AAIB
Air Accidents Investigation Branch

AAIB Bulletin 3/2014

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MISCELLANEOUS

ADDENDA and CORRECTIONS

None

(ALL TIMES IN THIS BULLETIN ARE UTC)

AAIB Special Bulletins / Interim Reports

AAIB Special Bulletins and Interim Reports

This section contains Special Bulletins and Interim Reports that have been published since the last AAIB monthly bulletin.

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AAIB Bulletin S1/2014 *SPECIAL*

ACCIDENT

Aircraft Type and Registration:	AS332 L2 Super Puma, G-WNSB
No & Type of Engines:	2 Turbomeca Makila 1A2 turboshaft engines
Year of Manufacture:	2002 (Serial no: 2582)
Location:	Approximately 1.5 nm west of Sumburgh Airport, Shetland Islands
Date & Time (UTC):	23 August 2013 at 1717 hrs
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 2 Passengers - 16
Injuries:	Crew - 1 (Serious) Passengers - 4 (Fatal) 3 (Serious)
Nature of Damage:	Helicopter destroyed
Commander's Licence:	Airline Transport Pilot's Licence (Helicopters)
Commander's Age:	51 years
Commander's Flying Experience:	10,504 hours (of which 1,515 were on type)
Information Source:	AAIB Field Investigation

Introduction

At 1717 hrs UTC on 23 August 2013, an AS332 L2 Super Puma helicopter, with 18 persons on board, crashed into the sea whilst on approach to Sumburgh Airport in the Shetland Islands. Four of the passengers did not survive.

AAIB Special Bulletins S6/2013 and S7/2013 were published to provide initial information on the circumstances of the accident. This Special Bulletin is published to highlight a safety concern relating to pre-flight safety briefings, given to passengers, on the functionality of emergency equipment provided to them for UK North Sea offshore helicopter flights.

Emergency breathing systems

Research[1] has identified that in about 60% of all helicopter water impacts, the helicopter inverted or sank, immediately or after a short delay. A capsize often occurred before evacuation of the occupants could be completed. As a result, Emergency Breathing Systems (EBS) were developed to allow helicopter occupants to breathe underwater for a short period of time. The EBS can bridge the gap between the maximum breath-hold time of an occupant and the time required to complete an underwater escape, thereby increasing the chances of survival. EBS were introduced in UK North Sea offshore helicopter operations as a voluntary industry standard; at present there is no regulatory requirement for such equipment.

Three types of EBS are currently in use:

- Compressed air systems, which are similar in design to a small 'Self Contained Underwater Breathing Apparatus' (SCUBA) cylinder, with mouthpiece.
- Rebreather systems, which allow the user to rebreathe the air contained in their lungs by expelling a breath into a bag prior to entering the water. The wearer can then breathe this air for a limited period.
- Hybrid systems, consisting of a rebreather system with a cylinder of compressed gas that provides a small initial inflation charge of air into the bag, that can be supplemented with the user's breath. Release of air from the cylinder to inflate the rebreather bag is automatically triggered when the system is submerged in water. This allows the user to breathe even if they have not taken a breath prior to submersion.

One example of a hybrid system is the Lifejacket Airpocket Plus (LAP) combined lifejacket and hybrid rebreather. This particular model of EBS has been widely adopted for use by operators of UK North Sea offshore helicopter flights and is routinely provided to passengers.

Passenger briefing material

Offshore helicopter passengers must complete initial and recurrent training which reportedly details the operation of the EBS and that it can be used without an initial input breath. Audio/visual DVD-based pre-flight safety briefings are also given prior to every flight. The briefings cover the donning and use of the various items of survival equipment, including the EBS, where applicable.

The pre-flight safety briefing material has been reviewed by the AAIB as part of its ongoing investigation. This has identified that the briefing material does not include fully representative information about the EBS. It does not highlight that the EBS provided may be a hybrid rebreather containing an air supply which is discharged automatically into the rebreather bag, or that the system can be used even if the wearer has not taken a breath before becoming submerged.

Footnote

1 Rice and Greer, 1973; Hayes, 1991; Brooks, 1989; Clifford, 1996.

Incomplete information in the pre-flight safety briefing material may give passengers the false impression that hybrid rebreathers such as the widely used LAP system are only of benefit if the user has taken a breath prior to becoming submerged. Knowledge that hybrid rebreathers contain their own supply of air may therefore influence a passenger's decision on whether or not to use the EBS in an emergency situation.

Safety action

The AAIB has approached the main helicopter operators flying in support of the UK oil and gas industry, whose passengers are equipped with a hybrid EBS. Whilst operation of the hybrid EBS should be covered in initial and recurrent training, it is not explicitly described in the pre-flight safety briefing. The operators have undertaken to amend their pre-flight briefing material to include information that the hybrid system contains its own air supply which is discharged automatically, making the system usable even if the wearer has not taken a breath before becoming submerged.

Published 23 January 2014

Summaries of Aircraft Accident Reports

This section contains summaries of
Aircraft Accident ('Formal') Reports
published since the last AAIB monthly bulletin.

