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None



**(ALL TIMES IN THIS BULLETIN ARE UTC)**

# AAIB Field Investigation reports

**SERIOUS INCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | Airbus A319-131, G-EUPX |
| **No & Type of Engines:** | 2 International Aero Engine V2522-A5 turbofan engines |
| **Year of Manufacture:** | 2001 (Serial no: 1445) |
| **Date & Time (UTC):** | 25 April 2012 at 1113 hrs |
| **Location:** | Runway 09L, London Heathrow Airport |
| **Type of Flight:** | Commercial Air Transport (Passenger) |
| **Persons on Board:** | Crew - 5 Passengers - 112 |
| **Injuries:** | Crew - None Passengers - None |
| **Nature of Damage:** | Tyres scuffed |
| **Commander's Licence:** | Airline Transport Pilot's Licence |
| **Commander's Age:** | 52 years |
| **Commander's Flying Experience:** | 7,700 hours (of which 5,000 were on type)<br>Last 90 days - 150 hours<br>Last 28 days - 34 hours |
| **Information Source:** | AAIB Field Investigation |

**Synopsis**

During the landing roll, as the Autobrake was disengaged, the aircraft veered towards the right edge of the runway. Control was subsequently regained and the aircraft was taxied onto stand without further incident. The pilot flying had depressed the brake pedals asymmetrically to disengage the Autobrake.

**History of the flight**

The aircraft was on a scheduled flight from Berlin Tegal Airport, Germany to London Heathrow Airport. The commander was the pilot flying the sector.

After an uneventful flight, the aircraft was established on the ILS for a landing on Runway 09L at Heathrow with Autobrake LO selected for the landing. The commander disconnected the autopilot at about 420 ft aal, having received clearance to land from ATC. The runway surface was damp and the surface wind transmitted by ATC was from 170° at 21 kt.

During the touchdown the commander removed the drift by applying left rudder, flared the aircraft and touched down "positively, but not firmly." The co-pilot then selected the thrust reversers and made the standard rollout calls. During the landing roll, with IDLE reverse, the aircraft decelerated on the runway centreline. Believing it would be better to vacate the runway at the second available rapid exit turnoff the commander "relaxed a little" and disengaged the Autobrake with the brake pedals; at this point the aircraft was travelling at a speed of about 100 kt. The commander reported that he momentarily glanced inside, possibly to check the spoilers had deployed. Then, he looked up, the aircraft was diverging to the right and heading toward the edge of the runway. To correct this, he initially applied both brake pedals simultaneously, followed by full left brake pedal and left rudder which brought the aircraft back towards the runway centreline. The co-pilot also applied left brake pedal at the same time.

Having regained the runway centreline, the aircraft was taxied off the runway and stopped on the taxiway. The pilots then checked the aircraft's systems and found them to be serviceable. The aircraft was then taxied onto stand without incident.

## Engineering

*Overview of the braking system*

Each main wheel is fitted with a hydraulically powered, multi-disk brake unit that can be operated by either of two independent brake systems. Each pilot position is fitted with foot-operated brakes that are integral to the rudder pedals. These enable either pilot to operate the brakes; the brake units on the left and right main gear can be operated differentially if required.

When selected, an Autobrake function will automatically apply the brakes, once certain conditions are met, to achieve the deceleration chosen by the crew (LO, MED or MAX). The Autobrake system can be disengaged if a pilot applies sufficient deflection to at least one brake pedal. On this aircraft and with the Autobrake setting selected, a deflection of 50.3% is required on a single pedal or deflection of 11.03% on both pedals to disengage the Autobrake.

The antiskid system provides maximum braking by preventing individual wheels from skidding. The anti-skid function is deactivated below a ground speed of 20 kt.

All braking (and steering) functions are controlled through a two-channel Brake and Steering Control Unit (BSCU).

*Examination of the aircraft*

The tread of all four mainwheel tyres had signs of lateral scratch marks consistent with the deviation; these were most prevalent on the outer edge of the outboard tyre of the left main gear, as would be expected. An extensive examination and test of the brake system was conducted and no faults were identified. As a precautionary measure, the operator decided to replace all the wheel and tyre assemblies, brake units and the BSCU. The aircraft was returned to service and no further incidents have been reported.

## Autobrake disengagement guidance

The aircraft manufacturer commented that there is no guidance as to when to disengage the Autobrake after landing, as it is dependent on the circumstances at the time.

The operator's procedures state that the Autobrake should be disengaged before the aircraft's speed has reduced to 20 kt:

> *'to avoid some brake jerks at low speed.'*

## Recorded Information

The aircraft was fitted with a solid state Cockpit Voice Recorder (CVR) and Flight Data Recorder (FDR). In addition, data from the operator's Flight Data Monitoring (FDM) system was recovered.

Aircraft touchdown was recorded at a normal acceleration of 1.4g, computed airspeed of 126 kt and groundspeed of 128 kt (Figure 1). Approximately 10 seconds after touchdown, the CVR recorded one

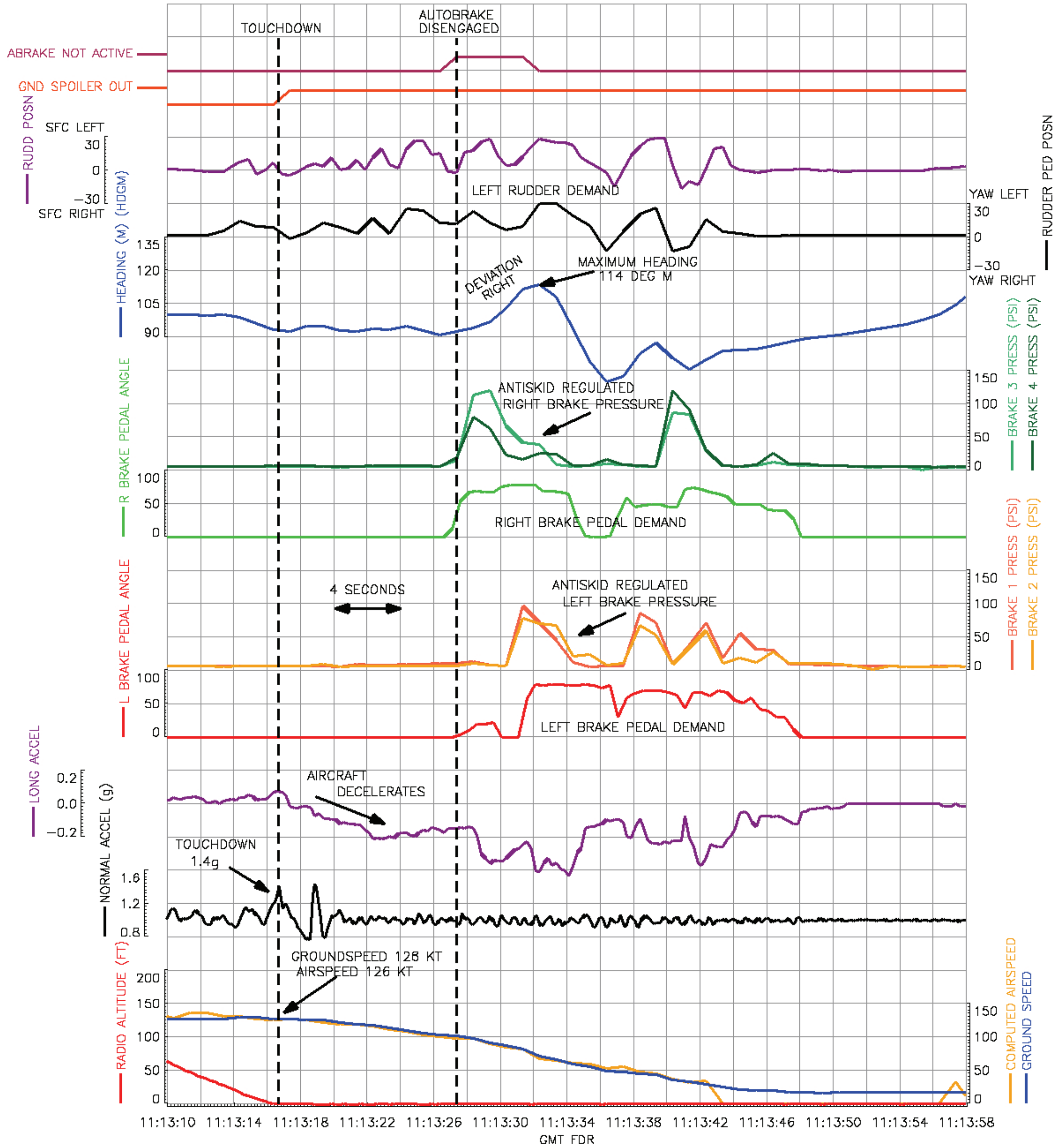


**Figure 1**

G-EUPX FDR and FDM data

of the flight crew announce 'DECEL', signifying that deceleration has been felt by the crew and has been confirmed by a speed trend on the primary flight display. The Autobrake system did not apply any brake pressure to achieve this as the effect of the aerodynamic braking and engine reverse thrust was sufficient.

Just after 'DECEL' was announced, the FDR recorded deflection of both brake pedals but significantly more on the right pedal, which disengaged the Autobrake. An increase in brake pressure on both right main landing gear brakes (brakes 3 and 4) was recorded, although the antiskid system limited the pressure to prevent the wheels from skidding. Four and a half seconds after the right pedal was depressed, the left brake pedal was applied along with left rudder, which slowed the yaw rate and returned the aircraft back to the runway centreline.

**Operator's comments**

During a simulator assessment after the incident, the commander demonstrated (under the same environmental conditions) a tendency towards inadvertently applying more pressure on the right brake pedal when disengaging the Autobrake. He has undertaken subsequent simulator training to correct this and has now returned to line flying.

The operator will be highlighting the incident in a newsletter which is available to all their flight crews. Attention will be drawn to the potential difficulty of disengaging the Autobrakes at high speed in crosswind conditions.

**Conclusion**

The aircraft veered to the right during the landing roll, following the asymmetric application of the brake pedals when the Autobrake was disengaged. No faults were found with the aircraft braking system.

## INCIDENT

| | |
|---|---|
| **Aircraft Type and Registration:** | Airbus A321-231, G-EUXL |
| **No & Type of Engines:** | 2 International Aero Engine V2533-A5 turbofan engines |
| **Year of Manufacture:** | 2007 (Serial no: 3254) |
| **Date & Time (UTC):** | 20 December 2011 at 1542 hrs |
| **Location:** | Near London Heathrow Airport |
| **Type of Flight:** | Commercial Air Transport (Passenger) |
| **Persons on Board:** | Crew - 7 Passengers - 116 |
| **Injuries:** | Crew - None Passengers - None |
| **Nature of Damage:** | None |
| **Commander's Licence:** | Airline Transport Pilot's Licence |
| **Commander's Age:** | 44 |
| **Commander's Flying Experience:** | 8,570 hours (of which 3,445 were on type)<br>Last 90 days - 68 hours<br>Last 28 days - 18 hours |
| **Information Source:** | AAIB Field Investigation |

### Synopsis

During the climb out from Heathrow Airport, both pilots experienced symptoms of dizziness and light-headedness. The pilots donned their oxygen masks and returned to Heathrow, where the aircraft landed without further incident.

No fault was found with the aircraft and no-one else on the aircraft experienced adverse symptoms. The incident uncovered a previously unknown fault with the cockpit voice recorder.

One Safety Recommendation is made.

### History of the flight

The aircraft was on a scheduled flight from London Heathrow to Glasgow. The pilots were on their first sector of the day and were well rested; neither had flown the day before. The pilots met 15 minutes before check-in and, after going through security, each of them purchased a snack meal from a food outlet. They chose different meals but did not eat them prior to the incident.

Pre-flight preparation was routine and there were no aircraft or operational issues. Start up and taxi out were normal and the aircraft took off at 1520 hrs from Runway 27R. The commander stated that, on passing approximately FL120, she started feeling light-headed and slightly dizzy. The point at which she first experienced these symptoms coincided with her looking down at the centre console to change a radio frequency, while the aircraft was rolling out of a 25° angle of bank (AOB) turn and the pitch attitude was increasing by 4°. The dizziness did not abate and, at FL210, she asked the co-pilot if she felt well. The co-pilot initially told the commander that she felt "OK", but shortly afterwards said she was feeling light-headed. Both pilots immediately donned their oxygen masks and the co-pilot levelled the aircraft.

The crew decided to return to Heathrow, declared an emergency and informed ATC of their intentions. The co-pilot asked which runway they could expect and was told Runway 27L. At an altitude of approximately 10,000 ft the crew were asked if they could accept Runway 27R for landing, to which they agreed. The crew requested a longer than normal straight-in approach and the aircraft landed safely at 1616 hrs.

After vacating the runway, the pilots removed their oxygen masks and, because some light-headiness returned, donned them again. Subsequently, as they approached their allocated parking stand they again removed the masks, this time with no ill effects.

Throughout the incident, there was no indication of an aircraft malfunction. The pressurisation system appeared to operate normally and the maximum cabin altitude indicated during the flight was 3,200 ft. Both pilots reported that they were not aware of any abnormal smells, smoke or fumes on the flight deck and none of the cabin crew or passengers experienced any ill effects.

Shortly after the aircraft arrived on stand, the Airport Fire and Rescue Service (AFRS) boarded the aircraft and examined the cockpit for smoke or fumes. None were detected. The pilots were examined by paramedics but neither showed any abnormal symptoms.

**Medical aspects**

The commander stated that she started to feel better shortly after fitting the mask but only felt fully recovered at an altitude of approximately 7,000 ft, in the descent. She also stated that she had recently suffered from a cold, although she felt fit to fly and had not taken any medication in the 48 hours prior to the flight. The co-pilot stated that she felt better approximately 5 seconds after donning her oxygen mask. She also stated later that this was the first time she could recall experiencing these symptoms in her 12-year career with the operator.

The following day the company flight operations department consulted a company doctor by telephone. The doctor informed the department that, as the pilots were no longer experiencing any symptoms or after effects, there was no need for them to be examined further. Both pilots have subsequently flown without a recurrence of these symptoms.

The investigation considered the following possible medical causes of the in-flight dizziness experienced by the pilots.

*Alternobaric vertigo*

This condition is caused by a difference between the left and right ear in the pressure felt across the tympanic membrane (or ear drum). An inability to equalise pressure across each ear drum at the same time, even to a mild extent, can lead to alternobaric vertigo. This effect can be aggravated by head movement as this may displace any residual nasal and Eustachian tube mucous. Alternobaric vertigo can also lead to mild disorientation.

*Oculogyric disorientation*

This condition occurs when the organs of balance within the ears become acclimatised to a prolonged turn and therefore appear to signal that the turn has stopped, even though it is actually continuing. Once there is an actual cessation of the turn this causes further signals to be produced leading to a further sensation of a turn even when it has stopped. If this is combined with a concurrent head movement, the pilot may experience unexpected and significant sensation of motion. This can manifest itself as vertigo and a sense of nausea, with rapid breathing and resulting light-headedness.

*Hyperventilation (increase in breathing rate)*

The combination of mild disorientation and a sudden onset of alternobaric vertigo would easily lead to a period of hyperventilation. Hyperventilation can also be brought on by stress or anxiety. Hyperventilation can lower the partial pressure of carbon dioxide in the blood (hypocapnia) and this can induce a sensation of light-headedness.

**Company procedures**

The company procedures define incapacitation as:

> *'the inability to function effectively as a Crew Member, it does not necessarily involve loss of consciousness.'*

The company Pilot Incapacitation Drill states:

> *'If a pilot appears to be in any way incapacitated for no obvious reason, the flight Crew should don oxygen masks without delay.'*

The co-pilot had discussed the Pilot Incapacitation Drill in a recent flight simulator training session.

The company operations manual requires any crew member who becomes incapacitated in flight to consult a company doctor as soon as possible after landing.

**Cabin air supply**

During normal operation, bleed air is taken from the engine compressors and passed through an air conditioning system to provide a supply of temperature controlled fresh air to the passenger cabin and cockpit. The air supply can also be provided by the auxiliary power unit (APU) or a ground source via an external connection if required. (See Figure 1.)

Each engine supplies a separate air conditioning pack and the output of conditioned air from both of these packs is fed into a single mixer unit before being distributed to one of the three cabin zones (cockpit, forward cabin and rear cabin). The air temperature for each zone is controlled independently by mixing hot unconditioned air into the conditioned air supply to that zone. This unconditioned air supply is a combined single supply of hot air that is taken from the inlet for each pack.

**Examination of the aircraft**

The aircraft was inspected by the operator's maintenance personnel under the supervision of the AAIB. There had been no engine oil or hydraulic fluid uplifts immediately prior to the flight and the aircraft had not been de-iced. An initial visual inspection of the aircraft was carried out and the cockpit area was inspected; no anomalies were noted. Analysis of the recorded flight data showed that the bleed air, air conditioning and pressurisation system appeared to be working normally throughout the flight.

An extensive ground run test was then carried out, with the bleed air and air conditioning systems configured in various combinations and temperature selections. These systems operated normally and nothing unusual was observed. No adverse affects were felt by any of the personnel in the cockpit during these tests. The aircraft

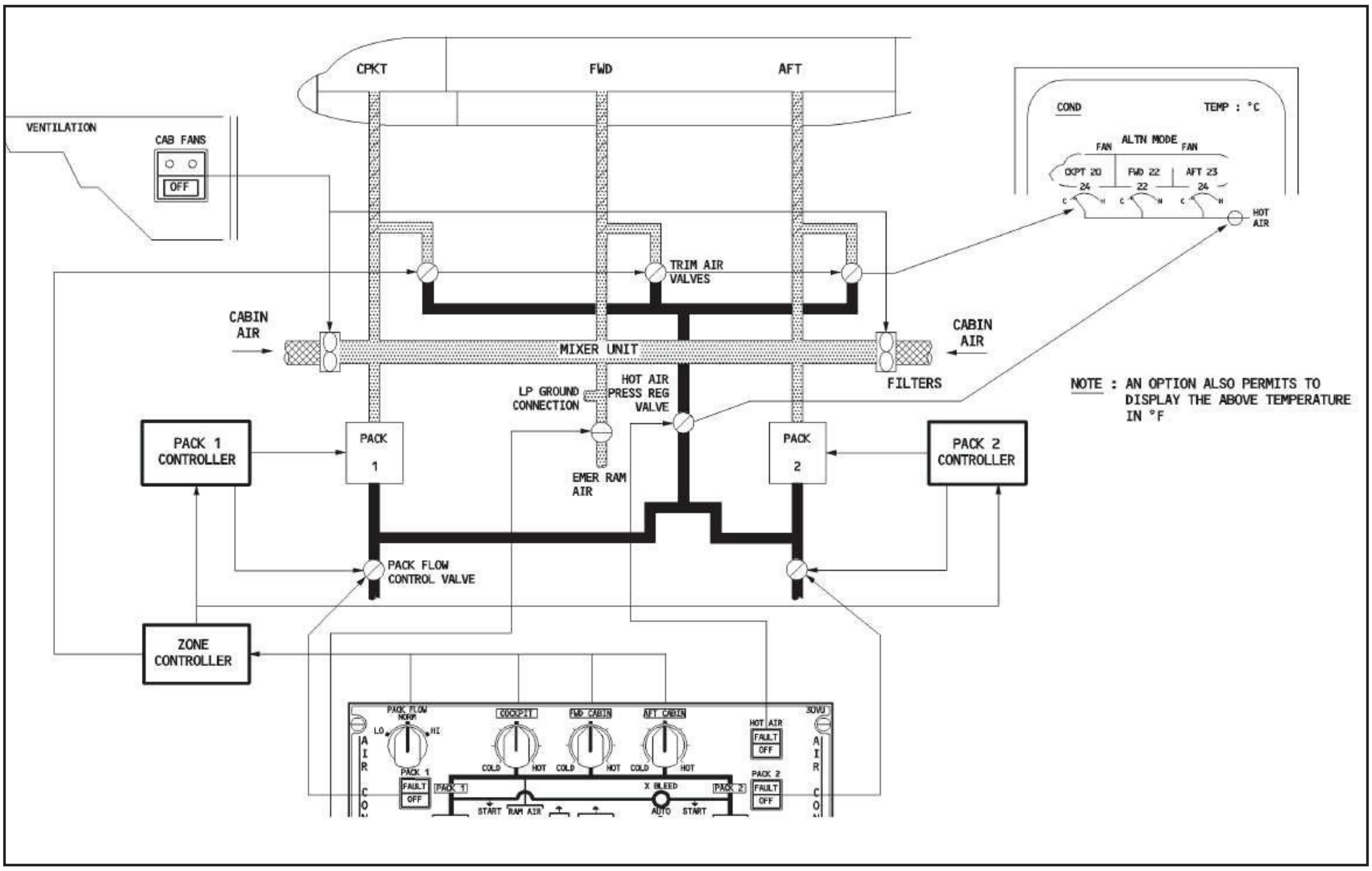


**Figure 1**

Schematic diagram of air conditioning system

bleed air and air conditioning systems, including the inside of ducting, were then thoroughly inspected. No anomalies or evidence of contamination were found. The aircraft subsequently flew without any reports of similar incidents.

### Flight recorders

The aircraft was equipped with a 25-hour duration Flight Data Recorder (FDR), a Digital AIDS Recorder (DAR) and a 120-minute Cockpit Voice Recorder (CVR) that recorded audio to a solid state memory. FDR and DAR data was available for the entire flight. Also, the CVR provided a combined record of the commander's, co-pilot's and PA (Passenger Address) communications during the flight. However, due to a fault within the CVR, the Cockpit Area Microphone (CAM) recording was not available. The fault is discussed in detail in the following section titled CVR Fault.

The FDR and DAR data was analysed and no defect with the aircraft's environmental control system was identified. Figure 2 contains a plot of salient parameters commencing shortly before the flight crew felt unwell.

### CVR Fault

*CVR Description*

The CVR[1] recorded a total of five audio channels to solid state memory. The CAM and a combination of the commander's, co-pilot's and PA/third crew member's

**Footnote**

[1] Honeywell manufactured Solid State CVR, part number 980-6022-001, serial number CVR120-08990.

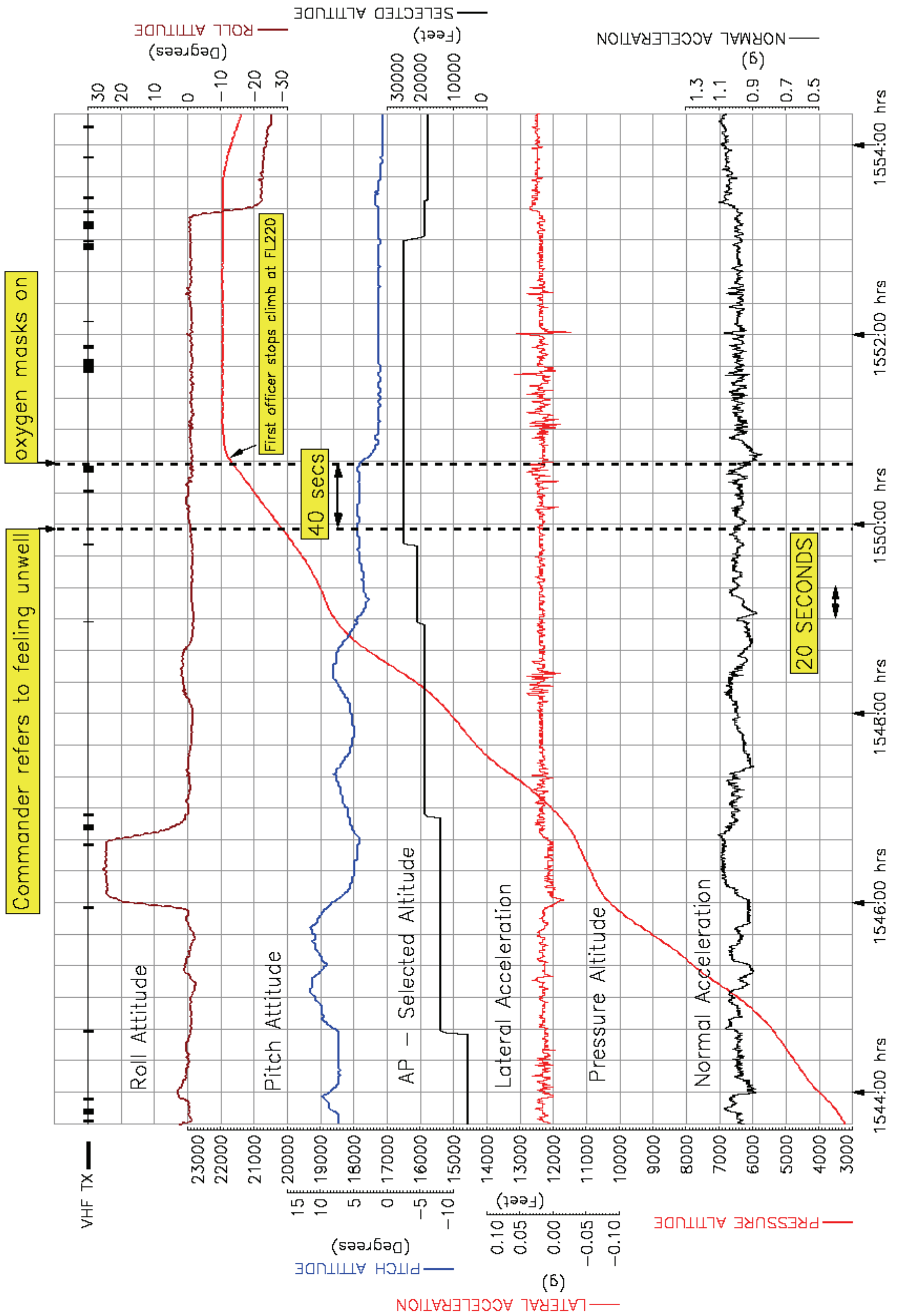


**Figure 2**

Aircraft attitude and vibration levels

communications are recorded to two 120-minute duration channels, and the most recent 30 minutes of the commander's, co-pilot's and PA/third crew member's communications to three separate channels (see Figure 3).

The CVR manufacturer refers to the CAM channel as the wide band (WB) channel, the combination of the commander's, co-pilot's and PA/third crew member's communications as mixed band (MB) and the three 30-minute channels as narrow band (NB). These terms are referenced for brevity where required.

The initial recording process consists of the analogue-to-digital conversion of the four audio signals. The commander's, co-pilot's and PA/third crew member's communications channels are also combined at this stage to generate the MB channel. The digital data for each of the five channels is then passed to a single integrated circuit (IC), referred to as the 'data packer[2]'. This component is central to the correct operation of the recorder. Under software control, the Data Packer component collects and packs the digital data into packets prior to it being written to the solid state memory. The data packer IC also forms part of the unit's Built-In Test (BIT) function.

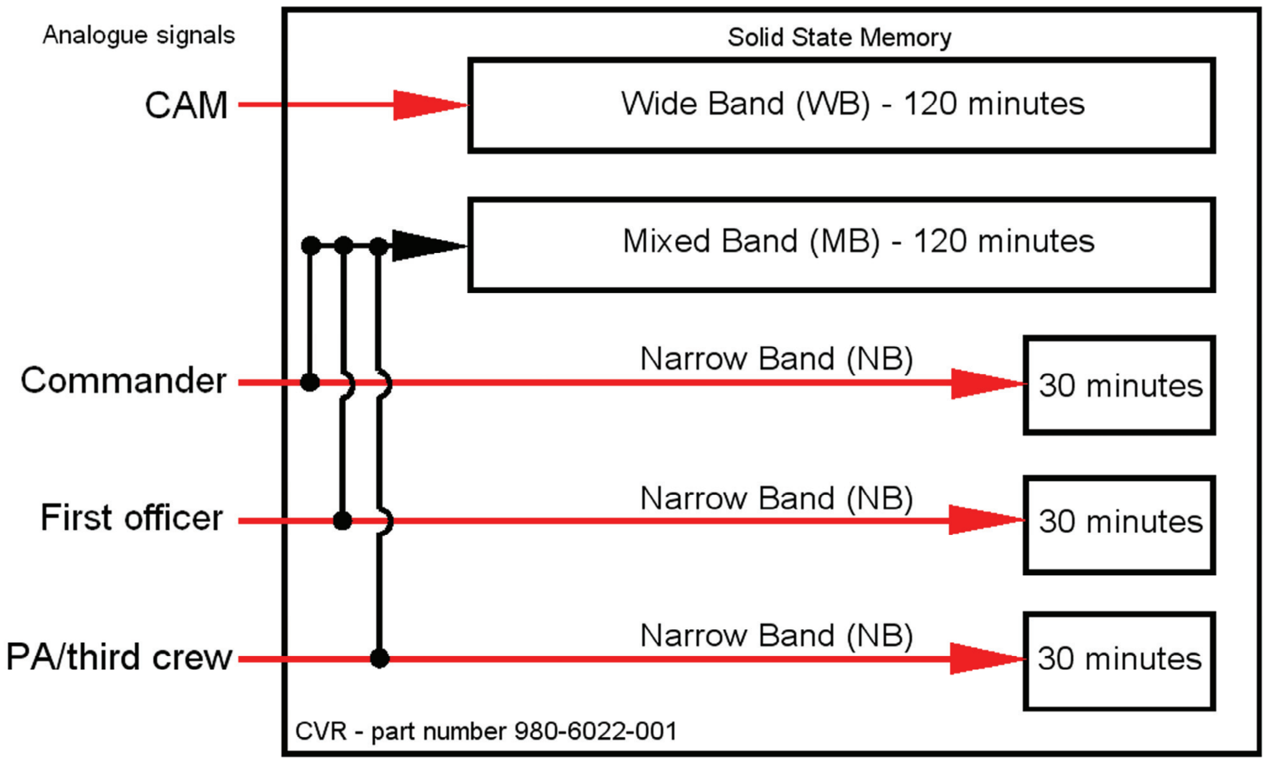


**Figure 3**

CVR channel architecture

**Footnote**

[2] Honeywell part number 718-1239-007. It is designated as component U21 and is installed on the system controller circuit card assembly (CCA), part number PN 722-4159-025. The component is a field-programmable gate array (FPGA) manufactured by Actel, with part number A1020B. A FPGA is an integrated circuit designed to be configured by the customer or designer after manufacturing. The component is widely used across industry.

The CVR's BIT function operates in one of three modes whenever the unit is electrically powered. The modes are Power-on, Background and Push-to-test. The Power-on mode is entered as soon as electrical power is supplied to the unit. Once the Power-on tests have been completed, the unit will enter the record mode and the BIT will enter the Background mode, which runs continuously unless the Push-to-test mode is activated or electrical power is removed. The Push-to-test mode may be activated by its selection on the CVR control panel, which is located on the flight deck. In the Push-to-test mode the unit performs additional tests over and above those conducted during the Power-on and Background modes. These include the use of a digital test pattern which is generated within the data packer IC. The data packer IC is permanently generating the test pattern, but it is intended that it should never be written to the solid state memory during normal recording operation. It is controlled by a multiplexer circuit within the data packer IC. When the Push-to-test mode is entered, the unit stops recording and switches the test pattern through the multiplexer circuit so that it is output from the data packer IC to the unit's recording circuitry, which is then tested by the BIT for the presence of the test pattern. The same multiplexer circuit switches the WB, MB and NB channels when they are to be recorded.

When the unit is recording, the BIT Background mode does not check for the presence of the test pattern being written to the solid state memory. The manufacturer advised that when the unit was in the record mode, it was not possible for the BIT Background mode to check for the test pattern as there is insufficient processing capacity.

If a fault is detected by the BIT, the unit's front mounted Built In Test Equipment (BITE) light will be illuminated, a failure message will be sent to the aircraft's central maintenance computer and a record written to a BIT history file, which is stored within the unit's solid state memory. When the unit's electrical power is cycled, the BITE light will be extinguished until a fault is detected again.

If no fault is detected during the Push-to-test, a tone will be generated and a status signal momentarily latched, which may be used to provide a visual indication in the cockpit. On G-EUXL, the tone is heard through the overhead speakers with no visual confirmation being provided. The CVR was not connected to the aircraft's central maintenance computer.

In addition to the Push-to-test, the unit provides a monitor function which loops back the incoming audio so that the serviceability of each of the channels may be established by speaking into each microphone and ensuring that the speech can be heard through a headset connected to the monitor connector. On G-EUXL, the monitor connector for the headset is located in the cockpit. The audio provided to the monitor does not pass through the data packer IC.

The unit also stores markers to the solid state memory whenever the unit enters the Power-on mode and when a Push-to-test has been activated.

*Unit History*

The CVR was manufactured in December 2006 and fitted to G-EUXL in September 2007. It had not been fitted to another aircraft and had remained installed until its removal following the incident. The operator had no history of a fault with the unit.

*Erroneous audio recording and BIT history*

The recovery of audio from G-EUXL's CVR required two processes. The first was to download the digital information stored in the solid state memory; this was successfully completed. The second process extracted the five audio channels and converted them to an industry-standard audio file. It was during this process that the manufacturer's software tool, Playback 32[3], indicated an error. Analysis of the audio files identified that although the WB channel was of the correct duration, it was found to contain only 12 minutes (seven towards the beginning and five at the end) of normal audio from the CAM. The remaining audio consisted of an erroneous 'pulsing' sound. Further, several minutes at the beginning of the MB also contained an erroneous pulsing sound and the three NB files were of only five minutes duration.

From information provided by the manufacturer, the AAIB developed its own software tool which generated 30-minute records for each of the NB channels. The PA/third crew member's channel was found to contain 30 minutes of normal audio, other than at the beginning, where there was a very short duration erroneous pulsing sound. For the commander's and co-pilot's NB channels, only the most recent five minutes contained normal audio. The beginning of these channels also contained a very short duration erroneous pulsing sound, which was followed by 25 minutes of erroneously recorded silence. Figure 4 depicts the erroneous recordings on each channel.

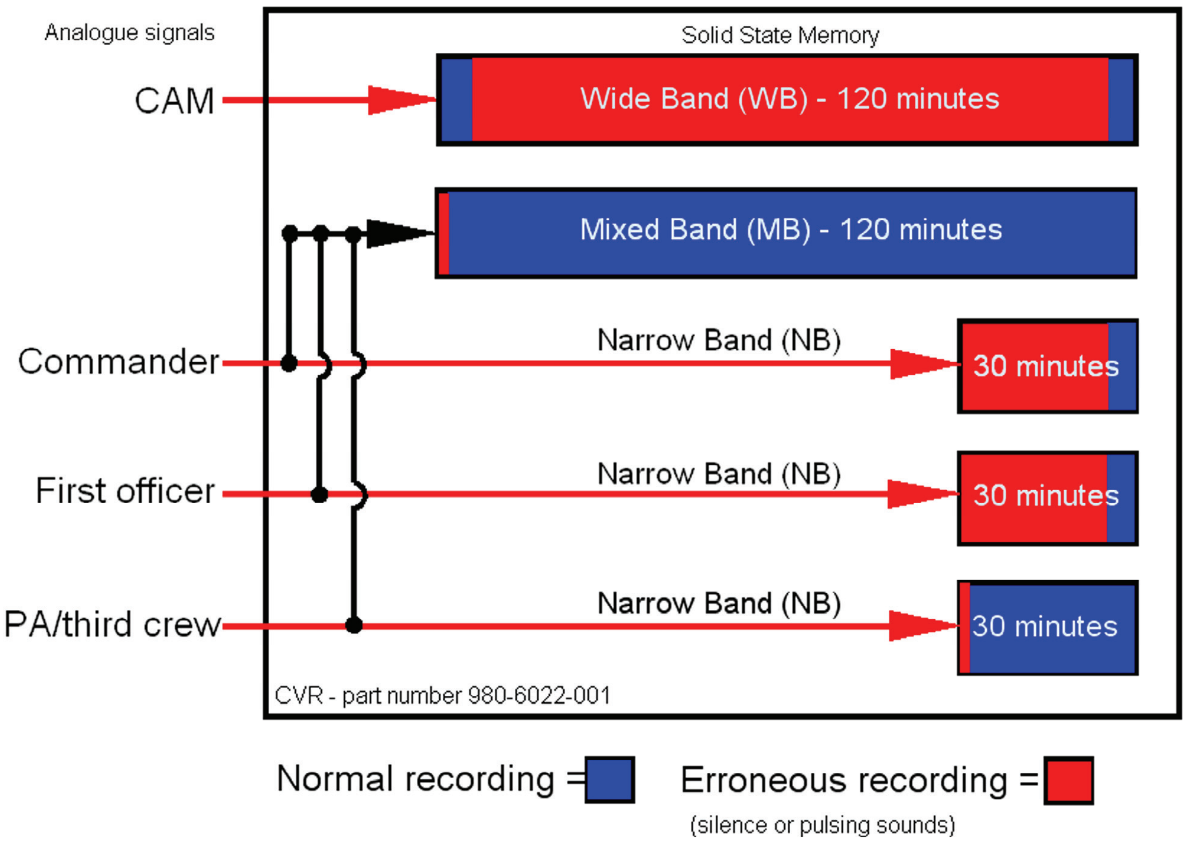


**Figure 4**

Erroneous recording

**Footnote**

[3] Honeywell manufactured software, part number 998-3414-509. This was the latest version released.

Analysis of the unit's BIT history by the manufacturer indicated that no fault had been detected during the period of the incident flight. The unit had operated for 17,286 hours and one fault had been detected. The fault occurred at 9,296 hours and related to the processing of the NB channels.

Through inspection of the Power-up and self-test markers, it was confirmed that the flight crew had carried out a Push-to-test on the unit shortly before the incident flight and that the unit's electrical power had been briefly cycled five minutes before the end of the recording as the aircraft's electrical power source automatically switched following engine shutdown. The electrical power cycle was found to coincide with the WB and NB (commander's and co-pilot's) channels returning to normal operation.

*Testing by the manufacturer*

The unit's lower cover was removed and the system controller circuit card assembly (CCA) was visually examined. No discrepancies were identified. The unit's record and Push-to-test functions were then tested using the Honeywell Automated Test System (HATS). No fault was found, having completed 3,548 test cycles over a period of about 12 hours; a unit would normally be subjected to one test cycle during a return to service test.

A test tone was then input to all four channels whilst the data packer IC was repeatedly heated and cooled. Shortly after commencing the test, multiple channels failed, with the recording of either no signal (silence) or the data packer IC test pattern. Cycling of the unit's electrical power or activation of the press-to-test was then found to return the unit to normal operation. The test was repeated a number of times and on each occasion at least one channel failed, with the channels affected and failure mode (silence or test pattern) varying randomly between each test. It was also noted that Playback32 generated normal length audio files, even though errors were present in the recording. The unit's BIT did not identify the failures.

Two further CVRs of an identical build standard were tested using these techniques but no faults were observed.

G-EUXL's CVR was then subjected to a thermal test, based on the one used during the manufacturing phase. The CVR was instrumented so that any erroneous recording could be identified. No fault was detected.

*Inspection of the data packer IC and failure analysis*

The data packer IC was removed from the CCA and inspected by a specialist company using a scanning electron microscope. Neither an external nor an internal inspection identified any defects.

The CVR manufacturer stated that although the physical inspection had been inconclusive, its analysis of the data and test findings indicated that the multiplexer circuit within the data packer IC was intermittently failing. Further, it considered the failure to be an isolated case.

*Operational test requirements and routine readouts*

The operator advised that, for its fleet of 87 Airbus aircraft, the flight crew were required to test the CVR prior to each flight by selection of the Push-to-test button in the cockpit. Additionally, once every 180 days, an operational test of each of the channels was conducted by engineering personnel using the CVR monitor function (refer to *CVR Description*).

The model of CVR in G-EUXL does not require any routine maintenance and will, typically, remain fitted to an aircraft until it fails or is removed for readout. ICAO recommends that annual readouts of the CVR are conducted and the EASA highlighted this in Safety

Information Bulletin (SIB) 2009-28, which discussed the detection of dormant failures. Currently, there is no EU-OPS regulatory requirement for an annual readout of the CVR. National Aviation Authorities (NAA)'s may impose their own requirements and, in the case of the operator of G-EUXL, they were instructed to readout annually a sample of CVRs that used magnetic tape as the recording media. Although many of its aircraft were no longer equipped with a tape-based CVR, the operator had continued to conduct two readouts each year on its solid state memory CVR-equipped Airbus fleet.

The operator advised that its readout process typically consisted of listening to the 30-minute NB channels in full, and then sections of the 120-minute WB and MB channels. The operator had readout a total of 130 CVR's of the same type fitted to G-EUXL. Discussions with a UK-based avionic repair facility that specialises in CVR readouts indicated that they typically conducted 100 to 150 readouts on the same type of CVR each year. Their replay procedure was similar to the operator's, in that sufficient audio was reviewed to validate that each channel was functional but did not extend to reviewing the full duration of each channel. Both the operator and avionic facilities replay techniques were in accordance with the guidance contained within UK CAA Publication CAP 731, *Approval, Operational Serviceability and Readout of Flight Data Recorder Systems and Cockpit Voice Recorders.* Neither the operator nor avionic repair facility had observed a fault similar to that on G-EUXL's CVR.

Testing of the unit within an avionic repair facility is conducted in accordance with the manufacturer's Component Maintenance Manual (CMM), using approved test equipment. Testing is largely automated and includes a test of the unit's ability to write data to the solid state memory. There is no requirement or recommendation in the CMM to download the unit and evaluate the recorded audio for erroneous recording, as part of the fault finding, testing or recertification phase.

*Previous occurrences of the fault*

The design of the CCA and associated implementation of the data packer IC dates back to 1993 when the manufacturer introduced its first 30-minute duration solid state memory CVR. There are now approximately 25,000 units in service that are based on the same design.

The AAIB had replayed approximately 250 units and the manufacturer estimated that it had replayed about 1,000. Neither had observed a similar fault before. In addition to reviewing audio files aurally and visually, the manufacturer generated a software tool that it used to scan 79 readouts digitally for the presence of the test pattern. No faults were found with these units.

In an attempt to determine if a similar fault may have gone unreported to the manufacturer, and to gather information on the number of the units analysed in detail, the AAIB contacted several international accident investigation laboratories. The Australian Transportation Safety Board (ATSB), Bureau d'Enquetes et d'Analyses Pour la Securité de l'Aviation Civile (BEA) of France, National Transportation Safety Board (NTSB), Transportation Safety Board (TSB) of Canada and National Research Council (NRC) of Canada all provided information. None of the laboratories had observed a fault of the same type before.

Figures indicate that, since 1993, approximately 3,000 units have been replayed by a combination of the manufacturer, the AAIB and the other accident investigator authorities mentioned above. It is unlikely that all the units were of the 120-minute duration model, but had they been, this would equate to a total of 6,000 hours of audio being analysed. On G-EUXL, the annual operation of the CVR averaged 3,850 hours. Based on an annual industry average of 3,000 flight hours per aircraft (mix of long and short haul routes), the operator's 198 aircraft, equipped with the same model of CVR, operate for a total of approximately 594,000 hours per year.

**Analysis.**

The commander of the aircraft experienced symptoms of dizziness during the climb and, when the symptoms did not abate, made the co-pilot aware. At this stage, the co-pilot was feeling well but, shortly afterwards, started to feel light-headed. Realising that they were both experiencing adverse symptoms without any obvious reason, and mindful of the possibility of incapacitation, the pilots immediately carried out the Pilot Incapacitation Drill as a precaution and donned their oxygen masks. Although the symptoms abated, the pilots took the precaution of continuing to wear the masks until after the aircraft had landed. Meanwhile, they were able to continue to operate the aircraft effectively and carried out a normal approach.

The commander's symptoms of light-headiness and dizziness started when she moved her head to look down at the centre console to change a radio frequency and this point coincided with a 25° AOB change and a 4° pitch attitude change. As a result, the commander may have suffered a disorientation episode caused by a combination of oculogyric disorientation and an alternobaric episode made more likely by the lingering effects of a cold. The resulting natural instinct to hyperventilation could lead to hypocapnia which may well have contributed to the feeling of light-headedness.

The onset and clearance of the co-pilot's symptoms within approximately 25 seconds may have been a reflection of the potentially evolving situation of crew incapacitation at an early stage in the flight leading to mild hyperventilation. However, the symptoms she experienced were unique in her 12-year career with the operator.

The reason for the dizziness experienced by both pilots when they first removed their oxygen masks on the ground could not be positively determined but it is possible that it was caused by the effect of a sudden reduction in inspired oxygen concentration on cerebral oxygenation, blood flow and pressure.

Whilst the company operations manual requires any crew member who becomes incapacitated in flight to consult a company doctor as soon as possible after landing, the crew were still able to operate the aircraft as effective crewmembers and, by definition, were not incapacitated. However, the operator did consult a company doctor and was advised that they did not require any medical treatment. Both pilots returned to flying duties without a recurrence of the symptoms they had experienced.

No anomalies were found with the bleed air and air conditioning systems during the ground tests or inspections and there were no signs of contamination. The recorded data shows that all relevant systems appeared to be working normally throughout the flight.

*CVR issues*

It was demonstrated that the CVR's erroneous recording of both erroneous silence and a pulsing sound was a result of an intermittent failure of the data packer IC. The physical inspection of the IC was inconclusive, although analysis of the data and test findings by the manufacturer indicated that the multiplexer circuit within the IC was at fault.

It was shown that the CVR's BIT function was ineffective in identifying the fault, and the design of the audio monitor function is such that the erroneous audio would not be evident at the monitor output. Thus, neither the Push-to-test nor the operational test of the CVR on the aircraft would have been able to identify the failure. The intermittent nature of the fault also meant that the unit was able to pass both the manufacturer's return to service test and a test used during the manufacturing phase. It is, therefore, possible that the fault had been present since the unit had been manufactured in 2006.

The initial indication of a fault occurred during the replay, when the manufacturer's software tool, Playback 32, generated shorter than expected NB audio files. However, during testing it was shown that shorter than expected audio files may not always be created by Playback 32 when a fault is present. Therefore, the only reliable method of determining if a fault of this type had occurred would be to conduct a thorough review of the audio file for each channel during readout.

