CONTENTS

SPECIAL BULLETINS

None

COMMERCIAL AIR TRANSPORT

GENERAL AVIATION

SPORT AVIATION / BALLOONS

ADDENDA and CORRECTIONS

None

(ALL TIMES IN THIS BULLETIN ARE UTC)

ACCIDENT

Aircraft Type and Registration:	Airbus A320-232, G-EUUF
No & Type of Engines:	2 International Aero Engine V2527-A5 turbofan engines
Year of Manufacture:	2002
Date & Time (UTC):	26 June 2006 at 1645 hrs
Location:	Taxiway Kilo, London Heathrow Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 7 Passengers - 83
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to right engine and to tractor
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	51 years
Commander's Flying Experience:	16,022 hours (of which 4,122 were on type) Last 90 days - 186 hours Last 28 days - 37 hours
Information Source:	AAIB Field Investigation

Synopsis

After an uneventful pushback from Stand 139 at London Heathrow Airport the tractor was disconnected from the aircraft. After receiving taxi clearance from Air Traffic Control G-EUUF started moving under its own power. Shortly afterwards it collided with the tractor that had just performed the pushback, damaging the right engine and the tractor. The headset operator had given the 'all clear' signal to the flight crew before the tractor had been repositioned to a safe distance from the aircraft. The co-pilot did not see the tractor and a defect prevented the tractor from being driven away before the aircraft began to taxi.

History of flight

The aircraft was prepared for a routine departure from London Heathrow Airport to Munich, Germany. There was no significant weather and good visibility. Due to ATC delays the pushback was delayed for ten minutes. Once ATC clearance was received the aircraft was pushed back from Stand 139 onto Taxiway Kilo. ATC requested a long pushback to allow another aircraft onto Stand 139. This meant that the aircraft would need to be pushed back into the narrower part of Taxiway Kilo, abeam Stand 118 and adjacent to a blast wall on the right side (Figure 1 - Airport diagram).

The pushback, during which both engines were started, proceeded without incident until the headset

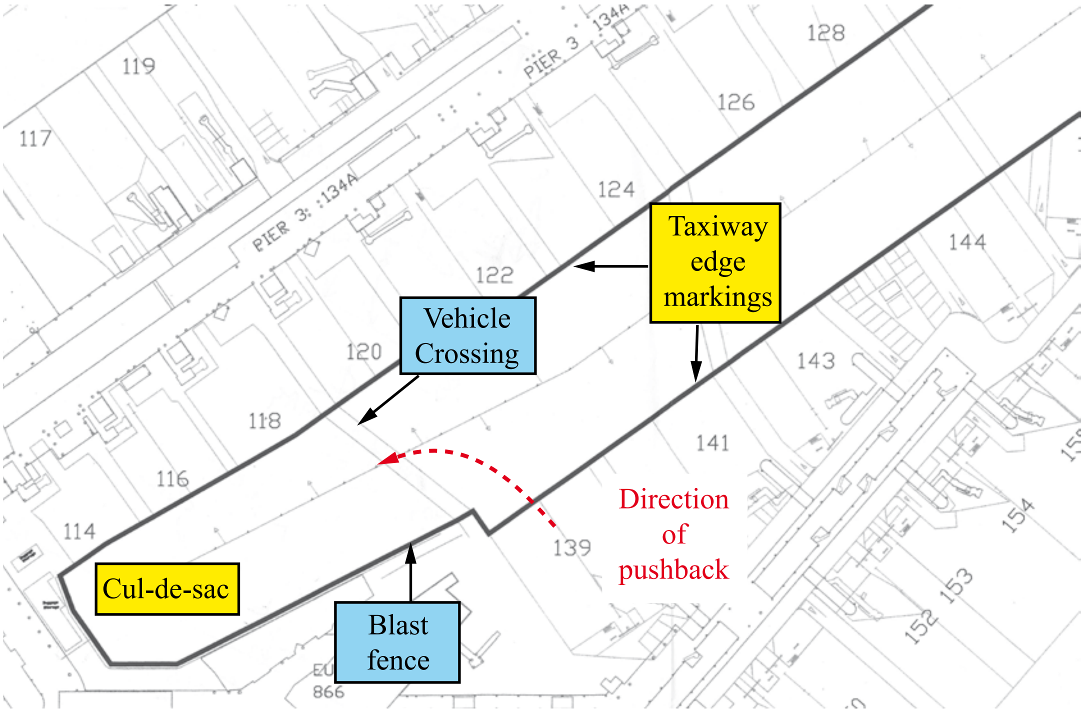

Figure 1

Plan of cul-de-sac, showing pushback details

operator (HO) requested that the commander apply the parking brake. On receiving acknowledgment from the commander that the parking brake was set the ground crew disconnected the 'towbarless' (TBL) tractor from the aircraft and the tractor driver moved it to the right side of the aircraft's nose. Having disconnected his headset, the HO removed and showed the steering lockout pin to the flight deck, received the correct acknowledgement from the co-pilot and got into the tractor.

As the HO entered the cabin of the tractor, the driver informed him that the 'cradle up' indicator light was not illuminated and that it was not possible to move the tractor. At this point the HO and the driver heard the aircraft's engines start to increase power and saw the aircraft start to move. They both got out of the tractor in an attempt to indicate, with hand signals, that they wanted the aircraft to stop as the tractor was not clear of the aircraft manoeuvring area. It became apparent that the flight crew were not looking in their direction and thus could not see their signal. They both returned to the tractor to make another attempt to move it and also for their own protection. The aircraft continued to move forward and the underside of the right engine struck the rear of the tractor, pushing it into the middle of the vehicle crossing point between Stands 139 and 118/120. The aircraft continued to taxi along Taxiway Kilo.

The ground crew believed the operating crew were unaware of the impact so the tractor driver contacted ATC and asked them to stop the aircraft. ATC then informed the operating crew of G-EUUF of the accident and instructed them to stop in their present position. The commander stopped the aircraft and applied the parking brake. The Aerodrome Fire & Rescue Service (AFRS) attended and the right engine was shut down and the APU started. After clearance from the AFRS was received the aircraft taxied to Stand 158 where the remaining engine was shut down and the right engine fire handle operated, to isolate the engine as a precaution after smoke was reported from the engine jetpipe.

Operating crew's comments

Commander's comments

The commander stated that, prior to the pushback, the boarding and dispatch of the aircraft proceeded without haste and uneventfully. When ATC instructed the crew to carry out a long pushback the commander asked why and was told: it was to allow an Airbus A320 onto Stand 139.

Both engines were started during the pushback. The commander later recalled that, after the pushback was complete, the headset operator asked for the parking brake to be applied. Upon informing the HO that the brake was applied, the commander was advised by the HO that the visual clearance would be given on the right of the aircraft. At this point the commander asked the co-pilot for the 'After Start' checklist. This was completed up to 'GROUND CREW CLEARANCE………RECEIVED.' At this point the co-pilot waited for, and shortly received, the visual clearance from the ground crew. As the commander could not see the tractor or HO from his seat he was reliant on the co-pilot in this situation. The 'After Start' checklist was then completed and taxi clearance was requested and received from ATC.

After the operating crew visually cleared the left and right sides of the aircraft the commander released the parking brake and applied a small amount of power to start the aircraft moving; he then checked the operation of the foot brakes. At that instant he heard a "graunching" sound, but was not sure where it had come from. He asked the co-pilot "What was that?", thinking they had taxied over an object on the taxiway. All engine parameters were checked, found to be normal and the tyre pressures were indicating correctly. No abnormal indications were noted, nor did the aircraft slow down or yaw with the impact. The taxi continued and a discussion took place between the two pilots regarding the event. They decided that, prior to taxiing from the cul-de-sac, an inspection by engineering would be required. Just as the commander was about to transmit a request for ATC to dispatch a vehicle to inspect the aircraft, he heard a transmission advising ATC to stop an aircraft as it had hit a tractor. Realising they were the aircraft involved, the crew stopped the aircraft and applied the park brake. At the same time ATC advised them to stop the aircraft in its present position, abeam Stand 144, and that the emergency services were on their way.

After stopping, the crew again noted that all engine indications were normal. When the AFRS arrived the commander established communications with them on radio frequency 121.6 MHz. The AFRS asked for the right engine to be shut down to aid their inspection. Upon inspection of the engine the AFRS reported significant damage but no fuel leaks. Having secured the engine and discussed with the AFRS that the engine appeared safe, it was agreed that the aircraft could be moved. The aircraft was then configured for a normal single-engine taxi to Stand 158.

On arrival on stand the left engine was shut down and the right engine fire handle operated after smoke was reported from the engine jetpipe. When the aircraft was on stand, with the jetty attached and passenger door open, the Police entered the flight deck and breathalysed both operating flight crew. The result of the breathalyser proved negative for both pilots.

Co-pilot's comments

The co-pilot stated that when he looked to his right to "Clear starboard" he did not see the tractor in his field of view. He predominately looked from his "three o'clock" rearwards to clear the aircraft's wing tip as he was aware of the proximity of a blast screen to the right of the aircraft.

Ground crew's comments

Headset operator (HO)

The HO stated that he had been working in this role for the past 4½ years and was fully conversant with the airline's procedures for pushback, contained in the Aircraft Towing and Pushback Manual (ATPM).

On the day of the accident he started work at 0515 hrs and was scheduled to do an eight hour shift plus overtime, to finish at 2045 hrs. He added that he had been working with the tractor driver involved in this accident throughout the afternoon and all other pushbacks had proceeded uneventfully.

He reported that a normal pushback from Stand 139 involves the aircraft being pulled forward to abeam the stand after the initial push, prior to disconnecting the tractor and signalling it to withdraw from the manoeuvring area. If a long pushback is required the tractor stops very close to an uncontrolled vehicle crossing point. In this situation, traffic should stop at the edge of the taxiway and wait for the aircraft and ground manoeuvring equipment to clear the crossing point before proceeding to cross.

Normally, a third member of the pushback team would be used to stop the traffic. However, the HO commented that, if a third man were not available, then some vehicles would stop while others would continue across the crossing. This might even involve vehicles overtaking waiting traffic and swerving off the marked crossing in order to get around the aircraft and tractor that might be parked across the crossing. The reason he did not signal the tractor to withdraw to the edge of the manoeuvring area was so he could be offered some protection by the tractor from crossing traffic. He added that he had performed long pushbacks from Stand 139, as he did in this accident, "lots of times."

Tractor driver

The tractor driver reported that he was not aware of any previously reported faults when he picked up the tractor at the beginning of his shift.

Weather information

The Met Office provided an aftercast for the time of the accident. The METAR published 30 minutes before the accident stated that the weather was light rain with visibility in excess of 10 km. The METAR issued five minutes after the accident stated that there was no significant weather and the visibility was in excess of 10 km.

Aircraft and tractor damage

The aircraft and tractor were examined at Stand 158, where they had been positioned following the accident.

The underside of the engine inlet cowl, fan cowl and thrust reverser 'C'-duct of the aircraft's No 2 (right) engine were badly damaged (Figure 2) from contact with the rear of the tractor. Scoring on the lower right side of the engine cowls correlated with blue paint transfer and score marks on the tractor legs. From these marks, it was deduced that the tractor had been positioned on the right side of the aircraft, with its longitudinal axis oriented between 70 and 80 degrees to the right of the direction of travel of the aircraft, with the rear of the tractor in line with the No 2 engine.

The engine had initially grazed the right leg of the tractor (aft, looking forward), scoring the lower right side of the

Figure 2

Damage to No 2 engine caused on impact with tractor

cowls, before riding over the top of the left leg, which caused more extensive damage to the underside of the engine. A piece of the thrust reverser 'C'-duct aluminium structure was found embedded in the reinforcing rib on the top of the left leg of the tractor.

The damage to the tractor was largely confined to its left leg. The force of the No 2 engine bearing down on the leg had deformed the wheel spat which is manufactured from 10 mm steel plate, reinforced by a stiffening rib. Two of the mounting bolts attaching the wheel spat to the chassis leg had also sheared.

Flight Recorders

The aircraft was fitted with a solid-state 25-hour Flight Data Recorder (FDR) recording a range of flight parameters from the time of engine start. The aircraft was also fitted with a solid-state two-hour Cockpit Voice Recorder (CVR) which recorded crew speech and area microphone inputs when electrical power was applied to the aircraft. Both recorders were downloaded at the AAIB and data and audio recordings were recovered for the accident.

A 'time history' plot of the relevant parameters is given at Figure 3. The data presented at Figure 3 starts after pushback, with the park brake set and starting checks complete, just over 10 seconds before G-EUUF started moving forward under its own power.

G-EUUF was cleared to turn right at 'Bravo' and hold at 'Bravo-One'. The crew then stated that the view from their respective sides of the cockpit were clear of obstacles, after which the park brake was released. Five seconds later the thrust levers[1] were advanced for six seconds, resulting in a peak EPR of just less than 1.02, just as the thrust levers were brought back to idle. As G-EUUF started to move forward and gradually accelerate, it also started a gentle turn to the right from its initial heading of 064ºM. Eight seconds later the aircraft had accelerated to about four knots, after which the foot brakes were applied

Footnote

[1] For clarity, only the thrust lever position (angle) for the right--hand engine is shown but this is also representative of the left-hand engine. Similarly, only the EPR for the left-hand engine is shown.

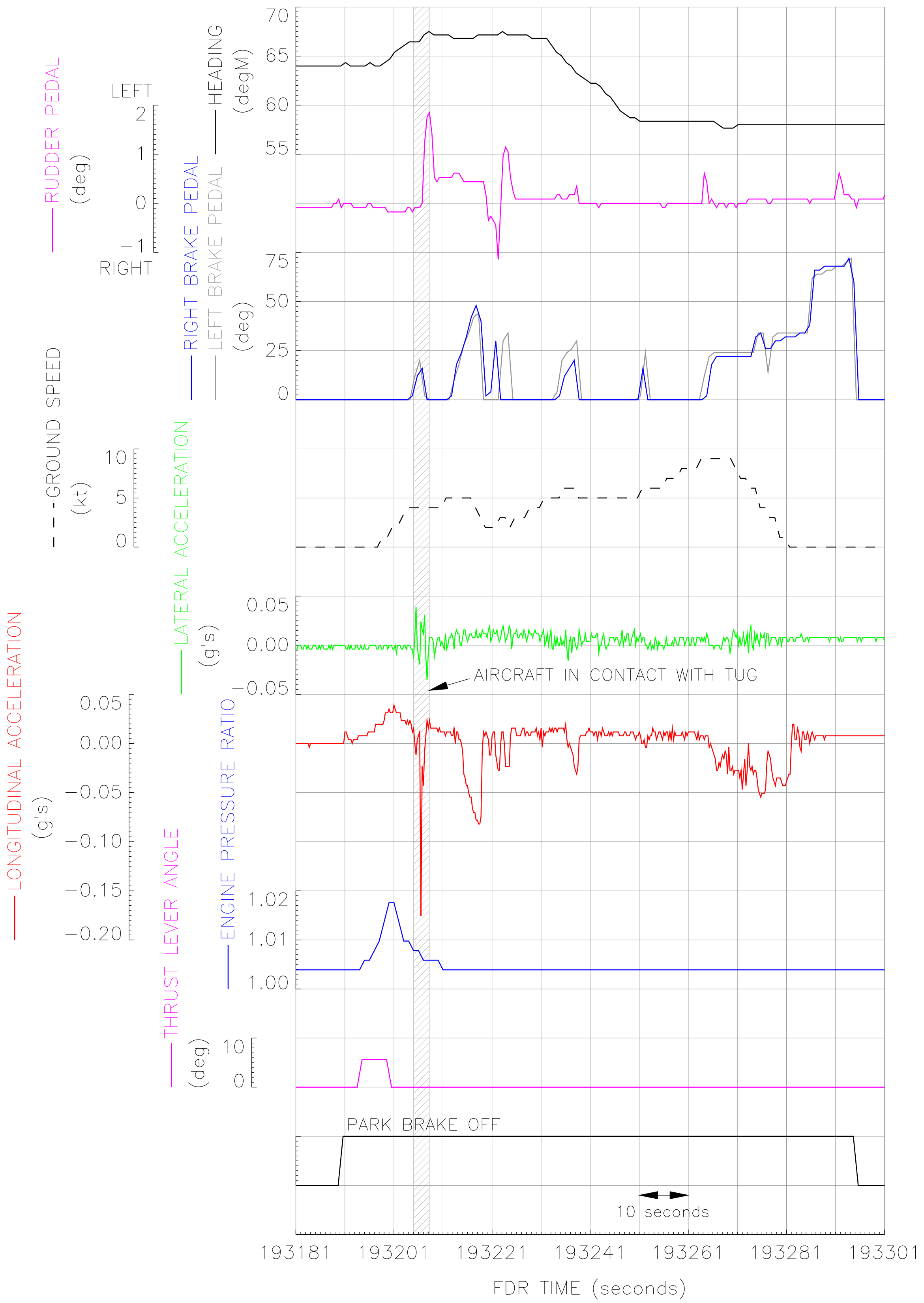

Figure 3

Salient FDR Parameters

momentarily as the commander performed a brake check. During this check G-EUUF struck the tug - indicated by spikes in both lateral and longitudinal acceleration over a three second period (highlighted). This jolt was also noted by the crew. A small amount of left pedal was applied immediately after the collision, lining the aircraft up on a heading of 067ºM, followed by braking which decelerated the aircraft to about two knots. The distance travelled before the collision was calculated to be 13 m.

