CONTENTS

SPECIAL BULLETINS

COMMERCIAL AIR TRANSPORT

FIXED WING

ROTORCRAFT

GENERAL AVIATION

FIXED WING

ROTORCRAFT

SPORT AVIATION / BALLOONS

CONTENTS (Continued)

ADDENDA and CORRECTIONS

(ALL TIMES IN THIS BULLETIN ARE UTC)

INCIDENT

Aircraft Type and Registration:	Airbus A319-111, G-EZIU
No & Type of Engines:	2 CFM56 turbofan engines
Year of Manufacture:	2005
Date & Time (UTC):	6 February 2007 at 1146 hrs
Location:	En route to from Barcelona to Liverpool
Type of Flight:	Commercial Air Transport
Persons on Board:	Crew - 6 Passengers - 78
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	46 years
Commander's Flying Experience:	Total 12,500 hours (of which 2,166 were on type) Last 90 days - 81 hours Last 28 days - 26 hours
Information Source:	AAIB Field Investigation

Synopsis

During a scheduled passenger flight from Barcelona to Liverpool, numerous caution messages and accompanying aural tones were generated, some of which occurred repeatedly for the remainder of the flight. Although the flight crew were unable to resolve the problem, they concluded that the messages were most probably spurious. A MAYDAY was declared and the aircraft was diverted to London Stansted, where it landed safely. No faults were confirmed that could have accounted for these symptoms, but an intermittent fault in one of the Display Management Computers was considered to be the most likely cause.

History of the flight

The co-pilot was the pilot flying on the scheduled passenger flight, which was uneventful until crossing the south coast of England, when the ENG 2 EGT DISCREPANCY Electronic Centralised Aircraft Monitor (ECAM) caution message appeared, with an accompanying aural tone.

The co-pilot continued to fly the aircraft on autopilot whilst the commander reviewed the ECAM checklist action items. The ENG 2 EGT OVER LIMIT caution message then appeared. The action items for this condition required the No 2 (right) engine thrust lever to be moved to idle and the engine to be shut down. The commander retarded the thrust lever and was considering the implications of shutting down

the engine, when the ENG 1 EGT OVER LIMIT caution message appeared. The ECAM actions for this message were identical, but related to the No 1 (left) engine. The commander observed that the ECAM engine parameter indications appeared normal and concluded that the caution messages were probably spurious and reinstated the No 2 engine thrust lever.

During this period, the normal indications on the captain's Primary Flight Display (PFD 1) and Navigation Display (ND 1) were replaced with red indications similar to those that appear during inertial reference system alignment. The red USE MAN PITCH TRIM warning and amber MAN PITCH TRIM ONLY caution messages also appeared intermittently on his PFD. These normally signify degradation of the flight control system operation, but this had not occurred. The CHECK ATT message appeared intermittently on the co-pilot's PFD (PFD 2) only.

The commander informed ATC of their situation and declared a MAYDAY. As there was fog at his intended destination of Liverpool, he requested a direct routing to Stansted, given its more favourable weather and long runway. The controller advised that Runway 23 was in use at Stansted and the commander programmed the Flight Management System (FMS) accordingly. When handed over to another controller, the crew were advised that Runway 05 was active. This further added to the crew's workload as the commander then had to reprogram the FMS for the different approach.

The ECAM continued to produce various cautions and associated aural tones throughout the rest of the flight, too frequently to be read, acted upon, or cancelled. The commander briefed the senior cabin crew member and informed the passengers of the intention to divert, a task complicated by the frequent sounding of aural tones. The pilots noted several other anomalies, including loss of the gross weight, outside air temperature and clock displays.

The crew were given radar headings to intercept the ILS for Runway 05 at Stansted, and the co-pilot armed the autopilot approach mode and engaged the second autopilot. The commander, who was looking out, assessed that they would overshoot the runway extended centreline and took control, manually flying the aircraft visually for the remainder of the approach. On selecting the landing gear down, one of the ECAM landing gear indications showed unsafe, even though the independent green 'gear down and locked' indicator lights were all illuminated. At approximately 700 ft agl, the No 1 engine N_1 indication turned amber and indicated slow rotation. The landing, which was attended by the Aerodrome Fire and Rescue Service, was uneventful.

The commander commented that the aircraft flew normally under manual control. The crew stated that there was no guidance in any of the manuals available on board the aircraft on how to deal with the combination of symptoms experienced during the flight.

Once parked on stand, the flight crew photographed the ECAM, which displayed the following messages:

CANCELLED CAUTION

ENG 1 N2 OVER LIMIT
ENG 2 N2 OVER LIMIT
ENG 2 EGT OVER LIMIT
ENG 1 N2 DISCREPANCY
ENG 1 EGT DISCREPANCY
ENG 1 N1 DISCREPANCY

Aircraft information

Electronic Instrument System

The Airbus A319 is equipped with an Electronic Instrument System (EIS) which includes six Display Units (DU): the Captain's and Co-pilot's PFD and ND, the Engine/Warning Display (EWD) and the Systems Display (SD).

The PFDs supply the flight crew with the short-term information required to fly the aircraft, including attitude, airspeed, vertical speed and altitude. They also display flight path trajectory deviation and autopilot/autothrottle mode selection information. The NDs present navigation and weather radar information. Loss of valid parameter data to a DU is indicated by a red cross appearing in the area of the screen where the parameter is normally displayed.

The EIS also incorporates three identical Display Management Computers (DMC). During normal operations the captain's PFD and ND, the EWD and SD are supplied by DMC 1 and the co-pilot's displays by DMC 2. DMC 3 is available as a standby and can be selected to replace DMC 1 or 2 via the EIS DMC rotary switch on the Switching Panel.

ECAM system

The ECAM system incorporates the EWD and SD. The EWD presents engine primary and fuel quantity indications, flight control information and warning and/or caution messages. The SD presents aircraft status messages and system synoptic diagrams. In the event of an aircraft system fault, warning or caution messages will appear on the lower left of the EWD screen, together with a list of abnormal or emergency actions to be performed by the crew. Some warnings and cautions (eg engine messages) have a higher priority than other messages and these will therefore appear at the top of the ECAM actions list.

Display Management Computers

The DMCs operate both as data concentrators for the DUs and graphics generators for some aircraft parameters. The DMCs also generate the engine exceedence thresholds and transmit them to the Flight Warning Computers (FWC). The DMCs receive data from aircraft systems via multiple input buses. Each DMC has a single output data bus which is used to transmit the engine exceedence thresholds to the FWC and data to a number of other aircraft systems including the FDR. Each DMC also has dedicated ARINC 629 connections with other DMCs for data exchange.

The DMCs contain electronic circuit boards which perform various functions. Two of these include major components which are designated as 'PUMA 0' and 'PUMA 1'. The PUMA 0 is responsible for handling some of the input data to the DMC and for sending all data to the single output data bus. It is connected to, amongst other components, a Central Processor Unit (CPU) for data processing and Static Random Access Memory (SRAM) for data storage. Engine parameter data is processed in parallel by both the PUMA 0 and PUMA 1 such that in the event of a fault in either component, engine parameters will continue to be displayed on the ECAM.

If a DMC ceases to provide any data to a DU, the complete DU image is replaced by the message INVALID DATA.

Flight Warning Computers

There are two identical FWCs, which operate simultaneously. They generate visual and aural alerts, and the alphanumeric codes corresponding to the text

messages that are displayed on the Warning and Status parts of the ECAM DUs. These are sent to the DMC for display.

Engine parameter data displayed on the ECAM via the DMCs is compared with data from the Engine Control Units (ECUs). The FWCs compare these data and if there is a mismatch, will generate an ECAM discrepancy caution message for the affected engine parameter(s). The FWCs will also generate an ECAM caution message if a discrepancy is detected between the roll or pitch angle outputs from the captain's and co-pilot's DMCs.

.

Recorded Information

The aircraft was fitted with a solid-state, two-hour, four-channel Cockpit Voice Recorder (CVR) and a solid-state Flight Data Recorder (FDR).

The relevant FDR data started with G-EZIU just north of the Isle of Wight, heading north, cruising at FL380, at an indicated airspeed of 246 kt. The autopilot and autothrottle were engaged and the engines were operating normally. At 11:46:43 hrs, the CVR recorded the sound of a Master Caution single chime tone[1]. At around the same time, a number of FDR parameters exhibited unusual behaviour (Figure 1).

After the first Master Caution tone, three more were recorded over the next 11 seconds. A further three were recorded before the commander stated "THRUST LEVER TO IDLE OK". Master Caution tones continued to be generated at the rate of one approximately every four seconds. The data shows the No 2 engine thrust lever was retarded around 28 seconds after the first Master Caution. The autothrottle responded by increasing the No 1 engine N_1 from 82% to 88%. The data showed that, 26 seconds after being retarded, the No 2 engine thrust lever began to advance over a period of 38 seconds, after which it was in the same position as that of the No 1 engine.

During the first three minutes after the first ECAM caution, a total of 61 Master Caution chimes were recorded on the CVR. During the taxi after landing, the rate of Master Caution triggering reduced to roughly one every six to ten seconds. In the 33 minutes between the first and last audible Master Caution, around 460 Master Cautions were recorded by the CVR.

No indication of any DMC fault was recorded by the FDR during the entire flight.

Aircraft examination

A review of the aircraft maintenance troubleshooting data following the incident confirmed that numerous ECAM caution messages had been generated during the flight, many of which were recurrent. The 'Post Flight Report', which records the 40 most recent faults, included the following DISCREPANCY messages: ENG 2 N1, ENG 2 N2, ENG 2 EGT, NAV ATT, ENG 1 FF and ENG 2 FF.

The operator's engine trend monitoring data did not highlight any evidence of a developing problem on either engine. The engine parameters for the incident flight were downloaded from the engine ECUs; these showed that no engine faults had been recorded during the incident flight and nor had any engine limits been exceeded. A series of engine ground runs were then performed, during which the EIS DMC switch was selected to all positions to check for correct DMC switching. Both engines performed normally and no ECAM messages were generated.

Footnote

[1] The Master Caution alert is not recorded on the FDR. The CVR and FDR have been time-aligned to allow the trigger points for Master Caution to be ascertained.

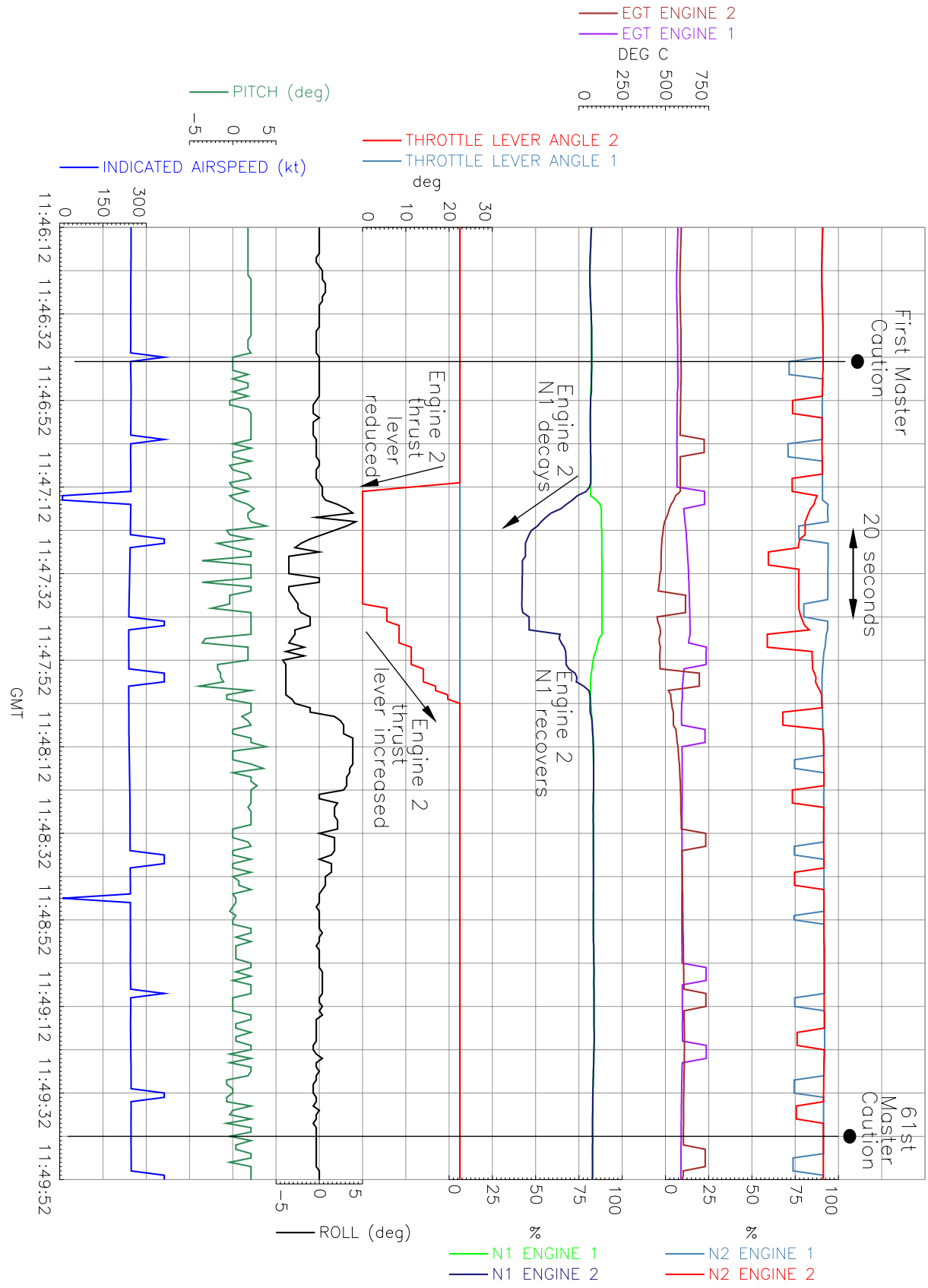

Figure 1

G-EZIU Relevant FDR Parameters

DMC 1 testing

The DMC 1 was removed from the aircraft and returned to the manufacturer for further investigation, where the contents of its BITE memory were downloaded. This revealed that during this and a previous incident in September 2006, data on the input data buses to DMC 1 had been declared invalid by the DMC. No faults were identified on the DMC 1 output databus.

The reason why DMC 1 had declared the input data as invalid was not evident. The manufacturer undertook extensive testing of the DMC, specifically on the input/output data handling of the PUMA 0 circuit board and on the SRAM. Whilst they were unable to establish the cause of the loss of the input data buses, they concluded that a corruption in the 'PUMA 0' SRAM was the most likely cause of the symptoms experienced by the flight crew.

Background information

The aircraft manufacturer stated that no other occurrences of this problem have been reported since the introduction of this EIS standard on A320-family aircraft. At February 2008, it was estimated that the total operating hours of this DMC type on A320-family aircraft was in excess of 5 million flight hours. The same hardware standard of DMC is also installed on A340-500/600 aircraft and some A340-200/-300 and A330 aircraft, which significantly increases this number.

Previous occurrence

G-EZIU experienced a similar event on 29 September 2006, during which the flight crew reported that the ENG 2 N1 DISCREPANCY ECAM message repeatedly appeared and disappeared. Similar discrepancy messages for Engine No 1, Fuel on Board and Fuel Flow were also generated. The ECAM messages ceased when the crew selected DMC 3 to supply the captain's instruments by setting the EIS DMC switch to CAPT 3. The reported symptoms could not be reproduced during subsequent troubleshooting and the aircraft was returned to service.

Information provided to pilots

The operator used a 'less paper cockpit' philosophy in which printed operating manuals were replaced by electronic documents accessible on laptop computers. The Quick Reference Handbook (QRH) was the only printed document containing operational procedures available in the cockpit.

The Airbus philosophy relies on the ECAM system to indicate to pilots the actions to be taken in most normal, abnormal and emergency situations. Pilots are required to commit only a small number of checklists to memory; EIS DMC switching is not one of them.

Analysis

Reported symptoms

Despite extensive on and off-aircraft testing, no hard faults were found that could account for the symptoms experienced during the incident flight.

The DMC 1 BITE data showed that, during this and the previous incident, data received by the PUMA 0 was judged to be invalid. The information on the captain's displays that used the PUMA 0 interface would have become unavailable; this was indicated by the crew report that the captain's PFD and ND indications were similar to those that appear during inertial reference system alignment. The engine parameters are processed by both the PUMA 0 and PUMA 1 in parallel within the DMC, so the engine parameter information on ECAM remained unaffected during this incident as the

data was provided by the PUMA 1. Other anomalies noted by the flight crew could also be explained by the invalid input data and corrupted output data from the PUMA 0.

The invalid data transmitted by PUMA 0 could also have caused the FWC to detect a discrepancy between the engine parameter values from the engine ECUs and DMC 1. This would have caused an ECAM discrepancy caution to be generated for the affected engine parameter(s). The fact that the ECAM engine caution messages repeatedly appeared and disappeared suggested that the fault condition on the PUMA 0 circuit board was intermittent. The FWC also generated a NAV ATT DISCREPANCY amber alert as a result of the discrepancy in roll or pitch values between the captain's and co-pilot's DMCs. This also resulted in the intermittent display of the CHECK ATT message on the co-pilot's PFD.

Data from the engine ECUs indicated that neither engine had exceeded any limits. It is probable that the data corruption within DMC 1 resulted in the exceedence thresholds being incorrectly set too low, so that when these were transmitted to the FWCs, exceedence cautions were generated.

All this is consistent with the manufacturer's supposition that a SRAM problem on the PUMA 0 circuit board in DMC 1 was the most likely cause of the incident.

Crew response

The ECAM caution messages initially presented to the pilots related to engine parameter discrepancies and exceedences. The ECAM action items would have therefore directed their attention towards the behaviour of the engines rather than the performance of the displays.

Given the nature of the fault, it was impossible for the pilots either to complete these ECAM procedures or cancel the messages, so the ECAM system could not assist them to address the loss of information on PFD 1 and ND 1. The only source of information readily available in the cockpit for this purpose, other than the ECAM, was the QRH, but this did not contain an obvious procedure for addressing this particular situation. This combination of factors probably persuaded the pilots not to attempt further remedial action, but to land the aircraft as soon as possible.

In the previous incident on 29 September 2006, the flight crew concluded, in less confusing circumstances, that the ECAM engine discrepancy messages were spurious and switched the captain's instruments to DMC 3, after which the messages ceased. In this more complex incident, the combination of symptoms observed by the crew did not obviously point towards a DMC fault and there was no readily available procedure nor any memory drill for dealing with such a situation. The crew did not try to recover the displays via DMC switching because it was not evident to them that a DMC fault had occurred.

The following Safety Recommendation is therefore made:

Safety Recommendation 2009-058

It is recommended that Airbus either amend the Quick Reference Handbook of Airbus aircraft with switchable EIS DMC selections, or introduce a memory drill, to emphasise that EIS DMC switching may be an appropriate response to abnormal display unit operation, even if no 'INVALID DATA' message is displayed.

Conclusion

Despite extensive testing, the equipment manufacturer was unable to reproduce a hard fault that could account

for the PUMA 0 input data being declared invalid and output data being corrupted. Nevertheless, the symptoms reported by the flight crew and recorded data are consistent with the manufacturer's supposition that the incident was caused by corruption of SRAM that affected the PUMA 0 in DMC 1.

On this occasion the circumstances were such that the crew were unable to diagnose that the symptoms were display-related and they therefore did not select the EIS DMC switch to 'CAPT 3'. It was subsequently determined, as a result of this investigation, that this would have resolved the problem.

SERIOUS INCIDENT

Aircraft Type and Registration:	Dornier 328-300, G-CJAB
No & Type of Engines:	2 Pratt & Whitney Canada PW306B turbofan engines
Year of Manufacture:	2002
Date & Time (UTC):	3 March 2009 at 1645 hrs
Location:	Inbound to Southampton Airport
Type of Flight:	Commercial Air Transport (Non-Revenue)
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	62 years
Commander's Flying Experience:	14,124 hours (of which 3,580 were on type) Last 90 days - 11 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and manufacturer's airworthiness investigation interim report

Synopsis

During cruise and on the approach in IMC, over a period of approximately 15 minutes all five display screens in the cockpit failed successively. An uneventful ILS landing was completed using the standby instruments.

History of the flight

The aircraft was being ferried after an extended period without flying. The engines were started using the APU due to the unavailability of ground power and the aircraft then departed Biggin Hill Airfield at 1610 hrs on a non-revenue flight to Southampton. After approximately 20 minutes, whilst established in the cruise in IMC at FL080, Multi-Function Display (MFD) 1 failed. 10 minutes later MFD 2 failed, followed shortly by Primary Flight Display (PFD) 2. The flight continued to Southampton, but whilst the aircraft was intercepting the ILS localiser for Runway 20, PFD 1 failed. Finally, on short final to land, the Engine Indication and Crew Alerting System (EICAS) screen failed. The crew completed the abnormal procedures checklist section 9-1, and carried out a successful landing using the standby instruments.

Aircraft history

The aircraft had been removed from service due to airframe damage about a year earlier. The damage to the tail section had been repaired successfully, but the

aircraft had only flown just over three hours since then, being kept in a hangar the remainder of the time. The owners had not stored the aircraft in accordance with the Approved Maintenance Manual requirements for long-term storage, but in a state of readiness for operation, with regular engine ground runs and the completion of routine continuing airworthiness maintenance requirements.

Initial engineering findings

Troubleshooting work carried out after the landing at Southampton confirmed that all five display units had failed completely. No other defects could be identified on the aircraft. The failed components were all DU-870 type display units, part number 7014300-902. The replacement display units worked without reccurrence of the problem and the aircraft was released serviceable. Following removal, the failed units were returned to the display unit manufacturer for detailed investigation.

Detailed engineering findings

The display unit manufacturer tested the units and confirmed that the display units' outputs were valid, but that the displays themselves remained blank. They then carried out detailed strip examinations, which determined that the High Voltage Power Supply (HVPS) unit had failed in each case. These components were returned to the HVPS manufacturer, who confirmed that the same transformer (SMI-20-04) had failed in each unit. The transformers were epoxy encapsulated and the potting around the secondary winding had failed, most likely due to overheating, causing the winding to short-circuit.

Component service history and modification standard

The service history for each of the display units was reviewed along with the modification standard. The failed transformers fitted to the removed display units were obsolete. This failure mode had been identified in 2001 due to a series of premature failures of the display screens and a new standard transformer was introduced in late 2002. The new standard formed part of a series of three modifications - J, K and L (introduced by service bulletins A21-2249-018, A21-2249-020 and A21-2249-021 respectively), which were developed to give better high temperature tolerance to the display units. Modification N (SB A21-2249-026), which added temperature indicators to the HVPS assembly, was also introduced to assist with future failure analysis of the units. Records identified that none of the five failed units had been returned for repair or overhaul since original installation, consequently none of these modifications had been embodied.

