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SPECIAL BULLETINS

None

COMMERCIAL AIR TRANSPORT

GENERAL AVIATION

SPORT AVIATION / BALLOONS

ADDENDA and CORRECTIONS

(ALL TIMES IN THIS BULLETIN ARE UTC)

ACCIDENT

Aircraft Type and Registration:	Dassault-Breguet Mystère-Falcon 900B, G-HMEV
No & Type of Engines:	3 Honeywell TFE731-5BR-1C Turbofan engines
Year of Manufacture:	1986
Date & Time (UTC):	20 January 2007 at 1651 hrs
Location:	Approximately 7 nm south-west of Worthing, Sussex
Type of Flight:	Commercial Air Transport
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers – N/A
Nature of Damage:	Severe No 3 Engine damage, nacelle cowl holed, slight damage to the horizontal stabiliser
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	38 years
Commander's Flying Experience:	6,515 hours (of which 3,002 hours were on type) Last 90 days - 139 hours Last 28 days - 45 hours
Information Source:	AAIB Field Investigation

Synopsis

As the aircraft was climbing through FL130 after takeoff from Farnborough there was a loud bang and the No 3 Engine Bay fire warning activated. The crew shut down the engine and fired the extinguisher first shot; the fire warning ceased. The aircraft diverted to Gatwick and landed without further incident.

It was found that the No 3 Engine low pressure (LP) turbine assembly had suffered major disruption. Debris from the turbine assembly ruptured the engine casing, penetrated the cowling and caused slight damage to the horizontal stabiliser. Many of the fractured parts were lost overboard but the available evidence indicated that the failure had probably resulted from the fracturing of an LP turbine blade, leading to the loss of rotational restraint for the turbine stators and the spin-up and non-contained rupture of the stators.

One of the Stage 2 blades had signs of a casting defect and fracturing of this blade probably initiated the turbine assembly break-up. However, there had also been a substantial number of previous cases of Stage 3 blade fracture and it was possible that such a failure caused the turbine assembly damage. The engine manufacturer has taken measures aimed at preventing turbine blade failure. However, the possibility that casting defects could be present in Stage 2 blades produced prior to these measures and remaining in service could not be

dismissed. The turbine casing had been ruptured in some of the previous cases of blade failure, but not where the newer of two available standards of casing had been fitted. The engine manufacturer issued Service Bulletins in the latter part of 2007 recommending replacement of the casing with the later standard but this modification had not been mandated.

Two Safety Recommendations have been made.

History of the flight

The aircraft, bound for Tel Aviv, departed Farnborough at 1640 hrs. Approximately 10 minutes after departure, as the aircraft climbed through FL130 in a position 7 nm southwest of Worthing the crew heard a loud noise from the rear of the aircraft. Shortly afterwards the engine fire aural warning sounded and the No 3 Engine fire warning light illuminated. The pilots noticed that the No 3 ITT[1] warning light was also illuminated and that the ITT indication was fluctuating "wildly". Indications for the No 1 and 2 Engines were normal. The pilots carried out the engine fire procedure for the No 3 engine, and declared a MAYDAY to the London Terminal Control Centre (LTCC). The crew were given immediate radar vectors for Gatwick Airport, the nearest airport; the crew accepted Gatwick since it was "fully equipped" (with rescue and fire fighting services) and had a runway of sufficient length to meet all the foreseeable performance limitations of the aircraft.

Two minutes after the MAYDAY call, the non-handling pilot announced that the fire was "under control" and that the engine fire procedure was complete. The subsequent diversion was uneventful, although on approach to Runway 26L at Gatwick there were several instances of the GPWS 'TOO LOW, FLAPS' callout. The pilots commented that the assistance provided to them by ATC had been "very professional"; approximately 12 minutes had elapsed between their MAYDAY call and the landing at Gatwick.

The operator indicated immediately after the incident that it intended to ferry the aircraft back to Farnborough using the remaining engines because there were no appropriate maintenance facilities at Gatwick. The operator also reported that the aircraft flight manual contained information about the correct procedures for conducting a two engine ferry flight and that it had received approval from the engine manufacturer for such a flight. When advised that the AAIB would inspect the aircraft at Gatwick, however, the operator decided that the aircraft would not conduct further flights until repairs had been carried out.

Ferry flights

An aircraft with one unserviceable engine would no longer meet the certification standards set for qualifying for a Type Certificate and as such the Certificate of Airworthiness would be invalid. In some cases a Permit to Fly can be issued so that the aircraft can be flown to a maintenance base. The procedure to be followed is contained in Flight Operations Department Communication (FODCOM) 28/2005, issued by the United Kingdom CAA. In addition to establishing technical and operational procedures for the safe conduct of such a flight, the FODCOM specifies that the operator must apply for a Permit in writing to the CAA. In the case of G-HMEV the operator provided evidence that such procedures were in place. In the event, no such application was made.

Recorded information

In addition to the FDR and CVR fitted to the aircraft, data which had been recorded from the Pease Pottage radar

Footnote

[1] Inter turbine temperature.

head was made available to the investigation. These three sources were used to reconstruct the history of flight. Both CVR and FDR retained recordings covering the period from the onset of the event until the subsequent landing at Gatwick. LP spool speed (N_1) was the only engine parameter recorded by the FDR installation; each engine was sampled and recorded at four second intervals. Spectral analysis, with particular reference to engine frequency signatures, was conducted on the CVR area microphone channel in order to corroborate the data obtained from the FDR.

The data showed that the event occurred whilst the aircraft was climbing through FL130 with all engines at 100% N_1. The heading was 167ºM and the IAS approximately 310 kt. The aircraft was located over water approximately 7 nm south-west of Worthing at the time.

The No 3 engine N_1 reduced from 100% and stabilised at 38% over a 10-second period and the No 3 engine bay fire warning activated. The engine was shut down 9 seconds later and N_1 reduced to about 22%. The other two engines were unaffected. For the remainder of the flight the No 3 Engine N_1 indicated that the fan was 'windmilling', with rotational speed proportional to airspeed. Mode C radar recordings indicated that the maximum altitude reached was FL136.

LTCC handed the aircraft over to Gatwick ATC and it was cleared to land. Seven instances of 'TOO LOW, FLAPS' were recorded during the approach. The aircraft landed 12 minutes after the event.

The model of FDR[2] fitted to the aircraft used a Group Code Recording (GCR) method of encoding data before writing the information to the magnetic tape. Overall, the quality of the recording was below average with numerous data errors. Following the engine failure, the recorded data quality deteriorated significantly with the result that there was more data in error than there was valid. The nature of GCR encoding together with the large quantity of data errors rendered large sections of the data irrecoverable.

From AAIB experience, this model of recorder is more susceptible to data errors induced through vibration of the tape transport mechanism than other tape-based recorders. Solid state recorders do not suffer from these vibration effects. In light of recording performance and continued airworthiness, the ICAO Flight Recorder Panel is reviewing the suitability of magnetic tape flight recorders with a view to amending the Standards in Annex 6 to discontinue their use. It is anticipated that such a change would also require a retrofit of existing installations and the replacement of magnetic tape recorders with those that use solid state memory as the recording medium. As the AAIB consider that this issue is being addressed satisfactorily, no Safety Recommendation is currently deemed necessary.

Aircraft description

Aircraft

The Falcon 900B is a long-range passenger transport aircraft with accommodation for two pilots and up to 19 passengers. It is a low-winged monoplane with a horizontal stabiliser mid-mounted on the fin; maximum takeoff weight is 45,500 lb (20,640 kg). The aircraft is powered by three rear-mounted turbofan engines, with the No 1 and No 3 Engines pylon-mounted on the fuselage, left and right sides respectively, and the No 2 Engine installed within the rear fuselage.

Footnote

[2] The FDR model number was 17M800-251 (commonly known as an F800) manufactured by L-3 Communications.

Powerplant

The Honeywell TFE731-5BR is a two-spool, turbofan engine with a sea-level static takeoff rated thrust of 4,750 lb. The low pressure (LP) spool consists of a three-stage axial turbine driving an axial compressor and, via a speed-reduction gearbox, the fan (Figure 1). The high pressure (HP) spool has a single-stage axial turbine driving a centrifugal compressor. Both turbines rotate clockwise (all circumferential positions noted are as viewed from the rear). At 100%, N_1 is 21,000 rpm and the HP turbine speed (N_2) is 30,300 rpm.

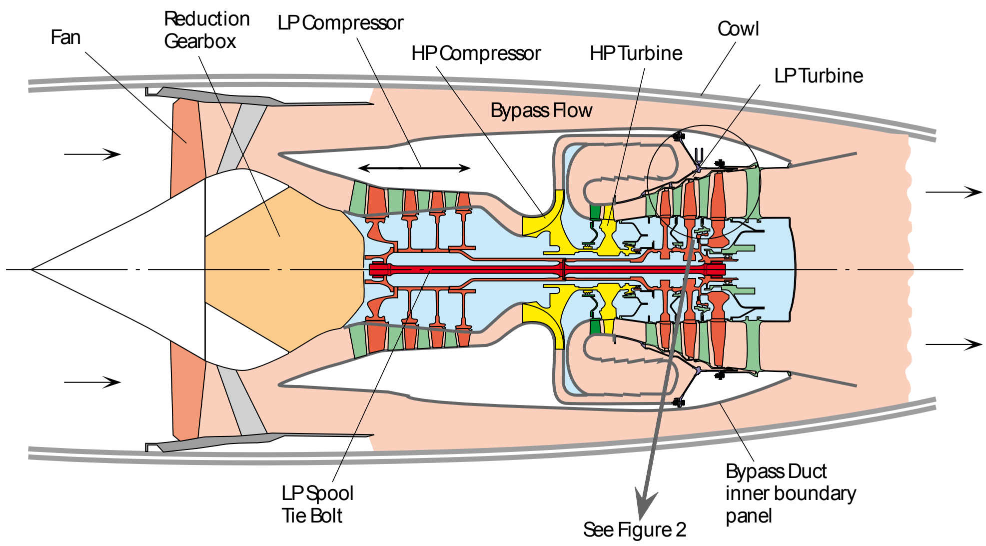


Figure 1

G-HMEV Engine Schematic

The turbine assemblies are of conventional configuration, with each turbine stage consisting of a series of radial aerofoil-section blades installed in fir-tree slots formed in the rim of a turbine disc. A ring of static nozzle guide vanes (NGVs) at the inlet to the HP and LP turbines controls the flow of gases from the combustion chamber. The flow onto the LP turbine 2nd and 3rd stages is directed by a ring of stator vanes upstream of each stage. Integral blade tip shrouds connect the LP turbine NGVs and stator vanes together (Figure 2). The Stage 2 stators are rotationally keyed to the Stage 3 stators, which are bolted to the aft flange of the interstage turbine transition duct (ITTD), a casing with a Y-shaped cross section that surrounds the LP turbine assembly.

The LP turbine blades each have an integral tip platform with a knife-edge profile that fits against the respective NGV or stator vane shrouds to control gas leakage at the tip. An integral platform at the root of

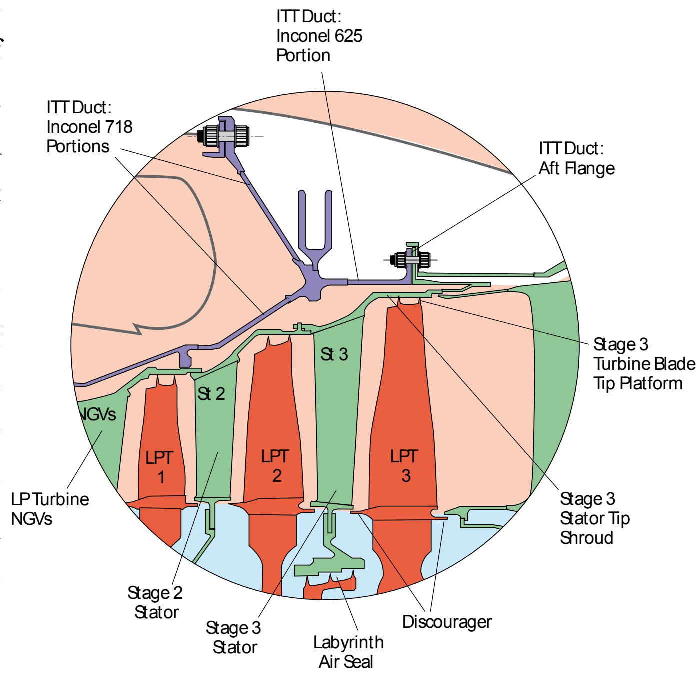


Figure 2

LP Turbine Schematic

each blade incorporates 'discouragers' to control gas leakage between the root of the blade and the adjacent stators.

The Stage 2 turbine has 52 blades, each around 3.4 inches long with a chord of 1.2 inches. They are produced by machining a casting of IN100 alloy, a nickel-chromium steel alloy, and protected with an aluminide coating.

A firewire sensing element for the engine bay fire detection system runs around the outside of the ITTD near to its aft flange. The hot section of the engine is covered by two relatively lightweight steel panels forming the inner wall of the bypass duct in this region. The cowls for the pylon-mounted engines of the Falcon 900 are of double-walled composite construction.

Examination

Aircraft

Examination of the aircraft revealed an approximately 6x6 inch triangular hole in the upper portion of the No 3 Engine cowl. The hole was at the longitudinal station of the LP turbine and located at around 2 o'clock. A 4-inch long scratch in the undersurface of the right horizontal stabiliser, near to the tip, appeared likely to have been caused by debris ejected from the engine.

No 3 Engine

The rear part of the No 3 Engine ITTD had been cut through circumferentially just forward of its aft flange, round 310°. The edges of the cut had been bent outwards, producing a gap in the duct of up to 2 inches (Figure 3). An 8-inch length of the circumference on the left side remained intact. The panels covering the engine hot section had sustained multiple impact damage in a band centred on the cut in the ITTD, together with overheat discoloration of the paint in this area. The damage included extensive holing of the panels; one area of holing concided with the hole in the cowl.

The engine manufacturer and the maintenance organisations responsible for the aircraft and engines provided an excellent level of co-operation and assistance with the investigation. The No 3 Engine (Part No 3075330-3. Serial No P95127C) was strip examined under AAIB control at the manufacturer's facility in Phoenix, Arizona, USA, with representatives from the USA National Transportation Safety Board (NTSB) and the USA Federal Aviation Administration (FAA) present.

The examination revealed that many of the components exposed to the hot gas path had been coated with a silvery metallic deposit, consistent with the deposition of fine aluminium debris ground from the LP and HP compressor shrouds by, respectively, the LP compressor blades and the HP impeller. Such an effect reportedly would commonly result in the event of operation of this engine type with major imbalance present. With this

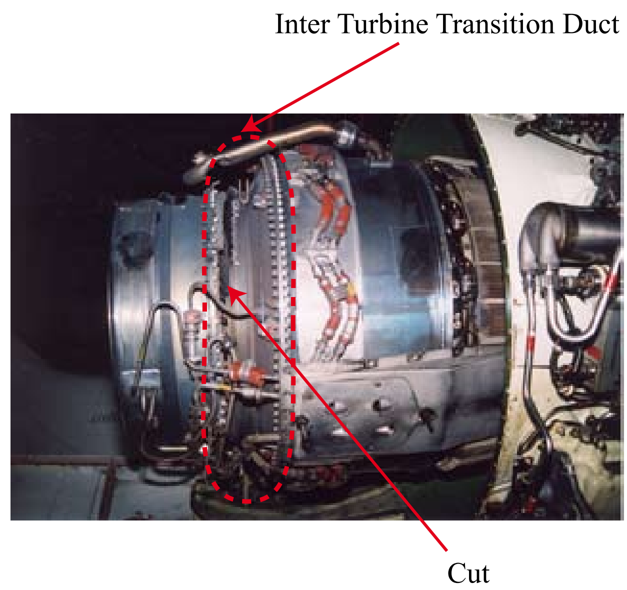


Figure 3

No 3 Engine Turbine Assembly

exception, no damage or anomaly was found upstream of the LP turbine. In particular, there were no signs of hard object impact on the HP turbine blades or on any other upstream gas path components.

No 3 Engine LP Turbine assembly

All of the LP turbine Stage 1 blades had suffered severe impact damage to their trailing edges and, for four blades, localised impact damage to the leading edge.

The outer portion of all Stage 2 blades had broken off, generally at around 1.5-2.0 inches from the root platform. However, three of the blades had fractured at around 0.5 inches from the root platform and one (No 5, numbered from a clocking index mark on the disk) had fractured at the platform (Figure 4). The outer portion of all Stage 3 blades had broken off, generally at around 70% span. Only a relatively small amount of the debris fractured from the turbine assembly remained with the powerplant, most of it having been ejected overboard. In particular, most parts of the Stage 2 and Stage 3 stators were absent.

The nature of the damage indicated that the disruption had resulted from a failure in the Stage 2 or Stage 3 of the LP turbine assembly. The leading edge damage to the Stage 1 turbine blades was consistent with the effects of limited forward penetration of debris into this region. The fracture surfaces of those stator and turbine blade parts that were available had features consistent with failure due to overload and no signs were found of pre-existing fractures, with the exception of the Stage 2 No 5 blade, as described below.

Stage 2 LP Turbine No 5 Blade

The fracture surface of the No 5 blade exhibited a discoloured region, extending over the rear one-third of the section, where the surface had a darker

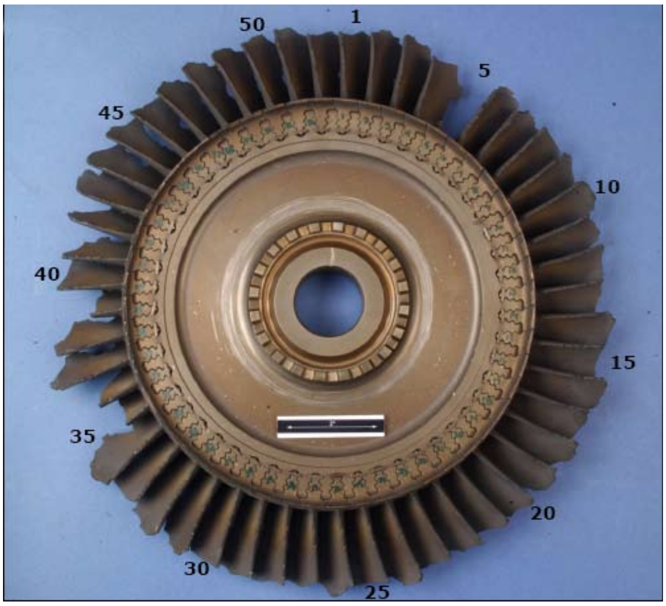


Figure 4

Stage 2 LP Turbine

appearance than for the remainder of the fracture (Figure 5). Detailed scanning electron microscope (SEM) examination of the discoloured region showed features of heavy oxidisation and areas with a smooth appearance, lacking typical fracture features. The characteristics indicated that these areas had been unbonded, ie the material had been separated before the blade had failed. Features evident with the SEM on the

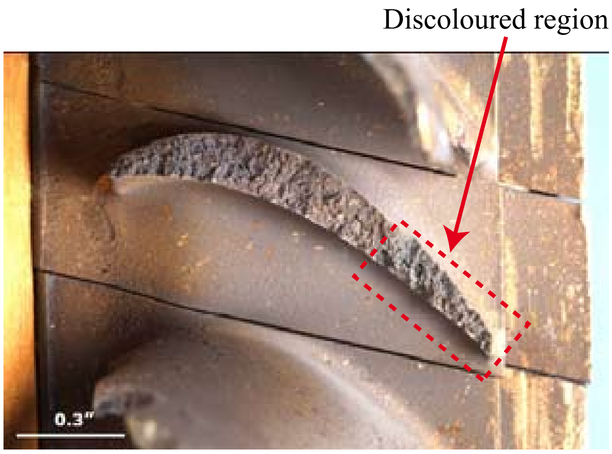


Figure 5

Stage 2 LP Turbine No 5 Blade

un-discoloured part of the fracture indicated that it had resulted from overload. The chordwise extent of the pre-existing crack was around 0.3 inches.