G-EUUF then accelerated forward before starting a turn to the left onto a heading of 058ºM, following the bend in the taxiway. It continued to accelerate to nine knots whilst the crew discussed the possible reasons for the jolt, before being informed by ATC that they had collided with the tug. The brakes were then applied bringing the aircraft to a stop, after which the park brake was applied. The total distance covered by the aircraft was calculated to be approximately 150 m over a period of 105 seconds.

Published pushback procedures

The airline's procedures for pushback are contained in the Aircraft Towing and Pushback Manual (ATPM).

The ATPM procedure once the aircraft has been released by the tractor after pushback and the aircraft parking brake has been applied, is as follows:

'36) Headset operator signals tug driver to pull away a minimal distance[2] from the aircraft (to position in full view of the flight deck - this may require the tug to be at an angle to the A/C).

37) Position a chock in front of the nose wheel.

Note:

Tug position and chocking.
These actions are to prevent the A/C moving away until all ground crew and equipment are clear. The tow crew will also provide fire cover while the engines are started on completion of push out.'

38) On completion of the movement, the cradle must be closed and raised, and the driving position rotated to face the direction of travel.

39) Torque links, re-connected by Engineering as appropriate.

40) Remove steering lockout pin and or set Nose Gear Steering mechanisms for taxi as required by specific A/C type.

41) When clearance from flight deck is given, disconnect headset lead from A/C and close panel.

42) Remove the nose landing gear wheel chock and place on tug.

43) When all crew clear of the nose leg, headset operator signals tug driver to move off manoeuvring area (two arm forward sweep).

44) Ground crew walks to edge of taxiway, in line with nose of A/C.

45) Headset operator displays steering isolation pin and flag to the flight deck crew (as appropriate to A/C type), gives visual sign (thumbs up) that all towing crew and equipment are clear of the A/C and that it may taxi away when given clearance by ATC.'

Footnote

2 The tractor is deliberately placed so as to block the path of the aircraft, to protect the headset operator if the aircraft should begin to taxi prior to receiving clearance.

Aircraft tractor information

The tractor, chassis number N4345 and fleet number AT0858, was a Douglas-Kalmar Tugmaster Type TBL280 Mark 2 'towbarless' tractor (Figure 4). This type of tractor clamps onto the nosewheel of the aircraft, eliminating the need for a tow bar.

Figure 4

Post-accident photograph of Tractor AT0858
(Stand 139 in background)

The front of the vehicle contains the cab, with the engine and gearbox being mounted in the mid-section. The driver's seat can be positioned to face forwards for towing and rearwards for pushback operations. A hydraulically-operated docking cradle is located at the rear of the vehicle, mounted between the chassis legs. A gate, which is hinged at one side, opens to allow the tractor to engage with the aircraft's nosewheels and is then closed, securely clamping them in the cradle. The entire cradle is then raised, lifting the aircraft nose gear off the ground by several inches, in preparation for towing or pushback. The sequence is reversed to release the nose gear from the cradle. The cradle is operated by a joystick located in the cab. Sensors detect when the cradle is in the raised or lowered position, causing the corresponding 'cradle up' or 'cradle down' indicator light in the cab to illuminate.

The tractor may be driven with the cradle either in the raised position, with the gate closed, or in the down position and the gate open. Drive to the wheels is electronically inhibited with the cradle or gate in any other position. A 'drive inhibit' override button located under the steering wheel allows the inhibit feature to be bypassed, so that the tractor can still be driven if there is a cradle malfunction.

The 'cradle raised' and 'cradle lowered' sensors are of the proximity switch type. An 'L'-shaped bellcrank (called the 'boomerang') is mounted in front of the sensors, one arm of which forms the target for the sensors (Figure 5). The other arm is connected to an adjustable operating rod, which converts the vertical movement of the cradle into rotation of the boomerang. The proximity sensors are mounted in locations that correspond to the positions of the target arm of the boomerang when the cradle is in the raised and lowered positions. The position of each sensor is adjustable.

The operation of raising the cradle is relatively slow and it is reported that tractor drivers often 'rev' the engine when raising the cradle, as this speeds up the movement of the cradle through the increased hydraulic flow to the actuators.

The tractor is predominantly blue and white in colour, but a significant area of its upper surface is covered with a dark grey anti-slip material. There is also a flashing orange beacon mounted on the top of the cab.

Tractor examination

The tractor was required to be moved from the accident location, as it was blocking both the taxiway and the vehicle crossing. The recovery crew who attended the tractor observed that the cradle was in the up position, but the 'cradle down' indicator light was lit. The drive was inhibited and the tractor could only be driven using the 'drive inhibit' override button. It was recovered to Stand 158, where it was first examined by the AAIB.

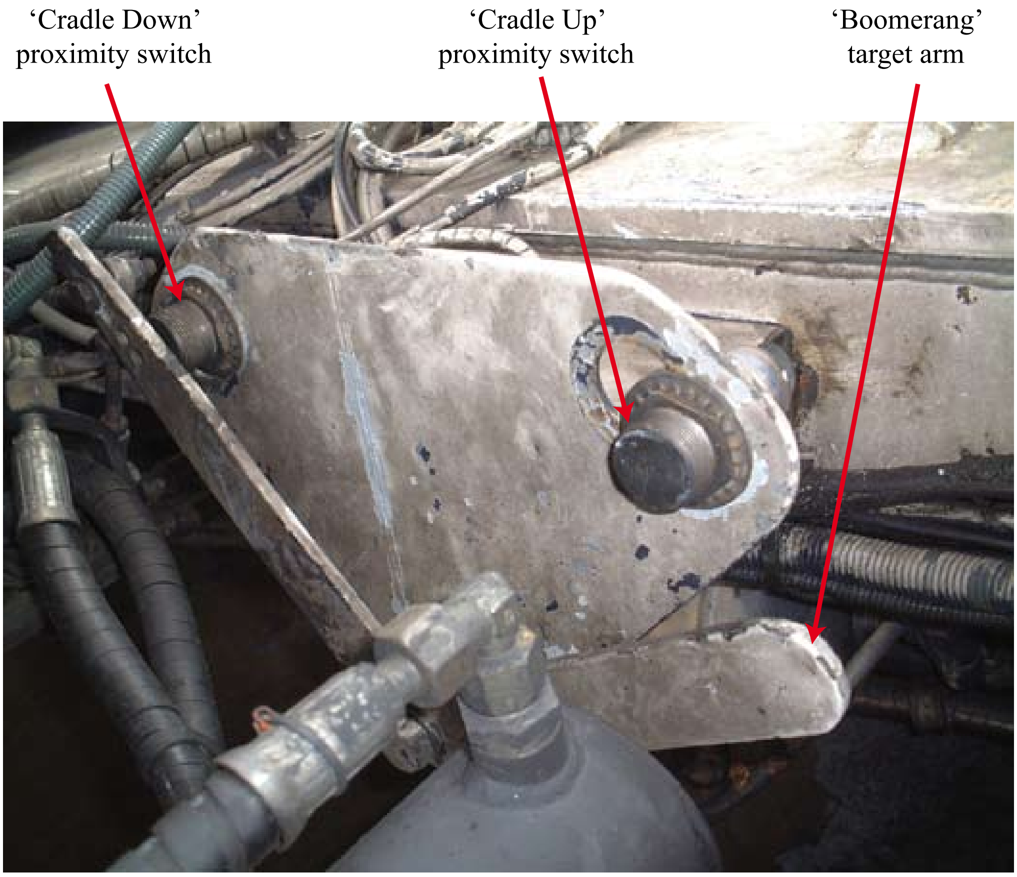

Figure 5

Cradle position sensor location showing 'boomerang' overtravel

On closer inspection, the target arm of the boomerang was found to have travelled past the 'cradle up' proximity sensor, to the extent that the boomerang operating arm was triggering the 'cradle down' sensor (Figure 5). During testing, it was found that the cradle overtravel could be reproduced occasionally if the tractor engine was 'revved' whilst raising the cradle. The defect was cured by adjusting the 'cradle up' and 'cradle down' proximity switch air gaps to the manufacturer's specified gap of 4 mm and reducing the hydraulic fluid flow rate to the cradle rams to slow the cradle raise speed. Following these adjustments, it was no longer possible to reproduce the fault.

The 'cradle raised' indicator light was also found to be missing its lens and the light was intermittent in operation. This was repaired by installing a new lamp holder.

The 'drive inhibit' override function was tested and found to operate satisfactorily.

Tractor maintenance history

A review of the maintenance history did not identify any previous recorded occurrences of the cradle overtravel problem.

The tractor was required to undergo a comprehensive inspection every six weeks. The most recent inspection prior to the accident took place on 19 May 2006. During this inspection, the 'cradle raised' height was found to be too low. One of the boomerang mounting bracket bolts was found sheared, requiring replacement. This was actioned and subsequent cradle checks proved satisfactory.

Tractor maintenance and defect reporting

The allocation of tractors to the crews and the logging of tractor defects is the responsibility of the 'duty allocators', based in the airline's Aircraft Movements department. The tractor drivers and headset operators working in this area of the airport are also based there. The duty allocators have face-to-face contact with the tractor crews and are also able to communicate with them via radio.

Although the tractors are owned and operated by the airline, their repair and maintenance is subcontracted to a separate organisation. This organisation has a number of mobile mechanics who are responsible for repairing the more urgent defects. A tractor with a drive failure which is blocking an aircraft or a taxiway, is an example of a situation that would warrant an immediate response. If the defect cannot be repaired *in situ*, the tractor is recovered to the maintenance organisation's workshop, which is remote from the ramp area.

When a tractor defect is reported, the duty allocators are required to log the defect on an electronic database, which is also accessible by the subcontract maintenance organisation. The defects are allocated a priority to assist the subcontract organisation in planning its work.

There was anecdotal evidence of another crew having experienced cradle problems with tractor AT0858 on the morning of the day of the accident. They had experienced an intermittent problem of difficulty in raising the cradle and on one occasion it was necessary to use the 'drive inhibit' override button to move the tractor. Although the problem was allegedly reported to the duty allocator, the AAIB could find no record of it in the defect tracking database.

Pushback/towing crew training

The training of the airline's tractor drivers and headset operators is currently performed by the airline's Airport Operations Training department.

The department is responsible for the initial training of tractor drivers and headset operators and also for conducting the three-yearly revalidation of headset operators. The revalidation requires the headset operator to be checked by a Line Trainer, who will monitor the headset operator on two aircraft pushback operations.

Tractor drivers are not required to undergo revalidation.

Monitoring of pushback and towing standards

The monitoring of the standards for towing and pushback was previously the responsibility of the former Ramp Standards and Training Department. However, some time ago this function was devolved to the Aircraft Movements department, which is currently responsible for aircraft pushback and towing operations, in addition to toilet servicing and aircraft external cleaning.

Annual audits of the ground operations activities, including pushbacks, are performed by the Heathrow Customer Service (HCS) department of the airline. There is currently no established requirement to monitor the day-to-day standards and compliance with procedures. The most recent HCS audit, conducted in late 2005, concluded that the management of health and safety standards within the Aircraft Movements department did not meet the corporate standard. This was deemed to be largely due to the lack of supervisory staff in the ramp area, which had allowed staff to lose sight of the importance of health and safety procedures. This was a general conclusion with respect to all of the Aircraft Movements department's activities and some shortfalls were found in the pushback and towing activities.

Accident reconstruction

The accident was reconstructed with the cooperation of the airport and the airline. Due to congestion it could only be carried out during the hours of darkness.

The purpose of the exercise was primarily to establish, as accurately as possible, with the help of eyewitnesses, the position of the aircraft and the tractor before the aircraft started taxiing. Once placed in their respective positions, the visibility of the tractor from the co-pilot's seat was assessed.

The exercise showed that if the co-pilot had been sitting upright in his seat, most of the tractor would have been visible to him through his side window. However, if he had been leaning forward in his seat, the tractor would have been largely obscured by the pillar between the co-pilot's windscreen and his side window.

Analysis

When the co-pilot saw the HO show him the nosewheel lockout pin, the HO was just visible in the left hand edge of the right hand window. However, having completed the 'After Start' checks, which included changing the view on the lower ECAM screen, the co-pilot's body position would most likely have been more leaning forward. As a result, the tractor could have been concealed behind the window frame upright. Given that the colouring on the tractor's upper surface was similar to that of the taxiway, there may have been some camouflaging effect, making it less visible to the co-pilot. There had been some rain in the previous 30 minutes and this may also have affected the likelihood of the co-pilot spotting the tractor through his side window.

Additionally the co-pilot's 'clear starboard' lookout scan would have been predominately to look for wing tip clearance. The co-pilot reported that he was concerned by the proximity of the adjacent blast screen and, as a result, he would have been leaning forward, to rotate his upper torso to see as far rearwards as possible, probably starting his scan no further forward than his three o'clock position.

While the HO's reason for not completing the pushback in accordance with the ATPM may have been due to traffic failing to stop at the taxiway crossing point, had he used the published procedure the problem with the tractor would have been highlighted earlier. He thus might have still had his headset connected to the aircraft and could have then informed the operating crew of the problem, avoiding this accident.

The accident might also have been avoided had the tractor not experienced a defect with the cradle, which caused the drive to be inhibited. It is believed that another tractor crew had reported intermittent problems with the cradle operation earlier that day, but the defect was not entered on the defects database and thus no rectification action was taken. This may have been an isolated lapse but it is also possible that the defect recording procedures were not being strictly followed.

It is also noted that, even with the cradle defect, the tractor could still have been moved out of the path of the aircraft had the tractor driver immediately used the 'cradle override' button. His decision to leave the cab robbed him of valuable time so that, by the time he returned to the cab, the collision had become unavoidable. In hindsight a better option would have been to have immediately used the override button in order to position the tractor clear of the aircraft as quickly as possible.

Conclusions

The primary causal factor of the accident was the headset operator giving the 'all clear' signal to the flight crew before the tractor had been repositioned to a safe distance from the aircraft. Contributory factors were the co-pilot failing to see the tractor and a defect which prevented the tractor from being driven away once the aircraft had begun to taxi.

Safety Actions applied by the airline

Following the incident, the airline's Corporate Safety Department conducted its own investigation into the accident. The investigation made several recommendations for changes to procedures to prevent similar accidents in the future. Key recommendations included:

- that Aircraft Movements should ensure that the headset operator, prior to giving the 'thumbs up' clearance, must positively confirm that the aircraft is clear of all ground equipment and is clear to taxi.

- that the airline should have a stronger and more visible supervisory presence on the ramp to improve the safety and security of both aircraft and staff by controlling and enforcing adherence to procedures.

- that Flight Operations should circulate the event through the flight crew community highlighting the requirement to ensure that all ground equipment is clear prior to taxi.

In light of these safety actions by the airline, it is not deemed necessary for the AAIB to make further safety recommendations.

INCIDENT

Aircraft Type and Registration:	Boeing 747-436, G-BNLE
No & Type of Engines:	4 Rolls-Royce RB211-524G2-19 turbofan engines
Year of Manufacture:	1989
Date & Time (UTC):	22 November 2006 at 0725 hrs
Location:	Stand 430, London Heathrow Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - N/K Passengers - N/K
Injuries:	Crew - None Passengers - None
Nature of Damage:	Hole in the fuselage to wing fairing
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	N/K
Commander's Flying Experience:	N/K Last 90 days - N/K Last 28 days - N/K
Information Source:	AAIB Field Investigation

Synopsis

As the hydraulically powered stabilisation jacks of a self-propelled passenger stair vehicle were extended the two 'stair height' jacks retracted, allowing the lower forward edge of the stair head to descend and damage the fuselage-to-wing fairing. An engineering examination found that there had been an electrical component failure.