Aircraft equipment cooling system

Cockpit ambient air is used to cool the display units once installed in the aircraft; a fan draws the air into the system and it is then ducted around the instrument panel. The manufacturer states that the units should not be run continuously in an ambient environment that exceeds 55°C. The maximum recommended cockpit air temperature is 40°C, as the display unit runs approximately 15°C hotter than the cooling air. The manufacturer also recommends that the displays be turned off when not required when the electrical power is on during maintenance. This information was communicated to operators in a Technical News Letter (A23-2249-003), issued by the display unit manufacturer. It is possible to switch off the fan via the Environmental Control System (ECS) panel on the flight deck, or by pulling the appropriate circuit breaker. However, if the fan fails during normal operation an amber caption appears on the EICAS screen. The aircraft manufacturer requested the operator of the incident aircraft to carry out additional inspection of the aircraft's cooling system, but no abnormalities were identified.

Other incidents

A further three recent incidents of this aircraft type experiencing loss of displays (on the ground, rather than in-flight) have also been identified. All three aircraft had been subject to extended periods without airborne operation. Some of the failed units were modified to 'N' standard and data from the temperature recording strips is assisting with those investigations.

Further work

The aircraft manufacturer has drafted a new service bulletin which highly recommends checking units which are modified to 'J' standard and ensuring that at least four of the five display units fitted to each aircraft have this modification embodied, otherwise a unit modified to 'K' standard or above should be fitted. EASA are considering whether any of the relevant service bulletins should be mandated. Investigations into the effect on display units of periods of extended ground maintenance operation, or inactivity, are also continuing.

Conclusion

Given the short period of time between display unit failures during the incident flight, it is unlikely that all five were random failures. However, it is also unlikely, given the UK climate in which the aircraft was operated and stored, that the ambient temperature of the cockpit exceeded 40°C for a sustained period of operation of the units. Given the lack of any additional findings from inspection of the incident aircraft, it has not been possible to determine a common trigger mechanism for the possible overheat and breakdown of the transistor potting, although investigations into the failure of other units in the world fleet may lead to a definitive cause being identified. The issue will continue to be monitored by EASA under their Airworthiness Review Meeting process until they consider the problem to have been adequately addressed.

ACCIDENT

Aircraft Type and Registration:	Avions Pierre Robin DR400-180, F-GDYD
No & Type of Engines:	1 Lycoming O-360-A3A piston engine
Year of Manufacture:	1984
Date & Time (UTC):	19 July 2008 at 1337 hrs
Location:	Llanfihangel Glyn Myfyr, near Corwen, North Wales
Type of Flight:	Private
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - 2 (Serious) Passengers - N/A
Nature of Damage:	Substantial
Commander's Licence:	Private Pilot's Licence
Commander's Age:	67 years
Commander's Flying Experience:	871 hours (of which 440 were on type) Last 90 days - 41 hours Last 28 days - 16 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft was on the second leg of a seven-day journey from France to the United States of America (USA). As it transited over North Wales, avoiding cloud and the high ground, the engine ran down. The pilot had selected the fuel to feed from the left wing tank. The time that had elapsed since that selection indicated that the engine could have suffered from fuel starvation. However, the conditions were also conducive to carburettor icing. The engine could not be restarted and the pilot carried out a forced landing into a field. During the landing the aircraft ran into a bank in the far corner of the field and was substantially damaged. Both crew members were seriously injured. Although there was a significant spillage of fuel, there was no fire.

History of the flight

The aircraft had departed from Chavenay in France on a seven-day journey to Oshkosh, in the USA, to attend the Experimental Aircraft Association's Fly-In Convention. The first leg from Chavenay to Cherbourg was completed without incident. After landing at Cherbourg, the aircraft was refuelled to full tanks, which equated to 350 litres, and the pilot amended the flight plan to show Inverness as the intended destination, because Stornoway, the planned stopping point at the end of the first day, was due to close before their estimated time of arrival.

The aircraft departed from Cherbourg at 1110 hrs and transited north over the English Channel at 3,000 feet amsl, on a direct track to Bournemouth. Fuel was being fed from the main tank. Five minutes after

passing Bournemouth, the aircraft climbed to Flight Level (FL) 65, on track towards Welshpool, near the England/Wales border. When level, the pilot selected the fuel to feed from the left wing tank. Forty litres of fuel from the main tank had been consumed, leaving 70 litres in that tank. The wing tanks each contained 40 litres and the crew's intention was to run the left tank dry to confirm the engine's fuel consumption at the aircraft's current weight, cruise speed, and at that level. Two weeks before, in preparation for the long transit flights over open water on the journey to North America, the pilot had carried out a series of flights, at different altitudes, to determine accurate fuel consumption figures. This was intended to be a further refinement on those calculations.

After 20 minutes at FL65, to avoid cloud, the crew requested clearance to climb to FL85. Due to air traffic conflictions this was not possible, so the pilot descended F-GDYD below the cloud base, to an altitude of between 2,500 ft and 3,000 ft amsl. The planned route took the aircraft east abeam Bristol, overhead Welshpool and on towards Rhyl on the north coast of Wales. Throughout the flight the crew applied carburettor heat every five minutes, checking that the engine rpm dropped and then recovered when the control was returned to the COLD position. On one occasion, after the descent from FL65, the co-pilot noted that the needle on the carburettor temperature gauge was in the amber band, indicating that there was a risk of carburettor icing, and he selected the control to HOT. The temperature indication moved above the amber band, the engine speed reduced by 100 rpm and then recovered as the carburettor heat control was returned to the COLD position. The co-pilot's other duties included operating the radio and assisting with the navigation, using his hand held GPS unit and charts.

North of Welshpool the terrain began to rise and the pilot altered course to the left to avoid high ground and remain clear of cloud. Because the aircraft's fuel consumption was no longer representative of a steady state condition, he considered changing the fuel selector to another tank but did not do so. Both crew members recalled seeing the left wing tank low level warning light illuminate and the pilot noted that there was approximately 15 minutes remaining before that tank would run dry and the engine would stop.

While manoeuvring to avoid the high ground, the engine suddenly ran down to 1,500 rpm. The pilot switched the electric fuel pump ON and moved the fuel selector a quarter turn anti-clockwise to the main tank position, expecting the engine to restart in one or two seconds. The co-pilot's recollection was that the pilot moved the fuel selector before switching the electric fuel pump ON. He also recalled that the fuel pressure gauge gave the same indication before and after the fuel pump selection. The engine did not accelerate, so the crew selected the carburettor heat to the HOT position, it having last been selected two minutes beforehand. Still the engine did not restart, although the propeller continued to windmill. The pilot lowered the nose of the aircraft to achieve an indicated airspeed of 230 kph (127 kt) and moved the fuel selector a further quarter turn anti-clockwise to the right wing tank position. He exercised the throttle control backwards and forwards and confirmed that the mixture was set to RICH. Later, after the accident, the pilot was unsure as to whether he moved the fuel selector back to the main tank or left it feeding from the right wing tank. He had no indication that the electric fuel pump was operating but did not recall seeing the fuel low pressure light illuminate.

Meanwhile, the aircraft descended from a height of between 700 and 800 ft agl and the pilot selected the

only field that was within range, and clear of obstacles, for a forced landing. Continuing to exercise the throttle, he carried out an approach to this field but does not recall whether he selected any flap. Just before the aircraft landed, the co-pilot switched off the magnetos. After a gentle touchdown, the aircraft yawed to the left and the pilot attempted to counter this with full right rudder. The aircraft descended into a depression in the far corner of the field, struck a bank nose first, yawed further to the left and came to rest. It was still upright but was substantially damaged. Both crew remained in their seats having suffered serious injuries, particularly to their legs.

A householder in a nearby farmstead, approximately 200 metres away, was alerted by the noise of the aircraft's forced landing. He contacted the emergency services and remained with the crew until assistance arrived. Other members of the public also went to the accident site to assist. There was a significant fuel leak but no fire ensued. Following the arrival of all three emergency services, both crew were airlifted to hospital and subsequently recovered from their injuries.

The Emergency Locator Transmitter had been triggered by the accident and was switched off by a crew member from the air ambulance. He also located the battery for the fire crew, who removed it from the aircraft. The fire service also laid two layers of foam to make the area safe.

Recorded information

The aircraft was fitted with four independent GPS receivers which were recovered and downloaded at the AAIB's facilities in Farnborough. Of the four GPS units, one was mounted in the aircraft instrument panel and powered by the aircraft. The other three were hand-held devices; two were discovered in the aircraft wreckage and the third some distance away from the aircraft's final resting position. Each of the GPS units featured a built-in logging system which recorded the aircraft's GPS position over time. Some also recorded altitude, groundspeed and heading.

Recorded data from the Clee Hill and St Annes radar heads was also analysed. This data included the aircraft's position and its associated pressure altitude, as transmitted by the transponder. These pressure altitudes were corrected for the QNH pressure setting, 1,009 mb, to give the aircraft's altitude above mean sea level (amsl). The altitudes were only approximate, due to the 100 ft resolution of the radar altitude data.

At 13:27:23 hrs, the aircraft was 15 track nm from the accident site at an altitude of 3,300 ft amsl. Over the next eight minutes, the aircraft gradually descended to an altitude of 2,500 ft, passing over an area of rising ground in North Wales. At one stage, over the undulating terrain, the aircraft was 415 ±50 ft agl.

At 13:35:07 hrs, the GPS derived groundspeed showed the aircraft speed starting to decay from 98 kt. This is the point at which it was suspected that loss of engine power occurred. Nine seconds later, recorded radar data confirmed that the aircraft began to descend from 2,500 ft amsl.

Airspeed and altitude continued to decrease for about 35 seconds following the suspected loss of engine power. The groundspeed then appeared to stabilise at approximately 74 kt, while the recorded radar and GPS altitudes suggested a rate of descent of about 900 ft/min. F-GDYD passed overhead Llanfihangel Glyn Myfyr at 13:36:28 hrs at a GPS altitude of between 1,375 ft and 1,530 ft amsl.

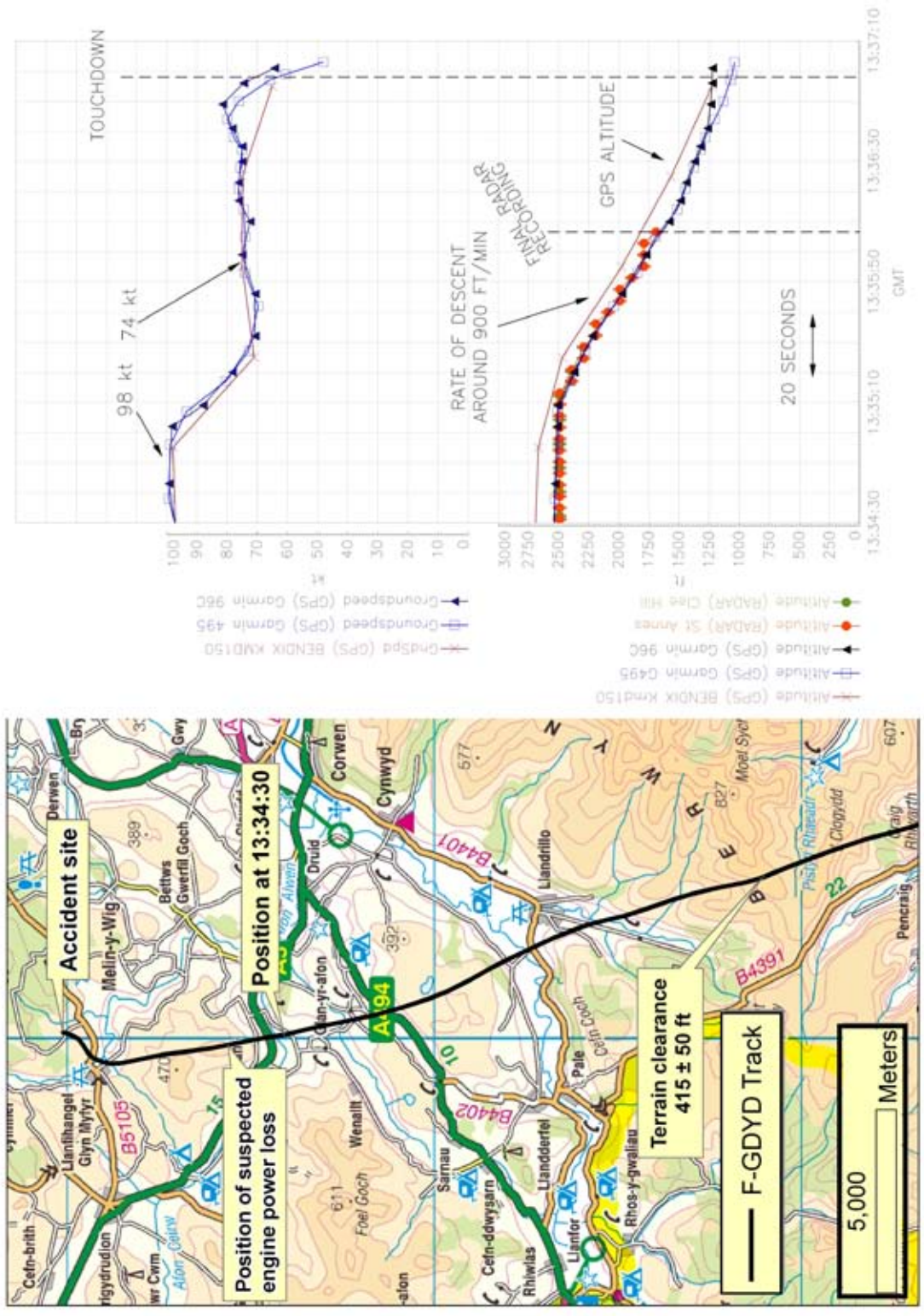

Figure 1

F-GDYD GPS and radar data[1]

Footnote

[1] Terrain elevations in this map are relative to the UK Ordnance Survey datum. Vertical clearances were calculated using radar altitudes by adjusting the terrain elevations to the WGS84 datum.

Using three of the GPS units, which were accurate relative to each other over the final part of the flight, and the locations of the ground marks, touchdown was thought to have occurred at 13:36:58 hrs. Touchdown groundspeed derived from GPS positions was about 63 kt, with a terrain elevation of 1,230 ft amsl. In the 111 seconds between the position where the suspected loss of power occurred and touchdown, the average rate of descent was calculated as 680 ft/min over a track distance of 2.5 nm.

Meteorology

An aftercast provided by the Met Office indicated that, with high pressure over the eastern Atlantic and low pressure over the North Sea, Wales was experiencing a fresh to strong Polar Maritime airflow. Visibility was approximately 25 km, reducing to about 6 km in showers and less than 200 metres in cloud and hill fog. Cloud was estimated to be few or scattered stratus at 1,500 ft amsl, few or scattered cumulus at 2,300 ft amsl and broken at 2,700 ft amsl. The cloud tops were calculated to be between 5,000 ft and 8,200 ft amsl.

In the area of the accident site, the wind at 2,000 ft agl was estimated to be from 330° (T) at 40 kt, reducing to 35 kt at 500 ft agl from the same direction. The crew assessed the wind speed to be less, at about 20-25 kt. The temperature and relative humidity at each height, outside cloud, were estimated to be 5.4°C and 85%, and 9.5°C and 80% respectively. The strong wind gradient gave moderate turbulence over the mountains, with isolated areas of severe turbulence.

Advice promulgated by the Civil Aviation Authority indicates that these combinations of temperature and relative humidity are conducive to serious carburettor icing at any power setting.

The pilot's recollection was that the outside air temperature (OAT) just before the accident was 17°C, with no rain and blue sky ahead. At that temperature, the risk would probably have been of moderate icing at cruise power and serious icing at descent power.

Aircraft information

The Robin DR400-180 is a monoplane constructed predominantly from wood with a fabric covering, and is identifiable by its 'cranked wing' design and one piece sliding perspex canopy. It has a tricycle landing gear and can seat four people in its normal configuration. The accident aircraft had a 110 litre main fuselage tank fitted under what would normally be the rear seat, a 50 litre supplimentary tank in the rear fuselage and 40 litre tanks in each wing root. It had been modified with an additional fuel tank which replaced the rear seat to provide extended range. This modification used a duplicate of the main fuselage tank giving a total capacity of 350 litres of fuel. The single engine fuel supply line could be isolated from all the fuel tanks, fed from an individual wing tank or fed collectively from the tanks in the fuselage by selecting the appropriate position on the rotary selector switch in the cockpit. The instrument panel was equipped with an optional carburettor temperature gauge with an amber band to indicate risk of icing, along with the standard horizontal strip of warning lights at the top of the panel. These included a red fuel low level light and a red fuel low pressure light. The aircraft was fitted with lap restraints only.

The aircraft appeared to have been well maintained prior to the accident. A 200 hour maintenance check on the aircraft had been accomplished two days earlier and the aircraft had flown 176 hours since a comprehensive 2,000 hour overhaul in April 2008.

Accident site and ground marks.

The landing took place in a field 1.4 km north-west of the village of Llanfihangel Glyn Myfyr. The field measured 275 m from boundary to boundary in the landing direction of the aircraft, with a 3.5° downward slope for the majority of its length. It contained a standing crop of grass about 18 in tall. Three distinct tracks of flattened grass were visible, initially on a heading of 086° and starting 90 m from the fence marking the furthest edge of the field. The tracks stopped as they reached a depression 25 m from the fence. At this point the ground dropped away steeply leading to an area of large boulders along the near bank of a small stream. The far bank of the stream was formed by a ridge of earth and large stones. Evidence of blue paint and fragments of the left wing was found on the boulders along the near bank of the stream. There was a clear impact mark in the far bank, where displaced rocks also had traces of blue paint. The grass around this area had become discoloured, consistent with exposure to fuel, as had sections of the adjacent field. The aircraft was located in the corner against a wire fence and steel gate, having turned through 180° from its landing direction.

Impact sequence

The ground marks indicate that the aircraft touched down towards the end of the field and rolled most of the remaining distance with weight on all three wheels. At the point where the ground dropped away it appears the aircraft then became airborne again, until the left wing dropped (a known characteristic for this aircraft at stall) and contacted the large boulders next to the stream. The aircraft then yawed rapidly to the left and impacted heavily on the far side of the stream, nose first into the earth bank. It continued to yaw anti-clockwise until being restrained on the fence and gate.

Initial wreckage examination

There was extensive damage to the fuselage and left wing of the aircraft. The left wing fuel tank remained intact, but had detached from its mount and was hanging by the flexible fuel pipe. The right wing was relatively undamaged but the right wing fuel tank was located some 15 metres away in the adjoining field. The three fuselage fuel tanks were intact and still contained a large amount of fuel. It is estimated that about 170 litres were lost following the impact. The nose and fuselage section forward of the wing spar were heavily disrupted, with the engine and instrument panel hanging down from the rest of the aircraft. Some of this disruption occurred when the crew were lifted out of the aircraft by the emergency services. The propeller blades had minor impact marks consistent with little or no rotation. The flaps appeared to be in the retracted position but heavy disruption of the airframe and the cockpit controls prevented positive confirmation of the selected flap position prior to impact.

Detailed wreckage examination

A significant quantity of fuel was drained from the aircraft at the accident site and, again, upon its arrival at the AAIB facilities at Farnborough. Approximately 107 litres of fuel were drained from the fuselage mounted tanks, but only 0.35 litres from the left wing tank. No fuel was found in the system forward of the fuel selector valve, apart from a very small amount (less than 0.01 litres) in the bottom of the gascolator. There were, however, several breaks in the pipework up to the engine driven fuel pump, caused by the disruption of the airframe during the impact. The fuel selector valve was selected to the right wing tank position. No blockages were identified in the fuel system, the fuel system components were all found to be fully functional and wiring continuity checks revealed no defects. It was not possible to test the fuel tank quantity and low level

warning indications due to the amount of disruption to the airframe.

The carburettor was removed from the engine and the bowl was found to be dry. The float was of metal construction with no evidence of leakage and it moved the needle valve correctly when tested. The air intake on the bottom of the carburettor had taken the full force of the impact with the earth bank and was severely crushed. However, there was no evidence of a pre-impact blockage. The carburettor heat valve showed no evidence of any fault but it was not possible to confirm its position at impact. The crew stated that the cockpit indication during the flight was consistent with a functional carburettor heat system. The engine accessory systems were found to be fully serviceable. The engine itself was inspected internally and externally with no evidence found of pre-impact seizure or mechanical damage.

The carburettor temperature gauge and thermistor were tested off the aircraft and found to be sufficiently accurate for indication purposes, though a small time lag was noted before a change of temperature at the thermistor was reflected with any accuracy on the gauge.

Fuel system tests

The aircraft fuel system, from the tank selector valve to the carburettor, was removed from the wreckage and reassembled. Testing was carried out to simulate a fuel tank running dry, then an alternative full tank being selected. A large number of test runs were completed with varying results. In the majority of the tests it was found that the system would re-prime and the carburettor bowl would fill in less than 20 seconds. However, it was observed that the presence of air in the pipe would, on occasion, generate a lock and stop the flow of fuel to the carburettor completely. The exact combination of factors which resulted in an airlock could not be definitively determined, but it demonstrated that fuel could be prevented from reaching the engine.

Individual testing of the fuel low pressure warning system components, including aircraft wiring continuity and pressure switch and transducer function, identified no defects.

Pre-journey planning and tests

The crew had carefully planned their seven-day journey from France to North America, and the return route which would take six days. In addition, the pilot had conducted a number of flights in the accident aircraft to establish accurate fuel consumption figures at different altitudes. To do this, he fed fuel from one of the wing tanks until it ran dry, knowing the quantity of fuel it contained. As the fuel quantity in that tank decreased, first the fuel low level light would illuminate, followed by the fuel pressure light. When the engine note changed, the pilot would switch on the electric fuel pump, select the fuel to feed from another tank and the engine would accelerate back to its previous speed.

The Aircraft Flight Manual gave fuel consumption figures of 40 litres per hour when cruising at 1,000 ft pressure altitude and 33 litres per hour when at 10,000 ft pressure altitude.

Following the accident, the pilot carried out further flights in an aircraft of the same type with a less powerful engine, but which provided some useful data. The fuel low level light illuminated 18 minutes before the low pressure warning light came on; 14 seconds later the engine started to suffer from fuel starvation and the indicated fuel pressure dropped from 350 mb (approximately full scale) to 150 mb. The unusable fuel quantity in that aircraft's wing tanks was found to be approximately 0.2 litres.

Discussion

The atmospheric conditions at the time of the accident were, at best, conducive to moderate carburettor icing at cruise power and there may have been a risk of serious carburettor icing at any engine power. However, the crew stated that they had regularly exercised the carburettor heat during the flight, the last time being two minutes before the engine ran down, and that they had checked the carburettor temperature gauge. If the engine had cut out due to severe carburettor icing, once the engine stopped the remaining heat in the exhaust may not have been adequate to increase the temperature of the incoming air sufficiently when carburettor heat was selected ON. Therefore, ice may have remained or continued to accumulate, preventing the engine from restarting.