A section cut through the discoloured region revealed a relatively thick coating on the fracture surface, with the appearance of an oxidation product (Figure 6). The sectioning also revealed a secondary crack, beneath the separation fracture surface and generally parallel to it, also coated with the oxidation-type material. The secondary crack extended to the surface of the blade at the trailing edge but, on the plane of the section, was not open at the surface. Some alloy depletion was evident in the parent material beneath the coating layer on both the separation fracture and the secondary crack, also indicative of oxidation effects. Energy dispersive x-ray analysis of the coating layer material revealed the presence of the IN100 base metal elements and of oxygen, again indicative of an oxidation product. Aluminium was not present in a high concentration.

The presence of the secondary crack and the oxidisation both of its surface and of the discloured region of the separation fracture were evidence of pre-existing cracks in this area that had been open at the blade surface while exposed to the hot oxidising environment. The features were indicative of a casting defect; the metallographic appearance suggested that this had been a 'hot tear' (see below). The absence of appreciable aluminium in the oxidisation layers suggested that the cracks had not been open at the blade surface when the aluminide blade coating had been applied.

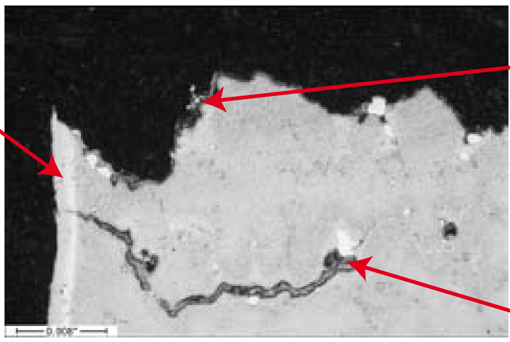


Figure 6

Section through Discoloured Region of Stage 2 LP Turbine No 5 Blade

Maintenance history

Maintenance documents indicated that the No 3 Engine had been converted from a TFE731-5A model to a TFE731-5BR-1C in 1998. A new LP turbine Stage 3 disc with all new Stage 3 blades (Part Number (PN) 3060690-1) had been installed at this time.

The engine had undergone repairs in early 2006, apparently to rectify a problem with excessively low margins from the allowable limits for turbine temperature and spool speed at takeoff power. All new LP turbine Stage 2 blades had been installed at this time. These blades had accumulated 624 hr/188 cycles from new at the time of the accident. The next scheduled inspection of the blades, including fluorescent penetrant inspection (FPI), would have been at the subsequent Major Periodic Inspection of the engine, required every 2,100 operating hours.

The records indicated that routine FPI and eddy current inspection of the LP turbine Stage 3 blades for cracking had been carried out during the 2006 repair work, the last inspection of the blades. These inspections are reportedly normally accomplished without removing the blades from the disc. At the time of the accident the Stage 3 blades had accumulated 3,109 hr/1,304 cycles from new and 624 hr/188 cycles since the 2006 inspection.

The last aircraft and engine check had been a 300/400 hr Check, followed by a ground engine run, completed immediately before the accident flight. At the time of the accident the engine had accumulated 8,409 hr/3,366 cycles from new.

Background

TFE731 engine

The Garrett (subsequently Honeywell) TFE731 engine was first certificated in 1972, as the TFE731-2. Development produced -3 and -4 versions, followed by the -5 model, a higher power version that was certificated in 1983. These four versions are referred to as the 'Classic' models. At the time of the accident the -4 and -5 engines, which constituted the majority of the Classic fleet, numbered approximately 2,795, with a total operating time of around 12.7 million hours.

Further developments generated -20, -40, -50 and -60 models, referred to as 'NG' (Next Generation) models. At the time of the accident approximately 1,894 NG engines had been produced, with a total fleet operating time of around 4.1 million hours.

LP Turbine Stage 2 Blades

The LP turbine Stage 2 blades are manufactured by filling a casting mould with the molten IN100 alloy in a vacuum furnace. The cooling rate of the casting during solidification is controlled by the mould insulation and the surrounding temperature.

Information from the engine manufacture indicated that occasionally the casting could suffer intergranular cracking during or shortly after solidification, a defect known as a 'hot tear'. This could apparently result from an inappropriate cooling regime or possibly because of physical disturbance of the mould and tended to occur towards the aerofoil root, where the thermal gradients were relatively high. It was intended for such a defect to be detected by inspection of the casting. The standard technique, after grit blasting of the casting, was FPI, intended to reveal the presence of a crack that extended to the surface. The engine manufacture stated that the critical crack length in the root fillet region of the blade (ie the crack length at which failure during the next engine cycle would be expected) was 0.250-0.375 inches.

For an approximately 10-year period the castings had been manufactured by a contractor in the USA. Two feeds to the mould had been employed, one at the tip and the other at the root. In early 2006 the production process had been changed and manufacture moved to Mexico. One of the changes was for a single feed to the mould, at the root. The Casting Number altered but the blade PN remained the same. At the time of G-HMEV's accident, around 55,000 TFE731 blades had been produced using the revised process.

In October 2006 a TFE731 engine suffered an LP turbine failure during a production test run, as the engine was nearing maximum power in a test cell. Investigation by the engine manufacturer found evidence of a hot tear defect in an LP turbine Stage 2 blade, which was found to be a revised production standard blade.

Further assessment by the engine manufacturer as a result of the failure found that a number of revised production standard blades exhibited hot tear defects that had remained undetected by the standard inspection process. It was concluded that hot tears in blades produced by the previous casting process had tended to be more open at the surface and therefore more readily detected than with the revised process. As a result, a thermal cycle was added to the revised production process whereby the cooled blade castings were re-heated to 2,000ºF and then re-cooled, prior to the FPI.

Following the failure, revised production standard blades installed in turbine assemblies that had not returned to service were re-inspected. As the aluminide coating on a completed blade could cover and hide a hot tear, affected LP turbines were removed and subjected to an overspeed spin before FPI in order to apply a controlled overload to the blades, with the aim of opening up any hot tear defects present. An eddy current inspection method was also developed, but was considered impractical for general usage.

The engine manufacturer estimated that the operating time before complete fracture of a blade with a defect such as that found on the No 5 blade from G-HMEV's failed engine would be less than 1,000 hours.

LP Turbine Stage 3 Blades

Information from the engine manufacture indicated that several versions of LP turbine Stage 3 blade had been employed on the TFE731 engine and others were in development at the time of G-HMEV's accident. The original type of blades (PN 3074755) had suffered a substantial number of in-service cases of high-cycle fatigue cracking and fracturing near the tip, apparently associated with a torsional resonant vibration mode and also possibly related to excessive bowing of the stator shrouds. At the time of G-HMEV's accident this type of blade was no longer in service.

Redesigned stator shrouds and redesigned blades (PN 3060690-1) with an elevated resonant frequency were introduced. This type of blade was fitted to G-HMEV's No 3 Engine. A minor variation of this version (PN 3060690-2) was also produced. At the time of G-HMEV's accident the PN 3060690 blade was fitted to approximately 40% of the TFE731 fleet.

The blade was made from a nickel-chromium steel alloy casting, treated with a hot isostatic press process to reduce porosity, and machined to the required dimensions. Variabilities in the shape of the cast blade could be corrected by 'straightening' (bending and twisting), while cold, in order to produce a casting that was within the final machined dimensions. Unlimited straightening was permitted for this version of blade.

One of the features of the blade that raised the resonant frequency above the normal operating range was a highly waisted profile (ie pronounced reduction in chord) at around 75% span. A region of the blade leading edge at the waist was found to experience relatively high operating stresses, with a normal maximum stress of around 90 ksi (thousands of pounds per square inch). However, this version of the blade remained in service for a number of years without major problems.

Several cases of blade fracture were then experienced, apparently affecting a particular batch of blades installed during 1999 and 2000. A Service Bulletin (TFE731-72-3691, initial issue date 12 August 2004) recommended replacing blades from this batch at the time of certain aircraft or engine maintenance checks or engine disassembly operations. However, failures of blades that were not from the suspect batch subsequently occurred. The failures were attributed to excessive local stress, probably related to residual stresses introduced by straightening operations during manufacture.

A further version of the blade (PN 3060788), with restrictions on the amount of straightening allowed, was developed as a replacement for the suspect batch of PN 3060690 blades. The operating stress in the highly stressed leading edge region was significantly reduced, but the blade remained susceptible to stress concentrations produced by any nicks in the leading edge and a number of failures occurred.

Two further versions of blade were in development at the time of G-HMEV's accident. One of these (PN 3061823) is made from a different material and has a different camber and less pronounced waisting. Its resonant frequency remains outside the LP turbine operating speed range and normal maximum peak stresses are significantly reduced (in the order of 50 ksi). No straightening during manufacture is permitted. Start of production was planned for December 2008.

Summary of previous failure cases

LP Turbine Stage 2 Blades

The engine manufacturer provided information on the failure of the Stage 2 blade in the production test bed in 2006. The casting defect was located just above the fillet between the root platform and the aerofoil, a relatively highly stressed area, and extended across approximately 75% of the section. The manufacturer concluded that stress concentrations created by the defect had caused the blade to fracture under normal loading conditions. With the possible exception of G-HMEV's accident, no similar failures to engines in service had been reported.

LP Turbine Stage 3 Blades

The engine manufacturer was aware of 65 previous cases of fracture of PN 3060690 Stage 3 blades in service, 44 on Classic engines and 21 on NG engines. Around 66% of the failures occurred on the TFE731-5B version of the engine. The failures had occurred at a blade operating time of between 811-6,000 hr from new. Six in-service failures of the PN 3060788 blade had occurred.

In some of the previous cases of blade failure the fracture surfaces were missing or damaged. However, the engine manufacturer considered that reliable fracture and materials analysis results had been obtained in around one third of the cases. This had led to the conclusion that blade fracturing had typically occurred when excessive stresses led to a small chordwise intergrannular crack in the leading edge at around 75% span that had then extended in low-cycle fatigue. Above a critical crack length of approximately 0.25 inches the remaining part of the blade cross-section had become overloaded and suffered rapid fracture.

The blade material is relatively notch-sensitive and thus a nick in the blade surface, as could be caused by hard object impact occurring during engine running or maintenance operations, tended to act as a significant stress concentrator. The blades were therefore considered to be quite sensitive to leading edge damage, particularly in the region of relatively high operating stresses at around 75% span. Additionally, testing and calculation reportedly showed that significant residual stresses could be introduced during blade manufacture by straightening operations on the casting. Because of the particular profile of the blade, the cold-working associated with straightening tended to be concentrated at the waist region, producing residual stresses in this area that could add to the relatively high leading edge operating stress in the same region.

LP Turbine blade failure effects

In many of the Stage 3 blade failure cases little further damage resulted, but in some cases the broken portion of blade caused other Stage 3 blades to break. Blade debris could then pile up and be dragged round in contact with the stator shrouds and could sever the shroud ring, thus separating the Stage 2 and Stage 3 stator rings from the aft flange of the ITTD. The consequent removal of the rotational restraint for the stator rings would lead to their spinning under the influence of aerodynamic forces on the vanes, while retained generally centralised by the inner labyrinth air seals. The forces would also tend to drive the stator rings aft, causing them to suffer damage from contact by the turbine blade discouragers. It was predicted that the rings would burst at around 2,000 rpm; debris from the rotating stators would then impact and damage the ITTD.

In four of the previous Stage 3 blade failure cases part of the ITTD circumference was cut through and engine debris non-containment occurred. In one of these cases debris struck the aircraft fuselage, causing denting and scratching but no penetration.

All four of the cases where the ITTD was ruptured occurred on Classic engines. Some cases of Stage 2 and Stage 3 stator spinning on NG engines occurred, but in none of them was the ITTD penetrated. This was attributed to the significantly stronger material used for the aft portion of the duct on the NG engines (see below).

Interstage turbine transition duct

The main part of the ITTD is fabricated from welded Inconel 718 for both Classic and NG engine types. The aft portion of the duct is also of Inconel 718 for NG engines, but is of Inconel 625 for Classic engines. The Ultimate Tensile Strength of the two materials at 1,200ºF is in the order of 158 ksi for Inconel 718 and 50 ksi for Inconel 625.

The engine manufacturer had plans in place at the time of G-HMEV's accident for a programme to modify Classic engine ITTDs by replacing the aft portion with an Inconel 718 component, as for the NG engines. Service Bulletins to incorporate this modification were issued on 12 September 2007 (Nos TFE-731-72-3727 and TFE-731-72-3728, applicable to different engine models). The Service Bulletins noted that compliance addressed a safety issue and that the manufacturer recommended accomplishment:

> *'at the next major periodic inspection (MPI), next access (next access is defined as removal of the ITT duct), or within three years of release of this service bulletin, whichever occurs first.'*

The FAA stated their intention to issue an Airworthiness Directive (AD) to mandate incorporation of the Service Bulletins. At the time the Service Bulletins were issued in late 2007, approximately 2,800 engines in service (all of the Classic engines) were fitted with the original standard of ITTD. On 4 April 2008 the FAA issued a Notice of Proposed Rulemaking (NPRM) to this effect (USA Federal Register Docket No FAA-2008-0264). The NPRM required comments by 3 June 2008. It was anticipated that the AD would be issued in July 2008.

Discussion

The evidence showed that the major disruption and non-containment of the No 3 engine during the climb had resulted from a break-up in the LP turbine assembly that had caused extensive rupturing of the ITTD surrounding the turbine. The engine bay fire warning that occurred very shortly after the break-up probably resulted from the impingement of hot engine gases, escaping through a substantial gap created in the duct, onto the firewire element fitted around the engine in this area. The pilots encountered no difficulties in carrying out the fire drill and the warning ceased shortly thereafter. An effective and helpful ATC service expedited the crew in diverting and landing without further difficulties.

Debris ejected through the gap cut in the ITTD penetrated the bypass duct wall and the engine cowling. It appeared likely that debris had contacted the horizontal stabiliser, albeit without causing substantial damage. However, the effects on the aircraft could have been more severe had the debris been ejected through the cowl at a different rotational position. A similar non-contained failure of an engine mounted within the fuselage, such as the No 2 engine of the Falcon 900, would appear to entail the risk of significant damage to aircraft systems and possibly to the structure.

Most of the parts broken from the LP turbine assembly had been ejected from the engine and lost into the sea and some fracture surfaces on the parts that remained had been damaged. Positive evidence as to the cause of the turbine assembly break-up was therefore not available.

However, service experience suggested the type of failure mechanism that had occurred. It had been found that in some cases a Stage 3 blade failure could initiate a cascade failure of the other blades in the stage, and that the resultant damage could cause the Stage 2 and Stage 3 stators to spin up and burst. Impact of the stator debris would damage the ITTD, in some cases to the extent of penetrating the aft limb of the duct. It appeared possible that similar effects would result from a Stage 2 blade failure. The damage to the available parts from G-HMEV's No 3 Engine was similar to that which had previously resulted from the above failure sequence and thus indicated that the disruption had originated with the failure of a Stage 2 or Stage 3 LP turbine blade.

Positive evidence was found of a defect in the Stage 2 No 5 turbine blade, consistent with a hot tear formed during casting. It appeared likely that a defect of the type found could cause a separation fracture of the blade under normal operating loads within the blade's operating time since new and that this had led to the turbine disruption. However, there was no evidence to determine whether the fracture of this blade had in fact initiated the turbine assembly break-up sequence, or had resulted from it, if the initiation event was the failure of a Stage 3 blade. Stage 3 blades of the standard fitted to G-HMEV's No 3 Engine had previously suffered a number of failures, apparently due to surface nicks and/or because of residual stresses that could be introduced at manufacture.

It was therefore concluded that the turbine disruption had probably resulted from the failure of the Stage 2 blade due to the casting defect present, but could have been caused by a Stage 3 blade failure.

The alterations introduced to the process for inspecting Stage 2 blades were intended to improve the detection of significant hot tear defects in the castings. However, it appeared that a substantial number of revised production process blades that had entered service before the improved defect detection process had been applied could be subject to an elevated risk of hot tear defects, in common with the No 5 blade from G-HMEV's engine. The first opportunity to detect such defects would normally be the FPI carried out at the next Major Periodic Inspection, required every 2,100 operating hours.

The engine manufacturer's planned introduction of an improved Stage 3 blade, with lower peak operating stress and a prohibition on operations during manufacture that might excessively increase residual stresses, was intended to address the failure problem affecting these blades.

While the above failure sequence had led to a number of cases of ITTD penetration on Classic engines, experience suggested that NG engines were unlikely to suffer duct penetration in similar circumstances because of the significantly stronger alloy used for the aft limb of the duct. Thus incorporation of the modification that upgraded the ITTD on Classic engines to the NG standard appeared likely to eliminate the problem of non-containment in the event of a turbine blade failure.

Safety Recommendations

The above measures, to improve the Stage 2 blade inspection process, to introduce an improved Stage 3 blade and to modify the ITTD on Classic engines, indicated a concerted aim by the engine manufacturer to resolve the problem. However, it appeared that it might take an extended time period for the measures to be incorporated across the engine fleet and, as none of them had been mandated, there was no certainty as to the level of take-up. In view of the appreciable number of previous cases of blade failure and resultant non-containment and the potential hazard to the aircraft of non-containment, the following Safety Recommendation is made:

Safety Recommendation 2008-013

It is recommended that the FAA comprehensively review the measures already proposed by the manufacturer aimed at preventing non-contained LP Turbine assembly failures of Honeywell TFE-731 engines, including the proposed timescales for incorporation of the measures across the fleet, with the aim of ensuring an adequate standard of airworthiness.

In view of the experience indicating that the upgraded version of the ITTD is likely to prevent possibly hazardous debris non-containment in the event of an LP turbine assembly break-up, the following Safety Recommendation is made:

Safety Recommendation 2008-014

It is recommended that the FAA require the timely incorporation of Honeywell Service Bulletins (Nos TFE-731-72-3727 and TFE-731-72-3728) for the fitment of an upgraded standard of Inter-Turbine Transition Duct to Honeywell TFE-731 engines, in order to ensure that the modification is embodied across the engine fleet within a reasonable timescale with the aim of eliminating the non-containment hazard posed by an LP turbine blade failure.

ACCIDENT

Aircraft Type and Registration:	Aerospatiale SA365N Dauphin, G-BKXD
No & Type of Engines:	2 Turbomeca ARRIEL 1C turboshaft engines
Year of Manufacture:	1983
Date & Time (UTC):	9 March 2008 at 1712 hrs
Location:	Leman 27 AD helideck, southern area of the North Sea
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 2 Passengers - 5
Injuries:	Crew - None Passengers - None
Nature of Damage:	Fenestron tail fairing damaged, possibly more extensive damage to tailboom
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	48 years
Commander's Flying Experience:	6,513 hours (of which 6,300 were on type) Last 90 days - 113 hours Last 28 days - 40 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot, operating company's report and helicopter flight recorders

Synopsis

While manoeuvring to land on an offshore helideck, the helicopter's Fenestron tail fairing struck the guardrails of a deck mounted crane. Choice of approach profile, limited helicopter performance, approach technique and possible fatigue were considered to be factors in the accident.

