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COMMERCIAL AIR TRANSPORT

(ALL TIMES IN THIS BULLETIN ARE UTC)

SERIOUS INCIDENT

Aircraft Type and Registration:	Airbus A320-232, G-EUUU
No & Type of Engines:	2 International Aero Engine V2527-A5 turbofan engines
Year of Manufacture:	2008
Date & Time (UTC):	27 March 2009 at 1520 hrs
Location:	Oslo, Norway
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 6 Passengers - 147
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	42 years
Commander's Flying Experience:	9,000 hours (of which 600 were on type) Last 90 days - 175 hours Last 28 days - 27 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further investigation by the AAIB

Synopsis

The aircraft was on final approach to land and was experiencing airframe icing. At about 1,700 ft, airframe buffet was felt which the crew thought was pre-stall buffet. The crew increased the aircraft's approach speed and the buffet reduced. It disappeared completely at 500 ft and the aircraft landed without further incident. It was probable that the buffet was due to ice accretion on the top surface of the wings and was not pre-stall buffet.

History of the flight

The aircraft was on approach to Runway 01 at Oslo but there were delays due to snow clearance operations on the runway. The crew had planned and briefed for an autoland and were using full flap (know as configuration full) and autothrust with an approach speed of 138 kt. The aircraft was vectored extensively during which ice was noticed on the icing probe. Both wing and engine anti-icing systems were selected to ON in response.

While descending through about 1,700 ft on the final approach, airframe buffet was felt which the crew assessed to be the "early stages of stall buffet". They considered going around but thought that might make the situation worse in the prevailing weather conditions. The approach speed was increased in stages to 145 kt and, although the buffet continued, it became "lighter in intensity". The buffet disappeared completely at 500 ft and the aircraft landed without further incident.

After the flight, the captain inspected the wings and saw "evidence of snow and ice in patches on the top surface and leading edges". However, in his opinion, the contamination would not have caused the aircraft to stall even though the buffet had felt like the early stages of stall buffet.

Weather conditions

The weather at Oslo was a surface wind of 050°/11 kt, visibility of 2,000 m, broken cloud at 800 ft and a temperature of -3° C. The runway headwind component was about 8 kt.

Recorded data

Data was available from the aircraft flight data recorder. During the incident, the aircraft was in configuration full and the landing gear was down. V_{LS}[1] was 128 kt and $V_{\alpha Prot}$[2] varied between 117 and 119 kt. The approach speed selected by the crew was 138 kt but this was increased progressively to 145 kt as the buffet was detected.

Analysis of the data by the manufacturer

The manufacturer analysed the flight data recorder information and stated that it:

> *'seemed to reflect the buffet, probably due to the presence of ice on the top of the wings. There was buffet but the alpha reached (up to +7°) was too far from the alpha stall to lead to stall buffet.'*

Footnote

[1] V_{LS} is the lowest selectable speed and is computed by the Flight Augmentation Computers (FACs) based on aerodynamic data.
[2] $V_{\alpha Prot}$ is a speed corresponding to an angle of attack at which the flight control system switches to a low speed protection mode.

Wing anti-icing

In flight, selecting the wing anti-ice system to ON opens a valve in each wing so that hot air from the pneumatic system heats the three outboard slats of each wing. There is no direct heating of the rest of the wing surfaces.

Guidance from the manufacturer on flying in icing conditions

The Flight Crew Operating Manual (FCOM) Part 3 has a section on ice protection. It states:

> *'If there is evidence of significant ice accretion, and to take account of ice formation on non-heated structure, the minimum speed should be, in configuration full, V_{LS} + 5 kt.'*

Calculation of approach speed (V_{APP})

For an approach using autothrust, the Flight Management and Guidance Computer (FMGC) computes V_{APP} as V_{LS} plus the higher of 5 kt or one third of the headwind component on landing. The crew can modify the figure in the FMGS (Flight Management Guidance System) to take account of conditions on the day. In addition, the crew may manually select the speed to be flown by the autothrust system.

The wind conditions reported at Oslo meant that the FMGS would have calculated the approach speed as V_{LS} (128 kt) plus 5 kt giving a V_{APP} of 133 kt.

Analysis

V_{APP}, at 133 kt, effectively included the 5 kt increment recommended in the FCOM for flight with ice formation on non-heated parts of the aircraft. The crew's manual selection of an approach speed of 138 kt, prior to the onset of buffet, gave an additional margin above V_{APP}. During the buffet, the aircraft speed was further increased from

138 to 145 kt during which time $V_{\alpha Prot}$ remained below 120 kt and the angle of attack remained below 7°. At no time did the low speed protection features of the aircraft become active.

It is probable that the buffet experienced was due to ice accretion on the top surface of the wings, as suggested by the manufacturer, and was not pre-stall buffet.

ACCIDENT

Aircraft Type and Registration:	Airbus A320 -233, HA-LPJ
No & Type of Engines:	2 IAE V2500-A1 turbofan engines
Year of Manufacture:	2007
Date & Time (UTC):	12 March 2009 at 0902 hrs
Location:	Stand 40, London Luton Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 6 Passengers - 136
Injuries:	Crew - None Passengers - None
Nature of Damage:	Nosewheel and damage to engine cowling
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	35 years
Commander's Flying Experience:	5,447 hours (of which 2,952 were on type) Last 90 days - 198 hours Last 28 days - 64 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

While the aircraft was being pulled forward by the tug after a misaligned pushback, both the towbar's shear pins failed and the aircraft became detached from the tug. The aircraft continued to roll forwards and collided with the tug causing damage to both. Neither ground crew was injured.

Background information

The towbar in this incident had a wheeled undercarriage to support it while being moved un-laden. The undercarriage was adjusted hydraulically through the range of heights necessary to facilitate connecting to, and towing, aircraft. It had two shear pins to provide torque and axial overload protection for the aircraft's nose gear that connects the towbar head to the towbar.

Approximately eight months before this incident, the towbar had two bricks attached to one side to help level the undercarriage when it was raised. After this incident it was discovered that the level imbalance was because one of the undercarriage's tyres was pneumatic and one was solid. The valve in the hydraulic pump, which holds up the undercarriage, was also found to be leaking.

Stand 40 at London Luton Airport has a descending gradient of between 1% and 1.5% to the east.

History of the flight

HA-LPJ was cleared to pushback from Stand 40 on the north apron at London Luton Airport, to face east. This meant it would initially be pushed back in a northerly direction before being turned west up the slope. In attendance were a tug driver and a headset operator. The towbar and tug were already connected to the aircraft when the tug driver arrived for the pushback. The headset operator was informed by the aircraft commander that they were cleared to commence the pushback. The headset operator then instructed the commander to release the aircraft's brakes and informed him he was cleared to start both engines; the pushback was then commenced.

The aircraft had been pushed back clear of the roadway, at the rear of the stand, when the manoeuvre was halted by the tug driver because the towbar's undercarriage had started to lower. The tug driver signaled to the headset operator to raise the undercarriage which he did. The pushback was restarted and the aircraft was pushed back and turned up the slope. The tug driver, believing the aircraft would not end up aligned with the taxiway centreline, decided to reposition the aircraft. He planned to do this initially by towing the aircraft forward towards the stand. During this manoeuvre both the shear pin and axial pin on the towbar failed, resulting in the towbar detaching from the aircraft. The tug driver stopped the tug and signaled to the headset operator to instruct the commander to set the aircraft's parking brake. At this point the aircraft, with both engines at idle power, began to move towards the tug. Anticipating a collision, the tug driver vacated the tug and ran clear two seconds before the aircraft's right engine collided with the tug cabin. The flight crew had been unable to see events developing on the ground because the aircraft's structure had obscured their view.

As a result of the collision the tug sustained substantial damage to its cabin and the aircraft sustained damage to its nosewheel tyre and the right engine inlet cowl and fan blades. The ground crew were uninjured.

CCTV captured the event on two separate cameras from different angles. It showed that just prior to the tug pulling the aircraft forward, the towbar and the tug were at a large acute angle. After the incident the aircraft's nosewheel was found having turned though nearly 90 degrees to the right. The towbar head was still attached to the nosewheel.

Commander's comments

The commander stated that after both engines had been started during the pushback the aircraft was pulled forward for what he believed to correct the pushback track. A few seconds later, the headset operator said "looks like we have a problem with the towbar" and then shouted "set your brakes." The aircraft started to shake as the commander "jumped" onto the brakes and stopped the aircraft. He was then informed by the headset operator and the cabin crew that the aircraft had collided with the tug.

Handling agent's comments

The handling agent commented that the maximum allowable nosewheel angle during a pushback for an A320 was 90° as indicated on the nosewheel door and stated in the aircraft manufacturer's ground handling manual. However, they would normally push at angles of between 45° and 60° at Luton Airport. At other airports however, aircraft are regularly pushed back using the maximum angle of 90°. They added that there were no markings on this aircraft to indicate this maximum angle (although there are on other aircraft) and there was no maximum angle stated in the aircraft operator's ground operations manual.

During rectification of the towbar's undercarriage hydraulic pump, it was discovered that the 'up, down and hold' valve was leaking in the hold position which allowed the undercarriage to creep down very slowly.

The handling agent also added that both pins had been replaced three weeks prior to the incident.

Towbar manufacturer's comments

A representative of the towbar manufacturer viewed the CCTV footage and inspected the towbar head. He commented that it is very unusual for both pins to fail. On inspection of the towbar head, he noted that the outer turn bush was sitting approximately 4 mm proud of the shear face because of apparent damage to the towhead. He added that this damage appeared to be pre-incident because of the lubrication and colour of the bush.

He also added that the pushback angle was close to the 90° limit and he believed that "due to the bush being out of position it would have acted as the shear pin, rather than the actual shear pin…this could explain how the tug was able to get such an acute angle without the shear pin breaking".

Discussion

Prior to the pins failing, the towbar's undercarriage unintentionally lowered, causing the pushback to be stopped so that it could be raised. This may have distracted the tug driver, which could have led to him pushing the aircraft off the ideal track.

The tug driver was in the process of re-positioning the aircraft when the torque pin and axial pin on the towbar failed, leaving the head unit attached to the nose gear of the aircraft. A combination of the towing angle, the gradient of the taxiway, the aircraft's thrust and the incorrectly seated bush resulted in an abnormal load being transmitted through the towbar, causing both pins to fail.

Had only one pin failed, the tug and aircraft would have remained attached and the incident would not have happened.

Safety actions

Although not a London Luton Airport requirement, the handling agent has amended its procedure for pushbacks on the north apron and will not permit aircraft to start engines until aircraft are positioned on the taxiway centreline.

As a result of the condition of the towbar and its prolonged usage with the bricks attached, the handling agent issued the following notice to all of its UK bases:

> *'[Handling agent's] WORK EQUIPMENT*
>
> *All staff must ensure that <u>all</u> work equipment is inspected before use, and any defects reported.*
>
> *Temporary repairs will only be carried by Fleet Maintenance or the relevant Service Engineer.*
>
> *Modifications can only be made with the authorisation of the Fleet Maintenance General Manager.'*

SERIOUS INCIDENT

Aircraft Type and Registration:	Boeing 737-33A, G-CELD
No & Type of Engines:	2 CFM56-3B1 turbofan engines
Year of Manufacture:	1987
Date & Time (UTC):	21 February 2009 at 1401 hrs
Location:	Runway 32, Leeds Bradford Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 5 Passengers - 115
Injuries:	Crew - None Passengers - None
Nature of Damage:	Right engine cowling
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	54 years
Commander's Flying Experience:	11,030 hours (of which 5,280 were on type) Last 90 days - 83 hours Last 28 days - 33 hours
Information Source:	AAIB Field Investigation

Synopsis

While landing on Runway 32 at Leeds Bradford Airport, G-CELD encountered windshear at about 30 ft agl and became unstable in the flare. As a result, and unbeknown to the crew at the time, the right engine nacelle contacted the runway. Inspection of the runway revealed a 15 m scrape mark on the threshold, with associated paint matching G-CELD's engine cowling.

History of the flight

G-CELD was flying a scheduled service from Paris Charles de Gaulle Airport to Leeds Bradford Airport (LBA). After an uneventful flight, it was positioned for an ILS approach to Runway 32. V_{REF} for the approach was 128 kt, but due to the wind a V_{APP} of 140 kt was bugged. During the approach the wind was observed as strong, gusty and largely across the runway from the left; however, the IAS was stable until approximately 100 ft agl. The co-pilot was the pilot flying for the sector and the runway was dry.

As the aircraft approached the flare, at about 30 ft agl, a speed loss of 10 kt occurred. The commander called "speed slow" and placed his hand near the throttles, with the co-pilot applying a small amount of power. The commander then felt the aircraft sink so applied a "handful of power" covering the co-pilot's hands as he did so, adding "you'll need more than that". At some point after this, the co-pilot thought he heard the commander say "I have control" to which he responded by taking his hands off the controls in accordance with the company SOP's. The co-pilot added that his "feet remained on the rudder pedals as there was no time to remove them". Both pilots then recalled a pronounced wing drop to the right, immediately prior to the aircraft touching down.

The commander informed ATC of the windshear as the aircraft taxied to stand. After the aircraft was shut down and the passengers disembarked the commander discovered damage to the right hand engine nacelle and informed ATC. A runway inspection revealed a 15 m scrape mark on the Runway 32 threshold, with associated paint matching G-CELD.

Another company aircraft commenced an approach five minutes later. The crew were warned by ATC of the potential for low level windshear and planned the approach accordingly. They too X experienced a stable approach initially but found the speed difficult to control below 100 ft agl.

Meteorological information

The following METARs were recorded at LBA:

211420Z 27023KT 9999 SCT015 06/04 Q1028=
211350Z 27030G40KT 9999 SCT009 07/03 Q1028=
211320Z 27032G42KT 9999 FEW007 SCT013 06/03 Q1028=

An aftercast was obtained from the Met Office. It stated that it was likely that there was no abnormal wind flow regime although the wind was strong and undoubtedly gusty. The gustiness was not abnormal, but reductions in speed of 10 to 15 kt over a short period of time/distance were likely. There was no indication of rotor streaming. Turbulence due to upwind buildings could not be determined, but this was not considered significant.

The aircraft's Flight Data Recorder (FDR) equipment recorded a wind of 271º/28 to 38 kt during the final stages of the approach. This gave a crosswind component of 23 to 30 kt from the left.

UK Integrated Aeronautical Information Package (UK IAIP)

The following is taken from the LBA section of the UK IAIP titled Local Traffic Regulations:

> ***'4 Warnings***
>
> *b Pilots are advised to expect windshear and turbulence when the surface wind is between 190° and 280° above 20 kt. Some variations to reported wind readings may also occur.'*

Crew's comments

The crew recalled a relatively smooth approach, with a pronounced crosswind, flown 12 kt above V_{REF} to allow for the gusty conditions. They added that the wind strength and direction was not unusual for LBA.

Although the co-pilot believed he heard the commander say "I have control" in the flare, the commander recalled saying this during the landing roll.

Recorded data

The aircraft was fitted with a Flight Data Recorder (FDR) and Cockpit Voice Recorder (CVR) which were removed from the aircraft and taken to the AAIB for downloading. The aircraft was also fitted with a Wireless Quick Access Recorder which was downloaded by the operator but subsequently found to have failed to record.

The duration of the CVR was 30 minutes and the period covering the incident landing had been overwritten. Data for the landing was available from the FDR, and a number of salient parameters for the landing, some of which are presented at Figure 1, were analysed. However, rudder pedal angle and rudder deflection parameters were not recorded. Rudder pedal was originally recorded on the FDR but subsequently removed during a modification to make space for right- flap position. This modification was deemed acceptable by the CAA as the regulations applicable to this aircraft only required primary flight controls to be recorded "when sufficient capacity is available" on the flight recorder system. The CAA is now recommending to the operator to re-instate the rudder position input as they believe this to be a more important parameter to record than right-flap position given the documented history of Boeing 737 rudder system problems, and the fact that left-flap position is recorded.

Figure 1 starts with the aircraft established slightly low on the ILS to Runway 32 and with the autopilot disconnected. The aircraft continued on or below the glideslope, wings level and decelerating, until 50 ft agl, when it started to roll left wing down (see Point A), reaching 12º three seconds later as the aircraft passed through 20 ft agl. The airspeed reached 124 kt as opposite control wheel was applied (Point B) and thrust was applied (point C). The thrust levels increased from a nominal 55% N_1 to 80% N_1 causing the aircraft to pitch up (Point D) and accelerate. However, as the aircraft responded in roll it also started to yaw to the right (Point E).

As the aircraft's left-roll attitude reduced and passed through wings level, the pitch attitude and thrust were reduced but the aircraft continued to roll and yaw to the right until the point of touchdown. The maximum roll and yaw rates recorded were 13º/second and 8º/second respectively. The aircraft touched down with approximately 12º of right bank and just under 0.2º of nose-down pitch, at about 145 kt computed airspeed, just as some left-hand control wheel was being applied.

Figure 2, taken from the Boeing 737 (B737) Crew Training Manual, illustrates body angles required on landing to contact various parts of the airframe. When the parameters recorded by FDR above are plotted, a probable nacelle impact is indicated (arrowed).

Boeing 737 handling characteristics

The B737, in common with similarly configured passenger aircraft, displays a marked tendency to roll when large yaw rates are induced. This results from the forward moving wing generating more lift than the other, therefore causing the aircraft to roll in the same direction as the yaw. Because of the positioning of the B737 engines relative to the wing, the application and reduction of power can have a pronounced effect upon the aircraft's pitch attitude.

The operator's crosswind limit for landing on a dry runway is 35 kt.

Analysis

In the final part of the approach, a significant amount of thrust was applied to counter the speed reduction induced by the wind. This resulted in the aircraft pitching up initially and when the thrust was rapidly reduced, the pitch attitude reduced, leading to some pitch instability.

The aircraft had maintained 8-10º of starboard drift during the approach and this drift was 'kicked off' in the flare to align the aircraft with the centreline; this induced a right roll. The FDR recorded that this roll was not anticipated with an opposite aileron input. As a result, this roll, induced by the yaw, caused the aircraft to achieve sufficient right bank for the nacelle to strike the ground. Confusion as to which pilot had control,

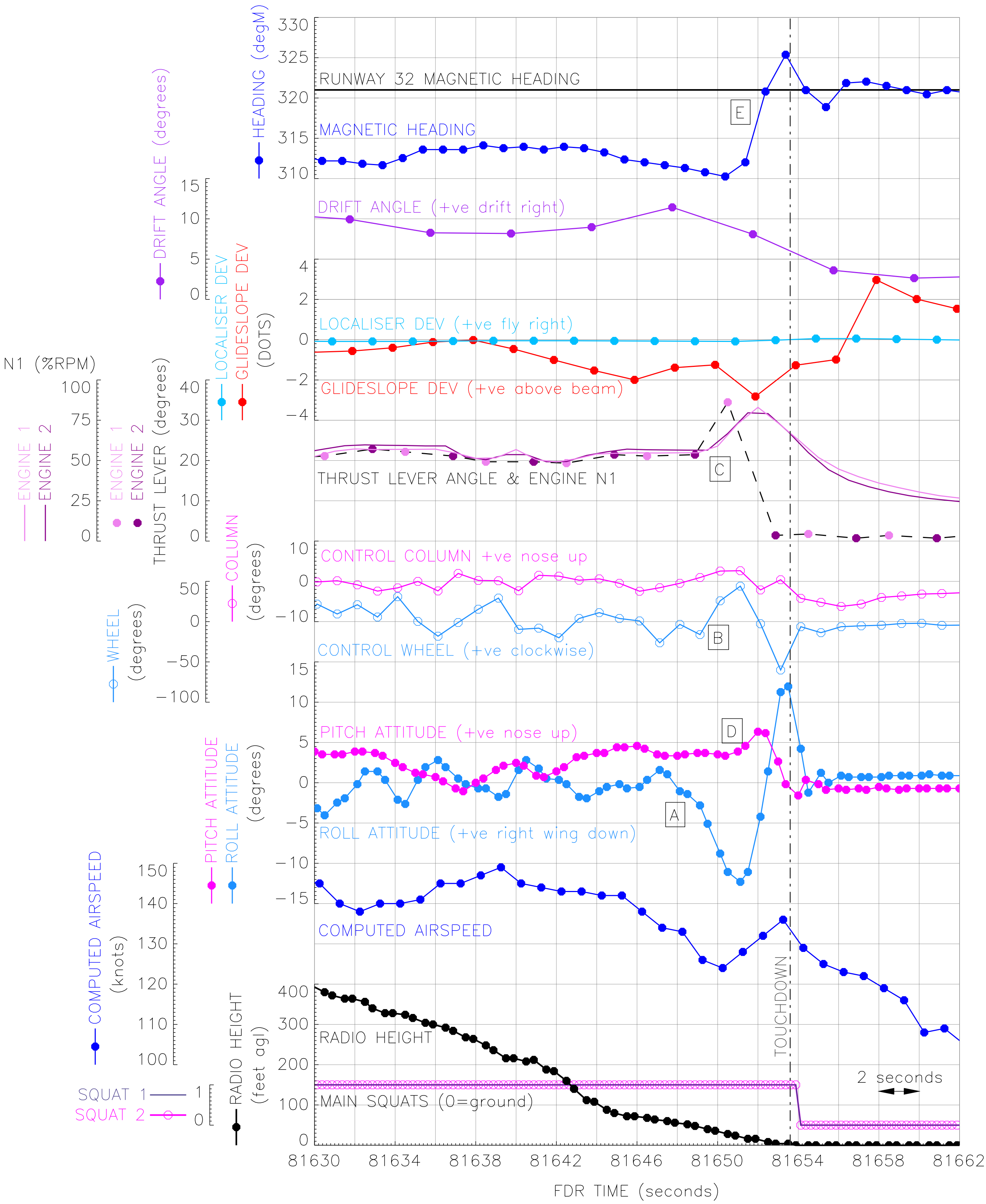

Figure1

Salient FDR Parameters for Incident Landing to G-CELD

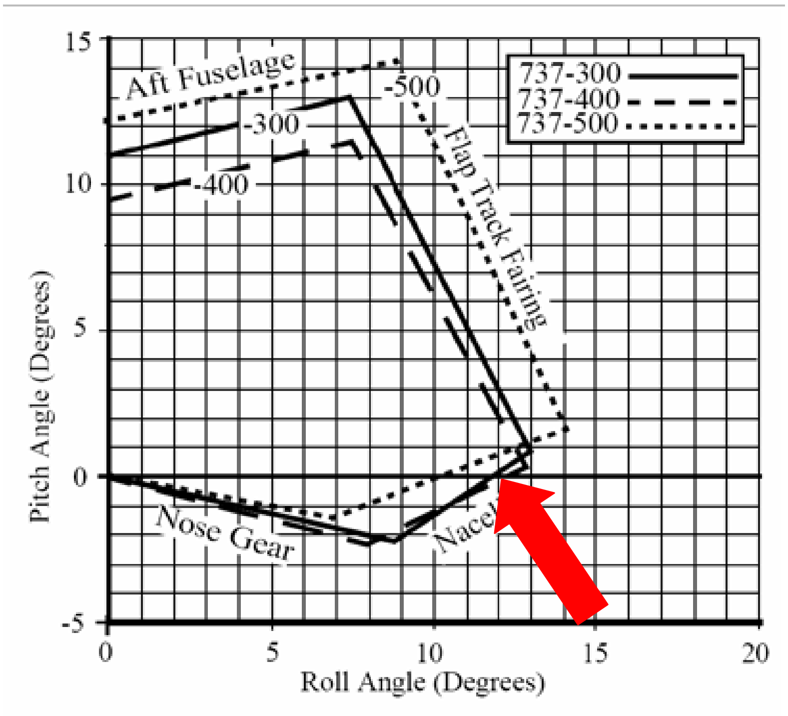

Figure 2

combined with encountering significant windshear, will contributed to the control instability at this critical time.

Safety action

As a result of this incident the crew received additional training on crosswind landings in a simulator and the operator issued an Operating Staff Instruction highlighting the need for a formal handover of control and acknowledgement from the other pilot. The instruction also added that, in normal circumstances, it is not appropriate for the PNF to make flying control or throttle inputs without a request from the PF.