The aircraft had been airborne for 2 hours 25 minutes when the engine ran down. This is consistent with the evidence that 80 litres of fuel was used and that all the usable contents of the left wing fuel tank, which was supplying the engine, were consumed. The crew were taken by surprise when the engine stopped but the pilot followed his usual procedure for re-establishing the flow of fuel to the engine. The lack of fuel found in the system downstream of the tank selector valve suggests that the engine stopped as a result of fuel starvation. However, neither pilot remembered seeing the fuel low pressure warning light illuminate and the co-pilot's recollection was that the fuel pressure gauge reading remained normal before and after the electric fuel pump was selected ON. It is possible that the engine was starved of fuel and that the indication system did not respond correctly to the drop in fuel pressure. However, the pilots report that the system was operating correctly prior to the flight and the absence of any defects during examination following the accident suggests that that was unlikely.

It is also feasible that the needle valve in the carburettor could have stuck in the closed position, only being freed by the final impact. This would maintain fuel pressure in the pipe, from where the indicated pressure is sensed, but allow the fuel level in the carburettor bowl to continue to drop until the engine stopped and prevent it from being restarted. This failure mode fits the pilots' recollection of events, but the fail-safe design of the valve, lack of any supporting evidence post-accident and the normal engine performance for the previous two hours of the flight, suggest it is unlikely to have been the cause in this case.

If the engine did cut out due to the selected left wing fuel tank running dry, fuel system testing demonstrated that air locks can be generated, preventing the flow of fuel to the carburettor. If the supply of fuel to the carburettor did eventually resume, given that the engine had been operating in cruise for two hours prior to it cutting out, the cylinder heads would have been sufficiently heat-soaked to remain at a reasonably high temperature. The throttle is linked to an accelerator pump in the carburettor housing, forcing an additional volume of fuel directly into the airflow when the throttle is opened quickly. By continuously pumping the throttle it is possible for the mixture to become too rich to support combustion in a hot engine at 2,500 ft amsl. The continuous selection of carburettor heat during this period may also have exacerbated the problem.

Conclusion

It was not possible to determine, with certainty, the reasons for the engine failure or its inability to restart. When the failure occurred the crew had few locations to choose from for a forced landing, due to the hilly terrain over which they were flying. The flaps may not have been extended before touchdown. If that was the case, the selection of full flap at the appropriate stage would

have reduced the landing distance required, though the downward slope of the field and the weight of the aircraft meant it was unlikely to have stopped safely in the landing distance available.

ACCIDENT

Aircraft Type and Registration:	Beagle B121 Series 1 Pup, G-AXDW
No & Type of Engines:	1 Continental Motors Corp O-200-A piston engine
Year of Manufacture:	1969
Date & Time (UTC):	26 February 2009 at 1310 hrs
Location:	Approximately 2 miles from Cranfield Airport, Bedfordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - 1 (Minor)
Nature of Damage:	Substantial
Commander's Licence:	Private Pilot's Licence
Commander's Age:	51 years
Commander's Flying Experience:	640 hours (of which 12 were on type) Last 90 days - 10 hours Last 28 days - 7 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The pilot attempted a forced landing as a result of a loss of power. The aircraft undershot the intended landing site and passed through two hedges and a road before coming to rest in a ditch. It is thought the loss of power was most likely caused by carburettor icing, although a technical failure could not be ruled out.

History of the flight

The pilot had intended to fly from Cranfield Airfield to Sibson Airfield near Peterborough. Due to poor weather encountered near the intended destination he elected to return to Cranfield.

On contact with Cranfield ATC the pilot was instructed to remain clear of the approach to allow a BAe 146 to land. He circled, clear of the airfield, at about 1,000 ft for more than five minutes whilst waiting for the BAe 146 to land and to receive his subsequent joining clearance. The pilot then attempted to reposition to join the circuit and stated that when he increased power, the engine faltered, causing him to select both the carb heat and electric fuel pump on. The engine picked up momentarily before again faltering and producing no useful power.

The pilot transmitted a MAYDAY call to ATC and looked for a suitable place to make a forced landing. Due to the presence of electricity pylons, he was unable to land in the immediate vicinity and attempted a forced landing in a field a short distance upwind. As

the aircraft descended through about 200 ft agl, it sunk markedly which the pilot believes was possibly due to a change in the local wind effects at this height. This resulted in the aircraft narrowly undershooting the desired field. The pilot attempted to clear the boundary hedge by pitching up but the aircraft failed to climb and passed through the hedge. It crossed an adjacent road and a second hedge before coming to rest in a ditch. The pilot and passenger were able to vacate the aircraft unaided through the pilot's door, the passenger's door having jammed.

Assessment of the cause

The pilot believes the temperature and dew point at the time of the accident were approximately 9°C and 5°C respectively, suggesting conditions likely to cause serious carburettor icing, regardless of engine power. However, as the engine has not been subject to inspection, a technical failure cannot be ruled out.

ACCIDENT

Aircraft Type and Registration:	Beech Baron, D-IBPN
No & Type of Engines:	2 Continental TSIO 520 WB piston engines
Year of Manufacture:	1982
Date & Time (UTC):	24 May 2009 at 1519 hrs
Location:	Elstree Airfield, Hertfordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Right landing gear detached, right flap damaged, front wheel detatched
Commander's Licence:	Private Pilot's Licence
Commander's Age:	60 years
Commander's Flying Experience:	824 hours (of which 89 were on type) Last 90 days - 5 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and discussion between the pilot and the AAIB

Synopsis

While landing at Elstree Airfield, the pilot initiated the flare early and the aircraft sank heavily onto the runway. The aircraft began to swing right and, despite the application of full left rudder, ran off the runway and onto the grass. During the deceleration, the right landing gear collapsed, causing the aircraft to swing further to the right, and the nose landing gear collapsed before the aircraft came to rest.

History of the flight

The aircraft departed from Bembridge on the Isle of Wight at 1525 hrs for a flight to Elstree Airfield. The pilot routed via the easterly visual reporting point at Elstree for a straight-in approach to Runway 26. There was excellent visibility, little or no cloud and a light and variable wind. He had 160 gal of fuel on board and, as he approached the runway at about 90 kt, he reduced power and began to flare. The aircraft began to sink and the pilot applied power but not enough to prevent a heavy touchdown just before the threshold numbers. As the aircraft touched down, it began to vibrate and shortly afterwards it veered to the right. Despite the application of left rudder, the aircraft departed the right side of the runway and ran onto the grass. As the aircraft slowed, the right landing gear leg collapsed causing the aircraft to swing further to the right and the right engine stopped

as its propeller came into contact with the ground. The nose landing gear leg also collapsed before the aircraft came to rest. The pilot and his passenger were both unhurt and vacated the aircraft through the main door.

Discussion with the pilot

The pilot, who would normally land the aircraft at 100 kt on a long runway, decided to land at 90 kt because the landing distance available was only 651 m and the wind was light and variable. He believed that he began the flare and reduced power too early which, given the high quantity of fuel on board, made the aircraft sink significantly. He remembered applying power but not enough to arrest the rate of descent before the aircraft touched down. It was possible that the aircraft landed in a 'three-point' attitude. The pilot did not know why the aircraft began to veer to the right. However, witness marks from the propellers were found subsequently on the runway and it is possible that, if the right propeller hit the ground first, it was enough to initiate the swing. Full left rudder was unable to prevent the aircraft leaving the runway, possibly because it was less effective at the lower approach speed and perhaps because of a significant loss of speed during the heavy landing.

At the time of writing, there had been no engineering inspection that could confirm whether or not damage to the propellers was consistent with the marks on the runway.

ACCIDENT

Aircraft Type and Registration:	Beech 76 Duchess, G-MULT
No & Type of Engines:	2 Lycoming O-360-A1G6D piston engines
Year of Manufacture:	1981
Date & Time (UTC):	11 June 2009 at 1621 hrs
Location:	Bournemouth Airport
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Both propellers bent and engines shock-loaded. Damage to right wing skin, lower fuselage and right engine exhaust
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	34 years
Commander's Flying Experience:	2,793 hours (of which approx 1,165 were on type) Last 90 days - 172 hours Last 28 days - 60 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During a touch-and-go landing the nose and right landing gears retracted due to the landing gear selector being in the UP position. In the opinion of the instructor the landing gear selector was knocked, accidentally, by the student's knee.

History of the flight

The flight was an MEP/IR Revalidation Proficiency Check. The flight proceeded normally, and to a high standard, until the visual circuits. The student flew an asymmetric circuit, and on final approach, the instructor checked for, and confirmed, 'three greens'. This was followed soon after by the student carrying out the asymmetric committal checks, which included verbally confirming 'three greens'.

The aircraft landed normally on the mainwheels, followed by the nosewheel. The instructor had raised the flaps, and was centralising the trims, when he became aware of the landing gear warning horn. He saw that the landing gear selector was in the UP position and the student immediately lowered it, but not before the nose and right landing gears collapsed.

At that moment the instructor noticed the proximity of the student's knee to the landing gear selector, and

guessed his knee must have knocked it. The student found that, when operating the rudders, or even just shifting in his seat to get comfortable, his knee touched the landing gear selector.

Other information

The previous day the student had flown with a different instructor in the same aircraft to practise for his MEP/IR Revalidation Proficiency check. During the 'Before Starting Engine' checks, the instructor noticed that the landing gear selector was in the UP position. The instructor asked the instructor of the accident flight if he knew anything about this as he had operated the previous flight, but he did not. Apart from this, the instructor reported that the student had flown to a good standard, and was ready for his proficiency check.

Comments by the instructor of the accident flight

In the instructor's opinion the accident was caused by the student inadvertently knocking the landing gear selector to the UP position with his right knee during a touch-and-go. He did not believe that there was anything that he could have done at the time of the accident to prevent it. He commented that before the flight he could have checked the student's seating position, although this was not something that he was in the habit of doing, nor had he heard of other instructors doing so on a regular basis, but it might have prevented this accident. This is relevant given the report of the landing gear selector having been found in the UP position the previous day, the significance of which the instructor did not realize at the time. With hindsight, the landing gear selector had almost certainly been knocked by the same student in the same way. The instructor commented that he will check students' seating positions from now on.

Other Beech 76 aircraft in the operator's fleet have a metal guard below the landing gear selector to prevent this kind of accident. The instructor understands that, since the accident, the operator has spoken to its maintenance organization about fitting such guards to all their aircraft, but have been advised that this may not be straightforward as EASA might view it as a 'modification'.

ACCIDENT

Aircraft Type and Registration:	CEA DR300/180R, G-BVYG
No & Type of Engines:	1 Lycoming O-360-A3A piston engine
Year of Manufacture:	1971
Date & Time (UTC):	31 May 2009 at 1541 hrs
Location:	Disused Runway 02, City of Derry Airport, Northern Ireland
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Right landing gear leg bent and damage to associated wheel brake.
Commander's Licence:	Private Pilot's Licence
Commander's Age:	55 years
Commander's Flying Experience:	138 hours (of which 99 were on type) Last 90 days - 3 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

After taking off from the Ulster Gliding Club, with a glider in tow, the right main wheel was seen by the glider pilot to fall from the aircraft. After climbing to the normal release height, the glider released from the tow rope and the aircraft flew to City of Derry Airport. Following discussion with ATC, a successful landing was made on the disused Runway 02.

The main wheels on this aircraft are secured by a collar and tapered pin arrangement. A split pin is used to retain the tapered pin in position. None of these items was recovered. On 28 May 2009, the wheel was being replaced but the person completing the task was called away to another task for a considerable time. After the event, he did not have a clear recollection of the reassembly process, and it was considered that the loss of the main wheel could have resulted from its incorrect/ incomplete re-fitting, due to this distraction.

ACCIDENT

Aircraft Type and Registration:	Cessna 152, G-GFIA
No & Type of Engines:	1 Lycoming O-235-L2C piston engine
Year of Manufacture:	1978
Date & Time (UTC):	10 April 2009 at 0922 hrs
Location:	Manchester (Barton) Airport
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Nose landing gear, firewall, propeller, left wingtip
Commander's Licence:	Private Pilot's Licence
Commander's Age:	71 years
Commander's Flying Experience:	303 hours (of which 32 were on type) Last 90 days - 2 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

Following an uneventful local flight the aircraft touched down heavily on the grass Runway 09L. A large bounce ensued and the pilot was unable to take remedial action before the aircraft landed, the nose landing gear collapsed and the aircraft came to a stop on its nose. Neither occupant was injured. The pilot assessed the cause of the accident as insufficient flare during the landing, allowing the nosewheel to impact the runway before the main landing gear.

ACCIDENT

Aircraft Type and Registration:	Cessna F406 Caravan II, N17CK
No & Type of Engines:	2 Pratt & Whitney Canada PT6A-112 turboprop engines
Year of Manufacture:	1985
Date & Time (UTC):	8 November 2008 at 1313 hrs
Location:	Tortola, British Virgin Islands
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to underside of fuselage, inboard flaps and both propellers
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	65 years
Commander's Flying Experience:	Not known Last 90 days - 20 hours (estimated from aircraft log books) Last 28 days - 10 hours (estimated from aircraft log books)
Information Source:	Aircraft Accident Report Form submitted by the pilot and reports collated by Air Safety Support International (ASSI)

Synopsis

The aircraft landed on Runway 07 at Terrance Lettsome Airport, Tortola, BVI, with the landing gear apparently in the retracted position. During the recovery, and subsequently, the landing gear operating systems were tested; no faults were found with their operation or the indication systems.

History of the flight

The aircraft was completing a VFR flight from St Thomas Airport, US Virgin Islands, with only the pilot on board. He was cleared to land and reported that he commenced the approach, selected the landing gear lever to the DOWN position and deployed the flaps. Shortly after touching down he felt and heard the propellers strike the runway and immediately cut the power and raised the nose of the aircraft as much as possible. The aircraft slid a short distance before coming to rest on its underside. The pilot selected all switches to OFF, and vacated the aircraft.

Emergency response

The airport Fire and Rescue Service, who were quickly in attendance, saw fluid leaking from both engines and the pilot moving around inside the aircraft. Communication was established with him through an open exit window and he was advised to "take the switches OFF". After the

pilot had vacated the aircraft, a foam blanket was laid around the aircraft. The assistance of a local mechanic was obtained to disconnect the aircraft battery. Air Traffic Control was kept informed of activities using a hand held radio.

Recovery

The aircraft was lifted using a mobile crane and strops, Figure 1, which enabled the local mechanic to lower the landing gear using the alternative 'blow-down' procedure. The gear lowered and locked in the DOWN position without fault and the three green, locked down, indicators in the cockpit illuminated. This procedure is available in-flight for emergency lowering of the gear should the normal system fail. The aircraft was lowered onto its wheels and towed to a hangar without further incident.

Initial inspection

Photographs of the aircraft taken immediately after the landing and during the recovery operation show the landing gear retracted with no damage apparent to any of the landing gear doors. The inboard flaps had sustained some damage to their inboard rear corners, and both appeared to be in the retracted position. In the cockpit, the landing gear lever was positioned at DOWN, and the flap lever at RETRACT.

Further examination and testing

An Airworthiness Surveyor conducted a detailed inspection of the aircraft. The following is a summary of the damage he identified:

Picture courtesy ASSI

Figure 1

Recovery Operation (courtesy ASSI)

'● *The propellers of both engines had suffered severe damage due to contact with the runway surface.*

- *The inboard lower surface of the left and right inboard flaps had substantial damage to the skin and the inboard part of the operating mechanism had been worn away due to runway contact.*

- *All aerials on the underside of the fuselage had been torn off and the mid left hand section of the wing centre box skin had been worn away. Although an aerial forward of the nose gear door had been damaged the overall damage to the aircraft underside was consistent with a nose up attitude during the runway slide.*

- *There was no damage to any of the landing gear doors. The left and right main wheel tyres had minor scuff marks on a section of their outer sidewalls.'*

With the assistance of the mechanic, the aircraft was jacked up and hydraulic power supplied to the aircraft by a ground based unit. The flaps were inspected for condition prior to operation. The damaged inboard guide roller was removed to prevent interference with the flap operation and preclude any further damage. The flaps and the flap indication system operated normally with correct indications; no abnormal noises were heard.

The landing gear was inspected for condition prior to its operation and no defects were identified. It was cycled up and down twice and, on each occasion, the landing gear operated normally with the correct indications and no abnormal noises.

A landing gear configuration warning horn is fitted to the aircraft. The horn should sound whenever the power levers are retarded to IDLE with the landing gear retracted, or whenever the landing gear is not in the locked down position and the wing flaps are extended to the landing position. During the testing, it was noted that the landing gear warning horn sounded as expected.

Aircraft documents and equipment

An Airworthiness Surveyor also conducted a detailed inspection of the aircraft log books and equipment. The following is a summary of his relevant observations:

'● *The aircraft was in compliance with its maintenance cycle and the recording of times to maintenance checks was generally accurate with minor corrections being made as required. An unusual amount of rectification work was undertaken on 01 Sept 2008 and 27 Sept 2008.*

- *The operator used aircraft and engine log pages to cover three to five days of flights.*

- *The operator did not record fuel amounts or fuel oil uplifts in the aircraft or engine log books nor any trend monitoring information.*

- *The pilot's abbreviated checklist manual was in poor condition and illegible on a number of pages.*

- *The pilot's operating handbook was in poor condition and held together with elastic bands; the weight and balance section was missing a number of pages.*

- *No weight and balance schedule could be found in the recovered documents.*

- *The cabin area and cockpit were in a poor condition including unsecured safety equipment, crew seat belt defects and general trim defects.'*

ATC

The transcript of the ATC voice recording showed the pilot contacted the tower and was advised to report at Road Town. On reaching Road Town, the pilot was cleared to land and advised of the wind speed and direction. Within the following minute, the pilot requested another wind check which was duly given by the tower. The pilot responded with "Roger, thank you. Cleared to takeoff and ah….cleared to landed and ah….. we got it." There were no further communications until three minutes later when the tower contacted San Juan to advise the runway was closed.

Analysis

The pilot stated that during the approach he selected the landing gear down and deployed the flaps. Following the accident, the cockpit flap selector lever was found in the RETRACT position and the landing gear selector was found in the DOWN position. Photographs taken immediately after the accident appear to show the landing gear and flaps in a retracted position.

Function testing of both the landing gear and flap systems demonstrated that both systems worked normally and gave correct indications in the cockpit. During the recovery operation the landing gear was lowered without any problems using the alternative 'blow-down' procedure and it is most likely that it would have done so in-flight, had the system been selected.

Also, had the landing gear been in the DOWN position, but then collapsed during the landing, the landing gear doors, due to their location and geometry, would most likely have been damaged as the aircraft settled onto the underside of the fuselage. There was no such damage seen on any of the landing gear doors.

The inboard flaps on both sides of the aircraft had damage to their inboard lower surfaces; the nature of this damage indicates that the flaps had not been in the landing position at the time of the accident.

The pilot did not report that he heard the landing gear configuration warning horn during the approach or landing. When tested during the examination of the aircraft, the horn was working normally. However, given the likely configuration of the aircraft, the warning horn would have only sounded when the power levers were retarded to IDLE after the propellers struck the runway. By this time the pilot's attention would likely have been fully occupied with what was happening to the aircraft, and may have masked his awareness of the sound of the horn.

Conclusion

No faults were found with the operation or indication of the landing gear and flap systems when tested after the accident. It is therefore possible that the aircraft was landed with the landing gear inadvertently left in the retracted position.

ACCIDENT

Aircraft Type and Registration:	Christen Eagle II, G-EGUL
No & Type of Engines:	1 Lycoming AEIO-360-A1A piston engine
Year of Manufacture:	1980
Date & Time (UTC):	29 October 2008 at 1349 hrs
Location:	Seething Airfield, Norfolk
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Fatal) Passengers - 1 (Fatal)
Nature of Damage:	Aircraft destroyed, structural damage to spraying vehicle
Commander's Licence:	Private Pilot's Licence
Commander's Age:	49 years
Commander's Flying Experience:	2,500 hours (of which 0 were on type) Last 90 days - 40 hours estimated Last 28 days - 13 hours estimated
Information Source:	AAIB Field Investigation

Synopsis

While making an approach to land, the aircraft collided with an agricultural vehicle that was spraying crops in a field adjacent to the runway threshold. The aircraft was destroyed in the impact and post-crash fire. Both occupants suffered fatal injuries. The investigation concluded that the aircraft's final approach was flown such that its occupants were unable to ensure that the flight path ahead was clear of obstacles. As a result, they were unaware of the vehicle's proximity to the runway. No Safety Recommendations have been made.

Background to the flight

The flight was intended to form the basis of an article in a magazine for General Aviation enthusiasts, in which G-EGUL would feature. The author of the intended article was an experienced private pilot. He had completed a number of such assignments in the past, for which he had established a common flight profile. It was agreed that he would accompany one of G-EGUL's joint owners on a short flight from Seething Airfield, whilst a professional photographer took photographs from the ground to accompany the article.

For the accident flight, the author occupied the rear seat as pilot-in-command, whilst the owner occupied the front seat. The rear seat was the primary position, and the owner did not hold an instructional qualification which would have allowed him to fly as pilot-in-command

from the front seat (which had limited controls). For consistency and ease of reading, this report refers to the author of the intended article as the 'author' or 'pilot'; the joint owner is referred to as the 'owner'.

History of the flight

On the morning of the accident day, the owner of G-EGUL flew the aircraft from its base at Old Buckenham Airfield to a friend's private airstrip nearby. The owner and friend, an experienced Eagle and Pitts Special pilot, discussed the proposed flight and the owner reportedly sought opinion about the manoeuvres that should be included and said he intended to allow the author to handle the aircraft. The owner, who was reported to be well and in good spirits, took off from the strip at about 1115 hrs, and made the short flight to Seething.

At Seething, the owner met the author and the photographer and the three men discussed a profile for the flight. After takeoff, the aircraft would climb overhead the airfield for a short period of general handling, before returning for a series of passes for the photographer, who was to be positioned next to the runway culminating in a low 'head-on' pass. The photographer would then move closer to the runway threshold, while the aircraft flew two or three touch-and-go landings and a full-stop landing. After this discussion, the owner and pilot went to the club house for a light lunch, during which they were overheard discussing aircraft handling aspects, including approach speeds.

The photographer subsequently positioned at the agreed point next to Runway 24, about 350 metres from the threshold. At 1336 hrs, G-EGUL took off and climbed overhead as planned. It returned to the circuit after a few minutes and, for about four more minutes, flew the series of passes as briefed. These were generally estimated by witnesses to be at 150 ft to 200 ft above ground level (agl), with the last 'head-on' pass being flown at an estimated 30 ft agl. Photographs taken during this period show the author handling the aircraft's controls from the rear seat. With the photo passes complete, the aircraft positioned into the left-hand circuit as planned.

The aircraft flew a touch-and-go which was seen by several witnesses. Some thought the approach looked normal, whilst others thought it rather high. The aircraft flared over a point near the threshold, but then floated above the runway for a considerable distance. There was a marked bounce or two, before power was applied and the aircraft climbed away.