History of the flight

The aircraft, having arrived on a scheduled flight from San Paulo, was parked on a remote stand situated to the east of Terminal 4. In preparation to disembark the passengers a self-propelled passenger stair vehicle was positioned at the No 2 left aircraft door. Having positioned the stair head against the aircraft's door sill, the vehicle operative extended the vehicle's hydraulically powered stabilisation jacks. As these jacks extended, the two 'stair height' hydraulic jacks retracted, allowing the lower forward edge of the stair head to descend into the honeycomb fuselage-to-wing fairing, where it came to rest.

Engineering examination

An engineering examination by the equipment operator and manufacturer found that there had been an electrical component failure. The manufacturer has, since this incident, introduced a modification to prevent a recurrence of this event and the operator has drawn up a plan to introduce the modification to the remainder of its fleet of these vehicles.

INCIDENT

Aircraft Type and Registration:	Boeing 767, C-GEOU
No & Type of Engines:	2 General Electric CF6-80C turbofan engines
Year of Manufacture:	1999
Date & Time (UTC):	11 October 2006 at 1345 hrs
Location:	Stand 329, London Heathrow Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 10 Passengers - 90
Injuries:	Crew - None Passengers - None
Nature of Damage:	Dent on top of engine cowling
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	52 years
Commander's Flying Experience:	19,800 hours (of which 5,100 were on type) Last 90 days - 184 hours Last 28 days - 89 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

Shortly after parking on Stand 329 at London Heathrow Airport, the aircraft rolled forward and collided with a pier damaging the left engine nose cowl. The parking brake had been incorrectly set.

History of the flight

The aircraft had flown from Calgary, Canada with three operating crew. After landing and taxiing onto Taxiway Golf at London Heathrow Airport, the aircraft was unable to taxi onto Stand 329 because there was no handling agent present to switch on the stand guidance system and monitor the aircraft onto stand. As the aircraft was blocking the taxiway a member of the airport's airside staff was dispatched to marshal the aircraft onto stand; this he did without event. Once the aircraft was on the stand the marshaller left the area without placing any chocks in front of its wheels. At the time the pier was correctly parked.

The aircraft commander reported that having been marshalled onto the stand and signalled to stop by the marshaller, he believed he set the parking brake correctly. This is done by depressing the toe brakes on top of the rudder pedals, then simultaneously pulling up the parking brake T-handle on the left side of the centre console, before releasing the pressure on the pedals. This leaves the T-handle extended on the centre console. The aircraft's engines were then shut down and the aircraft shutdown checklist completed; this included turning off the hydraulic pumps. The handling agent had still not arrived by that time so an attempt was made to contact him by radio. Because the passengers were unable to disembark an announcement was made to them, over the aircraft's Personal Address system, to remain in their seats.

After approximately 10 to 15 minutes the aircraft started to roll forward slowly. At first the pilots thought the pier was being moved into position but soon the commander realised that the aircraft was moving forward and gathering speed quite rapidly. He applied the toe brakes and noticed the parking brake T-handle was retracted. Noticing the accumulator pressure was low, the co-pilot immediately turned on the hydraulic pumps. The aircraft stopped just as the left engine made contact with the pier. There was no abrupt stop and no impact was felt by the cabin crew or passengers.

The aircraft was subsequently pushed back, the damage inspected and the passengers disembarked.

Stand gradient

The airfield operating company stated that their design standards stipulate that the slope of aircraft movement surfaces should not exceed 1% in any direction. It was found that the gradient on Stand 329 was approximately 0.42 % towards the terminal over the length of the stand.

Stand guidance systems

Stand 329 at London Heathrow Airport is equipped with a Parallax Aircraft Parking Aid (PAPA) board and Azimuth Guidance for Nose-In Stands (AGNIS). When established on the AGNIS centreline, the pilot in the left seat looks through the right windshield, to identify the correct stopping position for his particular type of aircraft. There is no STOP sign or any form of light on the PAPA board indicating when to stop, nor is there any requirement for there to be such a light. However, a flashing red STOP sign is fixed to the terminal fascia directly ahead of the centreline. This stop sign is not intended for routine use; its purpose is to signal an emergency stop at any time during the parking manoeuvre. Consequently, activating the STOP sign also switches off the PAPA and AGNIS lights but if the guidance is not switched on, the STOP sign will still illuminate.

Engineers' comments

The operating company's engineering personnel arrived at Stand 329 before the handling agent and started their visual inspection of the exterior of the aircraft. Approximately three minutes later the aircraft started to move forward slowly towards the terminal. In a bid to alert the operating crew, an engineer ran to and hit the STOP sign activation button just as the pier was struck. The aircraft had rolled forward 12 ft before the aircraft's left engine nose cowl hit the pier.

Commander's comments

In an open and frank report the commander admitted that the cause of the accident was his failure to set the parking brake correctly.

Damage assessment

The maintenance organisation measured the dent and found it to be 7 inches across and approximately 1 inch deep. As a result the left engine nose cowl was changed before the aircraft's next flight. The braking and hydraulic systems were also checked and found to be serviceable.

Discussion

Because the parking brake was not correctly set and chocks had not been placed under the wheels, the aircraft rolled forward and its left engine intake cowl was damaged. Chocks are not normally visible from the flight deck so it is imperative that all members of an operating crew monitor important flight deck actions, such as applying parking brakes, to ensure they are carried out properly.

ACCIDENT

Aircraft Type and Registration:	Bombardier Challenger 604, D-ABCD
No & Type of Engines:	2 General Electric CF34-3B turbofan engines
Year of Manufacture:	2003
Date & Time (UTC):	5 February 2006 at 1233 hrs
Location:	London Luton Airport
Type of Flight:	Non-scheduled Commercial Air Transport (Passenger)
Persons on Board:	Crew - 3 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to landing gear and airport approach lighting
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	41 years
Commander's Flying Experience:	9,041 hours (of which 688 were on type) Last 90 days - 102 hours Last 28 days - 41 hours
Information Source:	AAIB Field Investigation

Synopsis

On short final approach to Runway 26 the engine thrust increased to 64% N_1[1] (engine fan speed) and was not reduced before touchdown. Following a prolonged float, the aircraft touched down approximately 800 metres from the stop end of the runway, and ran off the paved surface. No evidence was found to indicate that any technical defect relevant to the approach or landing phase of flight was present before the aircraft left the paved surface. However, the investigation identified human factors that may account for the accident.

Footnote

1 N_1 is engine fan speed, a measure of engine thrust. The idle N_1 setting on this engine is approximately 30%.

History of the flight

The crew began their duty at Luton Airport at 0600 hrs. Following normal preparation they flew the aircraft empty to Geneva, where they boarded one passenger before departing to return to Luton. The weather forecast for their return indicated the possibility of low visibility on arrival, and additional fuel had been loaded. The planned landing weight (37,449 lbs) was close to the maximum permitted by the structural limit (38,000 lbs).

The flight towards Luton was uneventful and the visibility was good by the time the aircraft made its approach. The surface wind was from 350° at 11 kt. The commander flew an ILS approach to Runway 26 using the autopilot and autothrottle. The approach speed was 137 kt, which was five knots above the value calculated for V_{REF} at the landing weight. At about 300 ft above the threshold elevation, the commander disconnected the autopilot. Later, he recalled having disconnected the autothrottle closer to 60 ft. The engine thrust increased to 64% N_1 by the time the aircraft passed through 40 ft above the runway. The commander began to flare the aircraft at the normal point, with both hands on the control column. The aircraft floated along the runway in a manner which both crew members described as most unusual. The aircraft touched down approximately 800 metres before the stop end of the runway and the co-pilot selected the spoilers UP. After a short delay the commander selected reverse thrust and began aggressive braking. Both pilots stated afterwards that, when the aircraft touched down, they considered that there was sufficient runway remaining to stop.

The landing roll continued with the aircraft decelerating normally until it ran off the end of the runway, into soft ground, at about 35 kt. The nose and right main landing gear, running through soft earth approximately up to the depth of the axles, struck the vertical faces of concrete lighting bases upon which two Runway 08 approach lights were mounted. This caused damage to the approach lights and the aircraft landing gear. The aircraft came to rest and the flight crew identified that there was no immediate threat to their safety and carried out normal shutdown checks.

The flight attendant and passenger, both seated in forward-facing passenger seats, were unaware of the incident until the aircraft was almost at a standstill, when the flight attendant noticed that the emergency exit lights had illuminated. With the aircraft at rest, both saw that there was grass, not runway, outside the aircraft, and concluded that the aircraft had left the runway surface. The flight attendant assessed that there was no immediate threat to safety and reassured the passenger.

The Aerodrome Controller (callsign Luton Tower) observed the late touchdown and, when he recognised that the aircraft was not going to stop on the runway, activated the crash alarm. The airport fire service responded rapidly and reached the aircraft soon after it came to rest. Neither fire fighting nor rescue was necessary.

Flight crew

The crew consisted of two pilots and one flight attendant. The pilot in the left seat was an experienced freelance Type Rating Examiner, employed from time to time by the company, and was tasked with providing instruction and familiarisation to the right seat pilot, who was being trained to carry out supervision of new captains. The left seat pilot was over 60 years of age, and the operator had a policy which required aircraft commanders to be under this age, so the right seat pilot was nominated as commander. In the two months prior to the accident flight, the left seat pilot had operated 15 flights for the operator, nine in the left seat and six in the right. The left seat pilot stated that, until the accident, he had been impressed with the right seat pilot's ability, noting that he was particularly "circumspect" and that he gave very full briefings.

The right seat pilot was nominated as commander and 'pilot flying' on both of the day's flights. He was an experienced pilot employed full-time by the operator, and was already qualified to carry out supervision of new co-pilots. In the month before the accident, the right seat pilot had operated eleven flights, of which one was as 'pilot flying' in the right seat, two were as 'pilot not flying' in the right seat, and the others were in the left seat. Prior to that, he flew only in the left seat.

The two pilots had not previously flown together.

Landing technique

When interviewed, both pilots explained that in executive flying, they believed that passengers expected very smooth landings, and that achieving a very smooth touchdown was an important part of their task. However, they both acknowledged that on comparatively short runways it was necessary to concentrate on achieving an accurate touchdown in the correct place, to ensure safety.

Landing performance is calculated on the assumption that the aircraft will touch down within the touchdown zone (the area of runway around the point where the glideslope intersects the runway surface). On the Luton runway, this zone is identified by runway markings at 150 metre intervals from the landing threshold to a maximum of 600 metres, by the positioning of the PAPIs and by the ILS glideslope.

The operator's Operations Manual did not include any stipulation that a missed approach should be executed in the event of a prolonged float during landing.

Aircraft examination

This Challenger 604, D-ABCD, was built in July 2003 as serial number 5565.

At Luton, the aircraft was found to have run off the western end of the stopway of Runway 26. It came to rest having travelled approximately 30 metres beyond the end of the paved surface, the wheels having sunk into, and made tracks through, the soft ground. Tracks on the paved surface indicated that the aircraft was turning slightly to the right whilst sliding towards its left as it passed onto the soft ground.

When first examined, the flaps were retracted and the aircraft appeared to have been shut down in the normal way. The track created by the right main landing gear intersected the edge of a concrete plinth supporting a landing light. It was noted that the nosewheel axle was bent.

The aircraft was defuelled, the data recorders were removed and the aircraft was winched back onto the paved surface before being towed to a maintenance facility on the airport.

Accumulated mud was hosed from the landing gears. Detailed examination confirmed that all tyres remained inflated and were free from flat spots on their treads. A tyre on the right main landing gear had sustained cuts to a sidewall, apparently as a result of rolling contact with a lighting plinth. Three brake units were found to be within wear limits whilst the fourth was worn to slightly below the minimum specified thickness.

After the accident it was found that some electrical interlocks were not operating correctly and this appeared to be due to damage sustained by the weight switches and wheel speed sensors as the wheels 'ploughed' through the unpaved surface beyond the stopway. Borescope examination of one engine revealed slight ingestion damage to the compressor. The time of occurrence of this damage could not be determined and it was decided that the engines should not be run before removal. Accordingly, the electric pumps were used to power the hydraulic systems; all were found to hold pressure correctly and the spoilers were found to function appropriately.

A pitot-static test set was utilised to calibrate the ADCs (air-data computers) and the flight-deck displays. All parameters were found to be within limits. Electrical tests on the autothrottle system revealed no evidence of defects and, after replacement of the engines, the system was reinstated successfully.

Flight recorders

The aircraft was fitted with a Solid State Memory Flight Data Recorder (FDR)[2] capable of recording a range of flight parameters into solid state memory when power was applied to the aircraft. The aircraft was also fitted with a Cockpit Voice Recorder (CVR)[3] which recorded crew speech and area microphone inputs into solid state memory (120 minutes of combined recordings and area microphone and 30 minutes of separate higher quality recordings), again when power was applied to the aircraft. Both recorders were downloaded at the AAIB and data and audio recordings were recovered for this overrun accident. The BFU (Bundesstelle für Flugunfalluntersuchung, the German accident investigation authority) also assisted in analysis of the CVR, providing a transcript and commenting upon the manner of the flight crew's operation.

Flight data recorder

A time-history of the relevant parameters during the accident is shown at Figure 1. The data presented at Figure 1 starts 45 seconds before touchdown, with the aircraft on the extended centreline to Runway 26, 0.8 nm from the threshold. The aircraft's height was 370 ft aal and airspeed was 138 kt (V_{REF} + 6), descending at about 720 feet/minute, with the trailing edge flaps at 45º and the landing gear down. The autopilot was ON before being disengaged seven seconds later as D-ABCD passed through 300 feet aal[4].

The aircraft continued to descend towards Runway 26, with the engine N_1[5] parameters fluctuating between 50% and 63%, crossing the threshold at about 110 feet aal. At this point, the aircraft started to flare, pitching from -1.8º to 1.7º nose-up over seven seconds, while the thrust was increased to 64% N_1. Over the next 15 seconds the pitch attitude slowly decreased to zero at touchdown when the right main and nose landing gears contacted the runway first. The distance travelled over the runway before touchdown was calculated as 1,310 m. During this period the N_1 remained at 64% and the airspeed varied between 134 and 141 kt.

The spoilers deployed immediately at touchdown. All three main landing gear 'weight-on-wheels' switches then showed a slight 'bounce' and the right main landing gear 'bounced' momentarily again. The thrust reversers were deployed and the brakes were applied five seconds later, after the aircraft had travelled 400 m along the runway. The aircraft then travelled a further 450 m to the end of the runway, and 130 m beyond, over the runway's stopway and onto the grass (indicated by the fall in pitch attitude as the aircraft followed the ground as it sloped down from the runway), before coming to a stop. The time from touchdown to stopping was 20 seconds.

Cockpit voice recorder

Staff at the BFU analysed the cockpit voice recorder and provided a transcript. They reported that the recording showed an apparently high standard of flight crew operation with clear briefings and good co-operation in a professional, slightly formal, manner. AAIB analysis concurred with these opinions.

Footnote

[2] L3 F1000 FDR capable of recording at least 50 hours of data at 128 words per second data rate.
[3] L3 FA2100 CVR.
[4] Although autopilot status was available on the FDR, a parameter for autothrottle selection was not.

Footnote

[5] For clarity, only the N_1 for the right engine is shown but this is also representative of the left engine. Parameters for throttle lever angle were not available on the FDR but the thrust parameters (N_1) appear entirely consistent with normal operation of the thrust levers. There was no evidence of any defect before or after this event.