History of the flight

The flight crew reported for duty at Humberside Airport just before 0600 hrs for a duty day consisting of two duty periods with a rest period in between. The accident occurred in the early evening, soon after the crew had started the second of the duty periods. Although the crew normally remained offshore for two weeks at a time, the helicopter had required minor rectification of a door fault and so the crew had flown it to their engineering base at Humberside the previous afternoon. The fault had been rectified overnight and the helicopter left Humberside at 0626 hrs to return to the main installation in the Leman Gas field, some 41 nm north east of Norwich. The purpose of the day's tasking was to transfer personnel in the morning from the Leman 27A installation to various satellite installations for their days work before returning them to the Leman 27A in the evening.

The weather was fair, with occasional showers in the area. The surface wind was generally south-westerly at between 10 and 20 kt. During the morning detail the co-pilot, in the left hand seat, flew as the Handling Pilot. After the transit to the Leman 27AD helideck, the crew flew eight shuttle sectors of between two and ten minutes duration, mainly between the Leman 27AD and 27D platforms. The helicopter landed at 0810 hrs on the Leman 27AD platform and was shut down.

The crew spent the time before the evening detail resting, attending to minor administrative matters and taking a meal. The rest facilities on the installation were reported to be very good. Engines were started again at 1659 hrs. This time the commander was to fly as Handling Pilot from the right seat. The weather was similar to before, with a reported wind from 210º(M) at 12 to 20 kt.

The first sector to the Leman 27D was flown empty, and five passengers were then boarded for the return three minute flight. The helicopter was close to its maximum operating weight for the return flight but retained the ability to hover out of ground effect (OGE) within the certified power limits. The helicopter approached the platform from the east, positioning on its southern side before translating to the right towards the helipad. As it approached the landing point, the rearmost part of the helicopter struck a deck-mounted crane adjacent to the helipad. The crew, who were immediately aware that they had struck the crane, continued with the landing on the helideck. The passengers disembarked normally and the helicopter was shut down.

The helicopter had struck guardrails on the crane at a point 12 ft above the deck (Figure 1). It suffered damage to the tail Fenestron fairing and the emergency locating transmitter, which was housed within, was triggered. The helicopter was subsequently transferred by surface vessel to an onshore engineering base for a more detailed inspection. The full extent of the damage was still to be determined at the time of writing, but was likely to be more extensive than the first assessment indicated.

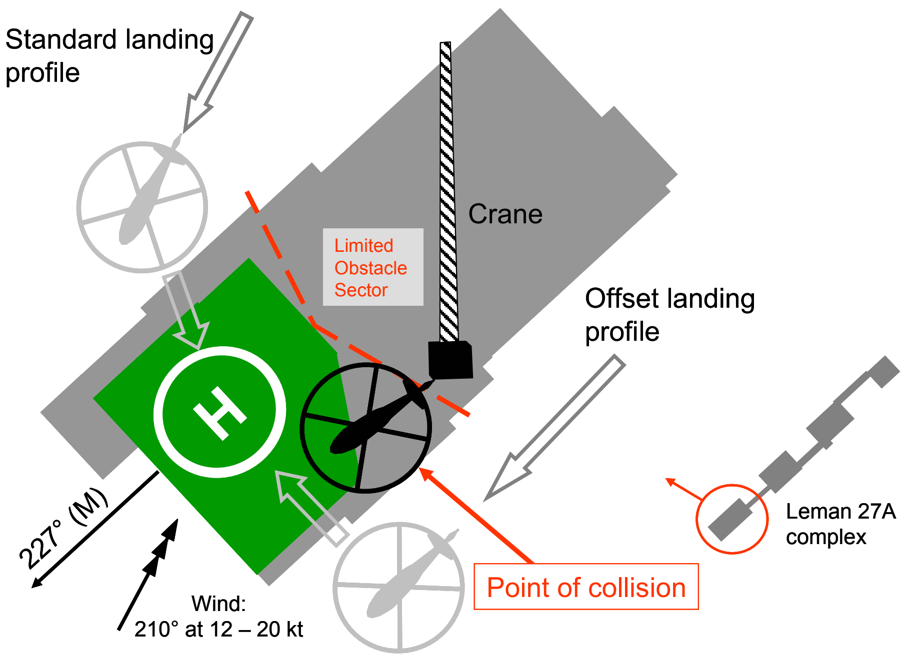


Figure 1

Helicopter's position at point of collision, with examples of standard and offset approaches as described in the operations manual.

Operating procedures

The operating company's operations manual described two landing profiles applicable to helideck operations (Figure 1). The standard landing profile was an into wind approach to a point outboard of the helideck, with the helicopter slowing to 10 kt groundspeed as it neared the deck, and maintaining 40 ft above the deck. When the aiming point for landing appeared 45º forward of the helicopter, the pilot was to manoeuvre forwards, sideways and downwards to achieve a hover over the landing point.

If the normal landing profile was impractical due to obstructions or the prevailing wind, an alternative offset approach procedure could be flown. This involved flying to a hover position about 90º offset from the landing point before flying slowly but positively sideways and down to a hover over the landing point.

The non-handling pilot was required to monitor the approach and call out any deviations from normal approach parameters. He was also required to call "55 KNOTS" when appropriate and advise the handling pilot if torque exceeded 90%. The handling pilot would call "COMMITTED" when the helicopter reached a point near the deck beyond which the helicopter would be committed to a landing on the deck if an engine failed. During the final stages of the approach, the handling pilot was to use the forward edge of the helideck as his forward visual reference rather than the 'H', thus increasing tail clearance during transition across the helideck.

The operations manual allowed for an abbreviated approach and landing briefing for offshore operations. In the example given in the manual, the briefing should include the type of landing, heading, the "COMMITTED" call, go-around flight path and a reminder that standard calls should be used. If this did not give the necessary level of information, a full briefing was to be given.

Recorded information

The helicopter's Flight Data Recorder (FDR) was downloaded by the operator and the Cockpit Voice Recorder (CVR) was downloaded by the AAIB. The FDR showed that the speed profile was normal but that the helicopter had approached the deck at a lower height than normal. After approaching the installation on a heading of 310º(M), the helicopter had turned left onto about 240º which it maintained (+/- 10º) until it struck the crane.

The CVR captured the last six flights of the morning period and both evening flights. Apart from occasional short periods of unrelated conversation, there was very little communication between the two pilots concerning the helicopter's operation. No briefings were recorded and there were no discussions about the helidecks being used or potential hazards. With one exception, neither pilot made any of the standard calls of "55 KNOTS" or "COMMITTED" as defined in the operations manual. The exception was on the accident flight, when the co-pilot first said "ALL GOOD", and then made the "55 KNOTS" call. The only other exchange between the crew during the final approach to the helideck was when the co-pilot called that torque was at 90%. This was almost coincident with the helicopter striking the crane.

From comments made prior to engine start on the evening detail, it was clear that the crew knew they would be operating at maximum weight early in the period. There was no further discussion about the effect that this might have on the operation of the helicopter . As far as could be told from the recording, both pilots were relaxed and comfortable with the operation, and neither voiced any concerns.

Helicopter performance

The helicopter was operating close to its maximum operating weight when it approached the helideck on the accident flight. The commander believed that the helicopter's performance at that weight was such that it would not be possible for it to hover OGE with the power available. Changes in airflow around and through the rotor disc of a helicopter hovering close to the surface in ground effect (IGE) lead to increased rotor blade efficiency. Less power is therefore required to hover at a given weight when compared to a higher, OGE hover. In situations where performance is limited, the helicopter needs to make a continuous and steady approach to a landing site, so that it gains the benefits of ground effect before losing the extra lift that is a function of forward airspeed.

Operating company's report

An investigation was conducted by the helicopter operator. Its internal report observed that the flight crew were on day 12 of a 14 day tour of duty. Although the crew were reportedly well rested and were operating to a Flight Times Limitation scheme accepted by the Civil Aviation Authority, it was thought that accumulated fatigue could have been a contributory factor.

The report considered the commander's decision to make the approach to the helideck on its south side (the same side as the crane), noting that the wind would have been slightly more favourable for an approach from the north side. This would have required the approach to have been flown by the co-pilot from the left seat. However, the report observed that a safe approach from the south side was achievable. It was noted that the helicopter was lower than recommended as it crossed the deck edge, as evidenced by the damage to the crane. The part of the crane that was struck was closest to the landing point; had the helicopter been nearer the recommended height (around 30 ft above deck level at that stage) the tail may have passed over that part of the crane structure. Additionally the report stated that the commander used the 'H' circle as a visual reference rather than the forward edge of the helideck, which would have contributed to reduced tail clearance from obstacles at the rear of the helideck.

The operator's investigation did not have access to the CVR recording,[1] but information from the crew indicated that standard calls were not always made. Because of this and other factors such as the possibility of crew fatigue, the repetitive nature of the task and familiarity with the environment, the report surmised that the crew may not have maintained the expected standards in terms of crew communication and flight management.

A number of internal safety recommendations were made. These included improvements to Crew Resource Management (CRM) training programmes and guidance to crews concerning handover of control between pilots to suit varying landing situations. The report also called for a review of the operator's existing offshore shuttle operation in the light of the investigation's findings.

AAIB comment

Given the helicopter's weight and restricted performance, an approach from the north side of the helideck would have been more prudent, as this would have allowed a standard approach profile, directly into wind and with greater separation from the crane. However, this would have required a handover of control to the co-pilot in

Footnote

[1] Disclosure by the AAIB of CVR recordings is prevented under normal circumstances by national and international regulations.

the left seat. As the evening detail was notionally to be flown by the commander, this may have influenced his decision to approach from the south side.

As performance was limiting, an offset approach as described in the operations manual would not have been the preferred option, but the presence of the crane prevented a standard approach profile from the south side. The commander was committed to keeping the helicopter moving until it could come to an IGE hover over the landing point. It would seem that this consideration, together with the use of an incorrect visual reference point, led to the helicopter crossing the deck edge before it had moved sufficiently far forward. The same consideration would also account for the helicopter's relatively low height as it crossed the deck edge.

ACCIDENT

Aircraft Type and Registration:	Cessna F150L, G-HFCI
No & Type of Engines:	1 Continental Motors Corp O-200-A piston engine
Year of Manufacture:	1972
Date & Time (UTC):	8 July 2007 at 1500 hrs
Location:	Clutton Hill Farm Strip, Bristol
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Fatal) Passengers - 1 (Fatal)
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	34 Years
Commander's Flying Experience:	79 hours (of which 60 were on type) Last 90 days - 7 hours Last 28 days - 0 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft took off and was seen to climb away at an unusually steep attitude to a height of approximately 200 ft. Witnesses reported that the engine appeared to stop and the aircraft rolled rapidly to the left and entered a vertical descent. The aircraft struck the ground and there was an extensive post-impact fire. Both occupants were fatally injured.

History of the flight

The pilot and his passenger travelled to the airfield by car early in the afternoon of 8 July 2007. Shortly after 1410 hrs the pilot was seen to be standing on top of the fuselage of his aircraft passing a white plastic drum down to the passenger. At approximately 1445 hrs the pilot spoke to the pilot of another aircraft that had just landed, and they discussed the weather conditions. A short while later G-HFCI's engine was started and the aircraft taxied to Runway 25. Eyewitnesses reported that the takeoff appeared normal and that the aircraft became airborne approximately 150 ft before the end of the runway. The aircraft climbed away steadily, but at a higher pitch attitude and with a lower airspeed than normal.

At 1500 hrs the pilot made radio contact with Bristol radar. After his initial call the pilot stated "WE'RE A CESSNA ONE FIFTY JUST LEFT FROM CLUTTON GONNA CROSS OVER BATH TOWA--!" The transmission, which lasted 14 seconds, ended abruptly at this point.

Eyewitnesses reported that when the aircraft was at a height of approximately 200 ft, some 350 m after crossing the end of the runway, the engine appeared to stop. The aircraft rolled to the left and entered a vertical descent. It struck the ground and there was an extensive post-impact fire.

Eyewitness testimony

Several eyewitnesses saw portions of the accident flight. Two eyewitnesses on the airfield described the start and taxi out as normal, although neither witness could be positive as to whether or not the pilot conducted the engine power checks prior to takeoff. A local pilot described the takeoff run as normal, with the aircraft becoming airborne in about the usual place. Several witnesses, both on the airfield and in the surrounding area, reported that after becoming airborne the aircraft adopted an unusually high nose-up attitude, with a lower airspeed than normal.

Witness assessments suggest that the aircraft reached a peak height of approximately 200 ft. They then described the engine going silent and the aircraft's left wing dropping rapidly, although there was no consensus on the sequence of these two events and it is possible that the wing dropped before the engine noise stopped. The aircraft then descended almost vertically and went out of sight, behind either trees or buildings, depending on the witness's position. No witness saw the ground impact. One witness, positioned almost directly below the flight path, described the engine noise as struggling then total silence followed five seconds later by a pop, "like a shotgun being fired".

Pilot information

The pilot conducted his flying training in Florida and gained his Private Pilot's Licence (PPL) during 2002. On his return to the UK he flew for 90 minutes in 2003 and then did not fly again until June 2006 when he completed a PPL proficiency check. In November 2006 he completed a check flight on a PA-28 aircraft at a flight training organisation near Bristol. He then flew two solo flights; one in November 2006 and one in January 2007. During the second of these flights he experienced navigation and airmanship difficulties, which resulted in the flight training organisation revoking his privileges to fly their aircraft solo.

In February 2007 the pilot purchased G-HFCI and flew approximately 20 hours in it before his PPL lapsed in May 2007. His revalidated PPL was issued on the 4 July 2007 and this was issued on the basis of the check flight in 2006. The flight on 8 July was his first since 20 May. During the 20 hours flown in G-HFCI between February and the end of May the pilot had been reported to the CAA's Aviation Regulation Enforcement branch because a number of ATC units were concerned about his navigation, radio communications and airmanship.

The pilot held a valid JAA Class 2 medical certificate issued on the 28 April 2007.

Airfield information

Clutton Hill farm strip is located 7.5 nm east-south-east of Bristol Airport. It is situated on a hilltop 600 ft amsl, and the grass runway is orientated 07/25. Runway 25 is approximately 1,936 ft long and 88 ft wide and has an upslope, most particularly in the final third of the runway. At a point approximately 150 ft before the end of the runway there is a small ridge which local pilots suggest acts as a ramp, effectively projecting aircraft into the air. The ground drops away from the departure end of Runway 25 and to the west the terrain forms a wide valley. The accident site was 50 ft below the level of the runway.

The airfield is situated underneath the Bristol Control Area (CTA), which commences at 1,500 ft amsl. It is normal practice when departing this farm strip to attempt to call Bristol Radar while still on the ground in order to obtain clearance into the Bristol CTA. There is, however, no requirement to do so, and when pilots are unable to contact Bristol prior to departure they call them shortly after becoming airborne.

Takeoff performance

The pilot's operating handbook for G-HFCI provided figures to enable the takeoff performance to be calculated. To take off from this farm strip, at the maximum permitted weight of 1,600 lbs, and allowing for the ambient conditions, the aircraft required a ground roll of 832 ft and the total distance to attain a height of 50 ft was 1,482 ft.

The CAA issued Change Sheet number 1, dated February 1993 [issue 1], to the Cessna 150 G-HFCI 1972 Owners Manual 'Performance' and this was attached to the Manual. It states: '*Increase the take-off distances by 15%*'. Based on this adjustment G-HFCI required a ground roll of 956 ft and a total distance to a height of 50 ft of 1,704 ft.

In General Aviation Safety Sense leaflet 7, entitled '*Aeroplane Performance*' the CAA suggests factoring performance data by 20% when taking off from grass runways, and then adding an overall safety factor of 33%. The use of these factors results in a calculated ground roll of 1,526 ft.

The aircraft manufacturer specifies a speed for the best rate of climb (76 mph for G-HFCI). This is higher than the best glide speed of 70 mph and considerably higher than the flaps up stall speed of 55 mph. This means that should the engine stop during the climb the pilot has sufficient time to lower the nose before the aircraft approaches an aerodynamic stall.

Meteorology

The Met Office provided an aftercast covering the period of the flight. The estimated surface wind at Clutton Hill, at the time of the accident, was from 230º at 9 kt, the surface temperature was 16ºC, the dew point was 9ºC and the relative humidity was 63%. The visibility was 25 to 40 km outside of rain showers, which were scattered throughout the region.

The latest forecast the pilot could reasonably be expected to have received for Bristol Lulsgate (the closest airport) was issued at 1200 hrs on the day of the accident, and was valid from 1300 hrs to 2200 hrs. It forecast a surface wind from 260º at 12 kt, visibility greater than 10 km and scattered cloud at 2,000 ft, with a temporary reduction to 7,000 m visibility in rain showers. It also included a 30% probability of a reduction to 4,000 m visibility in heavy showers of rain with broken cumulonimbus cloud at 2,000 ft.

Eyewitnesses located near the accident site confirmed that at the time of the accident there was no rain in the immediate area.

Post-mortem examination and toxicology

A post-mortem examination conducted by a specialist aviation pathologist confirmed that both occupants died of multiple injuries sustained on impact. With regards to the pilot, there was no evidence of natural disease which could have caused or contributed to the accident. It was of note he exhibited no injuries to suggest that his harness had been used at the time of the accident.

There was no evidence of drugs or alcohol in the passenger's blood or urine. The pilot had no evidence of alcohol in his blood, but toxicology revealed the presence of methylenedioxymethylamphetamime (MDMA, or 'Ecstasy') in the blood, at a concentration of 0.28 milligrams per litre. No other drugs were present. The level of MDMA measured in the pilot's blood was slightly above that usually seen following a typical recreational dose. The results suggest, therefore, that the drug is likely to have been taken within a few hours of the flight, rather than being present as a residue of a dose taken the night before.

The accident site

The aircraft crashed into the corner of a field some 370 m beyond the upwind end of the runway, slightly to the left of the extended centre line. The point of impact was about 50 ft below the runway level. Beyond it, along-track, the ground sloped steeply away towards floor of a wide valley some 500 m away, and about 50 m below it.

At the time of impact, the aircraft was pitched approximately 30° below the horizon, slightly banked to the right and sideslipping to the right, and was falling with a very high rate of descent, with negligible forward velocity and no discernible yaw rate, consistent with it having been in a fully developed stall. Upon impact, the fuel tanks in each wing ruptured and a severe post-impact fire developed, which consumed the whole of the upper section of the cabin and centre fuselage, and the inboard regions of both wings.

Wreckage examination at the site

Examination of the aircraft at the site showed that it was structurally intact and complete when it struck the ground, and all control surfaces and their respective control cables and cranks were intact and connected. The wing flaps were fully retracted and the elevator trim was set to a neutral position.

The leading edges of the propeller were undamaged, and neither blade exhibited any evidence to suggest that the engine was under significant power at impact; rather, a pattern of parallel score markings evident across the faces of the lower blade, running at an angle to the chordwise axis, was consistent with the propeller having been stopped at the time it was plunged into the soil. The carburettor hot air flap was set to the COLD position, but it was not possible to determine reliably the impact settings of the throttle or mixture controls.