As the aircraft flew around the circuit a second time, an agricultural spraying vehicle in an adjoining field was approaching the airfield boundary near the threshold of Runway 24. As it did so, the vehicle turned left to follow an established 'tramline' that ran about 20 metres from the edge of the paved surface (Figure 1). A farm hand, who had watched G-EGUL's manoeuvres and the previous landing, was less than 100 metres south of the spray vehicle tending a herbicide replenishment bowser. He reported that the aircraft appeared from his right and was quite low certainly lower than it had been on the previous approach and, he thought, faster. As it approached the threshold, it did not seem to take any avoiding action and collided with the sprayer vehicle. The aircraft suffered immediate and catastrophic damage. The fuselage came to rest inverted, on the border between the field and the paved area where the airfield perimeter road crossed the Runway 24 threshold.

The watching farm hand saw the accident, and ran towards the sprayer vehicle, which had also suffered

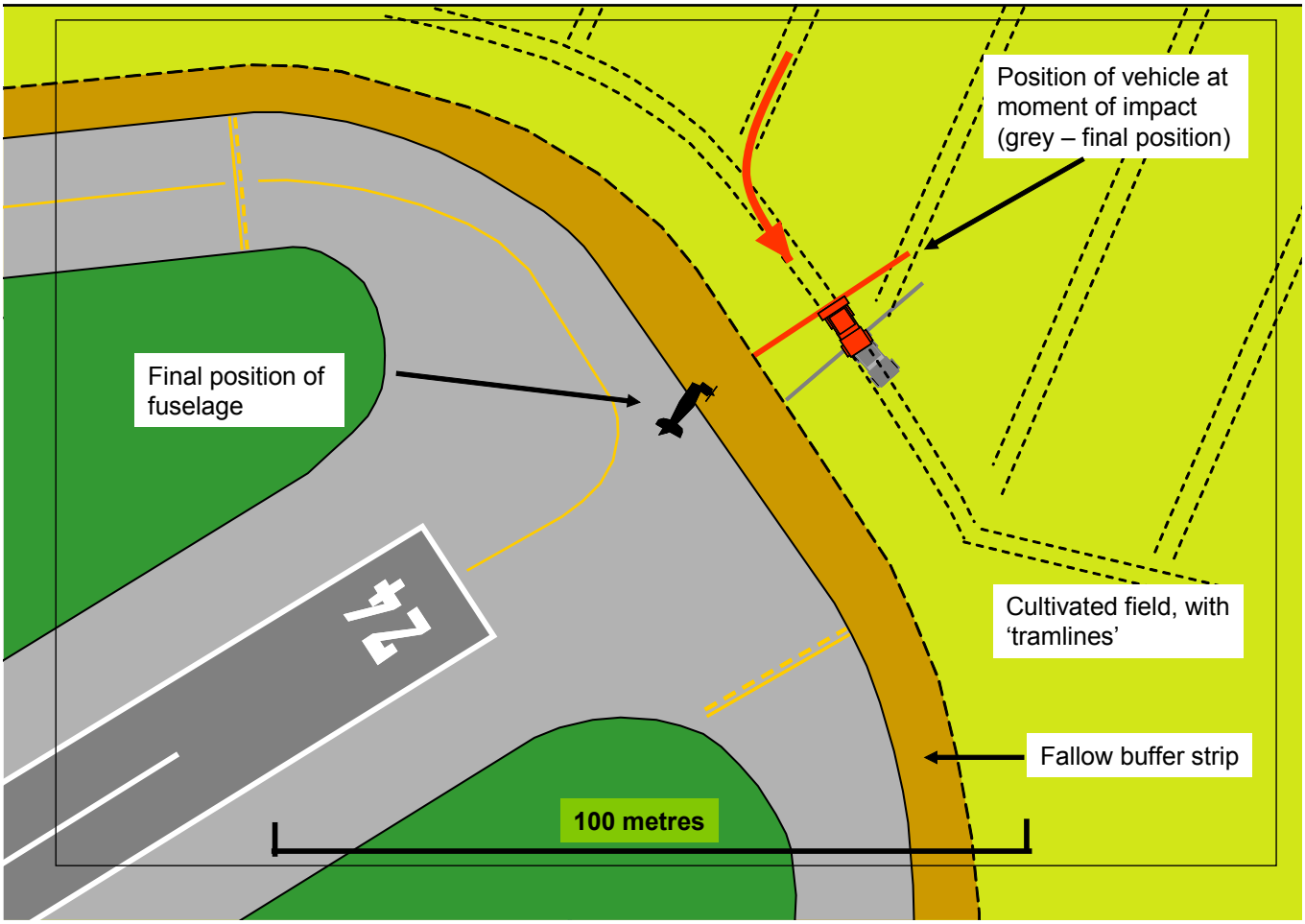

Figure 1

Plan of accident area, showing positions of spray vehicle and aircraft fuselage

considerable damage. He found its driver apparently uninjured, but in such a state of shock that he was unable to extricate him from the cab. The farm hand then went to the aircraft, where a fire had started but, as flying club members were starting to arrive with fire extinguishers, he returned to the cab to attend his colleague. The club members suppressed the fire and gave first aid to the severely injured crew. The emergency services were alerted and an Air Ambulance helicopter arrived at 1414 hrs. The rear seat occupant was declared dead at the scene. The front seat occupant, the aircraft owner, was taken to hospital in a critical condition, but died in hospital 24 days later as a result of his injuries.

Airfield information

Seething Airfield occupies part of a former wartime USAAF airfield; it is about 9 nm from Norwich and is owned and operated by a private flying group. The airfield is licensed by the CAA for operations at weekends, primarily to allow flying training to take place; at other times it operates as an unlicensed airfield[1]. An air/ground radio station operates during licensed hours; at other times the radio may be manned, depending on circumstances and availability of operators. The airfield was equipped with Rescue and Fire Fighting (RFF)

Footnote

[1] Civil Aviation Publication (CAP) 168 deals with the licensing of aerodromes in the United Kingdom.

facilities to 'Category Special' standard. Although this standard was only required to be met during licensed hours, the fire fighting equipment was nevertheless available for use at other times, and was used on this occasion.

The airfield has a single paved runway, designated 06/24, which is 800 metres long and marked on the paved surface of part of an original runway. For licensing purposes, an area surrounding the runway is established that offers, amongst other things, protection to landing aircraft by providing a defined area before the runway which is kept clear of obstacles. For Code 1 runways, such as that at Seething, the minimum length of this cleared area is 30 metres. The marked threshold of Runway 24 was 40 metres from the beginning of the paved runway surface, thereby exceeding the minimum requirement by 10 metres. The field beyond was not under the control of the airfield operator.

Private flights (such as the accident flight) were not required to use a licensed runway, so could take place at any time within the airfield's hours of operation. However, the number of movements on most weekdays was usually relatively low. Private flights could also use the full length of the paved runway surface for landing, without the requirement for a 30 metre cleared area.

The edge of the paved surface at the beginning of Runway 24 marked the airfield boundary at that point. A warning in the airfield's entry in the UK Aeronautical Information Publication (UK AIP) stated:

> *'Agricultural vehicles and equipment may be crossing close to the threshold of Runway 24.'*

The flying group at Seething, which owned the airfield, specifically prohibited flights over the airfield at less than 500 ft agl, (except during takeoff or landing), as well as *'beat ups'* and *'low fly pasts'*. These rules were promulgated in the group's *Pilot's Order Book*. Although some of those present on the day were aware of the general purpose of the flight, the airfield's management reported that no exemption had been sought from the group's low flying rules. The management was thus unaware of the planned activity, or of the presence of a photographer next to the runway.

Personnel information

The author of the proposed article had flown as a private pilot for 21 years, accruing a total of about 2,500 hours flying time. He was a regular flyer at Seething, having been a member of the club there for some 20 years. He part-owned a De Havilland DHC-1 Chipmunk which was based at the airfield, and which he also flew as a member of a display team. In November 2007 he gained a Class Rating Instructor qualification, which entitled him to conduct recurrent flight checks on other club pilots.

The author's flying experience was recorded in his personal logbooks, not all of which were located. However, it was clear that he had always flown regularly and in a number of different types, some of which he had part-owned. The majority of this flying was on older 'taildragger' aircraft such as Jodels and a Tiger Moth, as well as the Chipmunk, in which he was most current at the time of the accident. There were no logged flights in aircraft of similar performance or configuration to G-EGUL, and associates of the author confirmed that he had limited experience of this type of aircraft. The author's last logged flight was on 15 June 2008, though it was established that he continued to fly regularly until the date of the accident. Quoted flying hours for the periods beforehand are estimates, based on historical flying rates.

The owner of G-EGUL was aged 51 years and held an Airline Transport Pilot's Licence. He served 16 years in the RAF, latterly flying high performance single seat jet aircraft. He left the Service in 1995 and, from that date, flew commercially for a major international airline; by the time of the accident he was flying as commander on long range jet transport aircraft. He acquired a share in G-EGUL and first flew the aircraft in August 2004. A breakdown of his flying hours is at Table 1.

Flying experience	11,800 hours (of which 88 were on type)
Last 90 days	160 hours (of which 3.25 were on type)
Last 28 days	48 hours (of which 1 was on type)

Table 1

The majority of the owner's flying hours were on commercial jet aircraft. He last flew G-EGUL 16 days before the accident. During 2008, he had flown a total of 13 hours in an Eagle II, mainly in June and July, when he had use of another Eagle II (G-EGUL was being re-covered during this period, so was unavailable for use). The owner had then flown 1.75 hours since G-EGUL was returned to service in early September. The majority of his total flying in the Eagle II was logged as aerobatic, formation practices, displays (he held a Display Authorisation), and transit flights. On only one occasion had he recorded that he flew the aircraft from the front seat; this was during conversion training for a new joint owner, 11 months before the accident.

Aircraft information

The Christen Eagle II is a tandem-seat aerobatic biplane, with a tubular steel space-frame fuselage and wings constructed from wood and fabric. Flying controls are conventional and manually operated, with ailerons on both sets of wings; wing flaps are not fitted. The Lycoming piston engine drives a two-blade, metal constant-speed propeller. In its standard two-seat layout, the aircraft is flown solo from the rear seat. Full engine and propeller controls are provided for the rear seat occupant only, with only basic flight controls and throttle available to the front seat occupant. The cockpit is protected from the elements by a side-hinged one-piece canopy.

G-EGUL was built in 1980 but had not flown between January and September 2008, during which time the airframe was re-covered. The Permit to Fly renewal was dated 1 September 2008. A post-accident calculation showed that the aircraft was operating within the prescribed weight and balance limitations being below the normal maximum gross weight, with a centre of gravity slightly aft of the mid position.

Accident site details

A grass strip approximately 8 metres wide acted as a buffer between the edge of the paved surface and the cultivated area of the field. The crop-spraying vehicle had been travelling from right to left in front of the runway threshold (as viewed from the approach) with the tip of the right hand spray boom close to the edge of the grass strip. The span of the booms was 24 metres. It was clear that the aircraft had struck the vehicle amidships, with the fuselage passing through a fibreglass tank that contained the remnants of an agricultural herbicide solution. The collision actually occurred when the spray vehicle was about midway between the extended runway centreline and a line extending from the northern edge of the marked runway, ie just before the sprayer would have crossed the runway centreline.

Figure 2 shows a photograph of the aircraft and vehicle shortly before the impact, taken from the photographer's position beside the runway. The crop-sprayer was a

Photo: Oliver Wilson

Figure 2

Long focal length view of aircraft and spray vehicle shortly before impact

tall, four-wheel drive vehicle with the spray booms located at the rear which could be raised and lowered hydraulically on steel guide rails. Aft of the driver's cab was a steel gantry above the engine compartment, which provided access to the top of the tank. The handrail and other structural members had been distorted as a result of the impact, with similar damage visible on the boom support structure at the rear of the vehicle. Part of the lower left wing leading edge was found wedged in the air intake in the engine compartment on the left side of the vehicle. Oily deposits in the form of two parallel stripes were noted on the outboard leading edge of the right upper main plane 0.4 metres from the tip; these were consistent with striking the vertical guide for the left spray boom.

Figure 3 shows the vehicle with the likely impact positions of the wing leading edges. The right wings were torn off in the impact and came to rest by the side of the vehicle. The left wings mostly disintegrated, but the larger fragments remained attached to the bracing wires and were carried to the main impact area along with the fuselage.

The nose and engine of the aircraft passed through the vehicle, disrupting the relatively insubstantial tank structure, although, as can be seen from Figure 3, the landing gear would have impacted the vehicle chassis. It was clear that the main wheels had detached at this point, with the vehicle running over one of them during the estimated 4 to 5 metres it took to come to a halt. The fuselage had 'nosed over', striking the ground some

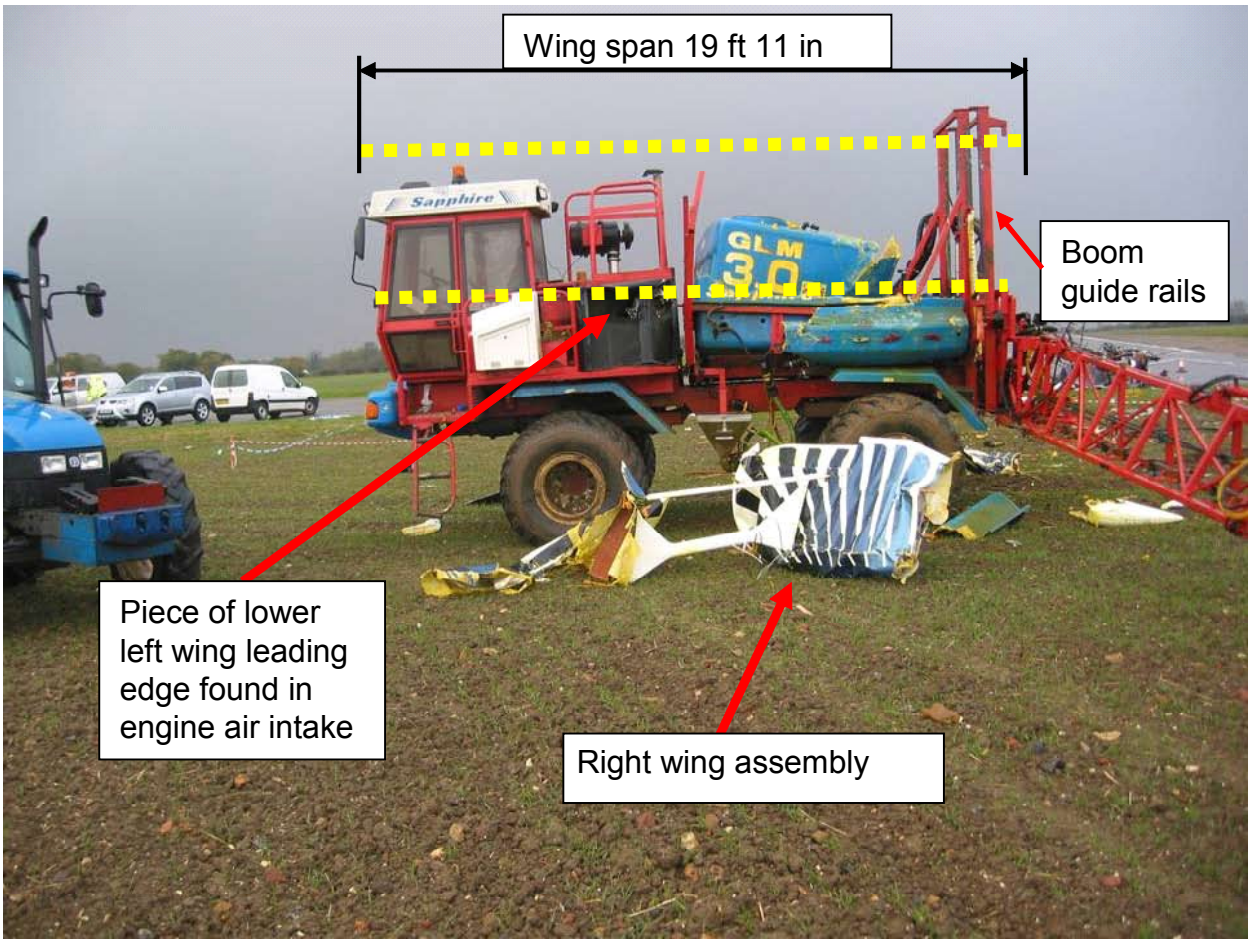

Figure 3

Probable wing impact positions on vehicle

15 metres beyond the vehicle. The fuselage structure partially failed ahead of the front cockpit; this had exposed the fuel tank and had resulted in fuel spillage that formed the seat of the post-impact fire. It is probable that the ignition of the fuel was caused by contact with part of the hot exhaust manifold. The tank itself had a large hole in it resulting from pieces of the tank wall melting and falling into the fuel. As found, the tank was still approximately one third full.

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

Airframe examination

No pre-existing faults or defects were discovered during the examination of the airframe. This finding was consistent with witness and photographic evidence of the aircraft being flown apparently under control until the moment of impact with the agricultural vehicle.

Engine examination

Inside the cockpit, it was noted that the mixture and propeller speed controls were at their fully forward positions, ie full rich and maximum speed. The throttle lever was towards its aft, ie low power position and the elevator trim was approximately neutral. Whilst these

indications appear to be representative of what might be expected to be set for an aircraft on final approach, there would have been some scope for movement during the impact.

Most of the damage to the engine was confined to the underside; this included detachment of the fuel injector body and part of the exhaust system. The spark plugs were normal in appearance and, following removal of the rocker covers, the valve gear was observed to operate when the engine was turned over by hand.

Although there was no reason to suspect that the engine had not been operating normally, it was decided to test the propeller governor, since a failure of this component to supply the appropriate oil pressure to the propeller hub could cause the propeller blades to adopt a fully coarse pitch angle and a consequent inability for the engine to develop maximum speed and hence power.[2]

The essential components of the governor comprised a gear-type oil pump, a flyweight assembly and a spool valve located within one of the rotating gear pump shafts. The spool valve was connected to the propeller speed control in the rear cockpit. Moving this control positioned the spool valve longitudinally relative to ports within the shaft and also adjusted the compression of a speeder spring attached to the flyweight assembly. This determined the force and hence the rotational speed at which the flyweights would operate to lift the spool valve to port oil pressure away from the propeller hub, thus increasing the pitch angle of the blades.

Although the governor had been close to the seat of the post-impact fire, it did not appear to have sustained any mechanical damage. However, after being placed on a test rig, it did not generate any output pressure, regardless of the position of the control lever. Subsequent disassembly revealed that the spool valve had become jammed inside the gear shaft; force was required to separate the components, which were otherwise in good condition. Measurement of the valve land diameters indicated that they were several tenths of a thousandth of an inch larger than the internal diameter of the shaft. Normally a clearance of a similar dimension would be expected, thus giving a sliding fit, although the governor Overhaul Manual indicated that an accumulation of tolerances could result in a maximum clearance of 0.002 in. A slight discoloration on the outer surface of the shaft showed that it had been heat affected and a metallurgical examination further indicated that the Rockwell Hardness value was at the very minimum of the range specified for the material. This led to speculation that the heat had resulted in physical changes to the shaft material, with a consequent dimensional change.

It was concluded that the governor could not have been in the observed condition prior to the accident, since it would have prevented the engine from developing high rpm/power. Clearly it had not operated in this condition, as the interference fit between the spool valve and the rotating shaft would have resulted in severe surface distress.

Determination of engine/propeller speed

In Figure 2, the blur of the rotating propeller is clearly apparent, and this enabled the angular arc of a propeller blade leading edge to be measured. Together with knowledge of the camera shutter speed, this led to the determination of an engine speed of approximately 1,960 rpm. Potential errors in the measurement process

Footnote

[2] Note: the propeller pitch control on this type of aircraft operates in the reverse sense to that found on most single engine aircraft, in that governor oil pressure is used to move the blades towards fine pitch, in opposition to coarsening forces generated by the blade counterweights and a spring within the hub.

mean that this calculated value would be subject to an estimated tolerance of ± 10%. Bearing in mind the as-found positions of the propeller and throttle controls, an engine speed of around 1,960 rpm appears credible, with the low power setting resulting in the speed falling below the governed range.

Survivability

In addition to the damage to the forward fuselage noted above, considerable damage had occurred to the underside as a result of the impact with the vehicle. This had resulted in disruption to the cockpit floors and the fracture of the steel tubes to which the main landing gear spar had been attached. Otherwise, the space-frame had remained substantially intact, which had largely preserved the 'living space' in the two cockpits. However, the survivability of the accident had been compromised by the inverted attitude in which the aircraft had come to a halt, and the deceleration forces involved. The canopy transparency would have afforded little protection, and in any event, a trail of clear plastic fragments between the vehicle and the main wreckage indicated that the canopy had disintegrated on impact with the vehicle.

Both occupants were dressed in normal, casual clothing and wore cloth flying helmets. They were secured in the aircraft by five-point harnesses and auxiliary lap straps. It was observed that neither harness had failed and these had all been cut by personnel from the rescue services during the operation to remove the occupants from the aircraft.

Medical and pathological information

The author in the rear seat was declared dead at the scene of the accident. A post-mortem examination showed that he had died of a head injury. The owner survived the accident with multiple injuries, including serious head injuries, fractures and burns. Of these, his head injuries were the most critical, and included those typically caused by abnormally large deceleration forces. After a period in intensive care, it became clear that, whilst he was expected to recover from the lesser injuries, he had suffered severe and irreparable brain damage. A decision to withdraw life support was made 22 days after the accident. He died two days later.

Meteorological information

The general weather conditions were excellent, with clear skies and a very light surface wind, generally from the north-west. The sun was 25º to the left of the runway heading, at an elevation of about 18º. It had been a consideration for the photo passes, but was not thought to have presented a problem for landing. Only the rear seat pilot was wearing sunglasses.

Aircraft handling aspects

Like other aircraft of similar configuration, the Eagle II's forward fuselage restricts the occupants' forward and downward view during approach and landing. The manufacturer's Flight Manual described a landing procedure which took this into account. It recommended that the final approach should be adjusted to keep the runway threshold in sight, by flying a continuously turning final approach until just before the landing flare.

The aircraft owners had agreed a standard finals turn technique which met the manufacturer's recommendation: from a base leg position, the aircraft would be turned and side-slipped towards the runway, approaching it at an angle of up to 30º from the centreline, so keeping the runway threshold in sight until the aircraft was straightened just before the flare. The aim was to make a relatively high approach, and to remain out of an area up to 15º either side of the runway centreline, so keeping the runway threshold in view.

Agricultural operations

Flying had taken place at Seething in close proximity to agricultural operations for many years. The vehicle involved in the collision had been spraying a young crop in an adjoining field, over which an aircraft approaching Runway 24 would need to fly. The field was about 900 metres long by 180 metres wide, and extended away from the Runway 24 threshold area in a generally north-east direction. The spraying vehicle had been operating in the field for about an hour before the accident. Its normal operating speed was 12 km/hour, which was about its maximum speed. The tramlines it was following were mainly orientated along the length of the field, so the vehicle's proximity to the airfield boundary had varied between about twenty metres and 900 metres during this time.