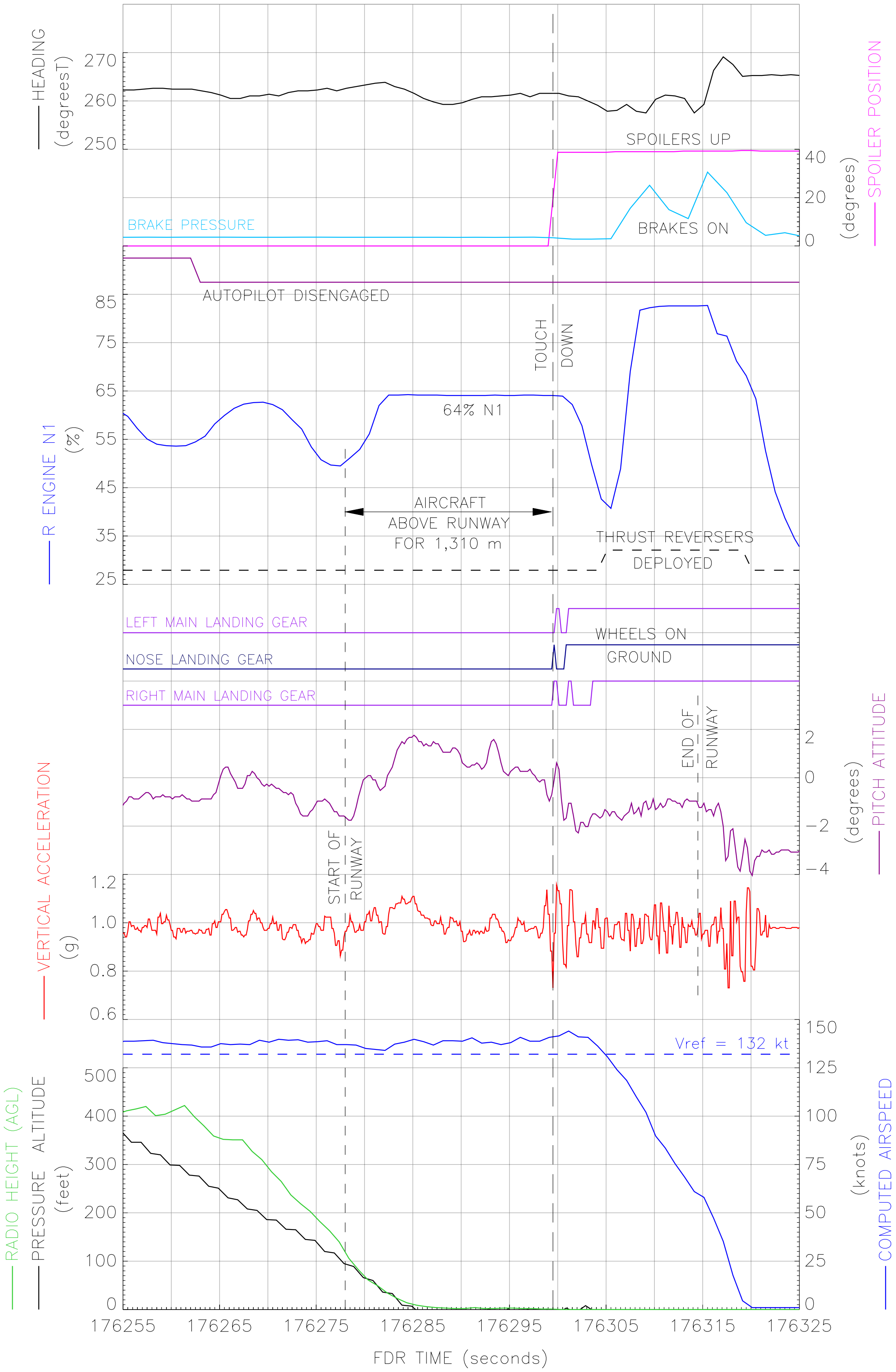

Figure 1

Salient FDR Parameters
(Accident to D-ABCD on 5 February 2006)

Autothrottle function

The autothrottle system fitted to the aircraft was an optional item, not fitted as standard equipment by the aircraft manufacturer although it was the only autothrottle system certificated on the type. The FDR did not record whether the autothrottle was engaged and no audio tone was triggered by disengagement. However, both pilots recalled that it had been disconnected "on short final" and, had it been engaged, it would have retarded the thrust levers to achieve a speed 10 kt below AFCS Airspeed Reference (speed bug) when the aircraft passed through 50 ft radio altitude. The commanded speed was 137 kt during the approach, and varied between 134 and 141 kt during the float.

The airport and landing performance

London Luton Airport is situated on the top of a hill, south-east of the town. The runway, orientated 08/26, is 2,160 metres long, and the Landing Distance Available (LDA) on Runway 26 is 2,075 metres. At the end of the Runway 26 LDA, a 60 metre stopway is provided. Although this stopway is the same width as the runway, it is not formally considered part of the LDA but is provided for use by aircraft executing a rejected takeoff.

The Landing Distance Required (LDR), given the conditions of the accident flight, was calculated. At a weight of 37,449 lbs and with a temperature of 4ºC, airport elevation of 526 ft and QNH of 1032 mb, the LDR was found to be 839 metres (2,755 ft).

Construction of the lighting plinths and relevant regulation

The elements of the approach lighting for Runway 08, which the aircraft struck during the overrun, were mounted on buried concrete plinths situated within the Runway Strip for Runway 26. The plinths were substantial and the lighting devices were bolted into the concrete, with appropriate wiring being fitted. The side faces of the plinths were vertical.

Civil Aviation Publication (CAP) 168 gives guidance and instruction on the design of aerodromes. The paragraphs of relevance to this investigation are reproduced below:

'4 Runway Strips

'4.1.1 A runway strip is an area enclosing a runway and any associated stopway. Its purpose is to:

'a) reduce the risk of damage to an aeroplane running off the runway by providing a graded area which meets specified longitudinal and transverse slopes, and bearing strength requirements…

'4.1.2 Ideally the whole of a runway strip should be clear of obstacles but in practice it is recognised that the strip facilitates the installation of visual, radio and radar aids, and some of these cannot perform their function if they are sited outside the runway strip.

'Equipment essential to an approach, landing or balked landing is permitted within the runway strip…

'Within the graded area of the runway strip constructions such as plinths, runway ends, paved taxiway edges, etc should be delethalised, that is, so constructed as to ***avoid presenting a buried vertical face*** *to aircraft wheels in soft ground conditions in any direction from which an aircraft is likely to approach. To eliminate a buried vertical surface, a slope should be provided which extends from the top of the construction to not less than 0.3 m below ground level. The slope should be no greater than 1:10.'*

It appeared that the lighting plinths had been in place for some years; inspections and audits of the aerodrome by the CAA had not revealed that the plinths did not meet the requirements of CAP168.

Analysis

No evidence was found to indicate that any technical defect relevant to the approach or landing phase of flight was present before the aircraft left the paved surface; in particular, the thrust parameters (N_1) appeared consistent with normal operation of the thrust levers. The one brake unit worn slightly below minimum limits was not considered to have affected braking performance. It was also possible that the unit was within dimensional limits when braking began on this occasion.

The flight proceeded normally until the last stages of the approach at Luton, and analysis of the cockpit voice recorder recording showed an apparently high standard of flight crew operation. This was also reflected in the recollection of the examiner, who stated that he was, until the accident, impressed with the right seat pilot's ability.

The approach was unremarkable, and well within the appropriate parameters, until the thrust increased to 64% N_1 and remained at this level until touchdown. The commander later recalled having disconnected the autothrottle close to 60 ft and the values of engine thrust (derived from the engine N_1 parameter) below 50 feet radio height appear inconsistent with the operation of the autothrottle system at this point.

It is concluded either that the commander selected a thrust lever angle which caused the engines to run at 64% N_1, in the last moments of the approach, or that he disconnected the autothrottle when the thrust levers were positioned to give approximately 64% N_1, and did not then retard them to the idle setting prior to the flare.

It is clear that although both pilots were aware of the unusual way in which the aircraft was floating along the runway, neither identified that this was caused by excess thrust. The right seat pilot had very little recent experience operating the aircraft from the right seat, having made only one flight as 'pilot flying' in the right seat in the two months prior to the accident, and it is considered that this lack of familiarity with the aircraft from the right seat is a likely factor in the accident. The brief delay between touchdown and the initiation of reverse thrust and braking may be explained by the short period between the first touchdown and the final touchdown of the right main landing gear; the commander may have been concerned to ensure that all three landing gear were firmly on the ground prior to braking.

The commander had placed both his hands on the control yoke for the flare and landing and it is possible that by doing this he was able to make smoother, more accurate, control inputs. Conversely, sensory feedback from the position of a hand on the thrust levers would provide a pilot with information about thrust lever position and movement.

The crew composition was unusual, as the commander, who had ultimate authority over the conduct of the flight, was nonetheless being 'trained' by a more experienced pilot and examiner. Neither pilot commented that he was conscious of this having affected their operation. However one factor, identified in earlier accident investigations, concerns the reluctance of a pilot who is not in command to dictate that a safety manoeuvre should be carried out. There can be an expectation that the commander, with overall authority, will be the one to dictate urgent safety actions, or to elect to continue a course of action which may be on the boundary of safe operation. The right seat pilot, nominally the commander, may have felt that he was effectively under the tutelage of the examiner in the left seat and that, in the absence of instruction or comment to the contrary, the examiner was content with the way the flight was going. The examiner may have felt that the nominated commander, in the right seat, was responsible, and that it was not for him to 'interfere'. The crew composition may have provided a fertile ground for an error of omission of a critical action.

Safety actions

Discussions concerning the crew composition on the accident flight took place between the operator, the AAIB, and the Luftfahrt-Bundesamt (the German civil aviation authority). As a result, the operator's operations manual is to be amended to require that, when training or checking is taking place, the instructor or examiner must be the aircraft commander.

The design of the lighting plinths did not satisfy the criteria laid down in CAP168. This was discussed with members of the Civil Aviation Authority's Aerodrome Standards Department, and safety action is to be taken as a result.

The Civil Aviation Authority's Aerodrome Standards Department informed the AAIB that it intended to publish a Notice to Aerodrome Licence Holders (NOTAL) reminding them of the provisions of CAP 168 with regard to delethalisation of structures within Runway Strips, and intended to raise the topic at aerodrome audits. This NOTAL, 5/2006, was published in May 2006.

The aircraft operator has published a bulletin to flight crew pointing out that 'A safe landing may well be gentle. However, a soft landing is not necessarily a safe one!' and instructing flight crew that touchdown must be made within the touchdown zone.

ACCIDENT

Aircraft Type and Registration:	Aerotechnik EV-97A Eurostar, G-CEGO
No & Type of Engines:	1 Rotax 912 ULS piston engine
Year of Manufacture:	2006
Date & Time (UTC):	6 November 2006 at 1400 hrs
Location:	Private Airstrip, Ashbourne, Derbyshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Propellor destroyed, noseleg bent, firewall creased, starboard main landing gear collapsed, passenger seat damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	49 years
Commander's Flying Experience:	427 hours (of which 5 were on type) Last 90 days - 21 hours Last 28 days - 6 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During a takeoff attempt, the left landing gear encountered brambles growing near the edge of the grass runway, deflecting the track of the aircraft and causing it to enter a ditch.

Pilot report

The aircraft was operating from a grass airfield with rows of brambles growing to the left of Runway 33. The pilot reported that he carried out some routine maintenance before undertaking a number of circuits.

He stated that he carried out a thorough pre-flight inspection and ensured that he allowed plenty of time after start-up for the engine to warm up. When the oil temperature gauge had moved off its stop he did his power checks followed by pre-flight checks. He then lined the aircraft up and took off as normal. After one circuit and landing on Runway 33 he taxied to the end before turning and back-tracking to carry out another circuit from the same runway.

He reported that he stopped at the hold, turned into wind and repeated the power and pre-flight checks. He lined up again on the centre of Runway 33 and re-checked he had one stage of flaps and that the trim was set. He applied full power and immediately felt the aircraft tending to turn to the left. He corrected with right rudder but felt the nosewheel judder as if it was bouncing over some grass on the runway. He then felt the nosewheel begin to lift clear of the ground and the aircraft start to pitch up, in the usual way. He checked forward on the stick but suddenly the aircraft veered violently to the left and pitched down. He pulled the throttle back to idle as the aircraft left the runway.

The pilot subsequently concluded that he had lined up too close to the brambles growing on the side of the runway. The aircraft appeared to have been deflected off to the left by the brambles. Thereafter it entered a deep ditch at the edge of the runway, causing all the damage sustained.

ACCIDENT

Aircraft Type and Registration:	Diamond HK 36 TC, G-OSFA
No & Type of Engines:	1 Rotax 912-A3 piston engine
Year of Manufacture:	1999
Date & Time (UTC):	12 June 2006 at 1030 hrs
Location:	Enstone Airfield, Oxfordshire
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - Nil
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damaged propeller, nose landing gear leg and nosewheel fork
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	60 years
Commander's Flying Experience:	89 hours (of which 80 were on type) Last 90 days - 3.6 hours Last 28 days - 0 hours
Information Source:	AAIB Field Investigation

Synopsis

Following a normal approach and touchdown a loud scraping noise was heard from the front of the aircraft which was followed by the nosewheel detaching from the nose leg. The metallurgical examination revealed that both the nose landing gear wheel fork arms had failed in overload and that the materials were of the correct specification.

History of the flight

The purpose of the flight was to re-familiarise the pilot with the aircraft type. The pre-flight checks showed no obvious problems and the weather was good with light and variable winds. The first circuit and landing were satisfactory with a normal touchdown. The second circuit, approach and initial touchdown on the main wheels were normal until the nosewheel was lowered, at which point there was a loud metallic scraping noise from the front of the aircraft and a loss of directional control. The instructor took control and immediately raised the nose and shut down the engine. As the nose of the aircraft settled back down on the runway the nose landing gear failed. The nosewheel was found approximately 150 m from where the aircraft came to rest.

Engineering examination

Initial examination showed that the nosewheel fork had failed at both sides approximately 45 mm forward of the wheel's axle hole in the fork (Figure 1). Metallurgical examination showed that both fork arms had failed in simple upward bending overload with a small amount of torsion in the right fork arm. This suggested that the left arm failed first, placing a twisting load on the unfailed portion of the right arm. Evidence from the failure surfaces indicated that a crack initiation had occurred from an event prior to that which resulted in the final failure. It was not possible to determine what the two events were or the time between them. There were no pre-existing material defects or damage to either of the fork arms. It was seen from the general appearance of the material surfaces that the fork arms had been sulphuric acid anodised. This could have adversely affected their resistance to surface crack initiation and propagation.

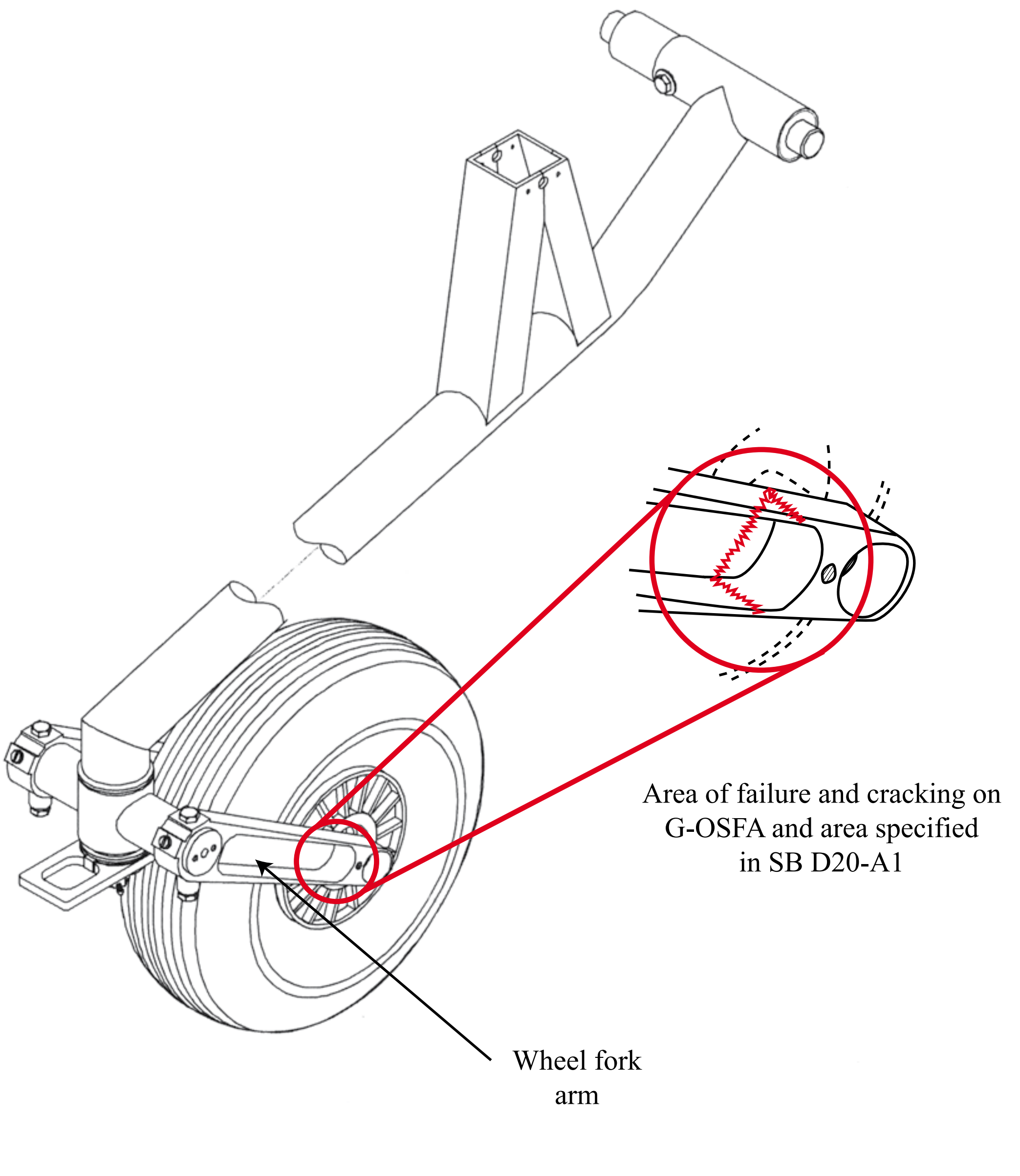

Figure 1

Nose Landing Gear

It was noted during the examination of the fork arms that there had been heavy contact between the insides of the arms and the sidewalls of the nosewheel tyre. It was also seen that the nosewheel tyre that was fitted was of a larger size (5.00-4) than that specified (4.00-4). With a 5.00-4 tyre fitted there is a 10 mm clearance between the tyre sidewall and the inside of the nosewheel fork arm whereas with a 4.00-4 tyre there is a 15 mm clearance.