INCIDENT

Aircraft Type and Registration:	Boeing 767-324, G-OOBL
No & Type of Engines:	2 General Electric CF6-80C2B7F turbofan engines
Year of Manufacture:	1995
Date & Time (UTC):	9 May 2008 at 1230 hrs
Location:	Manchester Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 11 Passengers - N/K
Injuries:	Crew - None Passengers - None
Nature of Damage:	Potable water system air compressor destroyed
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	N/K
Commander's Flying Experience:	15,780 hours (of which 8,000 were on type) Last 90 days - 85 hours Last 28 days - 0 hours
Information Source:	AAIB Field Investigation

Synopsis

During pre-startup checks, a burning smell was identified in the rear of the aircraft cabin. The commander investigated and decided to disembark the passengers. During the disembarkation it was reported that the aircraft was "on fire". The commander made a MAYDAY call to ATC, switched off all aircraft power and exited the aircraft.

Examination revealed that the 'unloader check valve' (a non-return valve between the potable water tank and the potable water air compressor) had failed and this allowed moisture or liquid into the air compressor which, in turn, caused the air compressor to lock up. The thermal cut-out switch, associated with the electric motor that powered the potable water air compressor, had cycled until it eventually became welded, or fused, in the ON position allowing a constant supply of electrical power to the compressors' motor, causing it to overheat severely.

History of the flight

During the flight crew's pre-flight checks the commander was informed by the In-Flight Supervisor (IFS) that there was a burning smell in the rear of the aircraft. He went to investigate, confirmed the smell, and decided to disembark the passengers. With three passengers still on the aircraft, an engineer ran to the cockpit from the rear of the aircraft and told the commander that the aircraft was "on fire" and to "kill" the power. The commander made a MAYDAY call to ATC, switched off all electrical power and left the aircraft via the normal exit.

Engineering examination

Examination of the aircraft revealed that the three-phase electric motor that drives the air compressor (part number 60B50012-9), which pressurizes the aircraft's potable water tank, had severely overheated. This unit is mounted under the rear cabin floor area. The 15 amp circuit breakers for the potable water air compressor, which are located in the E&E bay, had not 'tripped'. Following replacement of the water air compressor it was found that the 'unloader check valve' (a non-return valve - part number CV99-191) was leaking and required replacing.

Potable water pressurization system

The primary pressurization for the aircraft potable water system is provided by a self-contained 0.5 horsepower, three-phase, 400 Hz, 115/120 volt ac motor driving a double-bellows reciprocating pump. This supplies clean air at pressures up to 40 psi to the water tank. The motor 'start' current is approximately 11.5 amps and the 'run' current is about 7.5 amps. A thermal protection switch is fitted inside the motor and, at 11.5 amps, will trip at about 200°F. With no current it will trip at about 600°F. Once the thermal protection has 'tripped', it will automatically reset after approximately 1.5 seconds.

The operation of the air compressor is controlled by a pressure switch connected to the compressed air input line to the potable water tank. When the water tank air pressure reaches approximately 40 psig, the switch shuts off the electrical power to the compressor. When the tank pressure falls to below approximately 30 psig (gauge), the switch allows power to the compressor. The 'unloader check valve' is fitted between the compressor and the water tank to maintain the air pressure in the tank. It also prevents water from the tank going to the compressor. The unloader check valve is maintained on an 'on-condition' basis (that is, to replace the valve only after it has failed). A secondary water tank pressurization system is provided by the engine air bleeds, APU or ground support equipment.

Examination of the potable water air compressor

A strip examination was carried out on the potable water air compressor. Externally, the electric motor casing showed evidence of having experienced a high degree of overheating. The coating of protective paint had discoloured to a dark colour consistent with exposure to a temperature of at least 125°C. It was observed that the internal core of the motor had been exposed to significant heat which had removed the rotor from its core. Examination of the current-sensing overheat switch revealed that one of the three sets (three-phase switch) of electrical contact points had become welded, or fused, together.

Other information

The potable water air compressor (part number 60B50012-9) is fitted to Boeing 777, 767 and 737NG aircraft. The unloader check valve (part number CV99-191) is fitted to Boeing 767, 747-400 and 737NG aircraft. Unloader check valve part number CV99-191 was superseded by part number CV99-237 on the aircraft production line and subsequently on an attrition basis. On Boeing 777 aircraft, however, this check valve has been superseded by another part number (CV020T3E*3 in SB 777-38-0032) and, on B777 aircraft from production line position 586, the potable water pressurisation system has been replaced by a water pump.

The manufacturer of the air compressor (part number 60B50012-9) stated that they had seen in excess of

200 units where the electric motors had failed due to overheat as the result of moisture ingress into the compressor bellows.

The aircraft manufacturer stated that three flight diversions had resulted from smoke/fumes in the cabin generated by the electric motor of this potable water air compressor.

Service Bulletins and Service Letters

In February 2007, the aircraft manufacturer issued Service Letters (SLs) informing operators of a preferred unloader check valve used in the potable water system water pressurization line for Boeing 777, 767, 747-400 and 737NG aircraft. The SLs also informed operators of the elimination of the unloader check valve on B777 aircraft.

Following problems with the original unloader check valve, the manufacturer revised B747-400, B767, and B777 potable water system designs to specify installation of check valve, part number CV99-191, in place of the original valve. The replacement check valve was installed on all new production aircraft.

Some B767 and B777 aircraft operators reported problems with the potable water system air compressor (part number 60B50012-9). Examination showed that the compressor bellows had been contaminated with water. The aircraft manufacturer performed tests on a B777 aircraft with the unloader check valve removed, to determine whether water could be forced into the compressor during the potable water tank refill operation. These tests showed that water could leak into the compressor bellows. Further investigation revealed that the unloader check valve poppet could deteriorate, causing the check valve to remain in the open position.

The manufacturer revised the B777 aircraft potable water system design to specify installation of unloader check valve part number CV99-237. On B767 aircraft, this check valve was an option. On B747-400 aircraft, this check valve was added as a preferred option.

However, following a number of in-service failures of the later unloader check valve, part number CV99-237 on the B777 aircraft the manufacturer went back to installation of the earlier valve, part number CV99-191. On B767 aircraft, check valve part number CV99-237 was removed as an option and, on B747-400 aircraft, part number CV99-191 was added as the preferred option.

Revisions for B777 aircraft

As noted above, following service difficulties reported by operators, on B777 aircraft from production line position 586 the potable pressurization system was replaced with a pump system. This change eliminated the unloader check valve. On aircraft delivered prior to production line position 586, Service Bulletin 777-38-0032 provided instructions to replace the unloader check valve and made a number of other improvements. These included reducing the system operating pressure range to 30-40 psig and changing the compressor circuit breaker from 7.5 to 5 amps.

These changes have, so far, only been introduced for the B777 aircraft. The following Safety Recommendation is therefore made for the 767 aircraft:

Safety Recommendation 2009-090

It is recommended that the Federal Aviation Administration (FAA) review the continued airworthiness of the potable water air compressor system fitted to Boeing 767 aircraft, to ensure that the compressor's electric motor does not overheat, causing the generation of acrid fumes and creating a fire hazard.

SERIOUS INCIDENT

Aircraft Type and Registration:	Jetstream 4102, G-MAJV
No & Type of Engines:	2 Honeywell TPE331-14GR-901H turboprop engines
Year of Manufacture:	1995
Date & Time (UTC):	9 April 2008 at 0804 hrs
Location:	Climbing through FL90 north-west of Aberdeen
Type of Flight:	Non-scheduled Commercial Air Transport (Passenger)
Persons on Board:	Crew - 3 Passengers - 10
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	63 years
Commander's Flying Experience:	12,000 hours (of which 4,000 were on type) Last 90 days - 60 hours Last 28 days - 28 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft departed Aberdeen in snow and freezing conditions, but had not been de-iced and anti-iced appropriately. During the climb the elevator became jammed by ice. The crew used changes in power and higher forces on the elevator controls to gain sufficient control to descend into warmer air, where the ice melted. Two Safety Recommendations are made. The investigation also identified that the commander's fitness to fly, coupled with pressures he may have felt to operate the flight, may have been contributory factors in the incident.

History of the flight

The crew of two pilots and one cabin crew member reported for a planned 0645 hrs departure from Aberdeen to Vagar in the Faroe Islands. The operator had categorised Vagar airport as category 'C', meaning that special training was required for pilots to operate there. The commander, who worked on a freelance basis for the operator, had been engaged specifically to operate the flight as no other captain was available to do it at Aberdeen. He had travelled to Aberdeen the previous afternoon and spent the night in a local hotel.

The commander was recovering from a bad cold and reported that he had not slept "that well". Before the duty started, he discussed his fitness to fly with the co-pilot, saying he felt well enough to operate but that he would monitor his own performance as the duty went on. He had taken a soluble Aspirin the night before. The co-pilot reported that he was fully fit and had slept well.

The flight crew examined the weather and NOTAM information and planned the day's flying. The commander was to be pilot flying for the first sector. The weather in Aberdeen was inclement, with snow falling and lying on the ground in a temperature of 0°C. The aircraft was parked on a remote stand. He was aware that "there were clearly delays" over de-icing and ramp handling and called the company's operations staff to inform them that the flight would not depart on time. The commander recalled that the general situation regarding de-icing and despatch of aircraft was somewhat "chaotic". The flight crew decided to arrange to have the aircraft de-iced before departure, and the co-pilot spoke to the ground staff to arrange this.

The crew walked to the aircraft, where the commander carried out the walk-round inspection. He noted that "although there were some contaminants on the airframe, they were loose" and that he "could not see any sign of ice". Despite this, it was still the commander's intention that the aircraft should be de-iced before departure. He described that "it took some considerable time" for the aircraft to be fuelled and then moved to a suitable stand for loading. Both pilots were aware that de-icing and anti-icing of other aircraft was taking place, and appropriate equipment and personnel were at work, and would in due course be available to them. Their perception was that waiting for de-icing would incur a delay, and they communicated this to the company's operations staff. The airport's records showed extensive delays to departing flights.

Once the aircraft had been re-positioned, the commander carried out another walk-round. He decided that the aircraft "probably did not require fluid de-icing, and that the contaminants could be swept off". He instructed the ground crew to do this.

The commander joined the co-pilot on board the aircraft which was loaded with 10 passengers, 16 bags, and 53 kg of freight. The departure fuel was 2,370 kg, and the takeoff weight was 10,310 kg. The centre of gravity was calculated to be within the envelope and towards the aft end.

While the aircraft was being loaded, two members of the engineering company's ground staff arrived at the aircraft and began sweeping the snow from the wing surfaces. The flight crew continued preparing for flight, also observing the sweeping taking place. In due course, one of the ground staff stood in front of the aircraft and gave a 'thumbs up' signal to the commander. The commander stated that at this time he "was happy that the wings were clear" and that he "clearly made the assumption that they had done the tail section". Following this incident, the commander had no particular recollection as to how he came to this assumption.

The flight crew started the engines, powered back, and taxied for departure. Throughout this time, light snow was falling, and the RVR was varying between 1,100 and 1,400 metres; the temperature was still 0°C. The co-pilot noticed that there was light contamination of snow flakes on the wings. During taxi, the flight crew checked the flying controls "a number of times"; on one occasion the co-pilot remarked to the commander that he thought the controls felt a little heavier than usual. The commander then exercised the elevators and concluded that they felt "normal". As the aircraft lined up for takeoff, a further control check was carried out.

The aircraft took off uneventfully, and climbed into cloud at about 200 ft aal. Soon after takeoff the co-pilot looked at the wing on his side and saw that it was "completely clear". The commander reported that the rotation and handling in the climb "seemed to be normal". However, he delayed engaging the autopilot for a time, to ensure that the handling was normal.

The co-pilot established contact with Scottish Control and the aircraft was cleared to climb to FL240. The commander engaged the autopilot in IAS mode at a commanded speed of about 170 kt, with the engines at climb power. He recalled later that the conditions were light precipitation in IMC, with light rime ice building up on the airframe.

The flight crew recalled that, as the aircraft passed about FL90, the autopilot pitch trim warning activated. The commander disengaged the autopilot and found that the elevators were immovable, while the ailerons seemed normal, and he sensed that the rudder was also free. He informed the co-pilot of the problem, and handed control to him to assess whether his controls were similarly affected. The aircraft continued climbing and at about FL100 the aircraft climbed out of IMC and into blue sky. The commander reported that he was "now certainly quite concerned", and informed the co-pilot that he thought they should declare a MAYDAY and divert. He was mindful to avoid flying into IMC again and aware that the additional fuel load offered the opportunity to fly for some time to find a safe destination.

The commander made a MAYDAY call to ATC, stating that he had problems with the elevator controls and that he did not have full control of the aircraft in pitch. He informed the cabin crew member of the difficulty and instructed her to prepare for an emergency landing. Although the company's operations manual specified that the NITS[1] format should be used when communicating emergency landing instructions to cabin crew, the commander did not use the format. The cabin crew member did not read back the instructions and prepared for a normal landing. The co-pilot made an announcement informing the passengers of the circumstances.

Controllers at the Scottish Area Control Centre informed the Distress and Diversion Cell and the Rescue Co-ordination Centre at RAF Kinloss. Two RAF Tornado aircraft were tasked to intercept the aircraft, and flew to take position approximately half a mile astern of it. A Search and Rescue helicopter was also tasked in case an accident ensued.

The flight crew saw that the weather ahead of the aircraft and towards Wick looked clearer than that behind them. After consulting with the co-pilot, the commander decided to divert to Wick and to descend the aircraft into warmer air, maintaining VMC, in the hope that the controls would free. Both pilots applied strong forces to the control columns and stated afterwards that they felt that there may have been a small amount of movement in the elevator control. With both pilots forcing the controls forward, and with changes in power, they gained some control of the aircraft in pitch, and following a series of pitching oscillations, the aircraft began to descend. The commander also experimented with using elevator trim to control the aircraft but concluded that, although the trim system seemed to operate correctly, its operation had no apparent effect on the aircraft's pitch attitude.

Still maintaining VMC, the flight crew prepared for an arrival at Wick. During the descent, they continued to

Footnote

[1] NITS: Nature of the problem, Intentions, Time before landing, Special instructions.

apply force to the control columns in pitch and at about 4,000 ft amsl the controls suddenly became free and control was regained. The commander then carried out a precautionary and deliberate "handling check" to establish that the aircraft was fully under control.

During the approach the flaps were set, in stages, to FLAP 25. However, to avoid possible control difficulties during the landing, the flaps were then retracted to FLAP 15, and the aircraft landed without difficulty and taxied in to park.

As the aircraft landed, eyewitnesses saw material fall from the tail of the aircraft. Subsequent inspection of the runway revealed large fragments of ice laterally across the runway at the point of touchdown, in a path between four and six metres wide[2]. One eyewitness stated that, after landing, the aircraft's wings were clear of contaminant, but "the top of the fuselage had a coating of ice on it". As the engines were shut down, ice was blown from the tailplane. Personnel who inspected the tailplane from a step ladder after shutdown noted that ice was present in the elevator hinges and that when the elevators were exercised, more ice fell.

Meteorological information

Three METARs showing the conditions at Aberdeen before the aircraft's departure are reproduced below:

EGPD 090650Z 06003KT 1500 R34/1200 +SN OVC015 00/M01 Q0996 TEMPO 4000 –RASN=
EGPD 090720Z VRB02KT 1600 R34/1100 SN OVC012 00/M00 Q0996 TEMPO 4000 –RASN=
EGPD 090750Z 00000KT 1600 R34/1100 SN BKN006 OVC010 00/M00 Q0996 TEMPO 4000 –RASN=

These METARs described cold and snowy conditions, with light winds, visibility around 1,550 m, a runway visual range of around 1,150 m in snow or heavy snow, low overcast cloud, and a temperature on the ground of 0°C.

Aircraft description

The Jetstream 41 is a low-wing twin-turboprop aircraft of conventional construction. It has a cruciform tail with the horizontal tail set 3.8 metres above the ground. Some of the upper wing surface is visible from the flight deck, but the upper surface of the horizontal tail cannot be seen. During ground servicing, the top of the horizontal tail can only be seen or accessed by means of a 'cherry picker' or similar equipment. The wing is sufficiently low to the ground that it can be viewed by personnel standing next to it and swept without special access equipment.

The Jetstream 41 is equipped with de-icing and anti-icing systems. The de-icing system comprises pneumatic rubber boots on the leading edges of the wings, tailplane and fin. Anti-icing is provided by electrically operated heater mats on the elevator horn, electrically-heated air data system sensors, windscreen heaters, washers and wipers, together with engine anti-icing using engine bleed air, and electrically operated heating mats on the propeller.

The pitch control system connects the two control columns via pushrods, cables and the elevator final drive quadrant to the elevator surface. The left and right elevator systems can be split by means of a disconnect control that allows each side of the system to move independently. Operation of the disconnect disengages a clutch in a torque shaft that connects the two control columns; this cannot be re-engaged in flight.

Footnote

[2] The Jetstream 41 horizontal tailplane is 6.7 metres wide.

The wing has trailing edge flaps with four positions: UP; FLAP 9; FLAP 15; and FLAP 25.

Aircraft examination

The aircraft was examined by the AAIB at Wick the day after the incident. The examination showed no defects in the de-icing or anti-icing systems.

The pitch control system was inspected in accordance with the maintenance manual and no anomalies were found; the disconnect control had not been operated. The pitch trim system was also checked and found to be working correctly.

Previous incidents have been reported where both the elevator manual trim wheel and the condition lever friction wheel had jammed and were immovable. The condition lever friction wheel, which rotates about a common shaft with the elevator manual trim wheel, can make contact with the trim wheel if a circlip, designed to prevent axial movement of the trim wheel along the shaft, becomes displaced. When the condition lever friction was tightened on G-MAJV, the elevator trim wheel remained free to move, indicating that the circlip was correctly positioned.

Another possible explanation for the loss of pitch control was that repetitive application of thickened de-icing fluids could have led to a buildup of residues in aerodynamically 'quiet' areas such as wing and stabiliser trailing edges and rear spars. This residue can re-hydrate, and increase in volume to many times its original size during flight and freeze under conditions of cold temperatures, high humidity and/or rain, causing moving parts such as elevators, ailerons, and flap actuating mechanisms to stiffen or jam in flight. There was no evidence of any 'gel' residues around the elevator. Water was sprayed on the surface in order to re-hydrate any dried residues which may have been present but none was apparent.

The aircraft was returned to service and no further control difficulties were reported.

Recorded information

The aircraft was fitted with a solid state Flight Data Recorder (FDR) and solid state Cockpit Voice Recorder (CVR). Both recorders were removed from the aircraft and downloaded at the AAIB. The CVR contained a 30-minute four-channel recording which captured the last 15 minutes of the flight plus a further 15 minutes on the ground in Wick. The FDR contained just over 57 hours of operation including the incident flight, which lasted around 29 minutes.

The FDR commenced recording the flight from Aberdeen just after the left engine was started. Recorded Total Air Temperature (TAT)[3] was 0°C. During taxi to the runway a 'full and free' check of all flight control surfaces was performed, including the elevator which deflected to 25.8° (elevator up) and -16.6° (elevator down)[4]. Analysis of previous recorded flights suggests that the deflections achieved were consistent and in line with expected deflections from the aircraft manufacturer. At least two further significant deflections of the elevator were performed during the taxi, achieving maximum deflections of 25.8° and -16.7°.

After takeoff from Aberdeen, the aircraft was flown under manual control until passing through FL38 when

Footnote

[3] TAT is the temperature measured on the airframe where the air is brought to rest causing an adiabatic increase in temperature when the aircraft is moving through the air. TAT is higher than static (or ambient) air temperature when the aircraft is moving.

[4] Elevator position is only sampled once per second and only for the left elevator. As the full elevator movement was not held for more than one second, it is possible that further movement was achieved but not recorded.

the autopilot was engaged. The climb continued with the aircraft trimmed at around 13° nose-up.

Just after passing FL66, the autopilot commanded a pitch-down movement by applying an increasing pitch trim command over a period of 13 seconds. Recorded TAT was -4°C. Autopilot pitch trim warnings were not recorded but, according to the manufacturer, the warning would have been activated if the elevator trim was commanded in the same direction for more than nine seconds.

The autopilot was disengaged and it was then that the flight crew reported the elevator restriction. Control column position and force were not recorded. FDR data indicated that recorded elevator position was not completely static, as might be expected from a totally restricted control surface, with between 1.3° to 3.0° of movement. Just over 3 minutes after the restriction started, a spike in the elevator position was noted from 2.6° to 5.5° deflection, with a corresponding pitch change. As the control column position was not recorded, it is not known what caused this but it is possible that, with significant force applied to the control column, the elevator momentarily freed before then becoming restricted again. After this momentary recovery the elevator position varied between 1.3° to 2.8°.

For the duration of this restriction, a number of pitch oscillations were seen, along with a number of pitch trim inputs and changes in power settings. The maximum pitch attitudes attained were 18° nose-up pitch and 2.5° nose-down pitch. After analysis, the effect of applying an increasing pitch trim command (normally leading to a pitch-down effect) led to the aircraft pitching up. Conversely, applying a decreasing pitch trim led to the aircraft pitching down. This suggested that the effect of pitch trim had become reversed. The use of pitch trim in each instance led to oscillations in pitch which were then seen to decrease in amplitude as soon as the variations in pitch trim stopped. The data suggested that, at times, the flight crew were attempting to trim the aircraft using the pitch trim, which was acting in the opposing sense.

Just over 13 minutes after the disconnection of the autopilot, when descending through FL41, the FDR recorded a spike in the elevator position from 2.8° to 7.2°. When time-aligned with the crew discussion on the CVR, it was confirmed that the elevator authority had then been recovered. TAT at the time of recovery was -0.75°C.

No further unusual pitch activity was noted on the FDR for the remainder of the flight. Seven and a half minutes after the elevator recovery, during the approach to Wick, the CVR indicated that the commander elected to perform a "HANDLING CHECK BEFORE COMMITTING TO THE APPROACH TO LAND AT WICK". This appeared to consist of lowering the flaps a further two stages until full flap was achieved. One stage of flap was then retracted and the landing was performed with flap 15.

The commander

The commander was a very experienced type rating examiner on the Jetstream 41 and other aircraft types. He was engaged by the aircraft operator on a freelance basis and his duties included training and testing of the operator's pilots. Previously, he had been employed by the manufacturer of the Jetstream 41 and had worked for this operator in a management capacity.

Interviewed after the event, the commander stated that he believed that the purpose of sweeping contaminants from the airframe was "to clear the contaminants off the .... surfaces" and that once this had been done, it would be appropriate to depart, given that the conditions were "wet". However, he was also aware that sweeping sometimes preceded application of de-icing and anti-icing fluids.

In discussing the event, the commander was not aware of the possibility that, if the elevator was jammed, the elevator trim system might produce pitching in the opposite sense to that in which it usually operated (nose-down trimming would produce nose-up pitching in the aircraft).

The commander was aware that the emergency and abnormal checklist included a procedure appropriate to a jammed elevator. This procedure addressed a mechanical jam, affecting one side of the system. He stated that he had chosen not to carry out this procedure, as he felt that the problem was not a control jam but a restriction caused by ice.

The co-pilot

The co-pilot had undertaken a full-time integrated course of training between 1998 and 2000 and then worked as a flying instructor before being employed by the operator of G-MAJV. He flew the Jetstream 32 for two years before converting to the Jetstream 41 a year before the incident. He had received appropriate training to operate into Vagar.

The co-pilot stated that, at the holding point ready for departure, he was watching the wing carefully with the intention of suggesting that the aircraft should be de-iced before takeoff, if any significant contamination built up.

The de-icing personnel

The operator did not have staff or equipment at the airport for de-icing aircraft but had a contract with an engineering company to provide this, and other services.

The personnel who swept the snow from the wings of G-MAJV had only recently started their employment with the engineering company, though they had been engaged in similar tasks with another employer. The engineering company had not provided them with training in de-icing and anti-icing procedures.

On the morning of the incident, they were provided with appropriate equipment and instructed to sweep the snow from the wings of G-MAJV. They carried this task out in the anticipation that colleagues would then apply de-/anti-icing fluid to the aircraft. They stated that "heavy snow" had been falling when they reported for duty. Most of the material they removed from G-MAJV was "slush" and they recalled that as they were sweeping the aircraft, sleet was falling.

The purpose of de-icing and anti-icing of aircraft

Contamination of aircraft flying surfaces can cause catastrophic loss of lift and loss of control. Contaminants may also add significant weight to an aircraft. Therefore, prior to departure two criteria must be met.

First, all contaminants must be removed from the aerodynamic surfaces of the aircraft before flight. This is usually accomplished by application of de-icing fluid, and may sometimes be preceded by mechanical cleaning with brushes or similar equipment, which has the benefit of reducing the amount of fluid required to achieve de-icing.