Both fuel tanks exhibited characteristic hydrodynamic deformation, indicating that each had contained a substantial quantity of liquid at the time of impact with the ground. Both tanks had split in the impact and, in the case of the left tank, the whole of its contents had been lost and the aft portion of the tank burned away by the post-impact fire. The right tank was less badly damaged by fire and contained a small quantity of trapped liquid residues, which was collected for later analysis. Subjectively, the residues exhibited the characteristic aroma and pale blue colouration of AVGAS. Separated water was also evident in the residue, but the whole of the wreckage had been covered by fire-fighting foam and water from this had undoubtedly penetrated the tank through impact ruptures in the tank wall. Both fuel filler caps were locked, but their seals were damaged by heat and their effectiveness prior to the accident could not be determined.

Detailed examination of the wreckage

The wreckage was recovered to the AAIB at Farnborough where it was the subject of more detailed examination. This yielded no further technical evidence regarding the airframe or flying controls, but evidence was found which showed that one of the seat harnesses was not being worn at the time of impact. Specifically, the 'housing' and 'tongue' portions of one of the harness buckles were found widely separately from one another – the buckle portion incorporated in fire debris between the two front seats, and the tongue portion incorporated in debris just forward of the right seat squab. Because none of the associated harness webbing survived the fire, it was not possible to ascertain from the wreckage-evidence whether the disconnected buckle was that from the pilot's or the passenger's harness. (The remains of a buckle, with both halves connected normally, were recovered during post-mortem examination of the passenger, suggesting that it was the pilot's harness that was not being worn at the time of the accident.) Both seats were still attached their respective floor rails, and the fore/aft position-adjustment lock-pins of each of the seats were engaged at positions well forward of the rearmost seat position, suggesting that the pilot's seat had not jumped its locking mechanism and slid rearwards at any point during the takeoff or climbout.

The engine was removed and taken to an approved overhaul agency, where it was subject to bulk disassembly and examination, and key components were stripped, inspected, and, where appropriate, rig tested, under AAIB supervision. The engine was severely damaged both by the impact and the post-impact fire, but no evidence of any mechanical failure or defect was found. Except for some post-impact contamination with oil, the appearance of all spark plugs was within the normally expected range in terms of colouration and sooting. It was not possible to determine the pre-impact integrity of the induction system because of impact and fire damage, but the burnt remains of all the rubber connectors and associated hardware were present in their correct locations. The oil filter contained no significant debris, and the condition of the camshaft and all pistons, rings, cylinder bores, valves and associated hardware appeared normal for an in-service engine.

Both magnetos had suffered significant heat damage, including partial melting of casing plugs and other plastic components. The mechanical timing of the left magneto was checked in situ and found to be correct; the right magneto could not be checked in situ. Each was removed for more detailed bench-inspection and functional checks. Both were equipped with impulse drives, each of which was intact and functioned normally. Removal of the fire-damaged covers revealed evidence of significant heat damage internally, caused by the post-impact fire, which had partially melted and fused capacitor casings and some of the low tension wiring insulation. After replacement of the fire-damaged covers and HT leads with serviceable equivalents, the magnetos were installed in a standard test rig and functionally checked throughout their full operating range, from impulse-start through to maximum speed. Both functioned flawlessly throughout.

The carburettor was disassembled and visually examined. The fuel strainer at the inlet to the float chamber was clean and the fuel inlet passage unobstructed. The float was serviceable, the float chamber inlet valve opened and closed correctly with no perceptible leakage, and the main jet was clear of obstruction.

Search of the airfield

A number of items associated with G-HFCI were found at the airfield where the aircraft had been parked. These included two 5 gallon plastic containers, one containing what appeared to be residues of AVGAS and the other containing a small quantity of a greyish liquid, which neither looked nor smelled like gasoline. Both these containers were retrieved by the AAIB for further study, together with a third container of similar type, filled almost to the top with a clear liquid of unidentified origin, that had been taken from the same region of the airfield by the emergency services for safe keeping, prior to AAIB arrival. The other items comprised two improvised funnels, one large and the other medium sized, fashioned from cut-back plastic mineral water containers; a stilson pipe wrench, of new and unused appearance; and a fabric tie-on protective cover for the canopy and forward fuselage.

A search of the surroundings and a nearby temporary hangar revealed other equipment and materials which suggested that the owner of G-HFCI was planning a refurbishment of the fuselage transparencies and/or its paintwork and interior trim. No further containers were found similar to those at the tie-down location, or that were likely to have been used to transport or store fuel for the aircraft.

Analysis of fuel tank, and plastic container content and residues

Samples from each of the three plastic containers recovered from the airfield, together with the residue sample recovered from the right fuel tank, were submitted to the QinetiQ Fuels Laboratory for analysis and comment. The laboratory reported that each of the samples from the plastic containers consisted of a mixture of AVGAS and another organic material that could not be identified, but which contained much higher concentrations of toluene and higher-boiling point aliphatic hydrocarbons. The sample from the fuel tank was chemically consistent with the samples from the plastic containers, ie notwithstanding their very different appearances and aromas, the liquids in all three plastic containers were essentially the same, chemically, as the residue recovered from the right fuel tank. Lead was also found in all of the samples tested, consistent with the presence of AVGAS in each. It was not possible to determine the origin of these unknown liquids, but it is believed that they may have been solvents of some kind, possibly paint thinner.

Further testing

In light of the post-mortem toxicological finding of high levels of a recreational drug in the pilot's bloodstream, it was considered possible that the pilot may have mistakenly filled, or topped up, one or both fuel tanks with the unknown solvent like liquid(s) from the plastic drums found at the aircraft's tie-down point, notwithstanding their very different appearance and aroma compared with AVGAS. The practical implications, both for engine function and performance, of contamination of AVGAS with this liquid was therefore investigated in a program of tests using the facilities of a leading automotive engine research establishment. The engine used for the tests was a specialised single-cylinder research engine, installed in a test cell equipped with a dynamometer and instrumented to output real-time data for a range of parameters of relevance, including cylinder pressure. A special fuel supply was built into the rig enabling the fuel supply to the engine to be switched, with the engine running, between four separate tanks containing the following pre-mixed fuel/solvent concentrations:

a) 100% AVGAS;
b) 20% solvent/80% AVGAS
c) 50% solvent/50% AVGAS
d) 100% solvent.

Prior to the start of testing, the engine's compression ratio and ignition timing were set to values comparable to those of the aircraft's, and a series of initial runs carried out using 100% AVGAS with the engine operating at maximum power at 2,750 rpm, in order to prove the instrumentation and establish base-line data and test-rig settings. The testing was then carried out in a single extended run during which the engine was supplied for a period of 10 minutes from each tank in succession, in the order listed above, with no other change being made.

The engine was monitored throughout for any change in operating characteristics, both subjectively and via the instrumentation, and data records made five minutes after tank change-over, and again after 10 minutes. The exhaust plume was also monitored for any change in its visual characteristics.

In the event, no perceptible change was detected in the engine's performance at any stage during the tests, either subjectively or in the data: the engine performed identically, including power (torque and rpm) and cylinder pressure, whether fuelled by AVGAS or neat solvent. This result confirmed the similarity between the solvent and AVGAS found during the laboratory analysis of the samples, and rendered moot - in terms of accident causation - the issue of whether or not solvent had been added to the aircraft's fuel tanks.

Analysis

The weather conditions for the flight were good. The takeoff appeared normal and the aircraft became airborne at about its usual position and was seen to be climbing away, albeit in a nose-high attitude and at a slow speed. Eyewitness accounts suggest that the aircraft suffered a stall and wing drop shortly after take off, at a height that offered no possibility of recovery before ground impact.

Examination of the wreckage indicates that the damage was consistent with it having been in a fully developed stall at impact. Evidence from the propeller blades suggests that the engine was not under significant power at impact and that the propeller had stopped, but there was no technical evidence to explain why. The liquids from the plastic drums associated with the aircraft were analysed and subsequently tested in a research engine but they were, in all regards, similar to AVGAS and would have had no detrimental effect on the engine's performance.

In adopting a low speed, high nose-up attitude close to the ground the pilot placed the aircraft in a position where there was little margin for error when dealing with unforeseen events. A nose-high attitude reduces forward visibility and means that, in the event of an engine failure, the pilot has to lower the nose rapidly to prevent the aircraft decelerating to below its stalling speed. In this instance, it is conceivable that the pitch attitude was so high that the aircraft stalled even with the engine still operating.

The pilot had completed very little flying since 2002 and had not flown for 6 weeks prior to the accident. He completed a PPL revalidation with no significant problems in November 2006 but later experienced navigation and airmanship difficulties. This resulted in the flight training organisation revoking his privileges to fly their aircraft solo. The pilot was later reported to the Aviation Regulation Enforcement branch because of concerns about his navigation, radio communications and airmanship. His overall piloting abilities must therefore be considered to be variable, if not marginal, and this is considered to be a causal factor in this accident since a pilot should not lose control of an aircraft after takeoff, even if the engine does stop. In addition, the post-mortem examination revealed that the pilot's blood held quantities of MDMA, an illegal drug. This had probably been taken within a few hours of the flight, and may have impaired both his judgement and his ability to complete complex tasks, which would have further reduced his ability to operate the aircraft safely.

ACCIDENT

Aircraft Type and Registration:	Europa XS, G-BYFG
No & Type of Engines:	1 Jabiru Aircraft Pty 3300A piston engine
Year of Manufacture:	2003
Date & Time (UTC):	13 February 2008 at 1500 hrs
Location:	Tatenhill Airfield, Staffordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Nose leg bent and wheel lost, propeller damage, engine shock-loaded and minor fibreglass damage
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	57 years
Commander's Flying Experience:	110 hours (of which 3 were on type) Last 90 days - 7 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

Whilst landing on his second solo flight in this type of aircraft, the pilot over-controlled the elevator and power settings and the nosewheel struck the ground and detached.

History of the flight

The pilot was one of a syndicate which owned the aircraft. He had trained on, and flown regularly, the Cessna 152 type and was converting to the Europa, which was fitted with a tricycle landing gear. He had logged some 1 hour 50 minutes dual, during which time he had accomplished about 16 landings and, after a successful solo circuit, he was pronounced proficient to fly the aircraft.

After a break for lunch, the aircraft was refuelled and the pilot decided to do further circuit practice. The first approach, at just under 70 kt IAS and with 30º flap, was steady and, upon flaring for touchdown, he reduced the throttle setting. This caused an excessive sink rate which he tried to correct by applying more back pressure on the control column. Although the rate of descent decreased, the aircraft adopted a very nose-high attitude and, when it touched down on the mainwheels, bounced into the air again. Applying power seemed to increase the nose-high attitude, which the pilot tried to correct by pushing the column forward, by his own admission too much, and the nosewheel struck the ground. He opened the throttle for a go-around and the aircraft became airborne but, as he suspected, the nosewheel had detached although there were no indications that the propeller had contacted the ground. He completed the circuit after receiving confirmation that the nosewheel had indeed detached.

Touching down on the mainwheels at about 60 kt after a long, steady, final descent, the pilot held the nose high for as long as possible, before it dropped and the propeller contacted the runway. After completing the shutdown drill, he evacuated the aircraft normally and without injury. There was no fire or release of fuel or oil.

Analysis

The pilot supplied a thorough analysis of the factors which he considered led to the accident, summarised as follows:

> Without the weight of the instructor, the aircraft was 'livelier' than he had expected, requiring gentler adjustments to stick and throttle positions.
>
> The Europa was also much livelier than the Cessna 152, on which his previous flying experience had been gained, mostly with two people on board.
>
> He had reduced the throttle setting too much as he started to flare, and this had a marked effect on sink rate, which he tried to counter with aft movement of the stick.
>
> The combination of high nose attitude and excess speed, due to the early touchdown, launched the aircraft back into the air. The subsequent rapid application of power pitched the nose further upwards and he instinctively pushed forward on the stick to contain the situation.
>
> The degree of forward stick application was again excessive and the nosewheel struck the ground.
>
> He was probably fatigued by the intensive preceding period of dual instruction.

However, the pilot described the second landing as 'good' and commented that the circuit preceding it gave him time to prepare for the prospect of landing without a nosewheel.

ACCIDENT

Aircraft Type and Registration:	Grob G115E Tutor, G-BYYB
No & Type of Engines:	1 Lycoming AEIO-360-B1F piston engine
Year of Manufacture:	2001
Date & Time (UTC):	11 December 2007 at 1158 hrs
Location:	RAF Cosford, Shropshire
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Nose leg collapsed, propeller blades broken, engine shock-loaded, mounting frame and cowlings damaged
Commander's Licence:	Student pilot
Commander's Age:	20 years
Commander's Flying Experience:	15 hours (all of which were on type) Last 90 days - 1 hour Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the instructor

Synopsis

On her first solo flight, the student pilot performed a touchdown reported as 'firm and nosewheel first' and, on the subsequent landing, the nose leg collapsed.

History of the flight

The student pilot was on her first solo flight, having just completed a 50 minute dual sortie in the circuit, which was assessed as being of a 'high average' standard. She was briefed to carry out one normal circuit and landing and her instructor was observing from the control tower, in radio contact. The first landing was firm, followed by a slight bounce, and the pilot elected to go around. The next landing resulted in a significant bounce and go-around with the student now 'quite shaken'. The third landing was reported as 'firm and nosewheel first', resulting in damage to the nosewheel spat.

The instructor told the student to go around again and fly the circuit pattern in order to settle down, also allowing the broken spat to be recovered from the runway. Then, setting up the student for a final approach, he watched as the fourth landing was long and slightly fast, concluding with the nose leg collapsing and the aircraft coming to rest on the grass to the left of the runway. The student pilot evacuated the aircraft without difficulty and was taken to the medical centre.

The instructor was of the opinion that, flustered by the first two bad landings, his student had failed to round out on the third and damaged the nose landing gear structure, which collapsed on the fourth landing.

ACCIDENT

Aircraft Type and Registration:	Grumman AA-5A Cheetah, G-BFIN
No & Type of Engines:	1 Lycoming O-320-E2G piston engine
Year of Manufacture:	1978
Date & Time (UTC):	11 February 2008 at 1552 hrs
Location:	Prestwick Airport, Scotland
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damaged nosewheel and propeller
Commander's Licence:	Private Pilot's Licence
Commander's Age:	60 years
Commander's Flying Experience:	141 hours (all of which were on type) Last 90 days - 1 hour Last 28 days - None
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During a landing on Runway 13 at Prestwick, the pilot judged that he was high on final approach and reduced power to increase the rate of descent. During the flare the aircraft landed heavily on the runway and pitched nose down, causing the propeller to strike the runway surface.

History of the flight

The pilot was conducting a series of circuits using Runway 13 at Prestwick. This runway has a concrete/asphalt surface with a landing distance available of 2,743 m, a width of 46 m and was equipped with PAPIs at 3º. The surface wind was calm and weather conditions were fine.

The pilot judged that he was high on the approach and reduced power in an attempt to regain the correct approach path. As he flared he reported that the aircraft sank heavily and contacted the runway. The nose pitched down, the nose landing gear was damaged and the propeller struck the runway. The pilot taxied clear of the runway and, not realising that the aircraft had been damaged, he then took off for another circuit. The damage was discovered after the aircraft had shutdown at the flying club.

The flying club had a policy whereby to hire an aircraft without an instructor the pilot must have flown within the preceding 60 days. There was no requirement regarding the length of the required preceding flight. The pilot's previous flight was in the same aircraft, and took place on 24 December 2007, seven weeks prior to the accident, and was of 20 minutes duration. Although this was the only flight that he had completed in the three months preceding the accident, this did comply with the recency requirements both for the flying club and of the Private Pilot's Licence.

ACCIDENT

Aircraft Type and Registration:	Piper PA-24-250 Comanche, G-TALF
No & Type of Engines:	1 Lycoming O-540-A1B5 piston engine
Year of Manufacture:	1959
Date & Time (UTC):	12 January 2008 at 1130 hrs
Location:	Tatenhill Airfield, Staffordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to landing gear, underside of fuselage, exhaust and propeller
Commander's Licence:	Private Pilot's Licence
Commander's Age:	56 years
Commander's Flying Experience:	430 hours (of which 60 were on type) Last 90 days - 5 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot and AAIB inquiries

Synopsis

The aircraft suffered an electrical problem shortly after takeoff and the pilot decided to return to the airfield. When he selected the landing gear down, all the electrical power was lost. He did not have any indications to confirm that the landing gear was fully down, so he operated the emergency lowering mechanism. Believing that the landing gear was now down and locked he attempted a landing, but during the subsequent ground roll the landing gear collapsed. The investigation established that the electric motor was still connected to the gear operating mechanism, and that this prevented the landing gear from being fully lowered.

History of the flight

The pilot planned to fly with a friend to Caernarfon in fine weather conditions. The previous night had been cold so the pilot de-iced the aircraft before refuelling. The start-up, taxi and power checks were uneventful, and the pilot noted that all the aircraft instruments, including the ammeter, were indicating normally.

The takeoff was described as normal and the landing gear was retracted. After flying for a short distance, the pilot noticed that the aircraft's electronic horizontal situation indicator (HSI) had failed. He recycled the avionics master switch, and the HSI recovered briefly before failing again. He then noticed that the red low-voltage light was illuminated and that the ammeter showed that the battery was not charging. He switched off the non-essential electrical items and advised the tower at Tatenhill that he had an electrical problem and would be returning to the airfield.

The aircraft joined downwind for Runway 26. All the avionics, other than the HSI, were working normally. The pilot reduced the airspeed to below the landing gear limiting speed and selected the landing gear down. The pilot heard a 'clunk' as the gear appeared to lower; at the same time, all the avionics and electrical gauges and indicators in the aircraft failed. The pilot recycled the avionics master switch but was unable to recover any electrical power. He was now unsure whether or not the landing gear was down and locked. The green landing gear down indicator light was not illuminated, and as he had no electrical power to operate the radios he was unable to ask air traffic control (ATC) for a visual inspection. The pilot decelerated the aircraft to below 100 mph and selected the landing gear electrical selector switch to the centre position, in accordance with the emergency gear lowering instructions. He then attempted to lower the gear using the emergency system. He operated the locking release system but when he tried to move the emergency extension lever he found that it would not move and that it already appeared to be in a fully forward position. The pilot interpreted this to indicate that the landing gear was fully down.

The pilot flew the aircraft low and slow along the runway, in the hope that ATC would realise that he had a problem and perhaps give him a steady green light, indicating that he was clear to land. He received no acknowledgement from the tower and continued with a low level circuit. He considered that the landing gear was fully down, but as a precaution he briefed his passenger on what might happen if the landing gear was to collapse on landing.

The aircraft touchdown was normal, but shortly afterwards the landing gear collapsed and the aircraft travelled on its lower fuselage for about 100 metres before it slid off the left edge of the runway, destroying a runway edge light. The aircraft came to rest on soft ground a few metres south of the runway. The pilot instructed his passenger to leave the aircraft through the normal door, whilst he switched off the fuel and the master switch, before vacating the aircraft normally. The pilot and his passenger were uninjured.

Eyewitnesses confirmed that the aircraft landing gear appeared to be down prior to the accident.

Emergency landing gear lowering

The emergency lowering of the landing gear requires the pilot to carry out three actions: to move the landing gear electrical selector switch to the centre position; to position the electrical release arm fully forward; and to operate the emergency extension handle.

The electrical selector is moved to a neutral position so that the motor does not oppose the motion of the gear mechanism when the gear is manually lowered.

The electrical release arm disconnects the electric motor from the gear operating mechanism. If this does not occur then it is not possible to lower the gear manually.