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

Aircraft Accident Report No: 1/2014

This report was published on 12 February 2014 and is available in full on the AAIB Website: www.aaib.gov.uk

Report on the accident to
Airbus A330-343, G-VSXY
London Gatwick Airport
16 April 2012

Registered Owner and Operator:	Virgin Atlantic Airways
Aircraft Type:	Airbus A330-343
Nationality:	British
Registration:	G-VSXY
Place of Accident:	London Gatwick Airport
Date and Time:	16 April 2012 at 1131 hrs

Synopsis

The Air Accidents Investigation Branch (AAIB) was notified of this occurrence by Virgin Atlantic Airways shortly after it happened and the investigation was started the same day.

The occurrence was initially classified by the AAIB as a Serious Incident. However, when it became clear that two passengers had incurred injuries defined as Serious, the occurrence was reclassified as an Accident, in accordance with ICAO Annex 13 and the United Kingdom's 'Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 1996'. This classification as an Accident does not reflect the state of the aircraft, which sustained only very minor damage, during the evacuation.

In accordance with established international arrangements, the Bureau d'Enquêtes et d'Analyses (BEA) in France, representing the State of Design and Manufacture of the aircraft, appointed an Accredited Representative and was supported by a team which included advisors from Airbus, the aircraft manufacturer, and Siemens, systems manufacturer. The aircraft operator has co-operated with the investigation and provided expertise as required. The Civil Aviation Authority (CAA) and the European Aviation Safety Agency (EASA) have been kept informed of developments.

The aircraft was operating a flight from London Gatwick Airport to McCoy International Airport in Orlando, USA with three flight crew, 10 cabin crew and 304 passengers on board including three infants. Early in the flight the crew received a series of smoke warnings from the aft cargo hold and the commander elected to return to London Gatwick. The crew carried out the appropriate emergency drills, including the discharge of the fire extinguishers in the aft cargo hold, but the smoke warnings continued. The aircraft landed safely, the crew brought it to a halt on the runway and endeavoured to establish the extent of any fire. This produced conflicting evidence and, with smoke warnings continuing, the commander ordered an emergency evacuation.

The passengers all left the aircraft within 90 seconds but two injuries, classed as 'Serious', were incurred. Subsequent examination of the aircraft and its systems showed that the smoke warnings had been spurious.

The investigation identified that injuries were sustained during the evacuation of the aircraft. The evacuation was initiated based on the commander's assessment of the available sources of information, including the repetitive and intermittent nature of the aft cargo smoke warnings.

The investigation identified the following causal factor for the intermittent cargo smoke warnings:

(i) A latent fault on the T1 thermistor channel of smoke detector 10WH, in combination with a CAN Bus fault and possible high levels of humidity in the cargo compartment due to the carriage of perishable goods, provided circumstances sufficient to generate multiple spurious aft cargo compartment smoke warnings.

The investigation identified the following contributory factors for the intermittent cargo smoke warnings:

(i) The thermal channel fault in 10WH was not detected prior to the event by the internal smoke detector temperature monitoring.

(ii) The proximity of the fire extinguisher nozzles to the smoke detectors.

Findings

Operational aspects

1. The crew experienced a SMOKE AFT/BULK CARGO SMOKE Master Warning 15 minutes into the flight which repeated intermittently until just before the evacuation.

2. The crew carried out the appropriate ECAM actions in relation to the Master Warning which included discharging fire extinguishing agent into the aft cargo hold.

3. The message that there was smoke in the cargo hold was misunderstood by Brest ATC and corrupted during onward transmission leading to the RFFS at London Gatwick airport positioning fire vehicles at the wrong end of the aircraft.

4. Cabin crew reported to the incorrect location on the aircraft for their brief by the FSM.

5. Once the aircraft had come to a halt on the runway, the commander instructed the cabin crew to stand down rather than stand by.

6. The escape slide at Door 4R did not fully inflate which rendered the exit unusable.

7. The evacuation was completed in 109 seconds, with most passengers out within one minute.

8. There was confusion between the incident commander on the ground and the ATC Watch Manager, as to the correct status of the incident. Consequently, there was a delay in passing a message to relevant emergency and support agencies that there had been an evacuation on the runway.

9. The RFFS found no evidence of smoke or heat spots in the aircraft.

Technical aspects - general

10. The aircraft was certified, equipped and maintained in accordance with the applicable regulations.

11. There was no evidence of fire, smoke or heat damage in the aft cargo compartment.

12. The aircraft was carrying a cargo largely comprised of perishable goods.

13. Fifteen separate aft cargo smoke warnings were generated during the flight. They were determined to be spurious warnings.

Technical aspects - smoke detection system

14. Redundancy in the SDS was lost at electrical power-up during the incident sector due to a CAN Bus A wiring fault, resulting in the SDS operating in single detection mode.