As the sprayer approached the airfield boundary, it turned left to follow the 'head tramline'. The herbicide level was low, so instead of turning left again onto the next tramline, the driver intended continuing towards the replenishment bowser, stationed about 100 metres to the south and attended by the second farm worker. It was just after the sprayer turned left that it was struck by the aircraft.

At interview, both the farm vehicle drivers demonstrated a good understanding of the flying activities at Seething, and the potential for conflict between vehicles and aircraft. The driver of the sprayer, who appeared very familiar with airfield operations, said that he saw the aircraft take off, and again whilst it was flying low over the airfield. He saw it make an approach to the runway when he was furthest from the airfield and, as it disappeared from view down the runway, thought it had landed. There was not normally a great deal of flying activity on weekdays and, believing G-EGUL had landed and not having seen any other aircraft, he thought that the circuit was then clear of aircraft.

The driver did not see or hear the aircraft before the collision. He recalled only hearing it as a very loud bang and feeling a significant lurch to the right. At first, he assumed that something had failed or exploded on his vehicle, and was only aware that an accident had occurred when he saw the aircraft wreckage nearby.

Analysis

The engineering investigation, supported by witness and photographic evidence, established that the aircraft was serviceable and under control at the time of the collision. There was no evidence that either occupant was anything other than fit and well prior to the flight. This analysis therefore concentrates on the interaction between air and ground traffic at Seething, and possible reasons why the crew of the aircraft apparently remained unaware of the presence of the spraying vehicle.

The airfield operator had no authority or control over the land on which the spraying vehicle was operating, and there was no reason why the vehicle should not have been working in the area. Both farm vehicle drivers involved in this accident demonstrated good awareness of operations at the airfield and there was no evidence to suggest they would knowingly act in a hazardous manner. Nevertheless, the proximity of agricultural land, and the possibility of encountering uncontrolled farm vehicles close to the runway, necessitated the inset threshold of the licensed runway, and gave rise to the warning in the UK AIP.

The driver of the sprayer vehicle did not see the aircraft in the moments immediately before collision; had he done so, it is unlikely he would have been able to influence the outcome, considering the speed and

manoeuvrability of his vehicle. Similarly, as Figure 1 indicates, the decision to go to the replenishment bowser was not a factor. Had the vehicle continued spraying, it would still have been in about the same position, although probably at a different aspect because it would have been turning onto the next tramline.

During the photo passes, the vehicle would have been travelling away from the runway, and was at the far end of the field as the aircraft flew its first circuit. Before the start of the final circuit therefore, it was either unlikely to have been seen, or not considered a potential hazard. Thereafter, probably the only times the crew were likely to have seen the vehicle would have been whilst downwind, or early in the finals turn. It is reasonable to assume that, had the vehicle been recognised as a potential hazard, they would not have allowed themselves to lose sight of it on finals.

As one aim of the flight was to get photographs of the aircraft landing, and the photographer had moved closer to the runway threshold for the second approach, there would have been a desire on the part of the crew to avoid landing a long way up the runway a second time. This may have caused the crew to modify their next circuit. As a private flight, the aircraft was not required to use the marked threshold, but any attempt to land at the start of the paved surface would have lost the measure of obstacle protection afforded by the displaced threshold. The second approach appears to have been different from the first. Whether because of a modified circuit, use of a different aiming point, or just lack of familiarity with the aircraft, it appeared to have been flying a shallower final approach than the time before.

Had the aircraft maintained a steeper, curved or side-slipped approach to the point of flare over the threshold, there would have been increased obstacle clearance and a greater chance of seeing the vehicle in time to take avoiding action. However, the use of side-slip, and low applied power through a constant-speed propeller, creates high drag. This, combined with a drift into the declared 'no-fly' zone about the runway centreline (possibly resulting from a modified circuit pattern), could account for the aircraft being in the situation seen at Figure 2, ie approximately on the centreline, with wings about level and relatively low. It is clear from the photograph that neither occupant could have seen the vehicle at this point. If any avoiding action was taken by the crew of G-EGUL, it was so late as to have had no effect on the flight path. As both occupants were experienced pilots, either could have taken action to avoid the collision if they had seen the danger in time, but it appears neither of them did so.

A plausible scenario is that neither occupant saw the sprayer vehicle before starting the finals turn. With a left-hand circuit and the wind, albeit very light, from the north-west, any side-slip would naturally be to the left (ie aircraft nose displaced to the right and with increased left bank). Whilst this would afford a better view of the threshold, the blind spot behind the aircraft structure would have displaced to the right with respect to the ground, so shielding the approaching vehicle from view. Possibly because of the higher drag of side-slipping, or simple lack of familiarity, the aircraft ended up too low, and on the centreline too early. By the time it rolled wings level, the vehicle had moved closer to the approach path, and thus remained in the blind spot, now directly ahead and below. From this point, it was not possible to visually clear the flight path ahead. Both men knew that the approach path near the runway was over a flat field, and they appear to have relied on this fact for obstacle clearance. Although the only safe option would have been to discontinue the approach, it

is clear that neither occupant had any reason to suspect that an obstacle lay directly ahead of the aircraft.

From the available evidence and considering the aim of the flight, it is probable that the author was flying the aircraft at the time of the accident, although this cannot be established with certainty. Although an experienced private pilot, the author had very limited experience on this type of aircraft, and the owner, who had flown the aircraft for less than two hours in the preceding three months, had probably only flown once from the front seat with a pilot new to type in the rear. As the two men had not previously flown together, the owner's decision to let the author fly as pilot-in-command from the rear seat is likely to have been influenced by the author's experience and qualifications, and may have been a factor in the accident.

The airfield's management was unaware of the intended flight manoeuvres (which were specifically prohibited by the airfield's low flying rules), or of the presence of the photographer by the runway. Furthermore, there were no radio calls from G-EGUL informing other aircraft of the non-standard manoeuvres being flown. It is not known why the group's rules were disregarded, but they should have precluded Seething as a suitable location for the planned flight.

Conclusions

While making an approach to land, the aircraft collided with an agricultural vehicle that was spraying crops in a field adjacent to the runway threshold. The investigation concluded that the aircraft's final approach was flown such that its occupants were unable to ensure that the flight path ahead was clear of obstacles. As a result, they were unaware of the vehicle's proximity to the runway.

ACCIDENT

Aircraft Type and Registration:	DH82A Tiger Moth, G-AVPJ
No & Type of Engines:	1 De Havilland Gipsy Major 1C piston engine
Year of Manufacture:	1943
Date & Time (UTC):	13 April 2009 at 1425 hrs
Location:	Near Honeybourne (disused) Airfield, Hereford
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Aircraft severely damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	69 years
Commander's Flying Experience:	1,180 hours (of which n/k were on type) Last 90 days - 4 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

After a flight of approximately 25 minutes, the engine began to lose power and failed to respond to throttle inputs. The pilot selected a suitable field and, initially, carried out an uneventful landing on the main wheels. The aircraft's tail washeld clear of the ground for lowering when the speed had decayed sufficiently. However, as the aircraft travelled across the field, the right main wheel ran into a deep depression, which the pilot had not seen, causing the right landing gear strut to collapse and the aircraft to become inverted. The pilot and passenger were uninjured and able to vacate the aircraft unassisted.

Initial examination of the engine confirmed that the loss of power was due to the failure of a valve stem.

ACCIDENT

Aircraft Type and Registration:	Grob G115, G-BOPT
No & Type of Engines:	1 Lycoming O-235-H2C piston engine
Year of Manufacture:	1988
Date & Time (UTC):	4 August 2008 at 1140 hrs
Location:	Runway 27L, Manchester (Barton) Airport,
))	
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Failure of the right main wheel stub axle
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	52 years
Commander's Flying Experience:	4,637 hours (of which 772 were on type) Last 90 days - 182 hours Last 28 days - 56 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot, AAIB examination of the failed stub axle.

Summary

During a normal landing, the right main wheel separated from the aircraft due to failure of the right main gear stub axle.

.

History of the flight

Following an uneventful demonstration by the instructor of a precautionary circuit and full stop landing, control of the aircraft was handed to the student to repeat the exercise. The student executed an uneventful circuit followed by a stable approach and landing but, as the aircraft started to decelerate, it began to veer to the right. The instructor suspected a steering problem and applied left rudder, after which the aircraft regained runway heading. However, shortly afterwards, it veered to the right again and came to rest at right angles to the runway.

On leaving the aircraft, it was evident that the right main landing gear stub axle was broken, and that the complete right wheel assembly had separated from the aircraft. The instructor reported that a similar occurrence had taken place on 17 June 2008, when another instructor had been flying the aircraft[1], on that occasion involving the left landing gear.

Footnote

[1] This event was not reported to the AAIB.

Axle examination

The fractured stub axle was sent to the AAIB for detailed metallurgical examination. The axle had fractured as a result of fatigue cracking at a location a short distance outboard of its attachment to the landing gear strut, Figure 1. This was close to a change of cross-section that formed a shoulder providing an abutment for the inner wheel bearing, Figure 2.

The fracture plane was normal to the axis of the axle, fractionally outboard from the corner formed by the reduced axle diameter at the shoulder. Optical microscopy revealed two separate and distinct regions of fatigue cracking on diametrically opposing sides of the fracture, both originating from multiple origins on the outer surface. The configuration of the axle's flanged attachment to the strut was symmetrical, which allows it to be installed onto the strut either way up. Given the stub axle's loading environment, it was evident that the two opposing zones of fatigue had propagated at separate times, the first crack having initiated and grown to a size insufficient to cause a complete rupture during some earlier period in service. At that time, the axle had been installed at 180° from its position at the time of final failure. The second region of fatigue cracking had so weakened the remaining material that it had ruptured in overload, allowing the wheel to separate.

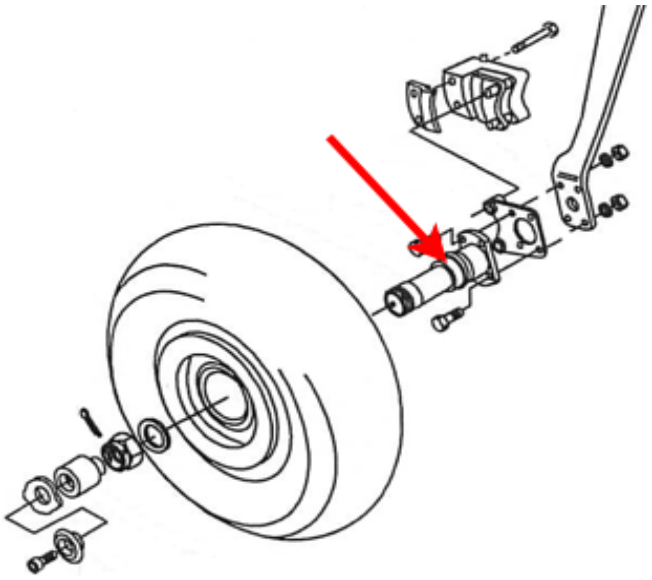

Figure 1

Main landing gear stub axle arrangement, showing location of failure

Figure 2

Stub axle fatigue cracking region

It was not possible to establish precisely when the orientation of the axle had been reversed, or the reason for its removal from the strut. The aircraft's log book recorded replacement of both axles with new items in March of 1998. A Grob Service Bulletin, dated 27 June 1990, required the axle to be inspected for cracks at the welded joint between the axle attachment flange and the axle proper, and it is possible that the change in orientation was associated with removal to facilitate these inspections.

ACCIDENT

Aircraft Type and Registration:	Jodel D120 Paris-Nice, G-BKCW
No & Type of Engines:	1 Continental Motors Corp C90-14F piston engine
Year of Manufacture:	1965
Date & Time (UTC):	6 March 2009 at 1450 hrs
Location:	Perth Airport, Scotland
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to the left wing and both landing gears
Commander's Licence:	Private Pilot's Licence
Commander's Age:	55 years
Commander's Flying Experience:	369 hours (of which 79 were on type) Last 90 days - 3 hours Last 28 days - N/K hours
Information Source:	Aircraft Accident Report Form submitted by the pilot, and AAIB examination of the failed landing gear strut.

Summary

Whilst landing at Perth Airport, the left landing gear strut buckled and folded inwards through approximately 60°.

History of the flight

The purpose of the flight was to enable the pilot to re-familiarise himself with the aeroplane. The pilot had not flown the aircraft since mid-December 2008 as he was waiting for the renewal of its Permit to Fly on 18 February 2009. He had been further delayed by inclement weather.

The start-up, power checks, and takeoff were all normal and, following a departure to the west of Perth.. The pilot completed some general handling exercises and practice forced landings. Before returning to Perth, he made a blind call announcing his intention to land. (Perth Radio had announced during his return to the airfield that it would be going off-air for a short period.)

The pilot reports that his base leg and approach to Runway 21 were normal, with no significant crosswind being apparent. The approach was flown at 55 kt, reducing to 50 kt shortly before touchdown, and the landing was made at 45 kt. The aircraft bounced slightly on touchdown, requiring the rudder to be "pedalled" a couple of times to maintain the runway centreline. Once

the situation had stabilised, power was applied to takeoff but, as the pilot eased forward on the stick, there was a brief shimmy. Almost immediately the aircraft became airborne in a nose-high attitude; the nose was pitched down and the aircraft climbed away normally.

Following a normal circuit and approach, the aircraft touched down again at 45 kt, some 50 m into the runway, and rolled straight initially. However, as the speed reduced through about 30 kt, the left wing dropped suddenly and the aircraft turned through 180º to the right, despite application of opposing rudder and aileron. It came to rest on the grass to the side of the runway. After shutting down and vacating the aircraft, inspection of the left landing gear leg revealed that it was bent inwards through about 60º.

The failed landing gear was forwarded to the AAIB for examination. The tubular steel strut, which had a streamlined 'aerofoil' cross-section, had evidently failed as a result of buckling instability at a location immediately below its lower attachment to the spar. There was no evidence of any pre-existing defect or significant weakening, either of the strut generally or of the material specifically in the vicinity of the failure. The failure, therefore, appeared to have resulted from excessive side loading of the strut.

ACCIDENT

Aircraft Type and Registration:	Pierre Robin R1180T, G-VECD
No & Type of Engines:	1 Lycoming O-360-A3AD piston engine
Year of Manufacture:	1979
Date & Time (UTC):	25 April 2009 at 1703 hrs
Location:	Eddsfield Airfield, East Yorkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - 1 (Serious)
Nature of Damage:	Damage to wings, canopy and propeller
Commander's Licence:	Private Pilot's Licence
Commander's Age:	61 years
Commander's Flying Experience:	274 hours (of which 102 were on type) Last 90 days - 19 hours Last 28 days - 12 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft was landing in a crosswind and the left wing rose after touchdown. During the pilot's attempt to correct this, the aircraft became airborne again and at the point of the second touchdown there was insufficient distance remaining to go around or to stop, resulting in the aircraft hitting a hedge at the end of the runway.

History of the flight

The aircraft had departed from Bourne Airfield and was returning to Eddsfield which is an unlicensed airfield with a grass runway designated 09/27. One commercial flight guide lists the runway's total length as 775 metres. Another guide listed the total length as 800 metres, but with an available distance of 700 metres for Runway 09. Measurements taken from 'Google Earth™' indicated the distance from the 09 threshold to the 20-foot hedge at the far end to be approximately 730 metres. There were 80-foot high trees located 90 metres beyond this hedge.

When the pilot called Eddsfield Radio for landing information he was informed that there was a 12 kt crosswind from the south. The pilot carried out a circuit to the north of the airfield to check the conditions and then lined up for a normal crosswind approach to Runway 09. The pilot considered the crosswind to be within both his and the aircraft's capability. The pilot reported that the aircraft initially touched down normally, but then the left wing rose. The pilot tried to correct this but the aircraft lifted off the runway and at the point of the second

touchdown he considered that there was insufficient runway remaining for a go-around, so he accepted that he was probably going to hit the hedge at the far end. The aircraft suffered substantial damage when it hit the hedge and the passenger suffered serious injury.

Pilot's assessment of the cause of the accident

The pilot stated that he believed the cause of the accident to have been a change in wind direction to a partial tailwind.

ACCIDENT

Aircraft Type and Registration:	Piper PA-28-140 Cherokee, G-UANT
No & Type of Engines:	1 Lycoming O-320-E3D piston engine
Year of Manufacture:	1973
Date & Time (UTC):	5 April 2009 at 1215 hrs
Location:	Runway 28, Blackpool Airport
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to propeller and nosewheel fork
Commander's Licence:	Student
Commander's Age:	27 years
Commander's Flying Experience:	44 hours (of which 43 were on type) Last 90 days - 9 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The student pilot touched down to the right of the runway with a higher than normal groundspeed. In attempting to regain the centreline he believes he applied too much rudder pedal for the speed of the aircraft, resulting in it veering to the left and departing the runway.

History of the flight

The student pilot had completed an uneventful navigation training exercise and returned to Blackpool Airport to land. He was instructed by ATC to extend his final approach to allow separation from a departing aircraft. The student found he was slightly low during the subsequent approach and increased power to compensate, touching down on the right-hand side of the runway, just beyond the runway numbers. He stated that, due to the lack of headwind and the increased power set, his groundspeed at touchdown was greater than normal.

The student applied left rudder to regain the runway centreline but he reported that on passing the centreline the aircraft veered sharply left and departed the side of the runway. The nosewheel entered a ditch, causing the propeller to strike the ground.

Cause

The student believes that, considering the higher than normal ground speed of the aircraft, he applied too much rudder pedal to steer the aircraft back towards the centreline.

ACCIDENT

Aircraft Type and Registration:	Piper PA-28R-201T Turbo Cherokee Arrow III, G-BFLI
No & Type of Engines:	1 Teledyne Continental Motors TSIO-360-FB piston engine
Year of Manufacture:	1977
Date & Time (UTC):	25 June 2008 at 1748 hrs
Location:	Bradford Leigh, Bradford-on-Avon, Wiltshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Aircraft damaged beyond economic repair
Commander's Licence:	Private Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	1,273 hours (of which 1,098 were on type) Last 90 days - 14 hours Last 28 days - 6 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and subsequent AAIB investigation

Synopsis

The aircraft was on its first flight after having had two new cylinders fitted to the engine. After approximately 90 minutes the engine started making an unusual sound and, fearing an imminent catastrophic engine failure or fire, the pilot elected to shut it down and make a forced landing. The aircraft came to rest in a lake; the pilot escaped with only minor injuries.

The engine problem was attributed to the rocker for the No 4 cylinder inlet valve becoming detached due to failure of the stud bolts, causing the inlet valve to remain closed. Metallurgical examination of the fractures revealed evidence of a fatigue-initiated failure mechanism in both bolts; this could not be attributed to any deficiency in the bolt material.

History of the flight

The aircraft was on its first flight after having had two new cylinders fitted to the engine. Two ground runs were completed satisfactorily prior to the accident flight.

About 90 minutes into the flight, at an altitude of 4,000 ft, the engine started to make what the pilot described as a "fluttering" noise and began to lose power. The engine oil temperature and pressure appeared normal and he varied the throttle setting slightly to see if the unusual

noise would change. A few seconds later the No 2, 4 and 6 cylinder exhaust gas temperature (EGT) readings on the engine data management system dropped. The pilot, fearing that a serious engine problem or fire might develop, elected to shut down the engine, put out a MAYDAY call, and carry out a forced landing.

The pilot reported that there was a tailwind of approximately 30-40 kt during the descent. As he turned onto final for his chosen field, he realised that with the given headwind he would be unable to reach the field and was likely to collide with some trees. He elected not to lower the landing gear, selected full flap and attempted to reduce his airspeed as far as possible, making a late turn onto a downwind heading. The aircraft struck a hedge, which caused the left wing to detach at the root, passed through the hedge and came to rest almost entirely submerged in a lake. The pilot, who was wearing a three-point harness, was able to exit the aircraft unaided, and sustained only minor injuries.

Engine information

The aircraft was fitted with a zero-lifed factory-overhauled engine in June 2007 which had logged 71 flying hours at the time of the accident. The aircraft was on its first flight after having had two new cylinders (No 2 and No 4) fitted to the engine because of low compression in the original cylinders.

The six cylinder engine has a horizontally-opposed layout, and the air induction system is divided such that the 'even' cylinders 2, 4 and 6 (on the left side of the aircraft) are fed from one inlet pipe and the 'odd' cylinders 1, 3 and 5 (on the right) are fed from the other inlet pipe.

The aircraft was fitted with a JPI engine data management system which provides real time display of engine parameters to the pilot, and also records the parameters for later analysis. The cylinder head and the exhaust gas temperature (EGT) were recorded for each cylinder.

Each cylinder has an inlet and an exhaust valve, operated by separate pushrods and rockers. Each rocker assembly is attached to the cylinder head by two stud bolts and tie-down nuts. The specified torque range for the nuts is 110-120 in-lbs, which places the bolts at 70% of their yield strength. As the rocker assemblies must be removed when replacing a cylinder, it would have been necessary to disturb the tie-down nuts during the recent replacement of the two cylinders. Replacement cylinders are supplied by the manufacturer with the rocker stud bolts already installed.

Aircraft information – Pilot's Operating Handbook

The PA-28 Pilot's Operating Handbook covers various emergency situations. In the section entitled 'Engine power loss in flight' it states that:

> *'complete engine power loss is usually caused by fuel flow interruption and power will be restored shortly after fuel flow is restored.'*

and:

> *'...if power is not regained, proceed with the power off landing procedure.'*

In the section entitled 'Engine roughness' it states:

> *'...engine roughness may be caused by dirt in the injector nozzles, induction system icing, or ignition problems.'*

It further states:

> *'...if roughness persists, prepare for a precautionary landing at pilot's discretion.'*

A precautionary landing is one that is conducted with engine power available and may be preceded by a circuit, or circuits, being flown to assess the suitability of the chosen landing site.

Engineering investigation

The JPI system and engine were recovered to AAIB headquarters. The JPI unit was dried slowly and the data downloaded. Figure 1 shows the EGT for all six cylinders at the time of the engine problem; it can be seen that the EGT for the No 4 cylinder dropped markedly, with the EGTs for the No 2 and 6 cylinders following shortly afterwards. Several seconds later the EGTs for the remaining cylinders decreased rapidly, consistent with the engine being shut down.

The engine was strip-examined with a representative from the manufacturer present. The two stud bolts that attached the inlet valve rocker assembly to the No 4 cylinder head were found to have failed (Figures 2 and 3), leaving the inlet valve closed. The valve opened satisfactorily when tested. Witness marks were present inside the rocker cover which appeared to have been made by the tie-down nuts from the failed stud bolts.

There were no other significant findings during the engine inspection and the engine manufacturer was confident that the engine was capable of running and developing significant power even with the failed rocker. However, it would probably have sounded and felt unusual to the pilot.