The emergency extension lever is permanently connected to the landing gear operating mechanism and moves backwards and forwards as the gear is raised and lowered. It can therefore be used as a broad indicator as to the position of the gear. The lever has a telescopic handle which is extended in order to lower the gear manually. However, the pilot will not be able to move this lever until the electrical motor has been disengaged by the operation of the electrical release arm.

Aircraft examination

A maintenance engineer, who examined the aircraft immediately after the accident, found that the aircraft's alternator circuit breaker had tripped. This circuit breaker is positioned such that it would be difficult for the pilot to see it in flight. With the alternator circuit breaker tripped the aircraft electrical systems are powered by the battery. The maintenance engineer checked the aircraft battery voltage and considered that the battery was effectively flat.

An AAIB engineering inspector later examined the aircraft and found that the rear mounting of the bracket, in which the gear lowering jack is positioned, had been pulled out of the structure. This failure could only have occurred if the electrical motor release arm had still been engaged when the aircraft touched down with the gear in an unlocked condition. The electrical motor release arm operated satisfactorily. It was noted that the release arm had to be moved fully forward in order to disconnect the electric motor from the gear operating mechanism.

Analysis

It appears that the aircraft suffered an electrical problem which caused the alternator circuit breaker to trip and the aircraft's electrical loads were then supplied by the battery. When the pilot completed the landing checks there was only sufficient electrical power remaining in the battery to partially lower the gear, and with no electrical power the gear indication lights were inoperative. Damage to the aircraft indicates that the electrical motor was still attached to the gear operating mechanism when the landing gear collapsed. It seems likely that whilst conducting the procedure for the emergency lowering of the landing gear the electrical motor release arm had not been moved far enough forward to allow the motor to be fully disengaged from the gear operating mechanism. Consequently, the pilot would have been unable to move the emergency extension lever fully forward. The landing gear was therefore not down and locked and it collapsed during the landing roll.

ACCIDENT

Aircraft Type and Registration:	Piper PA-28-181 Cherokee Archer III, G-MPAA
No & Type of Engines:	1 Lycoming O-360-A4M piston engine
Year of Manufacture:	2002
Date & Time (UTC):	2 March 2008 at 1045 hrs
Location:	Rochester Airfield, Kent
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 2
Injuries:	Crew - None Passengers - None
Nature of Damage:	Nose frame and nosewheel spat damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	51 years
Commander's Flying Experience:	313 hours (of which 73 were on type) Last 90 days - 4 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft landed nosewheel first after bouncing on initial touchdown, causing damage to the engine frame and wheel spat.

History of the flight

The aircraft had flown from Biggin Hill and was making an approach to grass Runway 34 at Rochester. The pilot obtained a forecast indicating that the surface wind at Rochester was 280º/17 kt, gusting up to 27 kt. As he approached the airfield, the Rochester AFISO informed him that the surface wind was 290º/18 kt.

The pilot selected one stage of flap[1] before turning onto base leg and a second stage before turning onto final. In his report to the AAIB he stated that he focussed much of his attention on "maintaining an accurate approach, crabbing in nose left to counter a gusting crosswind from left to right". He commented that he was also "aware of the increased weight of the aircraft and the need, therefore, for a slightly increased approach and touchdown speed" but that he overestimated these. The aircraft touched down at approximately 75 kt and bounced slightly. On the subsequent touchdown it bounced "much higher" and, in an attempt to control the bounce, the pilot "released back pressure" on the control column (reducing nose-up elevator) and applied "a very small amount of power to regain control of the aircraft". During the final touchdown the nosewheel contacted the

Footnote

[1] There are three extended flap settings, known as "stages" – 10°, 25° and 40°.

runway before the main wheels. The pilot was able to taxi clear of the runway and was not aware of any damage to the aircraft until a subsequent visual inspection.

Damage to aircraft

During an inspection of Runway 34, five pieces of the nosewheel spat were recovered. There was no evidence of the propeller having contacted the runway and a subsequent inspection by the maintenance provider to the aircraft operator indicated that damage was limited to the engine frame and nosewheel spat.

Aircraft information

The PA28-180 Archer III *'Pilot's operating handbook'* states a '*maximum demonstrated crosswind velocity*' of 17 kt. In the section entitled *'Normal procedures'* it recommends an initial approach speed of 75 kt and a final approach speed with "flap extended" of 66 kt[2]. No speed is given for landing with two stages of flap set, but the handbook contains the following advice:

> *'The amount of flap used during landings and the speed of the aircraft at contact with the runway should be varied according to the landing surface and conditions of wing and airplane loading. It is generally good practice to contact the ground at the minimum possible safe speed consistent with existing conditions.'*

Flying instructors familiar with the Archer III to whom the AAIB spoke all commented that two stages of flap was appropriate for landing in a gusting crosswind. The maximum permitted mass for takeoff and landing was 2,550 lb. Information provided by the pilot indicated that the takeoff mass was 2,531 lb.

Discussion

The AAIB receives several reports each year of light aircraft that have suffered damage as a result of landing nosewheel first, often following a bounce on initial touchdown. The nosewheel of most aircraft with tricycle landing gear is intended to provide steering and stability on the ground and is not designed to support the loads imposed by initial contact with the runway on landing. Accordingly, pilots are taught to touch down on the main wheels first. If the first attempt is unsuccessful, one option is to go around and reposition for another approach and landing.

Any control input which results in lowering of the nose close to the ground increases the risk that the nosewheel will make contact with the runway before the main wheels. As airspeed increases, a lower nose attitude is required to maintain the desired approach path, which also increases the likelihood of landing nosewheel first.

Footnote

[2] In the Performance section of the handbook this speed corresponds to landing with 40° of flap set.

ACCIDENT

Aircraft Type and Registration:	Piper PA-30 Twin Comanche, N65PF
No & Type of Engines:	2 Lycoming I0-320 piston engines
Year of Manufacture:	1967
Date & Time (UTC):	13 March 2008 at 1730 hrs
Location:	Biggin Hill Airport, Kent
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Substantial damage to the left wing
Commander's Licence:	Private Pilot's Licence
Commander's Age:	52 years
Commander's Flying Experience:	2,366 hours (of which 1,002 were on type) Last 90 days - 29 hours Last 28 days - 8 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

At about 900 feet amsl, after takeoff from Biggin Hill, the aircraft inadvertently entered cloud. The pilot carried out a descending left turn to regain visual flight; the ground rises to over 800 feet in this area. During the manoeuvre the left wing contacted the tops of trees, causing extensive damage to the left wing leading edge. The aircraft was still controllable and returned to Biggin Hill for an uneventful landing.

History of the flight

The pilot intended to fly N65PF from Biggin Hill (airfield elevation 598 feet) to Rochester, where it was due to have its interior refurbished. The aircraft had no functioning navigational aids, although the radio and transponder were operational. The weather at Biggin Hill was observed by the pilot to be overcast in light rain. The pilot also noted the departure information 'Tango', which gave a visibility of 4.5 km in rain and drizzle and the cloud as broken at 1,500 feet. A colleague of the pilot had just flown from Biggin Hill to Rochester and had reported that the weather at Rochester was good for a VFR flight in the light rain.

This was the first time the pilot had flown N65PF, so he conducted a thorough pre-flight check. The taxi, engine run-up checks and pre-departure checks were uneventful. The pilot took off from Runway 21 and the aircraft climbed away normally. Once stable in the climb the pilot began to make himself familiar with the aircraft and was checking the instruments, looking inside the cockpit at this time. At about 900 feet amsl he looked out and found that he had inadvertently entered cloud. The pilot levelled off; he was aware that he was close to the Gatwick controlled airspace so he started a left turn and descended to regain visual flight.

During the turn the pilot heard a loud bang on the left side of the aircraft, after which he noticed substantial damage to the outboard leading edge of the left wing. The pilot immediately climbed back to 900 feet amsl. Having established that he still had full control of the aircraft he elected to return to Biggin Hill. At about 2 nm from Biggin Hill the aircraft broke through the cloud and the pilot was able to approach Runway 03 visually for an uneventful landing.

After shutdown the pilot examined the left wing and noticed tree remains in the damaged sections.

A radar trace of the aircraft's track was obtained and it showed that the aircraft had started its initial turn to the left in an area where the North Downs rise to over 800 feet. The aircraft altitude at this time was reported by the pilot to be 900 feet amsl, leaving a minimal margin. It is probable that, during the descending left turn, the aircraft's left wing entered the top of the trees, causing the loud bang and subsequent damage.

ACCIDENT

Aircraft Type and Registration:	Piper PA-34-220T Seneca III, G-LENY
No & Type of Engines:	2 Teledyne Continental TSIO-360-KB piston engines
Year of Manufacture:	1982
Date & Time (UTC):	19 December 2007 at 1709 hrs
Location:	4 nm south of Oxford (Kidlington) Airport
Type of Flight:	Commercial Air Transport
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Serious) Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	52 years
Commander's Flying Experience:	4,268 hours (of which 1010 were on type) Last 90 days - 164 hours Last 28 days - 46 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft, with one pilot on board, was flying a non-precision approach to Runway 01 at Oxford (Kidlington) Airport when the accident occurred. It was night and the weather was poor. The aircraft commenced its final descent 2.3 nm before the correct descent point and continued to descend below the step-down Minimum Descent Altitude (MDA). It struck trees near the summit of a hill, 3.6 nm before the runway threshold, in what appeared to have been controlled flight. The pilot survived with serious injuries. No technical faults or defects were identified as contributory factors to the accident, which the investigation concluded was an instance of Controlled Flight Into Terrain (CFIT).

History of the flight

The aircraft pilot had been on standby duty at his home during the morning and was called at about 1230 hrs to operate a charter flight. The task was to fly from the operator's base at Oxford Airport to Denham Airport where the aircraft was to collect a single passenger and fly him to Plymouth City Airport. The aircraft was then to return to Oxford with only the pilot on board.

Normal pre-flight preparation included checking weather and route information at a computer terminal in a crew report area and examining the flights logs for the intended flights. The aircraft, which had not flown for six days, was fuelled to full tanks (466 ltr) which allowed for a flight time of about 5 hours.

The aircraft took off from Oxford at 1359 hrs and flew to Denham, 7.5 nm north of Heathrow Airport. The pilot's memory of the events preceding the accident was limited, but he did recall that the weather at Denham had been "murkier" than expected. He described having to fly a let-down through cloud using mainly GPS information. After a short stop at Denham, the aircraft flew on to Plymouth with one passenger on board. The passenger disembarked at Plymouth before taking off again at 1613 hrs for the return flight to Oxford. The aircraft was fully serviceable when it departed from Oxford, and there was no reason to believe that this was not the case when it took off from Plymouth on the accident flight.

The aircraft flew an almost direct track towards Oxford, cruising at FL50. As the aircraft neared Oxford, the pilot was in contact with ATC at RAF Lyneham and then at RAF Brize Norton. An Automatic Terminal Information Service (ATIS) broadcast was operating at Oxford which gave a visibility of 3,500 m in haze and overcast cloud at 500 ft aal. When the pilot first contacted Brize Norton ATC, at 1701 hrs, he requested "…POSITIONING FOR STRAIGHT IN FOR ZERO ONE AT OXFORD…" and reported that he was descending to 3,500 ft. The pilot was instructed to take up his own navigation towards Oxford, cleared to transit the Brize Norton control zone and further cleared to 3,000 ft on the Oxford QNH.

At 1703 hrs the pilot contacted Oxford ATC. He did not request nor receive Oxford weather information from Brize Norton or Oxford Approach and did not state to either controller that he had received the ATIS information. On his initial call to Oxford, the pilot said that he was joining for a 10-mile finals position and was asked by the controller to call again at 2 nm range. The pilot subsequently called at 4.5 nm range and was asked to report again when he was visual with the runway lights. The pilot acknowledged this instruction but no further transmissions were received from him.

When the aircraft failed to land at Oxford, an extensive search was initiated, involving helicopters and teams on foot. Poor weather hampered the search but the accident site was eventually located at 2015 hrs, close to the summit of a 539 ft hill, on the extended centreline, 3.6 nm from the Runway 01 threshold. The site was in thick fog at the time. The pilot was found 9 m from the burning wreckage. He was hypothermic and suffering from chest and limb injuries, as well as burn injuries to his lower legs. He was taken to hospital in Oxford and survived the accident.

Accident site

The aircraft crashed on Wytham Hill in Wytham Great Wood, which is approximately 3 nm west of the city of Oxford. The wood in the area of the crash site was very dense and the aircraft initially made contact with the tops of 60 ft tall trees sited on ground 500 ft amsl. The initial impact point was 3.6 nm from the threshold of Runway 01 and the tops of the trees were 310 ft above the runway threshold elevation.

The wreckage trail extended for 160 m on an average track of 025º(M). The first part of the wreckage trail was 90 m long and consisted of freshly cut branches, the right wing tip and composite material from the wing leading edge. The ground then sloped away towards the main wreckage site. There was no debris for the next 50 m, after which more cut branches, the left navigation light and the tail anti-collision light were found on the ground. During the last 20 m the aircraft sustained substantial damage when it struck several large trees.

From the distribution and damage of the wreckage, and burn marks to the trees, it was established that the left wing, from just outboard of the engine, failed and broke into four main sections after it hit a large tree, late in the impact sequence. The force of the collision was sufficient for one of the fuel tanks in the wing to explode and set a number of trees on fire. The fin and rudder also broke away after striking a large tree.

The aircraft came to rest inverted, with both engines and the remainder of the wings lying on top of the cabin. With the exception of the tail section, the aircraft cockpit and fuselage were destroyed by an intense post-crash fire. The upper part of the forward right cabin door was found separately; its damaged state indicated that the upper forward right fuselage had also made forcible contact with the trees.

Examination of the wreckage

The landing gear had been extended and from the flap operating lever, it was established that the flaps had been lowered to their first position (10 degrees). From the position of the trim screw jack it was established that the elevator trim was set at about the neutral position, which was consistent with the phase of flight. The steel components in the control systems were relatively undamaged and the control system appeared to have been intact prior to the impact. The pitch control mechanisms on both propellers were broken and the blades were all bent. From the damage sustained by both propellers and the width and length of the trail of broken branches, it was assessed that both engines were producing power as the aircraft flew into the trees. Moreover, the depth of two blade strikes on a large tree trunk indicated that, in the last 20 m, at least one engine was operating at a high power setting.

It was also established that the composite material found in the early part of the wreckage trail was from the right wing leading edge. Sections of this material were positively identified as coming from both the wing root and wing tip. The loss of the greater part of the fuselage and cockpit area in the fire prevented any examination of flight instruments or avionics components, including the automatic pilot system.

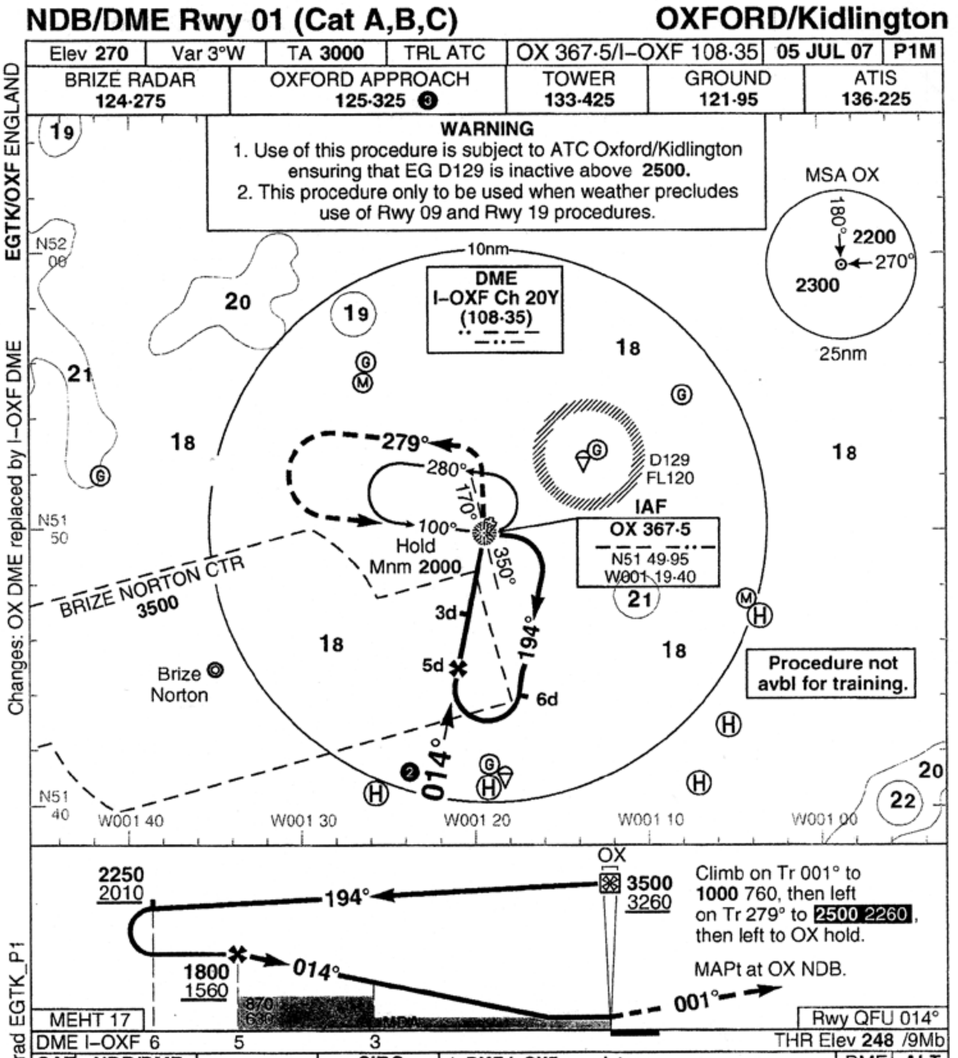
Airport information

Oxford (Kidlington) Airport (elevation 270 ft) is 6 nm north-north-west of Oxford. The main runway is orientated 01/19, is 1,319 m long and is equipped with an ILS on Runway 19 only. There is a secondary runway, 760 m long and orientated 11/29. A DME (coded "I-OXF") is zero-ranged to the threshold of the runway in use, and an NDB (coded "OX") is located on the airport. Runway 01 is equipped with high intensity bi-directional edge lighting with a low intensity omni-directional component. The threshold is equipped with high intensity green lighting and wing bars. Precision Approach Path Indicator (PAPI) lights are situated on the left side, 140 m from the threshold and set to an approach angle of 3.5º. Runway 01 had no approach lighting.

At the time of the accident the airfield lighting was all selected on and Runway 01 selected for use. The ILS was off and the NDB and DME were indicating 'serviceable'. No pilot reports were received that evening about the reliability of the available navigation aids. The minimum Sector Safe Altitude (SSA) to 25 nm from Oxford in the direction of approach for Runway 01 was 2,300 ft.

Navigational information

Runway 01 was served by an NDB/DME approach, shown at Figure 1 in the same format as that available to the pilot. The procedure involved a descent to the intermediate altitude of 1,800 ft as the aircraft



CAT	NDB/DME		CIRC
A	690 450 1500m	N/A	800 530 1500m
B	690 450 1500m	N/A	800 530 1600m
C	690 450 1800m	N/A	1100 830 2400m

GS (kt)		80	120	150	180	210
FAF–THR	5nm	3:45	2:30	2:00	1:40	1:26
ROD (fpm)	2·8°	400	590	740	890	1040

1. DME I–OXF mandatory.
❷ FAT does not intercept RCL.
❸ Proc penetrates Brize Norton CTR. Make initial ctc with OXFORD APP, for subsequent transfer to Brize Norton ATC as advised. Acft leaving awys – See D1.
4. Acft will normally be required to hold not below 3500 or equivalent FL.
5. Acft should not descend below the recommended profile due to noise abatement.
6. Rdr vectoring to final app will normally be to establish on FAT at 1800 1560 by FAF. Acft may be vectored from OX hold to FAT.
7. Procedural race–track not normally avbl if BRIZE rdr vectoring avbl. Sector 3 entry only (Tr 100°) from inbd leg of hold.
8. DME I–OXF reads zero at THR.