15. Redundancy in the SDS was restored at the subsequent electrical power-up.

16. Inspection of the CAN Bus A wiring did not reveal any wiring anomalies.

17. The root cause for the CAN Bus A fault has not been determined.

18. The aircraft manufacturer identified an unexpectedly high rate of similar CAN Bus faults across the A330 global fleet. These faults are under investigation.

Technical aspects - smoke detectors

19. The initial smoke warnings were initiated by smoke detector 10WH.

20. Smoke detector 10WH generated 12 of the smoke warnings. 10WH NVM was not available for the incident sector, however it is likely that these were all thermal alarms.

21. Three additional optical alarms were generated by smoke detectors 6WH and 8WH, as a result of the fire extinguishing agent discharge.

22. Release of the halon fire extinguishing agent resulted in damage to the humidity sensors of the 7WH and 8WH smoke detectors and resulted in them becoming DEGRADED.

23. Release of the halon fire extinguishing agent resulted in smoke detector 6WH temporarily becoming DEGRADED, due to a localised temperature drop below the operating range of the temperature sensors.

24. The insulation resistance of the 9WH and 10WH T1 thermistors was compromised by damage to the insulating envelope, which exposed the active area of the thermistor to the external environment.

25. The damage to the insulating envelope degraded the electrical characteristics of the 9WH and 10WH T1 thermistors, such that the resistance response, and consequently the measured temperature value for a given temperature, was inaccurate.

26. The investigation was not able to determine the cause of the damage to the Kapton film of the 9WH and 10WH T1 thermistors.

27. The investigation was not able to reproduce a reduction in thermistor electrical performance, even on thermistors with intentionally induced damage.

28. Acceptance Test Procedures did not detect the faults on the 9WH and 10WH T1 thermistors.

29. The smoke detector internal temperature monitoring did not detect the faults on the 9WH and 10WH T1 thermistors.

30. The T1 thermistors from 9WH and 10WH were part of a batch manufactured in 2008.

31. One other thermistor examined in the course of the investigation exhibited similar damage to that on the 9WH and 10WH T1 thermistors, and a similar deterioration of the thermistor's electrical performance. It had been subject to chemical spray during smoke detector qualification testing.

32. Bubbles were present in the insulating envelope of the T1 thermistors from 9WH and 10WH, and other thermistors examined in the course of the investigation.

33. Thermistors removed from in-service smoke detectors contained a greater number and larger size bubbles than new thermistors from stock.

34. The presence of the bubbles did not, in isolation, have any impact on the electrical characteristics of the thermistors, when tested.

35. A previously identified issue with silicon coating at the junction of the thermistors and the measurement board could not be ruled out as a contributory factor.

Technical aspects - escape slide-raft findings

36. The R4 slide-raft did not fully inflate and consequently the R4 exit was not available during the emergency evacuation.

37. The secondary restraint on the R4 slide-raft was unbroken.

38. The partial inflation of the R4 slide-raft most likely resulted from a packing fold, which caused early release of the primary restraint and non-release of the secondary restraint.

39. The R4 slide-raft was manufactured and packed before a change to packing instructions was implemented, to address previous similar partial inflations.

Safety Recommendations

The following Safety Recommendations were made at the time of publication:

Safety Recommendation 2014-005

It is recommended that the European Aviation Safety Agency amend AMC1 CAT.OP.MPA.170, 'Passenger briefing', to ensure briefings emphasise the importance of leaving hand baggage behind in an evacuation.

Safety Recommendation 2014-006

It is recommended that the European Aviation Safety Agency develops recommendations on the content of visual aids such as safety briefing cards or safety videos to include information on how passengers, including those with young children, should use the escape devices.

Safety Recommendation 2014-007

It is recommended that Airbus determine the causes of erroneous Controller Area Network (CAN) Bus faults and implement solutions to eliminate such faults.

Safety Recommendation 2014-008

It is recommended that Airbus amend the dispatch criteria for aircraft with single Controller Area Network (CAN) Bus faults, until such time as the causes of erroneous CAN Bus faults have been identified and addressed.

Safety Recommendation 2014-009

It is recommended that Siemens amend the Component Maintenance Manual procedures for multi-criteria smoke detectors returned for overhaul, or issue a service letter, to improve fault detection of thermal channel hardware failures which can lead to inaccurate temperature measurement.

Safety Recommendation 2014-010

It is recommended that Airbus introduce a maintenance requirement so that, following an activation of the Lower Deck Cargo Compartment (LDCC) fire extinguishing system in an aircraft equipped with multi-criteria smoke detectors, all smoke detectors in the affected cargo compartment are removed for examination and overhaul.

Safety Recommendation 2014-01

It is recommended that the European Aviation Safety Agency review the certification requirements for the location of fire extinguisher nozzles in relation to the smoke detectors, on aircraft equipped with multi-criteria smoke detectors, in order to minimise the adverse effects associated with activation of the fire extinguishing system.