Second, if precipitation is present, the aircraft must be protected against the accretion of further ice during the time between de-icing and takeoff. This is accomplished by the application of appropriate anti-icing fluid in the correct manner as well as ensuring that the aircraft takes off before the relevant holdover time[5] has elapsed; the

Footnote

[5] The period, in the given conditions, during which the fluid provides adequate protection.

application of the fluid relates to the conditions against which the aircraft must be protected. Following de-icing and anti-icing, flight crews ensure that there are no contaminants on the aircraft prior to flight. Once airborne, an aircraft's anti-icing and de-icing systems protect it against ice accretion in flight by heating the relevant surfaces or by clearing ice from them mechanically or by fluid.

Operations manual and other published advice

The operator's operations manual for the Jetstream 41 stated in paragraph 1.27.4 that:

> *'The aircraft must be cleared of all deposits of snow, ice and frost adhering to the surfaces immediately before take-off.'*

and in paragraph 2.3 that:

> *'If operating in cold conditions ensure that all snow, ice and hoar frost has been removed from fuselage, wings, ailerons, flaps and tail area, including elevators and rudder.'*

The manual did not state that safe flight is dependant not only upon removal of contaminants but also, in icing conditions involving precipitation, the protection of the aircraft's surfaces by the application of appropriate fluids.

The operator's emergency and abnormal checklist for the aircraft included a number of checklists for use in event of failure of various ice protection systems. Some of these checklists included the following note:

> *'In the event of any failure of the airframe de-icing system whilst flying in actual or potential icing conditions, it is recommended that the maximum flap used is 15º. If airframe buffet is experienced, the airspeed must be increased until the buffet stops.'*

There was no checklist applicable to an icing encounter or ice accretion not associated with a systems failure.

The operator's Emergency and Abnormal Procedures included the following advice and instruction about preparation for flight in icing conditions in section 3.3.6.1:

> *'Preparation for Flight*
>
> *External Inspection*
>
> *A thorough pre-flight inspection of the aircraft is vital for safe operation in icing conditions. Flight Crew should pay particular attention to the condition of the airframe de-icing boots and the propeller de-icing mats. In addition to normal checks, Pilots must ensure that the aircraft is clear of ice, frost or snow.*
>
> *THE AIRCRAFT MUST BE TOTALLY FREE OF ICE DEPOSITS BEFORE TAKE-OFF AS THE AERODYNAMIC PERFORMANCE OF THE WINGS AND TAIL CAN BE SEVERELY REDUCED EVEN BY THICK FROST.*
>
> *The Flight Crew must ensure that the following items are not contaminated, and arrange for de-icing where required:*
>
> *All external surfaces.*
> *Gaps between control surfaces and aircraft structures.*
> *Landing gear and associated doors.*

Engine nacelles, inlets and propellers.
ECS packs inlet / exhaust.
Pitot and static (main and standby) systems, AOA probes.

De-Icing and Anti-Icing

De-icing may be accomplished manually or by the use of hot air or fluid. These methods do not provide any ongoing anti-ice protection and may only be used when the aircraft is not subject to further icing before take-off.

Manual De-Icing

Manual de-icing should be performed using only soft brushes or rubber scrapers, taking care to avoid damaging the aircraft skin or any equipment.'

In the section dealing with ground operation of the aircraft in icing conditions, the manual stated:

'Pre Take-Off

The gust locks should be disengaged, and a careful check for full and free control movement must be made to ensure that freezing has not occurred. This should be repeated at intervals if awaiting take-off clearance, and especially performed immediately before take-off.

TAKE-OFF IS PROHIBITED IF DEPOSITS OF SNOW, ICE OR FROST ARE ADHERING TO THE SURFACE OF THE AIRCRAFT.

All visible parts of the airframe must be inspected for evidence of re-freezing, or contamination immediately prior to take-off. Do not assume freedom from contamination by observing other aircraft, they may have been treated more recently and/or effectively. If in doubt, and if possible, ask for an external inspection, otherwise always return for a de-icing re-spray.'

The operations manual did not include advice applicable to flight following departure with ice on the tailplane as such events should not occur. However, the section entitled *'Approach and Landing with Residual Ice Following Airframe De-Ice Fault'* included the following information and advice:

'Excessive ice may be present on either the tail, or the wings, or both. The maximum flap selection should not exceed 15 in order to maintain a safe margin from a possible tailplane stall.'

The emergency and abnormal checklist included a procedure for use in event of the autopilot pitch trim warning.

Manufacturer's advice

The manufacturer of G-MAJV had produced a guidance booklet entitled *'Think Ice!'* which had been updated from time to time. The 2007 edition included an extensive passage describing the rationale for reducing flap settings in landings following possible ice accretion events, to avoid the possibility of tailplane stall.

Previous events

Examination of the AAIB database identified three previous events involving pitch control restriction in Jetstream 41 aircraft in the UK[6]. In one event, lack of lubrication of the gust lock mechanism was the cause. In another, the condition lever friction control interfered with the pitch trim wheel.

Footnote

[6] Other events worldwide were also identified.

In the third event, in February 2005, a Jetstream 41 aircraft operated by the operator of G-MAJV experienced pitch control difficulties during climb after departure from Aberdeen. The AAIB report into the event[7] stated that *'The captain considers that, because no de-icing fluid was applied to the aircraft, ice which was not visible from the ground was present on the tailplane before takeoff'* and that later, the commander believed:

> *'that failure to ensure proper de-icing prior to departure had permitted ice to remain on the horizontal tail surfaces and that a further accumulation in flight caused the elevator to become jammed.'*

Safety actions

The engineering company involved in this event incorporated the following instruction into their de-icing procedures shortly after this event:

> *'In the event that ice/snow deposits are required to be removed from the aircraft using brooms prior to de-icing, and the de-icing equipment is not immediately available to complete the de-icing procedure the Aircraft Commander must be advised of the delay and that de-icing has not been completed.'*

In the course of the investigation, the incident to G-MAJV was discussed with the CAA's Flight Operations Inspectorate (FOI), who then reviewed the operator's operations manual. The review resulted in the CAA issuing a number of findings related to the de-icing and anti-icing of aircraft.

Simulation

The operator had a Jetstream 41 simulator at its headquarters. In the simulator the incident flight was recreated, with an elevator jam being introduced shortly before climbing through FL90. The simulator accurately replicated the aircraft's responses to power changes, and with some difficulty, the investigator succeeded in gaining sufficient control to establish a descent and then maintain the aircraft's altitude within a few hundred feet.

Analysis

Cause of the elevator jam

Extensive engineering investigation after the incident found no fault with the aircraft and no evidence of re-hydration of fluid residue, which has caused control restrictions in the past on other aircraft types. Having dismissed a mechanical cause of the control restriction within the aircraft, environmental factors became the most likely cause for the elevator jam.

Snow had been falling prior to the flight crew's arrival at the airport and continued to fall during the time preceding their departure. The precipitation left G-MAJV covered with contamination, in the form of wet snow and slush. Closer to their departure time, the snow gave way to lighter sleet. It is, therefore, highly likely that, before the aircraft took off, slush and/or ice was present on the horizontal tail surfaces and that, as the aircraft entered colder air at altitude, this contamination caused the mechanical pitch control to become restricted.

Actions before departure

During the preparation for flight, events proceeded normally up to the commander's decision not to have the aircraft de-iced and anti-iced with fluid. The fact that precipitation, albeit light, was still falling, and the

Footnote

7 AAIB report EW/G2005/02/16.

temperature was 0°C, meant that anti-icing, and an appropriate holdover time, were essential to ensure that the aircraft was protected from contamination before takeoff. This was not done, although de-icing and anti-icing resources at Aberdeen were available. The resources were not, however, adequate to ensure all aircraft were de-iced prior to achieving on-time departures.

The ground crew gave the clear 'thumbs up' sign to the commander once they had swept the wings. The gesture, intended as a greeting, may have seemed more of an assurance that their task had been completed and the aircraft was free of contamination. The flight crew were not aware that the tail had not been swept, and the commander's assumption that the tail had been cleared appears to have been a consequence of the signal. However, the safety actions taken by the engineering company after the event guard against a repetition of this sequence.

Examination of the operator's operations manual showed that it stated the importance of de-icing aircraft (removing contaminants prior to flight) very clearly. However, there was less clear exposition of the need to anti-ice an aircraft prior to takeoff in icing conditions and the CAA's review of the operations manual provides the opportunity for corrective action.

Actions in flight

After takeoff the flight proceeded uneventfully until the autopilot pitch trim warning illuminated. The commander carried out the relevant procedure from memory, without reference to the checklist. The checklist provided appropriate guidance for a trim malfunction caused by a mechanical malfunction, but not one caused by ice accretion in the tailplane. The commander's diagnosis, that the problem related to ice accretion rather than a systems problem, was correct.

Notwithstanding the autopilot pitch trim warning checklist, the emergency and abnormal checklist did not include a relevant checklist for the circumstances in which the crew found themselves. The circumstances of this flight were not unique: at least one previous UK event has been investigated by the AAIB and further events are likely to have occurred elsewhere. Therefore, the following Safety Recommendation is made:

Safety Recommendation 2009-077

It is recommended that BAE Systems review the emergency and abnormal checklist for the Jetstream 41 aircraft to ensure that it includes adequate instruction and advice for flight crews who encounter in-flight control problems associated with airframe ice.

The advice in the operations manual stated that flap setting greater than 15 should be avoided following an icing encounter. Given that the consequences of tailplane stall could be catastrophic, it may be better to prohibit extension of the flaps beyond 15 unless a safe landing is reliant upon the use of flap 25 (for example, because the landing distance is limiting).

Therefore, the following Safety Recommendation is made:

Safety Recommendation 2009-078

It is recommended that BAE Systems review the advice contained in the emergency and abnormal checklist concerning flap extension following failure of the aircraft's ice protection systems, or when ice is present on the airframe, to ensure that advice and instruction relating to flap extension is optimized for safety.

'Fitness to fly'

This event involved two experienced flight crew; the commander, in particular, was highly experienced. His decision-making was critical in the sequence of events, particularly the decision not to have the aircraft de-iced and anti-iced prior to departure and also his assumption that the tailplane had been mechanically de-iced. The additional 'full and free' checks of the controls prior to departure indicated a concern about the state of the aircraft, as did the commander's decision to hand-fly the initial part of the departure.

Before the flight, the commander discussed with the co-pilot his (the commander's) fitness and the poor quality of his pre-flight sleep and said he would monitor his performance as the duty went on. He knew there was no other captain at Aberdeen available and qualified to operate to Vagar so the flight would be cancelled, or significantly delayed, if he did not operate it. The service was a non-scheduled (charter) flight, and the usual option of transferring passengers onto a later flight was not available. It is thus possible that the commander's physical condition, coupled with a motivation to complete the flight, was a contributory factor in this incident.

ACCIDENT

Aircraft Type and Registration:	Beech 36, N7205T
No & Type of Engines:	1 Rolls Royce/Allison 250 B-17 C
Year of Manufacture:	1984
Date & Time (UTC):	1 July 2009 at 1055 hrs
Location:	Temple Bruer Airfield, Lincolnshire (Waddington and Cranwell zone)
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to the engine gearbox, propeller and flaps
Commander's Licence:	Private Pilot's Licence
Commander's Age:	49 years
Commander's Flying Experience:	2,515 hours (of which 1,439 were on type) Last 90 days - 25 hours Last 28 days - 12 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and discussion between the pilot and the AAIB

History of the flight

The pilot took off from Tatenhill Airfield for a transit to Temple Bruer Airfield which was unfamiliar to him. Before departing the circuit at Tatenhill, he decided to practise short field takeoffs and landings because the grass runway at Temple Bruer was shorter than the runway he was used to. He wanted to complete the circuits quickly and decided to fly tighter circuits than normal. He also decided to delay lowering the landing gear until the aircraft was on short finals. There was less distance than usual from the end of the downwind leg to touchdown and a low power setting was required in order to descend onto the final approach path. The low power setting, combined with the landing gear selected to the UP position, triggered the landing gear warning horn during each approach.

These circuits were completed uneventfully and the pilot flew to Temple Bruer Airfield where the surface wind was 090°/5 kt and the weather was CAVOK. He positioned for an approach to Runway 08 but did not lower the landing gear. Although the pilot remembered hearing the landing gear warning horn on the final approach, it did not prompt him to lower the landing gear. The aircraft touched down on the grass with the landing gear still selected UP and came to a halt on the runway shortly afterwards. The pilot was unhurt and exited through the passenger door.

Determination of the cause

The pilot believed he concentrated so hard on the landing at what was an unfamiliar airfield that he forgot to lower the landing gear. He also believed he had become used to the warning horn during the circuits flown before leaving Tatenhill. He thought this was the reason the horn did not prompt him to lower the landing gear at Temple Bruer.

ACCIDENT

Aircraft Type and Registration:	Boeing ST 75 Stearman, SE-BOG
No & Type of Engines:	1 Pratt & Whitney R-985-AN-14B piston engine
Year of Manufacture:	1942
Date & Time (UTC):	26 July 2009 at 1015 hrs
Location:	Edinburgh Airport
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Lower right wingtip damaged right tyre burst
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	51 years
Commander's Flying Experience:	14,408 hours (of which 53 were on type) Last 90 days - 171 hours Last 28 days - 46 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and discussion between the pilot and the AAIB

History of the flight

The aircraft was on an approach to Runway 24 at Edinburgh Airport. The surface wind was 160°/10 kt, the visibility was 10 km and there was overcast cloud at 1,500 ft. The aircraft made a "normal, gentle touchdown on the left hand main wheel" as was required in the crosswind. The pilot held the right main wheel and tail wheel off the ground, lowering them to the runway at approximately 40 kt. As the wheels touched the runway, the "aircraft executed a small swing to the right". The pilot corrected the swing but almost immediately the aircraft "swung rapidly to the left". The pilot was unable to prevent the swing with full right rudder and brake and the aircraft started to ground loop. During the turn, the right wingtip touched the ground and the right tyre burst before the aircraft came to a halt.

Assessment of cause

The pilot believed that the "unusually rapid" swing to the left might have been caused by a gust of wind combined with too much correction for the earlier swing to the right.

ACCIDENT

Aircraft Type and Registration:	Cessna 150D, G-ASMW
No & Type of Engines:	1 Continental Motors Corp O-200-A piston engine
Year of Manufacture:	1963
Date & Time (UTC):	14 July 2009 at 1700 hrs
Location:	Netherthorpe Airfield, Nottinghamshire
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Nose landing gear leg, firewall, cowlings, propeller, engine frame and mount, shock-loading to engine
Commander's Licence:	Student pilot
Commander's Age:	45 years
Commander's Flying Experience:	60 hours (of which 59 were on type) Last 90 days - 8 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The student pilot was carrying out circuits to a grass runway. While landing, the aircraft ballooned slightly and, following an attempted correction, a nose-down touchdown was made. The aircraft bounced, landed again and the nose landing gear collapsed as the brakes were applied.

History of the flight

The student pilot was practising solo circuits at Netherthorpe Airfield using grass Runway 24. The landing distance available is 370 m (1,220 ft). The weather conditions were clear, with a surface wind from 180º at 5 kt.

The flap was selected to 30º for the landing, the pilot's normal setting. The pilot reported that the approach was a little fast but that she did not consider that it was too fast for the conditions or runway length. As she commenced the flare, the aircraft ballooned slightly and, in attempting to make a correction, the aircraft touched down nosewheel first, bounced and became airborne again before landing normally. As the brakes were applied the nose landing gear collapsed.

The landing performance chart supplied in the aircraft Owner's Manual gives a landing ground roll of 445 ft and a landing distance of 1,075 ft, using flap 40º on a paved dry runway. A note on the chart requires an extra 215 ft to be added to each figure for a dry grass runway surface. According to the pilot's report the initial touchdown was made approximately half way along the landing runway. Thus, there would not have been much runway length available in which to make any corrections to the landing.

ACCIDENT

Aircraft Type and Registration:	Cessna 152, G-BRNE
No & Type of Engines:	1 Lycoming O-235-L2C piston engine
Year of Manufacture:	1980
Date & Time (UTC):	13 June 2009 at 1510 hrs
Location:	Redhill Aerodrome, Surrey
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Nose gear collapsed and propeller damaged
Commander's Licence:	Student pilot
Commander's Age:	43 years
Commander's Flying Experience:	49 hours (of which 9 were on type) Last 90 days - 21 hours Last 28 days - 9 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The student pilot was carrying out solo circuits, using Runway 18, at Redhill. The weather at the time was good with a wind of 7 kt from 210°. After 55 minutes of circuit work the aircraft bounced during landing, after which it porpoised, eventually causing the nose gear to collapse. The student pilot assessed that she should not have flown such a long circuit session and that as a result she may have been starting to suffer from fatigue.

ACCIDENT

Aircraft Type and Registration:	DHC-1 Chipmunk 22A, G-BWUV
No & Type of Engines:	1 De Havilland Gipsy Major 10 MK2 piston engine
Year of Manufacture:	1952
Date & Time (UTC):	20 February 2009 at 1529 hrs
Location:	Wombleton Airfield, Harome, North Yorkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Minor) Passengers - None
Nature of Damage:	Aircraft damaged beyond economic repair
Commander's Licence:	Private Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	416 hours (of which 303 were on type) Last 90 days - n/k hours Last 28 days - n/k hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

Engine power was lost at 300 feet after takeoff and the aircraft was damaged in the forced landing that followed.

History of the flight

The aircraft had taken off from Runway 29 at Wombleton Airfield and reached a height of 300 feet when the engine suddenly lost all power. The pilot selected full flap and attempted a forced landing straight ahead but the aircraft struck a hedge and wire fence. The wire fence caught in the right undercarriage leg, yawing the aircraft to the right and bringing it rapidly to a halt. The aircraft was severely damaged but the pilot suffered only minor injury and exited normally.

It was found that, upon rotating the engine, the left magneto contact breaker did not open at all and the right magneto was set to open too far. This meant that the left magneto would have been incapable of producing a spark and the right only a weak and mistimed spark. Since the pilot reports that prior to the accident the aircraft had flown for 15 minutes with no problems, it would appear that the left magneto setting slipped some time after his pre-takeoff checks, leaving operation on the deficient right magneto. This may have caused fouled plugs, which further reduced the engine's power output.

ACCIDENT

Aircraft Type and Registration:	Europa XS Europa, G-CCUL
No & Type of Engines:	1 Rotax 912 ULS piston engine
Year of Manufacture:	2004
Date & Time (UTC):	24 May 2009 at 1550 hrs
Location:	Rayne Hall Farm, Essex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to propeller and spinner and to wiring harness
Commander's Licence:	Private Pilot's Licence
Commander's Age:	48 years
Commander's Flying Experience:	1,247 hours (of which 177 were on type) Last 90 days - 18 hours Last 28 days - 9 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

On landing, the aircraft settled lower than usual and a smell of burning rubber was apparent in the cockpit. When the pilot exited the aircraft he realised the gear had semi-retracted and the tyre was rubbing against the wheel well structure. The pilot reported this was most likely due to the latch on the gear selection lever not being properly engaged when the gear was selected down, allowing a partial retraction under the weight of the aircraft.

History of the flight

After a routine flight, the pilot joined the circuit on a left base leg for Runway 09. About one mile from the threshold he completed his landing checks, including selecting the landing gear lever to the DOWN position. The flare and hold-off for landing were normal, but as the aircraft settled onto the runway after touching down, the pilot considered it to be much closer to the ground than normal. During the rollout the pilot noticed a smell of burning rubber, before observing a detached propeller blade pass over the aircraft canopy. He taxied the aircraft off the side of the runway and exited normally.

Aircraft description

The Europa is a popular homebuilt 'Permit to fly' aircraft. It may be equipped with either a conventional, fixed tricycle landing gear, or a large retractable main wheel with a fixed tailwheel and retractable outriggers on the wings. The accident aircraft was equipped with the latter of the two options. This system uses a single long-throw lever that lowers the single main wheel, flaps and outriggers at the same time. With the gear retracted, the lever is operated by moving it to the left, out of a gate, then firmly backwards to overcome the restraining bungee cords and the airloads acting on the deploying gear. To lock the gear and flaps down, the lever is moved to the right to engage another gate. The lever is biased to the right, such that it tends to drop into this gate. A spring-loaded latch then drops into the slot between the two gates to ensure the gear is locked in the DOWN position.

Operational aspects

When the gear is extended, the flaps are also deployed. This causes the aircraft to pitch nose-down and changes the 'approach picture' for the pilot. The pilot stated that he associated this change in 'picture' with the gear being successfully extended, since the two systems are linked mechanically. During his final approach he confirmed that the 'picture' was correct and his passenger cross-checked that he had called out the landing gear check and moved the lever. Observers on the ground later confirmed that the gear was deployed as the aircraft passed over on final approach.

Engineering findings

A thorough inspection of the aircraft after the accident, by the pilot and his LAA inspector, confirmed that there were no failures in the gear mechanism that could have caused the gear to retract on the ground. Additionally, there were no witness marks to suggest that the gear lever had jumped or been forced out of position.

Conclusion

The pilot concluded that the evidence pointed towards him having selected the gear down but not ensured that the latch had engaged to lock the gear in place, thus allowing it to retract under the weight of the aircraft. He added that confirming the latch was secure would normally be part of his pre-landing routine, but on this occasion he had omitted to carry out the check.

ACCIDENT

Aircraft Type and Registration:	Piper PA-28-140 Cherokee, G-AWPS
No & Type of Engines:	1 Lycoming O-320-E2A piston engine
Year of Manufacture:	1964
Date & Time (UTC):	2 January 2009 at 1154 hrs
Location:	Colwich Junction, near Little Haywood, Staffordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 2
Injuries:	Crew - 1 (Fatal) Passengers - 2 (Fatal)
Nature of Damage:	Aircraft destroyed, railway overhead gantry and power cables disrupted
Commander's Licence:	Private Pilot's Licence (lapsed)
Commander's Age:	59 years
Commander's Flying Experience:	Estimated 600 hours (of which 500 were on type) Last 90 days - not known Last 28 days - not known
Information Source:	AAIB Field Investigation

Synopsis

The aircraft was seen carrying out a manoeuvre described by witnesses as similar to a wingover or stall turn. During the manoeuvre it entered a steep nose-down descent from which it did not recover and which resulted in a high-speed impact on a railway line. The accident was not survivable. The pilot's medical and licence validity had expired a number of years previously. The aircraft maintenance records were incomplete and did not show that the required maintenance had been correctly performed. There was, however, no evidence of any mechanical defect causing, or contributing to, the accident.

History of the flight

The flight was planned to take place as air experience for a couple who knew the pilot through his work. On the morning of the accident the pilot went to Sittles Airfield where he kept his aircraft and prepared it for a flight. It had been cold overnight and as the aircraft was parked outside it was covered in frost. The pilot moved the aircraft from the parking area to the edge of the landing strip to allow it to defrost in the sun. Later during the morning he telephoned his wife to say that the frost was melting and that he would be able to fly.

The pilot met his passengers at an arranged location and guided them to Sittles Airfield. There was no-one else at the airfield and no witnesses to the takeoff. There were, however, some people at an airstrip ½ nm to the north of Sittles Airfield who reported seeing the aircraft shortly after takeoff. They said that it had taken off in an easterly direction, had flown directly overhead their airstrip and performed a couple of manoeuvres that were described as wingovers or stall turns, before flying away to the west.

The aircraft track was recorded on radar showing a generally north-westerly direction of travel as far as the area of Little Haywood, a distance of some 10 nm. The final part of the recording showed a turn to the right.

Various witnesses noticed the aircraft close to the time of the accident; some described it as climbing steeply or performing a wingover or stall turn before descending. A number of people described seeing the aircraft descending steeply or hearing a loud, or 'roaring', noise before the impact. The aircraft hit the ground in a steep nose-down attitude at high speed and there was a post-crash fire. The accident was not survivable.

Radar information

Recorded radar data was provided by the NATS, the UK national air traffic service provider. Data was recovered from the Claxby and Manchester radar recordings along with a screen-capture video of the controller's screen at Birmingham Airport. All three sources identified G-AWPS in various stages of its flight although only primary returns were recorded, meaning that no altitude information was available to the investigation. This, along with the generally poor resolution of the recorded radar positions, meant that a detailed flight path analysis could not be performed.

The Birmingham Airport recording indentified G-AWPS in the vicinity of Sittles Farm at approximately 1145 hrs, tracking north in the direction of Roddige. The aircraft then turned left and tracked in a north-westerly direction towards Little Haywood. This track was confirmed by both the Manchester and Claxby radar recordings, which commenced just after the turn towards Little Haywood.

