of a restriction at its FOHE.

112. For the left engine, the investigation concluded that the restriction most likely occurred at its FOHE. However, due to limitations in available recorded data, it was not possible totally to eliminate the possibility of a restriction elsewhere in the fuel system, although the testing and data mining activity carried out for this investigation suggested that this was very unlikely.

113. For the left engine, the likelihood of a separate restriction mechanism occurring within seven seconds of that for the right engine is very low.

114. In response to AAIB Safety Recommendation 2008-047, Boeing introduced operational changes to mitigate the risk from fuel icing in the B777 powered by Trent 800 engines.

115. In response to the findings of this investigation Rolls-Royce developed a modified version of the FOHE and this was approved, and mandated, by the EASA.

Safety Recommendations

Safety Recommendations made previously in S1/2008 published 18 February 2008

Safety Recommendation 2008-009

Boeing should notify all Boeing 777 operators of the necessity to operate the fuel control switch to CUTOFF prior to operation of the fire handle, for both the fire drill and the evacuation drill, and ensure that all versions of its checklists, including electronic and placarded versions of the drill, are consistent with this procedure.

Safety Recommendations made previously in Interim Report published on 15 September 2008.

Safety Recommendation 2008-047

It is recommended that the Federal Aviation Administration and the European Aviation Safety Agency, in conjunction with Boeing and Rolls-Royce, introduce interim measures for the Boeing 777, powered by Trent 800 engines, to reduce the risk of ice formed from water in aviation turbine fuel causing a restriction in the fuel feed system.

Safety Recommendation 2008-048

It is recommended that the Federal Aviation Administration and the European Aviation Safety Agency should take immediate action to Consider the implications of the findings of this investigation on other certificated airframe / engine combinations.

Safety Recommendation 2008-049

It is recommended that the Federal Aviation Administration and the European Aviation Safety Agency review the current certification requirements to ensure that aircraft and engine fuel systems are tolerant to the potential build up and sudden release of ice in the fuel feed systems.

Safety Recommendations made previously in Interim Report 2 published on 12 March 2009.

Safety Recommendation 2009-028

It is recommended that Boeing and Rolls-Royce jointly review the aircraft and engine fuel system design for the Boeing 777, powered by Rolls-Royce Trent 800 engines, to develop changes which prevent ice from causing a restriction to the fuel flow at the fuel oil heat exchanger.

Safety Recommendation 2009-029

It is recommended that the Federal Aviation Administration and the European Aviation Safety Agency consider mandating design changes that are introduced as a result of recommendation 2009-028, developed to prevent ice from causing a restriction to the fuel flow at the fuel oil heat exchanger on Boeing 777 aircraft powered by Rolls-Royce Trent 800 engines.

Safety Recommendation 2009-030

It is recommended that the Federal Aviation Administration and the European Aviation Safety Agency conduct a study into the feasibility of expanding the use of anti ice additives in aviation turbine fuel on civil aircraft.

Safety Recommendation 2009-031

It is recommended that the Federal Aviation Administration and the European Aviation Safety Agency jointly conduct research into ice formation in aviation turbine fuels.

Safety Recommendation 2009-032

It is recommended that the Federal Aviation Administration and the European Aviation Safety Agency jointly conduct research into ice accumulation and subsequent release mechanisms within aircraft and engine fuel systems.

Safety Recommendations made in this report

Safety Recommendation 2009-091

It is recommended that the European Aviation Safety Agency introduce a requirement to record, on a DFDR, the operational position of each engine fuel metering device where practicable.

Safety Recommendation 2009-092

It is recommended that the Federal Aviation Administration introduce a requirement to record, on a DFDR, the operational position of each engine fuel metering device where practicable.

Safety Recommendation 2009-093

It is recommended that Boeing minimise the amount of buffering of data, prior to its being recorded on a QAR, on all Boeing 777 aircraft.

Safety Recommendation 2009-094

It is recommended that Boeing apply the modified design of the B777-200LR main landing gear drag brace, or an equivalent measure, to prevent fuel tank rupture, on future Boeing 777 models and continuing production of existing models of the type.

Safety Recommendation 2009-095

It is recommended that the Federal Aviation Administration amend their requirements for landing gear emergency loading conditions to include combinations of side loads.

Safety Recommendation 2009-096

It is recommended that the Federal Aviation Administration, in conjunction with the European Aviation Safety Agency review the requirements for landing gear failures to include the effects of landing on different types of surface.

Safety Recommendation 2009-097

It is recommended that the Federal Aviation Administration require that Boeing modify the design, for the Boeing 777, of the indirect ceiling light assemblies, their associated attachments, and their immediate surroundings to ensure that the fluorescent tubes, or their fragments, will be retained in a survivable impact.

Safety Recommendation 2009-098

It is recommended that the Federal Aviation Administration and the European Aviation Safety Agency, review the qualification testing requirements applied by manufacturers to cabin fittings, to allow for dynamic flexing of fuselage and cabin structure.

Safety Recommendation 2009-100

It is recommended that the European Aviation Safety Agency mandate MSB4400-25MB059 Revision 3 to require the inspection and replacement of the video monitor fittings on the Recaro seat model 4400.

FORMAL AIRCRAFT ACCIDENT REPORTS ISSUED BY THE AIR ACCIDENTS INVESTIGATION BRANCH

2008

3/2008 British Aerospace Jetstream 3202, G-BUVC at Wick Aerodrome, Caithness, Scotland on 3 October 2006.

Published February 2008.

4/2008 Airbus A320-214, G-BXKD at Runway 09, Bristol Airport on 15 November 2006.

Published February 2008.

5/2008 Boeing 737-300, OO-TND at Nottingham East Midlands Airport on 15 June 2006.

Published April 2008.

6/2008 Hawker Siddeley HS 748 Series 2A, G-BVOV at Guernsey Airport, Channel Islands on 8 March 2006.

Published August 2008.

7/2008 Aerospatiale SA365N, G-BLUN near the North Morecambe gas platform, Morecambe Bay on 27 December 2006.

Published October 2008.

2009

1/2009 Boeing 737-81Q, G-XLAC, Avions de Transport Regional ATR-72-202, G-BWDA, and Embraer EMB-145EU, G-EMBO at Runway 27, Bristol International Airport on 29 December 2006 and on 3 January 2007.

Published January 2009.

2/2009 Boeing 777-222, N786UA at London Heathrow Airport on 26 February 2007.

Published April 2009.

3/2009 Boeing 737-3Q8, G-THOF on approach to Runway 26 Bournemouth Airport, Hampshire on 23 September 2007.

Published May 2009.

4/2009 Airbus A319-111, G-EZAC near Nantes, France on 15 September 2006.

Published August 2009.

5/2009 BAe 146-200, EI-CZO at London City Airport on 20 February 2007.

Published September 2009.

6/2009 Hawker Hurricane Mk XII (IIB), G-HURR 1nm north-west of Shoreham Airport, West Sussex on 15 September 2007.

Published October 2009.

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