DME I–OXF	ALT HGT
5	1800 1560
4	1480 1240
3	1180 940
2	880 640

OXFORD/Kidlington
PANS OPS (ICAO)
NDB/DME Rwy 01 (Cat A,B,C)

Figure 1

Runway 01 Approach Chart

established on the inbound course of 014°(M). Final descent started at the Final Approach Fix (FAF), which was at 5 DME. A step-down fix existed at 3 DME with an associated MDA of 870 ft amsl. The procedure MDA after the step-down fix was 690 ft amsl, equating to 450 ft above the runway threshold. The associated minimum required visibility was 1,500 m.

The full procedural approach was only to be flown if radar vectors were unavailable from Brize Norton ATC. The approach information published in the UK Aeronautical Information Publication (UK AIP), and also on the commercially produced charts in use by the operator included a number of notes and warnings. Among the notes was the item:

> *'**Rdr** (radar) **vectoring to final app** will normally be to establish on FAT[1] at **1800** 1560 by FAF'*

The Airport is situated adjacent to the eastern side of the RAF Brize Norton control zone, such that the instrument approach for Runway 01 penetrates the zone. It was therefore a requirement that inbound aircraft contact Brize Norton ATC for radar vectoring or procedural control until established on the final approach track. The procedure was notified as not being available for training purposes.

The approach chart included a table of altitudes against DME ranges, to assist a pilot to fly a Continuous Descent Approach (CDA). A note on the chart read:

> *'Acft should not descend below the recommended profile due to noise abatement.'*

The UK AIP also gave information on holding, approach and departure procedures in the UK. Concerning instrument approach procedures, the UK AIP states:

> *'…where an aerodrome is provided with one or more notified Instrument Approach Procedures, unless otherwise authorised by ATC, pilots requiring to use an Instrument Approach Procedure shall use only such notified procedures…'*

Footnote

[1] Final Approach Track.

The UK AIP also reminded readers that PANS-OPS (ICAO document *"Procedures for Air Navigation Services – Aircraft Operations"*) stressed the need for flight crew and operational personnel to adhere strictly to the published procedures in order to achieve and maintain an acceptable level of safety in operations.

PANS-OPS included the method of calculating minimum heights and altitudes for instrument procedures. Where an FAF was defined, a minimum obstacle clearance of 75 m (246 ft) was specified. In relation to flying a non-precision approach containing step-down fixes (such as the approach to Runway 01 at Oxford), PANS-OPS stated:

> *'Where a stepdown procedure using a suitable located DME is published, the pilot shall not commence the descent until established on the specified track. Once established on track, the pilot shall commence descent maintaining the aeroplane on or above the published DME distance/height requirements.'*

The obstacle necessitating the step-down procedure for the approach was a viewing / study platform close to the final wreckage position, with an elevation of 616 ft.

Recorded information

Radar

Recorded data from the Clee Hill area radar, 68 nm from the accident site, was available for analysis. The data included primary and secondary returns, and Mode C altitude data transmitted to the nearest 100 ft. The Mode C data originated from an independent encoding unit on the aircraft, which was referenced to the International Standard Atmosphere sea level pressure of 1013.25 hPa. Based on the Oxford QNH of 1036 hPa, and using a correction value of 28 ft/hPa, Mode C values in this report have been converted to a corrected altitude. Figure 2 shows the aircraft's vertical profile from before the FAF; vertical error bars represent the Mode C resolution limitation.

The aircraft descended from its cruise level of FL50 as it tracked in an almost straight line towards a point 10 nm on the extended Runway 01 centreline. It levelled just before reaching the 10 nm point, at 1,744 ft (which correlated to the 1,800 ft intermediate altitude). At this point the aircraft commenced a left turn to establish on the inbound course, with an average groundspeed of 140 to 145 kt. From then on, the groundspeed reduced steadily until it stabilised at about 115 kt when the aircraft was descending on final approach (consistent with a typical approach speed for the aircraft of 120 kt).

The aircraft maintained level flight until starting to descend at about 7.3 nm from the runway threshold (equivalent to 7.3 DME), at which point it was established on the inbound radial. At 5.5 DME the aircraft track started to drift slightly right of track, and at the 5 DME FAF, when the final descent should have commenced, the aircraft was indicating 1,144 ft altitude, 656 ft below the recommended approach profile. It had also just started to drift to the right of the inbound track. To this point, the rate of descent was about 500 ft/min.

The aircraft continued to descend at a slightly increased rate until the last radar return, at 1708:36 hrs. The aircraft was at 4.5 nm range and 944 ft altitude, 696 ft below the recommended profile. This was just before the pilot made his last radio transmission. Based on the observed

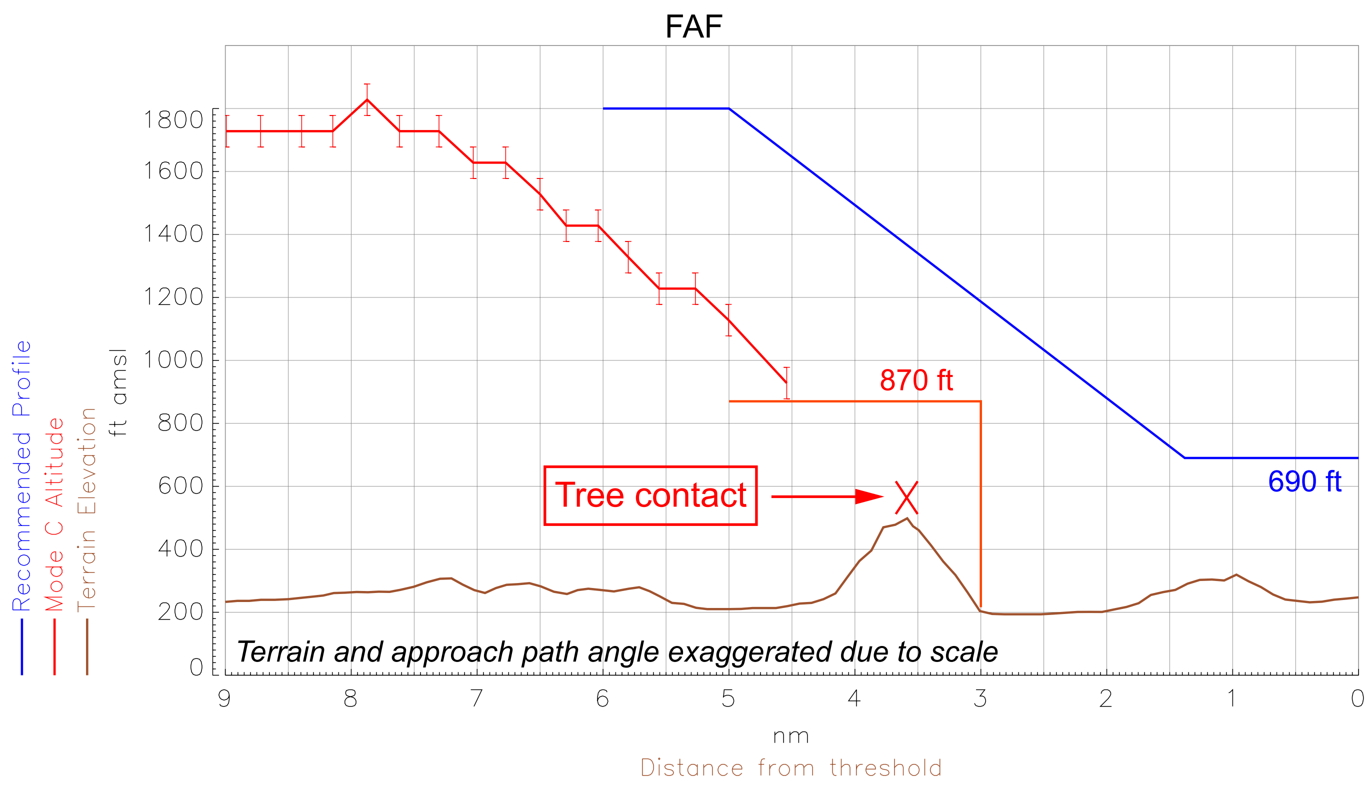


Figure 2

Approach profile

rate of descent, the aircraft would have descended below the step-down MDA of 870 ft just after the last radar return, at about 4.4 nm. The last radar position placed the aircraft 1,700 m from the point of first impact with the trees, at an altitude of 944 ft and 130 m right of the inbound course.

Between the last radar return and the first contact with the trees, the rate of descent would have been between 700 and 900 ft/min. As Figure 2 shows, the radar data does suggest a slight increase in rate of descent in the latter stage. Based on the average groundspeed at that point, the aircraft would have hit the trees 30 seconds later. The average rate of descent from starting descent at 7.3 DME to the point of impact was about 600 ft/min, which would have been the rate required to follow the recommended profile from the FAF.

If the final descent rate was as predicted, the aircraft descended through the procedure MDA of 690 ft about 650 m and 11 seconds before the first point of contact. Had the aircraft levelled at the procedure MDA of 690 ft, the aircraft would have cleared the trees on its track by approximately 130 ft, and would have cleared the trees on the adjacent highest ground by about 90 ft (using an average tree height of 60 ft).

Radiotelephony (R/T) information

The pilot called Brize Norton at 1701 hrs and reported that he was descending to 3,500 ft altitude on the Oxford QNH of 1036 HPa. He said "...REQUEST FURTHER DESCENT AND POSITIONING FOR STRAIGHT IN FOR ZERO ONE AT OXFORD THROUGH YOUR ZONE". The controller cleared the pilot to descend to 3,000 ft and placed him under a Radar Information Service. The controller then said "...TAKE UP YOUR OWN NAVIGATION FOR OXFORD...". He cleared the aircraft through the control zone, and asked the pilot to advise when he wanted to change to the Oxford Frequency. The pilot then advised that he was content to change to Oxford ATC and, after rechecking that he was clear to penetrate the control zone, changed frequency. The entire exchange between the pilot and Brize Norton ATC lasted less than two minutes. The frequency was not busy, so controller workload was unlikely to have been high.

Just after the pilot contacted Brize Norton, the controller there contacted the Oxford controller by land line and pre-notified her of the inbound aircraft, saying "HE'S COMING STRAIGHT IN FOR ZERO ONE". The Brize Norton controller asked for and received the Oxford QNH, and the exchange ended.

Just after 1703 hrs, the pilot contacted Oxford, saying "....JOINING FOR A TEN MILE FINAL FOR ZERO ONE IF THAT'S OK..." The controller acknowledged this and gave the QNH. She also instructed the pilot to call at 2 nm finals, which he acknowledged. Just before 1709 hrs the pilot transmitted "FOUR AND A HALF MILES FINALS (call-sign)". The controller instructed the pilot to call when the runway lights were in sight, to which he replied "WILCO (call-sign)" at 1708:55. When compared with the radar data, this call was calculated to have been only 11 seconds prior to the accident, with the aircraft at an estimated 4 DME and at 690 ft, 180 ft below the minimum altitude for the aircraft's position on the approach. There were no further calls from the pilot.

Pilot information

After some years flying gliders and tug aircraft, the pilot trained in the USA for an FAA Commercial Pilot's Licence and Instrument Rating, which he subsequently converted in the UK to a JAR licence, issued in January 2003. At the end of that year he joined the aircraft operator, at its Oxford base, and completed conversion training on the PA-34 Seneca III in early 2004. At the time of the accident he was also qualified to fly the Piper PA-31 (Navajo Chieftain), PA-31T (Cheyenne I and II) and PA-42 (Cheyenne III), and was a Line Training Captain on the PA-34. The pilot had not flown the PA-34 since 24 August 2007, but because he had flown the PA-31 more recently and the two aircraft were of the same class, the applicable recency on type requirements were met.

From the pilot's training files, it was established that he was correctly licenced and qualified for the flight and that all recurrent training and checking had been completed. The pilot was well regarded by the operator's management team and considered to be a cautious and sensible pilot.

In the two days before the accident, the pilot had flown a PA-31T to Tenerife South in the Canary Islands, returning via Faro, Portugal, to land back at Oxford at 1655 hrs on the day before the accident. Although these were relatively long flights, his duty times were within prescribed limits and he considered himself to be well rested and in good health when he reported for duty on the day of the accident.

Pilot approach techniques

The pilot believed that he would have sought the latest ATIS weather information and given the reported overcast cloud at 500 ft, it would have been his intention to fly an instrument approach. His technique for flying a non-precision approach was to descend to MDA as soon as the procedure allowed and then to fly level until either acquiring the required visual references or reaching the missed approach point. Although he would frequently use the autopilot, he could not be sure that he would have used it during the accident approach.

The pilot believed he would have used the aircraft's GPS navigation system to assist with the approach. Using this equipment, deviation from a desired inbound course to a GPS waypoint could be selected for display on the aircraft's horizontal situation indicator, and this is what the pilot normally did. Raw NDB data would still be available, along with both DME and GPS ranges. The pilot would normally configure the aircraft with the first stage of flap prior to the approach and select landing gear down just prior to the FAF. From memory, he thought that the FAF for Runway 01 was at 7 or 8 DME.

Approach charts for a range of airfields were kept in a manual in the aircraft, which the pilot would normally position on the seat beside him. However, he kept a copy of the Runway 01 approach stuck to his kneeboard for easy reference. At interview, the pilot asserted that he would not have deliberately flown below the MDA for the approach (690 ft). However, he was unaware that the approach contained a step-down MDA of 870 ft to 3 DME. The pilot said that he had, in the past, flown the approach without reference to the published charts as he was familiar with it.

Meteorological information

The Met Office provided a report on the prevailing weather situation. A large high pressure cell was situated over the North Sea and Germany, resulting in a south-easterly airflow over the area. Although the airmass was essentially dry, low temperatures near the surface resulted in localised very low cloud and patches of mist.

Meteorological observations were made at 1650 hrs at RAF Brize Norton and RAF Benson, 18 nm from Oxford Airport. Brize Norton (elevation 288 ft) reported 4,000 m visibility in mist with broken cloud at 500 ft, while Benson reported 1,200 m visibility in mist with clear skies, which resulted in lower temperatures and hence the lower visibility. The latest usable visual satellite imagery was timed 1530 hrs, and showed low cloud or fog in the Oxford area. Given the reported winds, it is probable that the observed weather was low stratus rather than fog at this time. The atmospheric temperature structure suggested that a broken to overcast cloud base would be expected at around 800 to 900 ft amsl (around 300 ft above the hill top). The cloud tops would probably have been about 2,000 ft amsl, with clear skies above. Imagery showing cloud top temperatures suggested a very shallow sub-zero temperature layer may have existed at the top of the cloud layer.

The Oxford ATIS code "K" for 1620 hrs was applicable at the time of the accident. This gave a surface wind from 060º/10 to 15 kt, visibility of 3,500 m in haze and overcast cloud at 500 ft (770 ft amsl). The ATIS broadcast concluded with the instruction "ON INITIAL CONTACT WITH OXFORD ATC CONFIRM THE QNH AND INFORMATION KILO RECEIVED". Air traffic controllers and other flying staff at Oxford generally agreed that both cloud base and visibility gradually reduced during the afternoon, and probably reached their worse at, or not long after, the time of the accident.

Weather assessments were sought from pilots of other aircraft, including the crews of the two helicopters involved in the search. The pilot of an executive jet which landed 10 minutes before the accident recalled that he entered cloud at about 1,000 to 1,200 ft on the approach to Runway 01, and that there was no cloud immediately above this layer. No ground lighting was seen until the runway lights were sighted very late on the approach, with the aircraft at MDA. Pilots of each of two helicopters which were involved in the search for G-LENY reported a cloud base at about 700 ft initially, with a mix of very low cloud and fog. By 1830 hrs, the low cloud had largely dispersed, but ground fog persisted.

Air Traffic Control procedures

Oxford Airport was not equipped with radar, so Approach Control was procedural only. At the time of the accident the Tower and Approach positions were combined, operated by a single controller. A Letter of Agreement between RAF Brize Norton ATC and Oxford ATC detailed the air traffic procedures to be applied between the two units in respect of aircraft operating to and from Oxford Airport. Brize Norton ATC normally provided a Lower Airspace Radar Service to aircraft in the area, as well as a service to departing and arriving Oxford aircraft when controller workload permitted.

The Letter of Agreement listed three options for aircraft making an instrument approach to Runway 01. They were:

a. A radar vectored diverse approach onto the final approach track,
b. A radar vectored approach to the FAF from the 'OX' holding pattern,
c. A procedural approach from overhead the 'OX' NDB.

The radar vectored approaches were listed as the preferred options; there were no 'self-positioning' or 'straight in' options.

Responsibilities of the Brize Norton and Oxford controllers were listed in the Letter of Agreement for radar vectored and procedural approaches to Runway 01. In the case of a radar vectored approach, the Brize Norton controller was to obtain clearance from Oxford ATC for the approach and then to vector the aircraft to a 7 nm final approach point at 1,800 ft on Oxford QNH. For a procedural approach, the same controller would be required to issue a clearance for the full approach and notify Oxford of any relevant traffic information.

There was some ambiguity in the procedures relating to weather information at the time of the accident. The Letter of Agreement was subsequently amended to the effect that the Brize Norton controller would confirm that inbound pilots had received the latest ATIS information.

When the operator's management pilots were asked about instrument approach procedures at Oxford, they replied that inbound aircraft would often be allowed to self-position to final approach and to descend at the pilot's discretion to the intermediate altitude of 1,800 ft. The pilot of G-LENY also stated that this was the case.

Search and Rescue (SAR) activities

The pilot's last transmission was at 1709 hrs. When the aircraft had not landed after five minutes, and the pilot had made no further transmissions, the controller attempted unsuccessfully to contact the aircraft. She alerted Brize Norton ATC to the situation, who also attempted to contact the aircraft. The Brize Norton Approach controller alerted the Distress and Diversion (D&D) Cell at the London Area Control Centre, whilst the controller at Oxford alerted the local emergency services. She also requested that a Police Air Support Unit helicopter be made available but this was not possible due to fog at its RAF Benson base.

The crew of a private S-76 helicopter which was flying through the Brize Norton area was asked by Brize Norton ATC to assist with the search for the missing aircraft. The crew flew the helicopter along the approach and immediate go-around tracks for Runway 01 but reported that the weather was very poor and that they could not locate the aircraft. Meanwhile, D&D were able to establish the aircraft's last radar position, which was passed via Brize Norton to the helicopter.

The crew eventually located what was possibly a fire but this was under dense fog so could not be confirmed as such. The position of this was passed to Brize Norton who relayed the information to the Area Rescue Co-ordination Centre (ARCC) at RAF Kinloss, shortly before fuel considerations forced the helicopter to resume its onward flight. The position reported by the S-76 crew was later confirmed as being that of the crash site.