The final moments of flight from the Manchester and Claxby recordings showed G-AWPS performing a right turn, just to the south of Little Haywood. Again, due to the poor resolution of the position recording from these radar heads, there was significant scatter either side of an apparent straight-line track, which meant a detailed analysis of the final stages of flight could not be performed. The final recorded radar position was at 1153:40, approximately 150 metres from the accident site.

Aircraft information

The PA28-140 was originally produced as a two-seat aircraft. However, an optional jump seat modification is available and when this is installed four people may be carried. The most recent weight and balance schedule for G-AWPS, dated 19 June 1991, showed that there were two seats fitted, but the evidence from the wreckage suggested that there were four seats.

The Piper PA28-140 may be operated in either the Normal Category or the Utility Category, the latter has more restrictive weight and balance limitations. The Normal Category Maximum Weight is 2,150 lb, whereas that for the Utility Category is 1,950 lb with a relatively forward CG position, which generally precludes carrying a rear seat passenger. When operated in accordance with the Utility Category limitations certain types of aerobatic manoeuvres are allowed, these are spins, steep turns, 'lazy eights' and chandelles. The never-exceed speed (V_{NE}) of the aircraft is 168 mph IAS (146 kt), marked on the airspeed indicator as 171 mph CAS (corrected for position error).

A weight and balance calculation based on the 19 June 1991 schedule was carried out for the investigation using estimated figures for the fuel and the best available weights for the pilot and passengers. The seat which each person occupied could not be determined. This showed that if the fuel tanks were half full, 20 imperial gallons (91 litre), then the aircraft was probably within the Normal Category limitations, but was not within the Utility Category limitations.

Pilot information and records

The pilot qualified for his Private Pilot's Licence (PPL) in 1988 and initially flew on a regular basis, averaging about 22 hours each year until April 1997 when he purchased G-AWPS. At that time there were 300 hours recorded in his personal logbook, most of which had been conducted from Halfpenny Green Airport. These recorded hours were endorsed by annual Certificates of Experience (C of E).

After the pilot had purchased G-AWPS it was based at Tatenhill Airfield until September 1999, and after that at Sittles Airfield. In October 1997, some six months and 30 hours of flying since he bought the aircraft, the entries in his personal logbook ended, totalling 330 hours.

In September 1999 the pilot started a second personal logbook in which he recorded 800 hours as the starting value. This logbook was kept until January 2001; 47 hours were recorded in it, 42 of which were in G-AWPS. There was a recorded flight with an instructor and a C of E, signed on 6 January 2001, this was the final entry. The pilot's licence had thus been validated until 5 January 2003. No further personal logbooks were found. The airframe logbooks recorded 64 hours of flight time between 19 March 2006 and 24 May 2008 and it is likely that most of these were flown by the pilot. The last recorded medical examination for the pilot, according to the CAA records, was in 1995 and the validity expired in 1997.

One person, who had been on a flight with the pilot some years previously, described having been shown a manoeuvre in which the aircraft was placed in a shallow dive, then pulled up to a nose-high attitude before being turned with the rudder until it was in a nose-down attitude, and then recovering from the ensuing dive.

Pathological information

According to an expert aviation pathologist, all three people on board the aircraft died of multiple injuries and the crash forces were non-survivable. The condition of the pilot's body was consistent with peak deceleration forces '*in excess of 350g'*. It was not possible to determine whether any pre-existing natural disease could have affected the pilot; no such evidence was apparent from the post-mortem examination and there were no recent medical records available.

Accident site examination

The accident site was at Colwich Junction near Little Haywood, Staffordshire. The aircraft wreckage was found between the two branches of railway track that form part of the West Coast mainline. The aircraft's initial impact (Figure 1) was with an overhead power cable gantry. This moved the gantry on its mounting plinth, disrupted the cantilever part of the gantry and failed the overhead electric power cable. The first ground marks were scrape marks on one of the railway tracks and a significant crater to the side of the track, both close to the damaged overhead gantry. Most of the fragmented wreckage was distributed in a splay in a westerly direction from these initial impact marks. Parts of the wreckage were found outside this main splay and some parts were recovered up to 60 m from the initial impact point. There was a fire but it was localised and only affected parts of the wreckage. A police underwater search team recovered several items from the nearby canal.

Initial wreckage examination

All the major parts of the aircraft were accounted for at the accident site. The empennage remained relatively intact and the control cables to the stabilator, trim and rudder were still connected. There was no liquid fuel remaining on site, but in some areas there was a residual fuel smell.

The propeller was found in the impact crater and was complete except for approximately the last 10 cm of one blade; this missing piece was located a short distance from the main wreckage and damage indicated it had become detached during the impact. Both blades were bent rearwards, with chord-wise scratching and indentations to the blade leading edges, indicating propeller rotation at impact.

The core of the engine was found just outside the crater. It had suffered substantial damage and most of the external auxiliary components were detached. Parts of a cylinder head and its valve gear were found in the crater. No evidence of pre-existing defects was seen and the aircraft wreckage was recovered to the AAIB's facilities for detailed examination.

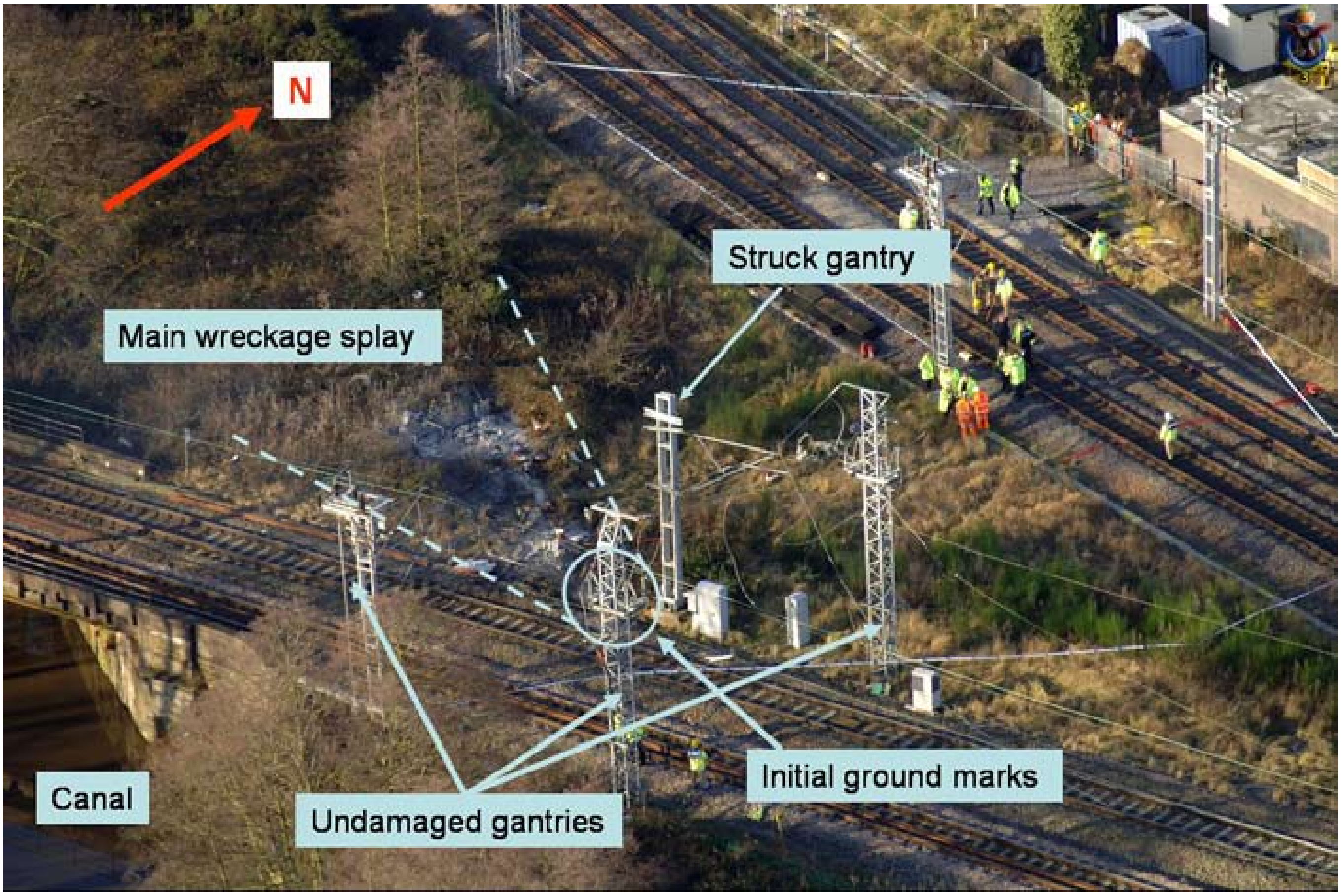

Figure 1

G-AWPS accident site (*courtesy Central Counties Air Operations Unit*)

Detailed wreckage examination

Flight, fuel and engine control systems

Detailed examination of the flight control systems indicated that they were intact up to the impact and that any disruptions were overload failures caused by the accident. In the fuel system, both wing tanks were ruptured and appeared to have been forcibly pulled forward, tearing along a riveted joint line. Both fuel filler caps had been displaced but were found amongst the wreckage and, as far as could be determined, the fuel system was intact and any disruption was as a result of the accident.

No pre-accident defects were identified in the engine. The throttle control is a plunger-type knob connected to the throttle by a push-pull cable. The knob was found in a partly closed position and the exposed shaft was bent from where it entered its mounting on the instrument panel. The engine primer was locked in the closed position and the ignition switch was in the normal BOTH position. It was not possible to check the other engine controls due to the extensive damage.

Instruments and fuel

The flight instruments were destroyed apart from the face of the airspeed indicator (ASI) and the compass. The needle of the ASI was stuck at an indication of 173 mph (Figure 2).

No records of fuel uplift were found. Aircraft operators at Sittles Airfield stated that the pilot/owner refuelled the aircraft using jerry cans; equipment in his car and a picture on the airfield club member's website confirmed this and there was no record of aviation fuel supplied to the pilot/owner in the previous four months. A jerry can found next to the pilot's lockup store at Sittles Airfield contained a small amount of fuel; the grass under the jerry can had died, indicating it had been there for some time. Chemical analysis of this fuel identified that it was most likely a type of unleaded motor fuel available from a petrol station.

A number of containers of fuel were found in a lock-up store the pilot used at the airfield, and one in the boot of his car, although it could not be confirmed whether this fuel was intended for the aircraft. There was no evidence to suggest that the aircraft was refuelled on the morning of the accident as no recently used empty containers were found either in the pilot's car or at the airfield.

Maintenance History

The aircraft held a non-expiring Certificate of Airworthiness (C of A) issued on the 19 March 2008 and an Airworthiness Review Certificate (ARC) which was valid until 17 March 2009.

Figure 2

Face of airspeed indicator (ASI)

The airframe log book contained entries from March 2006 to May 2008 and the engine log book entries from April 2005 to Mach 2008. Both log books recorded the last annual inspection, a three-yearly 'STAR' annual, on 13 March 2008 but there was no reference to the required worksheets detailing the inspections and their certification. No defects were recorded in either log book.

A separate certificate with the log books recorded the completion of the annual radio inspection on 7 March 2008 and the engineer who undertook the certification stated that the inspection was completed at Spanhoe. This certificate noted that both the transponder and the ADF were inoperative and were placarded as such. A propeller overhaul certificate was also with the log books and although the propeller was released to service from the overhaul on 6 November 2008, there was no record of it being fitted to the aircraft. Older log books, with entries up to the mid 1980s, were found at the pilot/owner's home with the current C of A, ARC and an EASA Form 1[1] for the propeller overhaul.

The last recorded maintenance organisations to be involved with this aircraft were those which undertook the 'STAR' annual inspection in March 2008 which included the transfer to a non- expiring C of A and an ARC. One was a maintenance company, which consisted of a single Licensed Aircraft Maintenance Engineer (LAME), based at Spanhoe Airfield, Northamptonshire and the other was an M3 Maintenance Organisation[2], based at Seething Airfield, Norfolk. The two signatories were interviewed about the maintenance activity and records.

Footnote

[1] An EASA form 1, Authorised Release Certificate, is issued by an EASA approved organisation to signify the component to which it refers is in an airworthy condition and ready for release to service.

[2] A maintenance organisation that is approved in accordance with British Civil Airworthiness Requirements (BCAR) Chapter A8-15 is identified as an M3 organisation.

The LAME stated that the aircraft had been at Spanhoe for approximately one month at the beginning of 2008, whilst maintenance activity prior to the C of A renewal was completed. He reported that he then took the aircraft to Seething to allow the M3 organisation to complete the necessary inspections and audit for the C of A renewal. He returned the aircraft to Spanhoe from where it was collected by the owner. The LAME could not provide the exact dates when these events occurred and did not have records of the work completed. He recalled having worked on the aircraft on one other occasion, a previous Annual Inspection.

The M3 organisation recorded the aircraft arriving at Seething on the 6 March 2008 and the survey was completed on the 13 March 2008. The signatory advised that the preparatory work had been completed at Spanhoe but the audit and 'STAR' annual inspection activity under the Light Aircraft Maintenance Schedule had been completed at Seething between 6 and 13 March 2008. The aircraft remained there until the new C of A had been issued. He was able to provide a copy of his Check Master Sheet which contained basic aircraft information.

For this period of maintenance activity, the aircraft log books contain a record of a flight of 35 minutes on 16 February 2008. The next recorded flight was on 13 March 2008 of 1 hour and 20 minutes duration; a further flight of 35 minutes was recorded on 22 March 2008.

The Civil Aviation Authority (CAA) was contacted to obtain copies of the previous C of A renewal recommendation forms for this aircraft. In January 2008 an application to renew the C of A had been received from a different M3 organisation at Seething. Further enquires found that it was, in fact, the same person who had made the recommendation for the transfer to a non-expiring C of A in March 2008, but at the time he was trading under a different company name and approval number. The previous recommendation for a C of A renewal was made in March 2007 by the same person, also in their earlier trading name. The preceding C of A renewal recommendation in March 2004 was made by the maintenance company at Spanhoe, who at that time was a CAA-approved organisation. Information about who completed the intermediate annual inspections would have been recorded in the missing aircraft and airframe logbooks.

Due to the gap in the aircraft log books, the airframe hours recorded at each Certificate of Airworthiness (CoA) renewal (three year intervals) by the CAA were used to determine the hours flown. This information showed that 30 hours were recorded as flown on the aircraft from when the owner/pilot purchased the aircraft in April 1997 up to 31 December 1999. From then until 31 December 2007 a further 170 hours were recorded.

Analysis

General

The pilot was on a local cross-country flight with two acquaintances. The weather conditions were good and he was familiar with both the aircraft and the route of the flight. There were a number of witnesses to the final part of the flight, they were consistent in their reports of a steep descent into the ground at high speed.

Aircraft capability

The aircraft, when operated in the utility category, is allowed to perform certain limited aerobatic manoeuvres. These include a 'lazy eight', which, when performed as an aerobatic manoeuvre, may be described as two wingovers in succession, leading to the nose of the aircraft following a horizontal figure of eight. Thus, a wingover is allowed to be performed in the aircraft provided the weight and balance criteria are met. Stall turns, where the rudder is used to turn the aircraft instead of the ailerons, are not allowed. At the time of the accident the aircraft was not operating within the utility category limits and therefore no aerobatic manoeuvres were allowed.

Final descent

The final steep descent at high speed, evident from the witnesses and the on-site examination, indicate that a loss of control of the aircraft occurred. However, several witnesses said that the aircraft had appeared to be under control until the final steep dive; this would be consistent with a deliberate entry to the final manoeuvre rather than with an inadvertent one. The pilot was known to have previously performed 'wingover or stall turn' types of manoeuvres on similar flights and it is possible that this is what he was attempting, but that he lost control of the aircraft. There are a number of reasons why such a loss of control could have occurred. These include an error of judgement by the pilot, unexpected handling characteristics of the aircraft because of an out-of-CG condition, interference with the controls by a passenger, a restriction of the control systems by a loose object, or an incapacitation of the pilot.

The height at which the pilot was flying before the accident could not be determined, but from the witness descriptions it was not at a great height and appears to have been insufficient to recover from a loss of control. There was no evidence that the pilot had received training in performing aerobatic manoeuvres.

Evidence from the on-site and wreckage examination

The damage and fragmentation of the aircraft was consistent with it striking the overhead gantry, and then the ground, at high speed in a 'right wing low' attitude.

The localised damage to the overhead gantries and electrical cables, and the proximity of the initial ground marks to the struck gantry, indicate the aircraft was descending at a steep angle.

The aircraft was intact prior to impact as all major parts were found with the wreckage. No significant pre-existing defects were found with the aircraft or its control systems. The throttle control was set to a low power setting and damage to the propeller indicates it was rotating but was at low power on impact. This is consistent with a high-speed dive with the engine running at a reduced throttle setting. The 'roaring' noise described by several witnesses and the indication on the ASI of 173 mph, which appears to be valid, are consistent with this scenario.

The fuel tanks appear to have been abruptly and forcibly pulled forward and away from their mountings. The nature of the damage suggests that fuel was present in the tanks and it was the mass of the fuel that led to the damage. It was not possible to determine the type of fuel used or how much was onboard. Witness accounts of the impact and evidence of fire also suggest that a quantity of fuel was in the tanks.

Records and record-keeping

The pilot, when he first started flying and for ten years thereafter, kept his personal logbook records, C of E and Medicals up to date. Once he acquired his own aircraft, and thus left the supervised environment of a flying/training club, his medical lapsed, he no longer kept his personal logbook record and his C of E expired. Other than in a flying club environment, there is no system for checking that pilots are suitably qualified for flying an aircraft. Thus, when a member of the public accepts a flight with a private pilot there is no assurance that the pilot is qualified and fit to fly other than the pilot's own integrity. This situation of mutual trust, however, is little different from accepting a lift in a person's car or other private vehicle and is not a basis for a safety recommendation.

The hours recorded in the aircraft logbooks, as declared to the Civil Aviation Authority at the time of each C of A renewal, were not consistent with those recorded in the pilot's personal flying log book on this aircraft and appear to have been understated. The airframe and engine hours recorded in the aircraft log books ceased in May 2008 and March 2008 respectively.

Since the accident, Sittles Flying Club Limited, the organisation that runs Sittles Airfield, has put in place measures to ensure that documentation is checked for validity on a regular basis, for all pilot members and their aircraft.

Fuel

Residual fuel found at the departure airfield was probably unleaded motor fuel available from a petrol station and was probably the fuel used in the aircraft. CAA publication '*CAP 747 - Mandatory Requirements for Airworthiness*', General Concession No. 5 allows the use of unleaded motor gasoline in certain light aircraft. This aircraft is included in the concession subject to the embodiment of the modifications, described in a supplemental type certificate (STC) issued by the Federal Aviation Administration. The modifications consist of extra placards as well as operational and maintenance restrictions. There is no record in the aircraft logbooks of these modifications having been embodied.

Maintenance

Due to the missing logbooks, limited maintenance history was obtained. The last recorded maintenance was a 'STAR' annual inspection conducted prior to an application for a non-expiring C of A in March 2008. The maintenance organisation did not keep their own records to show the nature and extent of the maintenance activity conducted, or defects identified during the work. A summary of the activity was recorded in the aircraft and engine logbooks. '*CAP 411, Light Aircraft Maintenance Schedule – Aeroplanes'*, specifies in Section 3, Scheduled Maintenance Worksheets:

> *'Worksheets shown in Section 8 must be issued and the tasks certified for all scheduled maintenance checks. These worksheets become part of the maintenance records required to be kept by the operator.'*

The schedule specifies that the worksheets should be certified, suitably referenced and cross-referenced in the appropriate logbooks. No evidence was found for the existence of worksheets and there was no cross-reference information to them in the aircraft logbooks.

A 50 hour / six monthly check was due in September 2008. A pilot is permitted to conduct certain maintenance tasks and it is possible that the pilot/owner undertook this routine task but in the aircraft log books there was no record of it having been completed.

The propeller was removed from the aircraft to undergo overhaul and, following the work, was released to service on 6 November 2008. There was no record or certification for the refitting of the propeller and the task is outside the scope of permitted pilot maintenance.

STAR Annual Inspection activity

The LAME at Spanhoe stated he had conducted the maintenance activity for the annual inspection before the aircraft was taken to the M3 organisation at Seething for completion of the paperwork to recommend renewal of the C of A. The M3 organisation stated that the preparatory work was conducted at Spanhoe and the audit and inspection activity for the 'STAR' annual was carried out at Seething under the their control when the aircraft arrived on 6 March 2008.

The aircraft log book entries show that the aircraft completed a 35 minute flight on 16 February 2008 There is no record of a flight on 6 March 2008 when the M3 organisation recorded the aircraft arriving at Seething. A flight of 1 hour 20 minutes is recorded on 13 March 2008 and a further flight of 35 minutes is recorded on 22 March 2008.

The duration of the flight on the 16 February is consistent with the time it would take to fly between Sittles Farm and Spanhoe and the flight on 22 March is consistent with a return flight from Spanhoe to Sittles Farm. In the absence of a recorded flight on 6 March, and given the radio inspection at Spanhoe on 7 March, it appears from the log books that the only other time the aircraft would have been flown to Seething was on 13 March. The flight time recorded on the 13 March is of sufficient duration for a return flight to Seething from Spanhoe to be completed, although there was no record at Seething of the aircraft arriving or departing during this period. The airfield is unlicensed during the week and pilots are required to book themselves in or out as appropriate.

The British Civil Airworthiness Requirements (BCAR) state in Section A:

> *'A Star Inspection and the coincident annual inspection shall be carried out at the premises of an organisation approved in accordance with BCAR Chapter A8-15…'*

Given the time the aircraft spent at Spanhoe compared to that at Seething, and the description of the activities carried out, including the radio inspection at Spanhoe on 7 March 2008, it appears that most of the maintenance activity was conducted at Spanhoe, before the aircraft may have been moved to the M3 organisation at Seething for the audit and survey inspections to be carried out on 13 March 2008. This practice, however, is contrary to BCAR A8-15 which requires all the activities related to the 'STAR' and coincident annual inspection to be carried out at the premises of the M3 organisation.

Summary

The pilot was in current flying practice but neither his licence nor medical were valid. The aircraft maintenance records were incomplete and there is therefore a lack of evidence to show that the required maintenance was correctly performed on the aircraft. Despite this, the accident appears to have been as a result of a loss of control while the pilot was attempting an aerobatic manoeuvre, and not as a result of a mechanical failure in the aircraft.

ACCIDENT

Aircraft Type and Registration:	Piper PA-28-161 Cherokee Warrior II, G-BPDT
No & Type of Engines:	1 Lycoming O-320-D3G piston engine
Year of Manufacture:	1984
Date & Time (UTC):	27 March 2009 at 1600 hrs
Location:	On taxiway near holding point 'G', Jersey Airport
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Left main landing gear torque link broken
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	73 years
Commander's Flying Experience:	15,600 hours (of which 6,000 were on type) Last 90 days - 40 hours Last 28 days - 20 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft was damaged while taxiing for takeoff on Runway 27 at Jersey Airport.

History of the flight

The aircraft was taxiing for takeoff on Runway 27 at Jersey Airport. Having been cleared to line up from holding point 'G', (see Figure 1) the pilot taxied forward but his left mainwheel left the paved surface and ran onto the grass, which was flush with the concrete. Whilst attempting to return to the taxiway, the wheel sank into the 'gusset' between taxiway 'A1' and taxiway 'G' and became stuck. Applying power to continue moving, the pilot found the aircraft turned to the left and, although successfully regaining the paved surface, he found it impossible to taxi due to twisting damage to the left main gear.

The pilot shut down the engine and called for assistance from the airport fire service. With their help, and that of an engineer from the local maintenance organisation, the aircraft was pushed back to the flying club area. It was found that the left mainwheel torque link had broken.

The airport authority has since filled the area in question with a substantial fillet of sand.