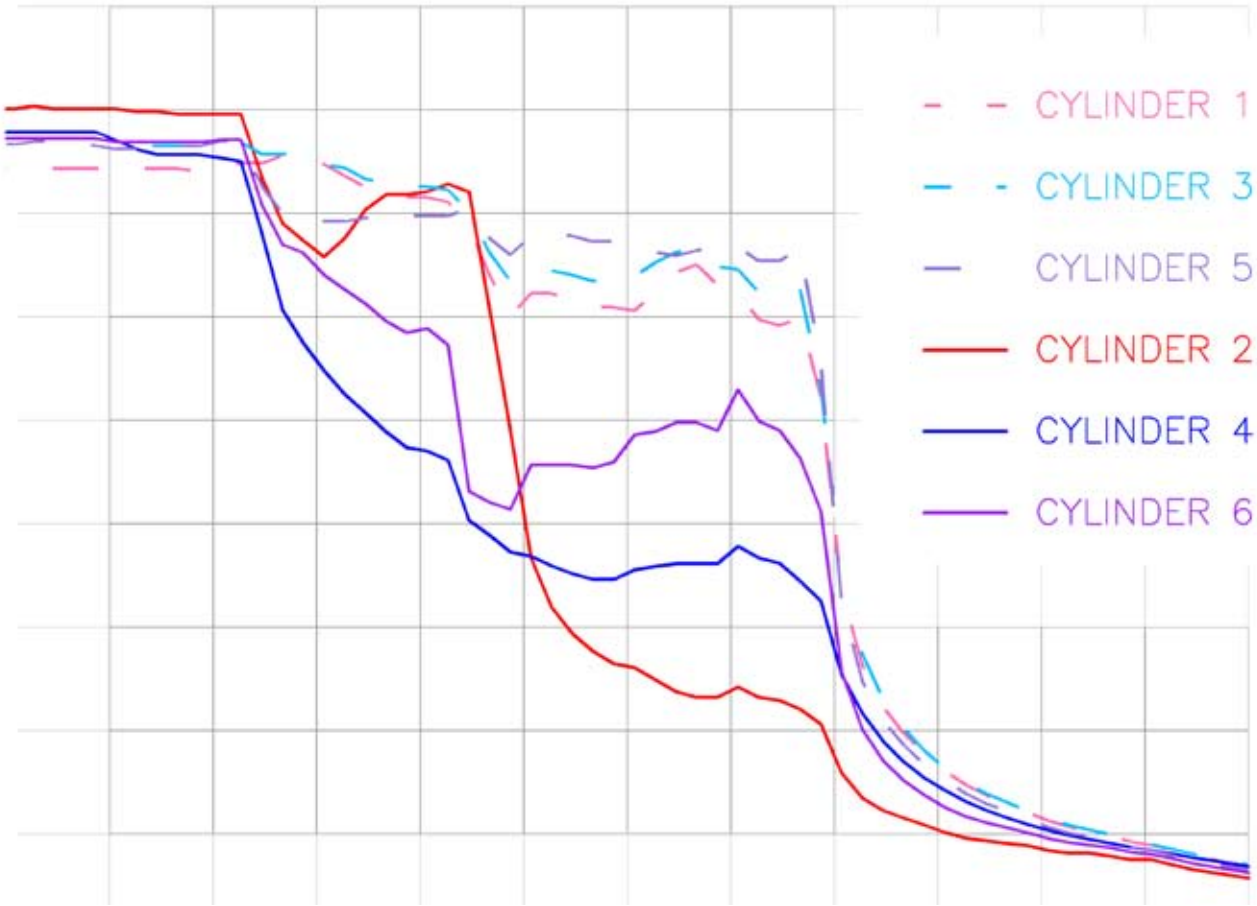

Figure 1

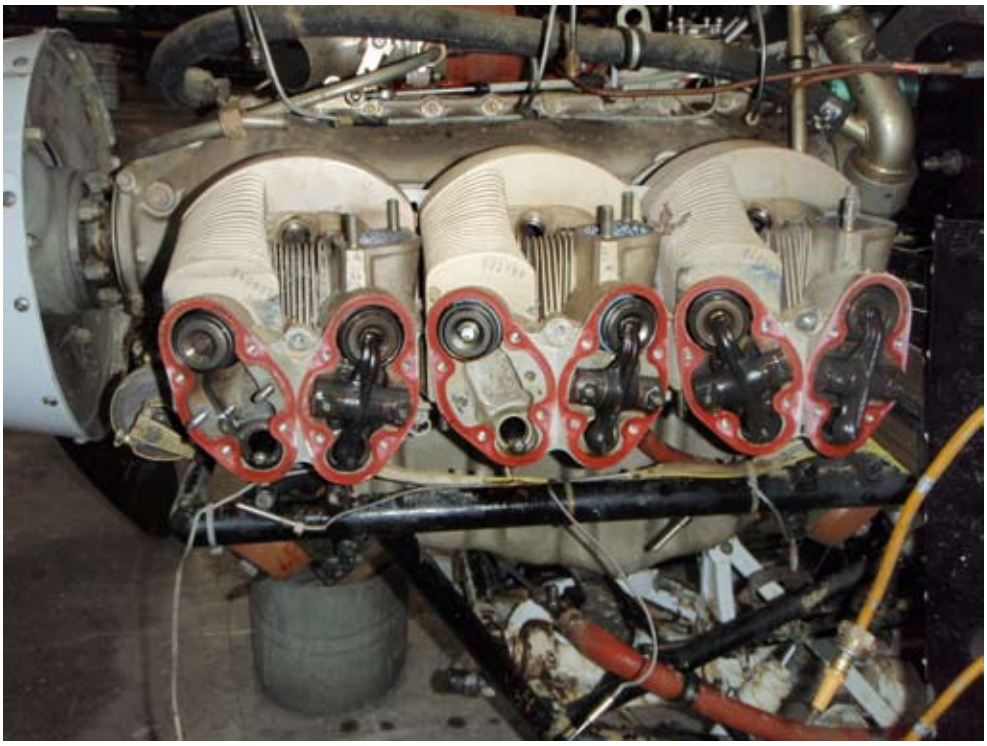

Figure 2

Figure 3

The No 4 cylinder was one of two new cylinders that had recently been fitted. The torque settings of the rocker tie-down nuts were checked on the three remaining rockers on the recently replaced cylinders and on the rockers on the other, undisturbed cylinders. These all appeared to have been correctly torqued.

The two failed stud bolts (bolt 'A', Figure 4 and bolt 'B', Figure 5) were sent to a metallurgist for detailed examination. Both showed evidence of fatigue, although no material defect that could have initiated the fatigue was found in either bolt. The hardness value of each bolt was checked; one was found to be 33 and the other 35 on the Rockwell 'C' hardness scale (HRC) the specified hardness range for this type of bolt being 28-32 HRC. The slightly high hardness values were not considered to be significant.

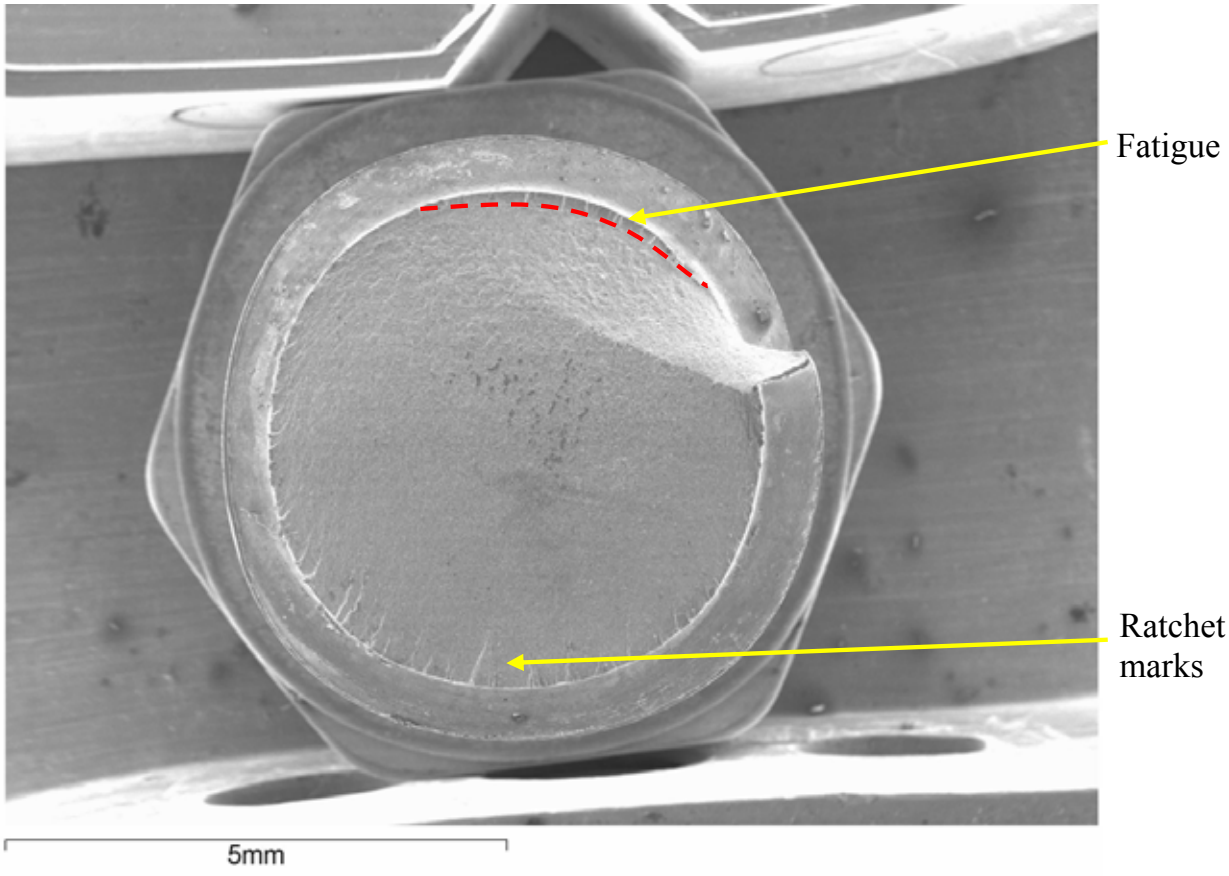

Figure 4

Fracture surface of bolt A

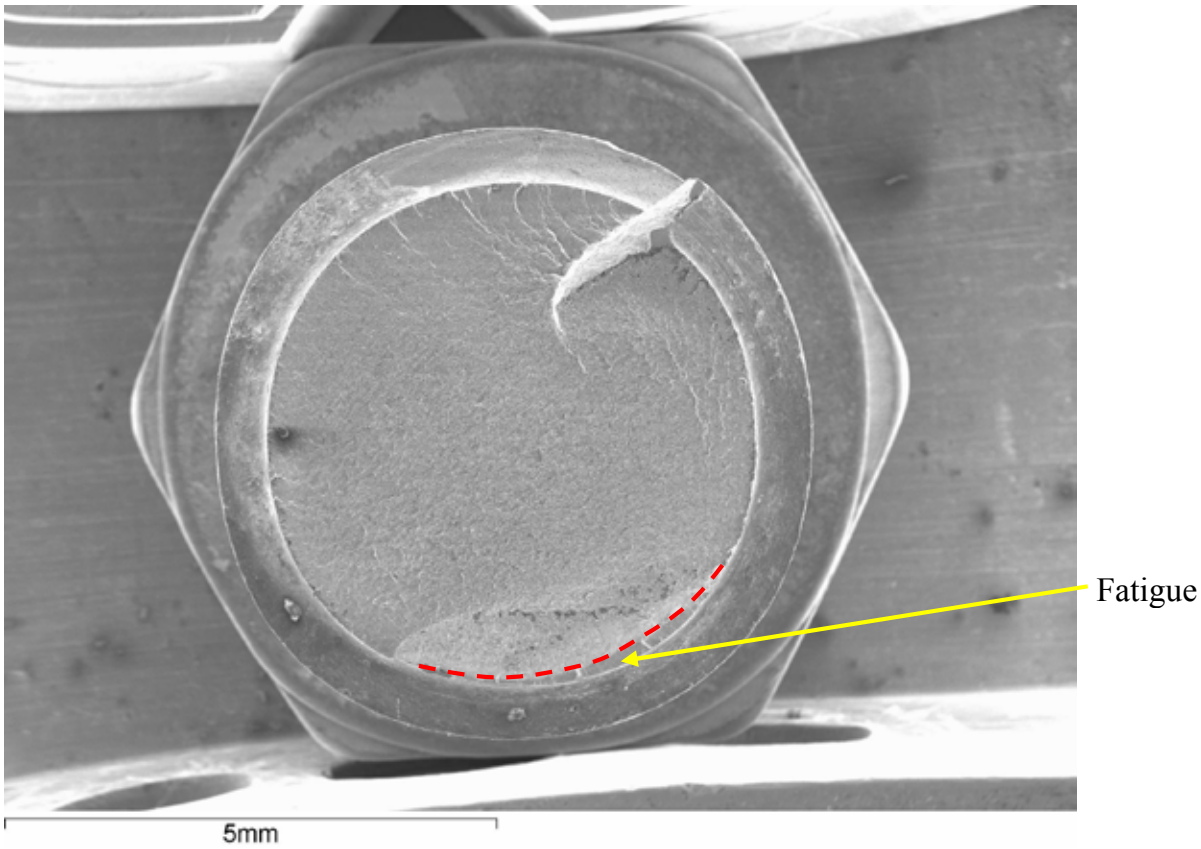

Figure 5

Fracture surface of bolt B

Discussion

The engine inspection revealed that the engine was probably capable of running and developing sufficient power for continued flight, albeit sounding unusual and with some vibration. The guidance provided in the Pilot's Operating Handbook for engine rough running is to execute a precautionary landing. By deciding to shut down the engine, the pilot was left with no other option than to carry out a forced landing without power. The pilot had been active for most of the day and felt that tiredness might have been a factor in his decision making.

No material defects were found in the failed stud bolts that could account for their failure. Given the recent replacement of the No 2 and No 4 cylinders, the possibility that the No 4 cylinder inlet valve rocker tie-down nuts had been incorrectly torqued on reinstallation could not be ruled out, but this could not be concluded with any degree of certainty.

ACCIDENT

Aircraft Type and Registration:	Piper PA-32RT-300T Turbo Cherokee Lance II, G-LUNA
No & Type of Engines:	1 Lycoming TIO-540-S1AD piston engine
Year of Manufacture:	1979
Date & Time (UTC):	28 June 2009 at 1355 hrs
Location:	English Channel, 9 miles offshore from Lydd Airport, Kent
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of damage:	Aircraft sank after ditching
Commander's Licence:	Private Pilot's Licence
Commander's Age:	46 years
Commander's Flying Experience:	667 hours (of which 25 were on type) Last 90 days - 10 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and subsequent AAIB enquiries

History of flight

The pilot reported that the aircraft was refuelled to full tanks before departure from Lydd Airport. Having levelled at 2,000 ft, and seven miles from Lydd, he switched the fuel pump on and changed the fuel selector from the left to right tank. Ten or fifteen seconds later, the manifold pressure dropped and the rpm decayed. The pilot immediately selected the mixture to fully rich, and re-selected the left tank. The engine continued to run, but at low power and with sounds of misfiring. The pilot selected the alternate air source but the engine did not recover, and then stopped. He made a MAYDAY call and selected 7700 on his transponder, whilst making several unsuccessful attempts to re-start the engine.

The pilot flew towards a ship, opened the cabin door, selected the landing gear manual override[1], and prepared to ditch. The ditching was carried out with full flap and with the aircraft fully stalled, onto the top of the five metre swell (the wind was approximately 210/9 kt and the ditching was carried out on a heading of 240°). The aircraft touched down tail first, and bounced. On the subsequent impact, the fuselage briefly submerged before it floated. The pilot, uninjured, put on his lifejacket and exited the aircraft onto the wing. He waved to the ship but it continued its passage; its crew had seen the ditching and contacted another ship

Footnote

[1] To prevent the landing gear extending automatically at low air speed.

behind them by radio with instructions to rescue the pilot. After approximately two minutes, the aircraft pitched 45° nose down, and sank. The pilot was rescued by the second ship, transferred to a lifeboat, and then airlifted to hospital by helicopter; he had been in the water for 20 minutes and was treated for mild hypothermia. The aircraft was not recovered, and no technical investigation into the engine failure was possible.

The pilot commented that he thought the engine failure might have been caused by debris in the fuel injectors, a faulty fuel selector, or contaminated fuel. No other aircraft which refuelled at Lydd reported problems. He added that he intended in future to wear his lifejacket for flight over water.

ACCIDENT

Aircraft Type and Registration:	Piper PA-38-112 Tomahawk, G-BOLF
No & Type of Engines:	1 Lycoming O-235-L2C piston engine
Year of Manufacture:	1979
Date & Time (UTC):	17 October 2008 at 1520 hrs
Location:	Robin Hood's Bay, North Yorkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Fatal) Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	45 years
Commander's Flying Experience:	50 hours (all of which were on type) Last 90 days - 27 hours Last 28 days - 4 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft suffered a loss of engine power whilst over the sea just off the North Yorkshire coast. The pilot transmitted a MAYDAY and attempted to ditch the aircraft, but it stalled just above the surface of the sea, causing its right wing to drop into the water. The aircraft then cartwheeled and inverted before sinking. The pilot, who was not wearing a life jacket, drowned. The cause of the power loss could not be positively determined.

History of the flight

The pilot arrived at Durham Tees Valley Airport at about 1400 hrs for a planned navigation trip around the North Yorkshire Moors. He had intended to make the flight earlier in the week, but the weather conditions had not been suitable. The weather on the day of the accident was good, and the aircraft departed from Runway 23 at 1452 hrs. After takeoff the pilot turned to the south-east and climbed to 1,500 ft. Once clear of the airfield he changed radio frequency and obtained a Flight Information Service from the radar controller, who identified the aircraft on radar and verified its transponder Mode C altitude readout. The pilot was cleared for further climb to not above 4,000 ft en route. He resumed climbing and proceeded towards the Whitby area.

Some time later, the controller observed that the aircraft was at 1,300 ft overhead the Whitby area. This did not concern her unduly, as aircraft often descend in this area for a better view of the scenery.

At about 1515 hrs, the pilot of another aircraft on the same frequency heard the transmission: "MAYDAY MAYDAY MAYDAY OSCAR FOXTROT FORCED LANDING". When the radar controller did not reply, the pilot relayed the MAYDAY call to her. The controller, who had not heard the original call, tried to contact G-BOLF, but received no reply. The pilot of the assisting aircraft also tried to contact G-BOLF, unsuccessfully. The controller passed the last known position of G-BOLF to the pilot of the assisting aircraft who carried out a search of the area, just off Robin Hood's Bay, but no signs of the missing aircraft were found.

Witness information

At about 1515 hrs, a witness at Robin Hood's Bay heard the sound of an engine increasing to a high power, reducing to low power then increasing again. He assumed that the sound was from an aircraft which he could not see, that was performing aerobatics. Shortly thereafter he saw an aircraft flying low over the water, on the other side of the bay.

Witnesses at Ravenscar, to the south, saw a small, single-engine aircraft heading in their general direction. It was initially just above cliff top height and descended gently towards the sea in an apparently controlled manner. When it was just above the surface a wingtip suddenly dropped and entered the water, causing the aircraft to cartwheel. It became inverted and quickly sank below the surface.

Emergency response

Search and rescue aircraft, lifeboats and the coastguard were dispatched to the scene. Witnesses confirmed that they were searching in the correct area, but neither the pilot nor the aircraft could be found. The aircraft was found later that evening at low tide; the pilot's body was found the following day.

Recorded data

The Great Dunn Fell and Claxby radar heads recorded the flight from Durham Tees Valley Airport to the Whitby area. The data show the aircraft climbing to a maximum height of 3,500 ft at 1458 hrs, before descending gently to 1,200 ft. It then climbed back up to 1,500 ft at 1513 hrs, then descended more rapidly to 1,000 ft at 1514.35 hrs before disappearing from radar. No other aircraft were recorded in the area at the time.

From recordings of the RTF transmissions obtained by the AAIB, it was confirmed that a MAYDAY call was transmitted at 1514.58 hrs; the words "ROBIN HOOD BAY", and "ATTEMPTING FORCED LANDING" could be heard.

Weather

A weather aftercast obtained from the Met Office for the Robin Hood's Bay area for 1515 hrs on 17 October showed a weak warm front lying off the east coast of England, with much of the country, including the accident site, within a warm sector. Visibility in the area of the accident was 25 to 35 km, with few clouds around 3,000 ft and a more general cloud base around 4,500 ft. At 2,000 ft the wind was likely to have been westerly at 17 kt, the temperature 6ºC and the dew point 3.7ºC, giving a relative humidity of around 85%. The METAR report at Durham Tees Valley airport for 1450 hrs on 17 October gave the weather as wind westerly at 9 kt, more than 10 km visibility, with few clouds at 2,500 ft.

Accident site

The accident site was located in the sea towards the southern end of Robin Hood's Bay. The land at the southern end of the bay comprises, in the main, 200 ft to 300 ft high cliffs above which were fairly small, sloping grass fields interspersed with walls, hedgerows, trees,

telephone/electric cables and the occasional building. The land above the cliffs at the northern end of bay has larger and flatter grass fields with fewer obstacles.

Engineering examination

Examination of the wreckage after the tide had ebbed showed it to be inverted, with major damage to the outer right wing, and a twisting failure of the rear of the fuselage just forward of the empennage. This evidence correlated well with the witness evidence that the aircraft first impacted the sea with its right wing, before rapidly swinging to the right, inverting and sinking. The engine cowlings, right landing gear, cockpit windscreen and cockpit doors were torn off either during the impact or whilst on the sea bed prior to recovery of the aircraft. These items were not found. The propeller showed good evidence that it was not being driven by the engine when it impacted the sea. The wing flaps had been fully deployed, the fuel was selected to the left tank, the throttle was fully open, the fuel mixture was near the fully rich position, the carburettor heat was selected on, the fuel primer control was 'in-and-locked', the electric fuel pump, landing light, anti-collision light and pitot tube heater were selected off and the engine ignition was selected off. The fuel tank drains were found to be firmly closed. There was no evidence of an airborne fire.

A detailed examination of the flying control system, fuel system and engine operating systems did not reveal any evidence of pre-impact failure, disconnection or restriction.

The engine was taken to an overhaul facility for examination. External and internal examination showed no evidence of failure, disconnect or seizure. The general internal condition of the engine was found to be very good and consistent with the hours that the engine had operated since overhaul. During the disassembly of the engine it was found that the engine-driven mechanical fuel pump mechanism was stuck in an unusual position. During the disassembly of the fuel pump it became free to operate. A detailed examination of the pump's internal mechanism revealed possible evidence of stiction on the central spindle. The central spindle was found to be slightly bent in the area of the stiction marks, which could account for why the pump mechanism was found stuck in an unusual position when removed from the engine. The fuel pump had been fitted to the engine as a new item approximately 1,500 operating hours prior to the accident and there had been no reported problems associated with the pump. Two other mechanical fuel pumps of the same type were internally examined for comparison and both had similar, but less pronounced stiction marks on the central spindle, but neither spindle was bent. It was not possible to determine how or when the spindle of the accident mechanical fuel pump became bent.