Previous nosewheel fork arm cracking on G-OSFA

In June 2005 the nosewheel fork arms fitted to G-OSFA were found to have cracks in very similar positions to the failures that are the subject of this investigation. These fork arms had been retained by the operator and were made available to the AAIB, who submitted them for metallurgical examination. Initial examination showed that both fork arms had cracked approximately 45 mm forward of the wheel's axle hole in the fork (Figure 1). Detailed examination showed that both fork arms had cracked in simple upward bending overload. Both fork arm cracks contained frettage products and debris indicating that the cracks had been present for a considerable time and that they had been subjected to a large number of upward cyclic bending loads. These cyclic bending loads had progressed the crack in the right fork arm. There were no pre-existing material defects or damage to either of the fork arms. It was seen from the general appearance of the material surfaces that the fork arms had been sulphuric acid anodised.

As noted on the fork arms involved in the accident, there had been contact between the insides of the arms and the sidewalls of the nosewheel tyre.

Previous accident to G-OSFA

On 15 November 2005 G-OSFA was involved in a landing accident where, as a result of a heavy landing, the nose landing gear leg failed (AAIB Bulletin No 2/2006). The nosewheel fork assembly was inspected, found to be serviceable and fitted to the replacement nose leg.

Manufacturer's inspection requirement

In January 1999 Diamond Aircraft (Canada) issued Service Bulletin (SB) No DA20-32-02 (not mandatory), titled Nose Gear Fork Fatigue, which required the inspection of nose landing gear wheel fork arms fitted to DA20-A1 aircraft for evidence of cracking. The SB states:

*'**General:** As a result of hard landings, cracks have appeared in nose landing gear forks of some aircraft. This service bulletin is divided into two parts. Part 1 addresses an inspection of the nose gear fork. Part 2 addresses modifications required to remove the nose gear fork and replace it with an optional heavy duty fork.*

***Compliance:** Compliance with Part 1 of this service bulletin is urgently recommended upon receipt of this bulletin. Compliance with Part 2 is recommended.*

***Accomplishment Instructions:** ....Continued inspection every 100 hours in accordance with the Aircraft Maintenance Manual is required. ......'*

The nose landing gear wheel fork arms fitted to the Diamond HK36-TC aircraft are of very similar design to those fitted to the Diamond DA20-A1. The area of the fatigue cracking that is described in SB No DA20-32-02 is similar to where the cracking occurred in the fork arms of G-OSFA, the aircraft that is the subject of this report.

Safety Recommendations

As a result of the two events that have occurred to G-OSFA and similar events to DA20-A1 aircraft the following safety recommendations are made:

Safety Recommendation 2006-113

It is recommended that Diamond Aircraft Industries, the aircraft manufacturer, issue a service bulletin for HK36-TC aircraft requiring immediate and recurring inspections for cracking of the nose landing gear wheel fork arms.

Safety Recommendation 2006-114

It is recommended that Diamond Aircraft Industries, the aircraft manufacturer, fully appraise the sulphuric acid anodising of the nose landing gear wheel fork arms that are fitted to HK36-TC aircraft for its effect on fatigue crack resistance.

Safety Recommendation 2006-115

It is recommended that the European Air Safety Agency (EASA) review the design, manufacturing and material specifications for Diamond HK36-TC nose landing gear wheel fork arms for their suitability for continued airworthiness.

Further information

The aircraft manufacturer commented that, in their experience, the majority of cracks in the nosewheel fork have been due either to 'shimmy' (although there was no evidence of this in the accident to G-OSFA) or to hard landings. The 'shimmy' is generally attributed to improper friction adjustment of the damper in the nose landing gear.

ACCIDENT

Aircraft Type and Registration:	Jabiru J400, G-PUKA
No & Type of Engines:	1 Jabiru Aircraft Pty 3300A piston engine
Year of Manufacture:	2004
Date & Time (UTC):	27 January 2007 at 1210 hrs
Location:	Clutton Hill Farm, Near Bristol
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Broken left landing gear, broken noseleg, damage to left wing and shock-loaded engine
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	44 years
Commander's Flying Experience:	216 hours (of which 105 were on type) Last 90 days - 7 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During the takeoff run, the pilot became concerned with the aircraft's slow acceleration and decided to stop. As he applied the brakes, the left landing gear encountered some bumps and partially failed. This caused the left wing to touch the ground, the noseleg to fail and consequently the propeller to strike the surface. The pilot concluded that the slow acceleration was due to the runway's soft surface as a result of recent rain.

History of the flight

The pilot was intending to operate a private flight with one passenger on board; the fuel tank was half full of fuel. He calculated the takeoff weight to be 563 kg, which is 137 kg less than the maximum allowed. The forecast surface wind was from 260º at 6 kt with a temperature of 9ºC but whilst preparing for departure, the pilot noted that the windsock indicated calm conditions. He therefore decided to take off using the grass Runway 07, which is 590 metres long and has a significant downhill gradient. The engine indicated full power during the takeoff run but the pilot believed the acceleration to be slower than normal. Having operated out of this airfield for 18 months, the pilot had designated a point 200 metres from the end of the runway at which he considered a takeoff could be safely rejected. On reaching this point he was still concerned with the acceleration and so he closed the throttle and applied full braking. The left landing gear encountered some bumps and partially failed, causing the left wing to touch the ground. To counteract the drag from the left wing, the pilot applied full right rudder; the nose leg subsequently failed and the propeller struck the ground. The aircraft came to rest 15 metres from the end of the runway and the pilot and passenger, who were both wearing lap straps and diagonal harnesses, exited the aircraft through their respective doors.

The runway had recently been extended into an adjacent field and the boundary hedge removed to allow this. Bumpy terrain remains in the area where the hedge had been removed and this coincided with the point where the pilot rejected the takeoff.

Discussion

The pilot concluded that the slow acceleration on this particular takeoff was a result of the runway's soft surface due to heavy rain during the previous week. He noted that other types of aircraft with larger tyres appeared unaffected by the soft conditions.

The pilot also believes that the bump left by the hedge removal probably caused the partial failure of the left landing gear and subsequent bumps on the runway 'extension' caused the left wing to touch the ground. He no longer operates from this airfield as he feels that this model of aircraft is not suited to this particular runway surface under soft conditions.

ACCIDENT

Aircraft Type and Registration:	Jodel D9, G-BGFJ
No & Type of Engines:	1 Volkswagen 1600 (Fitton 1324) piston engine
Year of Manufacture:	1982
Date & Time (UTC):	26 February 2007 at 1223 hrs
Location:	Drain Farm, Trawsfynydd, Wales
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Minor damage to propeller and canopy
Commander's Licence:	Private Pilot's Licence
Commander's Age:	71 years
Commander's Flying Experience:	1,000 hours (of which 70 were on type) Last 90 days - 7 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft contacted soft ground before the runway threshold and overturned.

History of the flight

The flight was planned from Llanbedr to a private grass strip at Drain Farm, Trawsfynydd. On arrival in the area, the pilot set up for a long straight-in approach to the northerly runway at an airspeed of 50 kt. He estimated the headwind was 7 to 8 kt. On final approach the pilot reduced the airspeed to around 40 kt. Just prior to touchdown, the rate of descent increased allowing the main landing gear wheels to contact soft, boggy ground in the runway undershoot area, approximately 15 m before the threshold. The wheels sank into the soft ground and the aircraft turned over, coming to rest in an inverted position. The pilot was uninjured.

The strip at Drain Farm slopes uphill towards the northern end of the runway. The pilot wanted to ensure that the aircraft touched down as close as possible to the runway threshold. He also commented that the ground in the area of the threshold was very soft due to the recent rain.

ACCIDENT

Aircraft Type and Registration:	Piper PA-28-160, G-ARVU
No & Type of Engines:	1 Lycoming O-320-B2B piston engine
Year of Manufacture:	1962
Date & Time (UTC):	4 February 2007 at 1100 hrs
Location:	Barton Aerodrome, Manchester
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - Nil Passengers - N/A
Nature of Damage:	Damage to right wingtip of G-ARVU and to left wingtip of G-BYII
Commander's Licence:	Private Pilot's Licence
Commander's Age:	38 years
Commander's Flying Experience:	150 hours (of which 67 were on type) Last 90 days - 5 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot was taxiing from the fuel pumps, after refuelling his aircraft, to a temporary parking area where he intended to pick up two passengers. Having monitored the left wing to ensure that it was clear of the pumps he looked over to the right wing. A combination of bright sun and a misted windscreen made it difficult for him to see out to the right at first; he then saw the wing of a parked aircraft to his right but was unable to stop in time to prevent a collision.

The parked aircraft was a low wing type and its left wing was positioned on the right side of the taxiway. G-ARVU was being taxied along the marked centreline of the taxiway. The pilot commented that his engine had not been running for long enough for the windscreen demist to be effective. He had also learned that if you can't see you should stop and, if necessary, exit the aircraft to assess the situation.

ACCIDENT

Aircraft Type and Registration:	SMG-92 Turbo Finist, HA-YDF
No & Type of Engines:	1 Walter M601D-2 turboprop engine
Year of Manufacture:	2000
Date & Time (UTC):	18 February 2007 at 1000 hrs
Location:	Hibaldstow Airfield, Lincolnshire
Type of Flight:	Aerial work
Persons on Board:	Crew - 1 Passengers - 7
Injuries:	Crew - None Passengers - None
Nature of Damage:	Distortion of tail drag strut and empennage
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	26 years
Commander's Flying Experience:	1,188 hours (of which 250 were on type) Last 90 days - 110 hours Last 28 days - 32 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and AAIB enquiries

Synopsis

Whilst aborting a takeoff, the pilot lost directional control during the ground roll, which resulted in the aircraft ground looping.

Description of aircraft

The SMG-92 Turbo Finist is an all-metal high winged, tail-wheeled aircraft that can accommodate up to 10 parachutists. The aircraft was designed in Russia, built in Czechoslovakia and registered in Hungary.

History of the flight

The routine parachuting flight was the pilot's first flight of the day and he reported that the wind was light and variable. Shortly after he increased engine power and the aircraft began to accelerate down the runway, he became aware of some vibration and a noise which sounded as if the co-pilot's door was not fully closed. The pilot, therefore, decided to abort the takeoff. He retarded the throttle, moved the propeller into the beta range and commenced braking. Immediately the aircraft started to loose directional control, veered to the right of the runway and ground looped before coming to rest on the right side of the runway with the tail wheel in an adjacent field. The pilot and parachutists were all unhurt; however the tail wheel drag strut had bent to the left and there was some distortion to the rear of the fuselage and empennage.

The pilot believes that he lost directional control as a result of reducing the power, which changed the torque reaction, and also by moving the propeller into the beta range too rapidly which he believes reduced the airflow over the rudder.

ACCIDENT

Aircraft Type and Registration:	Van's RV-9A, G-CCZY
No & Type of Engines:	1 Lycoming O-320-D1A piston engine
Year of Manufacture:	2006
Date & Time (UTC):	24 February 2007 at 1050 hrs
Location:	Caernarfon Airfield
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - 1 (Minor)
Nature of Damage:	Propeller, nose wheel, port wing tip and wheel spats
Commander's Licence:	Private Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	368 hours (of which 34 were on type) Last 90 days - 6 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft bounced on landing at Caernarfon. The subsequent touchdown was on the nose wheel resulting in its collapse.

History of the flight

The flight to Caernarfon had been uneventful and the aircraft was set up for an approach to Runway 20. As the aircraft passed over the threshold of the runway the pilot closed the throttle and flared. The aircraft bounced on landing; the subsequent touchdown was on the nosewheel, resulting in its collapse and damage to the propeller and left wing tip. After the aircraft came to a halt the pilot and passenger, who were wearing full harnesses, exited the aircraft normally. The passenger suffered a minor injury to the hip.

ACCIDENT

Aircraft Type and Registration:	Robinson R44 II, G-CDJZ
No & Type of Engines:	1 Lycoming IO-540-AE1A5 piston engine
Year of Manufacture:	2005
Date & Time (UTC):	16 October 2006 at 0930 hrs
Location:	Denham Airfield
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Tail boom severed, rotor blades destroyed
Commander's Licence:	Student pilot
Commander's Age:	44 years
Commander's Flying Experience:	240 hours (of which 7 were on type) Last 90 days - 20 hours Last 28 days - 20 hours
Information Source:	Aircraft Accident Report Form submitted by the instructor

Synopsis

The helicopter inadvertently became airborne while the student, who was alone in the helicopter at the time of the accident, was carrying out the start checklist. He was unable to regain control and the tail boom was severed by the main rotor.

Note

The commander's details referred to above relate to the student who was alone at the controls of the aircraft at the time of the accident. Legally, the commander of the aircraft for the intended flight was the flying instructor, although he was not on board the aircraft when the accident happened.

History of the flight

The flight was planned as part of a training exercise and the student was briefed to start the helicopter in preparation for the flight. The instructor had intended to board the helicopter after the engine was started, and with the rotors running. The student started the engine without difficulty, but then continued with the 'starting engine and run-up' checklist. The final item in the checklist was to set the rotor rpm to between 101-102%, then lift the collective lever and reduce the rpm in order to check operation of the low rotor rpm warning light and horn at 97%. As the student lifted the collective lever the helicopter began to move and the student's response resulted in violent control inputs which led to the tail boom being severed by the main rotor. The helicopter remained upright and the instructor joined the student to shut down the helicopter. The student was uninjured.

Discussion

Although the student had experienced a number of starts, this was the first occasion that he had carried out the entire process alone. It is normal practice for students to build confidence in starting up a helicopter on their own prior to flying solo. However, in this case the student continued with the checks beyond the point briefed by the instructor. The student also held a fixed wing Private Pilot's Licence.

A helicopter has the capability of becoming airborne once its rotors are running with sufficient speed. It is important therefore that anyone at the controls at this time is competent to control the aircraft should it start to move, for whatever reason. A similar previous incident occurred to Robinson R22 Beta, G-DELT on 16 October 2003, where during the pre-flight low engine rpm warning horn check the aircraft suddenly yawed to the left and became airborne. The student pilot, who was on his own at the controls, was unable to regain control of the aircraft before it rolled over.

As a result of that accident the CAA introduced an amendment to the Air Navigation Order, which came into effect on 15 March 2007, to add after article 50(4) the following:

'(5) An operator shall not permit a helicopter rotor to be turned under power for the purpose of making a flight unless there is a person at the controls entitled in accordance with article 26 of this Order to act as pilot-in-command of the helicopter.'