AAIB Field Investigation reports

ACCIDENT

Aircraft Type and Registration:	Piper PA-38-112 Tomahawk, G-BGBN
No & Type of Engines:	1 Lycoming O-235-L2C piston engine
Year of Manufacture:	1978 (Serial no: 38-78A0511)
Date & Time (UTC):	5 June 2013 at 1239 hrs
Location:	Cranfield Aerodrome, Bedfordshire
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - 2 (Serious) Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	21 years
Commander's Flying Experience:	390 hours (of which 145 hours were on type) Last 90 days - 77 hours Last 28 days - 15 hours
Information Source:	AAIB Field Investigation

Synopsis

During the climb following a touch-and-go landing, the engine began to run roughly. A turn was commenced during which the engine failed and control of the aircraft was lost. The aircraft crashed within the aerodrome boundary.

History of the flight

G-BGBN took off from Runway 03 at the aerodrome at 1232 hrs for a circuit training flight with the instructor sitting in the right seat and the student in the left. The weather reported by ATC at 1220 hrs was: wind from 040º at 8 kt, 20 km visibility, broken cloud at 1,400 ft aal, a temperature of 13ºC, a dew point of 10ºC and a QNH of 1022 hPa. The aircraft flew a right hand circuit and an approach to touch-and-go which seemed to observers to be uneventful.

G-BGBN was seen to touch down near the touchdown zone markers, power was applied and it lifted off near the intersection of the runway and taxiway C (see Figure 1). Approximately two seconds later, the instructor transmitted "GOLF BRAVO NOVEMBER ROUGH RUNNING ENGINE TURNING AROUND FOR RUNWAY 21". The aircraft was in a gentle right turn as it passed the intersection of the runway and taxiway B but it then reversed its turn abruptly to the left. As the aircraft passed the upwind end of the runway in the left turn, the nose began to drop. The aircraft descended and crashed within the aerodrome boundary 100 m north-west of the threshold of Runway 21.

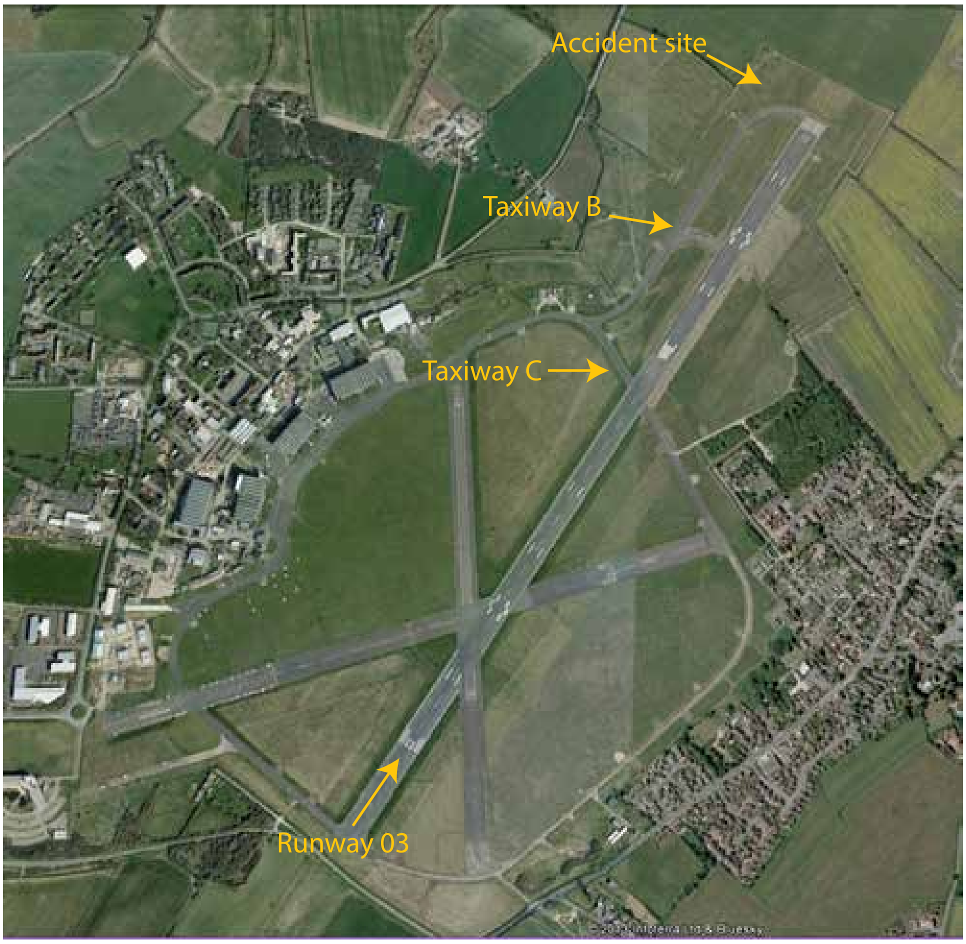

Figure 1
Cranfield Aerodrome

Witness information

Approximately one to two seconds after he heard the instructor mention rough running, the controller in the ATC tower sounded the crash alarm because it appeared to him that the aircraft might crash. He estimated that the aircraft climbed to a maximum of 50 to 75 ft agl which it had achieved by the time it was in its gentle right turn. It then made a "very sharp" reversal and began a turn to the left with an angle of bank high enough for him to "see the aircraft in plan form". Almost as soon as the aircraft had established itself in the left turn, the nose began to drop. Another witness estimated that the aircraft climbed to a maximum of approximately 200 ft.