The electric fuel pump was tested and, even after immersion in the sea for about 24 hours, it functioned satisfactorily.

Carburettor icing

The Met Office aftercast for the Robin Hood's Bay area at the time of the accident gave the air temperature, dew point and humidity from the surface to 3,000 feet in bands of 500 ft. When these figures were plotted on the Civil Aviation Authority (CAA) Carburettor Icing Prediction Chart it gave a prognosis that serious carburettor icing could occur at any power setting between 1,000 and 3,000 feet amsl (Figure 1).

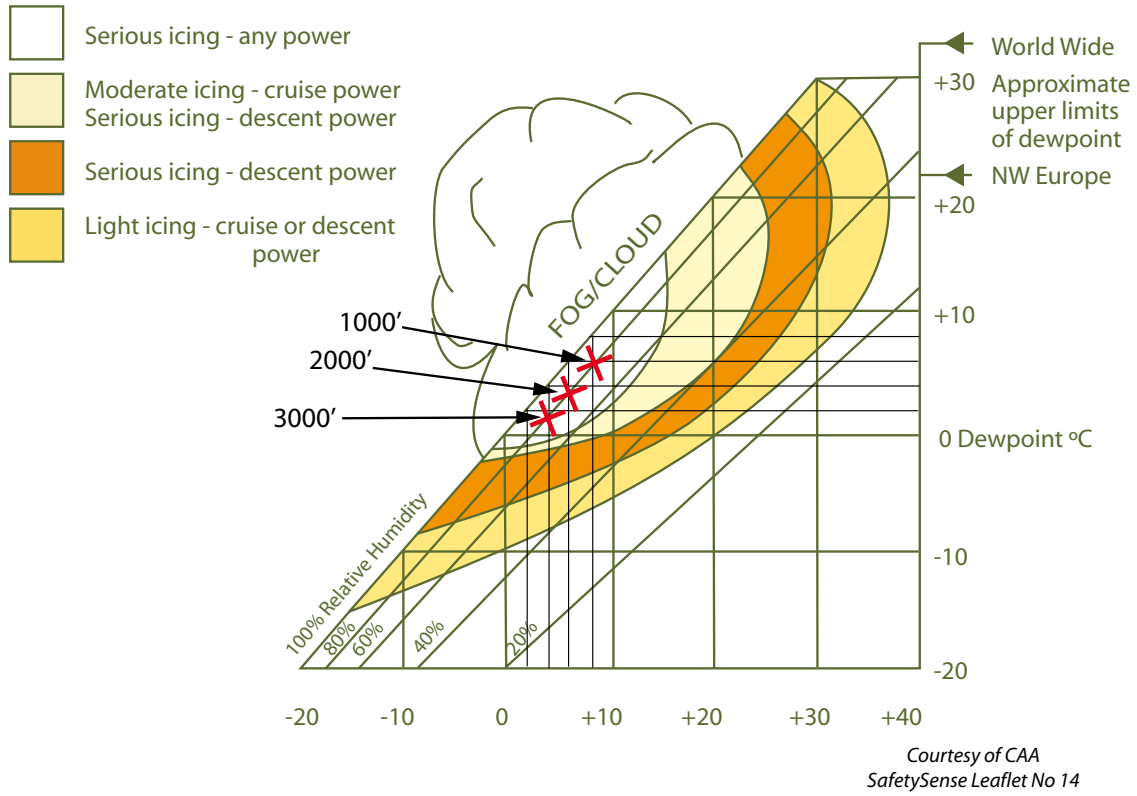

Figure 1

CAA carburettor icing probability chart

Maintenance

Documentation showed that the aircraft had sufficient fuel on board for the intended flight and that it had been maintained in accordance with CAA regulations. A 50-hour maintenance check was completed on the 13 October 2008.

Pilot training

The pilot had obtained his licence after 45 hours of training. He made his first solo flight after 17.5 hours and he was considered by his instructor to have made satisfactory progress throughout his training. The examiner who conducted the pilot's PPL Skills Test on 15 September 2008 considered that the test was flown to a good standard.

Investigation flight

During the investigation the AAIB conducted a flight in a PA-38-112, following the route of the accident flight as closely as possible. This showed that when the MAYDAY call was transmitted, it was theoretically possible for the pilot to achieve a forced landing on land. However, the nearest land would have been behind the aircraft and hidden by the wing. It would not, therefore, have been immediately visible to the pilot.

Pathology

The post-mortem examination revealed that the pilot had survived the impact with the water and had died from drowning. This evidence, and the fact that his body was found outside the aircraft, suggests that he was able to extricate himself from the aircraft after it impacted the water, but had then drowned.

None of the witnesses to the accident reported seeing the pilot on the surface of the water. He was not wearing any form of flotation aid.

There was no evidence of significant pre-existing natural disease which could have caused or contributed to the accident and toxicology revealed no evidence of alcohol or drugs in the pilot's body.

Discussion

It was apparent that the aircraft had suffered a loss of engine power. Given that the conditions at the time were conducive to carburettor icing at any power setting, the possibility of loss of engine power due to carburettor icing could not be ruled out, but this does not appear consistent with the witness report of hearing an engine increasing to high power, then decreasing and increasing again. It could not be determined how or when the spindle of the fuel pump had become bent. It was not possible to positively determine the reason for the loss of engine power from the available evidence.

When the engine failed, the pilot could have achieved a forced landing on land, but the location of the nearest land would not have been obvious to him as it was behind the aircraft and hidden by the wing. He may have been initially occupied with making a MAYDAY call and trying to restore engine power. By the time he had completed these actions the aircraft may have been beyond gliding distance of land. It appears that the aircraft stalled just prior to entering the water, causing the right wing to drop into the water and the aircraft to cartwheel into the sea.

CAA Safety Sense Leaflet No 21 contains advice on ditching an aircraft. It points out that the main cause of death after ditching is drowning, and that in many cases the deceased person either was not wearing a life jacket, or did not have one readily available. This accident reinforces the importance of wearing a suitable life jacket to maximise the chances of survival whenever there is a risk of ditching.

ACCIDENT

Aircraft Type and Registration:	Speedtwin ST2, G-STDL
No & Type of Engines:	2 LOM M332B piston engines
Year of Manufacture:	2007
Date & Time (UTC):	22 April 2009 at 1515 hrs
Location:	Near Woodbridge Airfield, Suffolk
Type of Flight:	Private
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Right and left propellers, right engine cowls, and front fuselage
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	51 years
Commander's Flying Experience:	9,600 hours (of which 22 were on type) Last 90 days - 61 hours Last 28 days - 23 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and subsequent AAIB examination of the propellers

Synopsis

Whilst in the cruise at 4,000 ft and accelerating towards maximum speed, a loud bang was heard and the right engine began to vibrate, followed by some smoke and a smell of hot oil. The pilot shut down the right engine and selected the propeller switch to the feather position. However, the propeller failed to feather and the engine continued to rotate. Control of the aircraft was maintained with the left engine but the right engine vibration remained severe, which necessitated an immediate forced landing. This was subsequently achieved at the disused airfield of Woodbridge. After landing, it was apparent that one of the blades on the right propeller unit had failed at the root. Additionally, it was evident that the departing blade had struck the aircraft nose and one of the left propeller blades.

Description of the aircraft

The Speedtwin ST2 is a low-wing, twin-engine, tandem two-seat prototype aircraft, equipped with two-bladed, variable pitch propellers. The propeller manufacturer supplies propellers for a number of light aircraft types, many of which are administered by the Light Aircraft Association (LAA). The propellers on G-STDL were prototypes, with wooden blades encased in a carbon fibre skin. Threaded aluminium alloy root sections were screwed into steel sleeves within the hub. The sleeves in

turn were connected to the pitch-changing mechanism, which is powered by electric actuators mounted on the front face of the hub. Circular clamps attach to the slotted outer portions of the sleeves which, when tightened, prevent rotation of the blades relative to the sleeves.

The propeller assemblies were fitted to the aircraft on 10 June 2008 and had achieved 52 flight hours at the time of the failure.

History of the flight

The aircraft departed Elmsett Airfield for a test flight to be conducted northeast of Felixstowe; the commander was a CAA test pilot. At the time of the incident, the aircraft was maintaining 4,000 ft and accelerating towards its maximum level speed. At approximately 184 mph IAS, engine speed had been selected to 3,000 rpm on both engines. The superchargers were engaged and, some 30 seconds later, a loud bang was heard and the right engine began to vibrate. This was followed by some smoke and a smell of hot oil. The pilot shut down the right engine and selected the propeller switch to the feather position. However, it was soon apparent that the engine was not feathering as the engine continued to rotate. A MAYDAY call was transmitted but any response could not be heard due to the noise in the cockpit. The pilot found he was able to maintain control of the aircraft and also control the descent with power from the left engine. However, he considered that the continuing severe vibration from the right engine made an immediate landing imperative. The disused airfield at Woodbridge was close by where a successful approach and landing were made. Whilst approximately one mile from the airfield, the pilot transmitted a further MAYDAY call to Wattisham to inform them of the aircraft's position. It was subsequently found that vibration had caused the radio to become dislodged from its mounting and it was possible, therefore, that the transmission was not received.

As the aircraft slowed immediately prior to landing, the right engine stopped rotating, and it became clear that one propeller blade was missing. Subsequent inspection revealed that the departing propeller blade had struck the nose of the aircraft as well as the left propeller assembly, partially removing the carbon fibre skin and some of the wood laminations from one of the blades.

Examination of propeller blades

The failed propeller blade was not recovered, although a portion of the root section had remained with the hub. After manufacturing a special tool, this was unscrewed and, together with the other blades, it was subjected to metallurgical examination.

Figure 1 shows the hub in which the root portion of the failed blade, (Figure 2) had been located. Corrosion products were present on the threads in the hub and there was no evidence of a jointing compound having been used in the assembly. The fracture face had propagated around the circumference of the root of a thread and had continued into the adjacent root, causing a 50 mm overlap. A 'thumbnail' feature was visible on the fracture face together with two 'bright' areas; these are shown on the photographs and are designated 'Cracks 1, 2 and 3'. It was concluded that all the cracks were progressive in nature, although outside these areas it was apparent that the fracture was the result of overload. Additional examination of the cracks, using a scanning electron microscope at low power, revealed fracture surface delamination, which is characteristic of stress corrosion cracking (SCC). A section was taken through one of the cracks and it was found that smaller cracks branched off it; all the cracks were intergranular in nature. This, together with the branching feature, is also characteristic of SCC.

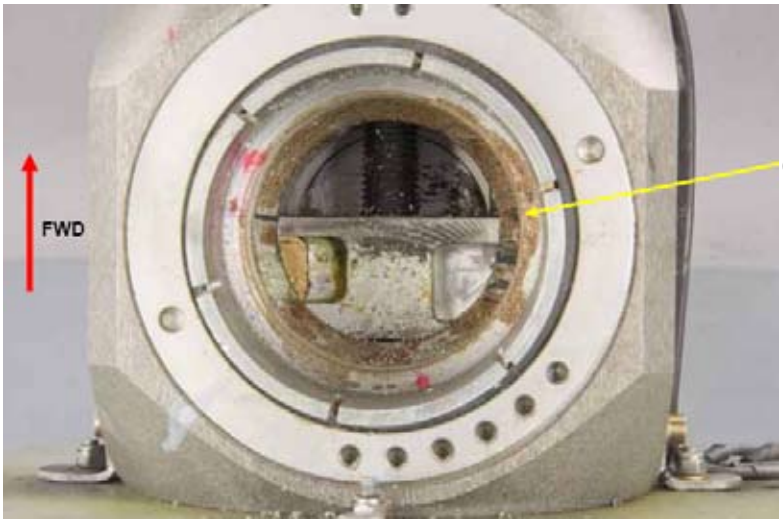

Figure 1

Hub after removal of the failed blade root portion

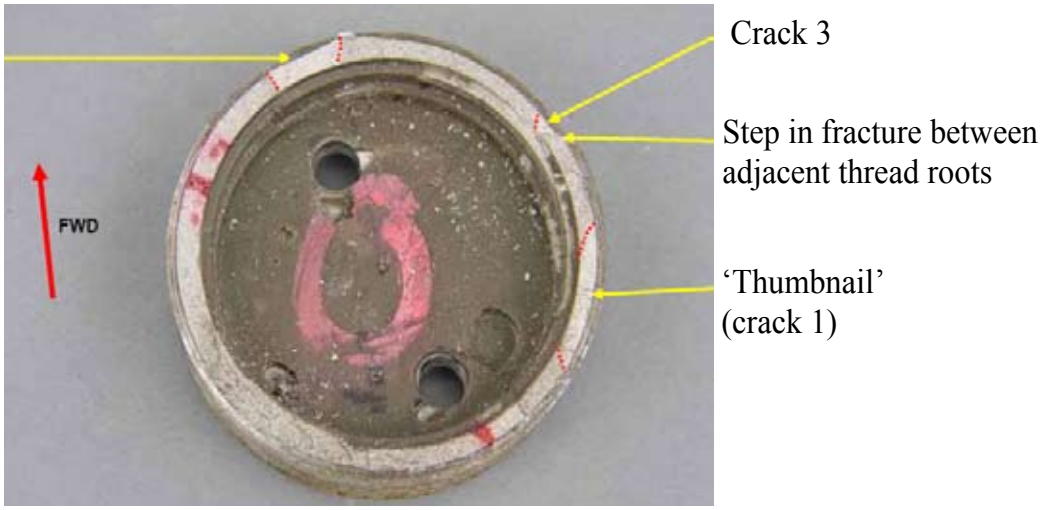

Figure 2

Failed blade root section showing cracked areas

For SCC to occur, a sustained tensile stress must be present in the material, in a corrosive environment. A microstructural examination indicated that the threads had been machined rather than rolled; this had exposed end grains at the thread roots, which would make them susceptible to SCC[1]. Although a considerable tension would be present in the blade roots during engine operation, the low operating time of 52 hours, compared with their calendar age, led to the conclusion that the most likely source of sustained tensile load was residual stresses arising from the thread machining operation. It is not known whether the blade roots were heat treated following the thread machining operation, but this would have relieved much of the residual stress.

Footnote

[1] Thread rolling is a cold forming process, which imparts a compressive layer to the surface of the material, and which does not result in exposed end grains.

Examination of the damaged left propeller revealed a spiral crack running around the root section of one blade, Figure 3. It was concluded that this was an overload feature that occurred as a result of being struck by the failed right hand blade. The root sections of the remaining left and right blades revealed no sign of cracks, although all displayed evidence of moisture ingress and associated spots of corrosion.

Discussion

Although the propeller assemblies fitted to this aircraft were prototype units and do not necessarily reflect the likely production standards, various features of their design and construction are considered worthy of comment. For example, the assembly consisted of dissimilar metals in contact, ie, the aluminium alloy threaded blade roots were assembled into steel sleeves in the hub, with no jointing compound, or O-ring type seals to protect against moisture ingress. In addition, the blade root threads had been machined, whereas a thread rolling process would have been more appropriate, in that exposed end grains not have resulted. Moreover, rolled threads would have conferred a higher degree of resistance to fatigue cracking.

Conclusions

It was concluded that the right propeller blade failure was the result of stress corrosion cracking within the threads of its root section. This probably occurred due to a combination of residual stresses within the root arising from the thread machining process, and a corrosive environment arising from moisture ingress.

Following this incident, the developers of the Speedtwin aircraft are reviewing the engine/propeller combination, with the probability of alternative suppliers being selected.

Figure 3

View showing crack in root of one blade from the left propeller

ACCIDENT

Aircraft Type and Registration:	Vans RV-9A, G-HUMH
No & Type of Engines:	1 Lycoming O-320-D3G piston engine
Year of Manufacture:	2006
Date & Time (UTC):	22 May 2009 at 0814 hrs
Location:	Runway 25, Shoreham Airport, Sussex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Nose landing gear collapsed, propeller strike, engine shock-loaded
Commander's Licence:	Private Pilot's Licence
Commander's Age:	68 years
Commander's Flying Experience:	239 hours (of which 73 were on type) Last 90 days - 2 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During the flare, following a normal approach to Runway 25 at Shoreham, the aircraft contacted the ground before the pilot had anticipated that it would. It bounced several times before tipping onto its nose, damaging the nose landing gear and propeller, before righting itself. Both occupants were uninjured. The pilot commented that the inadvertent ground contact was due to an unseen undulation in the grass runway surface.

ACCIDENT

Aircraft Type and Registration:	Rotorway Executive 162F, G-ESUS
No & Type of Engines:	1 Rotorway RI 162F piston engine
Year of Manufacture:	1999
Date & Time (UTC):	20 April 2009 at 1500 hrs
Location:	Street Farm, Takeley, near Stansted, Essex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Canopy, right door, main rotor blades and tailboom.
Commander's Licence:	Private Pilot's Licence (FAA)
Commander's Age:	74 years
Commander's Flying Experience:	195 hours (of which 195 were on type) Last 90 days - 10 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and observation of a video recording

Synopsis

Following a normal flight the helicopter was manoeuvering to shut down on an area of concrete driveway. The right skid touched down on the concrete, while the helicopter was still moving forwards and yawing left, and the helicopter rolled over. There were no injuries to the two persons on board.

History of the flight

The helicopter initially landed on an area of grass but the pilot then wanted to manoeuvre onto a concrete driveway behind, before shutting down. The general area was clear of any buildings or other obstructions and the wind was less than 5 kt.

He lifted off, went backwards slowly across the driveway at a height of 3 to 4 feet (1 m), turned through some 45º to the left and then moved forward to land. The pilot observed a loss of rpm as he was manoeuvering to land and, to avoid a heavy landing on one skid, he attempted to lift off again. The helicopter dropped down fairly rapidly from a height of about 2 feet, while yawing to the left, and the right skid contacted the concrete surface. A roll to the right developed, with the nose of the helicopter still yawing left. The pilot was unable to correct the roll and the helicopter pivoted about the right skid and rolled over.

The touchdown on the concrete occurred before the helicopter was in a stable hover and caught the pilot by surprise. He was unable to act in time to prevent the rollover, either by lowering the collective lever to accept a hard landing, or by lifting off again to a stable hover. The pilot and his passenger exited on the left-hand side through the uppermost door and were not injured in the accident.

ACCIDENT

Aircraft Type and Registration:	BFC Challenger II Long Wing, G-IBFC
No & Type of Engines:	1 Rotax 582-48 piston engine
Year of Manufacture:	2001
Date & Time (UTC):	21 June 2009 at 1330 hrs
Location:	Husbands Bosworth Airfield, Leicestershire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Left main landing gear leg failed
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	57 years
Commander's Flying Experience:	220 hours (of which 64 were on type) Last 90 days - 10 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The pilot completed a normal touchdown but, as the aircraft decelerated through 20 kt, it struck a bump in the runway surface and was lifted into the air. On the second touchdown, the aircraft hit the ground heavily with its left main wheel, which resulted in the failure of the left landing gear leg.

ACCIDENT

Aircraft Type and Registration:	Dynamic WT9 UK Dynamic, G-JFDI
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	2007
Date & Time (UTC):	23 May 2009 at 1600 hrs
Location:	Kimbolton Airstrip, Cambridgeshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to right flap; right landing gear collapsed
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	88 hours (of which 45 were on type) Last 90 days - 9 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

On landing the pilot raised the nose of the aircraft sufficiently for the tail to contact the ground. As a result he was unable to steer the aircraft properly, resulting in it departing the runway and causing the right gear to collapse.

History of the flight

The pilot made an uneventful approach to the landing strip, using three stages of flap. On touchdown he kept the nose of the aircraft high to protect the nosewheel from any ruts or bumps on the grass surface. At a speed of about 20-25 mph the aircraft started to drift to the left which the pilot attempted to correct by applying right rudder, but the pedal was "stiff and incompliant". The aircraft continued to the left, the left wing tip clipping a rape crop growing adjacent to the strip, swinging it still further to the left. This caused the aircraft to depart the airstrip, collapsing the right landing gear.

Cause

The pilot stated that he normally landed with only two stages of flap and that he usually operated from a concrete runway. This contributed to him raising the nose more than usual on landing, sufficient for the tail skid to contact the ground. The skid had then dug into the ground allowing the lower part of the rudder to contact the grass. The aircraft has a steerable nosewheel which operates through the rudder pedals, but by restricting the rudder's movement, as in this case, the pilot's ability to steer the aircraft was significantly affected.

ACCIDENT

Aircraft Type and Registration:	Gemini Flash IIA, G-MTIA
No & Type of Engines:	1 Rotax 503 piston engine
Year of Manufacture:	1987
Date & Time (UTC):	16 June 2009 at 1155 hrs
Location:	Caernarfon Airport, Gwynedd
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Minor) Passengers - 1 (Minor)
Nature of Damage:	Substantial
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	70 years
Commander's Flying Experience:	109 hours (of which 41 were on type) Last 90 days - 13 hours Last 28 days - 8 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft was unstable on the approach and rolled over on the subsequent landing.

History of the flight

The aircraft is a flex-wing microlight type. The pilot and his passenger went for a local sightseeing flight along the Lleyn Peninsula, south of Caernarfon Airport. The weather conditions were fine and clear with a surface wind varying from westerly to south-south-west at 6 to 10 mph, scattered cloud and a temperature of 20ºC. On returning to Caernarfon the pilot joined the left hand downwind leg for Runway 20.

The trim speed for the aircraft was set at 53 mph. The pilot found that on the final approach he was having difficulty making the necessary corrective control movements in turbulence and realised afterwards that he had been low and slow, about 42 mph to 45 mph. He reported that this had been corrected shortly before touchdown. However, over the threshold the aircraft was destabilised, possibly by a gust of wind, and drifted to the left of the runway centreline (see Figure 1). The aircraft touched down on the left main wheel first, then rolled to the right and pivoted about the right main wheel. The starboard wing contacted the ground, both wings folded backwards and the trike rolled onto its right hand side and slid along the ground until it stopped. Both occupants were able to get clear of the aircraft without assistance, suffering only minor injuries.

Figure 1

View on short final approach from on board the aircraft before the accident

ACCIDENT

Aircraft Type and Registration:	Mainair Blade 912, G-WAKE
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	2000
Date & Time (UTC):	21 June 2009 at 1210 hrs
Location:	Field near Kilberry, Argyll, Scotland
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Tyre puncture and damage to pod and landing light
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	62 years
Commander's Flying Experience:	266 hours (of which 266 were on type) Last 90 days - 15 hours Last 28 days - 8 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During a precautionary landing a tyre burst and the aircraft hit a wall.