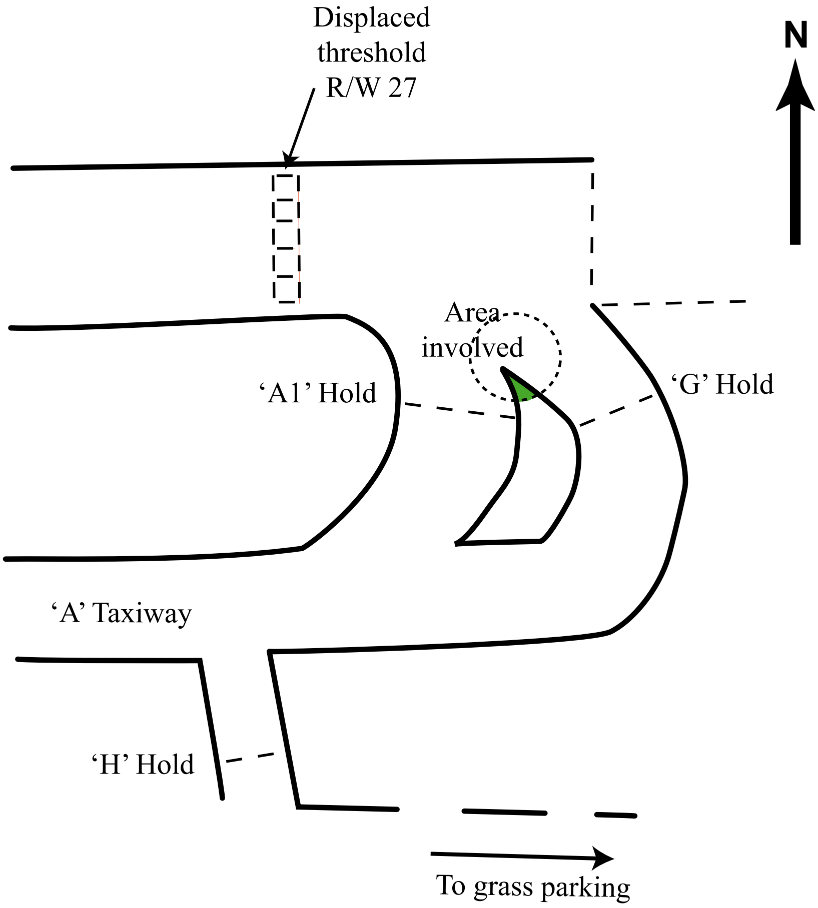

Figure 1

Sketch diagram of holding points, Runway 27 at Jersey Airport

ACCIDENT

Aircraft Type and Registration:	Piper PA-28R-201 Cherokee Arrow III, G-HERB
No & Type of Engines:	1 Lycoming IO-360-C1C6 piston engine
Year of Manufacture:	1978
Date & Time (UTC):	9 June 2009 at 1112 hrs
Location:	Deanland Airfield, East Sussex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to the wings, undercarriage, propeller and engine
Commander's Licence:	Private Pilot's Licence
Commander's Age:	64 years
Commander's Flying Experience:	1,038 hours (of which 87 were on type) Last 90 days - 32 hours Last 28 days - 19 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft touched down on the wet grass runway and, as the brakes were applied, entered a skid. The pilot executed a go-around and although the aircraft became airborne it failed to clear a hedge at the upwind end of the runway, striking it with the left wingtip. This caused the aircraft to descend and impact the surface of the field beyond.

The wet runway surface condition degraded the aircraft braking and acceleration performance. This resulted in the aircraft becoming airborne beyond the point at which it could safely clear the hedge.

History of the flight

The pilot was flying the aircraft from Rochester Airport to Deanland Airfield, in order to have a transponder fitted. He had operated a Piper Archer into Deanland Airfield on about 30 separate occasions and, more recently, three times in G-HERB.

The transit was uneventful and carried out at an altitude of 1,800 ft. The weather was not good, with light drizzle and broken cloud. Given the calm wind conditions, the pilot elected to make a straight–in approach to Runway 24 at Deanland.

Deanland is an unlicensed airfield with a single runway, orientated 06/24, which is 500 metres in length, 27 metres wide and has a mown grass surface. The airfield elevation is 65 ft AMSL. At the upwind end of Runway 24 is a substantial hedge, several metres high, with a gap created at the threshold of Runway 06.

At about 4 nm on the final approach, cloud obscured the pilot's view of the runway and he executed a go-around climbing to 1,300 ft to avoid noise sensitive areas. After completing a wide circuit he made a second approach. The approach was slightly higher than normal and flown at 85 kt, as opposed to the promulgated speed of 75 kt. As a result, the aircraft touched down some 20 to 30 ft longer than normal.

On touchdown, it was apparent to the pilot that the grass surface was very wet and, in places, almost water logged. When he applied the brakes the aircraft started to skid, so he applied full power, raised the flaps to the takeoff position and executed a go-around. He noticed that the aircraft took slightly longer to rotate than normal, probably due to the 'sticky' surface condition, but at about 420 metres into the runway it started to rotate and became airborne, climbing gradually. The pilot tried to fly through the gap in the hedge at the end of the runway but the left wing tip struck the top of the hedge at a height of about 15 ft, causing the aircraft to yaw to the left. The right wing dropped, struck the ground and the aircraft rotated to the right through approximately 180° before coming to rest facing the threshold of Runway 06.

The pilot isolated the fuel and electrical systems before vacating the aircraft through the normal exit. He was uninjured and there was no fire. Personnel at the airfield were quickly on the scene.

CAA Safety Sense Leaflet

The Civil Aviation Authority (CAA) General Aviation Safety Sense Leaflet Number 7, entitled *Aeroplane Performance*, contains guidance on the safety factors to apply to the performance information supplied with an aircraft type. This includes, for example, the factors to apply for unusual conditions, such as wet grass. The leaflet also refers to Air Information Circular 127/2006 (Pink 110) which contains more detailed information.

The Safety Sense Leaflet strongly recommends that the appropriate Public Transport factor should be applied for all flights. For takeoff this represents an increase of 33% in the (unfactored) Take-Off Distance Required (TODR), and for landing an increase of 43% in the (unfactored) Landing Distance Required (LDR). This allows for pilot operating technique and any mechanical deterioration of the aircraft.

Runway surface condition has an additional effect on aircraft performance. On wet grass, the LDR increases as a result of the reduced friction available from the surface. TODR will also increase due to the retardation effect created by the length of the grass as well as any soft or waterlogged surface condition. For the landing condition, wet grass up to 20 cm (8 inches) on firm soil may increase the LDR by 35%. Very short, wet grass may be slippery and distances may increase by up to 60%.

Aircraft performance

The Pilot's Operating Handbook (POH) contains a section on aircraft performance. Graphs are provided from which Landing Distance Required (LDR) from 50 ft and Landing Ground Roll Distance Required (LGRDR) can be determined. Both distances derived are unfactored and are based on specific associated conditions, which are: power off, wing flap 40°, full stall touchdown, maximum braking and a paved, level, dry runway. Any variation from these conditions will have an effect on the distances achieved.

The POH does not provide any factoring information for runway conditions which differ from a level and dry surface. The only reference to surface conditions is made in a statement at the beginning of the Performance section as follows:

> *'Effects of conditions not considered on the charts must be evaluated by the pilot, such as the effect of soft or grass runway surface on takeoff or landing performance'.*

The landing weight of G-HERB at Deanland was 1,043 kg which, from the performance graphs, produced a LDR of 434 metres and a LGRDR of 381 metres. Applying the safety factor for wet grass of 35% increases the LDR to 585 metres and the LGRDR to 514 metres. The appropriate Public Transport safety factor would increase these figures by a further 43%. The LDA for the runway at Deanland, as provided on the airfield's own website, is 457 metres.

The effect on aircraft acceleration due to a wet grass surface and any waterlogged areas may be applied and will increase the TODR. Whilst strongly recommended the additional safety factors are for guidance.

Analysis

The pilot considered that the accident occurred due to a combination of factors. He was slightly high on the final approach and 10 kt above the normal approach speed which resulted in a touchdown point further along the runway. The wet grass led to poor braking action which caused the aircraft to skid. Whilst he made an immediate decision to go-around, the retardation effect of the runway surface created a longer than normal takeoff run. As a result, the aircraft failed to clear the hedge with its left wing tip and descended into the field. The performance calculations support this outcome.

ACCIDENT

Aircraft Type and Registration:	Piper PA-32RT-300 Cherokee Lance II, G-RHHT
No & Type of Engines:	1 Lycoming IO-540-K1G5D piston engine
Year of Manufacture:	1978
Date & Time (UTC):	14 July 2009 at 1045 hrs
Location:	Spanhoe Airfield, Northamptonshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to the propeller, the underside of fuselage and a dent in the wing
Commander's Licence:	Private Pilot's Licence
Commander's Age:	52 years
Commander's Flying Experience:	311 hours (of which 95 were on type) Last 90 days - 5 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

Following an uneventful approach and normal flare the propeller struck the runway with the landing gear retracted and the aircraft skidded on its lower fuselage for about 400 yards before it came to rest.

History of the flight

The pilot carried out a daily check of the aircraft prior to starting the engine and taxiing to the refuelling point, where 69 litres were uplifted. Following post-start-up and pre-departure checks, the pilot, with ATC approval, took off and set course for his destination airfield. When the aircraft was approximately 3 miles from the destination airfield he carried out the 'downwind checks', which should have included lowering the landing gear. At about 300 ft on final approach the pilot selected the final stage of flap but, retrospectively, cannot remember checking to see that the three green landing gear 'down and locked' lights were illuminated. As the pilot flared the aircraft the propeller hit the runway and the aircraft skidded on its lower fuselage in a fairly straight line for about 400 yards before coming to a halt. This was not before the right wing impacted a low-level light, which spun the aircraft to the right. The pilot exited the aircraft without injury.

ACCIDENT

Aircraft Type and Registration:	Piper PA-46-310P Malibu, N9122N
No & Type of Engines:	1 Continental TSIO-520 SER piston engine
Year of Manufacture:	1988
Date & Time (UTC):	19 April 2009 at 1100 hrs
Location:	Guernsey Airport
Type of Flight:	Private
Persons on Board:	Crew - 2 Passengers - 2
Injuries:	Crew - None Passengers - None
Nature of Damage:	Minor damage to right landing gear wheel cover
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	64 years
Commander's Flying Experience:	2,038 hours (of which 1,250 were on type) Last 90 days - 16 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During a normal touchdown, the nosewheel steering connecting rod fractured at its attachment to the steering arm. This was due to abnormal bending loads caused by the seizure of a bush in its end-fitting. The aircraft yawed violently to the left, prompting an immediate go-around, during which the nosewheel was observed from the ground to be offset by about 45°. During the subsequent landing the aircraft again veered left and struck a runway light, causing minor damage to the right wheel cover.

History of the flight

After an uneventful flight from Oxford, the aircraft was vectored for an ILS approach to Runway 09 at Guernsey; the wind was reported as 15 kt from 040°. The landing gear was lowered, apparently normally, and the three green landing gear down-and-locked lights illuminated. After crossing the threshold at 90 kt, the aircraft touched down on the main wheels without incident but, as the speed decreased and the nosewheel came into contact with the runway, a screeching noise was heard and the aircraft yawed violently to the left.

Full power was applied immediately to initiate a go-around and, once airborne, the tower was appraised of the situation and a request made for a low fly-past and visual inspection. As the aircraft turned downwind, the tower informed to the pilot that the nosewheel appeared to be offset by about 45° and advised him not to attempt a retraction. After the offset had been confirmed during a low pass down the runway, and after unsuccessful attempts to realign the nosewheel by rocking and yawing the aircraft, the pilot advised the tower of his intention to make a short field landing approach at the lowest possible safe speed and to hold the nosewheel off the runway for as long as possible.

After waiting for a departing aircraft to clear the runway, the passengers were briefed for an emergency landing and a low-level short-field approach and landing was executed, crossing the threshold at 80 kt. After touching down on the main wheels, the nosewheel was held off the ground for as long as possible but as soon as it contacted the runway the aircraft again yawed violently to the left. Directional control was retained only marginally through asymmetric braking. After coming to rest, undamaged except for some light scratching to the leading edge of a landing gear door that had struck and broken a glass runway light, the shutdown procedures were completed and all occupants vacated the aircraft safely using the main door.

Subsequent investigation identified an overload failure of the threaded section of the steering actuation/damper rod end-fitting, at its aft end attachment to the steering arm, caused by a seizure of the 'rose joint' bearing element into its housing.

ACCIDENT

Aircraft Type and Registration:	Pitts S-1 Pitts Special, G-BXAU
No & Type of Engines:	1 Lycoming O-320-D2B piston engine
Year of Manufacture:	1978
Date & Time (UTC):	15 March 2009 at 1405 hrs
Location:	Little Rissington Airfield, Gloucestershire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Left landing gear leg buckled, left lower wing and propeller tips damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	46 years
Commander's Flying Experience:	472 hours (of which 43 were on type) Last 90 days - 7 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and subsequent AAIB investigation

Synopsis

The pilot lost control of the aircraft while landing on a tarmac runway with a crosswind of approximately 8 kt.

History of the flight

Tarmac Runway 22 was being used by the Venture Gliding Squadron based at the airfield but Runways 27/09, 32/14 were also available for takeoff. The pilot took off from Runway 22 at 1345 hrs. The surface wind, measured by a Met Office automatic weather station on the airfield, was 310/8 kt at 1300 hrs, and 320/8 kt at 1400 hrs.

Having completed a local flight, the pilot made an approach and go-around to Runway 22 followed by a visual circuit. The aircraft touched down from this second approach and yawed into wind. This caused the left main landing gear to collapse and allowed the left wingtip to contact the ground. The aircraft subsequently slid to a halt and the pilot, who was unharmed, was able to vacate the cockpit. There was no fire.

The pilot was involved in a similar landing accident, in the same aircraft, in July 2008 (AAIB Report EW/G2008/07/13); control was lost and the aircraft suffered similar damage whilst landing in a crosswind from the right on a tarmac runway. In this case the pilot reported that the wind had been calm at takeoff but during the flight the wind speed had increased to become approximately 10 kt, from a direction around 40º off the runway heading. Following that accident the pilot flew with an experienced Pitts pilot in a two-seat variant of the aircraft. He had advised the pilot not to fly in crosswind conditions.

Although no flight manual is published for the Pitts S1C, it is generally acknowledged by experienced Pitts pilots that the aircraft handles normally in crosswinds up to 17 kt.

Analysis

Three runways were available for takeoff at Little Rissington, and observation of the windsock should have shown that Runway 22 was not the most into-wind runway available. Although the Venture Gliding Squadron aircraft were using Runway 22, the pilot of G-BXAU was at liberty to choose a different runway. A landing on Runway 32 would have reduced or even eliminated any cross-wind component and would have allowed the pilot to adhere to the advice given by the mentor during his period of two-seater training.

ACCIDENT

Aircraft Type and Registration:	Yak-52, G-OCBT
No & Type of Engines:	1 IvchenkoVedeneyev M-14P piston engine
Year of Manufacture:	1990
Date & Time (UTC):	1 May 2009 at 0930 hrs
Location:	Little Gransden Airfield, Cambridgeshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Propeller, aerial, engine shock-loaded
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	39 years
Commander's Flying Experience:	1,145 hours (of which 50 were on type) Last 90 days - 4 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

Prior to landing, the pilot selected the landing gear lever from UP, to what he believed was DOWN. Just before the aircraft touched down the propeller was seen to shatter; the aircraft had landed with its landing gear retracted. The pilot had selected the three position landing gear lever from UP to NEUTRAL and had not checked the indication.

History of the flight

The pilot was returning from Wyton Airfield to Little Gransden Airfield, Cambridgeshire and this was his third flight of the day. Prior to landing he flew aerobatics for 20 minutes in the overhead of the airfield. Having joined the visual circuit downwind he completed the before landing checks. He selected the three position landing gear lever from UP, to what he believed was DOWN, but did not check the indication. Just before the aircraft touched down the propeller shattered and passed down the right side of the aircraft. When the aircraft stopped the pilot noticed the landing gear lever was in the NEUTRAL position. The aircraft had landed with its landing gear retracted.

The aircraft suffered damage to its propeller, landing gear up locks and the engine was shock-loaded.

The pilot believed the landing gear had lowered as he heard the "hiss" of the pneumatics which is the normal sound of it lowering. He added that he probably did not check the indication due to the "heavy work load" of the flight and the short transition from aerobatics to landing. He had also recently been flying another aircraft type that has a two position landing gear lever.

ACCIDENT

Aircraft Type and Registration:	Gazelle HT.MK3, G-CBXT (XW898)
No & Type of Engines:	1 Turbomeca Astazou IIIN2 turboshaft engine
Year of Manufacture:	1974
Date & Time (UTC):	1 November 2008 at 0928 hrs
Location:	Winchcombe, Gloucestershire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 2
Injuries:	Crew - 1 (Fatal) Passengers - 2 (Fatal)
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence (Helicopter)
Commander's Age:	55 years old
Commander's Flying Experience:	305 hours (of which 122[1] were on type) Last 90 days - 5 hours Last 28 days - 1 hour
Information Source:	AAIB Field Investigation

Synopsis

The aircraft was en-route from a private site near Tamworth, Staffordshire, to a maintenance facility near Royal Naval Air Station (RNAS) Yeovilton, Somerset. As it approached Langley Hill, near Winchcombe, Gloucestershire, it appears to have unintentionally entered IMC and subsequently impacted the hillside. All three occupants were fatally injured.

History of the flight

The helicopter was based at a private site at Baxterly, near Tamworth, Staffordshire, where one of its two owners lived. The other owner was the pilot of the accident flight. The co-owner who lived at Baxterly was not aware the pilot was intending to fly on 1 November 2008. However, prior to departure, from a window in his house, he witnessed the pilot strap a female passenger into the front left seat of G-CBXT.

The helicopter departed Baxterly at 0845 hrs and the pilot was planning to fly to a maintenance facility 3 nm north-north-east of RNAS Yeovilton, Somerset for a 25 hr inspection. En-route it landed and collected another passenger from a private site near Norton Lindsey, Warwickshire from where it departed at 0918 hrs.

Footnote

[1] The pilot's logbook was not recovered after the accident. All hours were obtained from the helicopter's technical log and data retrieved from its GPS.

Radio communications were established with ATC at Gloucestershire Airport at 0923 hrs as the helicopter approached Honeybourne[2]. The pilot informed ATC of his current position, routing and destination. They instructed him to report south-east abeam the airfield, which the pilot acknowledged. At 0938 hrs ATC attempted to contact G-CBXT as they had not received a position report; there was no reply. ATC continued to try to call the helicopter for the next 15 minutes and telephoned neighbouring airfields to see whether contact had made with them; it had not. At 0955 hrs ATC contacted the Distress and Diversion centre and overdue action was initiated.

The burned and smouldering wreckage of a helicopter was discovered by a horse rider at 1145 hrs on Langley Hill, 7 nm north-east of Gloucestershire Airport. This was later confirmed to be G-CBXT. All three occupants had been fatally injured.

Helicopter information

The Gazelle is an all-purpose, lightweight, military helicopter powered by a single gas turbine engine. It has three composite rotor blades and a fenestron (ducted fan) in place of a traditional tail rotor. It has an authorised maximum total weight of 1,900kg.

This helicopter was delivered to the Royal Air Force in 1973 and operated as XW898 until 1997, when it was put into controlled storage before being sold as surplus in 2001. The helicopter was then transferred to the civilian register as G-CBXT and after inspection and test, was awarded a Permit to Fly by the CAA in 2003. Conditions were placed on its operation which included the following limitation:

'5. Maximum number of occupants

5.1 Maximum number of occupants authorised to be carried (including crew): Four (Two flight crew and two ground crew, i.e. engineering staff required for the maintenance of the aircraft away from base).'

It was also to only be flown by day and in accordance with visual flight rules. An exemption allowed the helicopter to remain in its military livery and not display its civilian registration.

Maintenance History

Since its transfer to the civilian register, G-CBXT had been maintained in accordance with an approved maintenance schedule by a CAA approved maintenance organisation specialising in Gazelle helicopters. All lifed parts were controlled within operational limits and the next scheduled inspection, a 25 hr inspection, was due on the 5 November 2008. This is a relatively simple inspection to verify the helicopter's ongoing airworthiness. The Permit to Fly and Permit Maintenance release certificate were valid.

No details of any known defects were found. The maintenance organisation advised that had there been any, it was likely that the pilot would have contacted them to arrange rectification.

A radio altimeter was fitted to the helicopter, but had been disabled and placarded 'inoperative' since its transfer to the civilian register. The equipment is not approved for use in civilian machines.

The maintenance organisation was able to provide a duplicate Technical Log and copies of relevant certificates; the originals were destroyed in the accident.

Footnote

[2] Honeybourne is a disused airfield 16 nm north-east of Gloucestershire Airport that is commonly used as a visual reporting point.

Flights up to the end of September 2008 were available in these duplicate documents and details of subsequent flights were obtained from data recovered from the GPS equipment fitted to the helicopter.

The maintenance organisation stated that G-CBXT was coming to them for a 25 hr inspection. They added that they had sufficient personnel to manoeuvre the helicopter into the hangar to complete this.

Fuel

The pilot had positioned a 5,000 litre, purpose made, fuel bowser at an airfield close to his base. As far as could be determined, this was the main source of fuel for G-CBXT. The bowser had last been serviced on the 4 June 2008 and fuel samples taken at the time were satisfactory. It had been replenished with 4,500 litres of Jet A1 fuel on 7 June 2008. A copy of the release note was obtained from the fuel supplier. No contamination or water was present in samples taken from the bowser after the accident.

G-CBXT last visited the bowser location on 5 October 2008 and according to the airfield owner, the pilot was in the habit of not resetting the fuel totaliser until he next uplifted fuel. Assuming this information to be correct, the last uplift was 338 litres. The fuel capacity of G-CBXT was 457 litres, and since this visit it had flown for approximately one hour. Using a representative consumption rate, and assuming it had been refuelled to full, it is calculated that approximately 280 litres of fuel were on board at the time of the accident. It has not been possible to validate these assumptions accurately, but given the intense fire and smell of fuel present at the accident site, the estimate seems reasonable. The owner kept records of fuel uplift on a Personal Digital Assistant which was recovered in a poor condition and from which no data could be retrieved.

Examination of wreckage

Accident Site

The accident site and ground marks indicate that the helicopter was flying on a magnetic track of 020º and travelling forwards in a normal level flight attitude when it came into contact with the rising terrain at approximately 850 ft amsl. Using the ground witness marks made by the rotor blades, the ground speed was calculated to be 66 kt. The helicopter came to rest 18.5 m from the initial contact point and further up the hillside with the forward part of the main fuselage pointing back down the hill. There was a substantial fire which destroyed most of the main fuselage. The engine and gearbox fell to the right of the fuselage and the rotor blades remained attached; all three blades and their mountings sustained varying degrees of damage. Following this initial examination, the wreckage was recovered to the AAIB headquarters.

Controls

A detailed examination of the wreckage was conducted with the assistance of the French Bureau d'Enquetes et d'Analyses (BEA) and the airframe and engine manufacturers. No pre-existing defects or control disconnections were found but due to the fire damage, control runs could not be checked over their full length.

Engine and gearbox

An inspection of the engine, including an internal examination by borescope, confirmed that it was in a serviceable condition. Debris, consisting of mud and vegetation, was found as far into the engine as the turbine. The presence and nature of this debris indicated that the engine had been running at the time of the accident.

The coupling, connecting the engine to the gearbox, indicated that it had been under rotational load when it was pulled apart and damage to the coupling attaching the bolt heads indicated that the engine was still turning after the disconnection. The engine and gearbox separated as the helicopter reached its final resting position.

Rotor head and blades

Examination of the rotor head, gearbox and drive to the rear fenestron found no pre-existing defects. Damage to the assembly indicated that power was present at the rotor blades upon ground contact; the blade mountings showed distinctive deformation indicating the order of the blade strikes. Each of the three rotor blades sustained damage consistent with the order in which they struck the ground and parts of the blades were found up to 50 m from the main wreckage.

Fenestron

The tail fenestron housing was distorted in the ground collision, causing the blades to contact the shroud. The nature of these contact marks and damage to the fenestron blades and their mountings indicated that the fenestron was producing thrust at the time the distortion occurred.

Instruments

The instrument panel remained clear of the fire and the GPS unit was recovered and later downloaded.

The helicopter was equipped with two artificial horizons, a primary and a standby. Both were removed from the helicopter and taken to an organisation specialising in their overhaul and testing. Following examination and testing it was determined that prior to the accident the instruments were in good condition and were most likely working normally and giving correct indications. Accident damage to bearings within both instruments suggests the aircraft was in a level attitude when it struck the ground.

The altimeter had the correct reference pressure set but post-accident was reading 550 ft, approximately 300 ft low. Further testing showed that there were no internal leaks and its response to changes in static pressure and reference pressure setting were normal. As part of pre-flight checks it is standard practice for a pilot to check the accuracy of the altimeter before each flight. It is therefore most likely that the altimeter was working normally until the point of impact and it was the impact forces that caused calibration error. Had the inaccuracy existed prior to the accident, the helicopter would be 300 ft higher than indicated by the altimeter affording the pilot a greater terrain clearance than expected.