Information from the instructor

The instructor informed the AAIB that he did not recall flying a circuit and a touch-and-go landing before the accident; his recollection was that the accident occurred immediately after takeoff. He also stated that it was normal practice for him to select the carburettor heat control to HOT when reducing power on the base leg.

Approximately two hours before the accident flight, the instructor flew a circuit in G-BGBN because he had not flown in approximately 10 days and stated that, while on a short final to land, the engine began to run roughly. After landing, he carried out a magneto check before shutting down the engine. Moving the magneto selector from BOTH to a single magneto (he could not remember whether it was the left or right) led to a drop of approximately 500 rpm while selecting the other led to approximately 15 seconds of rough running before the engine stopped. The instructor stated that he obtained the same results when he restarted the engine and repeated the magneto check and so, after leaving the aircraft, he asked the owner of the flying school to investigate the fault.

The instructor stated that, just before walking with the student to G-BGBN for the circuit training flight, he was told by the owner of the school that the problem with the magnetos had been rectified and that the aircraft was "all fine". The instructor reported that the engine started normally and that the pre-takeoff power checks, including the magneto check, were normal.

The instructor recalled that after takeoff the aircraft drifted to the right because the student, who was handling the aircraft, over-compensated for the crosswind. The engine began to run roughly very soon after the aircraft left the ground and the instructor took control from the student. He stated that he "considered turning to land on Runway 21 and made a radio call to that effect because it was a "partial engine failure and the aircraft was still able to climb". He said that, had the aircraft been unable to climb, he would not have considered returning to the runway. Shortly thereafter, it became apparent that the aircraft was unable to climb and the nature of the rough running made him think that the engine might stop. A sports club was situated directly ahead of the aircraft on the near side of a road that ran left to right across his path. There were open fields to the left of the club on both the near and far sides of the road but the instructor did not consider the aircraft to be high enough to land beyond the road. He turned left away from the sports club and towards a clear area within the aerodrome boundary where he "considered that there would be sufficient space for the aircraft to land". He stated that, during the turn, the engine stopped completely and the stall warning operated immediately afterwards.

Aircraft information

The PA-38 Tomahawk is a single-engine, two-seat aircraft. The fuel is contained in two fuel tanks located in the leading edge of each wing and there is a combined useable capacity of 114 ltr. A strainer is fitted to the outlet of each fuel tank and the fuel pipes are routed down each side of the fuselage to the fuel selector valve located between the rudder pedals. The fuel selector valve has three positions: OFF, LEFT and RIGHT. Downstream from the selector valve, the fuel passes through an electrical fuel pump, gascolator and mechanical fuel pump before entering the carburettor. G-BGBN was equipped with a Lycoming 0-235-L2C piston engine with two magnetos and a 10-5199R Marvel-Schebler carburettor.

The wing was fitted with flow strips on the leading edges that were introduced under FAA Airworthiness Directive 83-14-08 in 1983 to improve the stall characteristics of the aircraft.

G-BGBN was equipped with four-point seat harnesses and one set of primary flying instruments positioned in front of the left seat position. The magneto switch was located beneath the left control yoke. Figure 2 shows the cockpit layout in a PA-38 similar to G-BGBN.

Figure 2

Location of primary flying instruments in a PA-38 similar to G-BGBN

Accident site

The accident occurred within the perimeter of Cranfield Aerodrome. G-BGBN impacted the ground approximately 100 m on a bearing of 320º from the threshold of Runway 21 in an area of firm, flat ground. The ground marks indicate that the left wing struck the ground first when the aircraft was on a heading of 180º. From the structural damage it is estimated that the aircraft was pitched 50º nose-down. The aircraft finally came to rest in a fairly level attitude on a heading of 090º, approximately 12 m from the initial impact point.

The left wing was destroyed and the nose section of the aircraft, including the cockpit and engine, were badly damaged. The right wing was mostly intact, with compression damage to the leading edge of the outer 2.6 m of the wing. The structure towards the rear of the fuselage had buckled and torn, leaving the tail section, which was upside down, attached by a small section of the skin. The seat harnesses and attachment points remained intact and connected to the airframe.

The fuel selector valve was found in the RIGHT tank position. The left fuel tank, which with the leading edge had detached from the wing, was empty. A small quantity of clean fuel was recovered from the right fuel tank which was intact. The fuel pipes from the left and right fuel tanks had been cut and crimped by the fire services where they were routed through the forward sidewalls of the cockpit. All the fuel pipes and fuel components forward of the firewall had been severely damaged. The aerodrome fire service reported that fuel continued to run out of a fuel pipe near the front left side of the aircraft for 20 minutes after the accident. The following marking was painted on the upper wing surface next to each fuel tank filler cap '*AVGAS Fuel 100LL Aviation Grade MIN 13.4 IMP GALLS*'.