An S-61 SAR helicopter from Lee-on Solent on the south coast was tasked by the ARCC via the Maritime Rescue Co-ordination Centre (MRCC) at Southampton. The helicopter was scrambled at 1818 hrs and lifted off at 1825 hrs. The crew encountered worsening conditions as they neared the accident area and decided to fly an instrument approach at Brize Norton before assessing the weather and the available search options. The helicopter remained on the ground for about 15 minutes before the cloud base, which was estimated to be varying between about one and two hundred feet during this time, lifted sufficiently to allow the search to begin. The helicopter eventually took off again and reported "on scene" at 1940 hrs.

When the S-61 arrived in the search area, the low cloud had dispersed and the crew could clearly see the runway lights at Oxford. With the aid of infra-red (IR) and night vision equipment, they could see search teams in the general area but not the crash site itself. Fog persisted in the accident area, and the moist conditions reduced the effectiveness of the IR equipment. It was not until an improvement in the conditions allowed the helicopter to safely descend lower that, at 2015 hrs, a positive identification was made of the aircraft wreckage and of the pilot lying close by. Ground search teams were directed to the site before the helicopter finally departed the scene at 2045 hrs.

Actions by the aircraft operator

The operator's senior flight operations staff indicated that the company had a policy whereby a non-precision approach should be flown as a continuous descent approach (CDA), observing the recommended profile if one was published. However, this policy was not reflected in written procedures in the operations manual. The pilot of G-LENY had been advised during a past proficiency check to adopt a CDA procedure for non-precision approaches, although he had chosen to continue using his favoured 'step down' technique. The operator had identified the lack of formal procedures and was in the process of introducing written Standard Operating Procedures (SOPs) during the investigation.

Analysis

General

The aircraft crashed during a non-precision approach at night and in poor weather, after descending below the step-down fix MDA applicable to the initial part of the approach. The aircraft travelled for a substantial distance after it first hit the trees, level or in a shallow descent at first. Damage to the trees and condition of the propellers indicated that both engines were producing power during the accident sequence.

The pilot had been navigating the aircraft satisfactorily until the point that radar contact was lost and, although it was begun early, the final decent was steady and controlled. The aircraft was correctly configured for the approach and flying in trim at the correct airspeed. The pilot had been in contact with ATC and made his last call only 11 seconds before the time at which it was calculated that the aircraft hit the trees. The pilot gave no indication at any point that he was managing an abnormal or emergency situation.

If a technical malfunction or failure had caused the accident, it either occurred after the pilot's last radio transmission or he was unaware of its presence. Had such an event occurred, it did not cause a significant change to the aircraft's ground track or descent profile after the aircraft was lost from radar. The aircraft appeared to have been in controlled flight when it hit the trees. Had an engine failure occurred (though there was no evidence of such), it obviously did not lead to a loss of control. The aircraft would have been capable of climbing with one engine failed.

Survivability

The pilot was extremely fortunate to survive the accident. Damage to the upper forward door, which became detached, pointed to significant disruption of the forward right fuselage structure and windshield. From the pilot's burn injuries and the place he was found, it is most likely that he escaped from the disrupted fuselage after impact, rather than being thrown from it.

Flight instruments

The flight and navigation instruments were destroyed in the post-crash fire, along with a substantial amount of the pitot/static system, so could not be examined. However, a number of related scenarios were considered. These were: incorrect altimeter setting, altimeter misreading, pitot/static system problem, and erroneous navigational indications.

When the pilot first contacted Brize Norton ATC, he said he was flying with reference to the Oxford QNH, and the radar data showed that the aircraft descended to, and maintained, the correct indicated altitude prior to its final approach. The pilot had recently been flying aircraft equipped with single-pointer altimeters, and the potential for misreading the more complicated three pointer arrangement is widely recognised. However, the aircraft levelled correctly at an indicated 1,800 ft prior to the approach, and a subsequent misreading during the final descent was unlikely. This is because, at almost any point on the final approach, if the pilot had mistakenly added 1,000 ft to the indication, the resultant value would have been above the starting altitude, and hence would have been nonsensical[2].

It is unlikely that the pitot/static system was affected by icing. The airmass was dry, possible exposure to icing conditions would have been very brief, and the aircraft was not normally susceptible to icing-related instrument problems. An iced or otherwise blocked static line would also have affected the other pressure instruments and Mode C altitude encoder, but no unusual parameters were seen on radar. It was not possible to rule out an internal altimeter malfunction or complete static line blockage in the critical last stages of the flight, after the aircraft had been lost to radar. However, the descent profile does not easily support it and the 'window of opportunity' after radar data ceased is so narrow as to make the scenario improbable. A standby altimeter provided an indication cross-check.

The aircraft was being navigated correctly with reference to the inbound course but descended about 2.3 nm before the correct final descent point. The pilot's range call of 4.5 DME was within 0.2 nm of the actual range, so an erroneous range display is unlikely. Additionally, two separate range sources (DME and GPS) were available to the pilot. If Oxford Airport had been selected as the reference GPS waypoint, the indicated range would have over-read by only 0.3 nm, and would have placed the aircraft closer to the runway than the equivalent DME range. This would account for the slight discrepancy described above.

CFIT factors

Although the pilot had not flown the aircraft type since the previous August, he met the recency requirements for that class of aircraft. He was in current flying practice and, by the time the aircraft started its final approach, had flown the aircraft that evening for more than two hours, including two approaches and landings. It was therefore considered that recency on type was not a factor in the accident. Recorded transmissions showed that the pilot had not become incapacitated.

The poor weather and consequential lack of ground reference, was almost certainly a major contributory factor in the accident. Although the pilot did not acknowledge receipt of the ATIS weather information, it is probable that he had received it, as he correctly quoted the QNH on first contact with Brize Norton. However, neither the controller at Brize Norton nor Oxford challenged the pilot for the correct ATIS code, nor passed him any weather update.

When the pilot contacted Brize Norton ATC, his request for "POSITIONING FOR STRAIGHT IN FOR ZERO ONE" was ambiguous because he did not state whether he desired radar-vectoring or self-positioning. Given that the Oxford weather was available to the Brize Norton controller (and was similar to that at Brize Norton), it could be concluded that the controller knew the pilot intended flying an instrument approach. However, it should be noted that, in military parlance, a request for a 'straight in' approach is taken to be a request for a visual approach. Self-positioning for the approach was not an option under the Letter of Agreement, yet the Brize Norton controller allowed the pilot to continue with this type of approach, effectively issuing no more

Footnote

2 Although not identified as a contributory factor in this accident, the operator undertook a fleet-wide standardisation of altimeter displays, converting aircraft with three pointer altimeters to single pointer displays.

than a zone crossing clearance and descent to 3,000 ft. Knowing that the pilot was not intending to fly the full procedural approach, the Brize Norton controller would also have known that the pilot would need to descend to 1,800 ft before commencing final approach, which was below the SSA of 2,300 ft. If the controller had imposed radar vectoring to 7 nm finals and 1,800 ft, it is unlikely that the pilot would have started such an early final descent or, if he had, it is possible that the controller would have seen it on radar and queried it with the pilot. When the Brize Norton controller pre-noted the aircraft to the Oxford controller, he repeated that the aircraft was "COMING STRAIGHT IN FOR ZERO ONE". The controller in effect passed on the ambiguity to the Oxford controller.

Pilot actions

From the report of the pilot who landed shortly before the accident, the pilot of G-LENY was probably clear of cloud when he let down to the intermediate altitude of 1,800 ft. The final descent, apart from starting early, appeared in all respects to be controlled and deliberate. The pilot had flown the approach from memory in the past and recalled at interview that the descent point was at 7 or 8 DME instead of the actual figure of 5 DME. However, the observed rate of descent was initially shallower than would be expected, considering the pilot's preferred method of flying a non-precision approach. Although it is therefore possible that the pilot was flying the approach from memory, it is equally possible, and perhaps more likely, that he was initially flying a mixed IF/visual approach in the belief that he would become visual with the runway before reaching MDA. It is likely that he was flying without reference to the approach chart.

At about the 5 DME point, the aircraft deviated slightly to the right of the inbound course and the rate of descent appeared to increase slightly. It is probable that this occurred soon after the aircraft entered cloud, which it is thought to have encountered at about this stage on the final approach. The deviations are unlikely to have been associated with an emergency situation, as the pilot had yet to make his final R/T call which made no mention of such. The displacement and rate of descent then remained largely unchanged until contact with the trees. Although no definite reason can be found for these slight deviations, their position and nature could very well coincide with an autopilot disconnection. If, as has been discussed, the pilot was flying a mixed IF/visual approach and encountered weather at this stage, it is quite possible that he increased the descent rate to ensure the aircraft arrived in good time at MDA, possibly disconnecting the autopilot at the same time.

The pilot's chosen method of flying the approach was a recognised technique and not inherently dangerous. However, for an approach with a step-down fix, it was less forgiving of inaccurate flying or navigational errors in that the aircraft may intentionally fly into closer proximity to terrain than would normally be the case using the CDA method.

The Runway 01 approach chart contained information which assisted pilots to fly a CDA, and a note on the chart specifically stated that pilots should employ this technique for noise abatement reasons. Had the pilot observed this instruction and adhered to the published range/altitude profile, the aircraft would have remained above the step-down MDA of 870 ft until after the 3 DME point.

The pilot was unaware that a step-down MDA existed and had flown the approach with the intention of descending directly to the procedure MDA of 690 ft. Thus, the risk of losing standard terrain separation would always have been present whenever the pilot flew the approach, as he had done many times on the past. The risk increased with an early descent, which made it much more likely that the aircraft would descend below 870 ft before the 3 DME point was passed. By starting the descent 2.3 nm early, the aircraft was placed on an almost direct flight path to the initial contact point on Wytham Hill.

Had the aircraft leveled at the procedure MDA of 690 ft, the aircraft would have cleared the trees, but with a dangerously small margin (although, in general terms, the final MDA for a 'stepped' procedure could well be below the actual elevation of obstacles earlier in the approach). The reason the aircraft did not level at or above 690 ft could not be determined but the probability is that it was due to human factors. The aircraft was correctly positioned laterally and was configured for the approach, so pilot workload would not have been excessive, particularly as the pilot was not attempting to follow the recommended profile. However, the observed flight path suggests that the pilot may not have been expecting the actual weather conditions to be as bad as they were. Penetration of low cloud relatively late in the approach would have increased stress and workload considerably and could therefore have been a contributory factor.

The pilot's call at 4.5 nm (rather than at 2 nm as requested) could have been an attempt to prompt an early landing clearance, as the aircraft was approaching the final MDA of 690 ft. The controller was not constrained in issuing a landing clearance, so the request to call again when the runway lights were in sight was unnecessary and created an additional uncertainty for the pilot. The pilot's response of "WILCO" indicates that he was not visual with the lights at this stage and, from the predicted flight path, was by then just reaching 690 ft. Following this last exchange, the pilot would naturally have started looking for the runway lights and could have inadvertently descended below the MDA. There was only 11 seconds between his transmission and contact with the trees.

Conclusions

The aircraft crashed during a non-precision approach at night and in poor weather, after descending below the MDA applicable to the initial part of the approach. The available evidence indicated that the aircraft made contact with the trees in a normal approach attitude and configuration, whilst under control and under power, and that the pilot then lost control as a result. Recorded data indicated that standard approach procedures had not been adhered to and the aircraft descended directly into contact with the trees. No evidence was found to suggest that a technical malfunction or defect had contributed to the accident, although this could not be ruled out. If a technical fault did play a part, it is likely that this was limited to a distraction at a critical stage of the approach. Had this occurred when the aircraft was below the applicable MDA, any transient loss of height would have been critical.

ACCIDENT

Aircraft Type and Registration:	Wittman W10 Tailwind, G-BJWT
No & Type of Engines:	1 Lycoming O-290-G piston engine
Year of Manufacture:	1984
Date & Time (UTC):	1 December 2007 at 1340 hrs
Location:	Hucknall Airfield, Nottinghamshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Significant damage to undercarriage, engine mount and propeller
Commander's Licence:	Private Pilot's Licence
Commander's Age:	48 years
Commander's Flying Experience:	254 hours (of which 80 were on type) Last 90 days - 1 hour Last 28 days - 0 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and subsequent investigation by the AAIB

Synopsis

The right gear leg fractured and collapsed after landing. The failure was attributed to incorrect material properties in the gear leg, probably introduced during heat treatment.

History of the flight

The pilot was returning to Hucknall after a local flight, and was making a straight-in approach from 2,000 ft to Runway 22. The wind was given by the tower as "estimated south-south-west, 20 gusting 30 kt". The approach and round-out appeared normal, but the aircraft bounced three times after the initial touchdown. The right gear leg fractured and collapsed and the aircraft slid to a halt, damaging the propeller and engine mount in the process. The pilot switched off the fuel and magnetos and radioed for assistance before exiting the aircraft with the passenger, without injury.

The pilot considered that he should have gone around after the first bounce rather than attempt to 'cushion' it. He also commented that the energy absorbent material used in the seats worked well.

Aircraft information

The Wittman Tailwind is homebuild aircraft that was designed in the 1950's and features a high wing and a tail-wheeled undercarriage, see Figure 1. The main gear legs are undamped steel struts and are attached to the tubular steel engine mount. These gear legs are 44 inches long with a bend immediately inboard of the axle. They are made of a heat-treatable alloy steel (6150) for which the Wittman drawings specifies:

> *'assemble gear struts in place and bend red hot (1/16" toe-in) and with 4-5° camber – then heat treat and temper to give 42-44 Rockwell "C" hardness.'*

This corresponds to a range of Vickers hardness of 400-430 HV.

This particular Tailwind was built in 1984. The legs were bent as specified and then sent to be heat treated by a specialist organisation. This operation was repeated some years later when the position of the main wheel was moved approximately 2" further forward.

Metallurgical examination

The right and left main gear legs, see Figure 2, were recovered to the AAIB and then sent to a metallurgist for examination. The metallurgist determined that the failure had resulted from a low-cycle, high-peak cyclic stress, fatigue mechanism that had initiated in three positions, see Figure 3, although the conditions could not be explained by the normal service loading in a gear leg with uniform properties throughout its volume.

The hardness was measured at several locations in the vicinity of the failure and the material was found to be very soft in the centre (circa 200 HV) and very hard on the surface (greater than 600 HV). It was concluded that the fracture had resulted directly from the use of incorrect heat treatment methods after the strut was fabricated.

Figure 1

Acknowledgement:
H T Consultants

Figure 2

Acknowledgement:
H T Consultants

Figure 3

Light Aircraft Association action

The LAA have been informed and will publish an article in their newsletter to highlight the importance of correct heat treatment for critical components. In view of this action, no safety recommendations are made.

AAIB comment

The fabrication of gear legs, including heat treatment, is probably a difficult task for many homebuilders. For many homebuild aircraft types it is possible to purchase complete gear legs which require no further manufacture, and it is currently possible to purchase such legs for this aircraft type.

ACCIDENT

Aircraft Type and Registration:	Robinson R22 Beta, G-OHSL
No & Type of Engines:	1 Lycoming O-320-B2C piston engine
Year of Manufacture:	1989
Date & Time (UTC):	30 January 2008 at 1415 hrs
Location:	Field 6 miles south-south-west Shobdon Airfield
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Severe damage: tail rotor section detached, main rotor crumpled, cockpit destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	36 years
Commander's Flying Experience:	1,500 hours (of which 1,100 were on type) Last 90 days - 88 hours Last 28 days - 23 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During the flare recovery manoeuvre at the end of a practice forced landing, the helicopter made contact with the ground. The ground was soft and the helicopter skids sank into the mud, causing the helicopter to pitch forward. The main rotor blades struck the ground, and the helicopter turned over, coming to rest on its left side.

History of the flight

The instructor was flying with a pilot who held a CPL(H), but who needed a 28-day currency check in order to comply with the company's self-fly hire policy. The weather conditions were good, with a light westerly wind and excellent visibility. The initial elements of the flight went as planned and the crew progressed to practising forced landings (PFL's) from 2,000 ft agl. The first PFL was flown uneventfully to an overshoot at 700 ft agl, and the helicopter was repositioned back to 2,000 ft for a further PFL. The crew had briefed that the objective of this exercise was to assess correctly the height for the initiation of the flare, and the intention was to level the helicopter and increase the power without making contact with the ground. After carrying out the necessary checks and applying full carburettor heat, the pilot commenced the second PFL.

The instructor was content with the handling pilot's choice of field so he instructed him to continue and to tell him when he judged that the height was correct to commence the flare. The handling pilot indicated that he thought that he should commence the flare at approximately 150 ft agl. The instructor considered that this was too early, so he took control and initiated the flare at height of about 40 ft. As the flare effect diminished, the instructor raised the collective lever but the helicopter continued to sink and the skids made contact with the soft ground. The skids sank into the mud, rapidly slowing the helicopter, which then pitched forward. The main rotor blades made contact with the ground and the helicopter turned over, coming to rest on its left side. The instructor switched off the electrics and both pilots vacated the helicopter through the right door.

The instructor considered that the accident occurred because he did not increase the power in sufficient time to prevent the skids from touching down on the muddy field.

ACCIDENT

Aircraft Type and Registration:	Robinson R22 Beta, G-RIAT
No & Type of Engines:	1 Lycoming O-360-J2A piston engine
Year of Manufacture:	1997
Date & Time (UTC):	2 May 2008 at 1340 hrs
Location:	Culter Helipad, Lower Baads, near Aberdeen
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Substantial
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	36 years
Commander's Flying Experience:	588 hours (of which 486 were on type) Last 90 days - 101 hours Last 28 days - 42 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

A student pilot was attempting to maintain the helicopter in the hover. A rearwards movement developed and the helicopter started to descend. The instructor intervened but was too late to prevent ground contact of the right skid, following which the helicopter rolled over. Both crew members were able to evacuate unassisted and there were no injuries.

History of the flight

The flight was being conducted as a trial lesson and an air experience flight. The student pilot had previous fixed wing experience but this was his first lesson in a helicopter. The flight lasted for one hour during which time the instructor considered that the student had demonstrated very good ability. On return to the practice square, the instructor decided to allow the student to maintain a hover, using all three controls. The student maintained the helicopter in a stable hover initially but a slow forward movement developed. He corrected for this but the helicopter then started to move backwards; this movement accelerated as the helicopter commenced a descent. The instructor took control and attempted to prevent further downward and rearward movement but he was unable to prevent the right skid from contacting the ground, and the helicopter rolled over. The instructor isolated the fuel and power, and both he and the student evacuated the helicopter without assistance.

The instructor considered that because the student had shown a good ability to control the helicopter he had allowed him too much time to correct his error before he intervened. By delaying his intervention, he left it just too late to be able to recover the situation. The training organisation has since prohibited hovering for air experience flights.

ACCIDENT

Aircraft Type and Registration:	Aeromot AMT-200S Super Ximango, G-CECJ
No & Type of Engines:	1 Rotax 912-S2 piston engine
Year of Manufacture:	2006
Date & Time (UTC):	17 August 2007 at 1520 hrs
Location:	Lasham Airfield, Hampshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - None
Nature of Damage:	Substantial damage to landing gear, wings, propeller, cowlings and engine bearer
Commander's Licence:	Private Pilot's Licence
Commander's Age:	68 years
Commander's Flying Experience:	505 hours (of which 12 were on type) Last 90 days - 10 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft was on approach to land at Lasham Airfield where extensive glider operations were taking place. Whilst his concentration was focussed on these activities, the pilot failed to notice that the aircraft had become too close to the ground, which it struck with a relatively high rate of descent just outside the perimeter track. The aircraft stopped with major damage to the airframe but with only minor back injury to the pilot.