The AAIB established that approximately 3,000 CVR's based on the same design as that of G-EUXL's had been analysed previously by a combination of accident investigation laboratories and the manufacturer. The operator had also obtained readouts from 130 units and the avionic repair facility from approximately 2,000 units. No similar faults had been observed during these readouts, although it must be noted that the operator and avionic repair facilities readout process did not check the full duration of each channel for errors, and so it remains a possibility that erroneous recordings may have gone undetected. It is reasonable to assume that other operators and companies offering a readout service would conduct readouts in a similar manner.

The manufacturer considered that the failure of the data packer IC was an isolated occurrence. This in part was supported by having no previous reports of a similar failure. The units that have been analysed in detail by accident investigators and the manufacturer represented about 12% of the total units manufactured. However, as the fault has been shown to be intermittent in nature, the significant measure to consider is the analysis of operational (recorded) hours since the units were introduced in 1993. The exact number of aircraft equipped cannot be determined easily, although if only 100 units had been fitted to aircraft since 1993, the operational hours would have reached nearly six million (based on an aircraft operating an average 3,000 flight hours per year); the estimated 6,000 hours analysed in detail by accident investigators and the manufacturer would reflect just 0.01% of this. Equally, if an annual readout was performed on every aircraft per year (which it is not), this would equate to a sample size of just 0.07 % for each aircraft (based on 3,000 flight hours) per year equipped with a 120-minute CVR.

Although this intermittent fault is likely to prove an isolated occurrence, it is possible that there are other CVRs with this fault currently in service and that the fault could remain undetected. It is considered that operators and approved CVR maintenance organisations should be made aware of the symptoms so that there is less chance that a CVR with such a fault is inadvertently released back to service. Therefore:

**Safety Recommendation 2012-029**

It is recommended that Honeywell Aerospace notify all relevant operators and repair organisations of the symptoms that may be observed when the data packer integrated circuit (Honeywell part number 718-1239-007), fitted to Cockpit Voice Recorder (CVR) part number 980-6022-001 and similar models, malfunctions. Honeywell should draw attention to the fact that such a malfunction may only be detectable by conducting a full readout of the CVR.

**Conclusions**

The symptoms experienced by the commander may have been the result of the after-effects of a cold, combined with coincidental head and aircraft movement. The temporary symptoms experienced by the co-pilot may have been a reflection of the potentially evolving situation of an incapacitation at an early stage in the flight leading to possible mild hyperventilation. Their subsequent actions were taken in view of this perceived potential for incapacitation. No aircraft faults were discovered and no other aircraft occupants were affected by any symptoms. The crew did not require medical treatment and resumed flying duties without any recurrence of their earlier symptoms.

A previously unknown intermittent fault with the CVR was identified and this has resulted in a Safety Recommendation.

**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | BAE Systems Jetstream 31, G-CCPW |
| **No & Type of Engines:** | 2 Garrett Airesearch TPE 331-10UGR-5164 turboprop engines |
| **Year of Manufacture:** | 1987 (Serial no: 785) |
| **Date & Time (UTC):** | 8 March 2012 at 1757 hrs |
| **Location:** | Runway 26, Isle of Man Airport |
| **Type of Flight:** | Commercial Air Transport (Passenger) |
| **Persons on Board:** | Crew - 2 Passengers - 12 |
| **Injuries:** | Crew - None Passengers - None |
| **Nature of Damage:** | Right main landing gear yoke pintle fractured, right engine and propeller blades damaged |
| **Commander's Licence:** | Airline Transport Pilot's Licence |
| **Commander's Age:** | 58 years |
| **Commander's Flying Experience:** | 6,000 hours (of which 2,300 were on type)<br>Last 90 days - 140 hours<br>Last 28 days - 48 hours |
| **Information Source:** | AAIB Field Investigation |

**Synopsis**

The aircraft's right main landing gear failed as it landed on Runway 26 at Isle of Man Airport. The right main landing gear detached, the aircraft slid along the runway on its remaining landing gear, right wingtip and luggage pannier before coming to rest on the grass adjacent to the runway. The passengers and crew vacated the aircraft without injury.

The right landing gear failed as a result of intergranular corrosion / stress corrosion cracking of the forward yoke pintle. Four Safety Recommendations are made.

**History of the flight**

The aircraft and crew were operating a passenger service from Leeds Bradford International Airport to Isle of Man Airport. The flight had been routine and the crew were flying a day, visual approach to Runway 26, in good weather, with the surface wind reported as 210° at 14 kt. The commander was the pilot flying (PF) and the co-pilot, who had recently joined the company, was nearing the end of his line training on type.

The approach was flown with full flap and the landing gear locked and confirmed down by the three green gear indicators. The landing weight was estimated to be 13,448 lb (6,099 kg) and the crew recalled that the $V_{REF}$ was about 105 kt.

The aircraft touched down and almost immediately leaned to the right accompanied by an unusual noise. The commander levelled the aircraft with a left roll input. However, as the speed decayed the lean increased and it became apparent that there was a problem with the right landing gear. The commander continued to apply left aileron and rudder. Both pilots recognised that the aircraft was likely to leave the paved surface and so the co-pilot held the control wheel and rudder to allow the commander to apply nosewheel steering and operate the feather levers[1]. The left engine was shut down and feathered as the aircraft departed the runway. The right engine was also shut down but its propeller did not feather. The aircraft left the paved surface, yawed to the right and slid sideways before it came to a stop 90° to the runway heading.

After the aircraft stopped the commander instructed the co-pilot to "GET THEM OUT" and, as all three landing gear green lights were still illuminated, he transmitted on the tower radio frequency that he thought the aircraft had burst a tyre. The commander then shut down the aircraft. He confirmed that both feather levers were pulled, their respective fuel valve lights on the overhead panel showed SHUT, and selected both hydraulic shut off switches to SHUT. He then electrically isolated the aircraft by pulling the battery circuit breakers before leaving the cockpit to assist in the cabin.

The Air Traffic Control Officer (ATCO), located in the visual control room of the tower to the north of the runway, saw the right propeller strike the runway as the gear collapsed. This was also seen by the airport fire-fighter on duty at the Airport Fire and Rescue Service (AFRS) watch office, located to the south of the runway. Both pressed their respective crash alarms while the aircraft was still moving and the AFRS arrived at the aircraft less than two minutes after it had come to a stop.

While the commander shut down the aircraft the co-pilot entered the passenger cabin. He instructed the passengers to remain seated while he ascertained that there were no significant injuries and that the cabin situation was stable. He visually checked the right wing area before opening the passenger door located on the left side of the fuselage at the rear of the cabin. The passengers seated near the single overwing exit, located on the right side of the aircraft, had considered opening it. However, they could see the damage to the right engine and steam or thin smoke rising from the engine area and elected not to do so. The co-pilot assisted other passengers off the aircraft before he returned to the cabin and, along with the AFRS, assisted two passengers of reduced mobility from the aircraft.

**Post-accident actions by ATC**

After the controller on duty pressed the crash alarm there was no confirmation in the tower that the alarm had functioned and the controller attempted to call the AFRS by direct line telephone to confirm they were aware of the accident. The AFRS did not answer this call as they were in the process of deploying and the controller terminated the call when he saw, on the opposite side of the aerodrome, the fire station doors open.

The air traffic assistant called the Emergency Services Joint Control Room (ESJCR) located in Douglas to initiate the deployment of off-site rescue services. The ATCO had categorised the accident as an Aircraft Ground Incident (AGI) and this message was relayed to the ESJCR. At the time of the accident the pre-planned deployment of off-site assets was identical for both AGI and Aircraft Accident, and consisted of deploying five

**Footnote**

[1] The feather lever shuts off fuel to its engine and feathers the propeller.

appliances from a variety of fire stations. The AAIB has been informed that future planning is to have a varied level of response to different incident categories.

The AFRS deployed three appliances and were in position to commence fire fighting 100 seconds after the aircraft stopped moving. While the Watch Commander was driving towards the aircraft he could see passengers disembarking and, using UHF radio, asked the ATCO to have the airport bus deployed to the runway to act as a shelter and transport. He was also in direct radio communications with the ESJCR.

The ESJCR had attempted to initiate its automated pre-planned deployment but a computer failure resulted in a delay of about two minutes while a manual override was initiated. This delay was sufficient for the Watch Commander to establish two-way communications with the ESJCR and confirm to them the level of assistance that he required. As a result the ESJCR stood down the majority of their response, leading some observers to comment on the apparently limited off-site response of a single fire vehicle.

The AFRS conducted visual and thermal imaging surveys of the aircraft, which revealed no signs of fire or fuel leaks. A small area of foam was laid around the right wing and engine as a precaution.

**Runway marks and debris**

The aircraft left a number of marks on the runway surface starting approximately 90 m from the start of the threshold markings. The first marks were made by the right engine propeller blades cutting into the runway surface. Sections of the right landing gear yoke pintle were found at 150 m and 180 m from the runway threshold, near the right landing gear door.

**Recorded information**

The aircraft was equipped with a 30-minute Cockpit Voice Recorder (CVR) and a continuous loop Digital Flight Data Recorder (DFDR). The DFDR recorded just over 26 hours of operation with five parameters which were time, pressure altitude, indicated airspeed, normal acceleration and heading.

Additionally, a Terrain Awareness and Warning System (TAWS) installed in the aircraft recorded 30 separate parameters including aircraft rate of descent, radio altitude and pressure altitude, at a higher sampling rate than the DFDR. These data sources were combined to present a more detailed picture of the aircraft's operation.

The rate of descent recorded by the TAWS, just prior to touchdown, was 463 ft / min (7.7 ft/sec) and is shown in Figure 1. This was within the landing gear limit load defined for a touchdown which was a rate of descent of 10 ft/sec at a maximum landing weight of 14,900 lb (6,758 kg). The normal acceleration at touchdown, after correcting for a maximum accelerometer drift of 0.04 g, was established as 1.72 g which was the highest recorded normal acceleration at touchdown from the 20 flights recorded on the DFDR.

**System description**

*Main landing gear*

The main landing gear was designed to meet the structural requirements of BCAR Section D with a limit load that equates to a maximum landing weight of 14,900 lb (6,758 kg) at a descent rate of 10 ft / sec. The landing gear legs are overhauled every 10,000 cycles or six calendar years after the previous overhaul.

Each main landing gear leg consists of a cylinder, manufactured from DTD 5094 aluminium alloy, and an inner sliding tube assembly on which the single wheel

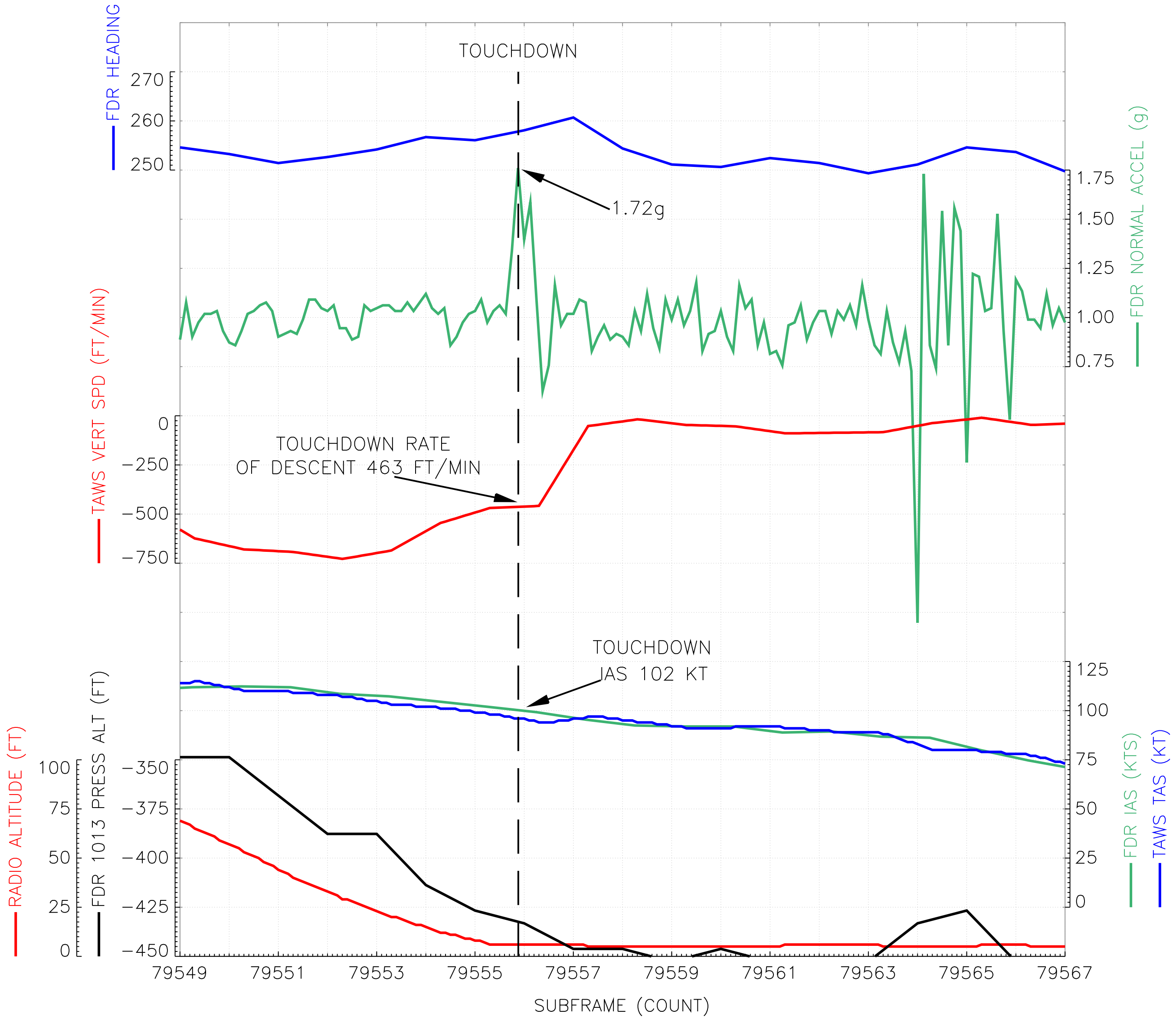


**Figure 1**

Flight data recorded during the landing

and brake assembly are mounted. The landing gear radius arm (retraction jack) is connected to the cylinder and incorporates the down-lock microswitch.

The landing gear is attached to the airframe by trunnions that fit into steel spigots bolted to the inside of the cylinder yoke pintles which form part of the cylinder. The upper surface of the forward yoke pintle is machined to introduce a weak link that, in the event of the landing gear being subjected to a force outside its design limits, will fail and allow the landing gear to detach from the aircraft without damaging the fuel tanks. With the exception of the machined area, which is 9 mm thick, the wall thickness of the pintle is 17 mm. A sketch of the yoke pintle is shown in Figure 2.

 

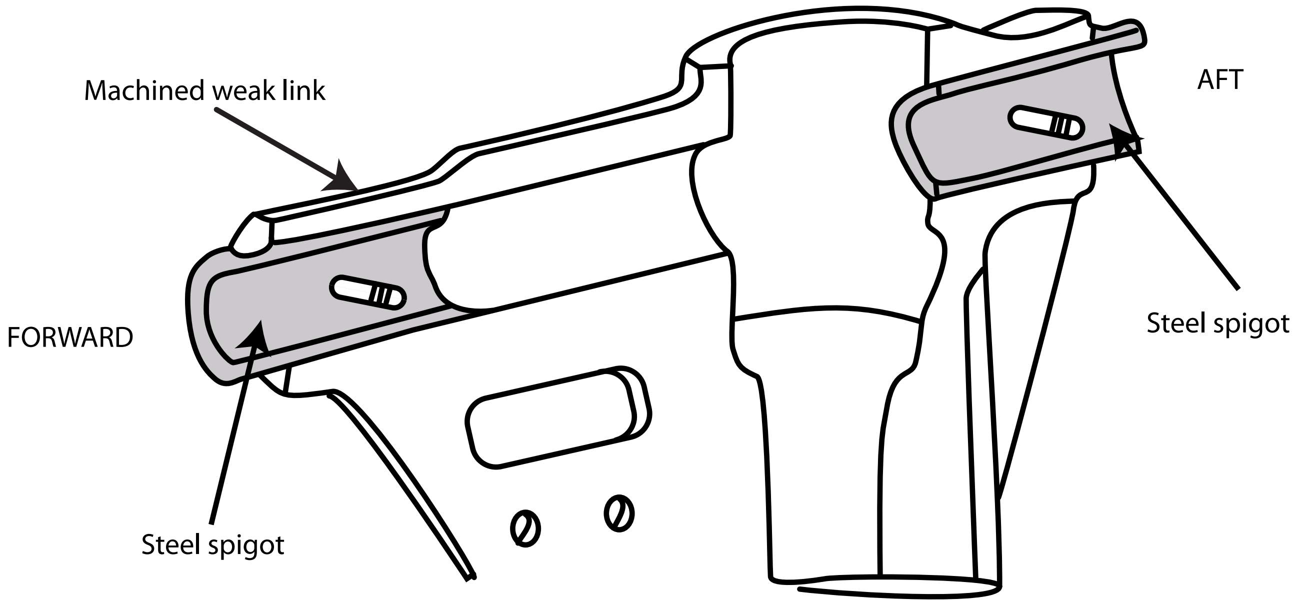


**Figure 2**

Sketch of yoke pintle

Stress Corrosion Cracking (SCC) had been identified in the forward yoke pintle housing of a main landing gear in 1985, following which an Airworthiness Directive (EASA AD G-003-01-86) and Mandatory Service Bulletin (SB A-JA851226) were introduced requiring an eddy current and visual inspection of this area. This inspection is required every 1,200 cycles or within one calendar year of the last eddy current inspection. The visual inspection is required every 300 cycles or within three calendar months of the last visual inspection. The SB also requires the inspections to be carried out following a heavy or abnormal landing.

Whilst the Jetstream 32 landing gear is of the same design as the Jetstream 31, it is manufactured from Aluminium Alloy L161 which is not as susceptible to intergranular corrosion and SCC.

*Feather / emergency shut off levers*

Two feather / emergency shut-off levers are situated towards the rear of the centre console and provide a rapid means of shutting off the fuel to the engines, feathering the propellers and inhibiting the engine starting system. The feather levers are operated by turning the handle clockwise by 90° such that a key on the shaft of the feather lever aligns with a slot in the hole in the console through which the lever passes. The lever can then be extended to the FEATHER position. The feather lever is spring-loaded counter-clockwise, such that when it is released the key will lock on the edge of the hole in the console. In the aircraft manuals this action is described as '*locking the lever in the detent.*' This feather lever and locking arrangement is also used on the Jetstream 32 aircraft.

Pulling the feather lever from the NORMAL to the FEATHER position performs the following actions:

- Manually, through a system of cables and control rods, closes the HP fuel cock
- Manually, through a system of cables and control rods, operates the propeller Feather Valve
- A microswitch on the lever operates and the LP fuel cock is electrically closed (the crew can also close the LP and hydraulic cocks using switches on the overhead panel)
- A microswitch on the lever operates and the LP hydraulic cock is electrically closed
- A microswitch on the lever operates and inhibits the engine starting systems

When the feather valve opens, it stops the flow of oil from the propeller governor to the propeller pitch control sleeve and allows the oil in the propeller cylinder to drain into the engine case. The propeller will then feather under the action of the spring and counterweights.

If, after the propeller has feathered and the engine has been shut down, the feather lever is moved to the NORMAL position the propeller will not unfeather unless the unfeather pump is operated. The HP fuel cock will also stay in the CLOSED position until the engine start sequence is initiated. However, the LP fuel cock, which is controlled by a microswitch, will move to the OPEN position and fuel can then flow from the aircraft fuel tanks to the engines.

The inadvertent opening of the LP fuel cock could present a significant safety risk during an emergency such as a forced landing or engine fire.

**Aircraft damage**

During the accident sequence the right main landing gear forward yoke pintle failed with three large segments breaking away.

The right landing gear broke away from its trunnions as a result of the failure of the forward yoke pintle housing (see Figure 3). However, the landing gear remained attached to the aircraft by the radius arm and hydraulic pipelines. The down-lock microswitch fitted to the radius arm remained intact and, when electrical power was selected ON, all three green landing gear position lights illuminated.

The blades on the right propeller had been badly damaged and the right engine appeared to be distorted in its engine mounts. The right propeller feathering mechanism had been damaged when the propeller blades contacted the runway. The right aileron balance horn, wingtip and a section of the pannier had abraded away. There was some distortion to the right wheel well and flaps where the landing gear had broken away but was no evidence of a leak from the wing fuel tanks. The main cabin door and over-wing emergency exit both opened freely. Apart

**Figure 3**

Damage to right forward yoke pintle

from the failure of the forward yoke pintle on the right main landing gear, there was no visible evidence that the aircraft had sustained a heavy landing.

**Aircraft weight**

The landing weight of the aircraft was estimated to be 6,067 kg (13,375 lb). This was below the maximum landing weight of 6,745 kg (14,870 lbs).

**Corrosion**

*Galvanic corrosion*

Galvanic corrosion, which is also known as dissimilar metal corrosion, is the process by which two dissimilar metals, or alloys, come into contact with an electrolyte and oxidise or corrode. In this situation one of the metals acts as an anode and the other a cathode with the anode dissolving in the electrolyte. On the Jetstream 31 landing gear the aluminium alloy pintle would act as the anode and the steel spigot the cathode. Anodising aluminium components and cadmium coating steel components can help to prevent galvanic corrosion.

*Stress Corrosion Cracking (SCC)*

Stress corrosion cracking occurs when susceptible metals, or alloys, are subject to a continuing tensile stress above a threshold level in a corrosive environment. The initiation phase normally occurs when the surface protective finish has been compromised and the crack will then travel along the grain boundaries. Unless the stress is relieved, the crack will continue to grow over time until it reaches the critical crack length when the remaining metal will fail in sudden overload.

*Intergranular corrosion*

Like stress corrosion cracking, intergranular corrosion can initiate when the surface finish has been compromised. The grain boundaries often contain small particles of dissimilar alloying metals which are less corrosion resistant than the grains. So the corrosion occurs along the grain boundaries. Unlike stress corrosion cracking, intergranular corrosion does not require the presence of a tensile load.

Exfoliation Corrosion is a form of intergranular corrosion.

**Metallurgy**

As part of the investigation into the failure of the forward yoke pintle on G-CCPW, metallurgy examinations of the failed parts were carried out by QinetiQ and the Royal Navy's 1710 Naval Air Squadron, Materials Integrity Group.

The examinations established that the crack initiated at the top outer edge of the forward yoke pintle and extended along the top of the pintle for approximately 120 mm before final failure occurred. (See Figure 4.) The first 10 mm of the crack was heavily corroded and lighter deposits of corrosion were found along the remainder of the crack. Scanning Electron Microscopy (SEM) of the first 10 mm of the crack showed evidence of intergranular failure consistent with SCC. A microsection taken through the outer 35 mm of the pintle identified branching crack growth which is also characteristic of SCC. Beyond the first 10 mm the crack failed as a result of overload.

The anodised layer on the end of the pintle had been disrupted, possibly as a result of rubbing against the bearing cap that secures the leg to the aircraft, leaving the end grain of the metal exposed. A dark stain approximately 60 mm long and 2 mm deep ran along the inside face of the failed section of the pintle. A section taken along the stain, approximately 12 mm from the end of the pintle identified the presence of intergranular corrosion which extended 0.13 mm into the pintle. It

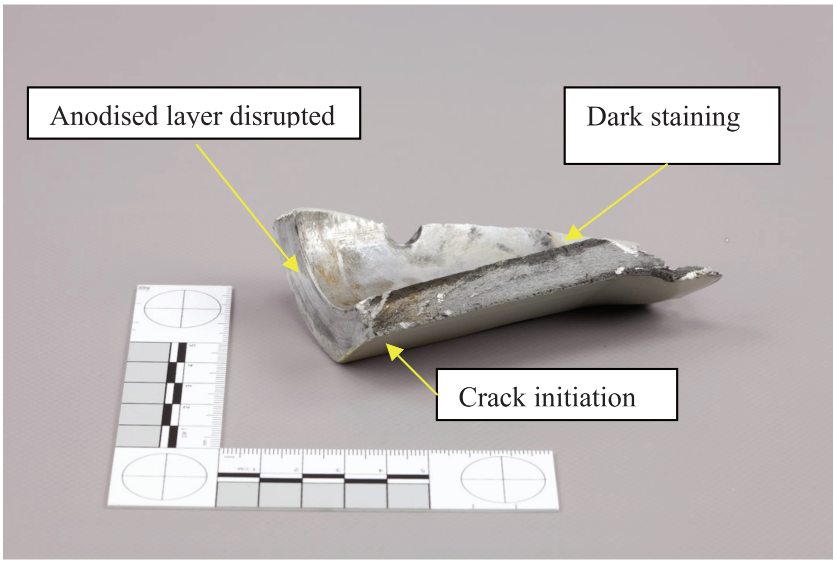


**Figure 4**

Failed section of forward yoke pintle

was also noted that the metal grain at this position flowed from the inner to the outer surface shown in Figure 5. This is probably due to the 'flash line' which is formed when the metal is forced out of the die during the manufacturing process.

Corrosion was also found on the steel spigot, (see Figure 6), and there was visible staining on the inner face of the yoke pintle that was in contact with the corroded areas of the steel spigot. Dye penetrant and visual examination of the stained area, using high magnification devices, revealed the presence of numerous defects, the majority of which were less than 0.5 mm across. Microsections taken from this area determined that these defects were not stress-driven, but were consistent with intergranular corrosion. A smaller number of these

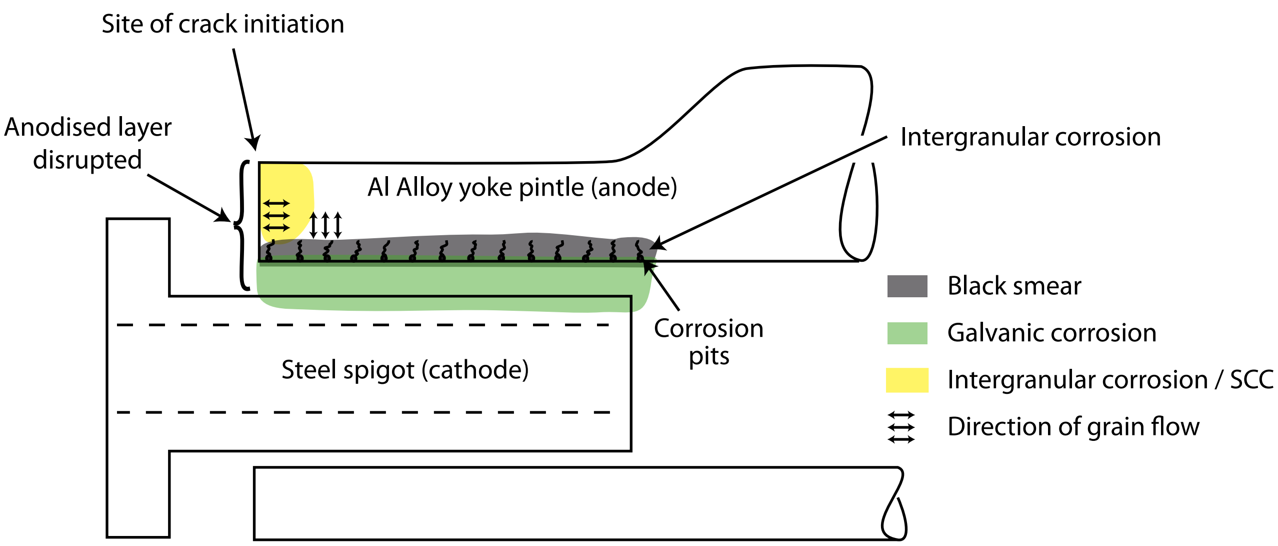


**Figure 5**

Defects found on forward yoke pintle

defects were also identified on the inner surface of the forward yoke pintle on the left landing gear. Energy-dispersive X-ray spectroscopy (EDX) of the fracture surface of the crack in the yoke pintle identified the presence of cadmium that had leached into the crack from the corroded steel spigot. It was determined that the dark stain along the inner face of the pintle was the result of fretting debris and dirt that had been drawn into the crack. This indicates that this section of the crack must have existed prior to the final failure of the yoke pintle.

## Maintenance history

*Main landing cylinders*

Both landing gear cylinders had last been overhauled in July 2009 and fitted to G-CCPW in August 2009. The maintenance organisation that carried out the overhaul advised the investigation that the paint had been removed prior to the NDT inspections. No damage had been found and no repairs had been carried out to either cylinder. At the time of the accident they had been subjected to 1,445 cycles.

Since being fitted to G-CCPW, eddy current inspections of the pintle on both landing gear legs had been carried out on 30 March 2010 and on 13 May 2011, 743 cycles prior to the accident. The last visual inspection was carried out on 26 February 2012, 29 cycles prior to the accident. There was no record of any damage having been found during these inspections. The aircraft operator also advised the investigation that they had no reports of the aircraft having sustained a heavy landing.

*Feather levers*

A 200-hour maintenance check, which included a functional check of the feather levers, was carried out on 21 November 2011, 173 hours and 269 cycles prior to the accident.

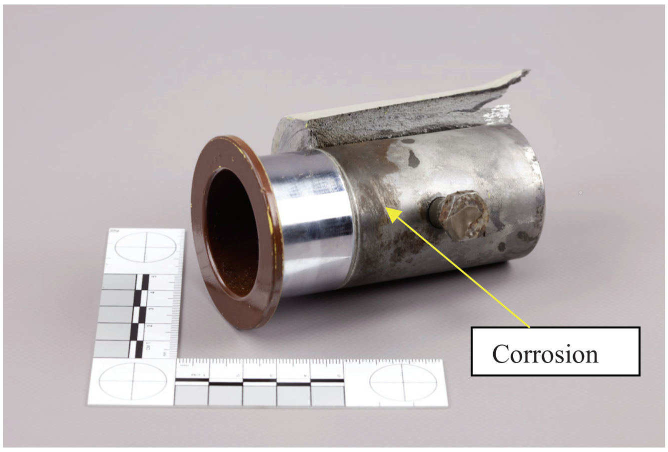


**Figure 6**

Corroded areas on steel spigot

## Other reports of cracking in the yoke pintle

*Royal Air Force (RAF)*

The RAF discovered cracks in the forward yoke pintles of landing gears fitted to their Jetstream T Mk 1 aircraft on three occasions between 1980 and 1987. Although not identical, the landing gear is of a similar design, is made from the same material and has the same overall dimensions as that fitted to the Jetstream 31.

*Registration XX493*

In 1980, a crack 127 mm long was discovered on XX493 during other work. The crack appeared to have originated from a number of intergranular corrosion cracks growing from the outer edge of the pintle. Fatigue banding was found at the end of these cracks. Photographs of the crack, after it had been opened, show evidence of dark staining similar to that seen on the failed yoke pintle fitted to G-CCPW. Two years prior to the discovery of the crack, the aircraft had been used for crosswind landing trials.

*Registration XX491*

In 1985 a crack approximately 160 mm long was found in the yoke pintle on the left main landing gear fitted to XX491; the aircraft had had a runway excursion five months and 478 landings earlier. The crack initiated on the outer edge of the face of the forward pintle and extended along the upper machined face for 130 mm when it then split into two branches that were 25 and 30 mm long. There was no evidence of fatigue and the failure did not appear to have been caused by overstress produced by a heavy landing. Examination of the crack found evidence of intergranular cracking and exfoliation along the inside of the bore, halfway along the crack. In addition, there was a 'dried mud' feature at the start of the fracture. There were also reports of a 'black' deposit on the surface of the crack, predominately at the outer edge and along the inner face of the pintle. The deposit was identified as hydraulic fluid containing particles of aluminium alloy and nitrile rubber – no corrosion ions were detected. SEM examination indicated the presence of stress corrosion cracking that the investigation concluded was driven by residual stresses introduced during the manufacturing process.

In 1987 a crack approximately 120 mm long was found in the forward yoke pintle in the landing gear that was fitted following the discovery of the crack in 1985. The investigation determined that crack was caused by SCC and the crack originated at the outer corner of the end face of the pintle. There was no evidence of the 'dried-mud' feature that had been observed during the previous occurrence. It was believed that the SCC most probably extended for no more than 5 mm, which then resulted in a subsequent rapid failure from a dynamically applied load. The investigation also concluded that a breakdown of the corrosion protection allowed inter-crystalline corrosion to propagate with subsequent crack propagation by SCC. The leg had flown a total of 10,289 landings and had last been overhauled 9 months and 2,622 landings prior to the discovery of the crack. During overhaul, corrosion had been removed from the end face of the pintle. The last eddy current inspection had been carried out 31 flights previously.

*Registration XX494*

As a result of the findings on XX493 and XX491 in 1984, the RAF inspected the yoke pintles on XX494 using an eddy current technique. The examination revealed small defects on the end face of the forward yoke pintles on both landing gear cylinders that had resulted from 'end grain' corrosion. They also identified that the protective treatment (anodised layer) on the end face of the pintle housing had been worn away.

*Civilian Jetstream 31, registration SX-SKY*

On the 12 February 2009 the forward yoke pintle on the right main landing gear fitted to SX-SKY failed on landing. The landing gear had flown 23,940 cycles since new and had been overhauled 148 landings prior to the accident. The aircraft landing weight was calculated to be 14,870 lb, which was within the maximum limit of 14,900 lb, and the FDR recorded a normal acceleration on landing of 1.79 g. A review of the data on the FDR identified two possible heavy landings of 2.5 g and 2.87 g that had occurred 5 and 27 landings prior to the accident.

The pintle on SX-SKY had failed in the same location as on G-CCPW. Although the final failure was due to ductile overload, a crack appeared to have originated from a region of intergranular corrosion on the outer end face of the pintle. A dark stain was also evident along the inner edge of the fracture surface, similar in size to the stain on XX493 and G-CCPW. There was no evidence of SCC on any of the fracture faces.

*Overhaul organisation*

The two organisations that overhauled the landing gears fitted to G-CCPW and SX-SKY advised the investigation that they had never rejected a landing gear as a result of discovering cracks in the yoke pintle. However, the organisation that overhauled the legs from G-CCPW was aware of one operator who had discovered cracks during the mandatory inspection of the pintle.

*Findings reported to the aircraft manufacturer*

The aircraft manufacturer and the landing gear design authority have advised the investigation that they have received no reports of cracking found during the mandated inspections detailed in SB A-JA851226. This is possibly due to the fact there is no repair scheme for cracks in the pintle, or requirement to report any findings to the aircraft manufacturer.

**Use of eddy current inspection to detect cracks in the yoke pintle**

*Principle of crack detection using eddy current examination*

Eddy current inspection uses a probe that generates an electromagnetic field that causes eddy currents to develop in the material being inspected. The strength of the eddy currents is sensed by the probe and can be presented to the operator on a display, or used to drive a needle on a gauge. Surface and near-surface cracks will alter the flow of the eddy current and produce a change on the operator's display. However, the operator is required to calibrate the equipment for the size of the crack being inspected and to compensate for the 'edge effect', which occurs when the probe is positioned close to the edge of the material. While the presence of a surface crack is seen as a change in the display, intergranular and SCC, which has not broken through the surface, can give a more subtle change which the operator might mistake as a change in the material properties. Even if the crack is surface-breaking, the branching nature of intergranular and SCC, and the possibility of numerous adjacent cracks, may give a more subtle, diffuse response than that of a sharp crack. Such a situation may occur on the end face of the pintle.

Following the discovery of cracks in the forward yoke pintles on RAF Jetstream 31 aircraft, the aircraft manufacturer established that a minimum crack length of 1.57 mm was required to initiate steady crack growth. Once the crack reached 1.57 mm it would then grow steadily to 6 mm in approximately 120 days at which point it would become critical and fast fracture would occur[2]. Once the crack had developed beyond 6 mm the pintle could fail under normal operating loads. The RAF determined that, due to edge effects, an eddy current technique would not be suitable for detecting cracks of less than 2.5 mm as the crack would be approaching its critical crack length before it was likely to be discovered.

*Minimum detectable crack length*

As part of this investigation, QinetiQ undertook a review of the eddy current technique called up in SB A-JA851226 to detect cracks in the pintle housing. The review considered a United States Air Force (USAF) assessment[3] of a high frequency eddy current technique

**Footnote**

[2] The nominal 6 mm is based on the manufacturer's assumed residual stress in the forging. Different forgings may result in different residual stresses.

[3] "Nondestructive inspection capability guidelines for United States Air Force aircraft structures." Structures Bulletin EN-SB-08-012, Rev B.

of up to 2 MHz. The USAF assessment determined that, using this technique, a reasonable minimum size for a detectable crack is 6 mm in length and 3 mm deep on a machined flat surface, and 13 mm by 6 mm respectively on a radius. Moreover, the crack should be detected 90% of the time with 95% confidence. QinetiQ also advised that, using this technique, SCC may be more difficult to detect than fatigue-initiated cracks. This is because of reduced local conductivity in the corroded region, due to the presence of a layer of non-conducting corrosion product, and the resulting rough surface of the parent material. Of more significance is that the eddy current response from surface-breaking corrosion pits could desensitise the operator to actual crack indications.

*Detection of SCC and intergranular corrosion*

During the investigation into the cause of the cracks on G-CCPW, a Level 3 NDT technician was tasked with inspecting both landing gear forward yoke pintles using an eddy current and dye penetrant technique. The operator was initially unable to detect the SCC, intergranular corrosion and pits on the inner bore of the yoke pintle until the metallurgists had advised him of the location and nature of the damage.

**Feather levers**

Following the accident, and before the aircraft had been moved, the propeller feather levers were found in the positions shown in Figure 7. The left engine feather lever was in the fully extended FEATHER position (63 mm) and the key on the lever was locked in the hole in the console; the right engine feather lever was found in a partially extended position (32 mm).

Examination of the right engine HP and LP fuel cocks established that they were both closed. The left engine propeller blades were visually established as being in the feathered position. The pitch mechanism on the right engine propeller blades had been damaged when the blades repeatedly struck the ground and all the blades were found in a non-feathered position. After the aircraft had been moved to a hangar, the aircraft battery power was selected ON; the left LP fuel cock indicator on the roof panel illuminated SHUT and the right indicator illuminated OPEN. The microswitch at the base of the lever was heard to operate when the right lever was pulled out by 33 mm and at the same time the right LP cock indicator changed to SHUT.

The dimensions of the holes in the console, through which the feather levers pass, are specified in the aircraft drawing as 0.500" +.01" (12.7 mm +0.25 mm), which gives an upper tolerance of 12.95 mm. On G-CCPW the left hole was found to be 13.35 mm and the right hole was found to be 14.61 mm. The detents on both feather levers were found to be 13.97 mm, as specified in the aircraft drawings.

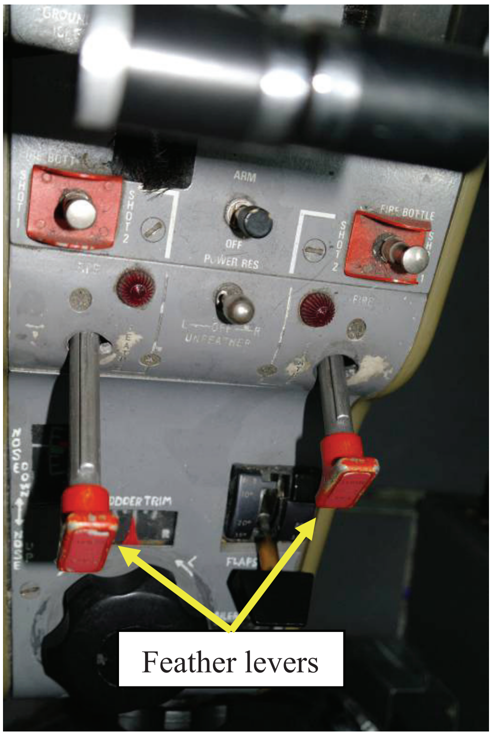


**Figure 7**

Position of feather leavers after accident

While the hole for the left feathering lever was found to be worn, and outside the drawing tolerance, it was still sufficient to ensure that the left feathering lever could be locked in the extended position. However, at 14.61 mm the hole for the right feathering lever was 0.64 mm larger than the key; consequently the right lever would not lock in either the feathered (extended) or non-feathered (fully in) position and could be easily moved in and out without having to first rotate it clockwise by 90 degrees. The wear around the hole suggested that it had been in this condition for some time.

With regard to the feather levers, the Jetstream 31 Flight Manual requires that they are checked at the start of the first flight of the day to ensure that they engage the detent:

> *'Verify Feather Levers are fully down.*
>
> *## IF……….first flight of the day:-*
>
> *Observe LEFT and RIGHT HYD and FUEL LP COCKS indicators show OPEN.*
>
> *Turn and pull FEATHER levers to engage detent and observe LEFT and RIGHT HYD and FUEL LP COCKS indicators show SHUT.*
>
> *Push stop and feather levers fully down and observe LEFT and RIGHT HYD and FUEL LP COCKS indicators show OPEN.'*

The aircraft and engine maintenance manuals require the airframe emergency feather / fuel shut off systems to be operated every 200 hours and, at the 'A' check, *'to determine if the engine feathering valve and fuel shut off valve have actuated'*. However, the procedure[4] does not require personnel to check that the key on the feather lever locks in the hole in the console.

The first flight of the day checks were discussed with the aircraft commander. He believed that the primary purpose of the check was to ensure that the LP Fuel and hydraulic cocks closed when commanded and that there were no control restrictions. The technique used to conduct the checks began with the crewmember looking at the overhead panel to note the valve indications. While continuing to observe the overhead panel, the lever was turned and pulled, the valve position indicator change noted before the lever was restored to its starting, flush position. Although individual techniques would vary, it appears likely that flight crew do not remove their hand from the lever whilst it is in the extended position.

## Analysis

*General*

Audio analysis of the CVR**,** witness marks on the runway and the location of the debris indicates that the right forward yoke pintle failed when the aircraft touched down. The available evidence indicates that the aircraft was being operated within its maximum landing weight and the rate of descent was within the certification standard for the main landing gear.

*Failure of the forward yoke pintle*

From the available information on the cracks found in the forward yoke pintles on five different main landing gear cylinders, and the defects found on the end face of the yoke pintles on both landing gear fitted to XX494, it would appear that the cracks probably initiated as a result of disruption of the anodised layer on the end face of the forward yoke pintle as a result of it rubbing against the bearing cap. The end grain of the metal would then be exposed to the elements and cracks would start to grow as a result of intergranular corrosion. However, the dark (black) stain reported on the inner surface of a number of occurrences indicates that the rapid crack growth, due to overload, was arrested for a sufficient

**Footnote**

4 Maintenance Manual TPE331-10 (Report No 72-00-42).

period of time for capillary action to draw debris into the crack before it then rapidly grew to failure. The investigation determined that there are probably two failure mechanisms that could have resulted in the failure of the yoke pintles:

Stress corrosion cracking. The crack is initiated as a result of intergranular corrosion growing from the exposed end grains. Internal residual stresses from the manufacturing process would cause SCC to develop and the crack would continue to grow to a nominal 6 mm. The stress resulting from the normal landing loads would then be sufficient to cause the crack to grow rapidly in overload, until either the yoke pintle fails or the crack is arrested by the increased wall thickness. If the crack is arrested, then debris would be drawn into it, creating the dark stain, until the stress resulting from normal landing loads is sufficient to drive the crack to failure. It should be noted that once the crack exceeds a nominal length of 1.57 mm, the residual stresses will be sufficient to cause the crack to grow; the aircraft manufacturer estimated that it would take 120 days for the crack to grow from 1.57 mm to 6 mm. The cracks could become critical at a shorter length if subjected to a high load such as may occur in a heavy landing. This failure mechanism is dependent on the materials susceptibility to SCC. The failures of the three yoke pintles on XX491 and G-CCPW appear to have been caused by this failure mechanism.

Intergranular corrosion followed by overload. The crack is initiated as a result of intergranular corrosion and grows to approximately 1.57 mm. The crack then propagates in overload. The lack of any evidence of SCC in some previous accidents suggests that the cracks in these pintles had grown to less than 1.57 mm before failing in overload as a result of being subject to a large load, such as might occur in a heavy landing. The lack of any evidence of SCC suggests that this was the failure mechanism that occurred on XX493 and SX-SKY.

*Defects in the bore of the yoke pintle*

The corrosion on the steel spigot and staining of the walls in the bore of the yoke pintle was most probably caused by surface corrosion that compromised their cadmium and anodising layers. Galvanic action might then have accelerated the corrosion. It is not known how the electrolyte entered the space between the two components, but it might have been drawn in through a crack in the yoke pintle or as a result of wear between the spigot and pintle.

It is believed that the manufacturing process resulted in the end grains in the area of staining being oriented towards the inner surface. The pitting from the surface corrosion would have compromised the anodised layer and exposed these grains allowing the onset of intergranular corrosion. During the investigation, the depth of the intergranular corrosion on the walls of the bore was only measured at one location and found to be around 0.130 mm deep. While this defect was unlikely to have significantly affected the strength of the yoke pintle on G-CCPW, the investigation was not able to determine how fast the intergranular corrosion would propagate and the effect it would have on the structural integrity of the pintle. The report of exfoliation corrosion having been found on the bore of the yoke pintle fitted to XX491, and the defects found on the left cylinder fitted to G-CCPW, indicates that intergranular corrosion has occurred in this area before.

Currently there is no requirement to remove the steel spigot and examine the bore of the yoke pintle between overhaul periods on the landing gears fitted to Jetstream 31 aircraft. To conduct an effective inspection of this area, it is likely that the spigot would have to be removed. However, such a maintenance activity could damage the cadmium coating on the spigot and the anodised layer on the pintle thereby initiating corrosion by another mechanism and the relative risks of this process would need to be considered. However, the following Safety Recommendation is made:

**Safety Recommendation 2012-024**

It is recommended that BAE Systems Regional Aircraft consider the introduction of a routine inspection on the main landing gear fitted to Jetstream 31 aircraft to detect and monitor the presence of intergranular corrosion in the bores of the yoke pintles.