The flying controls were examined prior to the aircraft being removed from the accident site and were assessed as being intact and serviceable prior to the accident with no evidence of a control restriction. The flaps were set at 15º down. The instrument panel and engine controls had been badly damaged and had been disturbed by the emergency services during the rescue operation. It was not therefore possible to determine with any confidence the position of the throttle, carburettor heater control or electrical fuel pump. The engine primer was found in the closed and locked position and the key in the magneto switch was found in the left magneto position. The key was undamaged and it is unlikely that it would have moved during the accident sequence. However, it was not possible to eliminate the possibility that the key had been moved after the accident in a belief that it would isolate the electrical power.

The carburettor, mechanical and electrical fuel pump had been ripped from the engine. All the spark plugs and their harness were correctly fitted. Scratches and damage to the propeller, and the ground marks made by the propeller blades during the impact, were consistent with the propeller producing very little or no power.

Detailed examination

Aircraft

A detailed examination of the aircraft and fuel system was carried out at the AAIB facility at Farnborough. The examination included a thorough examination of the fuel system using a video probe inserted into the fuel tanks and fuel lines. Both fuel tanks were clean and the filters at the tank outlets were clear of any debris. There was no blockage in any of the fuel lines and the fuel selector valve was fully open in a position consistent with the right tank having been selected. The electrical fuel pump operated when electrical power was applied and the internal parts were found to be in a serviceable condition. The flap for the carburettor heat was in the open (cold) position and the air intake filter was clean.

Engine

The engine was partially stripped and a number of components were tested by an independent engine overhaul facility under the supervision of the AAIB.

The engine turned freely, all the valves operated normally and there was no evidence of the engine having seized. Both magnetos were tested and found to be serviceable; the spark plugs were examined and tested in a pressurised test chamber and operated satisfactorily. The carburettor was dismantled and no blockages were found in either the idle or main fuel jets. The floats were intact and moved freely; the mixture control at the time of the accident was assessed as being in the fully-rich position. While it was not possible to test the carburettor, visually there was nothing to suggest that it would not have operated normally. The mechanical fuel pump and all the internal seals, valves and operating levers were also assessed as being serviceable. Due to the damage that occurred during the impact to the fuel priming line, the spark plug harness and the induction pipes, it was not possible to determine if a fault in any of these parts might have caused the rough running and loss of power.

Aviation fuel

Mogas

Mogas (Motor Gasoline) is not intended for aviation use and in comparison with Avgas (Aviation Gasoline) has different physical properties and quality requirements. CAA Safety Sense leaflet 4 '*Use of Motor Gasoline (MOGAS) in Aircraft*' provides advice on the use of Mogas. This includes the additional quality checks to be carried out on the fuel, additional maintenance requirements and entries that have to be made in the aircraft and engine log books.

Factors to consider when using Mogas

Characteristics of Mogas such as the stability of fuel in storage are not as good as for Avgas. Consequently, over time Mogas may suffer a loss of octane rating and form gum deposits that can cause intake and exhaust valves, and fuel metering valves to stick. The additives in the fuels are also chemically different and those in Mogas can cause corrosion and increase the amount of water in the fuel.

Lead additives are normally used to control the rate of combustion but in unleaded fuels these have been replaced with other components, such as aromatics. If the engine is not designed to operate on unleaded fuel then the different speed of combustion can result in hotter exhaust gasses that can damage the crown of the pistons, the exhaust valves and their seats. Aromatics can also damage seals in the aircraft and engine fuel systems.

A further significant difference is that in comparison to Avgas, Mogas has a relatively high vapour pressure[1] and is therefore much more susceptible to causing vapour lock in aircraft fuel systems, particularly at elevated temperatures and higher altitudes. So, although an engine may be able to operate on Mogas, other aircraft components have to be considered because of the potential for vapour lock within the fuel system, as well as potential adverse effects on seals and components. Therefore, approval to operate on Mogas is required for both the aircraft and engine.

Most Mogas contains alcohol (ethanol) which can adversely affect seals and elastomers; it also affects the fuel's vapour pressure leading to an increased probability of vapour lock. The ethanol also absorbs water which increases the likelihood of carburettor icing. Nevertheless, Civil Air Publication (CAP) 747, *Mandatory Requirements for Airworthiness,* permits the use of ethanol in Mogas used in microlight aircraft.

Fuels approved by the engine manufacturer

Lycoming Service Instruction number 1070S, dated 24 April 2013, which lists the fuels that can be used from that date in the Lycoming 0-235-L engine, authorises the use of Avgas 100LL and Avgas UL 91. The Service Instruction also authorises the engine to operate on unleaded Mogas provided it meets the specifications in ASTM D4814 and EN228. However, Lycoming do not permit fuel containing ethanol to be used in their engines.