History of the flight

The pilot was on his third solo flight in the aircraft, which he had just acquired. He had been advised to avoid landings with a crosswind component in excess of 5 kt so, as he approached the Aerodrome Traffic Zone from the south at a height of 2,000 feet, he was looking for signs of the wind direction and strength. From some smoke in the distance he estimated that the wind strength had decreased somewhat from when he had taken off, but he could not see a windsock.

In addition to a verbal account, the pilot provided a sketch (Figure 1) describing the activity on the airfield and the presence of an airborne glider to the south of the field, which he thought might be in contention for the landing area. He decided that he would land on the grass just to the south of the paved Runway 27, in order to avoid a glider which was being towed just inside the southern perimeter track. Mindful of the proximity of the

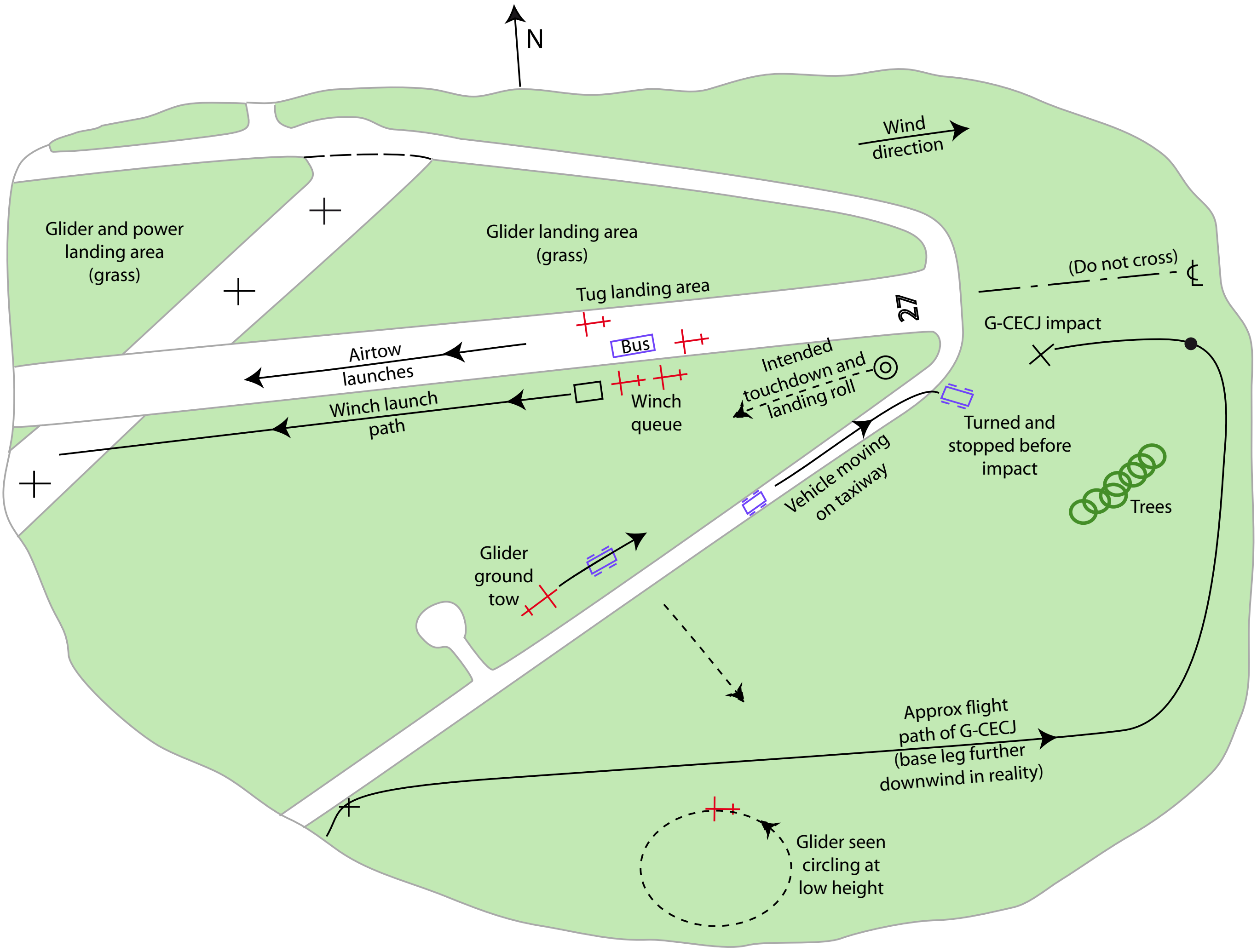


Figure 1
Reproduction of pilot's sketch

glider winch launch queue, he intended to touch down immediately after crossing the eastern perimeter track, as shown in the sketch. He was also concerned about his own tendency to bounce or balloon when landing a tailwheel aircraft on grass, (although he considered that he had overcome on his previous solo flying sessions). He trimmed the aircraft for a 60 kt gliding approach with the engine at idle and his right hand on the airbrake lever.

Initially using a fair amount of airbrake to achieve the selected touchdown point, the pilot then noticed a vehicle being driven towards him on the perimeter track and he was concerned that their two paths might intersect. However, as he watched, the vehicle turned onto the grass and stopped but, when his full attention returned to the approach, he suddenly realised that he was too low. He immediately closed the airbrake but did not think of opening the throttle as the aircraft struck the ground: he did not recall flaring but concluded that he must have achieved a roughly level pitch attitude because the tailwheel fork broke off at the first impact. The aircraft came to rest in about three fuselage lengths in long grass and on upward-sloping rough ground.

The pilot switched off the electrics, opened the canopy and prepared to evacuate. However, someone who had arrived almost immediately (probably the vehicle driver) advised the pilot to remain in the cockpit as he was in some pain from his back. Although the pilot was subsequently assisted in leaving the aircraft, he was satisfied that he would have been able to so on his own if fire had threatened.

Analysis

The pilot candidly admits that the primary cause of this accident was his own failure to 'aviate' due to distraction from the ground activity. In his opinion, the aircraft must have encountered a significant increase in rate of descent due to 'sink' or a change of wind gradient which went unrecognised due to his concerns with the ground activity. In future, he has resolved to fly approaches with this possibility in mind, his hand on the throttle or ready to use it, and with reference to the airspeed indicator.

The pilot also commented that he should have considered using the relatively uncluttered area north of Runway 27 (although he had earlier noted a glider having just landed in that area, not shown on the sketch). He cited several reasons why this did not seem attractive at the time. Firstly, he would have to extend his flight considerably to the east in order not to cross the extended centreline of Runway 27. Secondly, his normal parking spot was on the southern side of the airfield and he was uneasy at facing a long taxi in a high aspect ratio aircraft with which he was still relatively unfamiliar. Thirdly, the small wheels on the aircraft were very vulnerable to irregularities in the ground and he had previously found difficulty climbing the 'step' where the grass met tarmac runways or taxiways.

Finally, it is understood that a temporary seat cushion from domestic furniture was being used pending arrival of previously-ordered energy-absorbing cushions and that this may have been at least partially responsible for the discomfort caused to the pilot's back.

ACCIDENT

Aircraft Type and Registration:	Ikarus C42 FB100, G-EDEE
No & Type of Engines:	1 Rotax 912ULS piston engine
Year of Manufacture:	2005
Date & Time (UTC):	9 April 2008 at 1500 hrs
Location:	Sutton Meadows Airfield, Cambridgeshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Nose landing gear assembly, propeller blade and lower engine cowling damaged
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	63 years
Commander's Flying Experience:	123 hours (of which 29 were on type) Last 90 days - 11 hours Last 28 days - 7 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft was in the final stages of the approach to land when, at a height of about 15 ft, the aircraft unexpectedly pitched up. The pilot lowered the nose and the aircraft descended towards the runway. There was insufficient height to prevent the aircraft touching down on the nose wheel which collapsed.

History of the flight

The pilot and his passenger had departed from a private airstrip near Newark in Nottinghamshire for a flight to Beccles, before continuing to Sutton Meadows airstrip in Cambridgeshire. The purpose of the flight to Sutton Meadows was to visit friends before returning to Newark. The weather for the entire route was good with the surface wind generally westerly at about 15 kt.

After departing Beccles, the aircraft was climbed to an altitude of 2,000 ft for the transit to Sutton Meadows. The pilot joined overhead the destination and noted the windsock which indicated Runway 24 as the most suitable landing direction. He could not recall the exact wind direction he observed from the windsock but transmitted his intentions on the microlight radio frequency and was advised to use Runway 28. This was an acceptable landing direction and he flew a right-hand circuit, turning onto the final approach. Two stages of flap were lowered and the approach was stable at about 55 kt with no significant turbulence or gust disturbance.

At about 15 ft, the aircraft pitched up and the pilot responded with a forward movement of the control column. The aircraft pitched down in response to the control input and the aircraft descended towards the runway. The pilot attempted to raise the nose but there was insufficient height and the aircraft touched down on the nose landing gear which collapsed. The propeller contacted the grass surface of the runway, the engine stopped and the aircraft came to rest after a short distance. Both the pilot and his passenger were uninjured and they vacated the aircraft through the normal exits.

Discussion

The flight had been uneventful and the approach to Runway 28 appeared normal with no gusts or turbulence. The pitch up in the final stages of the approach was corrected with what appeared to be an appropriate level of forward control input. The pilot considered that the aircraft had encountered some degree of windshear. With the increased rate of descent and the nose-down attitude, there was insufficient height to prevent the nose landing gear contacting the runway with its resulting collapse.

ACCIDENT

Aircraft Type and Registration:	Ikarus C42 FB UK, G-EGGI
No & Type of Engines:	1 Rotax 912 ULS piston engine
Year of Manufacture:	2002
Date & Time (UTC):	6 May 2008 at 1430 hrs
Location:	Bitteswell Farm Strip, near Lutterworth, Leicestershire.
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Extensive damage to the airframe
Commander's Licence:	Private Pilot's Licence
Commander's Age:	81 years
Commander's Flying Experience:	475 hours (of which 250 were on type) Last 90 days - 8 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The pilot had flown an approach to Runway 31 at Bittwell Farm Strip in turbulent and gusty wind conditions. Having touched down at about the normal position, he then realised that the groundspeed was excessive and attempted to stop. Unable to do so, he then decided to go around but the aircraft struck a tall hedge at the far end of the strip.

The pilot considered that with the difficult approach and the gusting wind moving him towards the tall hedge, he should have initiated the go-around earlier.

History of the flight

The pilot had planned to carry out a number of circuits at Bittwell Farm Strip. The site has a single grass runway orientated 13/31. It is 300 m long, 20 m wide and with a 200 m overrun across a cattle grid on Runway 13. The upwind end of Runway 31 ends with a hedge which is approximately 5 ft high and forms a large gap between taller hedges, some 40-50 ft high, on either side.

The visibility was good and there was no significant cloud or weather; the windsock indicated a light and variable wind, mainly from the southeast. The surface temperature was high, but the actual temperature at the field was not observed or recorded by the pilot. The aircraft was fitted with a GPS navigation system but because the pilot only intended to fly some circuits he did not switch it on.

The aircraft made a normal takeoff from Runway 31. At about 100-300 ft the aircraft encountered severe turbulence with gusting winds and the pilot decided to return immediately since the conditions were not as good as he had expected. He flew a right-hand circuit at about 500-600 ft, and, when established on the final approach for Runway 31, he selected full flap. He experienced difficulty in maintaining an accurate approach speed of 50 kt in the very gusty conditions.

The aircraft touched down on the runway at about the normal position and the pilot became aware of the aircraft's excessive groundspeed, possibly due to a slight tail-wind component. Applying the wheel brakes appeared to have no effect and the pilot considered that the aircraft would overrun the end of the runway and strike the hedge at the end. He therefore applied full power for a go-around, and was confident that adequate distance was available to clear the hedge. The aircraft lifted off but when it was approximately 60 m from the hedge it began tracking to the right, towards the taller hedge. The pilot was unable to correct the situation and the aircraft impacted the high hedge at a height of approximately 25 ft. The aircraft came to an abrupt halt and descended to the ground relatively gently onto a cushion of hedge material.

When the aircraft came to rest, the pilot, who was uninjured, switched off the fuel and electrical system and vacated the aircraft through the normal exit.

Analysis

The turbulent and gusting wind conditions were not apparent to the pilot until he became airborne. These conditions made it difficult for him to maintain an accurate approach speed, which resulted in an excessive ground speed during the landing roll. Had the aircraft not tracked to the right during the go-around, probably caused by a strong gust of wind, the aircraft would have cleared the lower hedge. The pilot also considered that the GPS navigation system could have provided the aircraft's groundspeed during the approach, which would have given an early indicator of the need for a go-around.

ACCIDENT

Aircraft Type and Registration:	Mainair Blade 912, G-MAIN
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	1999
Date & Time (UTC):	31 March 2008 at 1515 hrs
Location:	Finmere Airfield, Buckingham
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Right main landing gear suspension damaged
Commander's Licence:	Private Pilot's Licence
Commander's Flying Experience:	2,440 hours (of which 997 were on type) Last 90 days - 69 hours Last 28 days - 27 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft was being flown on a dual training exercise. A practice Engine Failure After Take Off (EFATO) was carried out which resulted in a heavy landing.

History of the flight

The instructor was carrying out a dual training flight with a student. The student had completed 58 hours of dual training on flex-wing microlight aircraft. The weather conditions were fine with a light and variable southerly wind, estimated at around 3 kt. Runway 28 was in use, which has an asphalt surface with an available landing distance of 650 m and a width of 46 m.

A number of practice EFATOs were initiated at a low height. The first two practices resulted in successful landings back onto the runway. On the third practice, the same recovery action appeared to have been taken but the aircraft developed a high sink rate and landed hard on the runway. The right main landing gear suspension collapsed and the aircraft veered off the right side of the runway. Neither person on board was injured.

The wind, although light, was variable in direction and the instructor considered that the high sink rate could have developed as a result of either a slight tailwind component or disturbed air created by an area of trees located 200 m to the south of the runway.

ACCIDENT

Aircraft Type and Registration:	Scheibe SF25E Superfalke, G-FHAS
No & Type of Engines:	1 Limbach SL 1700-EA1 piston engine
Year of Manufacture:	1981
Date & Time (UTC):	16 February 2008 at 1500 hrs
Location:	Burn Airfield, North Yorkshire
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to the leading edge 'D' box and trailing edge of the right wing
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	61 years
Commander's Flying Experience:	913 hours (of which 117 were on type) Last 90 days - 7 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft suffered slight damage whilst manoeuvring after landing.

Details

After the fourth training flight of the day, on this occasion accompanied by a glider pilot, the commander reported that a slightly longer than normal landing was carried out to maintain adequate separation from a glider winch vehicle. The pilot then released the spoilers and, having landed, applied power to carry out a left turn in order to backtrack. He was conscious of moving the aircraft to the right to allow enough room to manoeuvre. He then felt the main wheel go over a small pothole and he thought the right outrigger caught on something, causing the aircraft to ground loop to the right. He cut the power before changing hands to apply the brakes (operated by full movement of the spoiler control). He then stopped the engine and the aircraft came to a halt at the edge of the runway, facing at 90 degrees to the landing direction.

The glider pilot left the aircraft and pushed it back before rejoining the commander who then backtracked to the launch point. Damage to the right wing only became evident when they both left the aircraft.

On subsequent investigation, it appeared that the right wing had struck a small bush on the right side of the runway.

ACCIDENT

Aircraft Type and Registration:	Skyranger 912(2), G-CDHE
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	2005
Date & Time (UTC):	3 May 2008 at 1030 hrs
Location:	Crosland Moor Airfield, near Huddersfield
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Minor) Passengers - None
Nature of Damage:	Damage to propeller, engine cowling, nose gear, wing and cockpit
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	49 years
Commander's Flying Experience:	120 hours (of which 76 were on type) Last 90 days - 5 hours Last 28 days - 30 minutes
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The pilot was unable to prevent the aircraft leaving the runway after landing in a crosswind. The aircraft struck a low mound of earth and inverted.

History of the flight

The aircraft departed from Barton Airfield near Manchester at 1000 hrs for a flight to Crossland Moor Airfield. Runway 25 was in use at the strip, which was 900 m long; the first 650 m of the runway was asphalt and the remaining length was grass. It was a fine day, with an estimated wind for landing from 160º(M) at 8 kt, giving a crosswind from the left. The pilot flew a flapless approach at 60 kt and touched down to the left of the runway centreline.

The pilot was unable to align the aircraft with the runway after landing and it left the paved surface on the left, upwind side. It then struck a low mound of earth to the side of the runway which caused the nose undercarriage leg to fail. The aircraft tipped over and came to rest inverted. There was some damage to the cockpit area, but the pilot and his passenger, who were wearing full harnesses, were able to vacate the aircraft using both side doors.

BULLETIN CORRECTION

AAIB File:	**EW/C2007/04/02**
Aircraft Type and Registration:	Piper PA-28R-201T, Turbo Cherokee Arrow III, G-JMTT
Date & Time (UTC):	9 April 2007 at approximately 1050 hrs
Location:	9 nm south of Oban (North Connel) Airport, Argyll and Butte, Scotland
Information Source:	AAIB Field Investigation

AAIB Bulletin No 6/2008, page 69 refers

The report contained four Safety Recommendations which were incorrectly numbered 2007-002, 2007-003, 2007-004 and 2007-005. They should have been numbered 2008-002, 2008-003, 2008-004 and 2008-005 respectively.

The correct numbering is shown below:

Safety Recommendation 2008-002

The Civil Aviation Authority should publicise the vacuum pump replacement requirements in Parker Airborne Service Letter 58A and recommend that operators and maintainers of such aircraft which will be operated under Instrument Flight Rules, comply with the limits specified therein.

Safety Recommendation 2008-003

The New Piper Aircraft Company should revise their maintenance manuals to ensure that the maintenance requirements for vacuum pumps are consistent across their product range.

Safety Recommendation 2008-004

The European Aviation Safety Agency (EASA) should mandate compliance with vacuum pump maintenance and replacement requirements, to ensure that aircraft fitted with vacuum-driven Attitude Indicators can be safely operated in Instrument Meteorological Conditions when such aircraft are certified to do so.

Safety Recommendation 2008-005

The US Federal Aviation Administration (FAA) should mandate compliance with vacuum pump maintenance and replacement requirements, to ensure that aircraft fitted with vacuum-driven Attitude Indicators can be safely operated in Instrument Meteorological Conditions when such aircraft are certified to do so.

FORMAL AIRCRAFT ACCIDENT REPORTS
ISSUED BY THE AIR ACCIDENTS INVESTIGATION BRANCH

2007

4/2007 Airbus A340-642, G-VATL
en-route from Hong Kong to London Heathrow
on 8 February 2005.

Published September 2007.

5/2007 Airbus A321-231, G-MEDG
during an approach to Khartoum Airport, Sudan
on 11 March 2005.

Published December 2007.

6/2007 Airbus A320-211, JY-JAR
at Leeds Bradford Airport
on 18 May 2005.

Published December 2007.

7/2007 Airbus A310-304, F-OJHI
on approach to Birmingham International Airport
on 23 February 2006.

Published December 2007.

2008

1/2008 Bombardier CL600-2B16 Challenger 604, VP-BJM
8 nm west of Midhurst VOR, West Sussex
on 11 November 2005

Published January 2008.

2/2008 Airbus A319-131, G-EUOB
during the climb after departure from London Heathrow Airport
on 22 October 2005

Published January 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.

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