ACCIDENT

Aircraft Type and Registration:	Cameron Z-315 Hot Air Balloon, G-KNIX
No & Type of burners:	3 Thunder & Colt Triple Stratus burners
Year of Manufacture:	2005
Date & Time (UTC):	29 October 2006 at 1550 hrs
Location:	Wivelrod, near Alton, Hampshire
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 1 Passengers - 16
Injuries:	Crew - None Passengers - 1 (Minor)
Nature of Damage:	Balloon envelope panels torn
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	33 years
Commander's Flying Experience:	401 hours (of which 230 were on type) Last 90 days - 42 hours Last 28 days - 10 hours
Information Source:	Balloon Safety Report Form submitted to the BBAC by the pilot and further enquiries by the AAIB

Synopsis

The hot air balloon carried a pilot and 16 passengers on an evening pleasure flight. After an aborted attempt to land, the balloon was climbing out of a field when it collided with a tree. As a result, seven balloon panels were torn and one passenger was injured by a branch. The balloon pilot carried out a controlled landing in an adjacent field without further incident.

History of the flight

The hot air balloon was being operated by a company which specialised in balloon pleasure flights. On this occasion 16 passengers were being flown from a site on the north-eastern edge of Alton. The balloon took off at 1505 hrs for a flight planned to last for approximately one hour. The pilot intended to land near Medstead, about 4 nm south-west of the launch site. The balloon was followed by two vehicles that carried the support crew. One vehicle was to transport the passengers and the other to transport the balloon and its basket after the flight. During the flight the pilot communicated to the support crew, when required, using a hand-held radio.

The pilot reported that the surface wind was from 065º at 4 kt, and at 2,000 ft amsl, it was light and variable. The visibility was in excess of 10 km, the surface air temperature was 14ºC and there was no cloud. After an uneventful takeoff and climb to approximately 1,800 ft amsl, during the initial part of the flight the balloon reached a maximum ground speed of 5 kt, measured on the pilot's hand-held GPS. After about 40 minutes the pilot looked for a suitable field in which to land. Having noticed a "fairly large" stubble field ahead, he asked the support crew to obtain permission to land from the land owners. This field had trees approximately 15 m high around its southern edge and one beech tree, which was about 20 m high, in the south-western corner.

The pilot added that having instructed the passengers to take their landing positions, he made an approach to the field while travelling at 2 to 3 kt. When the balloon was over the middle of the field, at about 25 ft agl, he pulled the main deflation line. At this point the balloon was subjected to a gust of wind that increased its speed to 8 kt. Realising he would not be able to stop the balloon by the end of the field, he ignited the burners to climb out of the field. Due to the design of the burner controls he was not able to leave all three burners on whilst he closed the partially open parachute valve. Consequently, he initially closed the parachute valve with one hand while operating two burners with the other, before lighting the third burner.

As the balloon was climbing it collided with the large beech tree at about 15 m agl, snagging and tearing several panels of the envelope. One passenger, who was in the front right compartment, was hit on the head by a branch and received two cuts to her head. Several branches, with a diameter of approximately 10 to 15 cm, ended up in the basket; these were later discarded over the side. The pilot continued the climb out of the tree, with the burners on, before carrying out a controlled landing in an adjacent field without further incident.

Passenger assistance

After landing the pilot asked the injured passenger if she would like an ambulance called, but she declined saying she "just shaken."

Due to limited access to the landing field, the support crew did not reach the landing site for approximately 45 minutes.

Balloon description

Balloon envelopes are of a sewn construction and made of high tenacity nylon fabric. The fabric is coated to make it airtight and to protect it from the effects of sunlight. All the main loads on the envelopes are carried by nylon or polyester load tapes. Horizontal tapes act as rip stoppers so that any damage to the envelope will be limited in extent. The base panels of the balloon are made from "Nomex" heat resistant fabric so that the nylon is kept at a sufficient distance from the flame to prevent heat damage. The lower ends of the load tapes are formed into rigging loops to which flying cables are attached.

The Cameron Z-315 envelope has closely spaced load tapes and narrow gores of horizontally cut panels to give a near-smooth surface. It is fitted with a Rapid Deflation System which allows for the controlled release of hot air (venting) and complete deflation of the envelope. It takes the form of a circular parachute-style panel sealing a circular opening in the top of the envelope. This panel is held in position by the hot air and by centralising lines which join its edge to the inside surface of the balloon. The parachute valve is opened by pulling a single length of line running through pulleys. For in-flight venting the parachute panel is opened for a few seconds, whereas for deflation it is held open until the envelope deflates.

The basket was of a traditional wickerwork construction with a solid plywood floor. The structural load was taken by stainless steel wires forming a continuous sling from the burner frame underneath the basket floor. The top of the basket was padded with foam trimmed with leather. The bottom edge was covered with rawhide which protected the basket during landings and transit.

G-KNIX was fitted with a partitioned basket. This type of basket had internal partitions woven into the walls and floor. The partitions provided greater structural integrity and separation between groups of passengers. The pilot and fuel cylinders occupied a compartment separate from the passengers.

Balloon manufacturer's Flight Manual

If the envelope is damaged in flight, Section 3 of the manufacture's Flight Manual entitled 'Emergency Procedures' states the following procedure:

> *Heat [air] to replace lost lift while maintaining a steady rate of descent.*
>
> *Remain at very low altitude and land as soon as possible.*

Passengers' comments

The majority of the passengers were contacted after the accident. Most remembered the conversation the pilot had with the one of the support crew whom they saw at a house close to the field where the pilot planned to land. The passengers reported that the pilot initially asked the crew member to obtain permission to land from the land owner. As the balloon reached the middle of the field, at about 20 to 30 ft agl, permission had not been obtained and the pilot said that he needed a decision, either way, quickly. At this instant, as the balloon was drifting across the field, most of the passengers could see the approaching tree from a "reasonable distance." They soon appreciated that they were going to collide with the tree and instinctively ducked inside the basket.

The passengers added that after the support crew arrived in their vehicles, they appeared to be more concerned with packing up the balloon than transporting the passengers.

As a result of a head injury, the injured passenger was unable to return to work for seven weeks. Other passengers reported that they too were hit by tree branches but were not injured.

Damage assessment

The envelope was returned to its manufacturer for damage assessment and repair. The manufacturer found that seven panels had been damaged; of these three were completely replaced, three were partially replaced and one was patched.

Operating company's operations manual

The balloon operating company's Operations Manual stated that the maximum number of occupants for G-KNIX, including the pilot, was 16. Because there were 17 occupants in the balloon at the time of the accident the flight appears to have been operating outside the terms of the company's Air Operator's Certificate. The company reported that this was a result of an oversight in the compilation of their operations manual. The balloon was insured to carry 16 passengers which, together with a pilot, makes 17 persons in total but the insured number of passengers had been inadvertently carried into the Operations Manual as the maximum number of occupants. Also, the weight computation with 17 people on board indicated that the balloon was 726 lb lighter than the maximum lift weight permitted.

Discussion

It appears from the passengers' comments that the pilot may have had enough time to abort the attempted landing safely. Thus there is a possibility that the pilot failed to prioritise his actions, to the detriment of the safety of the balloon and its passengers, and was distracted by trying to obtain permission to land.

The adverse effect of a gust of wind cannot be discounted. However, had the pilot kept the balloon at a height above that of the surrounding trees while awaiting a decision, the probability of colliding with a tree would have been much reduced.

ACCIDENT

Aircraft Type and Registration:	Letov LK-2M Sluka, G-MZOT
No & Type of Engines:	1 Rotax 447 1-V piston engine
Year of Manufacture:	1999
Date & Time (UTC):	6 August 2006 at 1525 hrs
Location:	On the edge of North Coates Airfield, Lincolnshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - Nil
Injuries:	Crew - 1 (Fatal) Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	62 years
Commander's Flying Experience:	450 hours (of which 16 were on type) Last 90 days -12 hours Last 28 days - 3 hours
Information Source:	AAIB Field Investigation

Synopsis

Whilst on a flight from Bucknall to North Coates, the aircraft was nearing its destination when the pilot transmitted a radio call indicating that he had an elevator control problem. He attempted an immediate approach to the airfield, but, as he was too high, carried out an orbit before making a second approach. On short finals, at a height of around 150 feet agl, the aircraft was seen to suddenly pitching nose-down and impacting the ground in a near-vertical attitude.

The investigation revealed that a nut and bolt attaching the tailplane bracing wires to the fin had come undone, resulting in what was effectively a structural failure of the tailplane.

History of the flight

The pilot had completed a return flight to a local airfield prior to departing on the accident flight and did not report any problem with the aircraft or flying conditions. After lunch at his home airfield, Bucknall, he decided to fly to North Coates together with a Thruster microlight which had landed at Bucknall earlier that day. He was observed refuelling his aircraft prior to this flight. At 1445 hrs he took off behind the Thruster and the two aircraft tracked north-west towards North Coates at approximately 1,500 feet amsl. The Thruster, having a faster cruising speed, arrived at North Coates several minutes ahead of the Sluka and landed on grass Runway 05 at approximately 1520 hrs.

As the Sluka approached the airfield boundary, the pilot transmitted[1]

> "I HAVE HEARD SOMETHING SNAP, I HAVE PARTIAL ELEVATOR FAILURE AND CANNOT FLARE. I AM THREE MILES OUT. CAN I HAVE CLEARANCE TO COME IN FOR AN EMERGENCY LANDING?"

This message was relayed by another microlight pilot in the circuit at North Coates who was able to witness the aircraft's flightpath, along with several others on the ground. As the Sluka crossed the threshold of Runway 05 it was still at approximately 500 feet agl and the pilot commenced a descending right hand orbit, transmitting "GOING ROUND I'M TOO HIGH", before rolling out on the centreline at about 200 feet agl. As he rolled out of the turn, he transmitted: "I'M STRUGGLING TO GET FULL ELEVATOR TRIM, I CAN'T GET THE STICK FORWARD". The aircraft was then seen either to climb or experience some lift for a few seconds before the nose rapidly pitched down and the aircraft impacted the ground in an almost vertical attitude. One witness believed he heard the engine increase in power as it appeared to climb. The pilot was fatally injured in the ground impact.

Meteorology

The surface wind at North Coates was reported as 120º at 8 kt with a high cloudbase and excellent visibility. The temperature was 22ºC and thermal-type turbulence was reported in and around the airfield circuit. This was particularly apparent over the field where the Sluka had experienced lift, or commenced a climb, just prior to the accident.

Footnote

1 In the absence of any RT recordings, these radio transmissions are based on witness recollections.

Pathology

The pathologist's examination of the pilot revealed that he died from multiple injuries and that the accident was non-survivable. No evidence was found of any disease in the pilot or of alcohol, drugs or any toxic substance which could have caused, or contributed to the cause of, the accident.

Description of the aircraft

The Sluka is a high-wing, single-seat aircraft in the Microlight Category; a photograph of an intact example is presented at Figure 1. The tail surfaces are of fabric-covered, tubular construction, with upper and lower vertical fins rigidly attached to the rear of the aluminium alloy fuselage boom. The horizontal stabiliser comprises left and right tailplanes that are pin-jointed to the boom, with structural rigidity being provided by upper and lower bracing wires attached respectively to the upper and lower fins. A bolt and stiff nut are used to secure the upper wires, although a castellated nut and a split pin are used for the lower wires. This is to allow the lower wires to be readily detached so that the two tailplane halves can be folded up against the fin for storage.

The elevator operating cables are attached to horns on the left elevator. A simple clutch mechanism connects the two elevators together, but allows them to disconnect when the tailplanes are folded against the fin. Although there is no conventional elevator trim system, an elastic bungee cord, with knots tied at intervals along its length, is attached to the floor at the front of the cockpit. Forward control force can be off-loaded by means of inserting one of the knots in a key-shaped slot in a plate attached to the control column.

Figure 1

Aircraft history

The pilot acquired the aircraft in May 2005 and transported it by road from its previous base in Scotland. It was subsequently kept in a shed at Bucknall. A note in the aircraft log book states that the wings and tail were refitted, with a check flight being carried out in June 2005; this was conducted by an Inspector from the Popular Flying Association (PFA).

During the next few months, the aircraft was not flown as the owner became involved with a modification on the aircraft that addressed a potential fatigue crack problem at the forward wing hinge attachment to the boom tube. This work was completed in the spring of 2006 and on 15 April the aircraft was inspected and check flown, for the purpose of renewal of its Permit to Fly, by the same PFA Inspector as before. The aircraft had achieved 323 flying hours at this time. By the time of the accident it had accumulated a further 15 hours over 27 flights. The only maintenance activity recorded in the aircraft log book since Permit Renewal was the fitting of the original propeller on 30 April, and adjustment of the rudder bar stops on 7 July. Both actions were the subject of dual signatures by the pilot and the PFA Inspector. In fact the owner, who was an engineer by profession, invariably discussed any matter relating to his aircraft with the Inspector.

Accident site details

The aircraft had crashed approximately 100 m from the threshold of Runway 05, some 10-12 m inside the airfield boundary fence at North Coates and on a heading of around 062º(M). It had come to rest lying inverted, with the engine detached. The disposition of the wreckage indicated that the aircraft had struck the ground in a near-vertical attitude, with the main force of the impact being borne by the engine and propeller, the cockpit area and the wing leading edges. It was possible to discern marks on the ground that had been made by the wing leading edges; the damage to the wings was symmetrical, indicating there had been no significant roll or yaw at impact.

Examination of the empennage revealed that the bracing wires that secured the left and right tailplanes to the vertical fin had become detached from the upper part of the fin. The tailplanes each had a pair of wires anchored at the approximate mid-span points of the leading and trailing edges and these wires were attached to a small steel bracket, or tang. The tangs were attached to each side of the upper part of the fin by means of a bolt and stiff nut. However, it was apparent that the nut was missing, which had allowed both tangs, together with their associated wires, to become detached. The bolt was found loosely inserted in its hole in the tang that was attached to the left wires. Figure 2 shows the bracing wires as they were found at the accident site.

Following an on-site examination the aircraft was recovered to the AAIB's facility at Farnborough for a detailed examination.

Detailed examination of the wreckage

Tailplane and elevators

As found, the right tailplane was significantly drooped relative to its normal position, with its associated elevator disconnected. As a result of the distortion, principally to the fin and rudder, resulting from the impact, the right tailplane could not be reinstated to its normal position until the rudder had been removed. This indicated that the right elevator had been in the drooped position, with its elevator disconnected, prior to the impact. With the tailplanes held in their normal position by the bracing wires, the two elevators had been connected by a simple clutch, as noted earlier, which consisted of a short length of rod on the right elevator that meshed with a similar length of channel section on the left elevator. These components meshed snugly together, with no visible distortion, which indicated that the elevators had disengaged cleanly when the right tailplane drooped.

Bracing wire attachment hardware

The bolt that had attached the tailplane upper bracing-wire tangs to the fin was identical to that removed from an intact aircraft during the investigation. It was thus established that the bolt was of sufficient length to accommodate the stiff nut safely (referred to in the manufacturer's build manual as a 'Lock Nut'). Similar components were used elsewhere on the aircraft. It was noted that removal of the tang necessitated the use of 9 mm and 8 mm spanners for the nut and bolt respectively. A photograph of a stiff-nut is shown at Figure 3, where it can be seen that it has been manufactured with a saw cut extending across approximately half the diameter of the nut, just above the hexagonal section. The top half of the nut has been slightly bent over, in a manner that tended to close the saw cut. This process results in the axes of the threads in the two halves of the nut being at a slight angle to each other, which is how the 'stiff' function is achieved. However, one feature of this type of nut is that when it is turned onto a bolt, no 'stiffness' is encountered until the threads in the upper portion become engaged.

There was no nut to examine in the case of the accident aircraft, so it was not possible to establish that the correct type had been used, although the components elsewhere on the aircraft were correct. Typical assembly

As-found tailplane bracing wires: arrow indicates attachment point on fin

Right tang

Left tang with bolt

Figure 2

Detached tailplane bracing wires, as they were found

torque values were found to be around 30 lbf in. The aircraft build manual did not specify a torque figure for the upper bracing-wire attachment other than to state that it should be *tightened until just tight*.

The bolt threads were examined under a microscope and were found to show no evidence of any distress caused by, for example, excessive load or a wrongly sized nut. Similarly, the holes in the tangs attached to the bracing wires also showed no evidence of distress.

Figure 3

Whilst examining the intact aircraft it was noted that the tailplane wire attachments to the upper fin were approximately at eye level and thus easy to check on a walk-round inspection. In the event that the nut should back off a significant amount, the tangs would no longer lie flush with the surface of the fin, a feature that would be readily visible. The PFA Inspector commented that he had visually checked the attachment prior to the Permit renewal check flight in April.

Analysis

The accident sequence

The available evidence indicated that what was effectively a structural failure of the horizontal stabiliser occurred in two stages. Following the loss of the nut from the fin attachment bolt, the right tailplane would have folded downwards under the influence of the aerodynamic load, accompanied by the disengagement of the right elevator from the left.