Footnote

1 Vapour pressure can be thought of as the ease by which a liquid turns into a gas.

Fuels approved by the CAA

CAP 747 specifies the fuel which can be used in aircraft and their engines. While the Generic Concessions in CAP 747 permit the use of unleaded Mogas obtained from garage forecourts to be used in the PA-38 and Lycoming 0-235-L engine under certain circumstances, the concession is not applicable to aircraft such as G-BGBN that are used for aerial work such as flight training. With the exception of microlight aircraft, the CAA generally prohibits the use of ethanol in fuel used by aircraft and requires that Mogas is tested for ethanol before it is used.

Testing of fuel

The following fuel samples were tested as part of the investigation:

– A sample taken from the right fuel tank of G-BGBN.

– A sample taken from the refuelling facility at Cranfield on 3 June 2013. The 3 June 2013 was the last time that the refuelling company's documentation recorded that G-BGBN was refuelled at Cranfield prior to the accident.

– Samples taken from two other PA-38 aircraft owned by the flying school and based at Hinton-in-the-Hedges.

– A sample taken from the fuel pump at Hinton-in-the-Hedges on 7 June 2013.

– A sample of unleaded Mogas obtained from a garage forecourt local to the laboratory where the testing was carried out.

The tests established that the fuel samples taken from the bulk supplies at Cranfield on 3 June 2013 and Hinton-in-the-Hedges on 7 June 2013 were blue in colour and consistent with the specification for Avgas 100LL. Ethanol could not be detected in either sample.

The sample taken from G-BGBN was very similar to the sample taken from the fuel installation at Cranfield on 3 June 2013 and was assessed to be Avgas 100LL. However a trace quantity of ethanol was detected in the fuel sample.

Of the two aircraft sampled at Hinton-in the-Hedges, one contained fuel which was virtually identical to the sample taken from the fuel pump at Hinton-in-the-Hedges and was assessed to be Avgas100LL. The sample taken from the second aircraft was green in colour, contained ethanol and had a lead content that was not considered to be consistent with the specification for Avgas 100LL. The laboratory concluded that this fuel sample had features that were consistent with it being a mixture of Avgas 100LL and unleaded forecourt Mogas. The investigation was unable to establish the source of this fuel.

Maintenance of flying school aircraft

Maintenance of aircraft operated in a flying school environment can be performed either by contracted individual Part 66 licenced engineers, or by third party Approved Maintenance Organisations. Pilot/owner maintenance is not permissible on aircraft undertaking aerial work such as flying training.

Hinton Pilot Flying Training is not approved as a maintenance or Continuous Airworthiness Management Organisation (CAMO). Instead it contracted the annual airworthiness review in support of issuing an Airworthiness Review Certificate (ARC) to a Part M, Sub-part G, CAMO. In order to issue an ARC, a CAMO needs to understand what maintenance work has been carried out on an aircraft.

Aircraft documentation

Under EASA Part M, Sub-part C, a technical log is required only for Commercial Air Transport operations. However, to ensure the continuous airworthiness of its aircraft, the flying school required a system to manage the recording of aircraft and engine hours, cycles and defects. The system that the flying school had in place was based on the aircraft technical log, and the engine and airframe logbooks.

Twenty Aircraft Daily Technical Logs dating back to 19 April 2013 were reviewed during the investigation. The logs were sequentially numbered and the hours to the next maintenance check were consistent with the hours recorded against each flight: at the time of the accident the logs showed that 35:20 hours remained to the next check.

It was noted that on a number of occasions the 'A' check had not been signed as having been carried out and there was no record of the amount of oil in the engine. A modified form was used from 26 May 2013 that included an entry for the hours of the next check and a column for the fuel quantity with an annotation that it '*must be completed before flight'*. In the subsequent 22 flights since the introduction of the form the fuel quantity was only recorded once. The hours that the next check was due was either not completed or completed incorrectly.

On the day of the accident, the 'A' check was signed as having been carried out by the instructor and there was one flight recorded in the Technical Log which had a '*Take off'* time of 1150 hrs and a '*Land'* time of 1210 hrs. A check of the aerodrome movements log showed that these times were British Summer Time and should have read 1050 and 1110 hrs. The column against this flight titled '*Nil Defects Initials'* was annotated NIL. The section at the bottom of the Technical Log used to report defects had no entries. There was no record in the aircraft technical log of the accident flight which departed at 1232 hrs.

While establishing how ethanol might have been introduced into the fuel, the investigation tracked the movement of G-BGBN during the month prior to the accident. While the investigation was unable to find any documentation to show that Mogas had been used in the aircraft, from the movement logs at Sywell Aerodrome it was established that on 3 May 2013 the aircraft flew one flight and on the 25 May 2013 five flights at Sywell Aerodrome. The movements log at Cranfield Aerodrome also recorded one flight on 3 May 2013 and two flights on 25 May 2013. None of these flights were recorded in the Aircraft Technical Logs or the aircraft and engine logbooks presented to the AAIB.