*Detection of cracks in the bore*

EASA AD G-003-01-86 mandates non-destructive testing and visual inspections to identify cracking in the forward yoke pintle housing on landing gears fitted to Jetstream 31 aircraft, with eddy current examinations carried out annually and visual examinations every three months. The heavy corrosion deposits at the start of the crack and previous reports of a 'dried mud' appearance indicate that intergranular corrosion can be be present for some time before the crack starts to grow beyond the first few millimetres.

Previous work undertaken by the aircraft manufacturer established that once the crack reaches 1.57 mm in length it could then grow, as a result of internal stresses, to 6 mm within 120 days. Once it reaches a length of 6 mm it could then fail in overload as a result of normal landing loads. The RAF previously advised that eddy current examination was not suitable for detecting cracks of less than 2.5 mm and the USAF assessment was that a 'reasonable' minimum detectable crack length was 6 mm with a 90% probability of detection. The visual inspection of the yoke pintle is undertaken every three months with the landing gear still fitted to the aircraft. However, given the restricted access, and modern flexible paint finishes, it is not certain that a crack in the yoke pintle would be detected before it reached the critical length of 1.57 mm.

As the current inspection requirements did not detect the crack in the forward yoke pintle before it failed on G-CCPW, the following Safety Recommendation was made to the European Aviation Safety Agency on 23 March 2012:

**Safety Recommendation 2012-008**

It is recommended that the European Aviation Safety Agency review the effectiveness of Airworthiness Directive G-003-01-86 in identifying cracks in the yoke pintle housing on landing gears fitted to Jetstream 31 aircraft.

**Feather lever**

The worn state of both feather lever detents played no part in the outcome of this accident. However, the inability to lock the lever in the FEATHER position has a safety implication in that it might inadvertently move towards the normal position and open the LP fuel cock.

The check at the start of the first flight of the day required the lever to be pulled to '*engage detent*' but did not make it clear that the lever should lock fully out. The commander believed that the primary purpose of this check was to ensure that the LP Fuel and hydraulic cocks closed when commanded and that there were no control restrictions. The check required the crew to monitor the overhead panel and operate the lever by feel; consequently they may not have noted that the detent was ineffective. Similarly the maintenance checks did not specifically require the functioning of the detent to be checked. Therefore the following Safety Recommendation is made:

**Safety Recommendation 2012-025**

It is recommended that BAE Systems Regional Aircraft review the functional checks of the feather lever detailed in the Flight Manual and Maintenance Manuals for Jetstream 31 and Jetstream 32 aircraft to ensure that a routine check on the positive locking of the lever in the detent is conducted.

As an interim measure, the manufacturer issued a Notice To Aircrew (NTA J31 007-1) on 30 May 2012, reminding crews of the correct operation of the feather levers.

**AFRS response**

The AFRS response was immediate, effective and proportionate. However, the ATCO was unsure if the crash alarm had worked and, as is common during high workload periods, the short delay between the crash alarm being pressed and the AFRS deploying was perceived by the ATCO as being much longer than it actually was. The lack of a feedback mechanism resulted in the ATCO attempting to phone the AFRS to confirm activation of the alarm. The AFRS, understandably, did not stop their deployment to answer the phone call and the ATCO was only satisfied when he saw the fire station doors opening. The period following an accident is one of very high workload and this uncertainty could be a distraction. In low visibility the ATCO would not have been able to see the fire station and so a mechanism to provide feedback that the crash alarm had activated would be essential. Therefore the following Safety Recommendation is made:

**Safety Recommendation 2012-026**

It is recommended that the Isle of Man Airport provide a feedback system to allow the Air Traffic Control Officer to be certain that the Airport Fire and Rescue Service have received and are responding to a crash alarm from the tower.

**Shut down and evacuation**

The commander's radio call, that he thought a tyre had burst, did not reflect the circumstances of the accident but, with all three landing gear green lights still illuminated his diagnosis was understandable. He was aware that the visibility was good and that the aircraft was in direct line of sight of the control tower. This led him to decide there was no need to provide further information and to concentrate on shutting down and disembarking the aircraft. As both ATC and the AFRS had witnessed the accident, the commander's radio call had no effect on their response to the event.

Once the aircraft stopped the commander instructed the co-pilot to "GET THEM OUT". The operator's *'on ground emergency'* or *'emergency evacuation'* checklist would have been appropriate but were not used. The shut down and disembarkation that followed did not follow any scripted procedure precisely but were accomplished safely and effectively.

After being instructed to do so by the commander, the co-pilot took responsibility for the cabin. When interviewed, more than one passenger commented that the co-pilot's control of the evacuation ensured that everyone de-planed in an orderly fashion and sustained no additional injuries.

**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | Aeronca 7ACA Champ, G-HAMP |
| **No & Type of Engines:** | 1 Continental Motors Inc C85-8F piston engine |
| **Year of Manufacture:** | 1971 |
| **Date & Time (UTC):** | 1 September 2011 at 1135 hrs |
| **Location:** | Lowfold Farm Airstrip, Wisborough Green, West Sussex |
| **Type of Flight:** | Private |
| **Persons on Board:** | Crew - 1 Passengers - 1 |
| **Injuries:** | Crew - None Passengers - None |
| **Nature of Damage:** | Damage to propeller tips, belly fabric and tailwheel spring |
| **Commander's Licence:** | Private Pilot's Licence |
| **Commander's Age:** | 62 years |
| **Commander's Flying Experience:** | 21,500 hours (of which 560 were on type)<br>Last 90 days - 67 hours<br>Last 28 days - 25 hours |
| **Information Source:** | AAIB Field Investigation |

## Synopsis

The aircraft landed heavily having encountered downdrafts on approach to a farm strip. One Safety Recommendation was made concerning the use of energy-absorbing foam cushions.

## History of the flight

At the conclusion of a local flight the aircraft approached to land at a farm strip. The strip is aligned approximately 020° and has a flat area near the threshold but the remainder of the strip slopes downhill; pilots normally takeoff in this direction and land uphill in a SW direction. There is a stand of trees to the east of the southern threshold area. The wind strength had unexpectedly increased during the flight and the pilot decided that a downhill landing into wind was required. As he positioned the aircraft he observed that the windsock indicated wind straight along the strip. However, the position of the windsock was such that it could not be seen in the later stages of the approach. As the aircraft approached the threshold, it encountered downdrafts from the trees and landed heavily in a three-point attitude, sufficiently hard for the belly of the aircraft to strike the ground. After landing the pilot noted that the wind had veered and increased.

## Impact protection

Neither the pilot nor passenger suffered any injury, despite the hard landing. The pilot had recently fitted to the aircraft new seat cushions manufactured from energy absorbing foam material. He believed that, had he not fitted these cushions, the occupants may have suffered back injuries.

Research on the use of energy-absorbing seat cushions to reduce the effect on the pilot of vertical impact loads was carried out by the Royal Air Force Institute of Aviation Medicine in 1986, and by the Defence Evaluation and Research Agency, Farnborough in August 1996. Test results showed that conventional seating foam cushions could increase the spinal load induced by vertical deceleration forces, whereas a cushion of energy absorbing seating foam, fitted on a rigid structure, reduced these loads and offered a good level of protection against vertical deceleration forces.

Following this research, the British Gliding Association has recommended, for over 10 years, that gliders should be fitted with energy-absorbing seat cushions.

In 2008, the AAIB investigated a gyroplane accident in which the aircraft landed heavily and the occupants suffered fractured vertebrae. The report stated that the foam cushions fitted to the aircraft were not designed to absorb the energy of a heavy landing and the AAIB recommended that the CAA promote the benefits of fitting energy-absorbing seating foam to microlights and gyroplanes. The CAA accepted this recommendation and published advice in General Aviation Safety Information Leaflet issue 10/2009 and at GA Safety Evening briefings. However, light aircraft such as G-HAMP were not covered by the advice, therefore the following Safety Recommendation is made:

**Safety Recommendation 2012-028**

It is recommended that the Civil Aviation Authority promote, on an ongoing basis, the benefits of fitting seat cushions made from energy absorbing foam in light aircraft.

**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | Piper J3C-65 Cub, G-BHPK |
| **No & Type of Engines:** | 1 Continental Motors Corp A65-8F piston engine |
| **Year of Manufacture:** | 1943 (Serial no: 12161) |
| **Date & Time (UTC):** | 28 January 2012 at 1523 hrs |
| **Location:** | Priory Farm, Tibenham, Norfolk |
| **Type of Flight:** | Private |
| **Persons on Board:** | Crew - 1 Others - 1 |
| **Injuries:** | Crew - None Others - 1 (Fatal) |
| **Nature of Damage:** | Damaged propeller |
| **Commander's Licence:** | National Private Pilot's Licence |
| **Commander's Age:** | 38 years |
| **Commander's Flying Experience:** | 370 hours (of which 2 were on type)<br>Last 90 days - 4 hours<br>Last 28 days - 4 hours |
| **Information Source:** | AAIB Field Investigation |

**Synopsis**

A Light Aircraft Association (LAA) coach, who had been coaching the pilot, vacated the aircraft and stepped into the path of the rotating propeller, receiving fatal injuries.

**History of the flight**

The pilot was undergoing training to convert onto tailwheel aircraft. The training was conducted at Priory Farm, a small grass airfield where the aircraft was based, and which was familiar to both the pilot and his LAA coach. On the morning of the accident they had flown some circuits and conducted general handling in the local area before returning to the airfield for lunch. The pilot reported that the coach had considered the engine had been overfilled with oil and that after the flight he had looked at the engine for signs of oil having been expelled.

In the afternoon they flew again, conducting a number of circuits until the coach considered the pilot was proficient to fly the aircraft solo. After landing on Runway 01 the aircraft was taxied back to the threshold, brought to a halt and the engine was left running. The coach undid his harness and disconnected his headset, although witnesses could not recall whether he removed it. Having opened the window and door panel, the coach vacated the aircraft by climbing out to the front of the wing struts and stood between the struts and the propeller. He then helped close the window and door before talking briefly to the pilot. The pilot then saw the coach turn away towards the front of the aircraft. At this point the pilot turned his attention back inside the cockpit. Another witness also saw the coach at this time turn towards the front of the aircraft. He reported that the coach, having turned around, stepped forward into the arc of the propeller. The propeller struck the coach, killing him instantly.

**Aircraft examination**

One propeller blade displayed evidence of impact damage approximately 10 cm from the tip. The impact had caused the propeller to split along the length of both blades. The coach's headset was found by the aircraft in a badly damaged condition. Later examination showed this damage to be consistent with the coach having been wearing the headset and it having been struck by the propeller. There was no other identifiable aircraft damage or defects that might have contributed to the accident.

**Aircraft description**

The J3C-65 is a two-seat civilian variant of the Piper Cub, fitted with a 65-horsepower Continental engine, and was used extensively as a training aircraft during World War II.

G-BHPK had a one-piece propeller of wooden construction with a metal plate reinforced leading edge. It had a clear varnish finish and light green painted tip sections (Figure 1). The propeller has to be hand-swung in order to start the engine and when hot, the engine can be hard to restart. For this reason it is not unusual for the engine to be left running whilst people are entering or exiting the aircraft between flights. The owners of the aircraft reported that due to the low power of the engine, the wind buffet from the propeller at idle is not particularly strong.

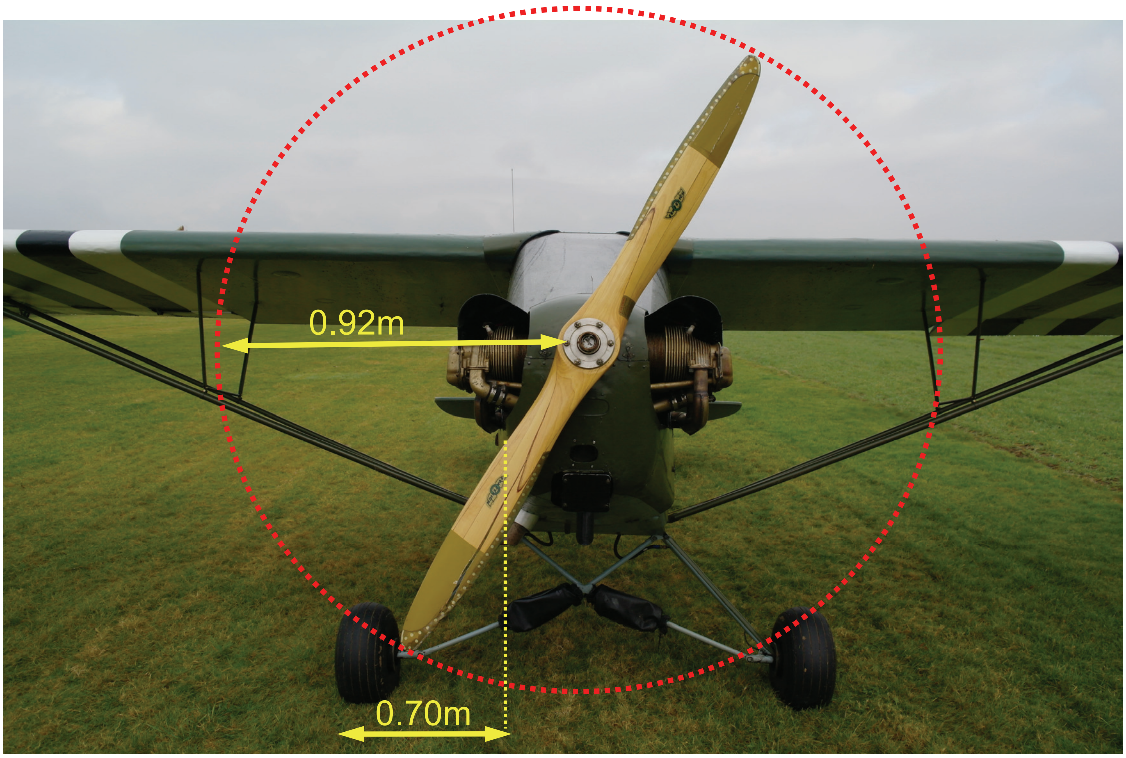


**Figure 1**

Aircraft front elevation

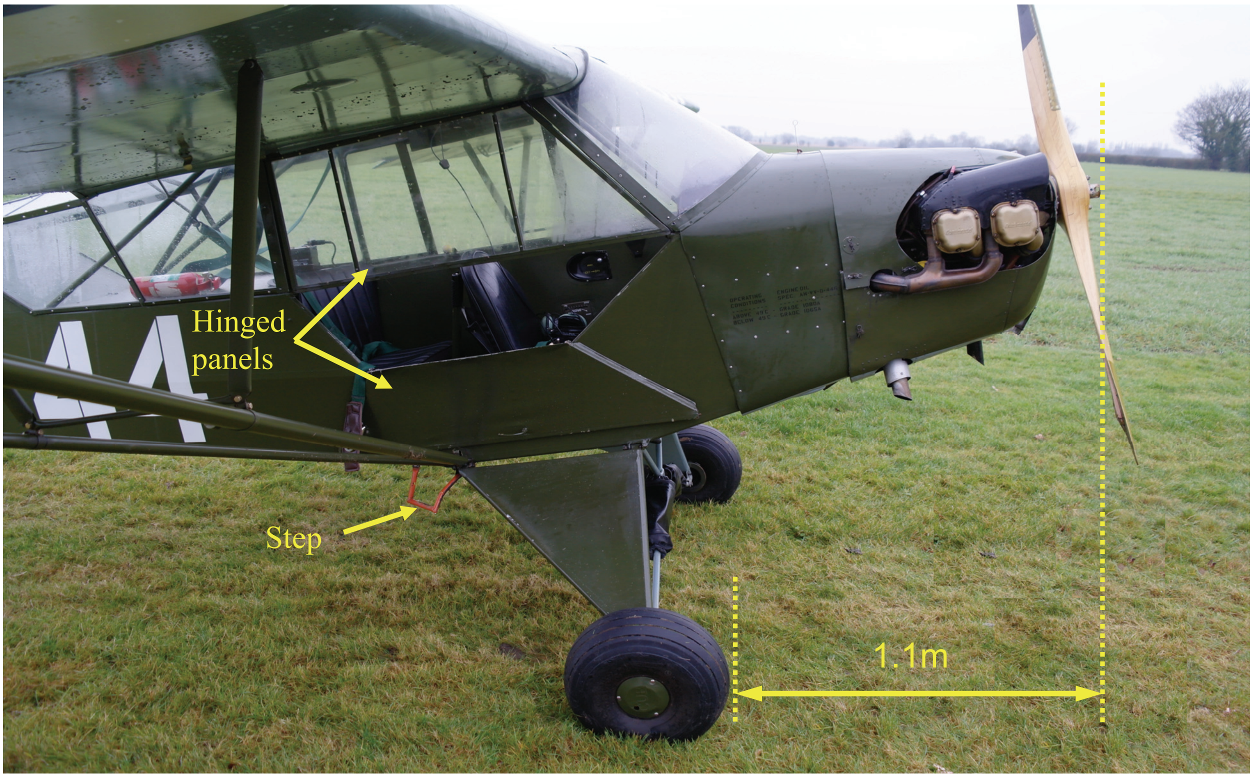


**Figure 2**

Aircraft side elevation

The aircraft has a tailwheel configuration, with a high wing supported by two lift struts per wing. The struts extend from the bottom of the fuselage, below the mid-point of the cockpit, outboard to the underside of the wing. There are two seats in a tandem configuration. If operated solo, due to centre of gravity limitations, the pilot occupies the rear seat. It is therefore normal for the instructor or coach to occupy the front seat during training.

The aircraft is not equipped with a conventional door, but has two horizontally hinged panels on the right side of the fuselage; one opening upwards and one downwards, to allow access to the cockpit (Figure 2). There is a step just to the rear of where the wing struts attach to the fuselage. This step is used to assist in climbing into the aircraft. The step is awkward to use for occupants exiting from the front seat, as it is located well to the rear and is out of sight when manoeuvring backwards over the struts. The struts are not intended, nor permitted, to be used as a step. As a result, some front seat occupants find it easier to exit the aircraft by stepping out forwards onto the ground directly next to the seat, using the tyre as a step, which places them in front of the wing struts and close to the propeller.

**Pathology**

The post-mortem findings and the damage to the propeller indicate that the coach was struck once on the head by the propeller. The injuries sustained were consistent with the coach having had his head down to some extent at the time this happened. The coach had no apparent medical conditions which may have contributed to the accident.

**Coach's background**

The LAA coach was 67 years old and had had formerly been a pilot in the RAF for thirty years. On leaving the RAF he had flown as an airline pilot until his retirement. His logbook recorded he had flown 14,709 hours at the time of the accident.

He was a respected and experienced coach with the LAA and had flown a large number of different types of light aircraft.

**Previous incidents**

A review of reported accidents involving propellers reveals that since 1991 there have been a total of 15 involving light aircraft. Of these, 10 occurred whilst attempting to start the engine by hand-swinging the propeller. A further five occurred when disembarking passengers or ground personnel were hit by rotating propellers.

**Analysis**

Witness evidence indicates the coach stepped, rather than tripped or stumbled, into the path of the propeller. The evidence shows that the coach was wearing his headset; this would have reduced his ability to hear the noise of the engine and propeller. In addition, the wind buffet from the propeller at idle is reportedly not particularly strong. Whilst the propeller had tips in a different colour, the colour used might not have presented an obvious visual cue to the presence of the rotating propeller.

**Safety action**

As a result of this accident, opinion was sought on whether the engine should be left running whilst embarking and disembarking on this and other similarly configured types of aircraft. Whilst there are hazards in leaving the engine running, it was considered equally hazardous having to hand-swing the propeller in order to restart an engine, especially when it is hot.

The LAA already includes instruction on hand-swinging propellers to its coaches as part of their training. They now propose to broaden the scope of this training to include the additional dangers posed by propellers whilst entering and leaving aircraft.

Finally, this accident illustrates the value of the procedure used by some pilots of following a path along the edge of the wing to ensure clearance from the propeller when vacating or approaching such aircraft.

**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | Piper PA-28-181, Cherokee Archer II, G-BXRG |
| **No & Type of Engines:** | 1 Lycoming O-360-A4M piston engine |
| **Year of Manufacture:** | 1978 |
| **Date & Time (UTC):** | 12 November 2011 at about 1527 hrs |
| **Location:** | 27 nm west-north-west of Alderney |
| **Type of Flight:** | Private |
| **Persons on Board:** | Crew - 1 Passengers - 1 |
| **Injuries:** | Crew - 1 (Fatal) Passengers - 1(Minor) |
| **Nature of Damage:** | Aircraft lost at sea |
| **Commander's Licence:** | National Private Pilot's Licence |
| **Commander's Age:** | 79 years |
| **Commander's Flying Experience:** | 150 hours estimated (all were on type)<br>Last 90 days - 3:30 hours<br>Last 28 days - 1:20 hours |
| **Information Source:** | AAIB Field Investigation |

**Synopsis**

The aircraft suffered a loss of electrical power during a day crossing of the English Channel to Alderney. The pilot became uncertain of his position and elected to ditch the aircraft near to a commercial surface vessel. The ditching was successful and the passenger escaped from the aircraft and was subsequently rescued. However, the pilot was unable to escape from the aircraft before it sank.

**History of the flight**

On the morning of Wednesday 9 November 2011 the pilot flew G-BXRG from Alderney, where the aircraft was based, to Lee-on-Solent Airfield on the English south coast. He was accompanied by his wife. The couple then travelled by car to Cheshire where they planned to remain before making the return trip to Alderney three days later. There were no reported problems affecting the aircraft before or during the outbound flight.

The pilot and his wife retired early on the Friday evening and rose at 0430 hrs on the Saturday (12 November 2011) for the return drive to Lee-on-Solent, arriving there about 1100 hrs. After checking the weather and phoning a pilot friend on Alderney, it was apparent to the pilot that the Channel Islands were affected by fog and takeoff would have to be delayed to await an improvement.

Eventually the weather cleared and the aircraft departed Lee-on-Solent at 1418 hrs. The flight plan filed on behalf of the pilot gave an expected flight time of 50 minutes, with a fuel endurance of three hours. After takeoff, the pilot made a brief radio call and announced his intention to change to an en-route frequency, though he did not state which. Enquiries with likely ATC agencies revealed that the pilot did not contact any of them which, as the flight was planned to remain outside controlled airspace until approaching the Channel Islands, was not mandatory.

The aircraft's flight plan route to Alderney was via the reporting point at ORTAC, situated on the north-eastern edge of the Channel Islands Control Zone (Figure 1, showing the track of the accident flight on 12 November).

Normal procedures required that the pilot contact Jersey ATC when 10 minutes from ORTAC, to receive clearance into the zone. When nothing was heard from the aircraft at the expected time, Guernsey ATC[1] became concerned and contacted Jersey ATC to enquire about the aircraft with a view to starting overdue tracing action.

At about this time, an aircraft was observed on radar to the north of the zone, tracking approximately south-west. It was returning a transponder code of 7000 but with no altitude reporting. Although there was a suspicion that this aircraft was G-BXRG (based on timing), it was outside the zone and some considerable distance from

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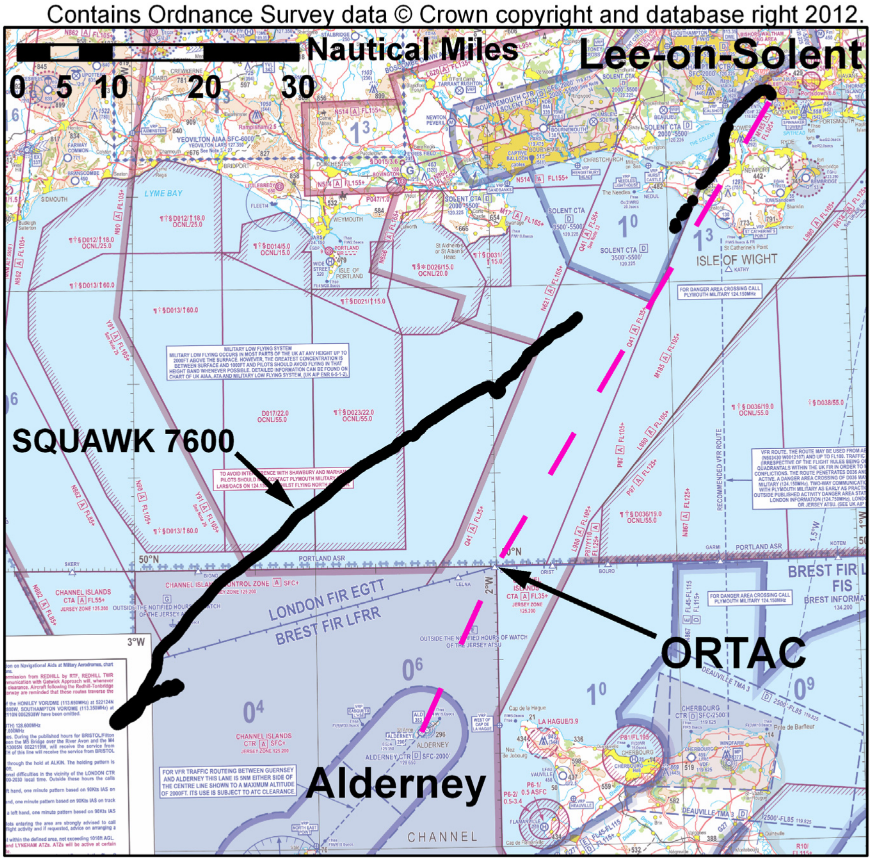


**Figure 1**

Radar derived plot of G-BXRG's track in black (accident flight, 12 November 2011), with expected routing via ORTAC in pink

**Footnote**

1 Guernsey ATC was responsible for the airspace immediately around Guernsey and Alderney, and would have been expecting to handle the aircraft as it approached Alderney.

G-BXRG's expected route. The track could equally have been routine VFR traffic, such as a fisheries protection aircraft. Guernsey ATC made radio broadcasts in an effort to contact G-BXRG or the unknown (at that stage) aircraft, but these went unanswered.

The unknown track then displayed a 'radio fail' squawk (7600), indicating that the radio failure code had been selected on the aircraft's transponder. The aircraft, now believed to be G-BXRG (although still not confirmed) continued initially on a non-deviating track which was taking it some 25 nm to the north west of Guernsey and Alderney. Then the aircraft's track started to deviate left and right before, at about 32 nm west of Alderney, it flew a 180° turn to the right and flew back in the direction it had come from. During this manoeuvring, the aircraft's transponder returns ceased. The aircraft disappeared from ATC radar displays shortly afterwards.

## Search and Rescue (SAR)

*Operations*

Guernsey ATC initiated its 'aircraft accident at sea' procedures. Coincident with this, the Channel Islands Coastguard received notification from their French counterparts of a 'Mayday Relay' message on the maritime distress channel from a commercial vessel, which stated that a light aircraft had been seen to ditch into the sea[2]. This message was timed at 1527 hrs. The master of the ship later stated that the aircraft circled the vessel several times before ditching about 100 m astern of it, on a similar course of about 070°. It appeared that the propeller stopped rotating shortly before the aircraft contacted the sea surface.

Lifeboats from Guernsey and Alderney went to the scene, and a French SAR helicopter was launched. Guernsey ATC requested the aid of a Piper PA-28 aircraft in their visual circuit, which was vectored to the scene. Additionally, a purpose-equipped SAR Islander aircraft was scrambled from Guernsey.

The commercial vessel returned to the site of the ditching and deployed a small launch. As this was happening, the crew of the PA-28 circled the scene and saw what appeared to be a square of fluorescent material floating in the water. The crew of the launch found a sole survivor, the pilot's wife, whom they lifted into the launch. She was then winched aboard the SAR helicopter and taken to Cherbourg hospital, where she was found to be suffering from hypothermia but otherwise with no significant injuries.

The search for the missing pilot continued. Although the lifeboats and Islander aircraft were stood down later that evening, the search was continued through the night by a Royal Navy warship and a French salvage vessel which had joined the operation. However, no trace of the pilot was found and the only piece of wreckage recovered was one of the main landing gear wheels.

According to one of the lifeboat crews, there was a long rolling sea swell at the time, with a height of about 5 ft.

*Survival equipment*

A four-person liferaft, weighing 9.5 kg (21 lb), was carried in the cabin on the floor behind the front seats of the aircraft. The instructions for inflation stated that the inflation handle should be peeled from its Velcro retaining strip, grasped firmly and then, after pulling out approximately 3 feet of slack lanyard, be pulled firmly for inflation.

A manually-activated Personal Locator Beacon (PLB) was carried in the front passenger side pocket but was not used.

**Footnote**

2 The area of ditching was just outside radio range of Guernsey Coastguard.

The pilot and passenger were both wearing their own Aircrew Slim-fit manually-activated lifejackets. The passenger's lifejacket successfully inflated.

**Passenger's account**

*Pre-flight preparation and initial flight phase – accident flight, 12 November*

The pilot's wife had flown with her husband on a number of occasions, including on cross-channel flights. Although she had not received any formal aviation training, she was aware of the general purpose and principles of operation of the aircraft radios and transponder and, to a limited extent, the GPS navigation display.

She recalled that the pilot's pre-flight actions seemed normal, and that he used printed checklists, which was his usual practice. The weather in the Solent area was fine after takeoff, with good visibility. The pilot made the radio call to Lee-on-Solent, but made no further radio calls at that stage. She described the height at which the aircraft flew as "typical" (radar information from the outbound flight on 9 November showed a typical cruise altitude of 1,200 ft amsl).

The pilot had a photocopied chart with flight details on it, whilst his wife held a chart with a line drawn on it; she recalled the figures "212" on the chart, which she assumed was the heading, though she was not aware of any timing markings[3]. She thought the pilot's photocopy included timings but he had previously explained that the times marked could be in error if there was a significant wind affecting the flight. She was used to seeing the desired track displayed as a pink line on the Garmin GNS 430 combined Communication / GPS display (Figure 2), and was aware that, if the aircraft symbol was on the pink line, then it was correctly on track. She later recalled that on the accident flight she saw the aircraft on the pink line during the initial stages of the flight over the Channel.


**Figure 2**

Detail of G-BXRG's instrument panel, showing a typical navigation display (with white aircraft symbol and the pink track line). Communications/navigation control panels radios are above and transponder panel below

*In-flight failures*

The pilot discussed with his wife the need to call Jersey ATC when 10 minutes from the zone boundary. She thought the aircraft had reached about that point when she first noticed anything unusual. The aircraft had drifted a little to the right of the pink track line on the GPS display, and she mentioned this to the pilot. Not long afterwards, the display reverted to one displaying only the maker's name, "Garmin". At the same time, she noticed all the illuminated digits in the communications / navigation control panels extinguish. However, she also recalled seeing the digits "7000" still illuminated on the transponder display[4].

**Footnote**

[3] The figures '212' are consistent with the required track (or still-air heading) to ORTAC.

**Footnote**

[4] The transponder was a Garmin GTX 328 unit.

The "Garmin" legend on the GNS 430 subsequently extinguished and, although the pilot made some switching selections in an apparent attempt to restore power, the display remained blank. He did not appear overly concerned and seemed to treat the malfunction as a temporary event at first.

Up to this stage the weather had been clear but now the aircraft encountered low cloud ahead and the pilot climbed the aircraft above it, such that his wife recalled being in clear weather again and looking down at the cloud tops. The pilot attempted to make radio calls but did not receive a response. He referred to a checklist, and set the transponder code to 7600, the radio fail code. In answer to a question from his wife about what they would do, the pilot responded with an assuring remark, indicating that he still had the compass (his wife recalled him gesturing in a manner to indicate he was referring to the compass atop the instrument coaming).

At a later stage, the pilot descended the aircraft through the cloud, telling his wife that they would need to do so if they were to see Alderney. However, the visibility was "not very good" below cloud and there was no sign of Alderney ahead. The pilot made a remark questioning where Alderney was, saying that they should have sighted it by that time.

*Ditching, egress and rescue*

After some time the pilot remarked that they would run out of fuel eventually and said he might have to ditch the aircraft. Several large ships had been seen in the Channel shipping lanes, and the pilot turned the aircraft back in order to find a ship next to which they could ditch. A ship was sighted and the pilot started circling it. He told his wife that the aircraft would sink after ditching, and reached back to bring forward the liferaft which he placed on his wife's lap. Both the pilot and his wife were already wearing their own lifejackets.

The pilot's wife recalled little about the ditching itself. The cabin door (there was only one, on the passenger's side) was opened after ditching by the pilot and the aircraft began to fill with water. The pilot assisted his wife to unbuckle her seatbelt and she left the aircraft with the liferaft. She was not aware that her husband had suffered any injury during the ditching and he said nothing to that effect. She believed that he had unfastened his own seatbelt, and was attempting to exit, but was hindered for some reason. She did not know what the problem had been, but thought he may have become entangled in something, possibly his headset lead.

The pilot was unable to exit the aircraft, which quickly filled with water and sank. His wife did not recall how to operate the liferaft, so unzipped the valise and extracted it. As she did not pull the activation lanyard, the liferaft came out of its valise uninflated and remained so. Aware that its bright colouring would assist rescuers, she kept hold of it, along with the aircraft wheel which she found floating beside her. She became aware of the ship approaching, an aircraft circling overhead and being recovered from the water into a small launch. She had become very cold and had only intermittent recollection of subsequent events.

**Meteorological information**

The Met Office's aviation forecast issued at 0855 hrs (which would have been available to the pilot at Lee-on-Solent) showed a band of weak frontal weather across the area. At 1200 hrs, this would stretch from south-east England across the Channel to northern France and the Channel Islands, moving slowly eastwards (Figure 3). Within the frontal area, the forecast visibility was generally 12 km, but reducing to

3,000 m in mist or light rain and drizzle. Occasional scattered or broken low level stratus cloud was forecast between 200 ft and 1,500 ft, with further broken or overcast cloud layers above.

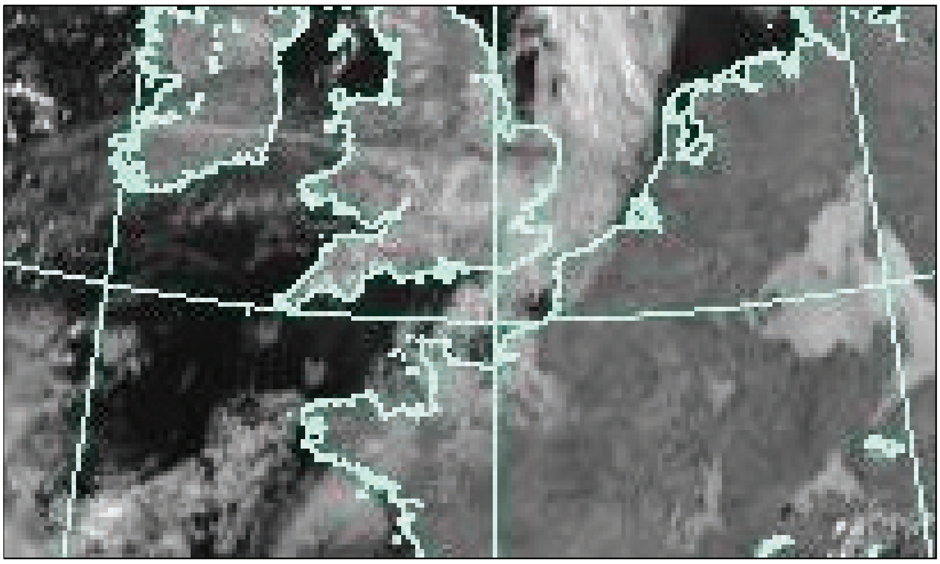

**Figure 3**

Visible-spectrum satellite image, taken at 1200 hrs

The orientation of the frontal feature was such that it would clear the Lee-on-Solent area before it cleared the Channel Islands. The area behind, which was forecast to include Lee-on-Solent from about 1200 hrs onwards, showed a greatly improved general visibility of 40 km, although with isolated areas down to about 7 km in rain showers. Scattered or broken cloud was expected in this area with a base of about 2-3,000 ft. The winds over the Channel at 2,000 ft were forecast to be from about 150° at 15 kt.

The pilots of the PA-28 and Islander aircraft, which were on-scene shortly after the ditching, were later asked for their assessment of the weather conditions. Their estimates of visibility varied from 6 to 10 km, with both pilots remarking that it was a little hazy, although quite acceptable for visual flight manoeuvring. There were only occasional and very small amounts of cloud.

**Pilot information**

The pilot started flying training in July 1999. He trained mostly on G-BXRG, a syndicate aircraft, in Alderney and it was the only aircraft he had flown in the last few years. His training was characterised by short periods of relatively intense flying interspersed by quite long periods of no flying. Periods of flying varied between one month and six months in duration, while the periods in between varied between eight months and three years, with an average of about 18 months.

In July 2008 the pilot's training programme was amended to align with the requirements of the National Private Pilot's Licence (NPPL). This was necessary after he underwent a medical procedure which prevented him from obtaining the required medical category for the full Private Pilot's Licence (PPL)[5].

In May 2010, following a break from flying of one year and ten months, the pilot commenced flying training again and, on 8 August 2010 passed the skill test for grant of an NPPL. His training records in Alderney showed that he had accumulated 102:05 hrs flying time at this point, of which 9:15 hrs were solo. He flew a further 3 hours during the remainder of 2010. The pilot is believed to have flown an additional 25 hours (approximately) at a flying school in England some years earlier, although these were not recorded on his training records in Alderney.

**Footnote**

[5] The medical requirements for a NPPL are less onerous than for a JAR-FCL licence, being equivalent to the DVLA group 2 standard, applicable to drivers of large lorries and buses. A declaration of fitness must be endorsed by an applicant's General Practitioner, who must have access to the applicant's medical records.

According to the aircraft operating group's records, the pilot had flown 18:45 hrs during 2011 up to the date of the accident flight. Before embarking on the flight to Lee-on-Solent, he had flown six return trips cross-Channel during 2011. These were from Alderney to Sandown on the Isle of Wight, Exeter (twice), Lee-on-Solent (in July) and Perranporth. The pilot's wife had accompanied him on some of these flights.

The pilot had flown with the Garmin GNS 430 equipment whilst training; the group's training records showed that he received introductory training in its use on 5 August 2010, the same day as his qualifying cross-country flight and three days prior to his NPPL skill test.

*Medical issues*

The pilot was generally considered fit and active with no significant current health issues. Although he had undergone the medical procedure which precluded him being issued further Class Two medical certificates by the UK CAA, he had been able to meet the medical requirements for issue and upkeep of an NPPL.

Being over 65 years of age, the pilot's NPPL medical declaration was valid for one year. Medical records showed that the pilot's GP had last countersigned a medical declaration in July 2010, which would thus have been valid to July 2011. Holders of NPPLs are required to forward a copy of completed medical declarations to the appropriate National PPL administrative body (in this case, the National Pilots' Licensing Group Limited (NPLG Ltd)). Enquiries of NPLG Ltd revealed that the pilot had sent them a copy of his July 2010 declaration. However, no further copies had been received so it is probable that the pilot did not hold a valid medical declaration at the time of the accident.

In March 2011, the pilot passed a medical examination in France for a DGAC[6] Class Two certificate, to allow him to fly to and from French airfields. In the UK, the CAA recognises DGAC Class One certificates, but not Class Two. Thus, although the pilot's DGAC medical certificate was current at the time of the accident, it was not itself valid for licensing purposes for flights in UK airspace.

**Aircraft and systems description**

*General*

The PA-28-181 Cherokee is a four-seat, low-wing monoplane aircraft powered by a 180 hp piston engine. It has dual flying controls that are connected to the flying surfaces by a series of cables and pulleys, and three-position flaps, manually operated by a lever situated between the front seats. The aircraft has a fixed landing gear.

Entry and exit from the cabin is through a door situated on the right side, secured by two latches. The front seats are adjustable fore and aft and are fitted with a three-point harness consisting of a lap belt and shoulder strap. The male portion of the lap belt buckle engages with the female portion of the buckle, which is mounted on a strap secured to the floor between the front seats. The shoulder strap incorporates an inertia reel which is connected to the aircraft structure, just above the side window. The shoulder strap is routed over the shoulder adjacent to the windows and attaches to the lap belt buckle, in the area of the occupant's inboard hip, by a spigot and slot arrangement (Figure 4).

In order for a front seat occupant to exit the aircraft, both door latches must be moved to the OPEN position

**Footnote**

[6] Direction Generalle de L'Aviation Civille, the French civil aviation authority.

and the lap belt quick release buckle must be released. The occupant can then either disengage the shoulder strap from the spigot on the lap belt buckle, or remove the arm from between the shoulder strap and lap belt.

*Engine*

The engine is equipped with two engine-driven magnetos and a mechanical fuel pump. Once the engine has started it will continue to operate independent of the aircraft electrical system.

*Fuel system*

The aircraft is fitted with two 91-litre (24 US gallons) fuel tanks, one mounted in each wing. A three-position fuel selector valve is located on the left side of the cockpit, forward of the pilot's seat, which allows the pilot to select the left tank, right tank or OFF position. An electrical fuel pump can be used, in the event of a failure of the engine-driven mechanical fuel pump, to provide fuel to the engine. Two fuel gauges, one for each fuel tank, are mounted at the bottom of the instrument panel in front of the pilot. In addition, a metal 'tab' is mounted below the refuelling cap in each fuel tank to provide a visual indication, on the ground, when the quantity of the fuel in the tank is at 64 litres.

*Electrical system*

The electrical system in G-BXRG included a 14V 60-amp alternator, a 12V battery with a 1-hour rate of 23 amps, a voltage regulator, an over-voltage relay and a battery master switch relay. The battery and alternator are both connected to the aircraft busbar from which electrical power is provided, through circuit breakers (CBs), to the aircraft and avionic systems. The CBs are located at the bottom of the instrument panel in front of the passenger and the battery and alternator are controlled by red switches mounted on the centre instrument panel. Figure 5 shows the switches fitted to another PA-28-181. The passenger believed that these switches had both been in the ON position during the accident flight.

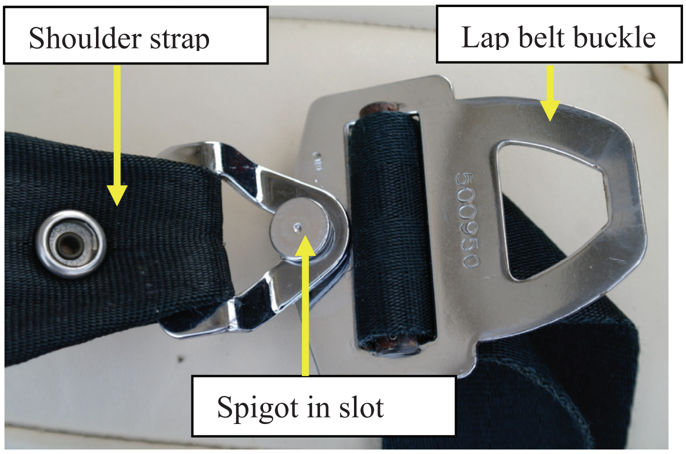


**Figure 4**

Seat belt buckle

An ammeter, located at the bottom of the pilot's instrument panel, displays the load, in amps, placed on the alternator (Figure 6). An annunciator panel above the pilot's primary instruments contains an amber 'ALT' warning caption which illuminates when the current from the alternator falls to zero amps. A non-flashing red 'Low Voltage' warning lamp, located on the left side of the instrument panel, operates when the voltage of the aircraft electrical system falls below 12.5 to 13 volts.

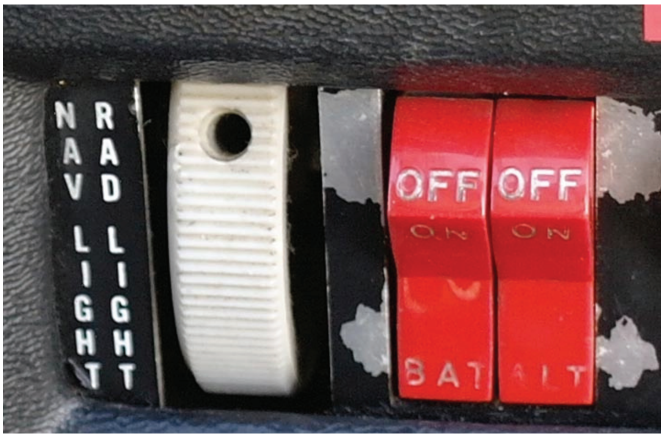


**Figure 5**

Battery master and alternator switches (red)

*Avionics and flying instruments*

In addition to the standard primary flying instruments that are operated by the pitot static pressure system, G-BXRG was also equipped with a magnetic compass and the electrical and vacuum-driven instruments detailed in Table 1.

In the event of a loss of electrical power, the pilot would still be able to operate, and navigate, the aircraft in day VMC conditions using the pitot-static instruments and the directional (DG) and attitude gyro indicators. The heading on a DG drifts over time and needs to be routinely realigned with reference to the magnetic compass.

**Compass deviation**

A magnetic compass mounted in an aeroplane is affected by the magnetic fields created by the aircraft, which includes those produced by the electrical circuits. The error from these fields is called 'deviation' and is corrected by the use of compensating magnets and the


**Figure 6**

Pilot's instrument panel on G-BXRG

| Equipment | Electrically operated |
|---|---|
| Directional gyro (DG) | No (engine-driven vacuum pump) |
| Radio / Nav (one) | Yes |
| Combined GPS/Radio/Nav | Yes |
| Attitude gyro indicator | No (engine-driven vacuum pump) |
| Turn indicator | Yes |
| Transponder | Yes |
| VORs (two indicators) | Yes |
| DME | Yes |
| ADF | Yes |

**Table 1**

Electrical and vacuum-driven instruments

use of a compass deviation card placed adjacent to the compass. In establishing and correcting the deviation the aircraft compass is 'swung' with the engine running and the electrical system switched on.

Following this accident the AAIB recorded the deviation on a similar equipped PA-28-181 and the magnetic compass aligned with the following headings when the electrical alternator was selected ON and OFF (Table 2).