The loss of download and elevator authority would have had an immediate effect on the aircraft, which most probably prompted the pilot's radio call, in which he mentioned elevator problems, as he approached North Coates airfield. As the elevator operating cables were attached to the left elevator, control would have been retained, albeit with more aft stick applied, so long as the bolt that attached the left tailplane bracing wires remained in the hole in the fin. The tension in the wires would have acted both axially and downwards on the bolt, with the latter force generating friction between the bolt threads and the bore of the hole, thus contributing to the retention of the bolt. It is probable that this tenuous condition persisted until after the aircraft had performed an orbit and was making its second approach to land. At this point the witness evidence indicated that the aircraft 'ballooned', possibly as a result of a thermal. This being the case, the pilot may have checked forward on the control column to regain his descent rate, which would have had the effect of aerodynamically off-loading the remaining tailplane, thus releasing the bolt and leaving the aircraft without an effective horizontal stabiliser. The absence of down force would have allowed the aircraft to pitch nose-down into a near-vertical dive.

With the benefit of hindsight, it is considered that there may have been an opportunity to avoid a fatal outcome if the pilot, after experiencing the initial elevator problem following the loss of the nut, had immediately attempted to land the aircraft in the nearest open area. Had he glanced over his shoulder, he would have been able to see the drooping right tailplane; however, regardless of whether or not he looked, it is likely he did not appreciate the seriousness of his predicament and wished to avoid possible damage to his aircraft that could occur in a forced landing. He therefore elected to continue to his destination, which, although it was nearby, involved extending the flight time by performing an orbit, thus giving more time for the bolt to migrate out of its hole in the fin.

Loss of the bracing wire attachments

The loss of the stiff nut could not be explained; indeed it was not even possible to establish whether the correct component had been installed. However, the remaining nuts and bolts on the bracing wires and elsewhere were correct and properly secure. It is possible that the tailplane upper bracing wire tangs were reattached to the fin in May/June 2005, when the aircraft was reassembled following its road journey from Scotland. However, there would have been no reason subsequently to disturb this attachment as the aircraft was housed, fully assembled, in a shed, thus negating any regular requirement to fold the tailplane sections out of the way. Had such a requirement arisen, this could have been accommodated by undoing the lower wires, which were attached to the fin by means of a bolt, castellated nut and split pin.

Other potential explanations for the in-flight loss of the nut could include the use of a plain nut, perhaps intended as a temporary measure until a correct item could be obtained, or that the stiff nut had become worn as a result of excessive re-use.

The location of the tailplane wire attachments on this aircraft is such that the pre-flight inspection process is simple and whilst the pilot may have had a low expectation of finding a defect, perhaps leading to an increased risk of missing it on one occasion, it is difficult to explain why he would not have noticed it. This might logically suggest that the nut came undone over a short period. Other 'short term' scenarios could include a mechanical failure of the nut, which, on such a low stress application, must be considered to be extremely remote, or tampering by a third party, for reasons unknown, which is also considered unlikely.

The use of stiff nuts in vital points throughout an aircraft structure is not uncommon in general aviation aircraft, although their re-use is discouraged. Any attachment that is regularly undone should not have a stiff-nut; this philosophy was embodied on G-MZOT in that the lower bracing wires attachment to the sub-fin used a castellated nut and split pin.

Conclusion

The accident occurred as a result of the loss of the nut on the tailplane upper bracing wire attachment to the fin. The nut was not recovered and no reason for its detachment was established.

The PFA has indicated that this accident will feature in a forthcoming issue of its magazine, which will also reiterate guidance on the use of stiff-nuts in aircraft structures.

ACCIDENT

Aircraft Type and Registration:	Zenair CH601UL, G-YOXI
No & Type of Engines:	1 Rotax 912S piston engine
Year of Manufacture:	2005
Date & Time (UTC):	25 August 2006 at 1503 hrs
Location:	Near Bramley, South Yorkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Fatal) Passengers - 1 (Fatal)
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	44 years
Commander's Flying Experience:	Approx 220 hours (of which approx 40 were on type) Last 90 days - Not known Last 28 days - Not known
Information Source	AAIB Field Investigation

Synopsis

The pilot was performing a low flypast in his aircraft along a farm strip; it was not his intention to land there and he made no attempt to do so. There were power cables at the end of the strip and the aircraft pulled up and climbed over them. As it did so the main wing spar of the aircraft failed causing both wings to fold upwards. The aircraft crashed into a field and a severe fire started immediately. The pilot and his passenger were fatally injured in the accident.

History of the flight

The pilot had flown one local solo flight from Askern Farm Strip, South Yorkshire on the afternoon of 25 August 2006. On his return from that flight he met the owner of Askern strip (the passenger) and they agreed to fly over to Bramley to have a look at another farm strip that was under construction. The passenger had some weeks earlier met the person constructing the new strip and they had discussed together methods of preparing the surface and also a problem with some power lines crossing close to the northern end. The pilot had been involved in some of these discussions and he had offered to fly over the strip and view it from the air.

The passenger telephoned the owner of the strip to say they intended to fly over but he was out so he spoke instead to the owner's wife and explained to her that they intended to fly over to view the strip from the air. When the owner of the new strip returned home his wife explained to him that the aircraft was on its way. He was concerned that the crew should be warned again about the wires and he tried to make contact both by telephone and by handheld radio on the helicopter frequency 122.95 Megahertz. He had previously discussed using this frequency with the visitors, but was unable to contact them. He then drove out to the north end of the strip and parked a small fuel bowser on a trailer, and his vehicle, underneath the wires to make their position obvious. He then stood by his vehicle and waited for the aircraft to arrive.

He saw the aircraft fly overhead at a height he estimated to be between 1,000 and 1,500 ft; it circled a number of times and then flew to the south. At about a mile from the south end of the strip he saw it turn to enter what he described as a steep descent, then level out and fly along the strip from south to north. He was surprised at the direction of flight as he noted that there was a wind of around 6 kt from the south, giving a tailwind. He saw the aircraft flying low along the strip with the wings level and he estimated it was at about 30 ft agl. As it came closer he started waving his arms in order to give warning of the wires. He then saw the aircraft start to climb at around 100 m from where he was standing and he ducked as it passed overhead. He turned and looked up at the wires which he expected would have been struck by the aircraft but noticed that they were intact and not moving. He then saw the aircraft wings fold upwards and parts of the aircraft break away before it descended steeply and crashed into an adjacent field. There was an immediate fire and he rushed into his house to get a fire extinguisher. He then drove down to the aircraft and attempted to tackle the fire but was unable to do so because of its intensity.

Witness information

A number of witnesses saw the aircraft around the time of the accident. They generally described it as being in a steep descent, before levelling out and then close to the ground starting to climb. Several witnesses saw the wings fold upwards as the aircraft climbed.

Pilot information

The pilot started flying in 2001 on flex-wing microlight aircraft. He qualified for his Private Pilot's Licence (Microlight) in August 2001 and over the next three years he accumulated some 150 hours of flight time. In 2004 he carried out a conversion to a fixed-wing microlight (of a different type from the accident aircraft) with a flying training organisation, and for a time he flew both flex and fixed-wing aircraft. The conversion training involved practical handling aspects of flying the aircraft; no groundschool training was included.

In May 2005 he purchased the kit for G-YOXI which he first flew in November 2005. Since then, although the details were not complete in the log books, he appears to have flown the aircraft at reasonably regular intervals and achieved a total some 40 to 50 hours flying in it.

On 8 June 2006 the pilot was sent a letter from the CAA regarding a complaint of low flying made about G-YOXI that had been reported by a member of the public, himself a qualified private pilot. The aircraft was reported to have been seen descending steeply and flying several times at a height of 150 to 200 ft across a small village with the wings 'waggling'. The reporter also noted that at the end of the low passes some steep turns were carried out. He reported that he was concerned for the safety of the aircraft as well as persons on the ground and pointed out that there were a number of power lines in the area.

Medical information

The pilot held a medical certificate countersigned by his general medical practitioner that was issued in

January 2001. At the time of issue the certificate was valid for a period of five years.

A post mortem examination was carried out on the pilot. There was no evidence of any pre-existing medical condition which could have influenced the accident.

Aircraft information

G-YOXI was a Zenair CH601UL, a derivative of the original CH600 Zodiac, and was of all-metal construction, predominately 6061-T6 aluminium. It was powered by a single Rotax 912S piston engine, driving a two-bladed composite propeller. The aircraft was fitted with two fuel tanks, one in each wing, and the fuel used was motor gasoline. The aircraft structural limitations were +4g and -2g. See Figure 1.

The aircraft had been acquired as a Quick Build Kit from Czech Aircraft Works in May 2005. This kit had been supplied with 51% of the structure, including the wings and fuselage, pre-constructed in the factory.

The Zenair Zodiac CH601L aircraft type has an airworthiness approval note issued by the PFA. The PFA had conducted flight tests on the aircraft type during which it was noted that the elevator control was 'light' and that

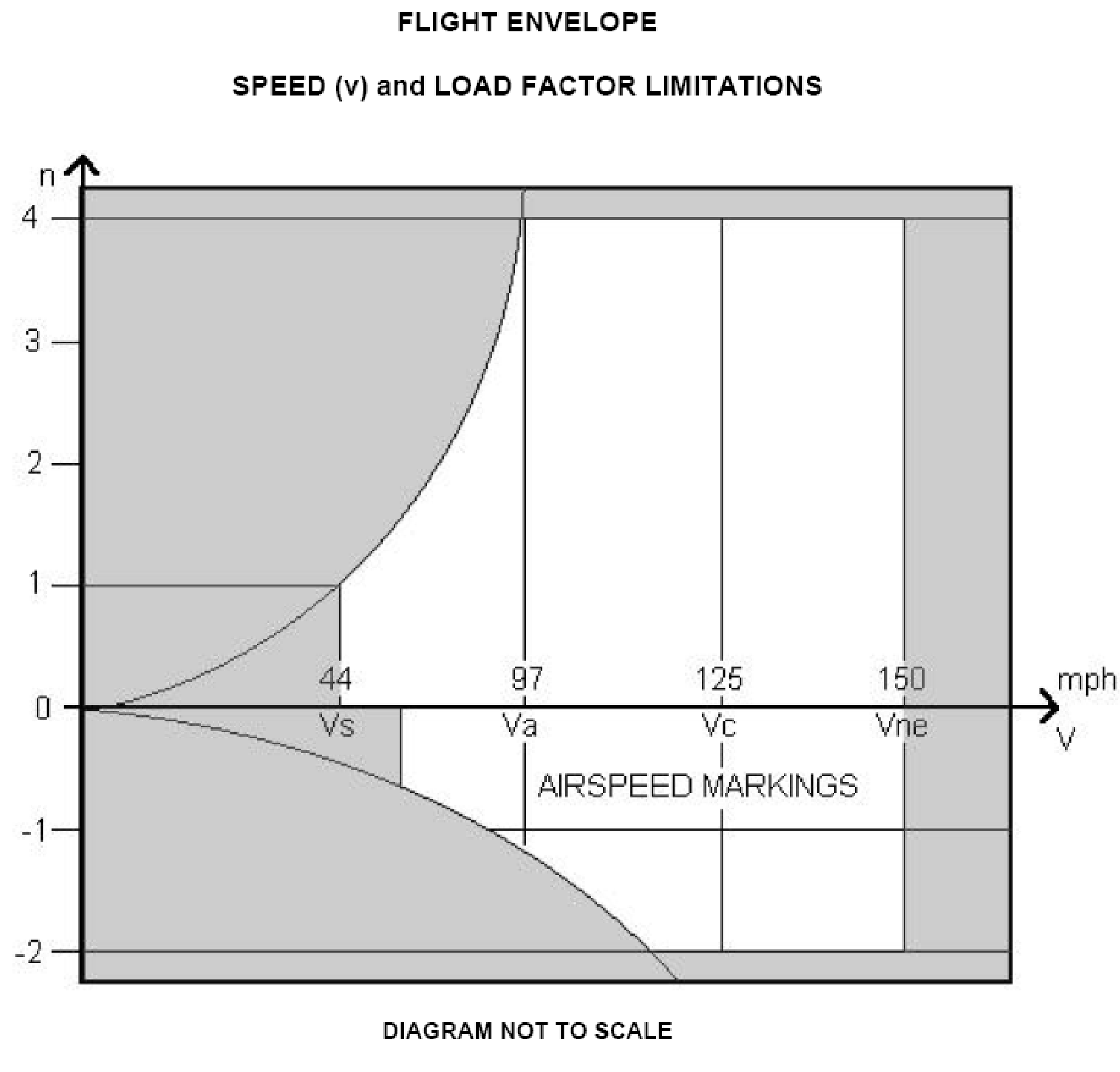

Figure 1

Load factor graph

there was a tendency towards pitch instability at higher airspeeds. As a result of this tendency a modification was introduced (MOD/162A/007) which restricted the aft CG limit to 17.5" (437.5 mm). To achieve this limit on G-YOXI it was a requirement that cushions were placed in front of the seat backs. The PFA provided the AAIB with a graph indicating the relationship of stick force to normal g for the aircraft. This shows that to achieve 4g a load of 9 daN (20 lbf) was required. The design requirements for the certification of very light aircraft are contained in CS-VLA, and paragraph 155 relates to the stick force per unit of g. The limit defined in CS-VLA 155 is that the stick force to achieve the positive limit load is not less than 7 daN (16 lbf). During flight tests of the aircraft the elevator control was described as 'very effective'.

The basic empty weight of the aircraft at the time of the certification flight test was 264 kg; the combined weight of the two occupants during the accident flight was around 160 kg. It was not possible to determine the amount of fuel on board at the time of the accident so, for the purpose of the investigation, it was assumed that a fuel load of at least 1/4 contents was available in each tank giving a total of 20 kg. The Maximum All Up Weight (MAUW) was 450 kg. This meant that at the time of the accident the aircraft was probably operating close to its MAUW.

Figure 2 shows a picture of an Airspeed Indicator (ASI) similar to that fitted to G-YOXI. The instrument is marked with colour banded airspeed ranges indicating the safe operating ranges and operating limits. The upper limit of the green band shows the maximum cruising speed for normal operation (V_{NO}), which in this case was the same as the manoeuvering speed (V_A) of 97 mph (see Figure 1). The V_A is the maximum speed at which the flight controls can be fully deflected without damage to the aircraft structure; it would not normally be indicated on an ASI. The yellow arc indicates the 'caution speed' range within which the aircraft should be operated only in smooth air. The red line is the never exceed speed (V_{NE}) and on this example is marked at 135 mph; however, the V_{NE} for G-YOXI was 150 mph, although it could not be determined what V_{NE} was actually marked on its ASI.

Wing structure

The CH601UL wing is a stressed skin cantilever design with the majority of the loads being carried by the front spar. The spar consists of three sections, each with additional upper and lower L section spar caps. The left and right front spars are attached to the centre front spar using two splice plates. For additional strength toward the centre of the wing, upper and lower spar cap doubler strips are added to the front of the spar. Wing ribs form the wing shape between the front and rear spars and are covered with a stressed skin. The rear spar consists of three z sections. The left and right rear spar sections each have an attachment plate through which a bolt attaches them to the centre rear spar. The entire wing structure is made from 6061-T6 aluminium.