History of the flight

The Mainair Blade 912 is a two-seat flex-wing microlight aircraft with a tricycle landing gear configuration. The aircraft was on a cross-country flight from Strathaven Airfield to Oban Airfield. The pilot stated that, during the flight, the "weather closed in on the west side of Tarbert" and he considered that he would not be able to return safely to the Sound of Bute while remaining in VMC. Therefore, he decided to carry out a precautionary landing in a field near Kilberry. The field he selected was rougher than he expected, with small stones hidden in the grass and on touchdown in the field one of the tyres burst. The pilot applied the brakes, but there was a slight downward slope towards the end of the field which resulted in a longer ground roll than he had expected. The aircraft weaved left and right and slid down the slope until it came to rest after hitting a wall at the end of the field.

ACCIDENT

Aircraft Type and Registration:	P and M Aviation Quik GT450, G-CEGJ
No & Type of Engines:	1 Rotax 912 ULS piston engine
Year of Manufacture:	2006
Date & Time (UTC):	30 May 2009 at 1330 hrs
Location:	Sywell Airfield, Northamptonshire
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - 2 (Minor) Passengers - N/A
Nature of Damage:	Minor damage to the trike, substantial damage to the wing
Commander's Licence:	Private Pilot's Licence
Commander's Age:	40 years
Commander's Flying Experience:	4,525 hours (of which 142 were on type) Last 90 days - 142 hours Last 28 days - 40 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During the landing roll the aircraft was affected by a gusty crosswind from the right and the pilot lost directional control. The aircraft veered to the left and the trike rolled over onto its right hand side.

History of the flight

The pilot-in-command was an instructor who was taking a student pilot for a trial lesson. The weather conditions were clear with a surface wind generally from 090º at 10 kt. The first part of the flight took place in the local flying area. Then, on returning to the airfield, the aircraft made an approach to grass Runway 05R, during which, the instructor later commented, there was light to moderate turbulence. The first part of the landing was uneventful but as the aircraft slowed during the landing roll he found that he was having difficulty maintaining control. The aircraft veered to the left and the trike rolled over onto its right hand side, sliding along the ground before stopping. The instructor suffered a dislocated shoulder and the student some minor injuries.

The Operator's Manual for the aircraft gives a crosswind limit of 10 kt for takeoff and landing, and 20 kt for taxiing. After the accident the pilot went to look at the recorded wind data which was available at the airfield. It showed that at around the time of the accident the average surface wind was from 090º at 10 kt, occasionally 14

kt, and that there had been an isolated gust of wind from the south-south-east at 18 kt.

ACCIDENT

Aircraft Type and Registration:	Rotorsport UK MT-03, G-CFAI
No & Type of Engines:	1 Rotax 912ULS piston engine
Year of Manufacture:	2008
Date & Time (UTC):	26 April 2009 at 1143 hrs
Location:	Popham Airfield, Hampshire
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Extensive damage to rotors, propeller and mast, and minor damage to the fuselage
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	48 years
Commander's Flying Experience:	83 hours (of which 20 were on type) Last 90 days - 12 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

On his first solo flight in a gyroplane, the student pilot made insufficient allowance for the runway slope and a crosswind. Immediately after landing, the gyroplane rolled onto its side and was extensively damaged. The pilot was uninjured.

History of the flight

The student, who held a National Private Pilot's Licence for aeroplanes, was learning to fly gyroplanes at Popham Airfield. He had flown the previous day with his instructor who considered that he was ready to fly his first solo. However, as an additional check he asked the student to fly once more with an independent instructor, prior to his first solo flight.

The next morning the weather at Popham was good, with the surface wind from 170˚ at 10 kt; runway 21, which has a left to right slope across it, was in use. The second instructor flew for 45 minutes with the student and agreed that he was ready to fly solo. He also gave the student a comprehensive brief on the differences that he would notice in the aircraft's handling characteristics when flying without an instructor in the back. The student was then authorised by his primary instructor and departed on his first solo gyroplane flight.

The student reported that the aircraft felt much lighter without an instructor and that the takeoff and circuit proceeded without incident. The student turned

onto finals and positioned the aircraft for a power-off approach at 70 mph with the wind from the left. Just before the round-out the student straightened the aircraft with his rudders, and commenced a flare, which lasted for about 100 yards. As the mainwheels touched down, the nose yawed sharply to the right. When the nosewheel touched the ground, the aircraft, which was almost stationary, yawed rapidly to the left and rolled onto its right side. The pilot, who was uninjured, switched off the magnetos and the master switch and vacated the cockpit. There was no fire.

The student considered that the accident was the result of insufficient into-wind control to counter the crosswind and the runway slope. He also recalled that a small amount of right drift had built up during the flare.

ACCIDENT

Aircraft Type and Registration:	Rotorsport UK MT-03, G-TATA
No & Type of Engines:	1 Rotax 914-UL piston engine
Year of Manufacture:	2008
Date & Time (UTC):	9 October 2008 at 1408 hrs
Location:	¼ nm east of Manchester (Barton) Airport
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Serious) Passengers - 1 (Serious)
Nature of Damage:	Substantial damage
Commander's Licence:	Private Pilot's Licence
Commander's Age:	52 years
Commander's Flying Experience:	316 hours (of which 78 were on type) Last 90 days - 82 hours Last 28 days - 21 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft had insufficient usable fuel for the intended flight. When a nose-down attitude for descent was selected on final approach, the engine was starved of fuel and stopped. The pilot realised that the aircraft could not reach the aerodrome and elected to carry out a forced landing in the nearest suitable field. After manoeuvring to avoid some houses he was left with insufficient airspeed to arrest the rate of descent. During the subsequent hard landing the pilot and his passenger suffered serious back injuries. The aircraft sustained significant damage but there was no fire.

Two Safety Recommendations are made.

History of the flight

The aircraft departed from Sleap Airfield, Shropshire at 1330 hrs with the pilot, a passenger and 14 litres of fuel on board. The weather was reported as being good and the pilot had planned on a 20 kt tailwind. He calculated that the aircraft had an endurance of one hour and the flight to City Airport Manchester (Barton) would take about 30 minutes. During the flight the pilot experienced some problems with his radio and had to extend the planned route further to the west to avoid a Military Air Traffic Zone (MATZ). To make up time, he increased speed. Ten minutes from his destination, the pilot noted that there was 'nearly 10 litres' of fuel remaining. The aircraft joined the circuit at City Airport Manchester (Barton) at 1405 hrs and during the downwind checks the passenger confirmed that the fuel

was 'OK'. The surface wind was from 200° at 10 kt, and Runway 27R was in use.

The pilot turned the aircraft onto final approach and selected a nose-down attitude that would give an approach speed of 70 mph. He noticed that the aircraft was descending below the normal approach profile and, when he attempted to increase power, realised that the engine had stopped. With the aircraft at a height of approximately 200 ft agl the pilot decelerated to the best glide speed, 45 mph, and turned the aircraft to the right to avoid some houses ahead. Having cleared the houses the pilot lowered the nose of the aircraft to increase speed. The aircraft descended rapidly from a height of about 50 ft agl and 'at the last second' the pilot flared the aircraft to cushion the touchdown. The aircraft landed heavily, the landing gear collapsed and G-TATA suffered significant damage to the airframe, enclosure, rotor head and rotors. There was no fire.

The pilot exited the aircraft unaided and assisted his passenger to vacate his seat; they then awaited the arrival of the emergency services. Both the pilot and passenger were later diagnosed with fractured vertebrae.

The pilot considered that the accident was caused by the engine being starved of fuel. The fuel supply is taken from the rear of the fuel tanks but during final approach to land the aircraft has a steep nose down attitude. The pilot was unaware of any limitations or information about unusable fuel.

Following the accident, approximately 6 ltr of fuel were found in the fuel tank.

Additional information

The Civil Aviation Authority (CAA) Gyroplane Type Approval Data Sheet for the MT-03, BG01 Issue 1 includes the limitations for operating the MT-03. It contains the information that, with a 70 ltr fuel tank, 6.8 ltr should be considered unusable.

On the same subject, the Pilot's Handbook for the MT-03 states:

> *'the fuel tanks retain an increasing amount of unusable fuel depending on the nose down*
>
> *(descent) angle. At a 5 degree descent there is approximately 1.1ltr of unusable fuel per tank.*
>
> *At 10 degrees nose down this increases to 3.4ltrs per tank. Be careful that you do not descend*
>
> *at a steep attitude with low fuel! The engine may stop from fuel starvation!'*

It also states that the fuel consumption of the aircraft is 12 ltr per hour at 60 mph increasing to 20 ltr per hour at 100 mph.

The CAA Safety Sense Leaflet 1, entitled *Good Airmanship Guide*, provides advice on fuel consumption. It states:

> *'Don't assume that you can achieve handbook fuel consumption. As a rule of thumb, due to service and wear, expect to use 20% more fuel than the 'book' figures'*

It also advises pilots to:

> *'understand the operations and limitations of the fuel system, gauges, unusable fuel etc'*

and

> *'Always plan to land by the time the tanks are down to the greater of ¼ tank or 45 minutes cruise*

flight, but don't rely solely on the gauges which may be unreliable.'

Comment

G-TATA was fitted with glass reinforced plastic (GRP) seats with industrial foam cushions which were not designed to absorb energy from a heavy landing. Research on the beneficial effects of using 'Dynafoam' carried out by the Royal Air Force Institute of Aviation Medicine (RAFIAM) in 1986, and, again, by the Defence Evaluation and Research Agency (DERA), Farnborough in August 1996, indicated that 'dense foam' cushions offer a good level of protection against vertical deceleration forces. The results suggested that flexible domestic foam cushions generally provided little attenuation of spinal loads and in some cases increased them. However, a cushion of highly damped seating foam, between 1 and 2 inches in thickness, was shown to reduce substantially the spinal loads induced by vertical deceleration. Such foam cushions did not seem to suffer significant deterioration in performance due to normal service use.

Civil Aviation Publication (CAP) 643, entitled the *British Civil Airworthiness Requirements (BCAR's), Section T Light Gyroplanes* contains the minimum requirements and constitutes the basis for the issue of Permits and Approvals in accordance with the Air Navigation Order. Gyroplanes which have been shown to comply with BCAR Section T will be eligible for a Permit to Fly. In Section T, Part 2, Acceptable Means of Compliance and Interpretative Material (AMC), AMC T 786 a) (Interpretative material) it states:

'The seat support structure should be designed, as far as is practicable, so as to prevent spinal or other serious injuries to the occupant in a minor crash landing in which the landing gear may have collapsed. It is recommended that rigid structural members are not located in a position likely to cause injury in such a crash landing. The CAA should be consulted concerning the use of energy absorbing material under the seat structure to reduce the impact loads being applied to the occupant's spine, as it has been found that the simplistic use of certain types of foam may result in unacceptable detrimental effects.'

In light of the above research, which demonstrated the beneficial properties of highly damped seating foam in reducing the risk of spinal injuries in minor crash landings, the following Safety Recommendations are made:

Safety Recommendation 2009-082

It is recommended that the Civil Aviation Authority amend the British Civil Airworthiness Requirements, Section T to make optimum use of energy absorbing materials in the construction of gyroplane seat structures, to reduce the possibility of spinal or other serious injuries to an occupant in a minor crash landing.

Safety Recommendation 2009-083

It is recommended that the Civil Aviation Authority promote the benefits of fitting energy absorbing seating foam to microlights and gyroplanes.

ACCIDENT

Aircraft Type and Registration:	Thruster T600N 450, G-CBIP
No & Type of Engines:	1 Jabiru Aircraft Pty 2200A piston engine
Year of Manufacture:	2002
Date & Time (UTC):	2 May 2009 at 0830 hrs
Location:	Popham Airfield, Hampshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	'A' frame and fibreglass fairing damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	3,161 hours (of which 830 were on type) Last 90 days - 40 hours Last 28 days - 22 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The pilot's attention was distracted by other traffic. During his approach he lost airspeed and made a heavy landing.

History of the flight

The pilot was flying from Deanland Airfield, Sussex, to Popham Airfield, Hampshire, to attend a microlight aircraft show. He joined the circuit pattern for grass Runway 21; the circuit was very busy. The pilot acknowledged that he became preoccupied with the presence of a lot of other aircraft and was keen to land to get out of the way. On final approach he reduced speed to maintain his separation from an aircraft ahead. The aircraft ahead landed and cleared the runway. The pilot said in his report that it was at this point that he considers he should have gone around, but that he continued to land. He attempted to flare in the normal way but because of his reduced airspeed a heavy landing resulted and the aircraft was damaged. Neither person on board was injured.

BULLETIN CORRECTION

AAIB File:	**EW/G2009/02/06**
Aircraft Type and Registration:	MW7, G-BREE
Date & Time (UTC):	21 February 2009 at 1120 hrs
Location:	Near Bishopstone, Swindon, Wiltshire
Information Source:	Aircraft Accident Report Form submitted by the pilot

AAIB Bulletin No 7/2009, page 25 refers

In the first sentence of the History of the Flight section of this report it was incorrectly stated that Lower Upham Farm Airfield was situated near Winchester - this should have read near **Swindon**.

AIRCRAFT ACCIDENT REPORT No 4/2009

This report was published on 24 August 2009 and is available on the AAIBWebsite www.aaib.gov.uk

REPORT ON THE SERIOUS INCIDENT TO AIRBUS A319-111, REGISTRATION G-EZAC NEAR NANTES, FRANCE ON 15 SEPTEMBER 2006

Registered Owner and Operator:	EasyJet Airline Company Limited
Aircraft Type and Model:	Airbus A319-111
Registration:	G-EZAC
Manufacturer's Serial Number	2691
Place of Incident:	Near Nantes, France at FL320
Date and Time:	15 September 2006 at 1052 hrs. (All times in this report are UTC, unless otherwise stated)

Synopsis

The serious incident occurred to an Airbus A319-111 aircraft operating a scheduled passenger flight between Alicante, Spain and Bristol, UK. The aircraft had experienced a fault affecting the No 1 (left) electrical generator on the previous flight and was dispatched on the incident flight with this generator selected off and the Auxiliary Power Unit generator supplying power to the left electrical network.

While in the cruise at Flight Level (FL) 320 in day Visual Meteorological Conditions (VMC), with the autopilot and autothrust systems engaged, a failure of the electrical system occurred which caused numerous aircraft systems to become degraded or inoperative. Some of the more significant effects were that the aircraft could only be flown manually, all the aircraft's radios became inoperative and the Captain's electronic flight instrument displays blanked.

Attempts by the flight crew to reconfigure the electrical system proved ineffective and the aircraft systems remained in a significantly degraded condition for the remainder of the flight, making operation of the aircraft considerably more difficult. The flight crew were unable to contact air traffic control for the rest of the flight. The aircraft landed uneventfully at Bristol, with the radios and several other systems still inoperative.

The incident was reported to the Air Accidents Investigation Branch (AAIB) by the operator at 1452 hrs local on 15 September 2006. An investigation was commenced shortly thereafter. France, as the state of aircraft manufacture and design, appointed an Accredited Representative from the BEA[1]. Assistance was also given by the aircraft manufacturer, Airbus.

Footnote

[1] Bureau d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation Civile, the French equivalent of the AAIB.

The reasons why the electrical system could not be reconfigured by the flight crew could not be established.

The investigation identified the following causal factors in this incident:

1. An intermittent fault in the No 1 Generator Control Unit, which caused the loss of the left electrical network

2. An aircraft electrical system design which required manual reconfiguration of the electrical feed to the AC Essential busbar in the event of de-energisation of the No 1 AC busbar, leading to the loss or degradation of multiple aircraft systems, until the electrical system is reconfigured

3. The inability of the flight crew to reconfigure the electrical system, for reasons which could not be established

4. Master Minimum Equipment List provisions which allowed dispatch with a main generator inoperative without consideration of any previous history of electrical system faults on the aircraft

5. Inadequate measures for identifying Generator Control Units repeatedly rejected from service due to repetition of the same intermittent fault

Preliminary information on the progress of the investigation was published in AAIB Special Bulletin S9/2006 on 13 December 2006 and four Safety Recommendations were made. Ten additional Safety Recommendations are made in this report.

Findings

1. The flight crew involved in the incident were licensed and qualified to operate the flight and were in compliance with the applicable flight time and duty time limitations.

2. The aircraft held a valid Certificate of Airworthiness and was maintained in accordance with an EASA-approved maintenance programme.

3. A reset of the No 1 generator control unit during maintenance carried out prior to despatch of the aircraft from London Stansted was technically incorrect but in accordance with common general practice.

4. The No 1 engine-driven generator tripped off-line on the flight sector between Stansted and Alicante and would not reset.

5. The aircraft was despatched from Alicante on the incident flight with the APU generator substituting for the No 1 generator, in accordance with the operator's MEL, which reflected the manufacturer's MMEL.

6. The MMEL did not require the reason for the No 1 generator trip to be investigated prior to dispatch.

7. The Operational Procedure in the MMEL did not contain the associated procedure for a check of the APU fuel pump.

8. While in the cruise at FL 320 in VMC, the aircraft suffered severe disruption of the electrical power system, causing multiple

aircraft systems either to cease operating or to become degraded, significantly increasing the flight crew's workload.

9. All means of radio communications became inoperative and remained so because they all relied on a single busbar which de-energised and was unavailable for the remainder of the flight.

10. The loss of all means of radio communications caused the crew considerable concern and delayed their continuation of the ECAM actions.

11. G-EZAC's transponder signal was lost for about 10 minutes, during which time the aircraft was not visible to Brest ATCC radar, leading to reduced separation with another aircraft.

12. The loss of power supply to the ATC 1 transponder rendered the TCAS inoperative until the ATC 2 transponder was selected some 10 minutes later.

13. Despite the pilots' attempts to follow the ECAM action messages, many of the affected aircraft systems were not recovered.

14. The flight crew reported that no captions were visible in the AC ESS FEED push-button selector switch and that operation of the switch failed to reconfigure the power supply with the result that power to the left electrical network could not be restored in flight. During subsequent testing on the ground, the system was found to operate normally.

15. The flight crew could not determine the settings of certain flight deck push-button selectors as the button position did not change significantly with selection and the caption lights were not visible.

16. The CVR ceased to operate following the loss of the AC ESS SHED busbar.

17. The FDR did not record any switching of the AC BUS 2-to-AC ESS contactor throughout the flight.

18. The potential effect of loss of all three VHF radios was categorised by the airworthiness authorities as 'Major' but, in the current security climate, was judged to be more severe.

19. An intermittent fault was found in an electronic component of the No 1 generator control unit (GCU 1) which probably caused the No 1 generator trip on the outbound flight.

20. Recurrence of the GCU 1 fault during the incident flight probably caused the de-energisation of AC BUS 1 and the consequent severe electrical system disruption.

21. The GCU 1 had repeatedly been rejected from service prior to the incident, possibly because of recurrence of the same intermittent fault, and returned to service without the fault having been found, but still present.

22. No effective system aimed at identifying units repeatedly rejected from service and not found to be faulty, or units suffering repetitive faults, was in place at the GCU manufacturer's repair organisation.

Causal factors

The investigation identified the following causal factors in this incident:

1. An intermittent fault in the No 1 Generator Control Unit, which caused the loss of the left electrical network

2. An aircraft electrical system design which required manual reconfiguration of the electrical feed to the AC Essential busbar in the event of de-energisation of the No 1 AC busbar, leading to the loss or degradation of multiple aircraft systems, until the electrical system is reconfigured

3. The inability of the flight crew to reconfigure the electrical system, for reasons which could not be established

4. Master Minimum Equipment List provisions which allowed dispatch with a main generator inoperative without consideration of any previous history of electrical system faults on the aircraft

5. Inadequate measures for identifying Generator Control Units repeatedly rejected from service due to repetition of the same intermittent fault

Safety Recommendations

Four Safety Recommendations were made in AAIB Special Bulletin S9/2006, published 13 December 2006, as follows:

Safety Recommendation 2006-142

It is recommended that Airbus should revise, for the A320 aircraft series, the fault monitoring logic of the Generator Control Unit to prevent the monitoring system from incorrectly interpreting a fault within the GCU as an external system fault.

Safety Recommendation 2006-143

It is recommended that Airbus should introduce, for Airbus A320-series aircraft, a modification to automatically transfer the electrical feed to the AC Essential busbar in the event of the loss of the No 1 Main AC busbar.

Safety Recommendation 2006-144

It is recommended that Airbus should advise all operators of A320 series aircraft with Radio Telephony (RTF) communications reliant upon a single busbar of the consequent possibility of loss of all RTF communications.

Safety Recommendation 2006-145

It is recommended that, for A320 series aircraft with digital Audio Management Units, Airbus should take modification action aimed at ensuring that electrical power supplies required for Radio Telephony communications have an improved level of segregation.

This report makes 10 further Safety Recommendations:

Safety Recommendation 2008-81

It is recommended that the EASA require modification of Airbus A320-series aircraft to provide automatic changeover of the electrical power feed to the AC Essential busbar in the event of de-energisation of the AC BUS 1 busbar.

Safety Recommendation 2008-83

It is recommended that the EASA and the FAA introduce certification requirements aimed at ensuring that flight deck control selectors are designed such that an immediate and unmistakable indication of the selected position is always provided to the flight crew.

Safety Recommendation 2008-84

It is recommended that the EASA requires the modification of affected Airbus A320-series aircraft so that the loss of a single busbar does not result in the complete loss of Radio Telephony communications.

Safety Recommendation 2008-85

It is recommended that the EASA and the FAA re-categorise the loss of all Radio Telephony communications for public transport aircraft as 'Hazardous'.

Safety Recommendation 2008-86

It is recommended that the EASA require Airbus to review the A320-series Master Minimum Equipment List (MMEL) for the validity of dispatch with an IDG inoperative, given that an intermittent fault in a Generator Control Unit can result in significant disruption of aircraft systems.

Safety Recommendation 2008-87

It is recommended that the EASA require Airbus to revise the A320-series Master Minimum Equipment List to include a requirement to check for correct operation of the manual AC ESS FEED changeover function prior to dispatch with a main generator inoperative.

Safety Recommendation 2008-88

It is recommended that Hamilton Sundstrand modifies its repair and overhaul procedures to ensure that a unit with an excessive service rejection rate or a recurrent fault is not repeatedly released back to service.

Safety Recommendation 2008-89

It is recommended that the EASA and the FAA require that approved component repair organisations have procedures in place to identify units with an excessive service rejection rate or recurrent faults.

Safety Recommendation 2008-90

It is recommended that the EASA require improvements to the fault monitoring logic of the type of Generator Control Unit (GCU) used on A320-series aircraft with the aim of preventing the monitoring system from incorrectly interpreting a fault within the GCU as an external system fault.

Safety Recommendation 2009-063

It is recommended that the EASA extend the guidance material provided for the EASA 25-1309 certification standard for failure effect analyses, to include consideration of the effects of delayed or non-achieved crew actions, in addition to crew errors.

FORMAL AIRCRAFT ACCIDENT REPORTS ISSUED BY THE AIR ACCIDENTS INVESTIGATION BRANCH

2008

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

Published February 2008.

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

Published February 2008.

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

Published April 2008.

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

Published August 2008.

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

Published October 2008.

2009

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

Published January 2009.

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

Published April 2009.

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

Published May 2009.

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

Published August 2009.

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