**Low voltage warning system**

Civil Air Publication (CAP) 747[7] recommends that for a 12 volt dc system a red 'Low Voltage' warning light should operate when the voltage drops below 12.5V to 13V. The battery duration should be sufficient to make a safe landing and should not be less than 30 minutes, subject to the prompt completion of any drills. Moreover, this duration need only be a reasonable estimate and not necessarily calculated by a detailed load analysis. When making this estimate, only 75% of the battery nameplate capacity should be considered as available.

The Flight Manual for G-BXRG contained supplementary information requiring that, if the 'Low Voltage' warning light illuminates in flight, the pilot should reduce electrical load and land as soon as possible as the battery duration would be approximately 40 minutes.

| | Indicated Heading | | | |
|---|---|---|---|---|
| **Alternator ON** | 000 | 090 | 180 | 270 |
| **Alternator OFF** | 012 | 085 | 168 | 278 |

**Table 2**

Compass deviation with Alternator selected ON and OFF (similar PA-28-181)

**Footnote**

7 CAP 747, Section 2, Part 3, GR No 6 and CAA Airworthiness Notice 88.

**Electrical load analysis**

The investigation was unable to obtain an electrical load analysis for G-BXRG; therefore a load analysis was undertaken by measuring the current draw on three similarly equipped PA-28-181 aircraft. The results of the tests are included in Table 3.

**Fuel calculations**

The aircraft was last refuelled at Guernsey on 8 November 2011, after which it made a short flight to Alderney and did not fly again until the flight to Lee-on-Solent on 9 November. The investigation established that, when the aircraft departed Alderney on the outbound flight, the fuel level was at 'tabs', which is approximately 128 litres. From the fuel consumption figures in the Aircraft Flight Manual, it was estimated that there would have been approximately 54 litres (46 litres useable) of fuel on the aircraft when it ditched. This equated to about 70 minutes flying time at normal cruise power setting, or about 110 minutes at endurance power setting.

**Recorded information**

*Radar data*

Recorded track information for the outbound flight to Lee-on-Solent (9 November 2011) and the accident flight (12 November) were available for analysis. The outbound flight was captured by a combination of the Jersey and Pease Pottage (near Gatwick) Secondary Surveillance Radar (SSR) heads. Their respective ranges were insufficient to capture the complete route but they overlapped south of the Isle of Wight. Mode C[8] altitude returns showed an average cruise altitude over the Channel of 1,200 ft amsl. Gaps in the radar coverage along the route were noted and were probably due to the aircraft's altitude.

The outbound track (9 November) contained two anomalies (Figure 7). The first occurred immediately after departure from Alderney with the aircraft not tracking towards ORTAC as planned, and this was resolved through discussion between ATC and the pilot. The second concerned the en-route phase in which the aircraft did not follow the standard route to ORTAC and subsequently tracked south of the direct track for Lee-on-Solent before turning for the airfield as the aircraft neared the Isle of Wight.

| Aircraft electrical status | Battery duration at 90% capacity | Battery duration at 75 % capacity |
|---|---|---|
| All equipment switched on. Transmit for 3 minutes on Com 1. | 36 minutes | 33 minutes |
| All equipment switched on except for the pitot heater and fuel pump. Transmit for 3 minutes on Com 1. | 54 minutes | 45 minutes |
| Battery master and Com /Nav 1 switched on. Transmit for 3 minutes on Com 1. | 199 minutes | 166 minutes |

**Table 3**

Electrical load analysis

**Footnote**

[8] Mode C transmission is selectable by the pilot.

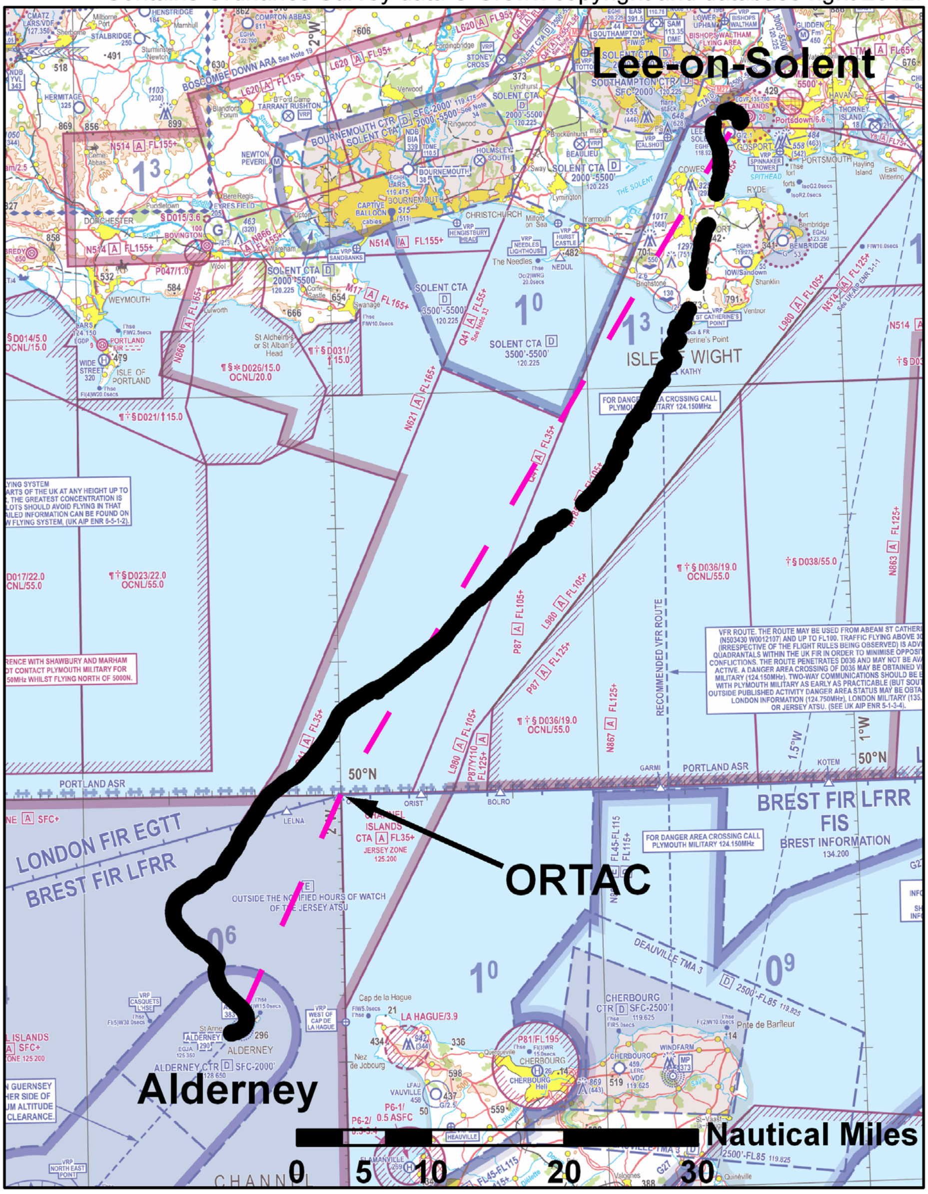


**Figure 7**

Radar derived track in black showing flight to Lee-on-Solent on 9 November 2011.
Flight plan route shown by broken pink line

The whole recorded track of the accident flight (12 November) is at Figure 1. The track was again recorded by Pease Pottage and Jersey SSR heads, but no Mode C altitude information was recorded. Gaps in the track again suggest that some of the flight was flown at similar, or lower, altitudes to that of the outbound flight. The final portion of the track was only recorded by the Guernsey Primary Surveillance Radar (PSR) head since the Jersey radar head's view of the aircraft at low altitude would have been obscured by Guernsey. The secondary radar returns ceased at 15:16:34 hrs, whilst the primary radar returns continued intermittently, showing the aircraft making a series of orbits centred about a point moving slowly north-east. These returns ceased at 15:27:38 hrs, within 4 nm of the reported ditching position. Based on the reported radar coverage in the area, the aircraft altitude would have been about 600 feet when it ceased to be detected by the Jersey SSR.

The initial portion of the accident flight is shown at Figure 8. The initial tracking out of Lee-on-Solent is as described by the pilot's wife, with a significant track adjustment occurring over the Isle of Wight. However, the aircraft then appeared to establish on a track which deviated to the right of the track for ORTAC. The track anomaly at 14:45 hrs occurred 20 nm north of ORTAC which, had the aircraft been tracking towards ORTAC, would have equated to the point where an initial call to Jersey ATC was required (ie 10 minutes from ORTAC). The pilot's wife thought that the anomaly was most probably due to inadvertent turning which occurred as the pilot was attempting to resolve his initial problem with the GPS display.

*Radiotelephony information*

Recordings of all relevant frequencies and landlines were available for analysis. Of note was an exchange between Jersey ATC and the pilot shortly after takeoff outbound from Alderney on 9 November. On observing the track discrepancy, the controller queried the pilot's intentions. After a delay, the pilot replied "JERSEY G-BXRG SORRY I HAD A LITTLE TROUBLE WITH THE GARMIN I'VE JUST SORTED IT OUT". The aircraft then turned right onto a more appropriate track (ie towards ORTAC – about 14 nm away) which it maintained for about 4 nm.



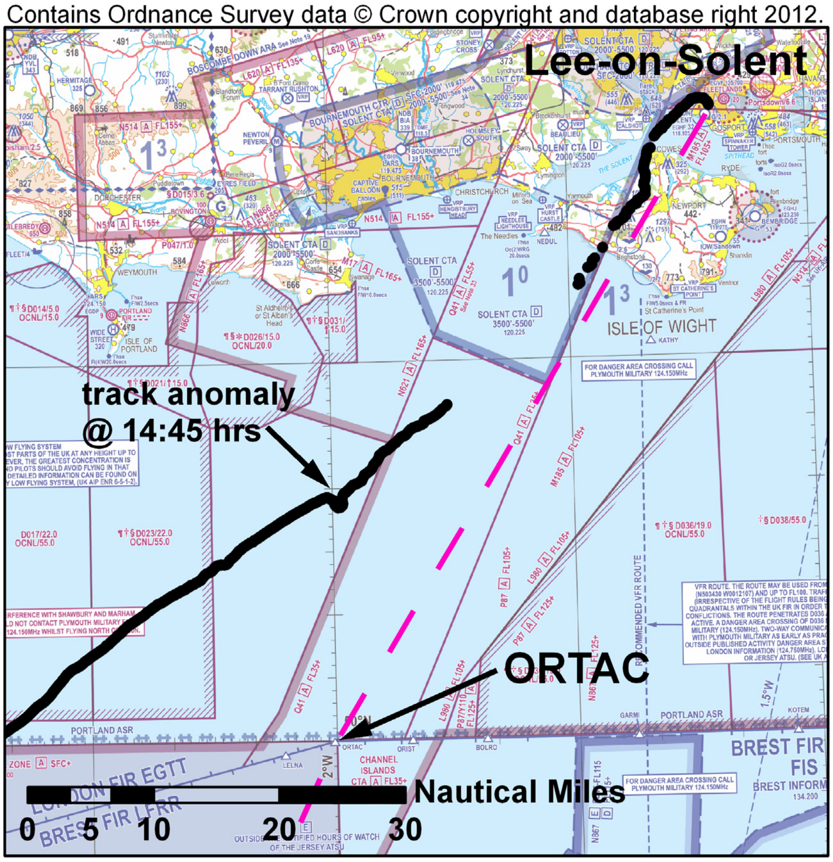


**Figure 8**

Initial portion of accident flight, showing departure from Lee-on-Solent and tracking anomaly. Flight plan course for ORTAC is highlighted in pink

**Analysis**

*Aircraft status*

The aircraft had been recently maintained, had no significant fault history and there had been no recent reports of technical problems. The pilot made no mention of technical problems with the aircraft after he landed at Lee-on-Solent and the available evidence indicates that the engine operated normally throughout both the outbound and accident flights. The witness report that the propeller stopped rotating immediately before the aircraft ditched is consistent with a deliberate action by the pilot.

*Electrical failures*

It was evident from the passenger's account that there had been problems with the electrical and navigation equipment during the accident flight. The passenger was familiar with some of the avionic equipment and later recalled the transponder, radios and GPS being selected ON and operating during the early part of the flight. This is supported by the transmission of the transponder code 7000 and the radio call the pilot made to Lee-on-Solent shortly after takeoff. The passenger's account of the GPS screen subsequently changing to the 'Garmin' start-up screen is consistent with a deterioration in the electrical power supply to the GPS/Com/Nav 2. The passenger's report that the GPS/Com/Nav 2 screen and the illuminated numbers on the Com/Nav 1 display then went blank indicates that full electrical power to these units had been lost. However, at this time the transponder was still transmitting, which indicates that there was still some electrical power at the busbar. The electrical power for GPS/Com/Nav 2 and Com/Nav 1 are provided from the busbar through independent circuit breakers, which meant that there was no common electrical path between the busbar and these units, and thus no single point of electrical power distribution downstream of the busbar. Therefore, the most likely explanation for the loss of power to GPS/Com/Nav 2 and Com/Nav 1 is that at some point during the flight the electrical output from the alternator was lost, leaving the battery to provide power to the busbar. As the battery discharged, its output voltage would decrease until the operating threshold for the different avionic units was reached and they would turn off. With the load on the battery reduced, the interaction between the electrolyte and the battery plates would result in a small recovery in the battery voltage, which might rise sufficiently above the operating threshold for some of the avionic units causing them to turn back on. However, the load would once again result in the voltage reducing and for units to switch off. This is the most likely reason why the passenger noticed that the GPS screen had changed to the start-up page before going blank. Eventually the battery voltage would reduce to a level where all the avionic and electrical equipment would no longer be able to operate. However, the pilot would still have been able to fly the aircraft using the magnetic compass, attitude indicator and primary flying instruments and the engine would continue to operate.

The 'Electrical load analysis' (Table 3) shows a predicted battery life of between 33 and 36 minutes, provided no actions are taken to reduce electrical load following a loss of alternator output. From the passenger's account, the initial onset of electrical problems can be linked to the track anomaly at 1445 hrs, or 27 minutes after takeoff. It is not known when the aircraft's engine was started, but an estimate of 5 to 10 minutes before takeoff is reasonable. This indicates that there had probably been no alternator output at all since the engine was started, or a point very early in the flight, either due to a failure or because the alternator was not selected ON. The passenger believed that the alternator had been selected ON, and that the pilot's use of checklists and usual diligent manner, would have resulted in him identifying an incorrect switch position prior to takeoff.

Loss of electrical power from the alternator would result in the amber 'ALT' warning lamp and the red, steady, Low Voltage Warning lamp illuminating. The ammeter would also lose power and the needle would move to the left stop on the gauge.

*Compass deviation*

The compass deviation would have been corrected, and the deviation card produced, using compass readings taken with the electrical system and equipment operating normally. With the alternator selected OFF, or not operating, the compass deviation would differ from when the electrical system was operating normally. A flight trial of another PA-28-181 determined that with the alternator selected ON and OFF the compass heading would vary by 12° on a southerly heading and 8° on a westerly heading. Therefore, if the pilot had used the compass either to steer the aircraft or align the Directional gyro (DG) after the electrical failure had occurred, then the actual heading could have been around 9° to the right of the desired heading.

*Navigation issues*

The information available suggests that the pilot was using the GPS as his primary navigation aid, and that it was functioning satisfactorily in the early stages of the accident flight. His wife reported seeing the aircraft symbol on the GPS track line before drifting slightly right of it, which suggests that the GPS track guidance may have been based on an erroneous destination. One possibility examined was that the selected destination was Brest Airport. Figure 9 shows the aircraft's track with a track to Brest overlaid. There is no evidence that the pilot had inadvertently selected Brest as a

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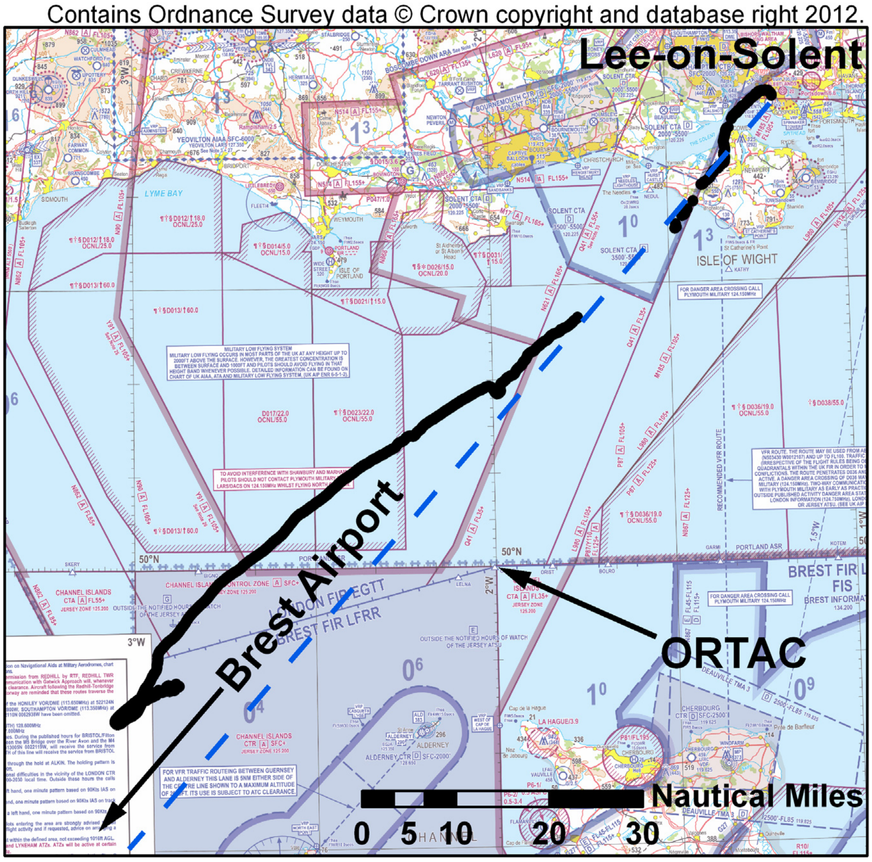



**Figure 9**

Accident flight with track for Brest Airport overlaid destination but such a scenario offers a good correlation with the pilot's wife's account of being on track initially before drifting slightly right of track shortly before the electrical problems occurred.

It is known that the track anomaly seen on departure from Alderney on the outbound flight (9 November 2011) was due to the pilot experiencing a problem with the GPS, which was established when ATC queried the routing. A possible explanation for the track error is that an incorrect GPS destination had been selected. Figure 10 shows the aircraft's actual track, with an overlaid track to Exeter Airport, to which the pilot had previously flown. This offers a possible explanation for the GPS-related problem on the outbound flight and supports the theory that incorrect GPS programming may also have occurred on the accident flight.

Once the aircraft had become established on its cross-Channel route on the accident flight, the opportunity for the pilot to identify a navigation error would be limited since, without ground features, only a cross-check of actual heading against planned heading or a check of position using shore-based radio navigation aids would have been likely to expose the error. It is uncertain whether the pilot carried out pre-flight planning for the wind conditions of the day which, if uncorrected, would have caused the aircraft to drift to the right of the desired track. If he did not suspect that he had made a GPS programming error, the pilot would have had no reason to doubt that he was on track for ORTAC, as the GPS display would have appeared to confirm.

Once the GPS had ceased operating, the pilot appears to have relied on visual navigation techniques. Even if shore-based radio navigation aids could still be received, there is no indication that the pilot had been using them on either flight. He did not appear concerned about navigation at this stage, so it is likely that his intention



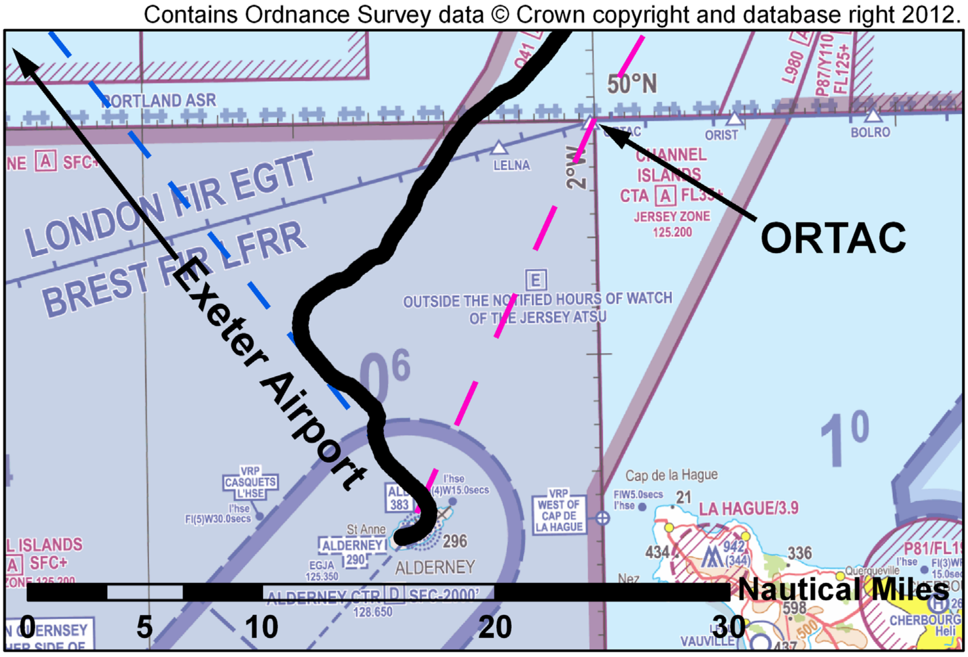



**Figure 10**

Navigation anomaly after takeoff from Alderney (9 November 2011), with direct track to Exeter overlaid was to hold an appropriate heading until such time as Alderney appeared ahead, as his comment and gesture to his wife seem to have confirmed. Even if drift due to the wind was not allowed for, it is likely this would have been a successful strategy since, had the aircraft actually been positioned correctly on track for ORTAC at the time the GPS was lost, the wind would have given a maximum track error of about 5 nm by the time the aircraft was approaching Alderney.

In fact, the aircraft's track deviated further to the right after the loss of the GPS. Up to this point the pilot would have only needed to fly a heading to satisfy the track requirement as demanded by the GPS, but afterwards the pilot would have to fly by heading only, which would need appropriate correction to allow for wind. The aircraft track observed after the GPS loss is consistent with what would result from the effect of the wind, combined with the compass deviation due to the electrical failure.

Weather conditions are likely to have contributed to the outcome. There had been a marked improvement in visibility in the Solent area and the fog in the Channel Islands had been reported as clearing, so it is probable the pilot initially expected to gain visual contact with Alderney relatively easily. This may account in part for his apparent lack of concern when the electrical problems first occurred. However, as Figure 3 shows, the frontal feature may not have fully cleared the area. As the pilot was forced to climb above the cloud, he would not have realised that Alderney was not where he expected it to be until he descended again, by which time Alderney would have been passing well to his left.

*Aircraft ditching*

Any analysis of the pilot's decision to ditch must observe that the aircraft did have sufficient fuel to remain airborne for a considerable time and that conventional techniques for dealing with uncertainty of position could have produced a course of action which would have stood a good chance of finding land, even if not an airfield initially. The decision to ditch was one which guaranteed loss of the aircraft and a high chance of injury or loss of life.

However, the pilot found himself in a confusing situation with apparently few options. His decision to follow a ship and ditch next to it would thus have been balanced against the option of remaining airborne and possibly finding himself in an even less favourable situation.

The ditching itself appears to have been well executed, giving both occupants the best chance of survival. The problem that prevented the pilot vacating the aircraft is not known. From his wife's account, it may have been a relatively simple problem, such as entanglement with headset or harness, which would normally be a minor hindrance but which, in the circumstances, cost vital seconds.

**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | Piper PA-28-151 Warrior, G-BCTF |
| **No & Type of Engines:** | 1 Lycoming O-320-E3D piston engine |
| **Year of Manufacture:** | 1974 (Serial no: 28-7515033) |
| **Date & Time (UTC):** | 25 March 2012 at 1225 hrs |
| **Location:** | Durham Tees Valley Airport, North Yorkshire |
| **Type of Flight:** | Training |
| **Persons on Board:** | Crew - 2 Passengers - None |
| **Injuries:** | Crew - None Passengers - N/A |
| **Nature of Damage:** | Right main landing gear leg separated from the wing |
| **Commander's Licence:** | Commercial Pilot's Licence |
| **Commander's Age:** | 79 years |
| **Commander's Flying Experience:** | 21,760 hours (of which 5,000 were on type)<br>Last 90 days - 40 hours<br>Last 28 days - 16 hours |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot and further investigation by the AAIB |

**Synopsis**

Following a normal landing the right main gear leg separated from its wing spar attachment. Two of the bolts which had secured the leg were found to have failed due to fatigue. The root cause of the fatigue failure could not be established.

**History of the flight**

The instructor and his student were carrying out takeoff and landing ('touch-and-go') practice using Runway 23. The wind was 8 kt from 200°. The student's first touch-and-go was normal, and the second touchdown was also normal. However, while the student applied power to take off again the instructor felt "a slight wobble" and immediately took control and closed the throttle. The right wing dropped towards the ground and the aircraft slewed to the right, coming to rest on the runway. After shutting down the engine and electrics they vacated the aircraft.

**Aircraft examination**

The right main landing gear leg was found to have separated from its wing spar attachment (Figure 1). After the aircraft was recovered it was examined by an engineering organisation. They determined that the landing gear leg had separated due to failure of the four upper screws and four lower bolts (items 1 and 6 in Figure 2) which secured the leg to the right wing main spar.

**Figure 1**

G-BCTF resting on its right wing (inset: close-up of separated gear leg with wing supported)

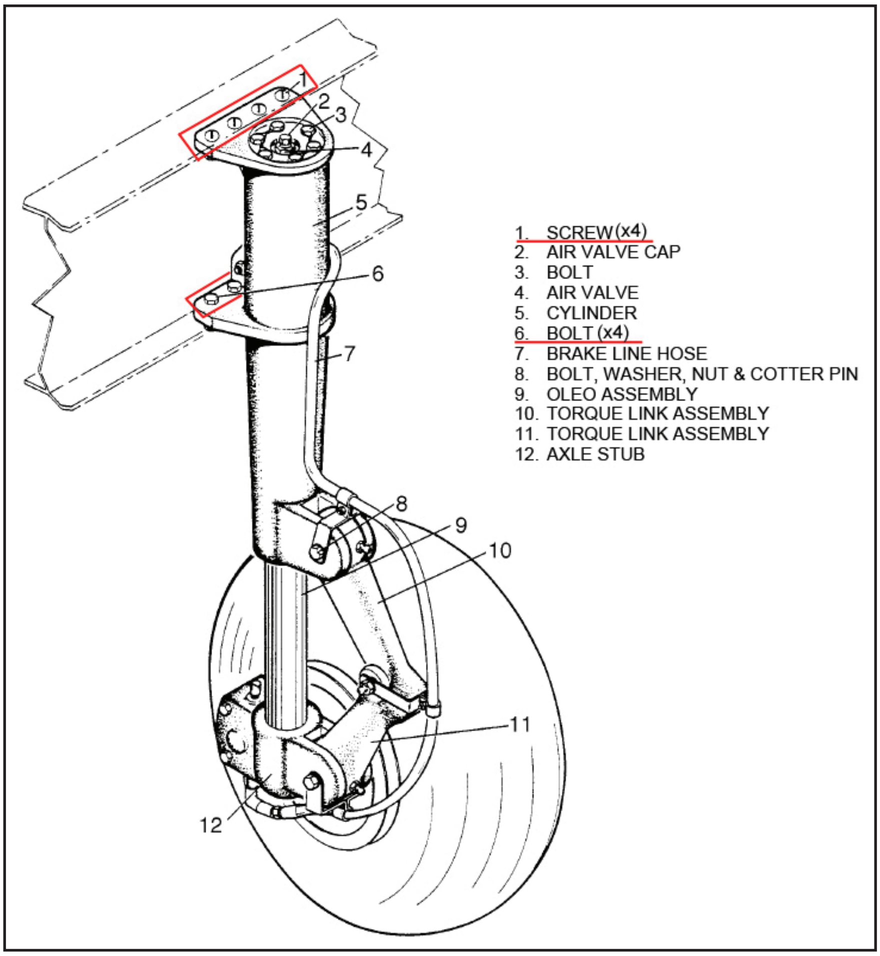



**Figure 2**

Diagram highlighting upper attachment screws and lower attachment bolts of the right main gear leg

Some of the failed parts were lost during the recovery. Three of the upper screws (AN525-416-R20) were recovered and were found to have failed in overload at the screw head. One lower bolt (AN4-11A) was recovered which had a corroded head and a fracture at its thread, but the fracture surface was smeared so it was not possible to determine its failure mechanism. Two further bolt/screw ends were recovered which had failed at the thread just above the nut (Figure 3). The AN4 bolts and the AN525 screws have the same 4/16" diameter and use the same nut in this location so it was not clear if these failed ends were from the upper or lower attachment, but as there are only four AN525 screws and three were already accounted for, one of these failed ends was part of a lower attachment bolt. Both of these bolt ends had a fracture surface consistent with a fatigue failure (Figure 4).

It was also evident that the nut on one of the bolt ends was not 'in safety' as there were no threads protruding beneath the nut (left nut in Figure 3).

**Figure 3**

Failed bolt ends that had evidence of fatigue on thread fracture surface

As part of the repair work the engineer decided to replace the attachment bolts on the left main gear leg as a precautionary measure. He recalled that one or two of the nuts on the lower attachment bolts were slightly loose by about half a turn. Unfortunately these bolts were not retained so they could not be measured for indications of stretch.

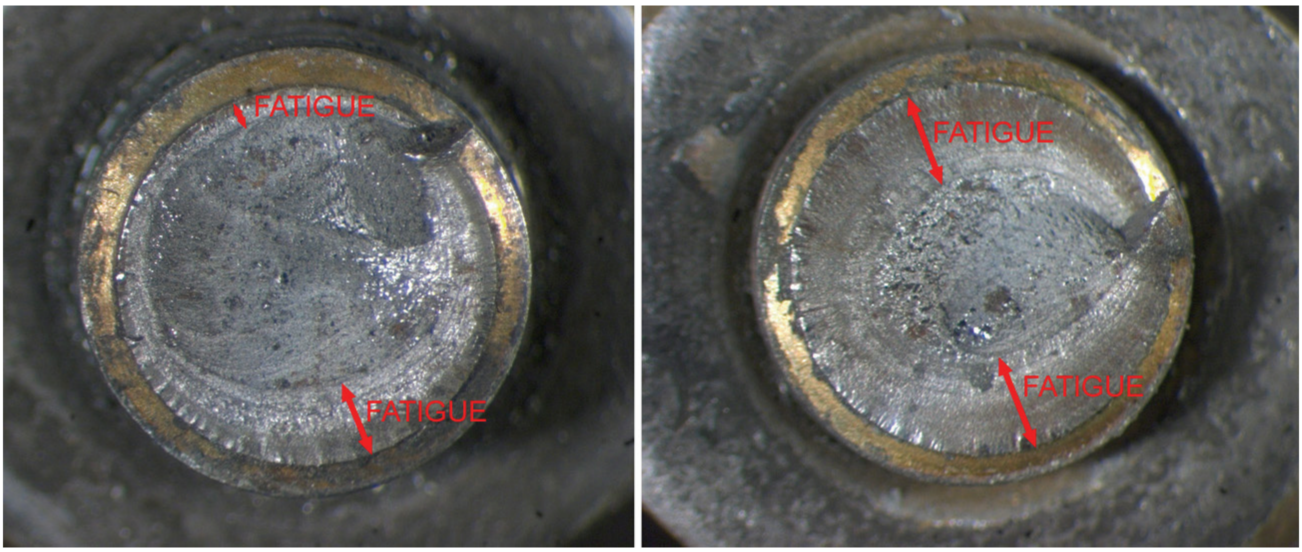



**Figure 4**

Fracture surfaces of the failed bolt ends showing fatigue features at the thread

**Maintenance history**

At the time of the accident on 25 March 2012 the aircraft had accumulated 10,634.4 hours. The aircraft's last annual inspection was completed on 24 February 2012, 35 hours prior to the accident. The aircraft manufacturer's maintenance schedule recommends that these bolts are inspected every 100 hours for '*condition and security*'. The maintenance engineer stated that he inspected the gear attachment bolts and screws during the annual inspection and did not notice any anomalies. No torque check was carried out as none was required, but the engineer stated that he checked the gear leg for security.

The aircraft owner and the engineer recalled that about seven to ten years previously the right gear leg was replaced following a failure of the upper lug which secures the torque links. A record of this repair could not be found, but the engineer stated that the attachment bolts on the right gear leg had not been disturbed since that repair.

The maintenance engineer stated that he believed the bolt failures were a result of repetitive heavy landings. He also said that he had heard from another engineer who had encountered landing gear leg bolt failures on three separate occasions. He believed that the bolts should be replaced at a specified interval.

The aircraft owner stated that no heavy landings had been reported to the flying school.

**Information from the aircraft manufacturer**

The aircraft manufacturer was informed of the findings from this investigation and was asked if they were aware of similar previous failures. They performed a search of the US Federal Aviation Administration's 'Service Difficulty Reporting' (SDR) database, which contains data back to 1995, and identified six discrepancy reports relating to fixed-gear PA-28 landing gear attachment bolts. These reports described failures of some of the lower and upper attachment bolts – most as a result of shear and one as a result of corrosion. None mentioned fatigue failures. Two of the reports recommended that the bolts be torque checked every 100 hours.

In light of the findings from G-BCTF the manufacturer was asked to consider adding a torque check to the maintenance schedule. The aircraft manufacturer responded that because there have only been six reports over the course of 18 years and they have manufactured over 30,000 PA-28 series fixed-gear aircraft, from 1961 to the present:

> *'The SDR data does not support changing the instructions for continued airworthiness with respect to these bolts.'*

**Analysis**

The right landing gear leg separated from its wing attachment following a normal landing. All eight gear leg attachment bolt/screws were found to have failed although it was not possible to determine whether any had failed prior to the landing. The three recovered upper screws had failed as a result of overload. The two recovered bolt ends showed evidence of having failed due to fatigue. It was established by a process of elimination that at least one of these was part of a lower attachment bolt and, due to the similarities in failure modes, it is probable that they were both part of lower attachment bolts.

There was no evidence of corrosion on these fracture surfaces and the circumferential nature of the fatigue cracking indicated a combined tensile and bending load failure mode. Bending loads would have been introduced if the bolts had been loose. The bolts had reportedly not been disturbed for more than seven years, so it was possible that loosening occurred as a result of bolt stretch caused by heavy landings. The fact that some of the lower attachment bolts on the left main gear leg were found loose would also support such a theory. It was also possible that the nuts had backed off, as evidenced by the nut that was found not to be 'in safety'. The bolt pattern does not allow for significant relative rotation between mating parts, so it is unlikely that the fasteners would see a torque in normal service that would cause these self-locking nuts to back off over time. The maintenance engineer considered that the nut not being 'in safety' was probably the result of an installation error with too many washers used.

The gear attachment bolts had been visually inspected 35 hours prior to the accident, but a visual inspection would not have detected a slight loosening or any cracking above the nut. However, a torque check of the nuts would have detected if the bolts had loosened due to stretch and were susceptible to a fatigue failure. The aircraft manufacturer was asked to consider whether such a torque check should be part of the recommended maintenance schedule, but they stated that, given the size of the PA-28 fleet, there was insufficient evidence of a problem to warrant such a change.

**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | Aerospatiale SA.341G Gazelle, HA-LFB |
| **No & Type of Engines:** | 1 Turbomeca Astazou IIIB |
| **Year of Manufacture:** | 1973 |
| **Date & Time (UTC):** | 8 March 2011 at 1907 hrs |
| **Location:** | Near Honister Slate Mine, Keswick, Cumbria |
| **Type of Flight:** | Private |
| **Persons on Board:** | Crew - 1 Passengers - None |
| **Injuries:** | Crew - 1 (Fatal) Passengers - N/A |
| **Nature of Damage:** | Extensive |
| **Commander's Licence:** | Private Pilot's Licence |
| **Commander's Age:** | 45 years |
| **Commander's Flying Experience:** | N/k hours (of which n/k were on type)<br>Last 90 days - n/k hours<br>Last 28 days - n/k hours |
| **Information Source:** | AAIB Field Investigation |

## Synopsis

The helicopter crashed in a valley during a night flight in meteorological conditions that included reduced visibility and low cloud. The investigation found that there were irregularities in the helicopter's maintenance and airworthiness, but no evidence was found of mechanical failure. The pilot was not qualified to fly at night.

## History of the flight

The pilot routinely used the helicopter to commute between his home and various locations in the Lake District. On 9 March he flew the helicopter to a slate mine at the top of the Honister Pass. He spent the day there and at other sites nearby to which he travelled by road. After his last appointment, which was near Keswick, he drove back to the mine with the intention of flying home. The flight time would, in good conditions, be less than ten minutes; the journey by car would have taken half an hour or less[1].

The mine is located at a saddle in the Honister Pass (Figure 1). To the west of the mine, the Honister Pass extends north-west towards Buttermere and Crummock Water; to the east, the Pass extends towards Seatoller, where it joins a valley orientated approximately north-south, descending to the north to meet the southern end of Derwent Water.

**Footnote**

[1] Journey time established using a proprietary route planning application.

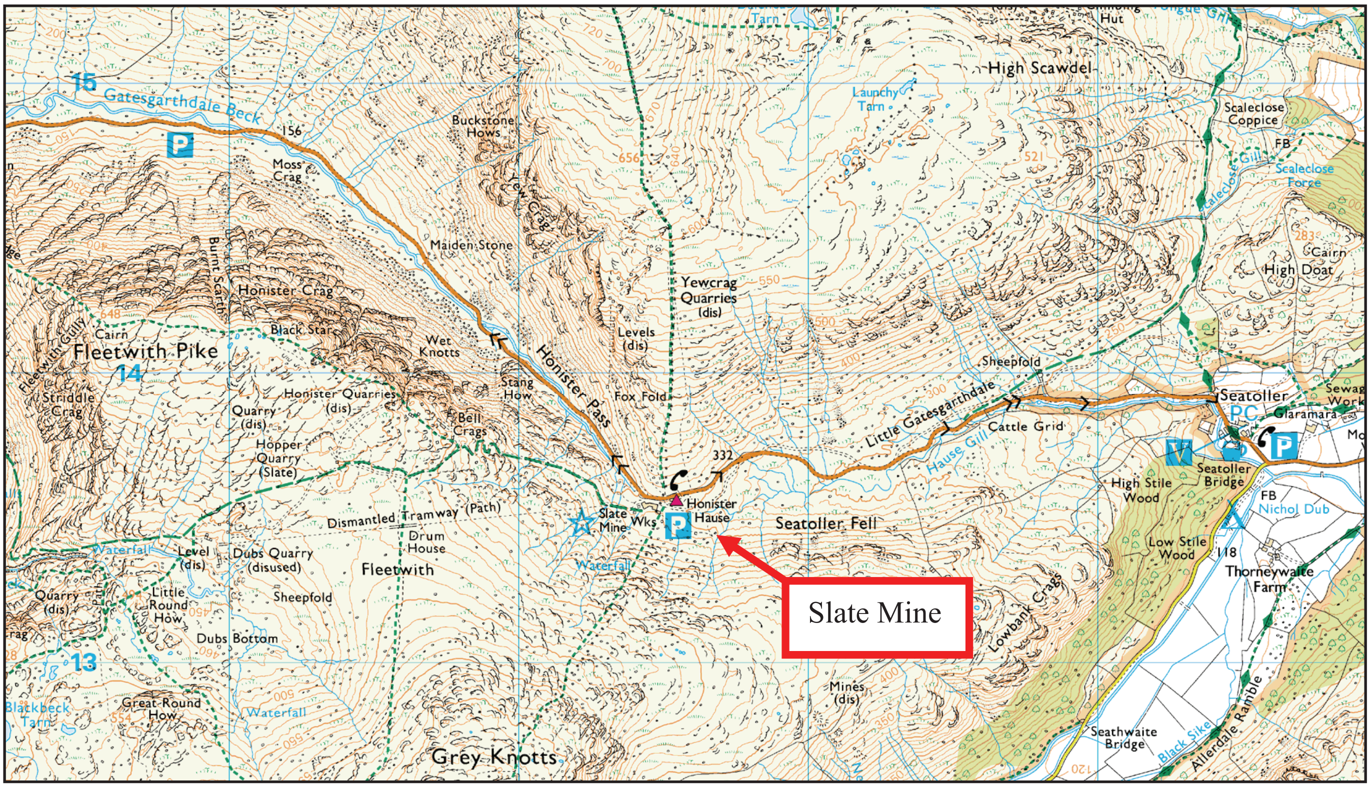



**Figure 1**

The area around the slate mine

The pilot telephoned his partner at their home south of Cockermouth before the flight, informing her that he was returning. He asked about the weather at home, and his partner later recalled describing it to him as "rather blustery" but with good visibility. She commented to investigators that he had flown in worse conditions. There was no evidence that the pilot obtained any other meteorological briefing before the flight.

Video evidence from closed circuit television (CCTV) security cameras showed the pilot arriving at the mine in his car, which he parked adjacent to the helicopter pad; the car's interior light was left on. Forty seconds later, the interior light in the helicopter illuminated. One minute and 55 seconds later, the helicopter's navigation lights and strobe light were activated. After a further 55 seconds, the helicopter lifted off, turned towards the mine building, and transitioned into climbing forward flight. Shortly after lift off, the helicopter's interior light was switched off and the landing light was switched on; it remained on for the duration of the CCTV recording (while the helicopter was in the camera's field of view). The helicopter flew west past the mine and turned to fly past again in an easterly direction, to the south side of the valley east of the mine. It was lost from the CCTV camera's view as it crossed towards the northern side of the valley. Recorded data showed that it passed over a point on the northern side of the valley at low speed, tracking north, with a relatively high pitch attitude.

There were no eyewitnesses and no further information was available about the history of the flight.

The pilot's partner became concerned when he did not arrive home, and telephoned a member of the mine staff who lived in Seatoller. The staff member went to the mine and found the pilot's car with the keys in the ignition and the interior light still on; the helicopter was not on its pad. The pilot's partner made further informal enquiries and at 2210 hrs informed the emergency services that he was missing. A search began shortly thereafter, and at about 0045 hrs members of the local Mountain Rescue Team (MRT) located wreckage of the helicopter approximately 330 m east of the landing site at the mine. The pilot was fatally injured.

**Meteorology**

The Met Office provided an aftercast of weather conditions near the accident site. The meteorologist stated:

> *'The situation was a cold front clearing to the southeast, but replaced from the northwest by a showery flow.*
>
> *Gradient wind (2000ft wind) at the site of the accident at 1800 UTC on 08th March 2011 estimated to be 260 degrees 35 knots... and at 0000 UTC on 9th March 2011 estimated to be 280 degrees 40 knots.*
>
> *The prevailing visibility in the area was initially rather poor and typically between 2500M and 8KM at 2000 UTC on 08th March 2011. The prevailing visibility generally improved to 10KM or more by 2200 UTC on 08th March 2011, but still with the likelihood of 200M or less in hill fog patches.*
>
> *The cloud base was variable and, whilst there were various cloud bases of stratocumulus between 1200FT and 1700FT AGL, there were also areas of SCT to BKN stratus at between the 300FT and 900FT AGL.*
>
> *There was some precipitation in the Honister area until around 2000 UTC on 08th March 2011, this being mainly light rain or drizzle. A drier spell followed, though with showers then moving in around midnight.'*

**Lighting**

The accident occurred at night. Almost no cultural lighting existed in the valley either side of the slate mine for some distance. Some lights at the mine may have been on, illuminating the building and area immediately around it. The interior light in the pilot's car was on, apparently because the door was ajar.

The phase of the moon was such that it would have provided little illumination and at ground level it would have been obscured by cloud.

**Recorded data**

The helicopter was not fitted with any crash protected recorders. The GPS receiver fitted to the helicopter was not of a type that records a track log.

*Dynon EFIS-D10A unit*

The helicopter was fitted with a Dynon EFIS-D10A unit with associated remote compass module connected to the GPS receiver. The unit uses internal solid state sensors coupled to pitot static inputs to sense the attitude, vertical acceleration, barometric altitude and airspeed of the helicopter. The remote compass module senses the magnetic heading and the GPS input provides GPS position, altitude, ground speed and track angle. The installation does not enable GPS time or date information to be transmitted to the EFIS unit so no date information is recorded and time data relate to the time manually set in the unit. An internal battery maintains power to the internal clock.

No documentation was found relating to the installation specific to this helicopter. The installation was set up to record a snapshot of parameters every 10 seconds. The EFIS recorded 14,291 sample points. The last 13 were consistent with the accident flight, 7 while in the air. The unit contained a battery to maintain power to the display in the event of loss of electrical power provided by the helicopter and no trigger for ending the recording was found other than impact damage. The manufacturer stated that there should be no significant delay in recording the data to memory after sampling.

*Radar data*

Due to the high surrounding terrain there were no recorded radar tracks for the accident flight. Recordings were available from three CCTV cameras located at the departure site. The quality of recordings made at night was very limited, mostly containing a black image with electrical noise. However, the lights from the pilot's car, the lights on the helicopter when in frame, and reflections of these lights on other surfaces such as the valley side, were visible in the recordings. The helicopter was only directly in the frame of the recording at the start of the flight and briefly when the helicopter was tracking towards the northern side of the easterly valley near the end of the flight. Given that the outline of the helicopter was not captured, the distance of the helicopter from the camera could not be gauged accurately. Therefore, the position and altitude of the helicopter could not be calculated from the CCTV recording. The CCTV did provide a time source that coincided approximately with UTC and for the purposes of this report is treated as such.

The EFIS recorded time was approximately 1 minute and 4 seconds behind the CCTV camera recorded time. All times relating to the EFIS recorded data have been adjusted to reflect the CCTV recorded time, taken as UTC.