Weather information

The horse rider who discovered the wreckage had been out around the farm, prior to her ride, from 0800 hrs to 0945 hrs. She stated that during that time there was "really dense fog" over the accident site and surrounding hills.

An aftercast of the routing and accident site was obtained from the Met office. It stated that in the immediate vicinity of the accident site, at the time of the accident, there was probably a range of likely cloud bases that would be generated by 'forced' ascent over high ground. It added that there was most likely broken (BKN) or near overcast cloud with patches of mist/haze likely to have reduced visibility to between 5,000 m and 10 km. Above 700 ft amsl, there was likely to have been cloud covering hills that would almost certainly have reduced visibility locally to less than 1,000 m, and quite likely to less than 200 m in places. Although patches of slight drizzle may also have been present, there is no direct evidence of precipitation. There was also strong evidence, from the High Resolution Visible satellite imagery, that skies were much clearer only a short distance north-west of the accident site. In the immediate vicinity of the accident site patches of stratus were likely to have formed on high ground to give a scattered (SCT) or BKN stratus base of 700 ft to 980 ft amsl and tops at about 1,000 ft amsl. SCT or BKN stratocumulus with a base of approximately 3,000 ft to 4,000 ft, was likely to have been present above.

An estimation of the wind speed and direction is shown in the table below:

Height ft amsl	Wind Speed & Direction
Surface	010º 10 kt
500	020º 20-25 kt
1000	030º 25-30 kt
1500	040º 30-35 kt

It is likely that some areas to the lee of the hills were sheltered from the prevailing wind. There may have been local wind speeds of less than 10 kt with a rather variable direction.

The Gloucestershire Airport METAR for 0920 hrs stated that the visibility was 7 km and the cloud was SCT at 1,000 ft aal; this equates to 1,100 ft amsl.

Recorded information

Radar data from the Clee Hill radar head, which is 34.5 nm from the last GPS position, was available for G-CBXT during the accident flight, starting at 0918 hrs and ending ten minutes late. Each radar return was approximately eight seconds after the last. No altitude information was available. The aircraft was, however, equipped with a Bendix King Skymap IIIC GPS that recorded position, ground speed and ground track angle every 30 seconds, covering the same period.

The recorded track starts near the village of Norton Lindsey, Warwickshire, with G-CBXT 120 ft above the ground and finishes approximately 100 m away from the accident site. At this point, the aircraft was 150 ft above the ground, with a ground speed of 33 kt and heading in an easterly direction. The radar track (in red) and GPS points (in black) are illustrated in Figure 1.

The ground speed during the majority of flight was approximately 150 kt with G-CBXT climbing to just under 1,500 ft amsl after takeoff, and then gradually descending throughout the rest of the flight although there were several 100-200 ft climbs (see Figure 2).

A close-up of the end of the accident-flight track is given at Figure 3 and shows G-CBXT decelerating and descending as it flew towards and passed over the ridge extending westwards from Langley Hill (899 feet amsl) at approximately 160 feet agl.

The time, ground speed, altitude, height above ground level and track angle, for each of the last three GPS logged points, are given in Table 1.

Point	Time (UTC)	Ground Speed (knots)	Track (degrees true)	Altitude (feet amsl)	Height (feet agl)
A	09:26:57	140	221	1,077	805
B	09:27:27	120	239	1,060	437
C	09:27:57	33	90	993	150

Table 1

Logged GPS data (last three points) with calculated height above ground

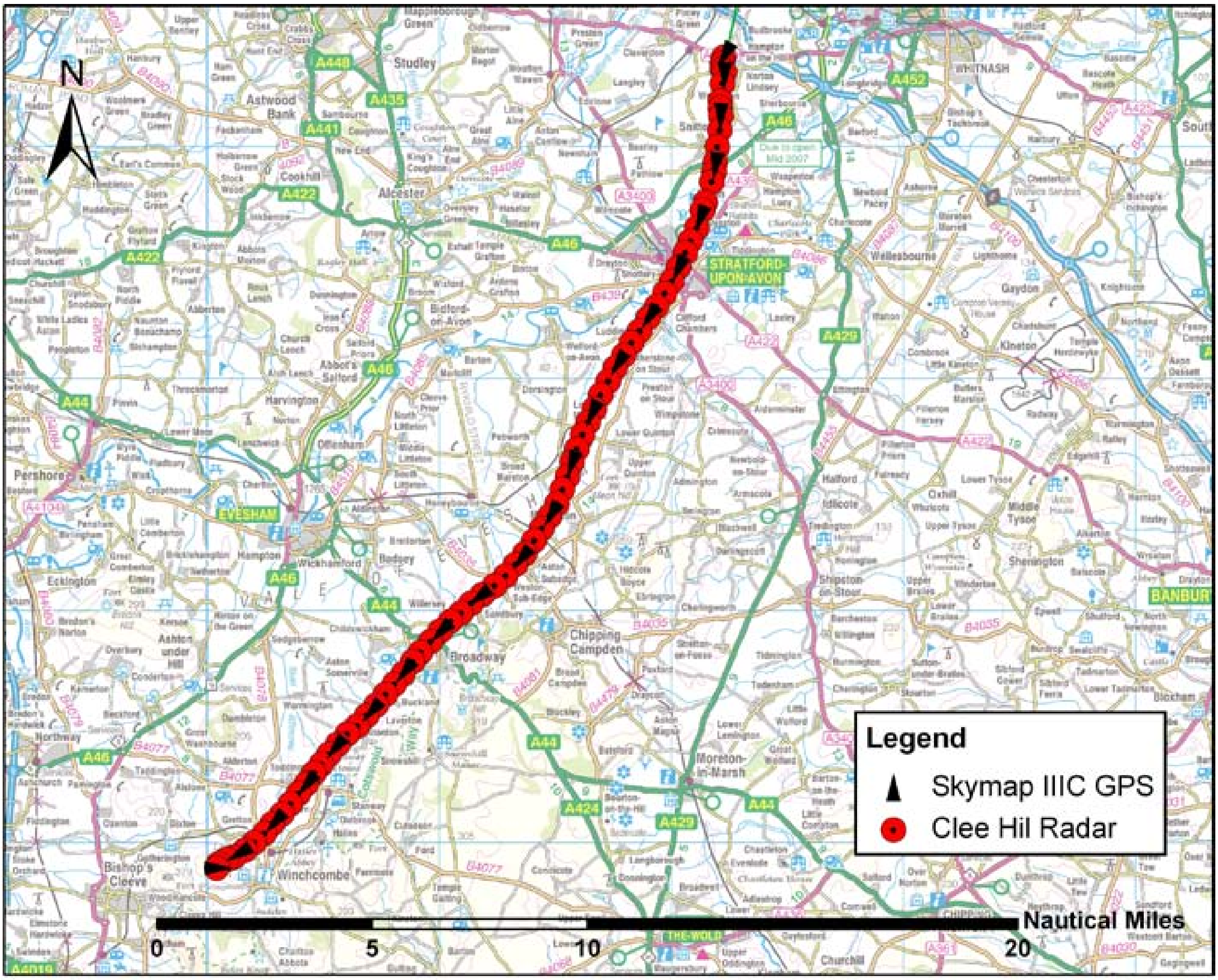

Figure 1

Radar and GPS tracks

Figure 4 show the relation of the last portion of the track with the crash site.

Occupant seating and harnesses

The helicopter was fitted with two individual front seats each with its own five-point harness attached to the seat. The metal end of each of the four other straps locks into a buckle on the crotch strap. To release the harness, a latch button needs to be depressed before turning the buckle head 90 degrees; this can be performed with one hand.

A rear bench seat capable of carrying three people was fitted. Due to the occupant restrictions of the Permit to Fly, only two car type (a lap belt with a single diagonal shoulder strap) harnesses were fitted. To unfasten the harness, a knob needs to be turned to release the buckle.

For all four seats, the buckle and metal strap ends remained intact but the strap material was consumed by the post-crash fire.

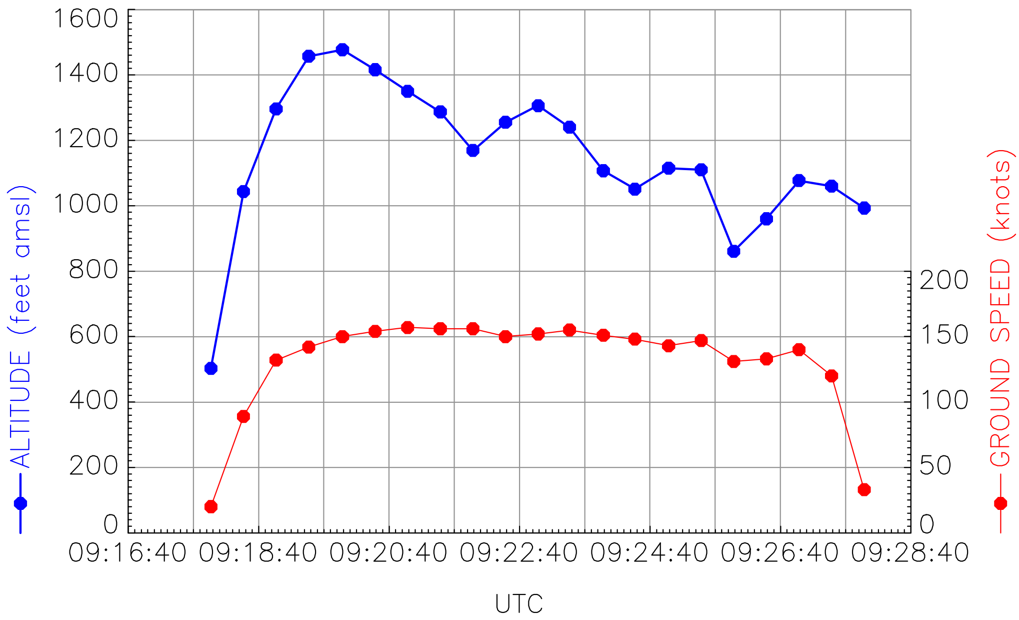

Figure 2

Accident track altitude and ground speed from GPS

The pilot was operating the helicopter from the front right seat but it could not be positively determined where the other two people were seated. It is likely that one would have been seated in the front left seat, probably the female passenger given that she was seen being strapped into that seat before the helicopter departed Baxterly, and the other on the rear bench seat.

The front right seat was detached from its mountings and the pilot remained secured to the seat by the harness; all four other straps were attached to the locked buckle of the harness. The front left seat was still attached to its mounting and its harness buckle was in the released position and did not have any of its other harness straps secured to it.

An unfastened front seat harness has the potential to restrict full aft movement of the cyclic control if the buckle falls down in front of the seat. This is a known issue and it is standard practice to fasten the harness whether or not the seat is occupied. The base of the cyclic control was inspected and as far as could be determined there was no evidence of contact with the harness buckle, but the inspection was not conclusive due to the severe damage caused by the accident. Other evidence shows that the helicopter was flying forwards in a level attitude and it is therefore unlikely that the cyclic control was affected by the harness buckle.

One of the rear seat harnesses was found in the secured position; it could not be determined to which seat this harness belonged.

Additional information

The pilot held a Private Pilot's Licence (Helicopter) with a Night qualification. This only allowed him to fly in VMC. During his skills test, prior to his licence being issued, he would have had to demonstrate to the examiner a rate one turn through 180º while flying on instruments. This is to show that he can safely turn the helicopter around to regain VMC in the event he accidently enters IMC.

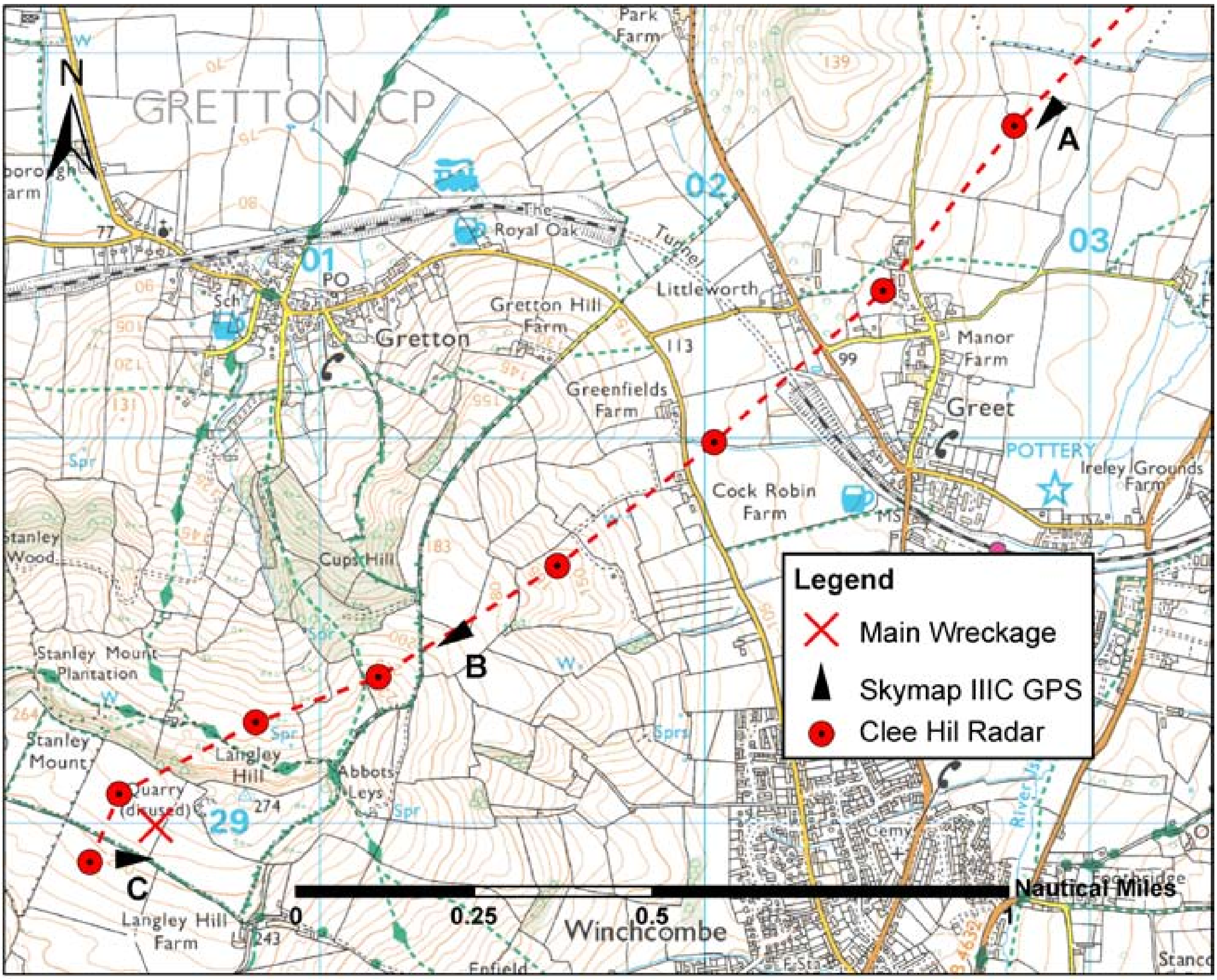

Figure 3

Close-up of the end of accident-flight track

The male passenger was a long standing friend of the pilot and had flown with him, according to the technical records, on numerous occasions before. The female passenger was believed to have been a recent business associate. Neither of them had any flying qualifications.

A homemade printed flight plan was recovered from the wreckage. It contained a list of waypoints from the en-route stop, near Norton Lindsey, to the destination, with their name, latitude and longitude, and bearing and distance information from the previous waypoint. The recorded flight path of G-CBXT remains within about 0.5 nm of the straight line track from abeam Honeybourne until about 2 nm north-east of the accident site where it gradually starts to converge onto the direct track line.

Medical information

Medical examination

A post-mortem of all three occupants was performed by a Home Office pathologist with a consultant aviation

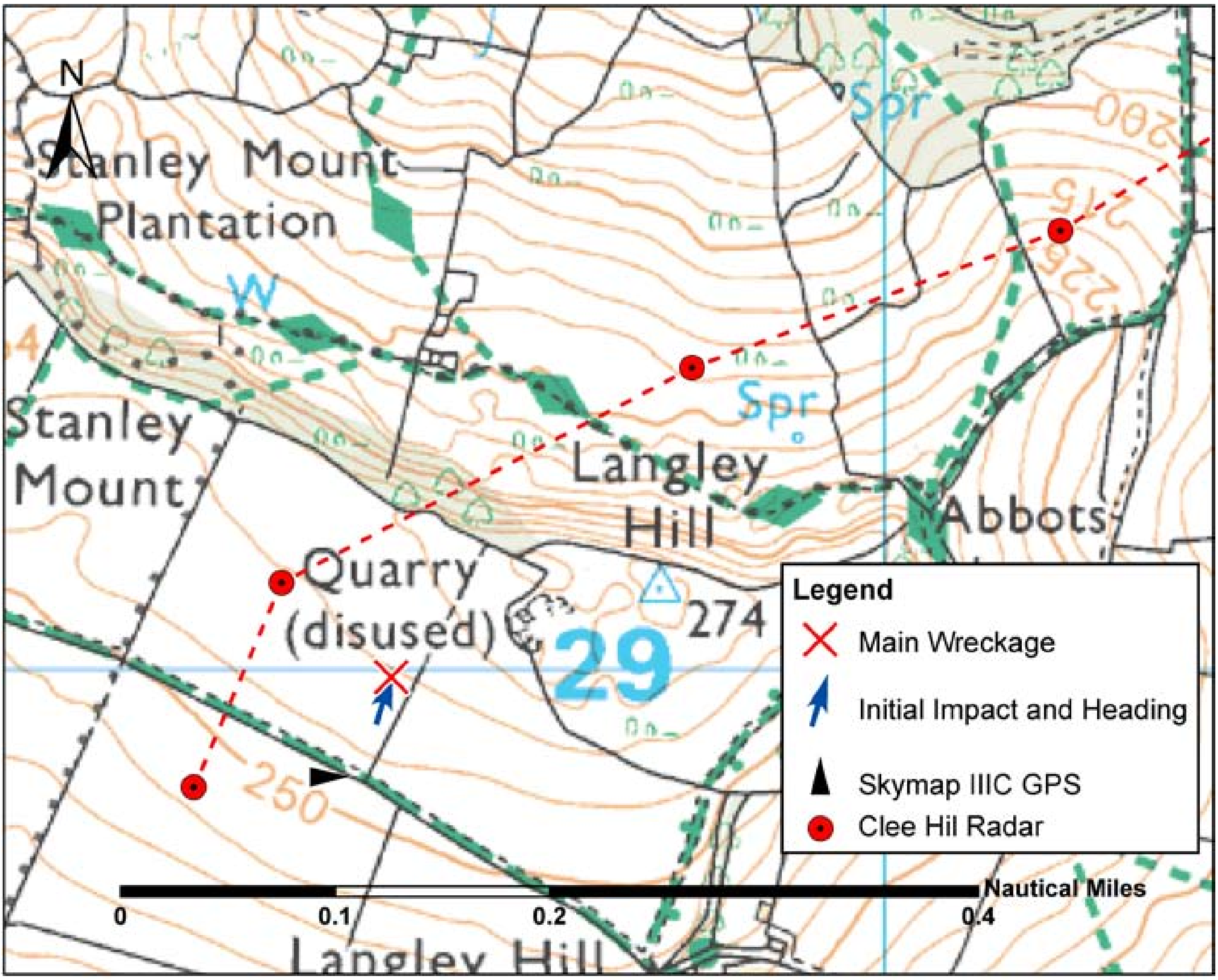

Figure 4

Crash site position with direction of ground marks

pathologist in attendance. It concluded that the two male occupants died of multiple injuries predominately due to deceleration at the time of impact.

The female occupant showed no evidence that she had been alive during the post-impact fire and that she was subjected to lesser decelerative forces with no injuries that could definitely account for her death. The report concluded that '*due to the limitations of the examination her cause of death was unascertained*'.

Only limited toxicology analysis could be performed on the pilot but no trace of drugs or drug metabolites were detected.

Medical records

The pilot held a current JAA Class 2 medical certificate. A report from his General Practitioner (GP) revealed that he had suffered from classical migraine for at least 10 years and that he had been prescribed assorted anti-migraine medication during that time.

He apparently suffered a migraine attack on average at least once a week at the time of the accident.

A review of his medical report forms, completed for the CAA for the renewal of his medical certificate in 1999, 2001, 2003, 2004, 2005, 2006 and 2007, confirmed that on each occasion he had not declared his history of migraine or medication to the CAA. The drug he was currently being prescribed would have been disqualifying for a Class 2 medical certificate and he would have been required to be headache free and off medication for a least two months prior to consideration of recertification.

The CAA medical department is required to operate under pan-European regulations which includes countries whose medical systems differ from those of the UK and as such, pilots' medical records are not examined. However, the NPPL style of self-declaration of fitness to fly requires a countersignature by the pilot's GP, who has access to the pilot's medical records.

Migraines

The symptoms of classical migraine include severe headaches and nausea and these can be preceded by visual disturbances, or other transient disturbances of brain function. The post-mortem could not determine whether a migraine attack contributed to the accident.

Analysis

Engineering

The helicopter was maintained to an approved schedule and the Permit to Fly and Permit Maintenance release certificate were valid. At the time of the accident, the engine was working normally, power was present at the rotor blades and the tail fenestron was working as expected. Of the control runs that could be checked, no pre-existing defects or control disconnections were found. Ground marks indicate that the helicopter was travelling forwards in a normal flight attitude, further suggesting that there were no control problems. Internal damage to both artificial horizon instruments reinforces the conclusion that the helicopter was in a level attitude at the time of the impact.

Medical

The pilot was being prescribed drugs for a medical condition which would have invalidated his medical certificate and as a result, his licence..

This accident highlights the ease with which a pilot, who has a disqualifying medical condition, may obtain a JAA medical certificate if they withhold information regarding their medical history and medication.

The CAA medical department is required to operate under pan-European regulations which includes countries whose medical systems differ from those of the UK. However, under present regulations there is a reliance on pilots to disclose potentially disqualifying conditions.

Conduct of the flight

The aftercast indicated that in the immediate vicinity of the accident site patches of stratus were likely to have formed on high ground to give SCT or BKN stratus with a base of 700 ft to 980 ft amsl and tops at about 1,000 ft amsl. As depicted in Figure 2, the helicopter's altitude gradually reduced as it tracked south-west from Norton Lindsey to Langley Hill. This is likely to indicate that the cloud base lowered and the helicopter descended to remain VMC below the cloud. The accident site was 850 ft amsl, and from the statement made by the horse rider, Langley Hill would have been in cloud at the time of the accident. Given the heights the helicopter was flying at before the accident, it was likely to have been in IMC from point A, shown in Figure 3, or shortly afterwards.

The final GPS recording placed G-CBXT at 993 ft amsl, with a ground speed of 33 kt. The ground marks indicated that it impacted the ground at 850 ft amsl (143 ft below the last recorded position), travelling forwards in a normal level flight attitude at about 66 kt ground speed. The impact point was approximately 100 m from the last GPS position. The wind at 1,000 ft amsl was from 030º at 25-30 kt, which meant the helicopter was likely to have had an IAS of 90-95 kt at impact.

The helicopter was tracking 239º at Point B in Figure 3. The accident site ground marks indicate that the helicopter was on a track of 020º at impact. This indicates that the pilot had turned through about 220º and may have been attempting to regain VMC from the direction the helicopter had originated, as he was taught in his PPL(H) training. However, the pilot was not qualified to fly in IMC, and would have lacked the practice to fly accurately on instruments.

While the likelihood of the pilot being incapacitated by a migraine attack cannot be discounted it is unlikely given that the helicopter appears to have impacted the hill in controlled flight.

The recorded data indicates that the helicopter was very close to the track that was probably active in the GPS. Flying 3 nm west of track in the River Severn valley over lower ground would have enabled the pilot to remain VMC below cloud.

Survivability

The female passenger was seen being strapped into the left seat of the helicopter before it departed its base. This seems to be confirmed by the positions of the bodies after the accident. Harnesses recovered from the wreckage indicate that the pilot's harness and one of the rear harnesses were secure, but the front left seat harness was undone. The post-mortem concluded that the female passenger showed no evidence of injuries which would necessarily have been immediately incapacitating. As a result she may have been able to release her harness following the impact.