Figure 2
Airspeed indicator

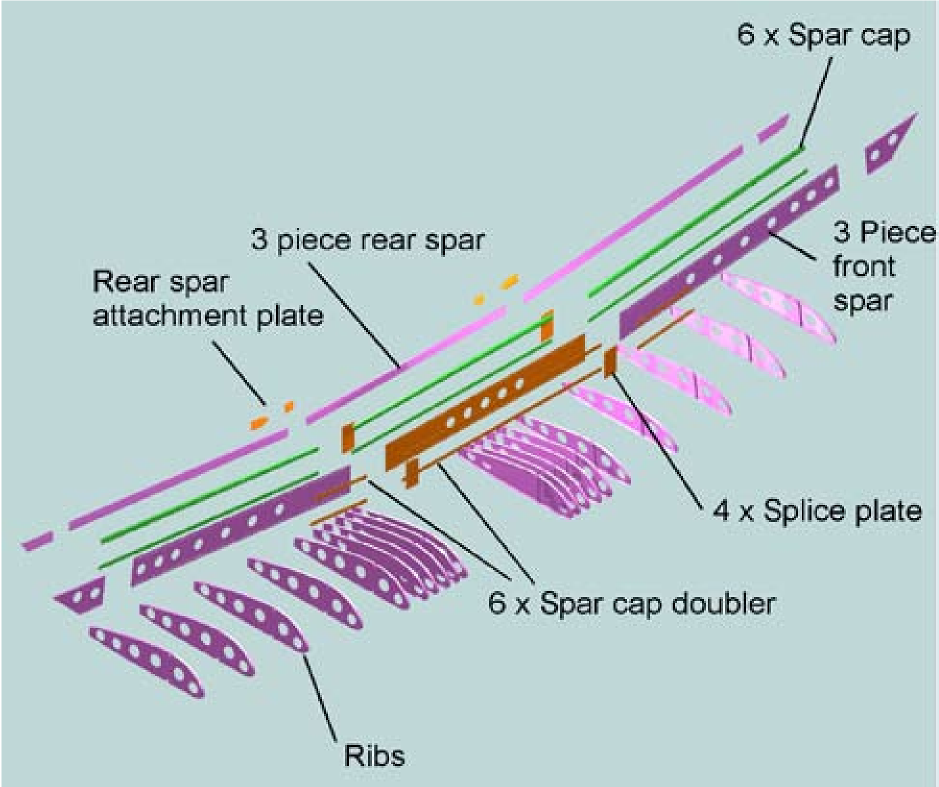

Figure 3

Wing Structure

Airstrip

The strip over which the aircraft flew was marked out with white edge marker posts and had recently been seeded with grass; it was 450 m in length. It was orientated in the direction 02/20 and sloped up in stages from south to north. At the northern end of the strip there was a helipad and nearby a sign on the ground indicting the presence of wires overhead. About 50 m from the north end across the extended centreline of Runway 02 was a line of three 11 Kva power cables at a height of 28 ft (4 m) agl. Beyond this the ground fell away again and there was an open field.

Accident site

The accident site was on a sloping field, which had recently been seeded with grass. The field was located to the north of the M18 Junction 1 and to the west of the carriageway. The aircraft had struck the ground some 330 m from the end of the strip on a heading of 020ºM. It initially hit the ground in a steep nose-down attitude, with the left wing low and at a relatively high speed. After the initial impact the aircraft bounced and travelled a further 20 m, inverting in the process before coming to rest. The left wing spar had remained attached to the centre spar. However the right wing front spar had become detached and the right wing was lying with its tip facing toward the direction of travel and on its leading edge. There was evidence of twisting of the right wing in relation to the fuselage and the left wing, as it remained upright whilst the remainder of the aircraft inverted.

The initial impact had caused the wing fuel tanks to rupture which led to a significant post-crash fire. The engine propeller was extensively damaged during the accident sequence, indicating that the engine was producing considerable power at impact. All the flying controls were correctly connected and continuous; the elevator trim was at neutral.

Further south, toward the strip and about 100 m from the end of the strip, several pieces of Perspex and a GPS receiver were found. These indicate that the canopy had shattered whilst the aircraft was still in the air, ejecting the GPS receiver at the same time.

Since it was possible that the aircraft had struck the power cables, these were examined for signs of contact with the aircraft. Although there appeared to be some small notches on the cables none of these could be attributable to the accident. Indeed, had the aircraft caused the cable damage it would have resulted in the power lines shorting together and the electrical supply being isolated. At no point was the electricity supply along these cables interrupted.

Based on the accident site ground marks and the position of the Perspex on the ground, a basic trajectory model was produced. This shows that the aircraft needed to have reached at least 200 ft above the ground before the wing folded. Extrapolating backwards, this meant that the aircraft must have cleared the electricity cables with a large margin to reach this height. See Figure 4.

The forces imparted during the initial ground impact indicated that the accident was not survivable.

Examination of wreckage

The wreckage was recovered from the site and taken to the AAIB for further detailed examination. Examination of the wing revealed extensive damage to the wing front spar. Unfortunately, the post-crash fire had melted much of the aluminium including a large section of wing and the area of possible initial failure. Despite this, the shear webs of both the left and right front spars revealed buckling indicative of over stress in upload. Similarly, buckling of the upper spar caps also confirmed a compressive stress indicative of an upload. The centre front spar had signs of torsion on the remains of the upper and lower spar caps, which were probably a result of the left wing and centre section inverting whilst the right wing remained upright. This also indicates that although the spar had failed, allowing the wing to fold, it had remained attached to a certain extent at impact. Figure 5 shows a summary of the damage found to the wing front spar.

The rear spar attachment point between the left and right sections and the centre section showed evidence that the attaching bolts had pulled out from the attaching plates in a down and inboard manner. This was also indicative of an upload on the wing structure.

Metallurgy

The front spar was sent for detailed metallurgic

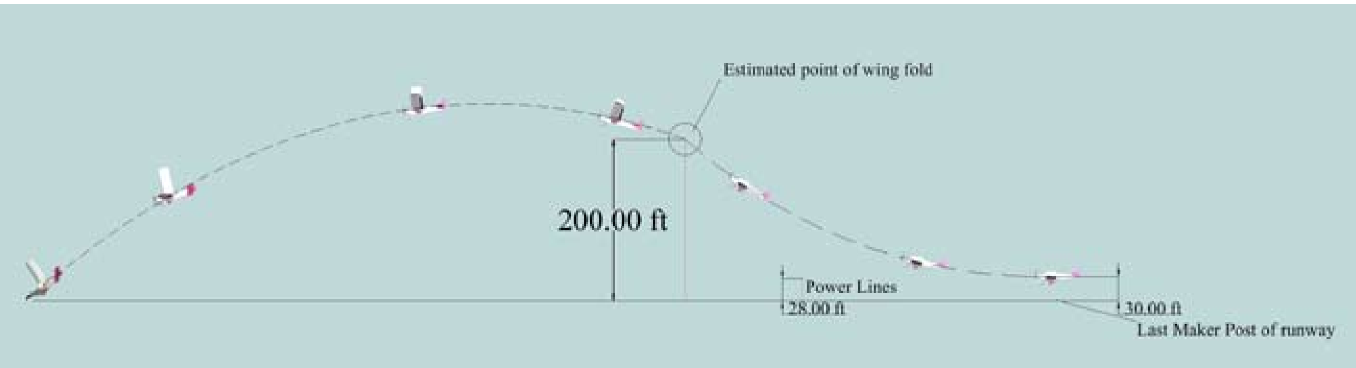

Figure 4

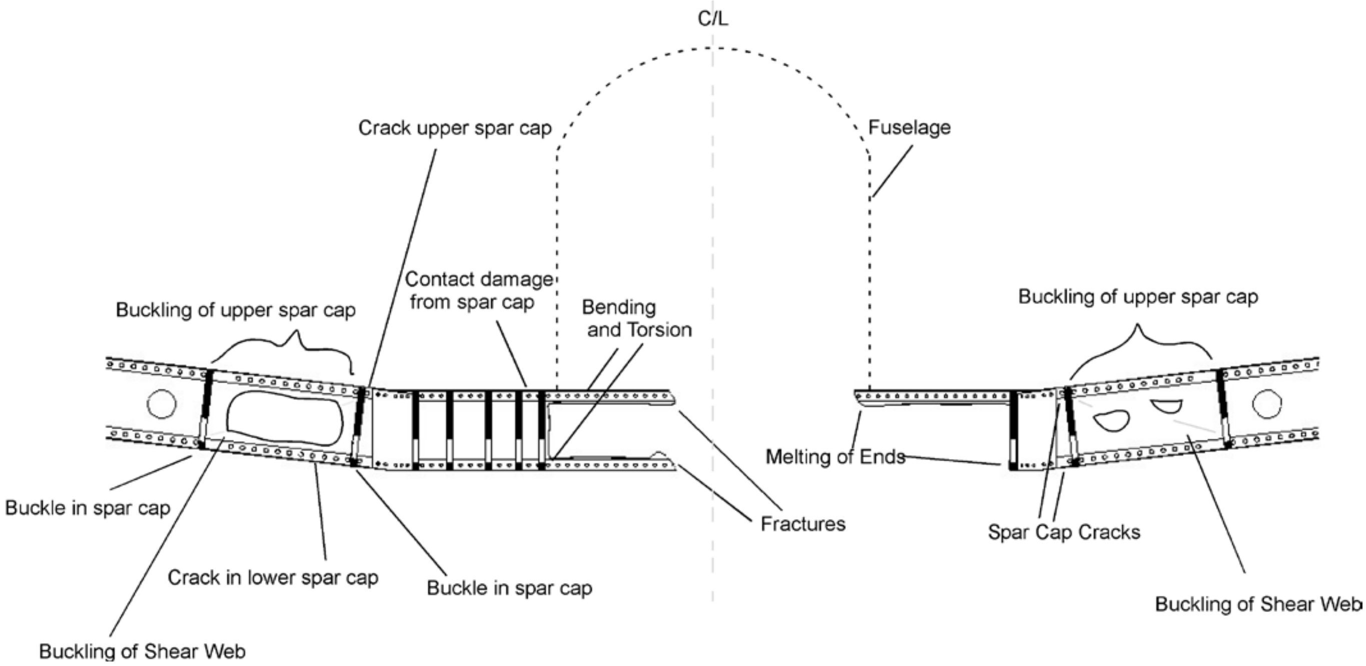

Figure 5

examination. This confirmed that the wing spar shear web, spar caps and doublers on all three sections of the front spar were constructed of 6061 aluminium. Unfortunately, due to the post-crash fire, it was not possible to ascertain if the heat treatment applied to the material at build was to the T6 specification. Examination of the fractures on the upper and lower spar caps of the centre spar section was inconclusive due to the damage of the surfaces caused by the post-crash fire, although the upper spar cap did show some topography suggestive of an overload failure.

Stress analysis

The CH601UL is designed to a limit stress of +4g and -2g so, with a normal safety factor of 1.5 incorporated, the ultimate load that the airframe can withstand would be +6g and -3g. The PFA provided the load analysis figures for the wing; one set were calculations by the aircraft manufacturer, the other set were those made by the PFA. Those calculations by the aircraft manufacturer declared either that the section being analysed was not critical or declared a margin of safety as a percentage at the ultimate load and at a higher MAUW of 480 kg. The PFA calculations were similar but declared a reserve factor, but these were for the CH600 rather than the CH601. The sections and the respective conclusions are shown in Figure 6 and Table 1.

The figure and table below reveal that the weakest point of the wing front spar is at the point at which the wing enters the fuselage, a similar position to that

Section	Aircraft Manufacturer Figures		PFA figures
	Shear	Bending	
A	Not Critical	Not Critical	N/A
B	Not Critical	Not Critical	N/A
C	Not Critical	Not Critical	N/A
D	Not Critical	Not Critical	1.7
E	11%	12%	1.6
F	Not Critical	2%	1.1

Table 1

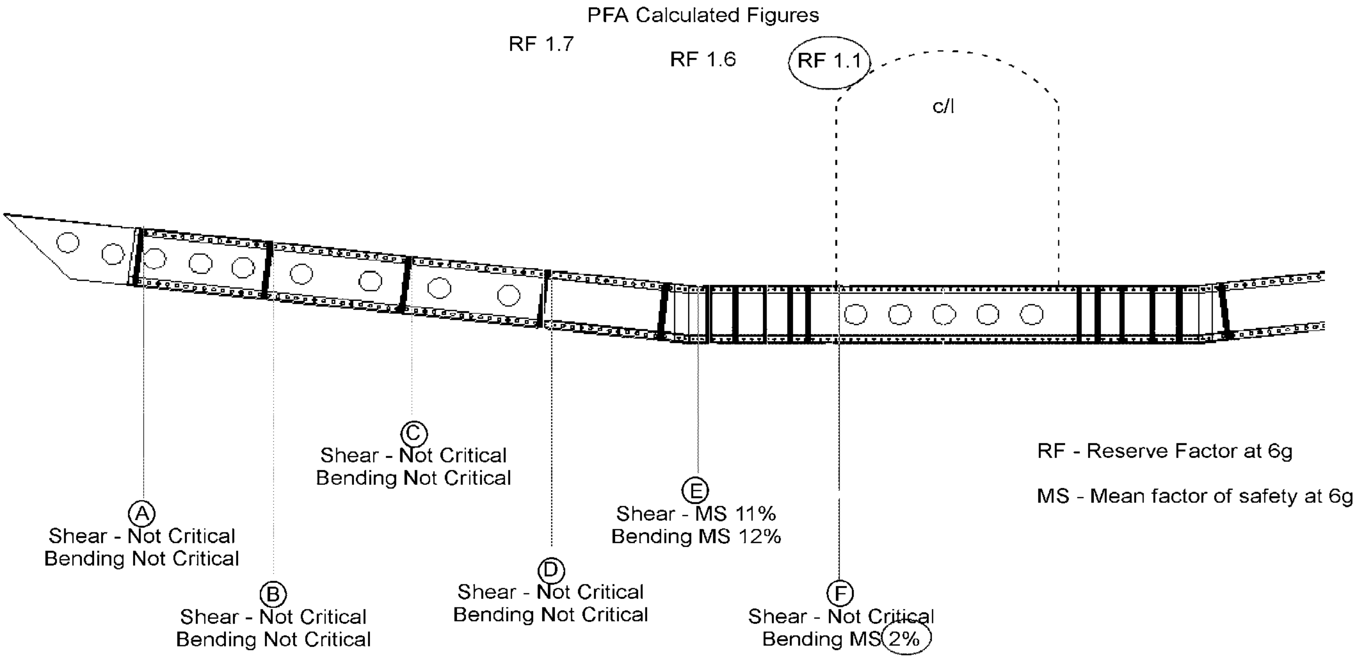

Figure 6

Aircraft manufacturer calculated figures

of the failure on G-YOXI. The aircraft manufacturer had conducted a destructive test to a similar wing on a CH600. The failure proved that the entire wing structure had a mean factor of safety of over 10% across the entire span.

Recorded information

A broken XDA II, which is a combination of a mobile phone and Personal Digital Assistant (PDA), memory card and associated Bluetooth Global Positioning System (GPS) receiver were recovered from the accident site. No useful data was recovered. Examination of radar data from Claxby radar head did not yield an aircraft track pertaining to the accident flight.

Analysis

The aircraft structure failed as a result of excess loads being applied; the breakage appears to have occurred at the most vulnerable point of the wing. The evidence is incomplete, but the aircraft was probably operating at, or close to, its weight and balance limits. The presence of the seat cushions in the wreckage suggests that they were probably in use, as required.

It could not be determined whether the structural failure was as a result of repeated overstress events, leading to a weakening of the structure, or whether a single event was responsible. In either case, the pull up at the end of the farm strip was the action that caused the eventual failure of the wing. It is not known whether the pilot pulled up as a result of seeing the wires only at the last minute, or whether he was always planning to pull up at the end of the strip.

On its approach to the strip from the south, the aircraft was seen in a steep descent prior to the low pass along the strip. This would have had two effects: firstly, the speed could have built up very rapidly, and secondly, to return to level flight for the pass along the strip, the pilot would have needed to pull up strongly, possibly applying high g forces. This manoeuvre could have resulted in a weakening of the structure.

The aircraft had been observed flying at low level on one other occasion. Although flying at low level does not necessarily impose any greater than normal forces, it may lead to manoeuvres being carried out more abruptly than usual. Such manoeuvres may impose higher stresses on the airframe. It is possible, therefore, that the aircraft had been overstressed on a number of occasions and as a result the structure had been weakened.

It is not possible to know how much knowledge the pilot had gained in the course of his training and subsequent flying regarding manoeuvering speeds and the structural strength of his aircraft. The markings on the ASI should have given an indication of the safe operating ranges but their meaning may not have been well understood by him. The aircraft had sufficient power to exceed 97 mph in level flight so it is possible that the aircraft had flown on previous occasions at a cruise speed within the amber caution range and thus above the manoeuvering speed. Any turbulence or sudden manoeuvre would then generate high stresses on the airframe. Moreover, the aircraft exhibited low stick forces when the elevators were used in flight. As a result it would be relatively easy to apply excessive loads, particularly at higher speeds. Much of the pilot's previous training experience was on a flex-wing aircraft and the higher forces involved in flying this type of aircraft may have led him to a false perception of the stick force that could safely be applied when manoeuvring G-YOXI.

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2005

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

Published February 2005.

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

Published November 2005.

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

Published December 2005.

2006

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

Published January 2006.

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

Published November 2006.

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

Published December 2006.

2007

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

Published January 2007.

2/2007 Boeing 777-236, G-YMME on departure from London Heathrow Airport on 10 June 2004.

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