*Dynon EFIS-D10A recording characteristics*

The EFIS started recording fresh GPS information soon after takeoff. It did not update the GPS altitude parameter until the last sample of the accident flight and to a value inconsistent with the barometric altitude recorded, even accounting for atmospheric conditions and filtering of the barometric parameters. This indicates satellite reception unfavourable for a 3D fix for the majority of the flight, but capable of providing 2D positional information and therefore also ground speed and ground track information. The resolution of the recorded GPS latitude and longitude parameters limited the position accuracy to approximately 19 m in north/south directions and 10 m in the east/west directions. Therefore, the recorded GPS data may not have had the accuracy of which the system is normally capable. However, it does still provide an indication of the flight path of the aircraft.

Altitude data is derived from air pressure sensed 64 times a second, filtered to be effectively an average over the last second. The vertical speed uses the filtered altitude data to derive a vertical speed parameter which is itself filtered to be effectively an average over the last two seconds. This reduces the effect of random errors in the process and so provides better accuracy during stable flight. Under the conditions of increasing vertical speed, the effect of the filtering will result in altitude and vertical speed figures that are under-reading as is typical with this type of instrument.

The lowest valid airspeed is 15 kt. Below this an airspeed of 0 kt is recorded.

The EFIS was installed on the helicopter instrument panel, forward of the aircraft centre of gravity so the sensed normal acceleration would have been affected by any rotational acceleration in pitch.

A review of the EFIS data recorded during previous flights showed that the magnetic heading was nearly always greater than the track, taking magnetic variation into account, regardless of direction of flight. The remote compass module was found to be installed at right angles to the manufacturer recommended installation orientation. This 90° difference was reflected in the earliest recorded flights. The relationship between magnetic heading and track then had a step change, likely associated with a calibration. However, a distinct discrepancy between heading and track was evident and remained stable for the rest of the recorded flights. Those with a valid GPS track, a roll angle of less than 10° and an airspeed of greater than 80 kt, showed an average difference between true track and magnetic heading of 23.7°. This is greater than the local difference due to magnetic variation and is too consistently positive to relate to wind drift. The data used in this report has been adjusted by this amount to give a true heading that is likely to be more accurate on average but may not have been the actual value.

The following amalgamates EFIS and CCTV evidence.

*Accident flight*

Figures 2 and 3 show data from the EFIS recordings. The recordings started at 1905:34 hrs with the helicopter stationery at the takeoff location and with a heading of approximately 025°(T). The barometric altitude varied whilst still on the ground during the helicopter start up, as would be expected. The CCTV showed the various lights and beacons becoming active. The helicopter took off at 1906:25 hrs and turned to head north-west with an airspeed of approximately 25 kt, climbing slowly. The helicopter then carried out a climbing turn and headed south-east towards the southern side of the eastern valley. The helicopter reached its highest recorded altitude in a left turn away from the valley side. The next and final recorded point, at 1907:34 hrs, placed the helicopter nearer the north side of the valley with no valid airspeed (ie below 15 kt), a ground speed of 34 kt, a track of 355°(T), a heading of approximately 20°(T), a descent rate recorded as -735 ft/min, 25.75°of nose-up pitch, 3.75° of right roll and a turn rate of 3°/s to the right. This implies a slow rotation to the right with little roll and a nose-up attitude, low airspeed, forward ground speed and in a descent.

*Comparison with previous flight*

Previous recorded tracks to and from the takeoff point sometimes involved flight paths that took the helicopter closer to the northern side of the valley than the last recorded point of the accident flight. However, these involved flight paths approximately in line with the valley and not across the valley. Turns in the valley on approach to or departing the area were carried out near or above the southern slopes of the valley or in the valley to the west of the slate mine facilities.

The final recorded point had no valid airspeed (less than 15 kt), 25.75°of nose-up pitch and a calculated height of approximately 550 ft agl. A review of the previous flights showed that, with one exception, each occasion the pitch was recorded as greater than 20° nose-up was associated with a flare before landing. The one exception was associated with flight involving a number of high pitch and roll manoeuvres at speed. The highest nose-up pitch angle recorded with a calculated height of 500 ft agl or higher, during previous flights, was 8.75°

Other than the final recorded point during the accident flight, with a calculated height of approximately 550 ft agl, no other flight recorded an invalid speed at a calculated height of more than 230 ft agl. The penultimate recorded point also indicated a lower speed than previously recorded for the given calculated height above terrain.

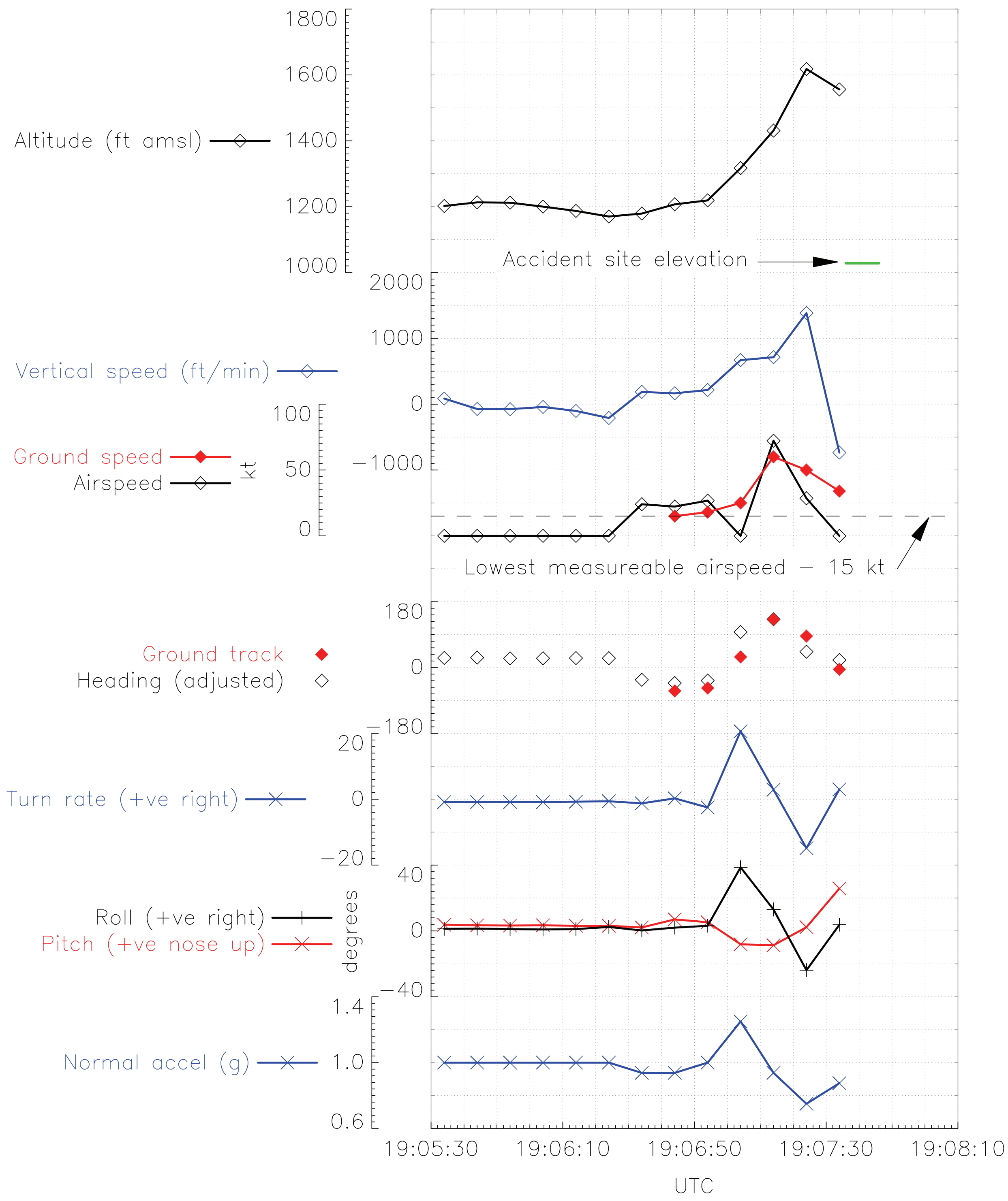



**Figure 2**

EFIS recorded data

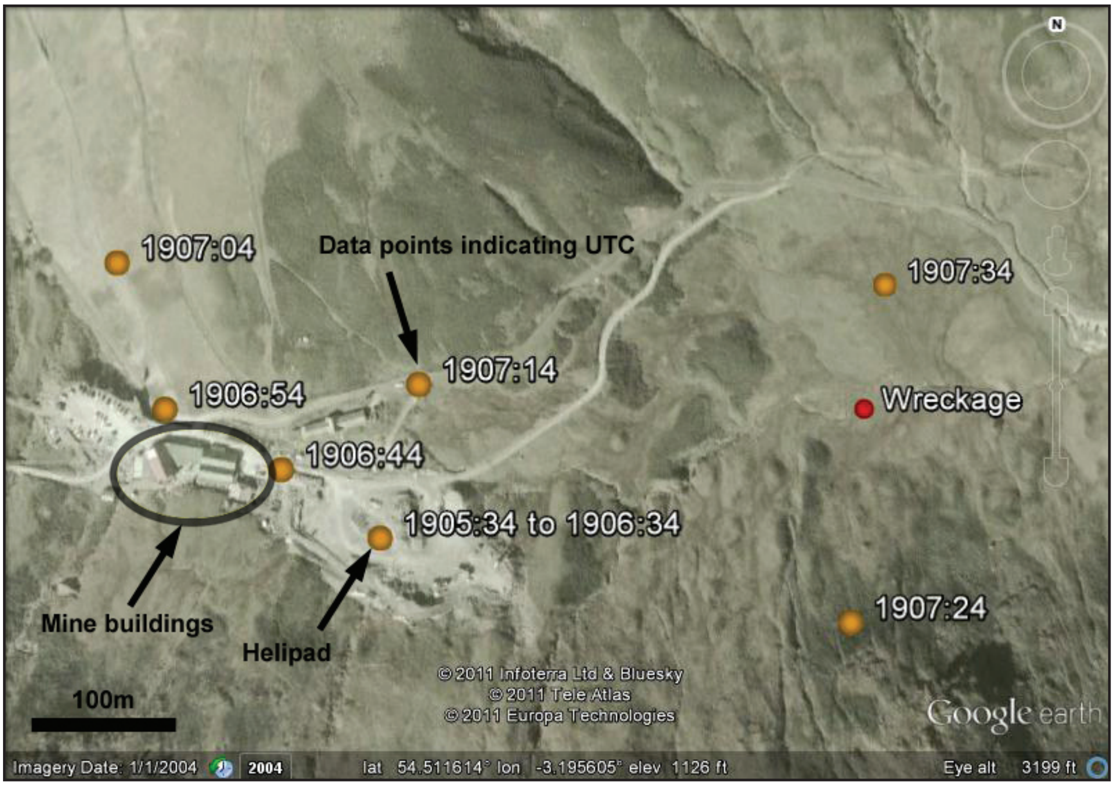



**Figure 3**

Recorded GPS positions during the accident flight

**Routes between Honister and Cockermouth**

The pilot's flying frequently took him between three sites in the Lake District: his home, south of Cockermouth; the mine at Honister, and another site north of Keswick. This is illustrated by the GPS recordings of his recent flights (Figure 4)

The pilot habitually flew more or less directly between these locations, although the tracks varied. The route from the slate mine directly to his home involved crossing the Honister Pass, and then following Buttermere and Crummock Water before reaching low-lying ground near his home. This route is through relatively deep and steep-sided valleys among high ground rising to a maximum of 2,792 ft. His route from the mine to the site near Keswick is down the valley towards Seatoller and then following falling ground into a wider valley towards Derwent Water and Keswick itself. From Keswick, a possible route to his home would follow the main road along low-lying ground from Keswick towards Cockermouth. This latter route featured more cultural lighting.

**The pilot**

The pilot flew fixed wing and microlight aircraft before taking up helicopter flying in 1993. He obtained a PPL (H) in 1993, and then owned or hired Robinson 22 and 44, Bell 206, and Enstrom 280C helicopters until 2005, when he bought a Gazelle helicopter, which he later sold. At the time of the accident he owned two similar Gazelles, both on the Hungarian civil register.

He held a crew member certificate issued by the Hungarian Civil Aviation Administration which validated his PPL for flight in Hungarian-registered aircraft.

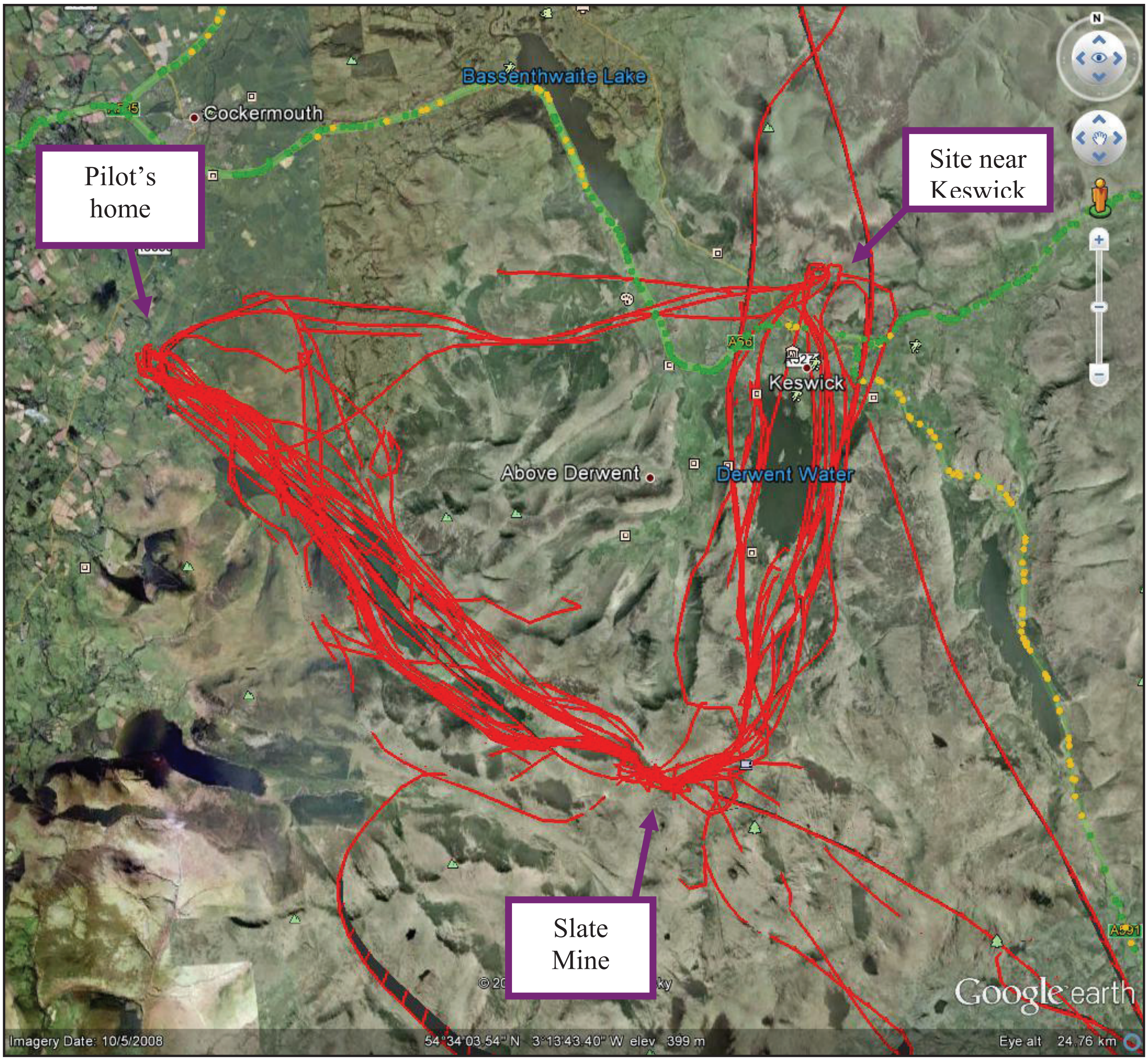



**Figure 4**

The pilot's usual routes within the Lake District (GPS tracks shown in red)

No recent flying logbook was located during the investigation[2]. Log books of helicopter flying between 1993 and February 2007 were found, which showed that by the latter date the pilot had accumulated a total of 371 hours flying experience in helicopters, of which 116 were in Gazelles. He continued to fly helicopters between 2007 and the date of the accident, but it was not possible to determine details of his flights. During his last medical examination, in July 2009, the pilot stated that he had accrued a total of 1,700 flying hours, 400 of which had been in the preceding two years.

**Footnote**

[2] The pilot reported to the CAA on 18 October 2010 that his log book had been in his car when the car was stolen.

The pilot completed a licence proficiency check with a freelance examiner, formerly a British military pilot, in July 2010. The examiner stated that he had conducted a number of proficiency checks with the pilot in recent years and considered him to be of above average flying ability, adding that his skill level was similar to that of a British military helicopter pilot of two or three years operational experience.

The pilot did not hold a night qualification, and there was no evidence that he had undertaken training towards one. His log book contained an entry in 2006 annotated:

> *'land 200 m away from home at night.'*

No other entries relating to night flying were found.

The pilot had lived in the Lake District all his life and, according to those who knew him well, was very familiar with the area, its terrain, and its features.

**Supervision of flying activities**

The helicopter was operated under the oversight of a Hungarian company responsible for the aircraft's airworthiness and the validity of the pilot's qualifications, but this oversight did not extend to the approval of each planned flight. The operator did require meteorological forecasts to be obtained before each flight and carried aboard the helicopter.

**Canopy misting**

If a helicopter has been parked in low temperatures, the canopy may mist up before, during, or after, engine start, as warm, moist, air meets the cold transparency. This effect may be exacerbated if an occupant or occupants board a helicopter in damp clothing. In serious cases, visibility may be reduced to the point at which the pilot can no longer maintain visual references outside the helicopter. A previous AAIB investigation[3] identified this as a causal factor in a fatal accident.

An examiner familiar with the Gazelle helicopter stated that prior to flight in these circumstances, the canopy should be wiped inside and out with a cloth which should be wrung out regularly, and that the bleed air demisting system was only effective five minutes or more after engine start.

It was not possible to determine if canopy misting had occurred in this case.

**Night flight in helicopters**

Night flight in helicopters presents several challenges different from flight by day. In particular, poor visual cues may require the pilot to make reference to flight instruments. In the absence of cultural lighting or clear moonlight, the pilot may have difficulty determining the presence of cloud and an inadvertent encounter with instrument meteorological conditions may be more likely. Without appropriate lighting at the destination, the approach to land may be particularly demanding, and emergency landings away from prepared landing sites, with or without power, are particularly challenging.

**Vortex ring state**

A vortex ring state is a condition in which the main rotors of a helicopter operate in the turbulent downwash they have created, reducing lift and causing control difficulties. Conditions for the onset of a vortex ring state include low forward airspeed, a rate of descent of more than a few hundred feet per minute relative to the air mass in which the helicopter is flying, with power

**Footnote**

[3] Accident to Agusta Bell 206B, G-FLYR at Glamis Castle, Forfar, Scotland, AAIB reference EW/C97/7/2.

(collective pitch) applied. A vortex ring may be entered, for example, in a low-speed near-vertical descent, or in a quick-stop manoeuvre.

**Flight in mountainous terrain and strong winds**

The combination of mountainous terrain and strong winds can cause turbulence, rotor and windshear. The strength of these phenomena is approximately proportional to the strength of the wind. The complexity, size and shape of the terrain also have an influence. The terrain around Honister, with a series of complex hills and valleys with slopes of considerable size and gradient, mean that turbulence, rotor, and windshear may have been encountered.

**Landing lights, strobe lights, and low cloud at night**

Reflection of landing lights or strobes on fog or cloud can be disorientating or degrade night vision.

**Pathology**

An aviation pathologist carried out a post-mortem examination on the pilot. No medical or toxicological factor was identified as having caused or contributed to the accident, but the pathologist commented:

> *'While it is unlikely to have had any effect on survivability in this particular accident, the fact that [the pilot] was not using the shoulder straps which were fitted to his seat could have compromised survivability had the crash forces been of a lesser magnitude.'*

**Aircraft description**

The Gazelle was originally designed for military use as a light battlefield support and observation helicopter and has been operated extensively in its military specification. A civilian version was later developed and certified, originally by the French DGAC and then by the EASA. The Gazelle is noted to have significantly better performance than most other civilian light helicopters in this category due to its power-to-weight ratio and has a reputation for being agile and manoeuvrable. Whilst the large vertical fin provides good stability in yaw at moderate or high speeds, accurate handling in yaw at low speeds may be demanding.

A single pilot normally flies the helicopter from the right seat, with removable dual controls for the left seat. Three passengers can be carried on the rear bench seat. The cabin structure is minimal with large, domed floor-to-roof Perspex panels forming the majority of the front surface of the helicopter. It has a main door on both sides that opens forwards and a smaller rearward opening door that the main door closes against, also on both sides. These doors form the sides of the cabin, with two Perspex panels forming the majority of the roof.

A narrow ceiling panel runs down the centre of the roof containing ducts and a diffuser to supply warm air from the engine for cabin heating. This arrangement also directs air onto the forward transparencies to provide a de-misting action. The engine throttle, emergency fuel shutoff, rotor brake, and heating mixer control are also located at the front of this roof panel. Below the cabin floor panels, a box section structure provides the main structural rigidity for the cabin and houses the flying control system and avionics cabling.

Between the cabin bulkhead and the rear bulkhead are the main fuel tank, luggage area and items of mechanical and avionic equipment. Several fuel system components are located on the back face of the rear bulkhead. Above the fuel tank is the transmission platform where the main rotor gearbox is attached to a flexible mounting plate and two V-frame mounts. An Astazou IIIA turbine engine is mounted behind this at the interface between the fuselage and the tail boom. The engine shaft is connected to the main rotor gearbox, through a clutch and flywheel arrangement, by a drive shaft and cardan ring assembly. As well as the main rotor head, the main gearbox also drives the tail rotor shaft, an internal oil pump, and a hydraulic pump to provide hydraulic pressure for the flying controls.

The tail rotor drive shaft runs from the main gearbox, via an intermediate bevelled gearbox, then along the top of the large diameter tail boom. The tail boom ends with a large vertical fin to accommodate a fenestron tail rotor and gearbox. Horizontal stabilisers with vertical endplates are also fitted on either side of the tail boom. The helicopter has four hydraulically assisted flying control actuators, one for each of the main rotor blades and one to change the angle of the fenestron blades. The main rotor actuators are connected to the cyclic and collective by conventional torque tubes and mechanical mixer units. The yaw pedals are connected to the fenestron actuator, via torque tubes, a pulley unit and then by control cables that run alongside the tail rotor shaft on the top of the tail boom. A simple stand-alone oil filled piston and restricted bypass attached to the crosstube provide rate damping for the yaw controls. In the event of a hydraulic system failure, the actuators revert to mechanical connections, but are sufficiently balanced to allow the helicopter to be controlled without excessive pilot effort.

The Astazou IIIA is a coupled turboshaft engine, with a reduction gearbox that drives a centrifugal clutch and freewheel assembly. The compressor section comprises a single stage axial compressor, followed by a centrifugal compressor. Fuel is delivered to the annular combustion chamber by centrifugal injection, with exhaust gas passing through a three-stage turbine. P2 air bleeds from the engine provide air for the cabin heating and purge the igniters following engine start. P2 air is also supplied to a flow limiter in the fuel system, to control the rate of increase in fuel supply to prevent engine surge following a high demand input.

During normal operation, once the throttle on the cabin roof is moved to the flight detent, the engine is designed to maintain a constant 43,500 rpm (+400/-0) irrespective of power demand, giving a nominal main rotor speed of 380 rpm. Fuel pressure is provided by an engine driven pump and maintained at a constant level, regardless of demand, by a differential pressure valve. A metering valve controls fuel flow. The engine has a speed governor, which uses a bob-weight system to sense changes in engine speed. If the speed is too low or too high, the governor ports oil to the appropriate side of the metering valve servo to open or close the valve, until the engine speed returns to nominal. When the metering valve opens fully, an alarm light on the instrument panel illuminates. This is a multi-function light but during flight, it advises the pilot that the engine has reached maximum fuel flow and therefore maximum engine power[4].

The instrument panel has a number of emergency and caution warning lights. The main central warning panel group of lights confirm the status of the major aircraft systems. This group includes a pitot heat warning light, which illuminates when the electrical pitot probe heater is switched off or has failed. There is also a light located on the torquemeter which flashes when the torque exceeds 97.5%, then remains on steady when the torque exceeds 102.5%.

**Footnote**

[4] During rapid transition from a low power demand to a higher power demand, the metering valve can open fully and illuminate the alarm light. The light will extinguish again as soon as the engine speed recovers.

Some military versions of the Gazelle are fitted with a variant of the Astazou engine designated the IIIB. Although identical to the IIIA in architecture, the engine has not been subject to a certification process and due to the non-standard nature of military operations, it is not listed as an approved model on the EASA type certificate for the Astazou engine. As such, if a IIIB engine is subsequently fitted to a civilian aircraft, it invalidates the aircraft's EASA Certificate of Airworthiness.

When granting FAA certification, the FAA added a number of special conditions to the Type Approval for the civilian SA341G, including the requirement for an engine fire detection system.

**Accident site and ground marks**

The accident site was located across both sides of Hause Gill stream in the relatively flat bottom of the U-shaped valley that forms Honister Pass. The majority of the wreckage came to rest approximately 330 m east of and 50 m vertically lower than the helicopter-landing site at the mine. The first ground mark was north of the main wreckage site and formed a relatively shallow, roughly triangular depression. It contained several items of wreckage from the lower surface of the cabin including the belly panel and the radar altimeter antennae. Both the rear sections of the skids and the vertical endplate from the left horizontal stabiliser were located immediately to the east of this ground mark. South-east of the ground mark was a deep, narrow ditch the length of a main rotor blade, with a circular hole at the end. Debris from the wreckage and large clumps of earth were scattered in a cone shape southwards originating from the initial ground mark, and extending each side of and beyond the main wreckage of the fuselage.

**Initial wreckage inspection**

The helicopter was heavily disrupted from the start of the tail boom forward. The tail boom rearwards was essentially intact and lay on its right side, roughly along an east-west axis with the vertical fin pointing north. The vertical fin was bent to the left (looking rearward) and the aerial on the right side of the fin (looking rearward) was flattened and distorted. The anti-collision beacon on the top of the fin had been knocked off. The underside of the join between the tail boom and the fuselage had crumpled and was heavily folded and creased. The main body of the fuselage also lay on its right side, with the remains of the cabin at approximately 90º to the tail, pointing towards the south. The cabin was completely disrupted and had extended forwards, held together only by electrical cabling, with the instrument panel the furthest item of wreckage still attached to the main fuselage. The pilot was found still strapped to his seat by the lap strap, but projected clear of the main wreckage. His shoulder straps had not been fastened.

The engine mounts had failed, as had the drive shaft to the main gearbox and the tail rotor drive shaft, both ends of the intermediate gearbox and at the main gearbox. The main gearbox was still attached to the transmission platform, but this had rotated backwards 90°, such that the rotor head pointed towards the tail. The main rotor blades remained attached at the rotor head, though the blade coning stops and top section of the rotor head had been damaged. The blade structure was severely damaged and delaminated along the length of all three blades. Various sections of some of the blades had detached during the impact, though these sections were still present around the accident site. The main flexible 'bag' fuel tank had been damaged and the contents had leaked away. The auxiliary fuel tank had been thrown clear of the main wreckage. It had been heavily disrupted in the impact and was also empty.

**Detailed wreckage inspection**

A significant amount of debris was found in the engine intake wire mesh guard. As air enters from the rear of the intake cover, this debris had been drawn into the intake by the pressure drop resulting from an operating engine. The engine was identified as an Astazou IIIB and was sent for strip and inspection at the manufacturer. Mud and debris were found in the compressor gas path as far back as the centrifugal compressor, with associated foreign object impact damage on the axial compressor blades and vanes. Heavy rotational rub marks were found on various components within the engine. These findings together confirmed that the engine was operating at speed at the point of impact with the ground. Unburnt fuel was found in the P2 air tapping, indicating that fuel was being supplied to the combustion chamber at impact and that the helicopter had rolled over at some point during the impact sequence. The engine's reduction gearbox was stripped and inspected. No defects were identified, but clear impression marks from the cogs were present on the casing, indicating the engine had experienced a significant frontal impact force. The gearbox and rotor shaft turned smoothly, without restriction.

The main accessory components of the engine were inspected and performance tested on the manufacturer's test rigs. The maximum fuel flow of 4.6 litres/hr delivered by the fuel control unit was low against the minimum specification for a newly overhauled unit, but the manufacturer advised that this would not have significantly affected the maximum power available from the engine. No other defects relevant to the accident were found in the core engine and accessories. As such, no evidence was identified that would have prevented normal engine performance prior to impact.

As HA-LFB was originally registered in the USA, the engine was fitted with four bimetal strip sensors which, when heated by a fire, would cause a warning light to illuminate on the instrument panel. A defect was identified on one of the fire detection sensors that would probably have resulted in a false fire-warning signal. The indicator light bulb unit was not present in the fitting on the instrument panel when inspected after the accident, but was recovered later by the family of the pilot. Filament analysis of its bulb confirmed it had not been illuminated during an impact. Further detailed inspection of the fitting showed that the bulb unit had been removed intentionally prior to the accident flight.

The main components of the helicopter were disassembled and inspected. The hydraulic pump showed evidence of significant frontal impact force and the driveshaft shear pin had failed. However, evidence from the rotor speed indicator, which receives its signal from a tacho generator driven by the hydraulic pump, confirmed that the pin sheared as a result of the rotor blades being forcibly stopped by the ground impact. The hydraulic control actuators moved freely, with the exception of one main rotor actuator, the main piston of which had been deformed during the impact. During the disassembly and inspection of the hydraulic system, it was noted that there was much less hydraulic fluid remaining than would be expected given the required total system contents. However, there was no evidence of a significant hydraulic fluid leak on the surrounding wreckage. Although no fuel remained in the fuel tanks, the main tank sump was undamaged and still contained fuel.

There was significant damage to the flying control rods, cables, mixer units, and bell cranks. However, all the damage was consistent with overload failure during the impact. The yaw damper was found to have very little oil within it, such that there would have been no damping effect on the yaw controls. As with the hydraulic system, there was no evidence of an obvious leak path or leaked fluid.

The pitch control rod attached to one rotor blade had failed at the upper end of the rod. However, the blade to which it had been attached had been knocked vertical at the 'flapping' hinge of the rotor head during the impact with the ground. The fracture surface on the control rod was consistent with an overload failure during this process. The main gearbox, intermediate gearbox and tail rotor gearbox were internally undamaged and turned without restriction.

Rub marks on the front inside face of the fenestron housing indicated that the fenestron blades had been rotating at impact and confirmed that there had been sufficient frontal impact force to cause them to contact the housing. The driveshaft was displaced forward from its bearing housings, also indicating a significant frontal impact. Score marks on the tail rotor shaft indicated that it had been rotating at impact.

The engine throttle lever was found fully forward and still located in the flight detent. The position of the hot air rotary selector could not be confirmed because the Teleflex cable had been severed in the impact. Likewise, the pre-impact position of the hot air mixer valve could not be determined reliably, due to impact damage in the surrounding area.

Strip and inspection of the torquemeter confirmed that maximum engine torque was being applied to the rotor blades at impact. This was consistent with the position of the collective. The adjustments for outside air temperature and altitude had not been correctly set on the torquemeter. This would have resulted in the warning light being triggered incorrectly, had the torquemeter warning light not been disabled due to the modification standard of the unit.

The vertical speed indicator was frozen at full-scale deflection (3000 ft/min or more) down. Hot filament failure analysis was conducted on the warning light bulbs fitted to the instrument panel. Of the main warning lights, only the pitot heater caution light was illuminated at impact. The alarm light indicating maximum fuel flow on the engine was also illuminated at impact.

**Maintenance**

Although the aircraft was flown privately, it was required to be 'operated' by an organisation approved by the Hungarian CAA because it was registered on the Hungarian civil register. This operator was responsible for the maintenance and airworthiness control of the helicopter. The operator provided maintenance records for the helicopter from 2007 onwards. These were the only such records available to the investigation. Only the last engine shop visit was recorded and there was no evidence of time accrued on life-controlled components prior to 2007. According to the operator's records the only routine maintenance conducted on the aircraft had been annual checks, which were accomplished by a member of the operator's staff travelling to the UK. The operator advised that it had fitted no new components to this aircraft since the original extended maintenance check, which it completed to bring the aircraft on to the Hungarian register in 2007.

**Airworthiness issues**

A number of serious airworthiness issues were identified with the helicopter during the course of the investigation. None of these issues could be directly linked to the cause of the accident, but did raise concerns regarding the way the helicopter was operated. Given the number, complexity and severity of the issues found and the fact that they are common to a number of other fatal accident investigations conducted on foreign-registered aircraft in the UK, they will be covered in detail in a separate Safety Study report. However, a brief summary is provided below:

*Life controlled parts*

Different life-controlled components had been fitted to the airframe from those recorded by the Hungarian operator. As such, their life remaining calculations were incorrect. No service life records or EASA Form 1's for these components were found and there were no maintenance records of their installation. As such the remaining fatigue life of these items, if any, was unknown.

A number of the components fitted to the helicopter were confirmed to be ex-UK military in origin. At least one was traced back to Ministry of Defence records, which confirmed it was sold as unserviceable and with an unconfirmed service history.

*Engine*

The Astazou IIIB engine fitted to the helicopter is a variant for military use only. This invalidated the EASA Certificate of Airworthiness.

The engine was overhauled by an unapproved repair facility in Serbia and issued with a counterfeit EASA Form 1.

The engine manufacturer's investigation identified a large number of discrepancies relating to unapproved overhaul practices carried out at the last shop visit. These included use of non-original equipment manufacturer parts, re-use of single use items and potentially dangerous overhaul practices on critical components.

*Modification standard*

An early landing gear modification standard was fitted to the helicopter. This required an early modification standard main gearbox mounting plate with a locking plunger system. This modification standard is not accepted by the UK CAA on UK registered aircraft.

The torquemeter fitted had been modified to a UK military standard, designed to be compatible with night vision goggles (disabled red warning light). This modification required an alternative green warning light to be fitted to the instrument panel. This was not present and as such, there was no warning of over-torque other than the indicator needle.

*Maintenance*

Maintenance work had been completed to change components without the knowledge of the approved maintenance organisation responsible for the aircraft. No record was found of who carried out this work or whether they had the appropriate training and approvals.

Based on inspection of physical evidence from the wreckage, the aircraft had been operated for an indeterminate period with the fire warning light removed from the instrument panel. It is likely that the warning light had been removed because a faulty sensor in the fire detection system had resulted in a false warning.

Evidence was found of chafing between the tail rotor drive shaft and its covers and between the hydraulic pipes for the tail rotor actuator and sections of the airframe. Fluid levels within various components on the helicopter were found to be much lower than expected, with no obvious leaks identified. This might indicate poor maintenance practices or missed maintenance checks.

No evidence was found that the torquemeter had been adjusted for the replacement torque liaison shaft or the new engine, leading to potentially erroneous indications.

*Records*

No current pilot, engine or airframe logbooks were found in the UK, preventing confirmation of the flight hours accrued. The total hours counter on the instrument panel did not match the recorded hours supplied by the Hungarian operator.

**Analysis**

*Recorded information*

The data was recorded at 10 second intervals, insufficient alone to build an accurate picture of manoeuvres being flown, prevailing conditions and the serviceability of the helicopter.

The last recorded set of data indicated that the helicopter had low airspeed and a vertical speed of -735 ft/min. At this point the helicopter's heading was to the right of its track with a drift of approximately 25°, a turn rate of 3°/s to the right and 3.75° of right roll . The helicopter had 25.75°of nose-up pitch. The attitude and speed of the helicopter at the final recorded point of the accident flight were significantly different from those previously recorded for the calculated height above terrain. This indicates that by this point, the flight was not normal. The penultimate point also indicates an unusual combination of low speed and height compared to previous flights.

The last point indicates more ground speed than airspeed in the direction of track and heading, with a slow rate of turn, indicating general tailwind conditions. This, in combination with a descent and nose-up attitude, is unusual.

Given the EFIS installation design, it is likely that a further data point was not recorded because the ground impact disrupted the unit within 10 seconds of the last recorded point.

The helicopter was approximately 500 ft higher than the accident site at the time of the last recorded sample. This implies an average vertical speed of approximately -3,000 ft/min following the last recorded point. Taking account of the lag in recorded vertical speed due to filtering, the actual vertical speed may have been greater.

The sample rate and comparisons of flight characteristics with previous recorded flights indicate a departure from normal speed/height characteristics approximately 15 to 25 seconds before impact. The cause could not be determined from the recorded data.

It is probable that the helicopter yawed through at least 180° between the final recorded point and impact, descending at a high rate.

*Engineering issues*

Evidence from the accident site showed that the aircraft approached from the north. It initially impacted nose first and with high energy. This resulted in the removal of the landing gear, lower antennae and belly panel and caused significant damage to the cabin and floor box structure. The helicopter fuselage continued to pivot round to the left, whilst rolling left, most likely because the aircraft was yawing right at impact. This caused the horizontal stabiliser end plate to break off on the left side as it touched the ground. The vertical fin then contacted the ground and bent sideways, flattening the aerial and knocking off the beacon. As the aircraft continued to roll, a main rotor blade struck the ground creating the large ground mark. The reaction of the fuselage to the rotor blade strike caused it to be lifted into the air again. It continued to roll inverted about the longitudinal axis, before hitting the ground again in its final location, with the remains of the cabin then continuing forward in the main direction of impact.

The rotational and deceleration forces resulted in the pilot, still attached to his seat, being thrown clear of the main wreckage, along with many smaller items of wreckage.

No evidence was found of a mechanical failure that might have been causal to the accident. Evidence found during the engine strip inspection indicated that one of the fire detection sensors would probably have triggered an erroneous fire warning, if fitted to an otherwise serviceable indication system. However, the fire warning light bulb was confirmed not to have been illuminated during an impact and the bulb unit had been removed from the instrument panel prior to the accident flight. As such, this did not contribute to the accident. As the aircraft was unlikely to have been flying in icing conditions, the lack of pitot heat identified by the warning light was also not relevant to the accident.

The yaw damper was incorporated to restrict the rate of application of yaw control inputs; the lack of fluid in the yaw damper meant that it was not functioning as intended. This would have increased the sensitivity of the aircraft's response to pedal inputs and would have increased pilot workload when flying low airspeed manoeuvres, especially in gusting and directionally variable winds.

Physical evidence from the wreckage confirmed that the engine was operating at full power at impact consistent with a high torque load, most likely due to control inputs by the pilot. The degree of damage to the helicopter, witness marks on various components and the vertical speed indicator reading, indicate a high rate of descent at impact, with forward speed and yawing motion to the right.

*Operational issues*

For the pilot, flying from the mine to his home was routine. He probably knew the terrain and his usual routes well. The flight occurred at night with very little cultural lighting and little, if any, moonlight. The wind was strong. Considerable turbulence, rotor, and up- and down-draughts would therefore have been present. There was much cloud, some below the level of surrounding terrain. Visibility in the area was variable, typically as low as 2,500 m but less in places.

Although his partner provided a report of weather at home, the absence of formal meteorological briefing, and the difficulty inherent in observing the visibility and cloud in a series of valleys in the dark, probably meant the pilot did not have a comprehensive understanding of the weather conditions in the area.

The progress of the early part of the flight could not be explained but the flight path chosen by the pilot may have been influenced by his assessment of the prevailing conditions. He may have been attempting to return to the mine, perhaps having deemed the weather unsuitable, having realised that he had left his keys in the car at the mine, or that a light was on in the car. It is also possible that he was attempting to return for some reason not identified by the investigation.

Pathological evidence indicated that pilot incapacitation was not a likely cause.

The pilot's ability to maintain a safe flight path may have been affected by diminished situational awareness or a loss of control, and there was evidence of poor lighting and weather conditions that might have contributed to these difficulties, especially if the helicopter had inadvertently entered cloud. In addition, canopy misting, distracting illumination of cloud by the landing light or strobes, turbulence, and windshear are factors that may be associated with the prevailing conditions but for which there was no direct evidence.

The pilot's difficulties may have been compounded by the helicopter's handling characteristics at low speed, the degraded performance of the yaw damper and the possibility that the helicopter entered vortex ring.

There was no evidence that the pilot had received training in night flight. His decision to depart in the prevailing weather conditions, and from a site with no cultural lighting, suggested either a lack of awareness of the inherent risk or an acceptance of the risk.

**Conclusion**

During a flight at night in challenging circumstances, control of the helicopter was apparently lost, or the pilot became disorientated to the extent that safe flight was not maintained. The helicopter impacted terrain and the accident was not survivable. It was not possible to determine the mechanism by which control was lost or disorientation occurred, though several possible factors were identified. Although irregularities in the helicopter's maintenance and airworthiness were identified, there was no evidence of mechanical failure. The pilot was not qualified to fly at night.

# AAIB correspondence reports

These are reports on accidents and incidents which were not subject to a Field Investigation.

They are wholly, or largely, based on information provided by the aircraft commander in an Aircraft Accident Report Form (AARF) and in some cases additional information from other sources.

The accuracy of the information provided cannot be assured.

**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | Airbus A319-111, G-EZDN |
| **No & Type of Engines:** | 2 CFM CFM56-5B5/3 turbofan engines |
| **Year of Manufacture:** | 2008 (Serial no: 3608) |
| **Date & Time (UTC):** | 14 May 2012 at 1743 hrs |
| **Location:** | Liverpool John Lennon Airport |
| **Type of Flight:** | Commercial Air Transport (Passenger) |
| **Persons on Board:** | Crew - 6 Passengers - 83 |
| **Injuries:** | Crew - None Passengers - None |
| **Nature of Damage:** | Damage to right wing trailing edge and right aileron |
| **Commander's Licence:** | Airline Transport Pilot's Licence |
| **Commander's Age:** | 29 years |
| **Commander's Flying Experience:** | 4,741 hours (of which 3,941 were on type)<br>Last 90 days - 197 hours<br>Last 28 days - 65 hours |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot |

**Synopsis**

During pushback from its stand at Liverpool Airport, the aircraft's right wing trailing edge struck a set of steps which had been positioned to service another aircraft arriving on the adjacent stand.

**History of the flight**

G-EZDN was positioned on Stand 53 at Liverpool Airport, ready for departure with the steps removed and the slides armed. All cabin and flight deck checks had been completed and the Pilot Flying (PF) made headset contact with the ground crew, who confirmed that all the external checks had been completed and that the aircraft was ready for dispatch. ATC were contacted for pushback and start clearance by the Pilot Not Flying (PNF). Clearance was given subject to the arrival of another company aircraft on Stand 52, which was immediately to the right of Stand 53. This conditional clearance was relayed to the ground crew whilst the pre-start checks were completed and the anti-collision beacons were switched on.

The other aircraft arrived on Stand 52 and the ground crew requested brakes release. The pushback proceeded but, after about 20 metres into the push with the aircraft still travelling in a straight line, an impact was felt and the tug slowed to a halt. The commander contacted the ground crew, who said they believed there had been a problem and the aircraft had struck something. The aircraft was towed back onto Stand 53, with no abnormal indications on the flight deck.

The commander and the cabin staff ensured that all the normal arrival checks were completed before the passengers were disembarked normally. The local engineering support advised that the right wing had received significant damage and the aircraft was now unserviceable. The aircraft had struck a set of steps intended to receive the aircraft on Stand 52. It was intended that they would be positioned at the rear left door of the inbound aircraft and had been moved backwards so that the left wing would clear them. Unfortunately, this meant that the steps now encroached into the pushback sensitive area of G-EZDN, despite the fact that the aircraft anti-collision lights were flashing and the external walk round by the ground handling agent had reported that the area was clear.

The aircraft operator confirms that the following safety actions have been taken:

1) A communication has been distributed to the ground handling staff throughout the operator's network to highlight the importance of a thorough walk round immediately prior to aircraft departure.

2) The ground handling agents' procedures have been altered to prohibit the parking of ground equipment in areas other than those designated by markings.

**SERIOUS INCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | Boeing 737-33V, G-THOO |
| **No & Type of Engines:** | 2 CFM56-3C1 turbofan engines |
| **Year of Manufacture:** | 1998 |
| **Date & Time (UTC):** | 11 February 2012 at 1445 hrs |
| **Location:** | London Gatwick Airport |
| **Type of Flight:** | Commercial Air Transport (Passenger) |
| **Persons on Board:** | Crew - 6 Passengers - 140 |
| **Injuries:** | Crew - None Passengers - None |
| **Nature of Damage:** | Damage to right ram air duct turbofan and surrounding pipes |
| **Commander's Licence:** | Airline Transport Pilot's Licence |
| **Commander's Age:** | 35 years |
| **Commander's Flying Experience:** | 8,813 hours (of which 3,184 were on type)<br>Last 90 days - 81 hours<br>Last 28 days - 21 hours |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot |

**Synopsis**

During the climb the flight crew noted the sudden onset of airframe vibration. There were no abnormal engine or system indications but a smell of burning was reported in the cabin. The commander declared a MAYDAY and initiated a diversion back to London Gatwick Airport where an uneventful landing was carried out. The source of the vibration and burning smell was subsequently identified to be a failed bearing assembly in the right air conditioning pack turbofan.

**History of the flight**

After departure from London Gatwick Airport, while climbing through FL200, the flight crew became aware of the sudden onset of airframe vibration and an accompanying "whining" noise. The engine indications were stable and all systems appeared to be operating normally. Cabin crew reported that the vibration and noise were noticeable throughout the aircraft, particularly so in the mid-cabin area and that the passengers were becoming alarmed.