Permit to Fly

This helicopter was allowed to fly subject to the conditions of its Permit to Fly with the limitation:

> *'Maximum number of occupants authorised to be carried (including crew): Four (Two flight crew and two ground crew, i.e. engineering staff required for the maintenance of the aircraft away from base).'*

The passengers had no flying qualifications and the helicopter was en-route to a maintenance facility where there were sufficient qualified engineering staff to assist with the handling of the helicopter. The passengers were thus not *required for the maintenance of the aircraft away from base* and should not therefore have been on board. They were also probably not aware of the conditions and limitations of the permit. In light of several accidents to ex-military helicopters, the CAA's Airworthiness team is working on a Permit Occupancy paper.

The following Safety Recommendation is therefore made:

Safety Recommendation 2009-089:

It is recommended that the Civil Aviation Authority review how the restrictions on occupancy of ex-military Permit to Fly Gazelle helicopters are notified.

ACCIDENT

Aircraft Type and Registration:	Robinson R22 Beta, G-TTHC
No & Type of Engines:	1 Lycoming O-320-B2C piston engine
Year of Manufacture:	1989
Date & Time (UTC):	14 February 2009 at 1240 hrs
Location:	Near Sandtoft Aerodrome, Humberside
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Fatal) Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Student pilot
Commander's Age:	54 years
Commander's Flying Experience:	75 hours (of which 75 were on type) Last 90 days - 6 hours Last 28 days - 6 hours
Information Source:	AAIB Field Investigation

Synopsis

The helicopter was being flown by a student pilot in the circuit on a solo consolidation exercise. The weather conditions were good although conducive to carburettor icing. During the downwind leg, the main rotor blades struck and severed the tail cone and the helicopter fell vertically into a field fatally injuring the pilot. The investigation established that it is probable that following the pre-takeoff magneto checks, the ignition switch was set at the L (left) magneto position. The left magneto then failed causing the engine to stop. The rotor rpm decayed and the rotor disc tilted rearwards allowing the blades to strike the tail cone.

History of flight

The pilot was a student who was undergoing training at a flying school based at Leeds Bradford Airport. On the day of the accident he flew with his instructor from Leeds to Sandtoft Airfield, a distance of 33 nm, to conduct dual and solo circuit training.

The flight from Leeds to Sandtoft was uneventful and included some general handling practice, including autorotations. Contact was made with Sandtoft Radio at 1052 hrs. The helicopter joined the right-hand circuit pattern for Runway 23 and completed a number of circuits before landing and shutting down at 1134 hrs. It was then refuelled with 32 litres of Avgas and the pilot and his instructor took a half hour break from flying.

After the break the instructor walked back to the helicopter with his student to ensure that he strapped in correctly and was prepared to continue with the solo training. The student took off at 1208 hrs.

The instructor watched a number of the student's circuits from the ground and then moved to another position where he could see just the approach area. At approximately 1240 hrs two independent witnesses saw the helicopter crash into a field and called the emergency services.

Search and rescue

The first people to arrive at the scene were a local farmer and a pilot who telephoned Sandtoft Airfield to advise them there had been an accident. Later, at the request of the fire crew this pilot moved the fuel shutoff valve from the fully-open position to the fully-closed position. He stated that he did not move, or see anyone else move, any other controls or switches.

The airfield has a fire and rescue service category RFF 1. The two Airport Fire Crew were alerted by the A/G radio operator and deployed immediately off the airfield to search for the accident site. They arrived at the site within a few minutes and found several members of the public already there. There was no evidence of fire. Access with their vehicle was impossible so they carried some rescue equipment across the field to the helicopter. They recovered the pilot from the wreckage of the helicopter and spent 15 to 20 minutes attending to his injuries. They also took photographs of the scene including the positions of switches and the distribution of the wreckage.

The local area rescue services, including the air ambulance, arrived at the scene within 15 minutes. All attempts to resuscitate the pilot were, however, unsuccessful.

Accident site details

The helicopter came to rest in an upright position, on a heading of 044^{o} in a waterlogged field just north of the M180 motorway. The tail cone had broken away from the main fuselage. The section aft of the strobe light was found approximately 30 m from the fuselage and the remainder of the tail cone was found next to the fuselage. Marks and indentations on the tail cone and tail rotor drive assembly were consistent with it having been struck at least twice by a main rotor blade. Items from the tail section of the helicopter, such as the rotor drive shaft and strobe light, were found on a heading of approximately 195^{o,} between 30 m and 150 m from the fuselage. Both main rotor blades had creases along their lower surfaces and the pitch horn had broken off from one of the blades. The instrument panel was found lying, instruments facing up, on the ground just in front of the cockpit. The canopy had fragmented into a number of small pieces. Both fuel tanks had punctured and a fairly large quantity of fuel could be seen floating on the water in the field.

Both skids had bowed outwards and the forward uprights had broken away from the skid attachment points. In addition, the heels of both skids had bent upwards and broken away. Personal equipment and aircraft documentation was found in the baggage compartments beneath both seats; however it had not prevented the sides of the pilot's seat base crumpling during the crash. There was also compression damage to the structure underneath the cockpit floor. The pilot's three point inertia seat harness was intact.

Initial examination of the wreckage by the AAIB found the controls in the cockpit in the following positions: the mixture control was fully IN, (full rich), the carb heat had been pulled out by 11 mm, the fuel shut off valve was in the OFF position, the primer was locked IN, the governor switch on the end of the cyclic was in the ON position and the ignition switch was at the L position (See Figure 1). The key in the ignition switch was undamaged and there was relatively little damage in the area adjacent to the switch. Movement of the key during the impact is therefore considered unlikely.

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The ground impact marks indicated that the tail cone and tail assembly had broken away from the fuselage before the helicopter struck the ground in a slightly nose-high, upright attitude. There was no evidence of any rotation or horizontal movement of the fuselage section when it struck the ground. The distribution of the wreckage around the front of the helicopter was consistent with a main rotor blade striking the cockpit area after impact.

Figure 1
Position of ignition switch

Pilot information

The pilot started his flying training at a flying school based at Leeds Bradford Airport in August 2005. He made steady progress and in July 2007, having completed 55 hours of dual instruction, he flew on his first solo flight. There were several breaks in his training and on 24 January 2009 he resumed training again, after a six month gap. Since then he had completed a further six hours of dual instruction before this flight, his sixth solo flight. The pilot had flown at Sandtoft Airfield on two previous occasions. He had completed an independent R22/R44 Flight Safety Course in July 2008 and held a valid medical certificate which had been renewed two weeks before the accident.

Pathology

Post-mortem examination revealed that the pilot died of multiple injuries sustained on impact. There was no evidence of any pre-existing medical condition which could have caused or contributed to the accident.

Radio communications

There is an A/G communications service at Sandtoft, callsign Sandtoft Radio. The service included a facility for alerting emergency and rescue services. The communications were not recorded but the A/G operator recalled having received only routine calls from the helicopter prior to the accident.

Local Aerodrome regulations required transponder-equipped aircraft to squawk the VFR aerodrome traffic pattern conspicuity code (7010) when asked by the ATS unit in accordance with AIC 9/2007. However, no request was made by Sandtoft Radio and no primary or secondary recorded radar information for the helicopter was available.

Witnesses

Two aircraft were operating in the circuit at Sandtoft around the time of the accident. One, on final approach to Runway 23, carried out a go-around when he saw that a helicopter was occupying the runway. He climbed away on the dead side and then turned crosswind early to keep clear of the helicopter's departure lane. He saw the helicopter climbing on the crosswind leg, to the left and below his aircraft. Later, he heard the helicopter pilot report "HOTEL CHARLIE DOWNWIND". He did not hear or see anything further of the helicopter.

A second aircraft took off after the helicopter. The pilot of that aircraft when climbing away, reported having seen the helicopter ahead and below him, turning from crosswind to downwind in the circuit at around 500 to 600 ft. He noticed that the helicopter did an unusual wobble/yawing manoeuvre during its turn, after which it apparently recovered. He later heard its pilot give a "normal" downwind radio call.

There were two people who were able to give eyewitness accounts of the accident. The first witness was in a car travelling west on the M180 motorway. He saw the helicopter cross the motorway ahead of his car and then, after briefly looking away, he looked back and saw it in an unusual nose-high attitude. The plane of rotation of the main rotor blades appeared to be at an abnormal angle to the main helicopter fuselage. The helicopter recovered to an apparently normal attitude, briefly, and then started spinning round. He thought that it had turned clockwise (viewed from above) through several rotations, and then rolled onto its side with the blades towards the east. He saw it fall to the ground apparently out of control. As it fell he saw what he thought to be a main rotor blade detach.

The second witness saw the helicopter in an apparently normal circuit pattern but lower than usual. He then heard a metallic "crack" and looked up to see the helicopter descending rapidly, in a tail-low attitude, before going out of sight.

Meteorological information

The UK low level area forecast valid from 0800 hrs to 1700 hrs showed a warm front, lying approximately north to south across the UK, moving east to cross Sandtoft Airfield at around 1400 hrs. The area ahead of the front was forecast to be mainly clear with localised areas of haze and some scattered or broken low level cloud.

The closest airfields to Sandtoft for which METARs are issued are Doncaster, 7 nm south west, and Humberside 19 nm east. The 1220 hrs METAR for Doncaster was surface wind from 190 º at 6 kt, visibility greater than 10 km, few cloud at 4,800 ft, temperature 5ºC, dewpoint 1ºC and pressure 1029 hPa. The 1250 hrs report for Humberside was surface wind from 210º at 6 kt, visibility 6 km, scattered cloud at 3,000 ft, temperature 4ºC, dewpoint 2ºC and pressure 1029 hPa. A Sandtoft Airfield meteorological report obtained from an airfield website at 1400 hrs was: surface wind from 225ºat 5-8 kt, scattered cloud 1,200 ft, temperature 5.6ºC, dewpoint 2.8ºC, and pressure 1027 hPa.

The instructor in another R22 helicopter operating at Sandtoft about an hour before the accident, reported that he had noticed a significant accumulation of carburettor ice when carrying out pre-departure power checks.

Aircraft information

General

The R22 is a two-seat, single-engine helicopter powered by a four-cylinder Lycoming air-cooled engine. Filtered induction air is supplied to the carburettor via an airbox. Ambient air enters the airbox via a duct connected to the right hand side of the aircraft and hot air is ducted from around the exhaust pipes. A sliding control valve in the airbox, operated by the carb heat control in the cockpit, regulates the proportion of ambient and hot air entering the carburettor. The normal procedure is for the pilot to monitor the Carburettor Air Temperature Gauge and apply sufficient carb heat to prevent the temperature in the carburettor orifice, which is sensed upstream of the throttle butterfly valve, falling below 10ºC. In practice this is achieved by keeping the gauge needle in the yellow arc.

Engine speed is controlled either manually, by twist-grip controls, one located on each collective lever, or automatically by the governor system. The main components of the governor system are a toggle switch, correlator, control unit and actuator. The governor is switched on by the toggle switch mounted on the end of the right hand collective lever and operates between 80% and 115% engine rpm. Engine rpm is measured by mechanical points mounted in the right-hand magneto and the electrical output is sensed by the control unit, which sends a signal to the actuator causing the throttle connecting rod between the two collective levers to move. Movement of the throttle connecting rod causes the throttle twist grips to rotate and the butterfly valve in the carburettor to move. The pilot can override the clutch in the actuator by firmly gripping the throttle twist grip. A correlator is connected to the collective lever such that movement of the collective lever causes the carburettor butterfly valve to move without providing any feedback to the throttle twist grips.

The rotor system consists of a two-bladed teetering main rotor and a tail rotor driven by vee-belts connected between the output of the engine and a clutch assembly fitted between the tail rotor drive shaft and main rotor gearbox. The clutch assembly allows the rotor assembly to freewheel when the engine power is reduced. However, the clutch only freewheels in one direction and a reduction in the main rotor rpm will cause the engine rpm to decrease with the possibility of stalling the engine.

Ignition system

The engine is fitted with a dual ignition system equipped with two magnetos each of which supplies a high voltage to one of the two spark plugs in each of the four cylinders. Within the magnetos the high energy electrical power is fed from the coil via its outlet tab to the distributor by a rotating carbon brush. The magnetos are turned ON and OFF by a key-operated, five-position, rotary ignition switch mounted on the lower instrument panel. The five switch positions correspond to:

OFF	Both magnetos switched off.
R	Right magneto switched on, left magneto switched off.
L	Left magneto switched on, right magneto switched off.
BOTH	Both magnetos switched on.
START	Operates the starter motor, both magnetos switched on.

The procedures in the R22 pilot's operating handbook require the magnetos to be checked after the engine has warmed up by setting the engine at 75% rpm and switching off each magneto in turn to check that the engine speed does not drop more that 7% rpm in two seconds.

A checklist, believed to have been used by the pilot, was found with the wreckage. The 'Start check' included a post-start test of the magnetos: 'Increase rpm to 75% -mag drop (7% max in 2 seconds)'. The instructor advised that the student had been taught to achieve this as follows:

- select one click of the ignition switch anticlockwise from both to the left magneto position

- watch that the drop of the needle is no more than 7% in 2 sec (ie. no less than 68% on the gauge
- click back to both
- two clicks anticlockwise to right magneto position same check and then turn the key back to both

There was no subsequent check of the switch position required before takeoff in either the pilot's checklist or the manufacturer's checklist.

Loss of engine power

A loss of engine power in the R22 helicopter will lead to a rapid decay in main rotor rpm if the corrective action of lowering the collective is not taken immediately. The Pilot's Operating Handbook (POH) contains a number of Safety Notices (SN) issued by the manufacturer in response to in-service experience of the R22 helicopter. SN-10, entitled '*Fatal accidents caused by failure to lower collective*' cites a failure to maintain rotor rpm as the primary cause of fatal accidents in light helicopters. The SN emphasises the importance of lowering the collective to maintain rpm as an instinctive response to any emergency and before any investigation of the problem takes place.

A loss of engine power in an R22 is evident by a nose-left yaw, change in engine noise and a rapid decay in main rotor rpm. If there is a delay in lowering the collective lever the rotor rpm might decrease to a level where the rotor blades stall. In forward flight the retreating blade will stall before the advancing blade. This will cause the rotor disc to tilt backwards, a phenomenon known as rotor blow back. With a reducing rotor rpm the helicopter would start to descend and the airflow impinging on the tail surface would cause the helicopter to pitch nose-down. If the pilot were to move the cyclic control rearwards to prevent the nose from dropping, then the combination of the rotor blow back and pilot input could cause the main rotor blades to strike the tail cone.

Carburettor icing

Carburettor icing is caused by the sudden drop in temperature of the air due to fuel vaporisation and pressure reduction at the carburettor venturi. The temperature can reduce by up to 30°C causing any moisture in the air to freeze, with a consequent build-up of ice in the carburettor throat adjacent to the butterfly valve. (The engine in the R22 is operated at a rated power so the butterfly valve does not open fully even at maximum power.) The subsequent reduction in cross-sectional area will gradually reduce the airflow and cause the engine rpm to decrease. Carburettor icing can occur when the ambient temperature is between -10°C and +30°C and the effect is most noticeable when the butterfly valve is closed.

If an engine, subjected to carburettor icing, is fitted with a governor, it will attempt to maintain the engine rpm by progressively opening the butterfly valve without the pilot being aware of what is happening. The POH for the R22 lists conditions when carburettor icing can be expected and warns the pilot that the governor system might mask the formation of carburettor icing. The limitations section of the POH, and a placard adjacent to the carburettor heat gauge, states "Caution below 18 in MP [manifold pressure] ignore gauge and apply full carb heat".

The student pilot had been trained to use the carburettor heat control routinely while flying in the circuit. Earlier in the day, while flying with his instructor, he had been applying full heat on the downwind leg before reducing power for descent, and then resetting to approximately half heat at 200 ft on final approach. Any further adjustments were made, if necessary, by reference to the gauge when above 500 ft on the climb out. The carburettor heat control is located to the left and below the pilot's knee, in a position where it would need to be operated by feel rather than physically looking at the control knob.

Detailed examination of wreckage

General

The helicopter was extensively damaged. There was no debris on the magnetic plugs in the main and tail rotor gearboxes and both gearboxes turned freely. The pitch horn had broken off from one of the main rotor blades, the eye end of its pitch link was missing and the push tube between the yoke assembly and swash plate had failed near the top of the cockpit. There was also minor damage to a number of the components in the main rotor head assembly. The main rotor gearbox frame was distorted and the tail rotor push tube was damaged. The governor actuator and the twist grip throttle were both at the fully open position. The vee drive belts were intact. Apart from the main rotor blade strike marks on the tail cone there was no other evidence of any pre-impact damage on any part of the helicopter.

Engine

The engine mounting frame had distorted in the crash and the engine had been badly damaged. Clean oil was found throughout the engine and in the oil filter, and all the spark plugs were light grey in colour indicating that the engine had been running with the correct mixture. The carburettor was examined in accordance with the maintenance manual and assessed as being serviceable. Clean fuel was found in the carburettor bowl, the acceleration pump operated normally and the jet was clean. The fan wheel slippage indicators were still aligned and there was no evidence to suggest that a mechanical failure had occurred prior to the accident.

Magnetos

Both magnetos were run on a test bench and whilst the right magneto operated satisfactory, there was no high voltage output from the left magneto. Both magnetos were dismantled and inspected in accordance with the maintenance manual. The right magneto was assessed as being serviceable. Whilst the coil and capacitor on the left magneto were found to be serviceable, the carbon brush in the distributor gear was found to be approximately 6.5 mm in length, which is 3 mm below the minimum permitted length quoted in the maintenance manual[1] of 9.53 mm (0.375 inch). The coil outlet tab, on which the brush runs, contained a depression, in the middle of which was a hole. The brush was replaced, the contact cleaned and the magneto was retested, but it still did not produce a high voltage at the distributor leads.

The brush and coil from the left magneto were examined by a metallurgist at the Royal Navy Material Integrity Group. They established that the wear pattern on the left and right magneto brushes was different and that material appeared to have been plucked out from the left brush. (See Figure 2)

Examination of the copper outlet tab on the left magneto coil revealed that it was covered in a layer of oxide and that the depression had formed due to a loss of material. The hole at the bottom of the depression had formed as a result of the copper melting and being pushed out of the depression. (See Figure 3).

Footnote

1 Teledyne S20/200 Magneto Overhaul, Item 3.

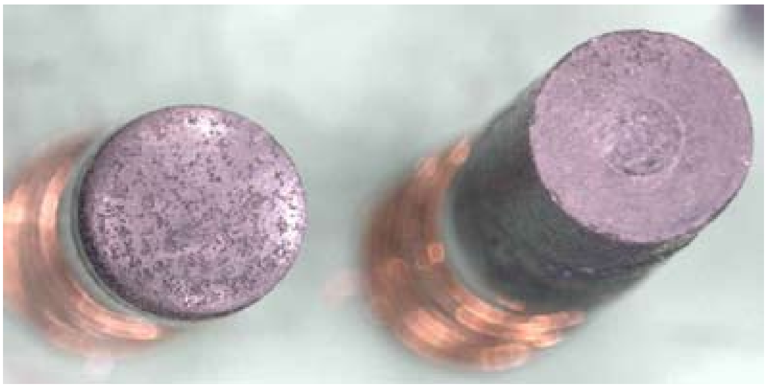

Figure 2
Wear pattern on carbon brushes

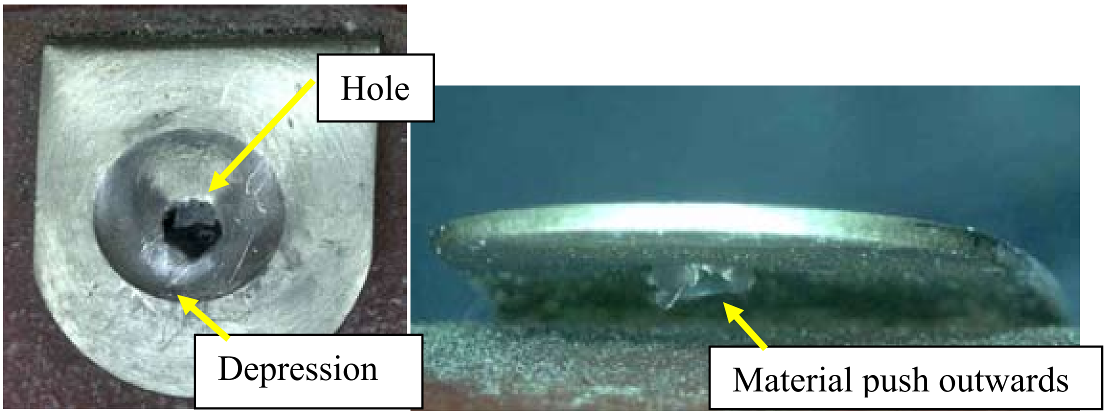

Figure 3
Copper outlet tab on left magneto coil

It is probable that the damage to the brush and outlet tab on the coil occurred over a period of time and started with a build up of oxides, which are abrasive and poor conductors. The presence of an oxide in the area between the rotating brush and outlet tab would have accelerated the wear in the brush and worn the depression in the outlet tab. This progressive build-up of oxides would eventually have resulted in arcing between the brush and tab which would have formed a carbon deposit. A metallurgist advised the AAIB that this particular type of carbon deposit would be abrasive with poor conductivity. Eventually the copper at the base of the depression would have reached a critical thickness such that the temperature rise from the arcing would be sufficient to melt the copper and force the remaining metal away from the tab. With the remainder of the outlet tab covered with oxides and a carbon (poor conducting) deposit there would no longer have been an electrical path between the coil and the distributor leads.

Carb heat control

The lock nut on the carb heat control cable end fitting was found to have unwound such that when the carb heat control was pulled ON the fitting would lift out of the instrument panel by approximately 6 mm (See Figure 4). The maintenance records show that this cable had last been disturbed during the rebuild about 462 hours earlier.

After the accident the carb heat control in the cockpit was found to have been pulled out by 11 mm, which corresponded to a 7% opening of the hot air port by cross section. However, the carb heat control valve, which is fitted to the air box, had detached from the bottom of the engine distorting the valve and causing the control cable to bend around the structure. It is, therefore, possible that it had been pulled out further than the 11 mm, but during the impact was pulled towards the cold position. From the damage to the air box it was established that the hot air port could not have been open by more than 60% of its cross-sectional area. Therefore it is assessed that at the time of the accident the hot air port had been open been between 7% and 60% of its cross-sectional area.

Maintenance history

The last 2,200 hour field overhaul was carried out in May 2007, approximately 462 hours prior to the accident, during which a 500 hr inspection was carried out on the left magneto. This inspection required the carbon brush to be checked for unusual wear and for the outlet tab on the coil to be checked for a visible depression. The maintenance organisation which undertook the work advised the AAIB that during this inspection the carbon brush was replaced and there was no evidence of excessive wear on the coil outlet tab.

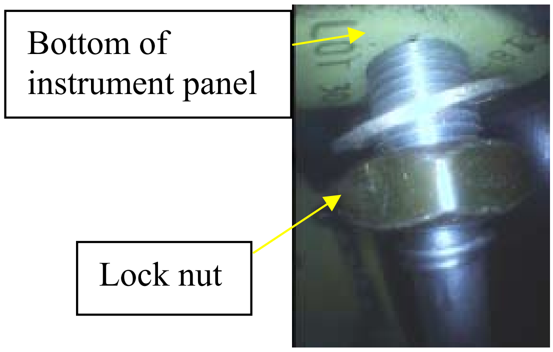

Figure 4

Carb heat cable end fitting

The aircraft was maintained in accordance with the CAA Light Aircraft Maintenance Programme and the last maintenance activity on the helicopter was the 100 hr inspection that was completed the day before the accident flight. During this inspection the ignition switch functional test and the magneto timing were checked. An engine ground run was also carried out before the helicopter was returned to service during which the operation of both magnetos was checked. From the DATCOM fitted to the helicopter it was established that the accident occurred 2 hr and 36 minutes after these checks had been carried out.

The organisation who maintained the helicopter advised the AAIB that they were unaware of any recent engine or ignition faults.

Analysis

The damage to the helicopter and distribution of the wreckage indicates that the main rotor blades struck the tail cone with a force sufficient to cause the tail section to break away from the helicopter. The damage was typical of that seen in other R22 accidents where there has been a low rotor rpm following a loss of engine power.

A loss of engine power in the R22 helicopter requires immediate and correct action from the pilot to enable a successful autorotation to be made. If there is any delay, or incorrect action, the rotor rpm will decay to the point from which recovery is impossible. This is emphasised in the POH supplied by the manufacturer.