On first contact with Brest ATC the aircraft was cleared to climb to FL330 but the co-pilot requested a level-off at FL290 due to a "slight technical problem". The air traffic controller approved the level-off and cleared the aircraft to proceed on its planned route.

After levelling off at FL290 the flight crew were unable to identify the source of the vibration and the commander made the decision to return to Gatwick. The co-pilot declared a PAN with Brest ATC, advising of a "technical problem with one of our engines". After a further exchange with ATC the aircraft was cleared to turn right to waypoint DIKRO. The flight crew discussed the situation, and approximately 2½ minutes after the initial PAN declaration, the co-pilot declared a MAYDAY. The flight crew declined further instruction to route to waypoint DIKRO, and instead initiated a direct route back to Gatwick. The controller then coordinated the aircraft's descent and subsequent handover to London control.

Cabin crew at the rear of the aircraft subsequently reported a smell similar to that of burning rubber. The flight crew briefed the senior cabin crew member to prepare for a precautionary landing.

Upon selection of FLAP 1 at approximately 6,000 ft the vibration and noise ceased. An uneventful landing was made at Gatwick. After vacating the runway the Airport Fire Services carried out an external inspection of the aircraft and reported no evidence of any external problems. While this inspection was ongoing, cabin crew at the rear of the aircraft reported that the burning smell in the cabin had become stronger.

Whilst the commander was making a PA call to place the cabin crew on standby should an evacuation become necessary, the right PACK TRIP OFF light illuminated. The flight crew turned the right air conditioning pack switch off and consulted the QRH. The intensity of burning smell in the cabin reduced and the flight crew therefore concluded that it had been associated with the right air conditioning pack overheat. The aircraft taxied to the terminal where the passengers disembarked normally. A subsequent internal inspection of the aircraft by the Fire Services revealed nothing unusual.

**Aircraft examination**

Inspection of the aircraft by the operator's engineers determined that the bearing assembly on the turbofan shaft within the right air conditioning pack had failed. There was evidence the impeller blade tips had rubbed against the turbofan casing. The turbofan had detached from its mounts and the turbine air duct was split. The operator sent the turbofan and turbofan valve to a repair facility for strip examination.

**Aircraft information**

*Relevant defects*

On the day prior to the incident a defect was raised in the technical log because the right ram air inlet door was indicating fully open throughout the flight. The B737 Dispatch Deviations Guide (DDG) permits continued operation if the ram air inlet door is locked open for the flight. The associated maintenance actions also require the electrical connector to the ram air actuator to be disconnected and the electrical supply isolated. This was accomplished on 11 February and the aircraft operated two further sectors in this configuration prior to the incident flight. The defect recurred after the incident and was finally resolved in late April 2012 after extensive troubleshooting.

*Air conditioning pack turbofan servicing*

A turbofan oil service is required every 2A Check (250 hours) and this was last carried out during a maintenance input approximately one month prior to the incident. The turbofan had last been overhauled on October 2007.

**Discussion**

*Air conditioning pack turbofan failure*

In normal conditions the turbofan operates only during ground operation or in slow flight with the flaps extended. However, the sustained vibration during the incident flight suggests that the turbofan was operating during high speed flight. The aircraft manufacturer initially considered that this condition could arise if the electrical connector on the ram air actuator had remained connected when the ram air inlet door was locked open. As the connector had been isolated in accordance with the DDG, other potential anomalies with electrical relays and switches in the ram air system which could have accounted for this condition, were also considered. However due to the various maintenance interventions associated with the troubleshooting of the ram air door defect, it was not possible to determine the precise reason for this.

The cause of the airframe vibration was identified as the imbalance in the turbofan shaft resulting from failure of the bearing assembly. The associated burning smell was attributed to the turbofan impeller blades rubbing on the casing as a result of the imbalance. In this condition the turbofan was unable to provide adequate cooling for the right air conditioning pack, resulting in an overheat condition and the illumination of the right PACK TRIP OFF light.

The workshop examination concluded that it was likely that the turbofan bearing had run dry of oil as a result of oil leakage at the seals. However there was limited detail in the strip examination report and the operator considered that it was not possible to verify this. Nor was it possible to ascertain whether operation during high speed flight contributed to, or accelerated, the failure of the turbofan bearing assembly.

*Air traffic control aspects*

A review of the radio telephony recordings revealed that the first part of the transmission in which the co-pilot declared the PAN was blocked (most likely by a transmission from another aircraft). The controller was therefore initially unaware that a PAN had been declared. Taking into account the airspace and traffic density she planned to route the aircraft via waypoint DIKRO before handover to London control, but did not communicate this intention to the flight crew. Believing that the controller was not facilitating their request for an immediate return to Gatwick, the flight crew upgraded the PAN to a MAYDAY, in order to take responsibility for their own routing.

As a result of this incident Brest ATC Safety Department conducted a review to determine whether they could make any improvements to the way they handle emergency flights.

**SERIOUS INCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | Boeing 737-8AS, EI-ENT |
| **No & Type of Engines:** | 2 CFM 56-7B turbofan engines |
| **Year of Manufacture:** | 2011 |
| **Date & Time (UTC):** | 7 February 2012 at 1204 hrs |
| **Location:** | On approach to London Gatwick Airport |
| **Type of Flight:** | Commercial Air Transport (Passenger) |
| **Persons on Board:** | Crew - 6 Passengers - 125 |
| **Injuries:** | Crew - None Passengers - None |
| **Nature of Damage:** | None |
| **Commander's Licence:** | Airline Transport Pilot's Licence |
| **Commander's Age:** | 31 years |
| **Commander's Flying Experience:** | 4,347 hours (of which 4,047 were on type)<br>Last 90 days - 199 hours<br>Last 28 days - 70 hours |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot and subsequent AAIB enquiries |

**Synopsis**

During a visual approach to London Gatwick Airport in hazy conditions, ATC vectored the aircraft onto the final approach track sooner than the pilots expected, which resulted in the aircraft being above the intended 3° glidepath. The increased workload to regain it, together with other cockpit duties, distracted the pilots. The aircraft descended below the intended glidepath until they were alerted by a call from ATC and an EGPWS caution, and saw the PAPIs.

**History of the flight**

The aircraft was descending into London Gatwick Airport after a scheduled flight from Shannon Airport. The pilots were expecting to carry out an ILS approach to Runway 08R and had briefed accordingly. During the descent, ATC informed the pilots that an ILS approach was not available and that the aircraft would be given radar vectors for a visual approach. The PF programmed the flight management computer so that vertical navigation (VNAV) path information on the navigation display (ND) would correspond to a 3° glidepath. The aircraft was flown with the autopilot engaged during the descent towards the final approach path with LVL CHG[1] mode engaged. The pilots were

**Footnote**

[1] LVL CHG autopilot mode in the descent is one in which the engine thrust is reduced to idle power and the aircraft pitch attitude is adjusted to maintain the speed selected on the Mode Control Panel (MCP).

asked by ATC if they could accept an early turn onto the final approach with a corresponding reduction in the number of track miles to touchdown, which they accepted. The aircraft was now higher on the vertical profile than the pilots expected but they assessed that, by using flap and speed brake, they could regain the correct glidepath and carry out a stable approach. Shortly afterwards, ATC requested that they reduce speed.

By approximately 4,500 ft, the aircraft was configured with landing gear down and flaps at 15° and the PF selected lateral navigation (LNAV) to intercept the final approach track. At 2,200 ft, the aircraft was established on the final approach track and was approaching the 3° glidepath from above, descending at 1,500 ft/min. The pilots noticed the VNAV indication that they were approaching the glidepath but omitted to engage VNAV. The aircraft continued to descend through the glidepath until, at approximately 1,000 ft, the EGPWS generated a terrain caution and the pilots saw the PAPIs. ATC informed them that the aircraft appeared slightly low and asked them if they were "visual". The PF disconnected the autothrottle and autopilot, reduced the rate of descent and, after re-establishing the correct approach angle, continued the approach. The aircraft landed without further incident. Both pilots stated that, due to haze, they could not see the PAPIs until about the time of the terrain alert, and that as they could see the ground and runway throughout the approach there was no risk of ground collision.

**Analysis**

The pilots accepted a shortened approach from ATC which resulted in the aircraft being above the ideal approach path. The pilots used a combination of flap and speed brake to increase the rate of descent in order to re-establish the approach path and to comply with the ATC speed constraint. The combination of the shortened approach track, the requirement to regain the correct glideslope and other routine cockpit duties increased crew workload. Although the pilots noticed the VNAV path information on the ND, the increased workload distracted them from engaging the VNAV mode on the autopilot that would have enabled the aircraft to follow a 3° glidepath. The aircraft remained in LVL CHG mode and descended through that glidepath. The pilots were alerted to the situation by a combination of the ATC call, the terrain caution and seeing the PAPIs.

**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | Cessna 550 Citation Bravo, G-CGEI |
| **No & Type of Engines:** | 2 Pratt & Whitney Canada PW530A turbofan engines |
| **Year of Manufacture:** | 2000 |
| **Date & Time (UTC):** | 30 April 2012 at 1655 hrs |
| **Location:** | Runway 08, Bournemouth Airport |
| **Type of Flight:** | Private |
| **Persons on Board:** | Crew - 3 Passengers - None |
| **Injuries:** | Crew - None Passengers - N/A |
| **Nature of Damage:** | Lower forward fuselage and nose landing gear doors damaged |
| **Commander's Licence:** | Airline Transport Pilot's Licence |
| **Commander's Age:** | 65 years |
| **Commander's Flying Experience:** | 14,000 hours (of which 6,000 were on type)<br>Last 90 days - 19 hours<br>Last 28 days - 3 hours |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot |

**Synopsis**

The aircraft had flown to Gloucester from Biggin Hill after being repainted. During the approach, the nose landing gear failed to extend. The aircraft landed with the nose landing gear retracted, damaging the forward lower fuselage and nose landing gear doors. Tests and inspections were unable to identify a probable cause for the failure of the nose landing gear to extend.

**History of the flight**

The aircraft was being flown from Biggin Hill where it had undergone an interior refurbishment and a repaint. During the approach to land at Gloucester the nose landing gear failed to extend using both the normal and emergency systems. The aircraft landed with the nose landing gear retracted, damaging the lower forward fuselage and nose landing gear (NLG) doors. The flight crew were uninjured and exited the aircraft through the main cabin door.

**Investigation**

After jacking the aircraft and depressurising the emergency landing gear extension system the nose landing gear doors were opened manually. Considerable force was required to open them due to the damage they had sustained during the landing. When the doors were opened, the NLG extended freely under gravity to the down position.

After recovering the aircraft, hydraulic fluid was found in the underside of the right wing and on the lower rear fuselage. This was traced to a hydraulic leak from the right main landing gear (MLG) uplock union. Landing gear function checks, with the NLG doors disconnected, confirmed that landing gear would extend normally and by use of the emergency landing gear extension system, despite the leak from the right MLG uplock union. The caster angle of the nose landing gear was measured as $4^{o}$ 30'. The caster angle limit in the aircraft maintenance manual was $4^{o}$ +/- 15'. It was not possible to measure the rigging of the NLG doors due to the damage they had sustained during the landing.

A review of the work carried out a Biggin Hill confirmed that no maintenance had been carried out on the NLG doors and that they had been painted in the closed position. There had been no reported problems with the landing gear prior to the aircraft flying to Biggin Hill, or during its subsequent departure for Gloucester.

**Analysis**

In view of the lack of reported problems with the landing gear prior to the incident, the satisfactory results of the functional test of the landing gear extension systems, and the inability to carry out rigging checks of the NLG doors, there is insufficient evidence available at this time to identify the cause for the NLG failing to extend.

**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | 1) DHC-8-402 Dash 8, G-JEDO<br>2) DHC-8-402 Dash 8, G-ECOO |
| **No & Type of Engines:** | 1) 2 Pratt & Whitney Canada PW150A turboprop engines<br>2) 2 Pratt & Whitney Canada PW150A turboprop engines |
| **Year of Manufacture:** | 1) 2003<br>2) 2008 |
| **Date & Time (UTC):** | 16 January 2012 at 0700 hrs |
| **Location:** | Southampton International Airport |
| **Type of Flight:** | 1) Commercial Air Transport (Passenger)<br>2) Commercial Air Transport (Passenger) |
| **Persons on Board:** | 1) Crew - 4 Passengers - 66<br>2) Crew - 4 Passengers - 52 |
| **Injuries:** | 1) Crew - None Passengers - None<br>2) Crew - None Passengers - None |
| **Nature of Damage:** | 1) Right elevator<br>2) Tailcone |
| **Commander's Licence:** | 1) Airline Transport Pilot's Licence<br>2) Airline Transport Pilot's Licence |
| **Commander's Age:** | 1) 41 years<br>2) 37 years |
| **Commander's Flying Experience:** | 1) 8,856 hours (of which 2,295 were on type)<br>Last 90 days - 156 hours<br>Last 28 days - 23 hours<br>2) 4,277 hours (of which 1,818 were on type)<br>Last 90 days - 192 hours<br>Last 28 days - 61 hours |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB |

**Synopsis**

The aircraft collided during pushback. G-ECOO was stationary on the taxiway when G-JEDO was given clearance for a standard pushback, to face south, from Stand 6. Just before the pushback would have been completed, G-JEDO collided with G-ECCO. Both sustained minor damage to their tail sections.

Safety action has been taken to prevent a recurrence.

**History of the flight**

At 0653 hrs, before daylight, G-ECOO requested and received permission from ATC to push back and start from Stand 9, to face north and to hold south of Bravo One Taxiway (approximately abeam Stand 7). This was a non-standard pushback to allow a Jetstream 41 on Stand 11 to taxi out via Bravo One, to Runway 02. This was completed without incident, the tug was then disconnected and all personnel and equipment cleared from the area. One minute later the Jetstream 41, having already started its engines on stand, requested and received permission to power back from Stand 11[1]. At the end of the manoeuvre it stopped on Taxiway Alpha abeam Stand 10 and Stand 11. When G-JEDO requested permission to push back and start from Stand 6; ATC instructed it to "STANDBY". The Jetstream 41 was then given permission to taxi via Holding Point Bravo One, back track, line up and takeoff from Runway 02. Figure 1 shows the apron layout.

G-JEDO was given permission for a standard pushback and start from Stand 6[2]. In attendance were a headset operative and a wingman positioned to the south of the aircraft, and the tug driver. Prior to commencing the pushback the headset operative indicated the direction of the pushback to the tug driver using hand signals. Two minutes later, having seen that the tug was disconnected from G-ECOO, ATC asked the pilots if they were ready to taxi; they replied they would be in about 30 seconds. ATC replied, "TAXI PLEASE WHEN READY [HOLDING POINT] BRAVO ONE". The wingman had by then left Stand 6 for another task. As G-JEDO's pushback neared

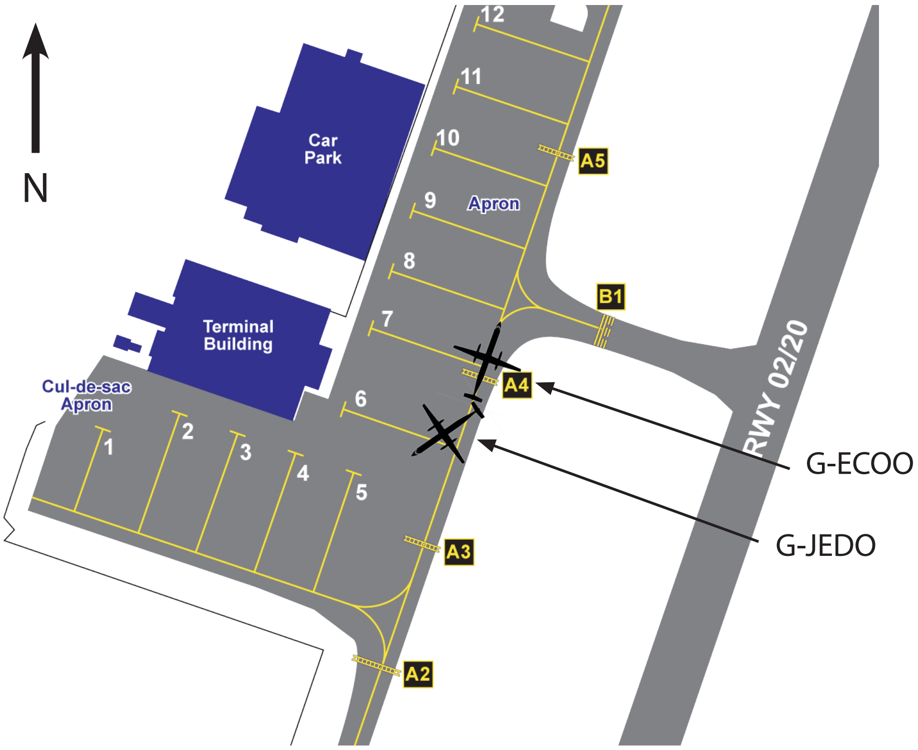



**Figure 1**

Apron layout and approximate position of aircraft at the time of the collision

**Footnote**

[1] Jetstream 41s power back at Southampton; they are not pushed back by a tug.

**Footnote**

[2] A standard push back for Runway 02 ends with the nose of the aircraft facing south.

completion it slowed and then stopped on a heading of approximately 220º. The headset operative asked the commander to confirm that the aircraft's brakes were OFF, which they were, then reported that they could not push the aircraft any further and asked for the aircraft's brakes to be set ON. A passing Airside Operations vehicle reported to ATC that there was an "AIRCRAFT TO AIRCRAFT CONFLICT ON STAND 6." G-ECOO then transmitted to ATC "WE JUST FELT A BUMP" and asked for confirmation that they had been hit. After photographic evidence had been acquired, both aircraft were pulled back onto stand.

G-JEDO sustained damage to its right elevator, G-ECOO sustained damage to its tail cone.

**ATCO's comments**

The ATCO stated that when he gave G-JEDO permission to push back, G-ECOO was stationary on the taxiway and that there appeared to be space for G-JEDO to be pushed back. He could see G-ECOO but not its position in relation to the paint markings on the taxiway.

**Ground crew procedures**

Operating procedures required the headset operative to stand on the side of the aircraft where the headset was plugged in. This varied between aircraft types, but was on the left side of the aircraft for the Dash 8, which in this incident was the outside of the turn. The tug was fitted with a radio tuned to the Tower frequency for monitoring purposes. The wingman's role was to stop traffic driving behind the aircraft prior to it being pushed back.

**G-JEDO ground crew's comments**

The headset operative stated that he was aware of the presence of G-ECOO and was not convinced that the pushback could be completed safely. However, feeling under some pressure to proceed, he commenced the pushback. He added that during the pushback he was on the outside of the turn such that he lost sight of G-ECOO about ¾ of the way along the stand, but did not squat down to try to see its relative position. G-ECOO came back in to his line of sight as the aircraft was being straightened and he was considering stopping the pushback when the collision occurred.

The tug driver stated although he usually listened to ATC transmissions on the radio he did not recall doing so on this occasion. He added that prior to pushing G-JEDO he had seen G-ECOO and thought there was enough room to complete the pushback. Accordingly, he did not monitor G-ECOO's relative position during the pushback.

The wingman stated that before commencing the pushback the headset operative did not indicate to him which way the aircraft should face. Being aware of G-ECOO on the taxiway he assumed G-JEDO would be pushed to face north. He left for other duties as the aircraft cleared the road, by which time it had not started turning to face south.

**Recorded data**

*Commanders' comments*

The commanders of both aircraft managed to preserve the CVRs on their aircraft by isolating the appropriate circuit breaker. However, both had difficulty finding the relevant instructions in the Operations Manuals aboard their aircraft.

**Discussion**

The ATCO gave G-JEDO pushback clearance before G-ECOO had taxied to Holding Point Bravo One and cleared Taxiway Alpha, believing there was enough space available. He did not transmit any information relating to the position of G-ECOO. Such information might have improved the pilots' situational awareness.

The headset operative accepted the instruction from the pilots to face south, as did the tug driver from the headset operative and, though aware of the presence of G-ECOO, pushed G-JEDO into the stationary G-ECOO.

**Safety actions**

As a result of this incident ATC, the airport operator and the aircraft handling agent will implement new pushback procedures and new holding points.

Additionally ATC will introduce procedures that do not permit aircraft to push back in proximity to each other, and review taxi clearances and holding points to ensure non-standard manoeuvres are removed.

The operator has amended the Quick Reference Handbook (accessible in the cockpit of each aircraft) to indicate to pilots the location of written procedures to be followed to preserve CVR and FDR recordings.

**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | DH110 Sea Vixen Faw MK2, G-CVIX |
| **No & Type of Engines:** | 2 Rolls-Royce Avon MK 208 turbojet engines |
| **Year of Manufacture:** | 1963 |
| **Date & Time (UTC):** | 5 April 2012 at 1505 hrs |
| **Location:** | Bournemouth Airport, Dorset |
| **Type of Flight:** | Private |
| **Persons on Board:** | Crew - 1 Passengers - None |
| **Injuries:** | Crew - None Passengers - N/A |
| **Nature of Damage:** | Left under wing fuel tank and forward fuselage damaged |
| **Commander's Licence:** | Airline Transport Pilot's Licence |
| **Commander's Age:** | 55 years |
| **Commander's Flying Experience:** | 7,832 hours (of which 12 were on type)<br>Last 90 days - 96 hours<br>Last 28 days - 35 hours |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot |

**Synopsis**

During the latter stages of the landing roll, whilst completing the after landing checklist, the pilot inadvertently selected the landing gear to UP which resulted in the retraction of the nose and left main landing gear. The operation of the left main landing gear microswitch on landing should have prevented retraction. However, it is thought that a combination of an increase in main landing gear oleo pressure, to allow for increased weight operations, and a low landing weight prevented the activation of the microswitch.

**History of the flight**

The aircraft had been carrying out a number of circuits at Yeovilton as part of a post-maintenance re-familiarisation flight. When retracting the landing gear following a touch-and-go the pilot observed that the right main landing gear indicator remained red. The pilot recycled the landing gear, but the indicator remained red. The pilot carried out a "fly by" of the ATC tower to allow a visual inspection of the aircraft to be carried out. This confirmed that the right main landing gear door had remained extended.

Following completion of another "fly by" at Bournemouth, the pilot made an approach to land. After selecting the landing gear to DOWN, the pilot observed that landing gear indicators showed that all three gears were "down-and-locked". ATC had alerted the AFRS and a number of appliances were deployed to assist the aircraft in the event of a landing gear collapse.

The aircraft landed with minimum fuel and its landing and deceleration was normal. When the aircraft had slowed to approximately 15 kt, the pilot began to carry out the '*After Landing*' checklist, during which he inadvertently selected the landing gear to UP. The nose and left main landing gear retracted and the aircraft dropped onto its nose and the left under-wing fuel tank. The aircraft turned through approximately 45° before coming to rest on the paved surface. The pilot made the aircraft safe before exiting the aircraft. The AFRS applied foam to a fuel leak from the damaged left under-wing fuel tank.

**Landing gear controls**

The landing gear selector switch of G-CVIX was located on the left of the main instrument panel and in front of the throttle quadrant adjacent to the left cockpit bulkhead.

The switch consisted of a lever with a spring-loaded knob that could be selected to one of four positions at the extremities of an H-shaped guide, by pulling out the knob and moving the lever to the desired position. Moving the lever to the top or bottom of the right vertical of the H-shaped guide controlled the normal retraction and extension functions respectively. Emergency retraction and extension could be achieved by translating the lever sideways to the left across the horizontal part of the H and then using the left vertical of the H to select UP or DOWN.

In normal gear selection mode, inadvertent retraction on the ground was prevented by the activation of a microswitch on the left main gear leg. G-CVIX had been modified so that the right main gear leg microswitch only activated the fatigue meter. A further microswitch on the nose landing gear leg prevented retraction whenever the nosewheel was not centred. Selecting emergency retraction by-passed these switches and permitted emergency retraction on ground. However, G-CVIX had been modified to prevent the selection of emergency retraction either intentionally or inadvertently.

**Recent flying experience**

The pilot reported that in the preceding 28 days he had flown both the Hawker Hunter and the BAe Hawk aircraft. Both of these aircraft types have the flap selector switch located to the left of the main instrument panel, adjacent to the left cockpit bulkhead in a similar position to the landing gear selector of the Sea Vixen.

**After Landing Checks**

The Flight Reference Cards (FRC) stated:

| | |
|---|---|
| ***'Checks After Landing*** | |
| *Wheelbrakes* | *Select mid position...* |
| *Hook* | *Up* |
| *Flaps* | *Up* |
| *Autostab* | *Standby* |
| *Fuel panel selector lever* | *Fully aft* |
| *ADD* | *Off* |
| *Pilot's hood* | *Open before* |
| | *Observer's hatch'* |

There was no guidance as to when the *'Checks After Landing'* should be performed.

The Pilots' Notes Chapter 3, Circuit and Landing Procedure, Paragraph 10, *'After Landing Checks and Shut-Down Procedure'*, also gave no recommendation as to the timing of this checklist.

It has been determined that it is not uncommon in military operations for the *After Landing* checklist to be initiated whilst the aircraft is in the later stages of the landing roll.

**Maintenance**

The aircraft had been configured to operate with pylon mounted fuel tanks. In anticipation of operating the aircraft at the higher weights associated with this configuration, the pressure in the main landing gear oleos was increased to the 'carrier landing' pressure, thus increasing the force required to compress the oleo and operate the landing gear microswitches.

**Technical examination**

The damage to the aircraft prevented tests being carried out on the landing gear systems. Building and modification work to the aircraft's maintenance facility further delayed these tests. However, a test of the left main landing gear microswitch confirmed that it operated correctly.

**Analysis**

The pilot's recent flying experience had been on the Hawk and Hunter aircraft, where the flap selector was located in a similar position to the landing gear selector of the Sea Vixen. It is therefore considered probable that, when the pilot actioned the *'After Landing'* checklist, his recent experience resulted in him inadvertently selecting the landing gear switch to UP instead of operating the flap selector.

It is possible that the increase in main landing gear oleo pressure coupled with the low landing weight prevented the left main landing gear oleo from compressing sufficiently to activate the microswitch, thus allowing the retraction of the landing gear on the ground when the gear switch was selected to UP.

**SERIOUS INCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | 1) Piaggio P.180 Avanti II, PH-DLN<br>2) Avro 146-RJ85, EI-RJW |
| **No & Type of Engines:** | 1) 2 Pratt & Witney PT6-66B turboprop engines<br>2) 4 Lycoming LF507-1F turbofan engines |
| **Year of Manufacture:** | 1) 2008 (Serial no: 1175)<br>2) 2000 (Serial no: E2371) |
| **Date & Time (UTC):** | 26 April 2012 at 1750 hrs |
| **Location:** | Near London City Airport |
| **Type of Flight:** | 1) Commercial Air Transport (Passenger)<br>2) Commercial Air Transport (Passenger) |
| **Persons on Board:** | 1) Crew - 2 Passengers - 4<br>2) Crew - 4 Passengers - 86 |
| **Injuries:** | 1) Crew - None Passengers - None<br>2) Crew - None Passengers - None |
| **Nature of Damage:** | 1) None<br>2) None |
| **Commander's Licence:** | 1) Commercial Pilot's Licence<br>2) Airline Transport Pilot's Licence |
| **Commander's Age:** | 1) 47 years<br>2) 40 years |
| **Commander's Flying Experience:** | 1) 2,088 hours (of which 1,072 were on type)<br>Last 90 days - 50 hours<br>Last 28 days - 17 hours<br>2) 6,800 hours (of which 6,500 were on type)<br>Last 90 days - 91 hours<br>Last 28 days - 33 hours |
| **Information Source:** | Aircraft Accident Report Forms submitted by the pilots, investigation report and documentation from National Air Traffic Services |

**Synopsis**

The Piaggio P.180 deviated from its approved departure routing and flew into conflict with the RJ85 which was on approach to land. The ATC controller intervened to turn the Piaggio away from the RJ85, after which it became apparent that an operational error by the Piaggio crew had led to erroneous heading indications on their cockpit displays.

**History of the flights**

Runway 27 was in use at London City Airport. There was a strong south-westerly wind, with good visibility and scattered cloud at about 3,000 ft. The Piaggio P.180 (PH-DLN) had just taken off and had turned right in accordance with its clearance when it flew into conflict with the RJ85 (EI-RJW) which was on final approach, following a flight from Dublin. Both aircraft were under a Radar Control Service.

The crew of PH-DLN reported on the Thames Radar frequency that they were climbing to 3,000 ft, about half a minute before the crew of EI-RJW reported established on the Runway 27 localiser. The crew of EI-RJW were instructed to establish on the glideslope and were transferred to the Tower controller. PH-DLN appeared to establish on an easterly track at 3,000 ft before the controller noticed it had turned onto a south-easterly track, towards the final approach path for Runway 27.

The controller instructed the crew of PH-DLN to turn left onto 030°. This was acknowledged but was apparently not complied with, so a further instruction to turn left was made using the phrase "AVOIDING ACTION" and with details of the conflicting traffic. At this point, EI-RJW was 3 miles ahead of PH-DLN, descending through 2,800 ft. The aircraft did not respond immediately so the avoiding action was reiterated. As PH-DLN began a left turn, the controller instructed its crew to climb to 4,000 ft.

The controller suspected that PH-DLN had suffered a failure affecting navigation, so instructed the crew to turn left until advised. The crew complied with this instruction, together with the subsequent instruction to stop the turn, although the crew then reported their heading as northerly when in fact it was seen on radar to be approximately 060°. The crew were informed of the discrepancy and advised to cross-check their instrumentation. After a short while the crew reported that their instrumentation had been reset. The aircraft was subsequently transferred to the next controlling sector. The crew of EI-RJW had heard ATC instructions being given to another aircraft, but were unaware of the situation as it had developed. No TCAS warnings were received by the crew of either aircraft.

The minimum separation between the aircraft was recorded on radar as 2.7 nm lateral and 700 ft vertical.

*PH-DLN heading indications*

Whilst at the holding point, the crew had selected Directional Gyro (DG)[1] mode for heading indications on their Horizontal Situation Indicator, and adjusted the indicated heading to match the runway QDM once lined up for takeoff. After takeoff, slaved mode was selected. The crew were occupied with flying the aircraft in turbulent conditions and did not recognise that a navigational error had occurred. After complying with the ATC instruction to turn left, the crew realised the indicated heading was in error by about 60°.

The pilot's report noted that the heading reference system should normally be kept in its slaved mode for normal operations, and DG mode only used in case of failure of the slaved system. The report identified an operational error and the distraction posed by turbulence as causal factors.

**Previous occurrences**

In October 2006 a Hawker 800XP aircraft experienced significant navigation problems after taking off from

**Footnote**

[1] The horizontal situation indicator (HSI) is normally slaved to the output of a magnetic flux valve. The directional gyro mode disconnects the HSI from the flux valve output.

London City Airport. An AAIB Field Investigation (report reference EW/C2006/10/10) revealed that several similar incidents had occurred previously. It was established that local magnetic anomalies in the area of the runway holding point could adversely affect cockpit heading indications and, in some cases, lead to heading system failure indications. Six Safety Recommendations were made, concerning airport standards in respect of magnetic anomalies, published aeronautical information regarding the anomaly at London City Airport, and advice to aircraft operators using the Airport.

**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | Aero AT-3 R100, G-SRUM |
| **No & Type of Engines:** | 1 Rotax 912-S2 piston engine |
| **Year of Manufacture:** | 2008 (Serial no: AT3-044) |
| **Date & Time (UTC):** | 23 June 2012 at 1050 hrs |
| **Location:** | Near Old Sarum Airfield, Wiltshire |
| **Type of Flight:** | Private |
| **Persons on Board:** | Crew - 1 Passengers - None |
| **Injuries:** | Crew - 1 (Minor) Passengers - N/A |
| **Nature of Damage:** | Landing gear, fuselage, wings, and canopy damaged |
| **Commander's Licence:** | Private Pilot's Licence |
| **Commander's Age:** | 63 years |
| **Commander's Flying Experience:** | 235 hours (of which 52 were on type)<br>Last 90 days - 4 hours<br>Last 28 days - 1 hour |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot and further inquiries by the AAIB |

**Synopsis**

Whilst on a local flight from Old Sarum, the cockpit canopy became unlatched and partially opened. The pilot could not maintain altitude and carried out a forced landing in a field but the aircraft overturned due to the tall crop.

**History of the flight**

The Aero AT-3 R100 is a two-seat light aircraft, certified by EASA in the VLA (Very Light Aircraft) category in 2005. It is low-winged and has a tricycle landing gear. Its large, single-piece cockpit canopy is hinged at the front and fastened either side of the cockpit.

G-SRUM had taken off from Old Sarum for a local flight. The flight was without incident until, in the vicinity of Langford Lakes, some 12 km north-west of Old Sarum and at an altitude of 2,800 feet, the pilot noticed that the right side of the cockpit canopy had become unlatched. He reached for the locking lever on that side and applied downward pressure to lock it. This appeared to be successful although he noticed that the action felt "soggy" and lacked the distinct click which he normally expected to hear.

He continued with the flight but, a few minutes later, he noticed that the right lever had moved towards open again and that the left lever had also moved out of the locked position. He grasped both levers and moved them back towards the locked position as far as he could. However, when he saw the right lever move again he decided to cut short the flight and return to Old Sarum, recalling that, about six weeks ago, he had been flying this aircraft when one of the canopy latches had become unlocked and the club Chief Flying Instructor, with whom he was flying, had taken the same precaution.

In the descent at about 1,800 feet altitude, the canopy suddenly began to open again and the pilot was unable to pull it shut. As he was within about a mile of his destination, he radioed a MAYDAY call to Old Sarum, saying that he had "lost the cockpit". He was aware that this was not accurate (the canopy had remained attached) but, given the urgency of his situation and the wind noise which was making communication difficult, he felt he did not have time to give more detailed information. He asked Old Sarum ATC for an immediate landing clearance. He heard their initial acknowledgement but the wind noise meant he could not hear the rest of their reply.

The aircraft was rapidly losing height and turning towards the runway increased the rate of descent – he was now at about 300 feet and he selected an appropriate field straight ahead of him for a forced landing. He just made the field but saw that it contained a tall crop of rape. He heard the wheels brush the top of the crop before he felt the aircraft 'dig in' and start to flip over. He believes he must have lost consciousness for a few moments because he next remembered hanging upside down in his harness. He turned off the fuel and electrics before kicking his way out through the canopy. There was no fire.

**Conclusions**

The circumstances of the accident to G-SRUM are similar to those of Zenair CH601 HDS G-CEZV, also described in this issue of The AAIB Bulletin (see page 139). In both cases, first one side and then both canopy latches became unlocked in-flight and the canopy partially opened. Both pilots were surprised at the degradation in performance and had to make a forced landings, having been unable to maintain height due to the increase in drag, despite having only one person on board.

So that operators of these and similar aircraft types are made aware of the consequences of canopies becoming unlocked in-flight, the Civil Aviation Authority and the Light Aircraft Association will be publishing articles in their public journals and urging care in both the operation and maintenance of the locking mechanism. These articles will include informing them of the need for a thorough understanding of the locking mechanisms and a double-check that the locks are secure before flight.

**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | Aerotechnik EV-97A Eurostar, G-CBRR |
| **No & Type of Engines:** | 1 Rotax 912-UL piston engine |
| **Year of Manufacture:** | 2002 (Serial No PFA 315-13919) |
| **Date & Time (UTC):** | 5 July 2012 at 1645 hrs |
| **Location:** | Farm strip at Raveningham, Norfolk |
| **Type of Flight:** | Private |
| **Persons on Board:** | Crew - 1 Passengers - 1 |
| **Injuries:** | Crew - None Passengers - None |
| **Nature of Damage:** | Left tyre punctured and right landing gear leg collapsed |
| **Commander's Licence:** | Private Pilot's Licence |
| **Commander's Age:** | 66 years |
| **Commander's Flying Experience:** | 195 hours (of which 28 were on type)<br>Last 90 days - 8 hours<br>Last 28 days - 3 hours |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot |

Towards the end of an otherwise uneventful landing at a farm strip in calm conditions the left main tyre suffered a puncture. At approximately 20 kt the pilot felt the aircraft swing to the left, accompanied by a high level of vibration. He was unable to counter the swing and the aircraft entered a field of standing crops to the side of the strip, coming to an abrupt stop. Neither the pilot nor his passenger suffered injury.

**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | Cessna 182T Skylane, G-MPLA |
| **No & Type of Engines:** | 1 Lycoming IO-540-AB1A5 piston engine |
| **Year of Manufacture:** | 2005 (Serial no: 18281686) |
| **Date & Time (UTC):** | 30 July 2012 at 1615 hrs |
| **Location:** | Bristol Filton Airport |
| **Type of Flight:** | Training |
| **Persons on Board:** | Crew - 1 Passengers - None |
| **Injuries:** | Crew - None Passengers - N/A |
| **Nature of Damage:** | Damage to forward bulkhead, nose gear assembly, wheel spats and rudder control mechanism |
| **Commander's Licence:** | Student pilot |
| **Commander's Age:** | 24 years |
| **Commander's Flying Experience:** | 46 hours (of which 41 were on type)<br>Last 90 days - 33 hours<br>Last 28 days - 12 hours |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot and training establishment occurrence report |

The student pilot was briefed and authorised for a solo navigation exercise from Oxford Airport to Filton Airport and return, with a visual approach and touch-and-go landing at Filton. Runway 27 was in use at Filton, with a surface wind from 270° at 12 kt. The student pilot reported that, during the landing at Filton, she flared the aircraft too early and a high sink rate developed. She applied full power to go around, but could not prevent the aircraft contacting the runway.

The student pilot subsequently realised that the aircraft required considerably more left rudder pedal input than she was used to and, after landing at Oxford, discovered that that she was unable to apply right rudder pedal.

The aircraft had suffered damage to the forward fuselage, including to the rudder control mechanism. An investigation by the training establishment determined that the most likely cause of the reported handling difficulty and damage to the aircraft was a hard landing. It was thought likely that this resulted from the student pilot encountering an unfamiliar runway aspect at Filton, so changes to internal procedures concerning the use of wider than normal runways by solo students were introduced.

**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | DH82A Tiger Moth, G-AGYU |
| **No & Type of Engines:** | 1 De Havilland Gipsy Major 1C piston engine |
| **Year of Manufacture:** | 1941 (Serial no: 85265) |
| **Date & Time (UTC):** | 27 July 2012 at 1700 hrs |
| **Location:** | Airstrip 5 nm east of Retford, Nottinghamshire |
| **Type of Flight:** | Training |
| **Persons on Board:** | Crew - 2 Passengers - None |
| **Injuries:** | Crew - None Passengers - N/A |
| **Nature of Damage:** | Damage to propeller, landing gear, right wings and forward fuselage. Damage to private car and caravan. |
| **Commander's Licence:** | Airline Transport Pilot's Licence |
| **Commander's Age:** | 57 years |
| **Commander's Flying Experience:** | 22,000 hours (of which 54 were on type)<br>Last 90 days - 49 hours<br>Last 28 days - 17 hours |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot |

The flight was the second in a series of conversion training flights, and was to consist of visual circuits. The plan was for the instructor to complete the first circuit and landing. The private airstrip was 550 m long and orientated 02/20 with the 02 direction in use. The weather was fine, with a surface wind from the west-north-west at 5 to 10 kt.

The aircraft experienced unexpected sink during the first approach and touched down closer to the beginning of the strip than expected. After a brief discussion, the instructor assessed there was sufficient distance remaining to for his student to carry out a takeoff. However, he had misjudged how far forward the aircraft had rolled and how much it had slowed. He also forgot to take into account an upward slope at the end of the strip, such that the aircraft became airborne but was unable to gain height.

The instructor took control and abandoned the takeoff. The aircraft collided with a vehicle parked near the far end of the strip as well as a caravan and a hedge at the field boundary. Both occupants were uninjured and able to vacate the aircraft in the normal manner.

**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | DH82A Tiger Moth, G-AHLT |
| **No & Type of Engines:** | 1 De Havilland Gipsy Major 1C piston engine |
| **Year of Manufacture:** | 1939 (Serial no: 82247) |
| **Date & Time (UTC):** | 12 August 2012 at 1240 hrs |
| **Location:** | 3 nm south-west of Mold, Flintshire |
| **Type of Flight:** | Private |
| **Persons on Board:** | Crew - 1 Passengers - None |
| **Injuries:** | Crew - None Passengers - N/A |
| **Nature of Damage:** | Right side wings and tailplane destroyed, propeller destroyed |
| **Commander's Licence:** | Private Pilot's Licence |
| **Commander's Age:** | 47 years |
| **Commander's Flying Experience:** | 624 hours (of which 464 were on type)<br>Last 90 days - 30 hours<br>Last 28 days - 21 hours |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot |

**Synopsis**

The pilot was attempting to land the aircraft at a site with restricted length and obstacles at its far end. The aircraft touched down too far into the field to complete a safe landing and the pilot applied power to go around, during which the right wings struck tree branches.

**History of the flight**

The accident occurred soon after the pilot had completed a multiple-leg tour of France, totalling 28 flying hours. Some three years earlier, the pilot had identified a field near Mold, North Wales for possible use as a landing site. On the day of the accident he intended to fly there on a short positioning flight from a field a few miles to the south, and obtained permission from the landowner to use the new field. The pilot walked it twice on the morning of the accident and was aware that it was a difficult landing site, approximately 200 yards (183 m) long, of which about 170 yards (155 m) was useable. The field sloped steeply upwards for its first half and less steeply for the second half. The pilot had measured the Tiger Moth's nil-wind landing roll on a flat grass surface as 120 yards (110 m), so estimated it would stop within about 50 yards (46 m) when the upslope was taken into account. The landing direction was to the north.

Crossing the northern end of the field were a small earth bank, a low fence, two trees and power and telephone lines at a height of about 50 ft. It was evident to him that any go-around decision would need to be made in good time, and would require careful flying to avoid the wires and trees. However, as the pilot had recently completed a lengthy series of flights and therefore had a good deal of recent flying practice, he was confident that a safe landing could be made.

On arrival at the field after the short positioning flight, the pilot made a flypast to assess the site. Conditions were fine, with a light and variable wind and a temperature of 20°C. The pilot abandoned the first approach to the field because the aircraft was too fast. The airspeed on the second approach was 55 mph, but the pilot felt he could decelerate to 50 mph by the start of the field (the aircraft's stall speed was 45 mph). However, as the aircraft crossed the hedge at the start of the field, the pilot became aware that the aircraft was still too fast to land safely, yet also now too low to be able to climb above the obstacles at the far end.

The main wheels touched down at the top of the steeply sloping section of field. Speed was still above the stall and the aircraft bounced, touching down again about 70 yards (64 m) before the end of the field. The pilot opened the throttle part way with the intention of maintaining flying speed and flying between the trees. Concentrating mainly on flying through the gap between the fence and the wires, the aircraft's right wing tip struck branches of one of the trees. The pilot ducked and protected his head. He was aware only of rolling sensations until the aircraft came to a stop, resting on its right side and pointing back in the direction from which it had come. He quickly made switches safe, released his straps and vacated the badly damaged aircraft.

In his report, the pilot observed that the choice of landing site was not a good one and that he had not adhered to his own pre-flight plan to go-around if the approach was not entirely satisfactory.

**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | DH82A Tiger Moth, G-ANFV |
| **No & Type of Engines:** | 1 De Havilland Gipsy Major 1F piston engine |
| **Year of Manufacture:** | 1942 (Serial no: 85904) |
| **Date & Time (UTC):** | 12 August 2012 at 1825 hrs |
| **Location:** | Private airstrip near RAF Lossiemouth, Moray |
| **Type of Flight:** | Private |
| **Persons on Board:** | Crew - 1 Passengers - 1 |
| **Injuries:** | Crew - 1 (Minor) Passengers - 1 (Minor) |
| **Nature of Damage:** | Extensive damage to the aircraft and some crop damage |
| **Commander's Licence:** | Airline Transport Pilot's Licence |
| **Commander's Age:** | 57 years |
| **Commander's Flying Experience:** | 22,100 hours (of which 13 were on type)<br>Last 90 days - 168 hours<br>Last 28 days - 44 hours |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot |

**Synopsis**

The pilot initiated a go-around after a bounced landing. As the aircraft turned crosswind, it encountered an increasing tailwind and its performance deteriorated rapidly. The pilot steered the aircraft to an area of low crops with the intention of regaining lost airspeed but was unable to prevent it from striking the ground.

**History of the flight**

The aircraft was being flown from a private grass airstrip which was about 500 m long and orientated 16/34. A weather forecast obtained from nearby RAF Lossiemouth gave good visibility and scattered cloud, with a surface wind from 140° at 14 kt. Although he assessed the surface wind to be from 150° at 12 kt, the pilot elected to land in the northerly direction, on an approximately 3% upslope.

The aircraft bounced on landing and the pilot initiated a go-around. As the aircraft turned left, crosswind, there was a loss of airspeed and its performance deteriorated rapidly. The pilot was concerned that the aircraft might settle into a small wooded knoll ahead, so chose to turn to the right towards an open barley field. His intention was to convert some of his remaining height into airspeed and re-establish a climb.

When the pilot attempted to level the aircraft just above the ground, he found that it would not respond in pitch. The aircraft struck the ground moments later, at a speed of about 55 kt and in a descending right turn. The aircraft came to rest after a short distance, with its wings folded about the fuselage. The pilot and his passenger were able to free themselves from the wreckage unaided. All three emergency services attended the scene and the pilot and his passenger were taken to hospital but had suffered only minor injuries.

The pilot believed that he had focussed too much on the ground handling characteristics of the aircraft and had not taken into account how the prevailing weather conditions would affect other phases of flight. He thought that the aircraft had encountered a tailwind as it climbed out of relative shelter at ground level and then had stalled when he initiated the right turn.

**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | Grob G115D 2, G-BVHD |
| **No & Type of Engines:** | 1 Lycoming AEIO-320-D1B piston engine |
| **Year of Manufacture:** | 1994 (Serial no: 82006) |
| **Date & Time (UTC):** | 3 May 2012 at 1423 hrs |
| **Location:** | Dundee Airport, Scotland |
| **Type of Flight:** | Training |
| **Persons on Board:** | Crew - 1 Passengers - None |
| **Injuries:** | Crew - None Passengers - N/A |
| **Nature of Damage:** | Damage to underside of the right wing and to two airport taxiway designator boards |
| **Commander's Licence:** | Student pilot |
| **Commander's Age:** | 18 years |
| **Commander's Flying Experience:** | 11 hours (of which all were on type)<br>Last 90 days - 11 hours<br>Last 28 days - 11 hours |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot, local investigation reports, ATC occurrence report and recorded radio telephony data |

**Synopsis**

The aircraft failed to negotiate a runway exit and ran on to the adjacent grass surface before colliding with two taxiway designator boards. The cadet pilot was on her first solo flight and had arrived at the exit too fast after landing, having been advised by ATC to keep her speed up on the runway to accommodate landing traffic behind.

**History of the flight**

The cadet pilot was undergoing flying instruction as part of the Air Cadet Pilot Scheme and was on day nine of a twelve-day course. She had undergone 11 hours of dual instruction, including a successful pre-solo check flight immediately prior to her first solo flight.

After the check flight, the aircraft was taxied to the main apron where the cadet's instructor briefed her to fly one solo circuit before landing and taxiing back to the same position. The instructor then made his way to the ATC tower to supervise the flight from there.

The cadet pilot taxied the aircraft for departure from Runway 09, using a dedicated local call-sign which indicated her status as a first solo flight. The meteorological report at 1420 hrs gave a surface wind from 110° at 10 kt, good visibility and small amounts of cloud at 1,300 ft. Planned circuit height was 1,000 ft.

The cadet pilot completed her solo circuit, which appeared satisfactory throughout. Two other aircraft were in the circuit, a PA28 from the same training organisation and a Dornier Do328 conducting crew training. As the cadet pilot slowed the aircraft after landing, the ATC controller advised her to "KEEP YOUR SPEED UP" and instructed her to vacate the runway at Taxiway 'A', with two aircraft landing behind. She, therefore, increased power and taxi speed to expedite vacating the runway. Taxiway 'A' was at the end of the 1,400 m runway and required a 90° left turn. There were two high speed turnoffs, but one was occupied by another aircraft and the controller was intending to vacate the Dornier at the other. As her aircraft approached the Taxiway 'A' exit, the cadet pilot heard the controller clear an aircraft behind to "land after" the Grob. At this stage, the cadet pilot realised she was going too fast to make the turn safely, despite full steering and differential braking. The aircraft left the paved surface at its junction between the taxiway and the runway, and continued across the adjacent grass surface. The aircraft's right wing struck two taxiway designation boards before the cadet pilot was able to bring it to a stop.

The cadet pilot reported that she felt she had been placed under pressure by the ATC instruction to keep the speed up, which resulted in her arriving at the exit point too fast and with some power applied. The instruction to the following aircraft to land further increased her anxiety and the belief that she needed to vacate the runway without delay.

**ATC report**

The ATC controller submitted an occurrence report which stated that the cadet pilot had landed safely and was instructed to exit the runway at Taxiway 'A'. The aircraft was seen to continue east of 'A' and onto the grass, striking a taxiway light and two designator boards before coming to a stop on an adjacent taxiway. An Aircraft Ground Incident was declared and the airport's Rescue and Fire Fighting Services deployed immediately.

**Published guidance**

The Manual of Air Traffic Services Part 1 (MATS Part1), produced by the Civil Aviation Authority, contains procedures, instructions and information which are intended to form the basis of Air Traffic Services (ATS) within the UK. Appendix E, Section 4 deals with communications techniques and standard phraseology. It includes paragraphs relating to radio dialogue with student pilots, a situation in which the Manual advises ATS staff to '*exercise caution*'.

The manual includes the following text:

> *'ATS personnel can expect student pilots to demonstrate the basic skills necessary to fly their aircraft under normal circumstances, including standard circuit procedures and limited cross-country flying. However, unexpected or non-standard instructions may confuse a student pilot and these may require amendment or clarification.*
>
> *Regardless of the student's personal confidence, ATS personnel should be aware that initial solo flights can represent a time of increased nervousness and pressure for the student. The requirements made of student pilots by ATS personnel should reflect this very limited experience.'*

**AAIB comment**

Although the cadet pilot was ultimately responsible for the safe operation of her aircraft, she could not, given her extremely limited experience and the unique circumstances of her first solo flight, be relied upon to deal with an unexpected instruction while landing in the same way as a more experienced pilot. The controller's instructions to the pilot did not reflect the guidance given in MATS Part 1 in that they were both unexpected and non-standard. Whilst it is acknowledged that the controller acted in the best interests of all circuit users to facilitate an orderly flow of traffic, he did have other options which may have been more appropriate, such as to instruct the following traffic to go around.

Even highly experienced professional pilots will treat a 'keep your speed up' instruction with caution, as it is much more difficult to judge ground speed on a wide runway than it is on a narrow taxiway, and excess speed may only become apparent when a pilot's attention is directed to the runway edge as the expected exit approaches. It may well be that the cadet pilot was subject to this effect and that, when her error became apparent, she did not have the experience or depth of training to make a safe recovery.

**Safety action**

The Airport Authority, Dundee ATC and the flying training organisation concerned agreed to undertake a joint review of early solo flying at Dundee, with a view to establishing clear guidelines for supervising instructors and codes of practice for controllers.

**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | Hawker Cygnet replica, G-EBJI |
| **No & Type of Engines:** | 1 JAP J.99 piston engine |
| **Year of Manufacture:** | 1977 (Serial no: PFA 077-10240) |
| **Date & Time (UTC):** | 16 April 2012 at 1700 hrs |
| **Location:** | Old Warden Aerodrome, Bedfordshire |
| **Type of Flight:** | Private |
| **Persons on Board:** | Crew - 1 Passengers - None |
| **Injuries:** | Crew - None Passengers - N/A |
| **Nature of Damage:** | Crankshaft fractured at propeller attachment hub |
| **Commander's Licence:** | Private Pilot's Licence |
| **Commander's Age:** | 59 years |
| **Commander's Flying Experience:** | 1,553 hours (of which 100 were on type)<br>Last 90 days - 15 hours<br>Last 28 days - 9 hours |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot |

**Synopsis**

The aircraft's propeller detached in flight but the pilot was able to execute a successful forced landing at Old Warden aerodrome. The cause of the propeller detachment was determined to be fatigue cracking of the engine's crankshaft, originating from a machined keyway feature that had previously been identified, by the engine manufacturer, as a site for fatigue crack initiation. The Light Aircraft Association (LAA) will update its guidance material for LAA Inspectors in relation to this problem and will also define a suitable non-destructive test and inspection interval for similar in-service engines.

**History of the flight**

The aircraft was a newly built replica of a 1924 design and was 2 hours and 30 minutes into a flight test programme, operating under the provisions of an LAA Permit Flight Release Certificate due to the experimental nature of the airframe, engine and propeller combination. After an uneventful 30 minute flight the pilot positioned the aircraft at 800 feet aal on a left hand downwind leg to Runway 21 at Old Warden aerodrome. Approximately halfway along the downwind leg, the pilot felt a momentary vibration before he saw the propeller detach and fall away from the aircraft. He closed the throttle, switched the ignition to OFF and performed a successful forced landing on Runway 21. The propeller was observed to fall to the ground but, despite an extensive search, it was not recovered.

**Design of the crankshaft**

The two-cylinder JAP J.99 engine is rated at 36 hp and features a tapered crankshaft, onto which a mating propeller hub is fitted. The propeller hub is restrained in rotation by means of a propeller hub key, which locks into machined keyways in the propeller hub and the crankshaft (Figure 1). The crankshaft, minus the missing tapered portion that was lost with the propeller, is shown in Figure 2.

**Metallurgical investigation**

The fractured crankshaft was sent to the AAIB for detailed visual examination.

The fracture surface was found to be inclined at approximately 45° to the longitudinal axis of the crankshaft, which is characteristic of crack propagation under torsional loading. Clear metal fatigue 'beachmarks' were visible on the fracture surface (Figure 3) and by tracing the pattern of these beachmarks it was possible to identify the origin of the fatigue crack, at the left side of the rear end of the crankshaft's machined keyway. The fracture surface was heavily discoloured, consistent with the crack having been present for a considerable period of time.

**History of the engine**

The engine was manufactured in April 1937 and had accumulated a total of 227 hours 40 minutes in service before being removed and placed into long-term storage in January 1969. During this initial period of service, the engine had been subjected to a propeller strike in May 1965 and also an incident in June 1967 in which the propeller bolts loosened in flight, damaging the propeller and bolts. It was acquired by the present owner in 1997 and, following a strip inspection, it was rebuilt with new pistons, piston rings, valve springs and valve guides. Both the magnetos were replaced by a dual electronic ignition system, the original carburettor

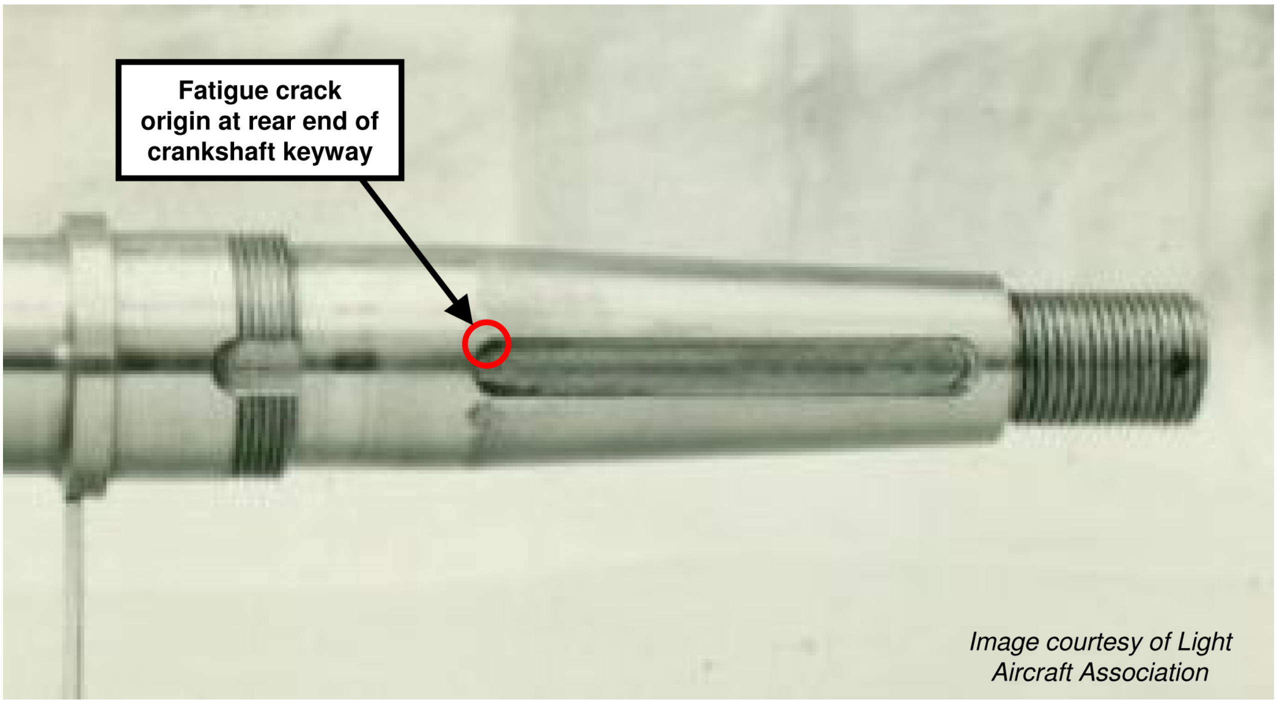



**Figure 1**

An intact JAP J.99 crankshaft, showing location of G-EBJI's fatigue crack was replaced by an alternative carburettor and a custom-built 59-inch diameter wooden propeller was fitted. Following installation of the engine in G-EBJI it had completed 22 hours 20 minutes of ground running and 2 hours 40 minutes of flight, prior to the crankshaft failure occurring.

**Previous crankshaft cracking**

The JAP J.99 engine was a licence-built version of the Aeronca E-113c engine, with the only significant difference being the installation of a dual ignition system on the JAP J.99. Instances of crankshaft cracking on E-113c engines prompted Aeronca to issue Service Memorandum M-36 in October 1939 which required removal of the propeller, at 25-hour service intervals, and inspection of the crankshaft for presence of a fatigue crack located at the rear end of the crankshaft keyway.

The existence of Service Memorandum M-36 became apparent during the course of the investigation but no reference to it was listed in SPARS, the LAA document containing information on Airworthiness Directives, Mandatory Permit Directives and Service Bulletins for reference by LAA Inspectors. Since Service Memorandum M-36 was not the subject of an Airworthiness Directive or a Mandatory Permit Directive, compliance with its instructions were not mandatory, even if Service Memorandum M-36 had been listed in the LAA SPARS document.

**Figure 2**

Recovered portion of the fractured crankshaft, following disassembly of the engine

**Analysis**

The aircraft's propeller detached due to fatigue cracking of the engine's crankshaft. The crankshaft fatigue crack initiated from the rear end of the machined crankshaft keyway and discoloration of the fracture surface indicated that the crankshaft had been cracked for a considerable period of time. Despite two recorded events in the engine's history, some 45 and 47 years previously, it was not possible to ascribe the cause of the crack to either of these events and it is possible that the fatigue cracking began from an unrecorded event, or through normal engine running.

The existence of Aeronca Service Memorandum M-36 became apparent during the course of the investigation. This 1939 document described previous instances of similar crankshaft fatigue cracking and

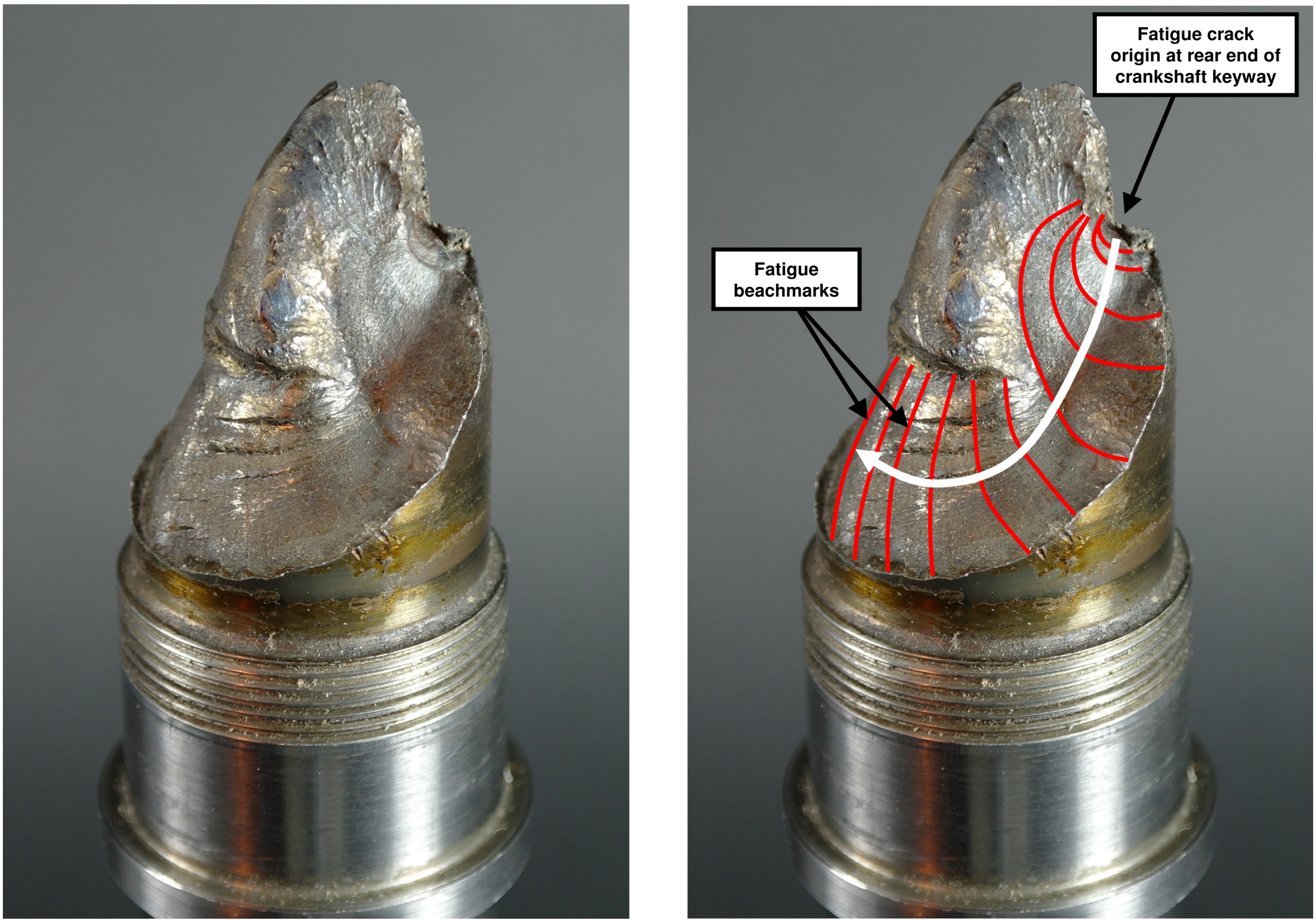



**Figure 3**

Crankshaft fracture surface

also contained instructions for recurrent inspection of the crankshaft at 25-hour service intervals. The LAA SPARS reference document for LAA Inspectors did not list Service Memorandum M-36 under the entry for the JAP J.99 engine and therefore an LAA Inspector assessing the engine during rebuild would not have been prompted to look for cracking at the crankshaft keyway.

## Safety actions

The LAA Engineering department will alert owners of aircraft fitted with JAP J.99 and Aeronca E-113 series engines to the potential for crankshaft fatigue cracking and additionally will include a reference to Service Memorandum M-36 for affected engines on the Type Acceptance Data Sheet (TADS) section of the LAA website. This is currently being updated to reflect the aircraft-specific technical information currently contained in the LAA SPARS document. LAA Engineering is also in the process of defining the inspection interval and method for non-destructive testing of in-service J.AP J.99 and Aeronca E-113 series crankshafts.

**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | Jodel D112, G-BHHX |
| **No & Type of Engines:** | 1 Continental Motors Corp A65-8F piston engine |
| **Year of Manufacture:** | 1954 (Serial no: 223) |
| **Date & Time (UTC):** | 9 June 2012 at 1557 hrs |
| **Location:** | Watchford Farm, Tiphayes, near Honiton, Devon |
| **Type of Flight:** | Private |
| **Persons on Board:** | Crew - 1 Passengers - 1 |
| **Injuries:** | Crew - 1 (Minor) Passengers - None |
| **Nature of Damage:** | Damaged beyond economic repair |
| **Commander's Licence:** | National Private Pilot's Licence |
| **Commander's Age:** | 65 years |
| **Commander's Flying Experience:** | 186 hours (of which 18 were on type)<br>Last 90 days - 6 hours<br>Last 28 days - 3 hours |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot and additional enquiries by the AAIB |

**Synopsis**

The aircraft experienced a loss of power immediately after takeoff and a forced landing was attempted. The aircraft probably stalled from a low height and struck the ground, causing extensive damage to the aircraft but without serious injury to either occupant.

**History of the flight**

The aircraft was taking off for a local flight with the pilot and passenger on board. The pilot performed the normal pre-flight checks, including ensuring that there was sufficient fuel for the flight. The engine was started and all indications were normal. Having warmed the engine, the pilot taxied the aircraft to the hold for Runway 22 where the magneto drop and carburettor heat checks were carried out, again with nothing unusual noted. After line-up, full power was applied and the aircraft took off but, as it started to climb, the engine started to lose power. The pilot checked the fuel and magneto switches, exercised the throttle and selected carburettor heat but could not get the engine to run normally.

The pilot estimates he was at about 100 feet, so he selected the only field available and pushed the nose down to head for it. The next thing he remembered was hanging upside down in his harness. He managed to release the harness, called for his passenger to do the same and both occupants crawled out "through a hole in the fuselage" (photographs of the aircraft show that the entire nose, including the engine and instrument panel, had broken off). The pilot suffered a cut to his head but the passenger appeared uninjured. The owner of the field arrived after a few minutes, followed by the emergency services, including the Devon Air Ambulance which airlifted both men to hospital.

The pilot had no precise recollection of the sequence of events between heading towards the field and finding himself upside down in what remained of the cockpit, although he suspects that the aircraft stalled and dropped a wing which is borne out by study of photographs of the ground marks and the wreckage. The reason for the engine losing power is also not known, although there were no obvious anomalies visible externally.

## ACCIDENT

| | |
|---|---|
| **Aircraft Type and Registration:** | Piper PA-28-140 Cherokee, G-KATS |
| **No & Type of Engines:** | 1 Lycoming O-320-E2A piston engine |
| **Year of Manufacture:** | 1972 |
| **Date & Time (UTC):** | 27 July 2012 at 1145 hrs |
| **Location:** | Eastbach (Spence) Airfield, near Ross-on-Wye, Herefordshire |
| **Type of Flight:** | Private |
| **Persons on Board:** | Crew - 1 Passengers - 1 |
| **Injuries:** | Crew - 1 (minor) Passengers - 1 (minor) |
| **Nature of Damage:** | The aircraft was destroyed by fire |
| **Commander's Licence:** | Private Pilot's Licence |
| **Commander's Age:** | 51 years |
| **Commander's Flying Experience:** | 544 hours (of which 242 were on type)<br>Last 90 days - 37 hours<br>Last 28 days - 16 hours |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot |

### Synopsis

Whilst landing on a grass strip, the aircraft bounced and floated before touching down again. The pilot judged that there was insufficient distance in which to stop safely and abandoned the landing. During the go-around, the aircraft struck a hedge at the far end of the strip and crashed in the field beyond. The aircraft was destroyed by fire, while its occupants suffered minor injuries.

### History of the flight

The aircraft took off from Ledbury at 1130 hrs for the short flight to Eastbach (Spence) Airfield. Conditions were fine, with a light wind of about 5 kt from the north-west. The pilot intended landing on grass Runway 19, which was 470 m long with an upward slope. At the end of the short flight, which was uneventful, the pilot flew a preliminary circuit to check the wind and the presence of obstacles. The wind sock indicated calm conditions and trees were seen on the approach to the runway.

The pilot reported that the approach appeared normal and was flown at 55 kt IAS, with full flap set. However, the touchdown was heavy and the aircraft bounced and floated for a distance, before touching down again. The pilot judged that the aircraft would not stop before the hedge at the end of the runway and decided to abandon the landing. He applied full power and retracted one stage of flap. During the go-around, the aircraft struck the top of the hedge.

The left wing was torn off and the remainder of the aircraft continued into the field beyond, coming to rest on its left side. It immediately caught fire, with flames entering the cabin. Although the cabin door (on the right side of the fuselage) was successfully unlatched, the occupants were unable to reach up to open it due to the attitude of the aircraft. The pilot, therefore, kicked the windscreen transparency out, helped his passenger out through the gap and then vacated the aircraft himself, before alerting the emergency services by mobile telephone. The pilot and his passenger sustained minor injuries but the aircraft was destroyed by the fire.

The pilot thought that the trees near the strip had caused him to approach steeper than he otherwise would, which contributed to a misjudged flare and the heavy landing. Although the windsock indicated calm conditions, it was also likely that any wind there may have been would have been a tailwind. He observed that the failure to clear the hedge was ultimately due to a slightly late decision to go-around.

**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | Piper PA-28-236 Dakota, G-BGXS |
| **No & Type of Engines:** | 1 Lycoming O-540-J3A5D piston engine |
| **Year of Manufacture:** | 1979 (Serial no: 28-7911198) |
| **Date & Time (UTC):** | 26 May 2012 at 1415 hrs |
| **Location:** | Rufforth East Airfield, Yorkshire |
| **Type of Flight:** | Private |
| **Persons on Board:** | Crew - 1 Passengers - None |
| **Injuries:** | Crew - None Passengers - N/A |
| **Nature of Damage:** | Damage to propeller blades, wing fuel drain valve, spats and engine compartment |
| **Commander's Licence:** | Private Pilot's Licence |
| **Commander's Age:** | 50 years |
| **Commander's Flying Experience:** | 308 hours (of which 10 were on type)<br>Last 90 days - 6 hours<br>Last 28 days - 3 hours |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot |

**Synopsis**

The aircraft ran off the end of the runway whilst landing at Rufforth East Airfield, on a runway intended to be used by microlight aircraft and gyroplanes. The pilot had misidentified the correct airfield for light aircraft to use at Rufforth.

**History of the flight**

The pilot intended to fly from Gamston Airfield, near Retford, to Rufforth, near York. As he had not flown there before, he checked the airfield's website and found that this WWII heavy bomber airfield had essentially been divided into two and named Rufforth East and Rufforth West; the former is operated by a microlight club and the latter by a gliding club.

However, the website the pilot had found was for the eastern part of the airfield and in web pages labelled 'Rufforth Airfield East Flying Order Book' there were cautions concerning the need to avoid the western area, including an aerial photograph with this area shaded out and the words 'AVOID THIS AREA - GLIDING AIRFIELD', reproduced in Figure 1.

Further pages outlined circuit patterns to be used, with emphasis on noise-sensitive areas close to the airfield for each runway, including an instruction not to overfly a farmhouse on base leg for Runway 06 (Runway 05E in Pooley's Flight Guide - Figure 2). The pilot of G-BGXS considered that to comply with this he would need to fly the right-hand base leg very close to the runway threshold, since flying on the other side of the farmhouse would mean infringing the 'precluded' shaded area of Rufforth West.

The website carried further information that the circuit height was 500 ft for all runways, that the aerodrome was '*Strict PPR*' (Prior permission required) and that there was a '*safetycom'* frequency which pilots were encouraged to use by '*calling blind*'. Having noted this information, the pilot checked the weather and NOTAMS and then sought advice about Rufforth from other pilots before departing. He asked a friend, who was also a pilot, to obtain the required PPR for him to land at Rufforth; this was obtained but without mentioning the type of aircraft in use.


**Figure 1**

Reproduction of web image from 'Rufforth Airfield East Flying Order Book Rev 1.1', including farmhouse area

Because he had not flown G-BGXS for some time, the pilot performed two touch-and-go circuits at Gamston before setting course for his destination. During the transit, he was aware of areas of intense glider activity, which he avoided before arriving at Rufforth. Upon arriving, he noted that Runway 36 (Runway 35 in Pooley's Flight Guide) at Rufforth West seemed ideal for his PA-28 Dakota but he believed that this area was reserved for gliders only, so instead he made blind calls on the Rufforth East Safetycom frequency, stating that he intended to land on Runway 06. A pilot responded, stating he was in an aircraft at the hold for that runway "if that helped him" to identify the active runway and reiterated the need to avoid the farmhouse.

The pilot in G-BGXS joined the right-hand circuit on the downwind leg at 500 ft and avoided the farmhouse, even though he realised that the turn onto finals was going to be difficult. Applying full flap, fine propeller pitch and closing the throttle fully he brought the aircraft over the runway centreline but realised that far too much runway had been used to get to this point. He considered going around but decided to continue with the landing and, despite shutting down the engine and full braking, was unable to prevent the aircraft from running off the end of the runway, through a barrier, across the perimeter road and coming to a halt in rough grass and shrubs. He shut down all systems and vacated the aircraft normally.

## Analysis

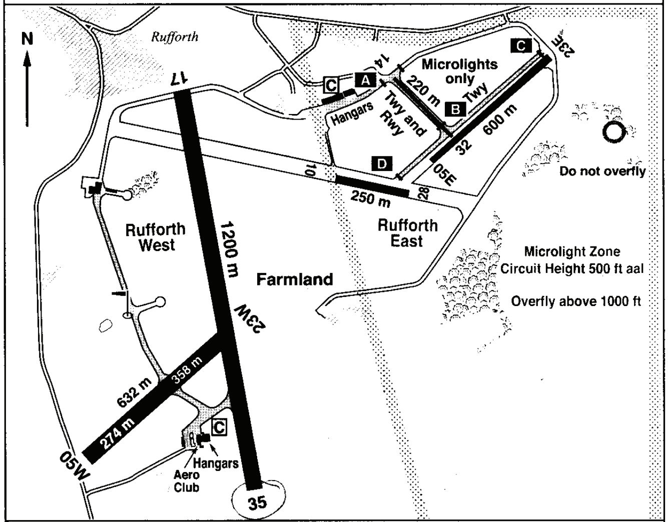
In addition to supplying a full and frank narrative of the events, the pilot of G-BGXS provided a critical appraisal of the chain of errors and assumptions he had made which resulted in attempting to land on an unsuitable runway having flown an unsuitable circuit.

2012

N53 56·85 W001 11·27 **YORK (Rufforth)** 65 ft AMSL

3 nm W of York. **POL 112·10 073 34·6. GAM 112·80 351 40·9**
**OTR 113·90 295 41·2**

**Rufforth West: c/s Rufforth Radio 129·975 A/G** - Gliding operations only.
**Rufforth East: SAFETYCOM 135·475** - Microlights and Gyrocopters.




| Rwy | Dim(m) | Surface | TORA(m) | LDA(m) | Lighting |
|---|---|---|---|---|---|
| **RUFFORTH WEST** | | | | | |
| 17/35 | 1200x46 | Asphalt | | Unlicensed | Nil |
| 05W/23W | 632x46 | 358 m Asphalt/274m Grass | | Unlicensed | Nil |
| **RUFFORTH EAST** | | | | | |
| 05E/23E | 600x23 | Asphalt | Unlicensed | | Nil |
| 10/28 | 250x23 | Asphalt | Unlicensed | | Nil |
| 14/32 | 220x23 | Asphalt | Unlicensed | | Nil |

**Op hrs:** Strictly PPR. Daylight only.

**Hangarage/ Maintenance:** Nil. **Customs:** Nil

**Remarks:** Aerodrome is located between Church Fenton and Linton-on-Ouse MATZs.
Use of aerodrome is at pilot's own risk and the operators do not accept any liability for damage to visiting aircraft.
Avoid overflying local villages and farms.

*continued*

 642

*Courtesy: 'Pooley's Flight Guide'*

**Figure 2**

Extract from Pooley's Flight Guide showing details for Rufforth East and West

He considered that the first link in the chain was his misidentification of Rufforth East as being appropriate to the type of aircraft he was flying. Having consulted the Rufforth East website, with its strict warnings on circuit patterns, he had assumed that these instructions were also intended for light aircraft such as his. The pilot considers that, had he consulted more authoritative documents, such as Pooley's Flight Guide (Figure 2), he would have seen that the runway at Rufforth East was designated 'Microlights only'.

The pilot identified that the next link in the chain of events was that he had not personally telephoned for PPR at Rufforth East. It is possible that if he had, the type of aircraft he intended to use might have been discussed. The conversations he had with other club members had not resolved the misapprehension and, arriving at Rufforth, the brief exchange with the aircraft on the ground might also have betrayed that he was flying a higher performance light aircraft. The pilot later learned that the aircraft on the ground was a gyroplane.

Finally, the pilot considers that he was mistaken in allowing the circuit restrictions to override his judgement that he could not, in his aircraft, safely fly the circuit and approach. He considers that he should have flown a circuit which was reasonable and safe for the type of aircraft he was flying.

**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | Piper PA-30 Twin Comanche, G-ATMT |
| **No & Type of Engines:** | 2 Lycoming IO-320-B1A piston engines |
| **Year of Manufacture:** | 1964 |
| **Date & Time (UTC):** | 14 August 2011 at 1315 hrs |
| **Location:** | Maypole Aerodrome, Kent |
| **Type of Flight:** | Private |
| **Persons on Board:** | Crew - 1 Passengers - 3 |
| **Injuries:** | Crew - None Passengers - None |
| **Nature of Damage:** | Main and rear wing spars bent, skin rippling |
| **Commander's Licence:** | Basic Commercial Pilot's Licence |
| **Commander's Age:** | 59 years |
| **Commander's Flying Experience:** | 10,400 hours (of which 2,000 were on type)<br>Last 90 days - 24 hours<br>Last 28 days - 12 hours |
| **Information Source:** | AAIB Investigation |

**Synopsis**

The aircraft was damaged during a hard landing. The landing distance required shown in the aircraft flight manual was greater than the length of the grass runway. Low airspeed on short final may have been a factor.

**History of the flight**

The aircraft left Alderney on a private flight to Maypole Airfield. The pilot, three passengers and a small amount of baggage were on board. The fuel load was 470 lb of Avgas, the wingtip tanks were relatively full, the takeoff weight was 3,484 lb, and the pilot calculated that the centre of gravity was near the centre of the allowable range. The pilot planned to visit an event at Maypole, run by an aviation organisation with which he was associated, on his way back to the aircraft's base.

Before flight, he obtained weather forecasts for a number of airports, the only mainland UK one being Southampton, where the forecast wind was westerly at 8 kt. The weather throughout southern England was fine, with a relatively high cloudbase and good visibility.

During the flight, the pilot selected wingtip tank fuel for a short time but recalled that there was still a significant quantity of fuel in the wingtip tanks on landing. Before reaching his destination, he obtained weather information including the latest Manston METAR.

The pilot contacted the air/ground radio operator at Maypole and was informed that Runway 20 (which had a grass surface) was in use. The airfield website stated that Runway 02/20 was 560 m long, and that:

> *'clearways at either end (not useable in winter months) give 700 m maximum.'*

Runway 02 sloped uphill, but the airfield operator had not measured the slope.

The pilot joined the circuit for Runway 20, but before turning onto final approach, he saw another aircraft making an approach onto Runway 02, and he flew away from the circuit area and re-joined for an approach onto Runway 02.

The pilot usually flew the approach with full flap at 95 KIAS, reducing to 80 KIAS shortly before touchdown. He stated that he would have monitored airspeed indications, but that "I don't think anyone who's experienced on an aeroplane… looks at the airspeed indicator whilst they are on the approach …". He added that "When you fly an aeroplane regularly, I don't think you stare at the airspeed indicator".

When interviewed some months after the accident the pilot could not recall what indications the windsock had given during the approach. He stated that the wind was variable in direction, and that there was "a lot of sink" on final approach, which prompted him to apply "a lot of power". The touchdown was "quite firm" and the aircraft yawed significantly on touchdown, which he countered with rudder and differential power. The landing run was short. An eyewitness commented that the aircraft fell suddenly immediately before touchdown.

The pilot inspected the aircraft after it had been moved clear of the runway. He saw that the left main landing gear tyre had deflated and that there were "definite lines" on the wing skin. Subsequent engineering inspection confirmed that the left wing main and rear spars were distorted and the left main landing gear had over-travelled.

**Performance**

The landing weight was calculated to have been approximately 3,300 lb. The aircraft flight manual[1] showed that the approach speed at the landing weight would have been approximately 76 KIAS. It added that:

> *'in all cases, turbulent air or crosswind may dictate higher approach speeds and judicious use of flaps.'*

Examination of the landing distance table in the flight manual, and addition of the factor for a dry grass runway given in the flight manual[2], of 10%, showed that the minimum landing distance required (with a safety factor of 100/70 included in the flight manual graph) was 972 m. Without the flight manual 100/70 safety factor, the actual landing distance (on grass) was 618 m.

The airfield website stated that the runway length, including *'clearway'* was 700 m. Discussions with the airfield operator revealed that the available runway length was 700 m, when the ends were not water-logged. The whole distance was available on the date of the accident.

The pilot stated that he felt under no pressure to carry out a slow approach.

**Footnote**

[1] At a gross weight of 3,600 lbs, on a normal two-engine approach, the runway threshold should be crossed at 79 KIAS, this speed reducing by 1 mph (0.87 kt) for every 100 lbs reduction in weight.
[2] CAA Safety Sense Leaflet 7 *'Aeroplane Performance'* suggests a factor of 15% for dry grass up to 20 cm on firm soil.

**Meteorology**

The European Low Level Spot Wind Chart for flights between 0900 and 1500 hrs on the day of the accident showed that the 2,000 ft wind near Maypole was approximately westerly at 10-15 kt. This suggests that the surface wind was west-south-westerly at 7-12 kt.

METARs at Manston Airport (7 nm east of Maypole) were:

141250Z 23008KT 160V290 9999 SCT041
22/11 Q1007=
141320Z 26007KT 200V320 9999 SCT043
21/10 Q1007=

**Analysis**

The flight towards Maypole Airfield was routine until the aircraft joined the circuit. Although the pilot was informed that Runway 20 was in use, he followed another aircraft's example and made an approach to Runway 02. The meteorological information suggests that there may have been a tailwind on Runway 02, and that Runway 20 (as promulgated by the air/ground radio operator) would therefore have offered a slight headwind.

The landing distance available, assuming that the *'clearway'* mentioned on the airfield website was available for the landing run, was less than the landing distance required indicated in the aircraft flight manual, and 82 m more than the unfactored landing distance required.

In these circumstances a pilot might be particularly focussed on achieving an accurate touchdown close to the beginning of the runway and without excessive speed, although in this case the pilot stated that he felt under no such pressure. Although the flight manual speed for short final at his approximate landing weight was 76 KIAS, and the flight manual suggested that turbulence may dictate higher approach speeds, he stated that he used his routine approach speed of 80 KIAS. His habit of giving greater attention to outside cues than the information from the ASI may have been a factor in the aircraft reaching a low speed without him being aware.

If there is a tailwind component, a pilot who judges speed primarily by reference to cues outside the aircraft, which relate to groundspeed rather than IAS, may fly too slowly. It is possible that the pilot, already focussed on achieving a prompt touchdown on a relatively short runway, may have allowed the speed to reduce close to, or down to, the stall, immediately before touchdown, precipitating a heavy landing.

The "sink" (loss of energy) encountered on approach may also have contributed to the development of a low speed situation.

A stall, at low height, would be consistent both with the damage sustained by the aircraft and the witness account. The mass of the wingtip tank fuel may have contributed to the bending load on the main and rear spars.

**Reporting of the accident**

A third party notified the AAIB of the accident in February 2012. The pilot did not consider that the damage to the aircraft constituted a reportable occurrence. Accidents and serious incidents that are reportable to the AAIB are defined in the Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 1996, available on the AAIB website.

**Safety action**

The operators of Maypole Airfield stated that they would revise their website to take account of the correct definition of clearway.

**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | Piper PA-34-200 Seneca, G-BBPX |
| **No & Type of Engines:** | 2 Lycoming IO-360-C1E6 piston engines |
| **Year of Manufacture:** | 1972 (Serial no: 34-7250262) |
| **Date & Time (UTC):** | 27 June 2012 at 1207 hrs |
| **Location:** | St Mary's Airport, Isles of Scilly |
| **Type of Flight:** | Private |
| **Persons on Board:** | Crew - 1 Passengers - 3 |
| **Injuries:** | Crew - None Passengers - None |
| **Nature of Damage:** | Damage to left main landing gear leg and fuselage skin |
| **Commander's Licence:** | Basic Commercial Pilot's Licence |
| **Commander's Age:** | 65 years |
| **Commander's Flying Experience:** | 7,762 hours (of which 233 were on type)<br>Last 90 days - 32 hours<br>Last 28 days - 15 hours |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot, reports from St Mary's Air Traffic Control, meteorological documentation and recorded radio transmission data |

**Synopsis**

The pilot flew a NDB approach to Runway 27 with the intention to circle to land on Runway 14. Weather conditions were marginal, and after losing visual contact with the Runway 14 threshold, the pilot discontinued the approach. He elected instead to land with a tailwind component on Runway 27. After touchdown, as the aircraft passed from the paved portion of runway to the grassed portion, braking effect was lost. The aircraft overran the runway and the left landing gear leg collapsed when it struck a runway light. The aircraft came to rest upright and none of the occupants was injured.

**Pilot's report**

The aircraft took off from Newquay Airport at 1130 hrs for the flight to St Mary's, with the pilot and three passengers on board. The pilot had received the latest weather information for St Mary's while at Newquay. It forecast a surface wind of 150° at 12 kt, good visibility, nil weather and 'FEW' cloud at 300 ft above the aerodrome. On arrival at St Mary's there was scattered cloud at 200 ft and broken cloud at 300 ft. The pilot elected to fly a NDB approach to Runway 27, to circle to land on Runway 14.

After flying the NDB approach, the pilot circled to land as planned, but found that a fog bank to the north of the airfield obscured the Runway 14 threshold. He initiated a go-around, and saw that the south side of the airport was clear of fog and that Runway 27 was clearly visible. He reported that at no time during the go-around and subsequent approach did he penetrate the fog, nor enter cloud. The pilot had previously landed on Runway 27 in calm conditions, and considered that a 5 kt tailwind component would be acceptable.

The aircraft touched down on the Runway 27 threshold at 75 kt. It decelerated on brake application but, as it passed onto the grass portion of runway, all retardation appeared to cease. The pilot called for his passengers to "brace", shut down the engines and switched off the fuel. The left landing gear leg collided with a runway end light and collapsed. The aircraft overran the runway and slid down the grass slope at its end. After the aircraft had come to rest, the pilot informed ATC that all occupants were uninjured. They were able to vacate the aircraft through the cabin door.

The pilot observed that the grass was wet and offered minimal braking effectiveness. He considered that this, together with the tailwind component and downwards slope on the latter part of the runway were direct causal factors. He noted that there had been some pressure to complete the flight, which had already been delayed by weather. He added that his familiarity with St Mary's and the aircraft may have resulted in giving insufficient consideration to all the performance factors which could adversely affect the landing.

**St Mary's ATC report**

The ATC controller on duty at St Mary's reported that, after breaking off the approach for Runway 14 the pilot asked for wind information for Runway 32. The tailwind on Runway 32 was unacceptable, so the pilot asked about Runway 27, which was showing an 8 to 10 kt tailwind. The aircraft was seen to fly a visual manoeuvre to Runway 27 before landing at what appeared to the controller to be about 80 to 100 m beyond the threshold. The aircraft was seen to commence heavy braking, but this appeared to cease as the aircraft passed on to the grass portion of runway.

The airport's Rescue and Fire Fighting Service (RFFS) had been placed on standby prior to the aircraft's arrival, as the weather conditions had been changeable. They were alerted and dispatched at the first sign of the aircraft failing to stop and were on scene within seconds. ATC initiated implementation of the airport's full emergency orders in accordance with local procedures.

**Radiotelephony information**

A recording of radio transmissions between the ATC controller and the aircraft pilot was available for analysis. Also recorded were landline exchanges between the controller and the RFFS.

After clearing the aircraft for the NDB approach, the controller contacted the RFFS to place them on standby. In this exchange, both parties commented on the poorer weather on the north side of the airfield affecting the approach for Runway 14. At 1159 hrs the pilot announced that he was at the starting point of the NDB procedure, and he was instructed to continue and to call "visual". The controller passed the surface wind at this point as 140° at 15 kt.

When the pilot subsequently called "visual", he was asked "DO YOU WISH TO CIRCLE FOR ONE FOUR?". He replied "AFFIRM" and was instructed to call "final" for Runway 14. The ATC controller was not visual with the aircraft at this stage and warned the pilot of the 400 ft television mast to the north of the field. When the pilot advised "DOWNWIND" and was cleared to land, the controller passed the surface wind as 140° at 15 kt and advised the surface was damp.

The pilot subsequently advised that he was going around. He said that it was quite clear to the south and asked the controller about the wind for Runway 32. The controller said the tailwind component on Runway 32 was 15 to 17 kt, which the pilot rejected as unacceptable. He then asked about the wind for Runway 27, and the controller replied "THE WIND IS ONE FOUR ZERO DEGREES AT SIXTEEN KNOTS, GIVING YOU AN EIGHT TO TEN KNOT TAILWIND". The pilot responded "ROGER, WE'RE LATE DOWNWIND FOR TWO SEVEN, GOLF PAPA XRAY". When the pilot reported 'final' he was passed a last wind of 140° at 15 kt.

**Meteorological information**

There had been no scheduled flying at St Mary's on the day of the accident, due to a low cloud ceiling. A meteorological forecast issued at 1110 hrs on 27 June, for the period 1200 hrs to 1900 hrs, gave a surface wind of 130° at 15 kt and visibility of 300 m in fog, temporarily improving to 4,000 m visibility and scattered cloud at 400 ft. A fog warning for St Mary's was issued by the Met Office at 0846 hrs on the morning of the accident. It was valid for the daytime period, and stated that fog with visibility less than 600 m was expected.

A weather observation taken at the time of the accident gave a surface wind from 140° at 16 kt, visibility in excess of 10 km, scattered cloud at 200 ft and broken cloud at 300 ft. The temperature and dew point were both 15°C. The weather at 1150 hrs was similar, except the visibility was 9 km and the cloud was broken at 200 ft.

**St Mary's Airport**

The airport occupies an elevated position on the island of St Mary's in the Isles of Scilly. Its main runway, which is all asphalt, is designated 14/32 and is 600 m long by 23 m wide. A second runway, designated 09/27, is 523 m long by 18 m wide; it is part asphalt and part grass. Airport elevation is 116 ft.

Runway 27 is asphalt for its first 287 m (to the point where it crosses Runway 14/32), beyond which it is grassed. The first 100 m rises with a gradient of 4.3%, while the last 100 m slope downwards with a gradient of 5%. Information for St Mary's in the United Kingdom Aeronautical Information Publication includes the warnings:

*'a. Pilots should exercise extreme caution when landing or taking-off at this aerodrome, which is markedly hump-backed. The gradients increase to as much as 1 in 13 at runway ends.*

*b. Pilots are warned of the different braking characteristics of the grass/asphalt sections of Runway 09/27.'*

Two instrument approaches are available, for Runway 27 and Runway 32. Both are based on the St Mary's NDB, which is situated on the airport. The Obstacle Clearance Altitude applicable to circling manoeuvres is 700 ft (584 ft AAL), reducing to 520 ft (404 ft AAL) south of Runway 09/27.