A number of potential causes of a loss of power were considered during the investigation. The evidence suggests that only two of these were likely to have occurred. The atmospheric conditions were conducive to serious carburettor icing at any power setting which was consistent with the report received from an instructor flying another R22 locally. A build-up of carburettor ice, which could ultimately lead to the engine stopping, had been masked by the governor gradually opening the butterfly valve in the carburettor. However, the pilot had been correctly applying carb heat when he flew with his instructor and there was physical evidence that some carb heat had been applied at the time of the accident. Although the carburettor heat control lock nut had unwound this would not have prevented the full operation of the carb heat. Therefore, whilst the possibility of carburettor icing can not be excluded, with the available evidence it seems unlikely that this was a causal factor.

The helicopter should have been flown with the ignition switch selected at BOTH so that the failure of one magneto would not result in the engine stopping. However, the evidence indicates that the magneto switch was inadvertently set to the L position during the pre-flight checks, and the selected left magneto had failed in flight. The left magneto passed the checks undertaken during the 100 hour servicing carried out 2 hours 36 minutes before the accident and would have been checked by the instructor and student at the start of each of the flights undertaken on the day of the accident. Nevertheless, from the available evidence, it appears that as a result of wear of the coil outlet tab the left magneto failed during the accident flight. With the right magneto turned off this would have resulted in the engine stopping.

The unusual 'wobbling' manoeuvre observed by another pilot in the circuit may have been the result of a yaw caused by an earlier, temporary, loss of engine power during the climb. The left magneto could have started to operate intermittently before failing altogether, causing engine power to be reduced and erratic. The downwind radio call made by the pilot, which was heard by several people, was described as routine, suggesting that he had not noticed any problem.

The pilot had practised autorotations earlier in the day with his instructor but, despite this, it seems he was not able to maintain rotor rpm and successfully enter autorotation when an actual loss of power occurred. There could be several explanations for this. One is that he would have needed time to recognise the failure. In a practice engine failure, the instructor will give the student a prior warning, but in the event of a real failure it is likely to be sudden and without warning. Another reason is that with the pilot's relatively low experience, the response of lowering the collective may not yet have become a conditioned reflex.

In summary it seems that there was an abrupt loss of engine power, as a result of the failure of the left magneto. The pilot was subsequently unable to maintain rotor rpm which allowed the rotor disk to strike the tail boom causing a loss of control and a high rate of descent into the ground.

ACCIDENT

Aircraft Type and Registration:	Robinson R44 Clipper II, G-CLPR
No & Type of Engines:	1 Lycoming IO-540-AE1A5 piston engine
Year of Manufacture:	2009
Date & Time (UTC):	28 May 2009 at 1120 hrs
Location:	Goodwood Aerodrome, Chichester
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A Others - 1 (Serious)
Nature of Damage:	Extensive
Commander's Licence:	Student Pilot
Commander's Age:	62 years
Commander's Flying Experience:	302 hours (of which 53 were on type) Last 90 days - 52 hours Last 28 days - 12 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

The student pilot was landing on a concrete apron in front of some hangars. As the helicopter descended from a low hover, it was seen to rock from left to right and then to rotate quickly to the left. It lifted slightly in a nose-low, right skid-low attitude and then rolled over onto its right side. As parts of the rotor blades broke up, a piece of debris was flung across the apron and seriously injured a workman approximately 200 ft away.

History of the flight

After a solo navigation exercise, the student pilot joined the circuit and transitioned to a low hover at 'the triangle', which was within the helicopter training area. The wind was reported as calm, the visibility was more than 10 km and the base of the cloud was reported at 1,800 ft. The pilot hover-taxied to the centre of the concrete apron, "stabilised the hover" and started to lower the helicopter towards the concrete. The helicopter felt "under total control". As the helicopter approached the ground, the pilot felt "some buffeting" and just before the skids touched the concrete the pilot remembered "a sudden swing to the left". He did not remember clearly the order of events but he recalled "lowering the collective at one point and also raising it, immediately realising that was wrong and putting it back down". The helicopter rolled onto its right side and came to rest but the pilot remained in his seat until the energy from the engine and rotor had dissipated. He released his seat belt, turned off the battery master switch and fuel valve and vacated the helicopter from the left pilot's door.

Damage to the helicopter

The helicopter came to rest on its right side pointing approximately 100° right of its heading before the loss of control. The main rotor stopped in line with the fuselage. The forward rotor blade was broken at a point approximately one third of its length from the rotor mast and most of the blade outboard of this point had become detached or had disintegrated.

The tail rotor blades were intact. A number of fragments of the main rotor blades and tail section were found on the concrete apron and grass nearby. One piece of the rotor blade was found on the airfield approximately 300 m from the accident site.

Injury to a contractor

A workman was standing in the gap between two hangars approximately 200 ft from the helicopter. As the rotor disintegrated, a piece of debris weighing approximately 1.1 kg was flung across the apron towards where he stood. The debris cut through the Heras fencing separating the work area from the apron. It hit and seriously injured the workman's leg. It then penetrated the outer skin and insulation layer of the new hangar sheeting, rebounded and landed approximately four metres away next to the other hangar.

Witness information

A witness estimated that just prior to the accident the helicopter was hovering about two feet above the ground. As the helicopter descended, he saw a "left to right rocking movement". He remembered that the right skid made contact with the ground first, followed by the left. However, as the left skid touched, the right skid lifted off the ground again and "the aircraft bounced slightly from left to right". At this point "it appeared as though the pilot tried to lift the aircraft back up into a hover" but "the aircraft rocking from left to right got more extreme and suddenly the aircraft spun violently to the left while banking to the right and the main rotor blades impacted the ground".

Another witness, who held a Commercial Pilot's Licence (Helicopters), saw the helicopter "spinning quickly" to the left approximately one foot above the ground. "After one complete revolution, the helicopter raised from the ground in a nose-low, right-skid low attitude resulting in dynamic rollover onto the right side of the aircraft. The blades contacted the ground and shrapnel was fired as parts of the blades separated."

Static and dynamic rollover

If a helicopter were to be lifted by its skid on one side, an angle would be reached where a vertical line drawn through its centre of gravity would fall outside the skid on the other side and the helicopter would topple over. This is static rollover and it occurs typically at angles between 30° and 35°[1].

By contrast, dynamic rollover can occur at angles of less than 10° in certain circumstances. If during lift-off one skid were to remain in contact with the ground, it would become a pivot point about which the helicpoter could rotate. Should the helicopter begin to roll about the pivot point, the total rotor thrust would tilt in the direction of the roll and a proportion of that thrust would tend to increase the roll angle. As the roll angle increased, the rotor thrust would tilt further and increase the roll

Footnote

[1] Flight Safety Foundation; Helicopter Safety; Volume 14, Number 1.

rate and angular momentum. Should the pilot raise the collective lever, the overall rotor thrust would increase, the roll would increase still further and the situation would be made worse.

The use of opposite cyclic control inputs to reduce the roll rate might not be successful because the angular momentum could exceed the control authority available. The correct action, should a pilot notice a roll rate building about one skid, is to lower the collective control to reduce the rotor thrust that would otherwise accelerate the roll.

Action by the airfield operator

After the accident, the airfield operator introduced new rules restricting the use of the concrete apron near the hangars to licensed pilots and more experienced students. Less experienced students are required to land on the grass.

Analysis

The first thing the pilot noticed was some buffeting as the helicopter neared the ground which probably coincided with the witness seeing the helicopter rocking left to right. The next event the pilot remembered was the sudden swing to the left although witness information suggested the skids touched the concrete alternately before the swing began. It was possible that the buffeting the pilot felt was caused by the skids coming into contact with the ground but it was not possible to determine this with any certainty. There was also no direct evidence to show why the yaw to the left began but, in the absence of any other obvious cause, it was possible that the left yaw pedal was pushed forward inadvertently.

Witness evidence suggested the helicopter swung through about 360° either on, or nearly on, the concrete which was consistent with the pilot lowering the collective lever slightly. The helicopter then lifted into a nose-low, right skid-low attitude probably caused by the pilot raising the collective again. With the helicopter spinning left in this attitude, if the front part of the right skid touched the ground the helicopter was likely to topple onto its right side. The evidence suggested that this is what happened and, even though the pilot lowered the collective lever again, it was not in time to prevent the dynamic rollover.

ACCIDENT

Aircraft Type and Registration:	Aerosport Ltd Ikarus C42, G-CEAN
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	2006
Date & Time (UTC):	16 July 2009 at 1000 hrs
Location:	Popham Airfield, Hampshire
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to nose landing gear, trailing edge beam, rear tubes, and one under tube
Commander's Licence:	Private Pilot's Licence with flying instructor rating
Commander's Age:	54 years
Commander's Flying Experience:	894 hours (of which 681 were on type) Last 90 days - 59 hours Last 28 days - 47 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and subsequent AAIB enquiries

History of flight

The pilot was carrying out a bi-annual flight with a flying instructor in benign weather conditions with a light southerly wind. The instructor demonstrated a takeoff on grass Runway 21, (which has a length of 900 m) followed by a simulated engine failure and landing on the remaining runway. He commented to the pilot that a positive round-out was necessary to take account of the up-sloping runway. The pilot then attempted the exercise twice, but on the first attempt the instructor took over, and on the second the pilot landed the aircraft heavily. Two further demonstrations were flown by the instructor and the pilot then flew one successful manoeuvre. The pilot asked to fly one more practice and, although the instructor commented that nothing appeared abnormal until "the last milliseconds", the aircraft struck the ground hard, sustaining damage. The instructor commented afterwards that he believed the aircraft might have encountered windshear during the landing.

ACCIDENT

Aircraft Type and Registration:	Flight Design CTSW, G-KFLY
No & Type of Engines:	1 Rotax 912ULS piston engine
Year of Manufacture:	2007
Date & Time (UTC):	2 July 2009 at 1415 hrs
Location:	Damyn's Hall Aerodrome, Essex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to the engine frame and its mountings, and the nose landing gear attachment points
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	48 years
Commander's Flying Experience:	90 hours (of which 22 were on type) Last 90 days - 28 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft's approach to the runway was stable with a flare initiated at the normal height. Just before the aircraft touched down, it was caught by a gust of wind from the left, landed heavily and bounced. The pilot carried out a go-around and diverted to Southend Airport where he landed safely. The next day he inspected the aircraft and discovered damage to the engine frame and mountings and the nose landing gear.

History of the flight

The pilot had intended to carry out a flight from Sywell Aerodrome to Abbeville in France, stopping at Damyn's Hall Aerodrome on the outbound leg. He recalled that the weather for the flight was warm and sunny with a moderate wind from the northwest and that the visibility was reducing in haze as he progressed south. There was a small amount of cloud at about 4,000 ft agl and he considered that the weather was within limits for the flight.

The flight from Sywell to Damyn's Hall was uneventful and, after lunch, the pilot and his passenger departed for France. Their route took them to Dover, before crossing the English Channel at its narrowest point. The transit altitude was 3,500 ft in VMC but with the visibility reducing. Shortly after crossing the coast, the visibility reduced to about 2 nm with no horizon and only the vessels and their wakes providing a reference. The pilot then realised that the direction of the vessels was changing and the aircraft was in a tight, left turn, descending rapidly. He began to experience disorientation and, with considerable effort, managed to stop the left turn and level the wings. He decided to turn back and carried out a gentle right turn until the cliffs came into view which provided him with a horizon.

The experience had left the pilot shaken and he noticed his flying was "wooden" and mechanical. Instead of returning to Sywell he decided to land back at Damyn's Hall and take stock. As he approached the airfield he called on the radio but received no response and joined overhead for Runway 03. The windsock indicated a crosswind from the left which was within his limits.

On the final approach, 15° of flap was selected and the airspeed reduced to the normal approach speed of 55 kt. The approach and flare were normal but as the aircraft was about to touch down, a gust of wind caught it and it landed heavily and bounced. The pilot countered a roll to the right and the aircraft veered to the left towards some buildings, so he executed a go-around. Having climbed back to circuit height he re-assessed the situation and elected to divert to Southend where he made a safe landing. The next day he inspected the aircraft and found damage to the engine frame and mountings and the nose landing gear, all of which was sustained during the heavy landing.

Analysis

Throughout the latter part of the flight following the disorientation experience, the pilot was aware that his handling of the aircraft was not as smooth and natural as usual. The wind conditions for the landing at Damyn's Hall on the return flight were not as difficult as those in which he had previously landed the aircraft safely. He considered that he had been shaken by the experience of the disorientation over the Channel and this had affected his flying ability.

ACCIDENT

Aircraft Type and Registration:	Pegasus Quik, G-CDAX
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	2004
Date & Time (UTC):	31 May 2009 at 1750 hrs
Location:	Popham Airfield, Hampshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to right wing leading edge, wing keel and control frame
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	55 years
Commander's Flying Experience:	284 hours (of which 64 were on type) Last 90 days - 64 hours Last 28 days - 22 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft was taking off on Runway 03 in good weather conditions, with 15 kt of wind down the runway. Immediately after the pilot thought he was airborne it started to yaw to the right. The pilot tried to turn the aircraft back onto its initial heading but it rolled onto its right side and slid along the runway before coming to rest. The pilot exited the aircraft uninjured and there was no fire.

After examining the ground marks left by the wheels, the pilot considered that the accident occurred because the right main wheel had been in contact with the surface when he thought that the aircraft was clear of the ground. This had yawed the aircraft to the right.

ACCIDENT

Aircraft Type and Registration:	Pegasus Quik, G-MAXS
No & Type of Engines:	1 Rotax 912ULS piston engine
Year of Manufacture:	2005
Date & Time (UTC):	5 June 2009 at 1830 hrs
Location:	Rosall Field, Cockerham, Lancashire
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to kingpost, hangbracket and propeller blade
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	23 years
Commander's Flying Experience:	300+ hours (of which 3 were on type) Last 90 days - 0 hours Last 28 days - 0 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During the landing roll the aircraft began to make an uncommanded right turn. An unsuccessful attempt was made to steer it back onto the runway. The aircraft rolled to its left, causing the left wing to contact the ground.

History of the flight

The purpose of the flight was for training of the pilot for conversion to a flex-wing aircraft. After an uneventful local flight, the pilot joined the circuit for the grass Runway 02 at Rosall Field. The weather was good with a wind from the north-north-east at 10 kt. The approach and initial touchdown were without incident, but during the landing roll, about 5 to 10 metres after the touchdown, the aircraft began to turn to the right. The pilot and instructor attempted to steer the aircraft back onto the runway, but without success. The aircraft continued to turn through 180°, during which the aircraft rolled to its left causing the left wing to contact the ground at a slow speed, before coming to rest. Whilst the aircraft was turning and rolling the pilot switched off the engine magnetos.

Neither pilot was injured and both were able to exit the aircraft normally. During the accident a propeller blade was damaged as it severed one of the left flying wires and the loads imparted onto the left wing caused damage to the kingpost and hangbracket.

The pilot, in a subsequent report to the BMAA, stated that the turn to the right on landing may have been due to an inadvertent application of the foot brake.

ACCIDENT

Aircraft Type and Registration:	Tecnam P92-EM Echo, G-DWPF
No & Type of Engines:	1 Jabiru Aircraft PTY 2200A piston engine
Year of Manufacture:	2002
Date & Time (UTC):	1 June 2009 at 1946 hrs
Location:	Dunnaval Road, Kilkeel, Northern Ireland
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - 1 (Serious)
Nature of Damage:	Extensive damage to fuselage and left wing, ight wing detached
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	30 years
Commander's Flying Experience:	41 hours (of which 14 were on type) Last 90 days - 14 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft stalled on approach and impacted a low wall.

History of the flight

On the day of the accident the pilot completed several solo flights at a private airstrip before collecting a passenger for the short flight to nearby Kilkeel Airfield. He reported that the takeoff and flight were uneventful and that the aircraft behaved normally. Approaching the northbound grass runway at Kilkeel he initially flew the aircraft at an indicated airspeed of 60 kt and then selected full flap. Judging that the aircraft was lower than intended, he applied power and raised the nose but, at a height of approximately 100 ft, found that this was insufficient to regain the desired approach path. He then applied full power and raised the nose further, at which point the aircraft rolled suddenly to the left. The pilot could not recall the control inputs he made after this manoeuvre but remembered that the aircraft hit the ground banked to the right and in a nose down attitude.

The aircraft came to rest in an agricultural compound near the southern boundary of the airfield, approximately 60 m west of the extended centreline of the runway, demolishing a low breeze block wall as it did so. There was no fire and, despite considerable damage to the aircraft, the cabin remained essentially intact and provided a survivable space for both occupants. The pilot was able to vacate the aircraft unaided and assisted the emergency services with the evacuation of his passenger who had sustained serious injury.

Other information

The pilot reported that the surface wind was calm and the weather "fine", with visibility in excess of 10 km. He also provided information that indicated the aircraft would have been close to its maximum takeoff and landing weight of 450 kg. The UK importer of the type stated that, based on the experience of operators of the type, it is likely that with full flap and high power set, the aircraft would roll to the left upon stalling.

Pilot's assessment of the cause

The pilot commented that, although he had operated at Kilkeel on several occasions, this was the first flight on which he had carried a passenger. He considered that he made insufficient allowance for the heavier aircraft with its higher stalling speed and the extra power required to maintain the desired approach path compared to previous flights. He concluded that the aircraft stalled and rolled to the left as it did so leaving him insufficient height to effect a recovery.

Aircraft Accident Report No 5/2009

This report was published on 15 September 2009 and is available on the AAIB Website www.aaib.gov.uk

REPORT ON THE SERIOUS INCIDENT TO BAe 146-200, EI-CZO AT LONDON CITY AIRPORT ON 20 FEBRUARY 2007

Registered Owner and Operator	CityJet
Aircraft Type	BAe 146-200
Serial No	E2024
Nationality	Irish
Registration	EI-CZO
Place of Accident	London City Airport
Date and Time	20 February 2007 at 0833 hrs All times in this report are UTC (equivalent to local time)

Synopsis

On 20 February 2007 London City Airport notified the Air Accidents Investigation Branch (AAIB) of a serious incident involving EI-CZO in which the aircraft burst all four main landing gear tyres during the landing. Enquiries by AAIB revealed that the aircraft had overrun the landing distance available (LDA), but remained on the paved surface, and that the flight crew had reported a total failure of the aircraft's brakes. In light of previous overrun events involving the BAe 146 and Avro RJ series of aircraft the Chief Inspector of Air Accidents ordered an Inspectors Investigation to be carried out into this incident.

The Inspectors involved in the investigation were:

Mr PT Claiden	Investigator-in-Charge
Mr T Atkinson	Operations
Mr P A Sleight	Engineering
Mr A Burrows	Flight Data Recorders

Three Safety Recommendations are made.

The following causal factors were identified:

1. The incorrect determination of the approach reference speed (V_{REF}) as 119 kt, resulted in the aircraft landing faster than was necessary.

2. The data suggested that the control columns may have been positioned forward of their customary position after touchdown, which could have contributed to a reduction of the aircraft's weight applied to the main wheels during the first part of the landing roll.

3. Despite the commander's recollection that he moved the airbrake/lift spoiler lever to the 'lift spoiler' position, the lift spoilers did not deploy, although the system was determined to have been serviceable.

4. The non-deployment of the lift spoiler surfaces after touchdown did not enable the timely transfer of the aircraft's weight from the wing to the main wheels, and hence the effectiveness of the wheel brakes during the early part of the landing roll was not maximised.

5. The commander's perception of brake system failure led him to select the emergency braking system which removed the anti-skid protection.

6. The lack of any positive force required to hold the lift spoiler lever at the lift spoiler activation position probably resulted in the lever moving away from the point of activation before the conditions required to satisfy the lift spoiler deployment logic could be met.

Conclusions

The combination of touching down at a speed higher than was appropriate for the aircraft's weight at the end of the touchdown zone, the failure of the lift-spoilers to deploy at any time during the landing roll, the commander's mistaken belief that the aircraft's wheel braking systems had failed, and an incorrect braking technique, combined to cause the aircraft to overrun the specified landing distance available. Use of the emergency brake system, which is not fitted with anti-skid protection, caused all four main landing gear tyres to burst.

Findings

1. The flight crew was properly licensed, adequately rested and medically fit to conduct the flight.

2. The flight crew operated the aircraft within the limits laid down by the operator's Flight Time Limitations scheme.

3. The aircraft's documentation was in order and there were no relevant outstanding defects recorded in the technical log.

4. The operator required that landings at London City Airport were only to be carried out by aircraft captains, so the commander was the Pilot Flying for the sector.

5. The approach reference speed (V_{REF}) was incorrectly determined for the aircraft's actual landing weight as 114 kt, instead of 110 kt, but 119 kt was entered on the landing data card.

6. The commander flew an ILS approach to Runway 10 and gained visual contact at around 1,000 ft aal.

7. The flight crew reported seeing two white and two red PAPI lights during the visual phase of the approach.

8. By 500 ft aal, the aircraft was fully configured for landing with the checklist completed.

9. The reported wind at the time the aircraft was cleared to land was 170°/6 kt.

10. The later stage of the approach was flown at 124 kt, ie, the incorrectly written down V_{REF} of 119 kt + 5 kt (referenced to a 34 tonne landing weight).

11. The aircraft was seen to touch down at the far end of the touchdown zone.

12. The aircraft touched down in a zero degree pitch attitude and with an indicated airspeed of 119 kt.

13. The correct touchdown speed for the aircraft's actual weight was 103 kt.

14. After touching down, the commander selected the thrust levers to ground idle, the airbrake/lift spoiler lever to 'lift spoilers' and applied pressure to the rudder pedals to operate the wheel brakes.

15. As the co-pilot was about to check for indications that the lift spoilers had deployed and that the wheel brake hydraulic pressure was normal, the commander called "NO BRAKES…." as the aircraft was not decelerating normally.

16. The commander selected the wheel brake hydraulic system from Green to Yellow and because the aircraft was still not decelerating normally, then selected the emergency braking system.

17. Skid marks on the runway surface indicated that all four main wheels had locked up over the last 473 m of the ground roll.

18. The locked main wheels caused all four tyres to be worn through by friction with the surface and to deflate.

19. The aircraft came to a halt on the paved surface beyond the end of the declared landing distance available (LDA), approximately 160 m from the edge of the dock, after a total ground roll of 1,027 m.

20. The flight crew was not aware of the tyre failures.

21. The lift spoiler surfaces did not deploy at any time during the ground roll.

22. Subsequent examination of the aircraft failed to find any defects within the lift spoiler or wheel braking systems.

23. It was established that the force required to move the lift spoiler lever from full airbrake to lift spoiler was 14 lb, and from lift spoiler to airbrake, close to zero. Both values were within the limits specified in the aircraft's Maintenance Manual.

24. A non-mandatory modification, issued in March 1988, to change the operating force characteristics of the lift spoiler lever when moving from 'lift spoiler' to airbrake, from close to zero to 12 lb, had not been embodied on EI-CZO.

25. A manufacturer's analysis of 17 BAe 146/ Avro RJ series overrun accidents indicated that non-deployment of the lift spoilers on landing was a factor in only 35% of these events, but three predominant factors were identified; landing long, the condition of the runway (wet or contaminated) and landing with a tailwind component.

26. An analysis made by the manufacturer indicates that the BAe 146/RJ aircraft is no more prone to overrun the runway on landing than other aircraft types with which it was compared.

Safety Recommendations

Safety Recommendation 2008-062

It is recommended that the European Aviation Safety Agency should mandate BAe Systems Service Bulletin 27-73-00889 for the BAe 146 series of aircraft, which increases the operating force in the forward direction from zero to 12 lb, of the lift spoiler/airbrake selector lever, to prevent the lever moving forward under the influence of vibration or being inadvertently nudged forward during the landing roll.

Safety Recommendation 2008-063

It is recommended that Cityjet should incorporate in their Operations Manual allowable heading, pitch attitude and speed deviation criteria with respect to steep path angle ILS approaches.

Safety Recommendation 2008-064

It is recommended that Cityjet should remind their flight crews of the necessity to preserve recorded data on Flight Data Recorders and Cockpit Voice Recorders following an incident or accident, by isolating the electrical power to the recorders as soon as practical after any such event.

FORMAL AIRCRAFT ACCIDENT REPORTS ISSUED BY THE AIR ACCIDENTS INVESTIGATION BRANCH

2008

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

Published February 2008.

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

Published February 2008.

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

Published April 2008.

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

Published August 2008.

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

Published October 2008.

2009

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

Published January 2009.

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

Published April 2009.

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

Published May 2009.

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

Published August 2009.

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

Published September 2009.

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http://www.aaib.gov.uk