**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | Piper PA-38-112 Tomahawk, G-BOHU |
| **No & Type of Engines:** | 1 Lycoming O-235-L2A piston engine |
| **Year of Manufacture:** | 1980 (Serial no: 38-80A0031) |
| **Date & Time (UTC):** | 9 August 2012 at 1029 hrs |
| **Location:** | Elstree Aerodrome, Hertfordshire |
| **Type of Flight:** | Private |
| **Persons on Board:** | Crew - 1 Passengers - 1 |
| **Injuries:** | Crew - None Passengers - None |
| **Nature of Damage:** | Nose landing gear and propeller damaged |
| **Commander's Licence:** | National Private Pilot's Licence |
| **Commander's Age:** | 67 years |
| **Commander's Flying Experience:** | 274 hours (of which 220 were on type)<br>Last 90 days - 14 hours<br>Last 28 days - 5 hours |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot |

The aircraft was landing after a short flight from Denham to Elstree, halfway through a multi-leg trip from the aircraft's base at Swansea. On board were two qualified pilots, who were exchanging the pilot-in-command role on each leg.

The weather was fine, with a forecast wind from the north-west at 3 kt. The wind for landing was assessed as variable in direction at less than 5 kt. Runway 08 was being used, which was 651 m long and 20 m wide, with an overall down slope of 1.3%. The pilot experienced some difficulty achieving target approach speed and executed a go-around from his first two approaches. On the third approach, the aircraft touched down at a higher speed than was intended and started a sharp yaw to the left, which the pilot was unable to control. The nosewheel departed the paved surface, causing the aircraft to decelerate and yaw further left, during which the nose landing gear collapsed and the propeller was damaged. Both occupants were uninjured and vacated the aircraft in the normal manner. The pilot considered that difficulties achieving the target approach speed and his aircraft handling during the landing were the factors involved in the outcome.

**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | Societe Menavia CP301-C3 Emeraude, G-BIVF |
| **No & Type of Engines:** | 1 Continental Motors C90-14F piston engine |
| **Year of Manufacture:** | 1962 (Serial No 594) |
| **Date & Time (UTC):** | 28 July 2012 at 0830 hrs |
| **Location:** | Private airstrip near Rutland Water, Rutland |
| **Type of Flight:** | Private |
| **Persons on Board:** | Crew - 1 Passengers - 1 |
| **Injuries:** | Crew - None Passengers - None |
| **Nature of Damage:** | Landing gear collapsed, fuselage, engine cowling and propeller damaged |
| **Commander's Licence:** | Private Pilot's Licence |
| **Commander's Age:** | 49 years |
| **Commander's Flying Experience:** | 196 hours (of which 2 were on type)<br>Last 90 days - 3 hours<br>Last 28 days - 2 hours |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot |

The aircraft was landing at a private airstrip after a 40-minute local flight. The weather was fine, with a westerly wind of about 10 kt and temperature of 25°C. The grass airstrip was orientated 06/24 and was approximately 800 m long with a hedge crossing the beginning of the strip in the 24 direction.

The pilot reported that the aircraft became slow on the approach and sank. He applied power to correct this, but the aircraft landed heavily approximately 40 m short of the start of the airstrip. Both occupants were wearing full harnesses and neither was injured. The pilot considered that his low flying time on type was probably a contributory factor in the accident.

**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | Staaken Z-21A Flitzer, G-ERTI |
| **No & Type of Engines:** | 1 Volkswagen 2180 piston engine |
| **Year of Manufacture:** | 2009 (Serial no: PFA 223-14166) |
| **Date & Time (UTC):** | 26 July 2012 at 1400 hrs |
| **Location:** | Newnham, near Baldock, Hertfordshire |
| **Type of Flight:** | Private |
| **Persons on Board:** | Crew - 1 Passengers - None |
| **Injuries:** | Crew - None Passengers - N/A |
| **Nature of Damage:** | Damage to the wings, fin, propeller and landing gear |
| **Commander's Licence:** | Private Pilot's Licence |
| **Commander's Age:** | 55 years |
| **Commander's Flying Experience:** | 129 hours (of which 6 were on type)<br>Last 90 days - 5 hours<br>Last 28 days - 1 hour |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot |

**Synopsis**

The aircraft drifted to the side of the airstrip during takeoff and, after it was airborne, a mainwheel struck an adjacent earth bank. The aircraft crashed and came to rest inverted, although the pilot was uninjured.

**Description of the event**

The aircraft was taking off from a private grass airstrip which was 750 m long, 15 m wide and orientated east-west. The weather was fine, although conditions were hot and humid. The surface wind was reported to be light and variable but mainly from the east, and occasionally increasing in strength with the effects of strong thermal activity. Using the easterly direction for takeoff, the pilot had completed a short flight an hour earlier without difficulty.

As the pilot raised the tail of the aircraft early in the takeoff and gained an improved forward view, he realised that the aircraft had drifted to the left of the strip and was heading towards a track running alongside. His attempts to steer the aircraft back to the centre of the strip were unsuccessful and he considered aborting the takeoff. However, as the aircraft's brakes were intended for taxiing purposes only and the aircraft was close to becoming airborne, the pilot elected to continue the takeoff. As the aircraft became airborne it drifted further left, towards an earth bank adjacent to the track. The left mainwheel was believed to have struck the bank, after which the aircraft tumbled and came to rest inverted.

The pilot, who was wearing a six-point harness, was uninjured. He made the aircraft safe and vacated it. He thought that an increased crosswind at a critical stage during the takeoff had contributed to the accident, possibly exacerbated by local funnelling effects.

**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | Yakolev YAK-18T, G-VYAK |
| **No & Type of Engines:** | 1 Ivchenko Vedeneyev M-14P piston engine |
| **Year of Manufacture:** | 1993 (Serial No: 01-32) |
| **Date & Time (UTC):** | 24 July 2012 at 1600 hrs |
| **Location:** | Popham Airfield, Hampshire |
| **Type of Flight:** | Private |
| **Persons on Board:** | Crew - 1 Passengers - None |
| **Injuries:** | Crew - None Passengers - N/A |
| **Nature of Damage:** | Propeller destroyed, minor damage to wing trailing edge and flaps |
| **Commander's Licence:** | Air Transport Pilot's Licence |
| **Commander's Age:** | 52 years |
| **Commander's Flying Experience:** | 16,954 hours (of which146 were on type)<br>Last 90 days - 235 hours<br>Last 28 days - 54 hours |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot |

The pilot intended to fly a number of visual circuits at Popham. The weather was fine, with light winds and good visibility. Runway 21 was in use, which was a 900 m long grass runway.

Whilst turning downwind for a touch-and-go, the pilot heard a transmission to a joining aircraft that there were two aircraft in the circuit. He thought that his aircraft was the only one in the circuit at that time (another had recently departed), but commenced a visual search for another. He could not see one, but noted three aircraft at the runway holding point awaiting departure. Two of these took off as his aircraft turned finals. The pilot selected landing flaps but forgot to lower the landing gear. The aircraft settled onto the grass runway and slid to a stop. The pilot secured the aircraft, made a radio transmission to the effect that he was uninjured and vacated without difficulty.

The pilot considered that he had allowed himself to become distracted by the search for other circuit traffic and monitoring aircraft lining up and taking off ahead and that this had led to his omission to lower the landing gear.

**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | Zenair CH 601HDS Zodiac, G-CEZV |
| **No & Type of Engines:** | 1 Rotax 912 ULS piston engine |
| **Year of Manufacture:** | 2008 (Serial no: PFA 162-13748) |
| **Date & Time (UTC):** | 29 May 2012 at 1210 hrs |
| **Location:** | Swansea Airport |
| **Type of Flight:** | Private |
| **Persons on Board:** | Crew - 1 Passengers - None |
| **Injuries:** | Crew - None Passengers - N/A |
| **Nature of Damage:** | Destroyed |
| **Commander's Licence:** | Private Pilot's Licence |
| **Commander's Age:** | 51 years |
| **Commander's Flying Experience:** | 590 hours (of which 13 were on type)<br>Last 90 days - 17 hours<br>Last 28 days - 13 hours |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot |

**Synopsis**

The aircraft's cockpit canopy became unlatched during climb-out after takeoff. The resulting high drag of the partially-open canopy meant the pilot had to perform a forced landing on a disused runway. The landing was heavy and a fire developed in the engine compartment which destroyed the aircraft.

**History of the flight**

The pilot intended to fly from Swansea Airport to Haverfordwest in his Zenair CH601HDS, which is a two-seat low-wing aircraft with a single-piece bubble-style canopy hinged at the front. Having started the engine, he taxied to holding point Bravo for Runway 28 where he completed the pre-flight checks which included pushing the hooks which lock the canopy into place to ensure they were engaged.

The takeoff was normal, with the aircraft climbing at more than 1,000 feet per minute. It was a hot day, so the pilot had opened the small sliding windows in the canopy for ventilation and noticed that there was moderate, but not extreme, turbulence. However, at about 1,200 ft, he encountered a "bump of turbulence" which the pilot likened to driving over "a speed hump too fast". He heard a click and felt a draught in the cockpit which had not been there before. He immediately noticed that the canopy was displaced on the passenger's side and that the hook on that side had popped out.

As he was still only a few miles from Swansea, he decided to return and fly a gentle circuit to land and investigate. As a precaution, he put his left arm through the sliding window on his side in order to hold the canopy down in case the other hook on this side also unlatched, which it did shortly afterwards. Despite still having his arm hooked around the canopy, he could not prevent it opening about 12-14 inches, although he believes he was preventing it opening further. He states that he was surprised at the effect of the unlatched canopy on the aircraft's performance and handling; even with full power applied, he was having to descend and also having to exert considerable back-pressure on the control column to prevent the nose from pitching down.

With traffic in the circuit and insufficient height, the pilot decided to land on the disused Runway 33 just outside the airfield perimeter. As he turned onto finals, the sink rate increased substantially and the aircraft landed heavily some three metres short of the runway, striking a gorse bush as it did so. At first appearance, it did not seem that the aircraft was badly damaged, so the pilot started to collect his belongings, including the portable GPS, but within a few seconds the front of the aircraft caught fire and he had to evacuate the aircraft. The aircraft was subsequently destroyed by the fire, despite attendance by the fire service.

In his assessment of the cause of the accident, the pilot says he believes that the sudden encounter with turbulence caused the canopy to unlock and reiterates that he was surprised at the degradation in performance caused by the partially-open canopy. The unanticipated high drag of a partially-open canopy was also a major factor in the forced-landing and overturning of Aero AT-3 R100, G-SRUM, the accident to which is also described in this issue of the AAIB Bulletin (see page 104).

**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | Zenair CH 601XL Zodiac, G-CDJM |
| **No & Type of Engines:** | 1 Rotax 912 ULS piston engine |
| **Year of Manufacture:** | 2005 (Serial no: PFA 162B-14303) |
| **Date & Time (UTC):** | 22 July 2012 at 1230 hrs |
| **Location:** | Langham, Norfolk |
| **Type of Flight:** | Private |
| **Persons on Board:** | Crew - 1 Passengers - 1 |
| **Injuries:** | Crew - None Passengers - None |
| **Nature of Damage:** | Extensive damage to fuselage, cockpit area, wings and engine ancillaries |
| **Commander's Licence:** | Private Pilot's Licence |
| **Commander's Age:** | 74 years |
| **Commander's Flying Experience:** | 1,312 hours (of which18 were on type)<br>Last 90 days - 18 hours<br>Last 28 days - 7 hours |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot |

**Synopsis**

The aircraft suffered a loss of engine power, believed to be due to fuel starvation. A forced landing attempt was made to a disused runway, but the engine stopped before reaching it. The aircraft touched down in a wheat field and inverted. Both occupants were uninjured but had extreme difficulty escaping from the wreckage.

**History of the flight**

The aircraft took off from its base at Little Snoring in Norfolk for a local flight. The weather was fine, with an estimated surface wind of 250° at 15 to 20 kt. Air temperature was about 23°C. Fifteen minutes into the flight, with the aircraft at 1,500 ft altitude, the engine started to lose power and run roughly. The pilot applied carburettor heat immediately and, noticing that the fuel pressure was reading zero, selected the electric fuel pump on. Both fuel tanks were indicating one third full (which was believed to be accurate) so the pilot switched fuel feed from the left tank to the right tank, but without improvement.

About 2 nm ahead was a disused runway at the airfield at Langham, which the pilot decided to attempt to reach; it had a short but usable paved length, orientated into wind. Just short of the start of the intended landing area, at a height of about 50 ft over a wheat field, the engine stopped abruptly. The pilot slowed the aircraft to 45 kt and unlocked the canopy prior to touchdown in the field. As soon as the mainwheels touched the crops the aircraft pitched nose-down and inverted, coming to a very rapid halt in about 15 m.

The pilot and his passenger, who were both wearing four-point harnesses, were uninjured. With the aircraft inverted and the canopy transparency shattered, there was only a space to the left side of less than 12 inches through which to escape, and both occupants had extreme difficulty exiting the aircraft. The pilot subsequently contacted his home airfield by telephone to inform them of the accident.

The pilot attributed the rough running engine and stoppage to fuel starvation. The aircraft was recovered to a local facility and the pilot inspected it the following morning. Damage was extensive, and included a severely distorted cockpit floor which trapped the main fuel line, precluding an attempt to check fuel flow. The cause of the fuel starvation could not be established.

The pilot noted that the aircraft had made one 15-minute flight earlier on the day of the accident and three flights totalling about 1.5 hours duration three days earlier. All these flights had been uneventful. Prior to the first flight on the day of the accident, the pilot had refuelled with AVGAS 100LL (as was usual) to 40 litres total fuel, sufficient for about 2 hours normal flying with 20 minutes reserve.

**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | Bantam B22S, G-MZEY |
| **No & Type of Engines:** | 1 Rotax 582 piston engine |
| **Year of Manufacture:** | 1996 (Serial no: 96-002) |
| **Date & Time (UTC):** | 28 July 2012 at 1210 hrs |
| **Location:** | North Coates Airfield, Lincolnshire |
| **Type of Flight:** | Private |
| **Persons on Board:** | Crew - 1 Passengers - None |
| **Injuries:** | Crew - None Passengers - N/A |
| **Nature of Damage:** | The aircraft was extensively damaged |
| **Commander's Licence:** | Private Pilot's Licence |
| **Commander's Age:** | 67 years |
| **Commander's Flying Experience:** | 248 hours (of which 0 were on type)<br>Last 90 days - 3 hours<br>Last 28 days - 2 hours |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot |

**Synopsis**

Shortly after engine start, the microlight was turned over by a sudden and very powerful gust of wind which had the appearance of a small tornado.

**Description of the event**

The pilot carried out a full pre-flight inspection of the aircraft. He was accompanied by its owner, with whom he had flown recently, and it was to be the pilot's first solo flight on the microlight type. Following normal pre-start checks, the pilot started the engine. The surface wind was westerly, and described by a witness as "freshening" to 5 or 6 kt by this time. The witness, who was on duty as the airfield radio operator, enquired with the microlight owner whether he thought the conditions, which appeared to be changing, were still suitable for the flight. A large, dark cloud was passing close to the airfield and the owner decided conditions were not suitable for the time being. Consequently, the radio operator approached the microlight from the right side to attract the pilot's attention, before giving him a 'cut engine' signal.

It was reported that, before the pilot could shut down the engine, an unusually large gust of wind lifted the microlight's right wing and pushed it across the apron, with its left wing tip scraping across the ground. The microlight owner attempted to hold onto the right wing strut but had to release it after he was lifted off the ground. As the left wingtip reached the grass verge, the microlight turned over onto its back. The pilot released himself from his harness and vacated the microlight, as people nearby arrived to assist. The pilot was uninjured but the microlight sustained extensive damage.

The gust of wind which overturned the aircraft was seen to move up the taxiway and across open fields towards the sea. It had a rotating appearance, as of a small tornado, and extended from the ground to an estimated height of 20 ft.

**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | Cameron Z-350 balloon, G-VBFG |
| **No & Type of Engines:** | None |
| **Year of Manufacture:** | 2007 |
| **Date & Time (UTC):** | 5 March 2011 at 1604 hrs |
| **Location:** | Ulpha, near Broughton-in-Furness, Cumbria |
| **Type of Flight:** | Commercial Air Transport (Passenger) |
| **Persons on Board:** | Crew - 1 Passengers - 16 |
| **Injuries:** | Crew - None Passengers - 2 (1 Serious) (1 Minor) |
| **Nature of Damage:** | 51 panels damaged |
| **Commander's Licence:** | Commercial Pilot's Licence |
| **Commander's Age:** | 50 years |
| **Commander's Flying Experience:** | 887 hours (of which 139 were on type)<br>Last 90 days - 11 hours<br>Last 28 days - 4 hours |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot and further enquies by the AAIB |

**Synopsis**

The pilot aborted the landing while attempting to land in a valley. During the subsequent climb the balloon impacted trees. One passenger was injured by tree branches protruding into the passenger compartment through foot holes in the basket.

**History of the flight**

The pilot planned to fly 16 passengers over the Lake District. He met his ground crew and passengers at the pre-notified launch site at Gilpin Bridge, 4 nm south-west of Kendal, Cumbria. However, a launch site at Kentmere, approximately 5 nm north-east of Windermere was then chosen due to a more favourable wind.

The surface wind at Kentmere was from 040º at 8 kt and from 040º at 12 to 15 kt between 2,000 ft and 3,000 ft amsl. Rigging of the balloon was completed by the ground crew while the pilot gave the passengers a safety briefing. Inflation of the envelope proceeded without incident in a slightly gusty and variable wind. The balloon took off at about 1445 hrs and climbed to 2,000 ft amsl where the winds were found to be from approximately 070º at 12 to 15 kt.

After approximately 45 mins the pilot attempted to land in a field on the western shore of Coniston Water. However, as the balloon descended, its track changed to a more westerly direction taking the balloon away from the landing site. The pilot aborted the landing and climbed the balloon with the intention of landing near Broughton-in-Furness, 2 nm north of Ulverston.

The wind at 2,000 ft amsl took the balloon in a more westerly direction so the pilot planned a landing in Dunnerdale Valley, 4 nm north of Broughton-in-Furness. After flying over the top of Caw, on the Dunnerdale Fells, the pilot began the descent into the valley. The descent was steady with a small change of track towards the west. The pilot selected a field on the east side of a river and briefed the passengers to adopt the landing position, adding that if they did not land in the selected field he would fly over the river and land on the other side.

During the final part of the descent a gust of wind pushed the balloon down into tree tops, turning the basket. The pilot stated this made the balloon buoyant which, with an increase in wind strength, forced him to abandon the landing and initiate a climb. The air in the envelope had been allowed to cool for descent and it took time, using the balloon's four burners intermittently, to heat it to initiate the climb. The balloon had by this time crossed the field and was heading towards a tree-lined upslope on the western side of the valley. The distance between the first contact with trees and the end of the field was about 150 m. As the balloon climbed the basket "brushed" through the upper branches of deciduous trees for approximately l00 m. The pilot used a mixture of two and four of the burners for up to 5 seconds at a time to avoid setting fire to the branches. He added that there was no impact or jolting, but the basket was dragged through the upper levels of light branches. After clearing the deciduous trees the balloon continued to climb but then contacted some taller coniferous trees further up the slope. Once clear of the trees the balloon climbed to 1,500 ft amsl and continued west. The balloon landed about 4 mins later, on Birker Fell. As it did so the basket knocked over a barbed wire fence and tipped onto its side as the envelope deflated.

After making the balloon safe the pilot helped the passengers from the basket. Fifteen passengers stated they were uninjured but one complained of a pain around her lower ribs, saying that she thought a branch had come through the footstep in the basket, and "jabbed" her in the ribs. She added that she felt sore on her right side although there was no break to the skin and no sign of abrasion. She told the pilot that as the basket had tilted upon impacting the trees, the three other passengers in her compartment had pushed against her, squashing her against the end of the basket. The pilot asked her if she would like to be taken to hospital by ambulance, but she declined. The ground crew arrived about 10 minutes later and together with the pilot transferred her to their vehicle. A member of the crew stayed with her and ensured that she was comfortable.

Having packed the balloon, envelope and basket onto the trailer everyone left the accident site at about 1800 hrs to return to the original rendezvous point at Gilpin Bridge. En-route the injured passenger requested and was taken to Barrow-in-Furness General Hospital, where she remained for two days.

Another passenger received minor injuries. Others commented that they had suffered back and neck pains for which they did not seek medical treatment.

At 1604 hrs an eyewitness informed police that a hot air balloon was being dragged through trees. The caller went to the landing site to see if he could offer assistance and advised the pilot that he had telephoned the police. Accordingly, the pilot rang the police and informed them there were no injuries. Emergency services, including an air ambulance, were going to deploy but were subsequently stood down.

**Local topography**

The gradient of the slope from Corney Fell to the coastal plain is approximately 10%. The gradient of the slope from Dunnerdale Fell into the Dunnerdale Valley is approximately 22%.

The width of land available for landing, ignoring roads, rivers and railways is approximately 2,000 m on the coastal plain and approximately 500 m in the Dunnerdale Valley.

**Balloon information**

G-VBFG's envelope was fitted with a Rapid Deflation System (RDS) parachute valve. Pulling a red RDS rip line gathers the parachute panel into a column in the centre of the circular opening for final deflation. The action of the red line can be reversed by pulling a red and white venting line.

The balloon was fitted with Stratus quad burners. The burners are fitted with squeeze-action blast valves which are operated by squeezing the control lever towards the hand grip. Each handle has a latch fitted on its underside to allow the valve to be locked on for 'hands free' operation. The blast valve handles are arranged so that pairs of burners can be operated simultaneously with one hand. These should give it the ability to climb away quickly following an aborted approach.

**Cameron Balloons Hot Air Balloon Flight Manual**

Section 2.12 of the balloon's flight manual states that the RDS rip line is not to be used at heights greater than 6 ft agl, except in an emergency.

Section 3.2.1 states that emergency climbs should be made by operating the main burner valve on each burner unit simultaneously.

Section 4.6.2.3 states that the RDS rip line may be pulled immediately before touchdown.

The basket, which is rectangular in shape, has foot holes in its shorter sides to help people climb into and out of the basket.

**Video and photographic evidence**

A 41-second video of the first landing impact on the upslope was taken by one of the passengers. It starts with the shorter side of the basket leading, just before it impacted the trees with no burners on. Figure 1 shows a still taken from the video at the moment of impact. The balloon initially impacted trees about 20 ft into the canopy, breaking large branches. Seven seconds into the video the pilot is visible in a position where he is likely to be pulling the red and white venting line in order to close the RDS. Fifteen seconds into the video the pilot can be seen pulling on the red and white venting line for 2 seconds, followed by a burn with two burners for 1 second. He then pulls on the red and white venting line for 4 seconds. There is then a 5 second burn using four burners followed by an 8 second period of inactively from the pilot as the balloon appears to be deeper into the tree canopy. The final 2 seconds of the video shows the pilot using all four burners for 2 seconds as it clears the trees. The video does not show the pilot using the burners 'hands free'.

In total the pilot can be seen making 12 'pulls' on the red and white venting line, without releasing it, and is likely to have made others not captured in the video.

**Figure 1**

Picture from the video at the moment of impact

**Pilot's comments**

The pilot commented that he had flown passengers in hot air balloons in the Lake District since April 2008 and that he had landed in the Dunnerdale Valley, at Whistling Green, 1 km south of the accident site, on two previous occasions in 2009.

He added that it would "never be advisable" to plan on landing on the coastal plain, 6 nm further west, as Corney Fell descends from 2,000 ft to sea level "very quickly" approaching the coast. This combined with an easterly wind causes a lot of curlover[1] in the lee of the Fells when descending. The coastal plain, which averages one mile in width, contains a high voltage power transmission line, a railway line and a main road with an aeronautical Danger Area off the coast.

**Passengers' comments**

All the passengers made statements after the accident describing their impressions of the impacts with the trees. Several said that broken branches from the trees fell into the basket during the impact and that the basket tilted significantly. Some commented on the lack of attention to their welfare after landing and the relative priority accorded them over the need to pack and recover the balloon and its equipment, despite several of them showing signs of shock.

**Footnote**

[1] Curlover is a downdraft and turbulence downwind of hills, trees or buildings.

**First Aid Training**

All commercial balloon pilots have annual recurrent training in first aid. In the course of this training they are taught that after administering first aid they should, where it is available, seek expert advice. This could be from an ambulance paramedic or from a hospital.

An injured passenger, who may be in shock, is not necessarily best placed to decide whether or not they need additional treatment.

**Damage assessment**

The pilot commented that several of the lower 'Nomex' panels around the base of the balloon were torn and two panels, four or five panels up from the base, were also damaged. The left side corner of the basket was scuffed.

The repair agency found that 51 panels were damaged of which 19 needed replacing. The 'Scoop'[2] was also heavily damaged and required repair.

**Analysis**

Having aborted the landing attempt at Coniston Water the only realistic options available to the pilot, given the wind, were to land in the Dunnerdale Valley or on the coastal plain.

The pilot discounted the coastal plain because he felt that the slope was steep and curlover, as a result of the easterly wind, would have been prevalent. However, the gradient of the slope onto the coastal plain is about half that of the slope into the Dunnerdale Valley and therefore curlover in the Dunnerdale Valley would have been more severe than that onto the coastal plain. It may have been preferable to stay committed to a landing there rather than attempt to climb out of the valley. A more viable plan may have been to land where the balloon subsequently landed or on the coastal plain.

The pilot used the quad-burners intermittently as he started to climb out of the valley. Use of all four burners 'hands free' as soon as he had made the decision to abort the landing may have reduced the severity or number of impacts.

The video begins, at about the moment of impact, with the burners OFF. It is then 18 seconds before the pilot uses two of the burners, as he was closing the RDS/parachute vent. Had the pilot latched all four burners on in the 'hands free mode' as soon as he decided to abort the landing and then closed the RDS, maximum heating would have been achieved, improving climb performance and potentially reducing the chance of impact with the trees. Using four burners may also have prevented the second impact.

The video shows the pilot making 12 'pulls' on the red and white venting line, without releasing it, as he attempts to close the RDS parachute valve. This indicates that the RDS parachute valve was OPEN at the time of impact with the trees. The flight manual states that red RDS rip line is not to be used at heights greater than 6 ft agl and may be pulled immediately before touchdown. Had the pilot kept the RDS closed, until a landing was assured, heating of the air in the envelope would have been more efficient, heat would not have escaped through the open RDS and the climb after the aborted landing may have been expedited making an impact with the trees less likely.

**Footnote**

[2] The Scoop is a shaped skirt which, narrows to an inch or two on one side and widens to extend all the way from the top of the poles to the base of the envelope proper, forming a tilted mouth. The purpose of the Scoop is to assist in keeping the balloon envelope fully pressurised.

The comment from the passengers that the basket tilted during impact explains why passengers in the injured passenger's compartment pressed her against the basket's side, leaving her no room to avoid any object protruding through the foot holds.

The injured passenger declined the pilot's offer of an ambulance. However, timely examination by a medical expert would have been advantageous and could be given priority over the packing and recovery of the balloon and its equipment.

**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | Cameron Z-350 balloon, G-VBFH |
| **No & Type of Engines:** | None |
| **Year of Manufacture:** | 2007 (Serial no: 10985) |
| **Date & Time (UTC):** | 31 July 2012 at 0700 hrs |
| **Location:** | Kirby Lonsdale, Cumbria |
| **Type of Flight:** | Commercial Air Transport (Passenger) |
| **Persons on Board:** | Crew - 1 Passengers - 16 |
| **Injuries:** | Crew - None Passengers - 1 (Serious) |
| **Nature of Damage:** | None |
| **Commander's Licence:** | Commercial Pilot's Licence |
| **Commander's Age:** | 63 years |
| **Commander's Flying Experience:** | 2,150 hours (of which 550 were on type)<br>Last 90 days - 40 hours<br>Last 28 days - 10 hours |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot |

The balloon landed gently in light wind, and the basket remained upright. The pilot supervised initial disembarkation of four or five passengers, who assisted with the balloon control lines to ensure proper deflation of the envelope. Once the envelope was sufficiently deflated such that any risk of the balloon basket moving was removed, the pilot (who was still in the basket) instructed the remaining passengers to disembark. The pilot and his ground crew, who had recently arrived, became aware that a female passenger had fallen to the ground whilst getting out of the basket and suffered a significant leg injury. An ambulance was called to attend.

The pilot reported that the passengers received a safety briefing prior to flight and practised procedures for getting into and out of the basket. The basket had not moved during disembarkation and he thought it likely that the passenger had misjudged the distance to the ground. It is possible she had not used the lower of the foot step holes in the basket side.

**SERIOUS INCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | Cameron Z-350, G-VBFH |
| **No & Type of Engines:** | None |
| **Year of Manufacture:** | 2007 (Serial no: 10985) |
| **Date & Time (UTC):** | 8 August 2012 at 1930 hrs |
| **Location:** | 13 nm east of Lancaster |
| **Type of Flight:** | Commercial Air Transport (Passenger) |
| **Persons on Board:** | Crew - 1 Passengers - 15 |
| **Injuries:** | Crew - None Passengers - None |
| **Nature of Damage:** | None to balloon; electrical power lines damaged |
| **Commander's Licence:** | Commercial Pilot's Licence |
| **Commander's Age:** | 63 years |
| **Commander's Flying Experience:** | 2,153 hours (of which 553 were on type)<br>Last 90 days - 41 hours<br>Last 28 days - 10 hours |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot |

**Synopsis**

During an approach to a landing site the balloon struck power lines. The lines and supporting poles were partially obscured and not seen until late. The pilot took action to land the balloon and, while the balloon contacted the lines, no damage occurred to the balloon and its occupants were uninjured.

**History of the flight**

After an uneventful flight, the pilot prepared the balloon and his passengers for landing. Recent wet weather had made the ground soft, so the pilot needed to choose a field with road access and where he could land near to the gate. He selected a field in a valley which appeared ideal, with a dry stone wall on the approach side and a lane with access to the left.

As the balloon approached the landing field the pilot saw poles supporting electricity power lines which ran across the direction of travel. The poles had not been visible until relatively late, being hidden by trees beforehand. The balloon was either level or in a shallow descent at this point, with no possibility of climbing above the power lines. The pilot shouted to his passengers to adopt landing positions and operated the balloon control line to deflate the envelope and start an immediate descent.

The balloon contacted the power lines above basket height. Two wires were pushed together and an arc occurred, after which they broke. The balloon made a landing some 100 m further on, with the basket remaining upright; none of those on board were injured and the balloon was undamaged.

The pilot observed that the balloon had been travelling slightly faster than was expected on approach, reducing the time available to see obstructions such as the wires, which were difficult to see against the similarly coloured background. The supporting poles were partially hidden by trees and, as the power line finished at a nearby farmhouse, there was not an extended line of poles to each side, reducing the chance of seeing them still further.

**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | EV-97 Teameurostar UK Eurostar, G-CEHL |
| **No & Type of Engines:** | 1 Rotax 912-UL piston engine |
| **Year of Manufacture:** | 2006 |
| **Date & Time (UTC):** | 5 June 2012 at 1200 hrs |
| **Location:** | Michaelwood Airstrip, near Lower Wick, Gloucestershire |
| **Type of Flight:** | Training |
| **Persons on Board:** | Crew - 2 Passengers - None |
| **Injuries:** | Crew - None Passengers - N/A |
| **Nature of Damage:** | Right wing, right main landing gear and nose leg |
| **Commander's Licence:** | Airline Transport Pilot's Licence |
| **Commander's Age:** | 55 years |
| **Commander's Flying Experience:** | 19,000 hours (of which 350 were on type)<br>Last 90 days - 200 hours<br>Last 28 days - 70 hours |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot |

The pilot intended to perform a touch-and-go on the grass runway, which was bordered by a tall crop, but when the aircraft touched down its left wingtip entered the crop and the resulting drag yawed the whole aircraft into it. The sideways motion caused the right wing to touch the ground, resulting in damage to the wing, right main landing gear and nose landing gear leg.

**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | Pegasus Quik, G-CEVG |
| **No & Type of Engines:** | 1 Rotax 912 ULS piston engine |
| **Year of Manufacture:** | 2007 (Serial no: 8319) |
| **Date & Time (UTC):** | 1 July 2012 at 1131 hrs |
| **Location:** | Manchester Barton Aerodrome |
| **Type of Flight:** | Private |
| **Persons on Board:** | Crew - 1 Passengers - 1 |
| **Injuries:** | Crew - 1 (Minor) Passengers - None |
| **Nature of Damage:** | Damage to wing, propeller blades, pylon, engine, front wheel strut and right mainwheel |
| **Commander's Licence:** | National Private Pilot's Licence |
| **Commander's Age:** | 53 years |
| **Commander's Flying Experience:** | 316 hours (of which all were on type)<br>Last 90 days - 23 hours<br>Last 28 days - 5 hours |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot |

The aircraft was landing on grass Runway 27L after an uneventful local flight. The weather was good, with the wind from 250° at 11 kt but reported as "gusty". The final approach had gone smoothly but, as the pilot flared the aircraft for touchdown, a gust of wind blew it to the right and the left mainwheel made premature contact with the ground. The aircraft bounced and the pilot found that he could not level its attitude or climb away. The aircraft struck the ground on its right side in a nose-low attitude, causing damage to the nose and right main landing gears. It skidded to a halt on its right side, destroying the propeller blades and causing the engine to overspeed, because the pilot could not change the throttle setting or reach the magneto switches. The engine eventually stopped and although a considerable quantity of smoke was generated by oil leaking onto the hot exhaust, there was no fire. The emergency services attended and the occupants were helped from the wreckage. The pilot sustained minor injuries.

The pilot considered that the accident was the result of the gust of wind just as he was about to touch down.

**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | RAF 2000 GTX-SE, G-ONON |
| **No & Type of Engines:** | 1 Subaru EJ22 piston engine |
| **Year of Manufacture:** | 2005 (Serial no: PFA G/13-1313) |
| **Date & Time (UTC):** | 14 August 2012 at 1530 hrs |
| **Location:** | 4 nm north-west of Canterbury, Kent |
| **Type of Flight:** | Private |
| **Persons on Board:** | Crew - 1 Passengers - None |
| **Injuries:** | Crew - None Passengers - N/A |
| **Nature of Damage:** | Damage to landing gear and propeller |
| **Commander's Licence:** | Private Pilot's Licence |
| **Commander's Age:** | 59 years |
| **Commander's Flying Experience:** | 3,789 hours (of which 2,000+ were on type)<br>Last 90 days - 158 hours<br>Last 28 days - 21 hours |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot |

**Synopsis**

The gyroplane suffered a loss of engine power soon after lift off. The pilot arrested the gyroplane's forward speed and made a hard landing at the runway end.

**History of the flight**

A new electronic throttle position sensor had been fitted to the gyroplane, and subsequent engine ground runs had been satisfactory. Prior to the accident flight, the gyroplane had been parked in direct sun but with the fuel tanks shaded. The airstrip had a grass runway, about 460 m long and orientated 13/31. Over about 130 m at its south-easterly end, the strip had a marked down slope. The weather was fine, with a very light wind from west-south-west and a temperature of 24°C.

After a normal engine start, the engine was allowed to warm to operating temperature before a takeoff was commenced in a south-easterly direction. The pilot thought he felt an engine hesitation, so discontinued the takeoff and landed again before the runway end. All engine indications were checked and found to be normal.

A further takeoff was started, this time in the north-westerly direction. The takeoff was normal initially as were the engine indications, which the pilot checked while still in ground effect immediately after lift off. The pilot therefore decided to continue with the takeoff but, at a height of about 40 to 50 ft, the engine lost power. The pilot checked the throttle had not been displaced and prepared for an immediate landing; he did not have time to observe any engine indications. The only option available to the pilot was to land on the remaining airstrip ahead. To achieve this, he had to arrest all forward motion before descending vertically, accepting that this would result in damage to the gyroplane. The gyroplane came to a rest at the end of the runway with the rotors still turning and the engine running at idle.

The pilot's investigation showed that no electronic fault codes had been registered and that the fuel pumps operated normally and produced the correct pressure. Although the engine idled at the specified rpm in ground runs after the accident, it subsequently idled significantly higher, and the recently fitted throttle position sensor was found to have failed. It was not possible to establish if this was as a result of the accident. The temperature of the day was such that the possibility of fuel vapour lock could not be excluded.

**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | Tanarg/iXess 15 912s(1), G-TEAS |
| **No & Type of Engines:** | 1 Rotax 912ULS piston engine |
| **Year of Manufacture:** | 2006 (Serial no: BMAA/HB/489) |
| **Date & Time (UTC):** | 29 May 2012 at 1143 hrs |
| **Location:** | Calton Moor Airfield, Derbyshire |
| **Type of Flight:** | Private |
| **Persons on Board:** | Crew - 1 Passengers - 1 |
| **Injuries:** | Crew - 1 (Serious) Passengers - None |
| **Nature of Damage:** | Extensive |
| **Commander's Licence:** | National Private Pilot's Licence |
| **Commander's Age:** | 59 years |
| **Commander's Flying Experience:** | 83 hours (of which 83 were on type)<br>Last 90 days - 15 hours<br>Last 28 days - 5 hours |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot |

The pilot reported that he had taken off in a north-westerly direction from the airfield at Calton Moor. The weather conditions were fine, with a light south-westerly surface wind. The temperature was 21°C and the pilot described the conditions as "thermic". The takeoff had been normal until a height of about 80 ft, when the microlight (which was near the maximum takeoff weight) stalled. The left wing dropped and the aircraft descended in a spiral to the ground. The pilot, who was wearing a lap strap, suffered serious leg and internal injuries, while the passenger, who was wearing a lap strap and diagonal harness, suffered no injuries. Both occupants were wearing protective helmets.

**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | Thruster T600N 450, G-MGTV |
| **No & Type of Engines:** | 1 Jabiru Aircraft PTY 2200A piston engine |
| **Year of Manufacture:** | 2002 |
| **Date & Time (UTC):** | 30 March 2012 at 1330 hrs |
| **Location:** | Tandragee Airstrip, Portadown |
| **Type of Flight:** | Private |
| **Persons on Board:** | Crew - 1 Passengers - 1 |
| **Injuries:** | Crew - None Passengers - None |
| **Nature of Damage:** | Collapsed nosewheel and cracked pod and windscreen |
| **Commander's Licence:** | Private Pilot's Licence |
| **Commander's Age:** | 55 years |
| **Commander's Flying Experience:** | 250 hours (of which 30 were on type)<br>Last 90 days - 4 hours<br>Last 28 days - 2 hours |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot |

**Synopsis**

The aircraft took off with an estimated 10 kt tailwind and stalled shortly after becoming airborne.

**History of the flight**

The pilot had planned to undertake a local flight with a passenger. The forecast indicated good weather, with northerly winds of 5-10 kt. The pilot reported that when he took off the wind conditions had become gusty with an estimated wind speed of 10 kt.

The airstrip is constructed of crushed stone and is orientated north-south, with a downhill gradient in the southerly direction. A hedge and a number of trees present obstacles at the edge of the airfield to the north. In order to take advantage of the runway slope and to avoid the obstacles at the northern end, the pilot chose to take off in the southerly direction. He reported that shortly after becoming airborne at a height of 10-20 feet, the right wing dropped and, before he could react, the aircraft hit the ground. The pilot shut down the engine, which remained running after the impact, before he and the passenger vacated uninjured from the aircraft.

**Pilot's assessment of the cause**

In choosing the southerly direction for takeoff the pilot judged that the advantages conferred by the downhill slope and lack of obstacles outweighed the loss of performance due to the tailwind, but did not calculate the relative affects. He believed that insufficient airspeed at takeoff, especially in view of the gusty conditions, led to the aircraft stalling at a height at which he could not react effectively to the situation.

**Comment**

Useful information for assessing aircraft performance, especially when operating from airstrips, is available in the CAA Safety Sense leaflets 7 - *'Aircraft Performance'*, and 12 - *'Strip Sense'*, which are available from the CAA website at www.caa.co.uk/safetysense.

**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | Ultramagic SA N-250 balloon, G-VBFA |
| **No & Type of Engines:** | None |
| **Year of Manufacture:** | 2006 |
| **Date & Time (UTC):** | 23 May 2012 at 2000 hrs |
| **Location:** | 13 nm north-west of Plymouth |
| **Type of Flight:** | Commercial Air Transport (Passenger) |
| **Persons on Board:** | Crew - 1 Passengers - 12 |
| **Injuries:** | Crew - None Passengers - 1 (Serious) |
| **Nature of Damage:** | None |
| **Commander's Licence:** | Commercial Pilot's Licence |
| **Commander's Age:** | 52 years |
| **Commander's Flying Experience:** | 1,109 hours (of which 720 were on type)<br>Last 90 days - 19 hours<br>Last 28 days - 8 hours |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot |

**Synopsis**

Following a firm but otherwise normal landing, a male passenger complained of pain in both legs which prevented him moving. The 62-year old passenger was subsequently taken to hospital and found to have suffered a serious injury to each leg. There were no other reported casualties.

**History of the flight**

Before flight, the passengers were given a safety briefing by the pilot, which included a chance to practise the landing positions within the balloon basket. The balloon took off normally in 8 to 10 kt of wind, and made a slow climb to 5,000 ft. After about 30 minutes, the pilot descended the balloon to 1,000 ft and then to 500 ft to check the wind, which was 13 kt.

The pilot reminded the passengers of the landing positions, telling them that the wind strength had not reduced as much as had been anticipated or forecast, and that they should hold on tightly and expect a fast landing. A landing field was identified and the passengers instructed to adopt landing positions. The balloon made a "positive" landing before dragging a little and lifting off again to a height of approximately 6 ft. The subsequent landing was gentle, after which the balloon dragged again until the basket slowly tipped over and the balloon deflated.

The pilot became aware that a 62-year old male passenger appeared to be injured and was complaining of pain in his legs. As the pain prevented him from moving and the injury appeared serious, the pilot telephoned for an ambulance. Two paramedic vehicles arrived and assisted the passenger until an ambulance attended and transferred him to hospital.

**Injury**

The pilot was later told that the passenger had suffered a broken bone at the top of his shin in both legs, and that after surgery was confined to a wheelchair whilst the injuries healed. The pilot considered that the injury was unusual for a firm but normal landing in an estimated wind of 8 kt. There were no other reported casualties.

**Passenger comment**

The passenger reported his impression that the landing was "extremely severe" and commented that the impact occurred very shortly after the call to brace.

**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | X'AIR Falcon 133(1), G-CCNL |
| **No & Type of Engines:** | 1 Verner 133M piston engine |
| **Year of Manufacture:** | 2004 |
| **Date & Time (UTC):** | 5 July 2012 at 1845 hrs |
| **Location:** | Near Sandy, Bedfordshire |
| **Type of Flight:** | Private |
| **Persons on Board:** | Crew - 1 Passengers - None |
| **Injuries:** | Crew - None Passengers - N/A |
| **Nature of Damage:** | Damage to left landing gear and rear fuselage |
| **Commander's Licence:** | Private Pilot's Licence |
| **Commander's Age:** | 48 years |
| **Commander's Flying Experience:** | 70 hours (of which 70 were on type)<br>Last 90 days - 6 hours<br>Last 28 days - 1 hour |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot |

The aircraft was descending through about 1,500 ft prior to joining the circuit at Sandy Airfield when the engine lost power. The pilot carried out the appropriate actions to restore normal power, but without success. Although the engine continued to run, it would not produce more than 1,800 rpm.

The pilot selected an area of common ground in which to make a landing. The landing itself was successful, but the aircraft encountered an unseen ditch which caused damage to the landing gear and airframe. Upon inspecting the engine, it was found that part of a valve rocker on the inlet valve side had sheared off.

# Miscellaneous

This section contains Addenda, Corrections and a list of the ten most recent Aircraft Accident ('Formal') Reports published by the AAIB.

The complete reports can be downloaded from the AAIB website (www.aaib.gov.uk).

# TEN MOST RECENTLY PUBLISHED FORMAL REPORTS ISSUED BY THE AIR ACCIDENTS INVESTIGATION BRANCH

1/2010 Boeing 777-236ER, G-YMMM
at London Heathrow Airport
on 17 January 2008.

Published February 2010.

2/2010 Beech 200C Super King Air, VQ-TIU
at 1 nm south-east of North Caicos Airport, Turks and Caicos Islands, British West Indies
on 6 February 2007.

Published May 2010.

3/2010 Cessna Citation 500, VP-BGE
2 nm NNE of Biggin Hill Airport
on 30 March 2008.

Published May 2010.

4/2010 Boeing 777-236, G-VIIR
at Robert L Bradshaw Int Airport
St Kitts, West Indies
on 26 September 2009.

Published September 2010.

5/2010 Grob G115E (Tutor), G-BYXR
and Standard Cirrus Glider, G-CKHT
Drayton, Oxfordshire
on 14 June 2009.

Published September 2010.

6/2010 Grob G115E Tutor, G-BYUT
and Grob G115E Tutor, G-BYVN
near Porthcawl, South Wales
on 11 February 2009.

Published November 2010.

7/2010 Aerospatiale (Eurocopter) AS 332L Super Puma, G-PUMI
at Aberdeen Airport, Scotland
on 13 October 2006.

Published November 2010.

8/2010 Cessna 402C, G-EYES and
Rand KR-2, G-BOLZ
near Coventry Airport
on 17 August 2008.

Published December 2010.

1/2011 Eurocopter EC225 LP Super Puma, G-REDU
near the Eastern Trough Area Project Central Production Facility Platform in the North Sea
on 18 February 2009.

Published September 2011.

2/2011 Aerospatiale (Eurocopter) AS332 L2 Super Puma, G-REDL
11 nm NE of Peterhead, Scotland
on 1 April 2009.

Published November 2011.

Unabridged versions of all AAIB Formal Reports, published back to and including 1971, are available in full on the AAIB Website

http://www.aaib.gov.uk