Fuel used in flying school aircraft

The flying school advised the AAIB that Mogas had not been used in G-BGBN and provided recent fuel receipts showing that it had been refuelled with Avgas 100LL; there was no record in the aircraft documentation that Mogas had been used.

The movements log at Sywell Aerodrome shows that G-BGBN operated from this aerodrome on a number of occasions in the month preceding the accident flight. The aerodrome has the facilities to dispense three types of fuel: Jet A1, Avgas 100LL and unleaded Mogas. The unleaded Mogas is the same fuel that is supplied to garage forecourts and can contain ethanol. The fuel pumps are normally manned during the day when the flying school account would be debited. However, outside of the normal working day for the aerodrome refuelling personnel, fuel can still be obtained from the pump by inserting a debit or credit card into a card reader on the pump. CAP 747 allows microlight owners to use Mogas containing alcohol and a notice displayed on the Mogas dispensing pump at Sywell Aerodrome stated:

> *'Unleaded MOGAS BS EN228 1995, BS707*
> *For use by Rotax microlight engines only in accordance with Airworthiness Notice 98B'*

Sywell Aerodrome authorities advised the AAIB that on two occasions during April 2013, instructors from the flying school attempted to refuel a PA-38 with Mogas against the advice of the refuelling personnel that the fuel was not authorised for use in the aircraft. As a result of these concerns, the aerodrome managing director contacted the owner of the flying school who told him they would not use the fuel again. The PA-38 concerned was not the accident aircraft but was the aircraft from which a fuel sample – later found to contain ethanol – was taken at Hinton-in-the-Hedges on the 7 June 2013. The fuel records at Sywell Aerodrome show that G-BGBN was refuelled with Avgas 100LL on 3 May 2013 (52 ltr) and on 25 May 2013 (20 ltr).

A document from the flying club titled 'STAFF UPDATE NOTES MAY 2013' included the following statement:

> *'FUEL - The aircraft are certified for UL91 or AVGAS 100 or AVGAS 100LL. The PA38s ARE NOT CERTIFIED FOR THE USE OF MOGAS (which is different from UL91)…'*

Recent fuel usage

G-BGBN operated from Cranfield between 26 May 2013 and 5 June 2013 when the accident occurred. During this period it had flown 22 flights, uplifted 300 ltr of Avgas 100LL and the engine had operated for 15.6 hours.

Aircraft maintenance

The aircraft and engine log books recorded that a 50-hour inspection had been carried out on 13 May 2013 at 10,298 hours, by the authorised maintenance organisation, during which the ignition switch was checked and found to be satisfactory. The investigation did not identify any documented technical faults following completion of the 50-hour check.

On the day of the accident, and just prior to the accident flight, an individual was seen with the engine cowl open working on the engine. There were conflicting witness accounts as to the work that the individual carried out. The individual concerned told the AAIB that the instructor had informed him that there had been a magneto drop of around 200 rpm and that the engine had been running roughly. He removed the lower two rear plugs and found a build-up of lead. After cleaning and refitting the spark plugs, he stated that he carried out a power check and the magneto drop was found to be within limits. No documentation had been completed to support this maintenance activity. The CAA later advised the investigation that the individual who carried out the work is not currently a Part 66 licensed engineer.

Although the individual reported that he had previously held an engineer's licence issued by the CAA, the CAMO stated that he was not authorised to carry out maintenance on this aircraft.

Carburettor icing

Carburettor icing occurs as a result of vaporisation of fuel and a reduction in pressure as the fuel / air mixture passes through the venturi in the carburettor. These effects cause a drop in the temperature which, if it falls below the dew or freezing point of water, will result in ice forming on the sidewalls and the butterfly valve in the carburettor. As the ice builds up, it gradually blocks the venturi and alters the fuel / air balance which causes the engine to run roughly and lose power. Figure 3[2] shows combinations of atmospheric temperatures and dew points where there is a risk of carburettor icing. At the time of the accident, the temperature was 13ºC and the dew point was 10ºC. In these conditions, there was a risk of serious carburettor icing at any power setting.

CAA Safety Sense Leaflets

Safety Sense Leaflet 14 – '*Piston Engine Icing*' explains in detail the cause of carburettor icing and the precautions to take during different phases of flight.

The leaflet states that, during base leg and final approach:

> *'Unless otherwise stated in the Pilot's Operating Handbook or Flight Manual, the HOT position should be selected well before power is reduced and retained to touchdown. On some engine installations, to ensure better engine response and to permit a go-around to be initiated without delay, it may be recommended that the carb hot air be returned to COLD at about 200/300 ft on finals.'*

Safety Sense Leaflet 1e – *'Good airmanship'* states:

> *'In the event of engine failure after take-off, achieve and maintain the appropriate approach speed for your height. If the runway remaining is long enough, re-land; and if not, make a glide landing on the least unsuitable area ahead of you.'*

Footnote

2 Figure 3 was taken from CAA Safety Sense Leaflet 14, '*Piston Engine Icing*'.

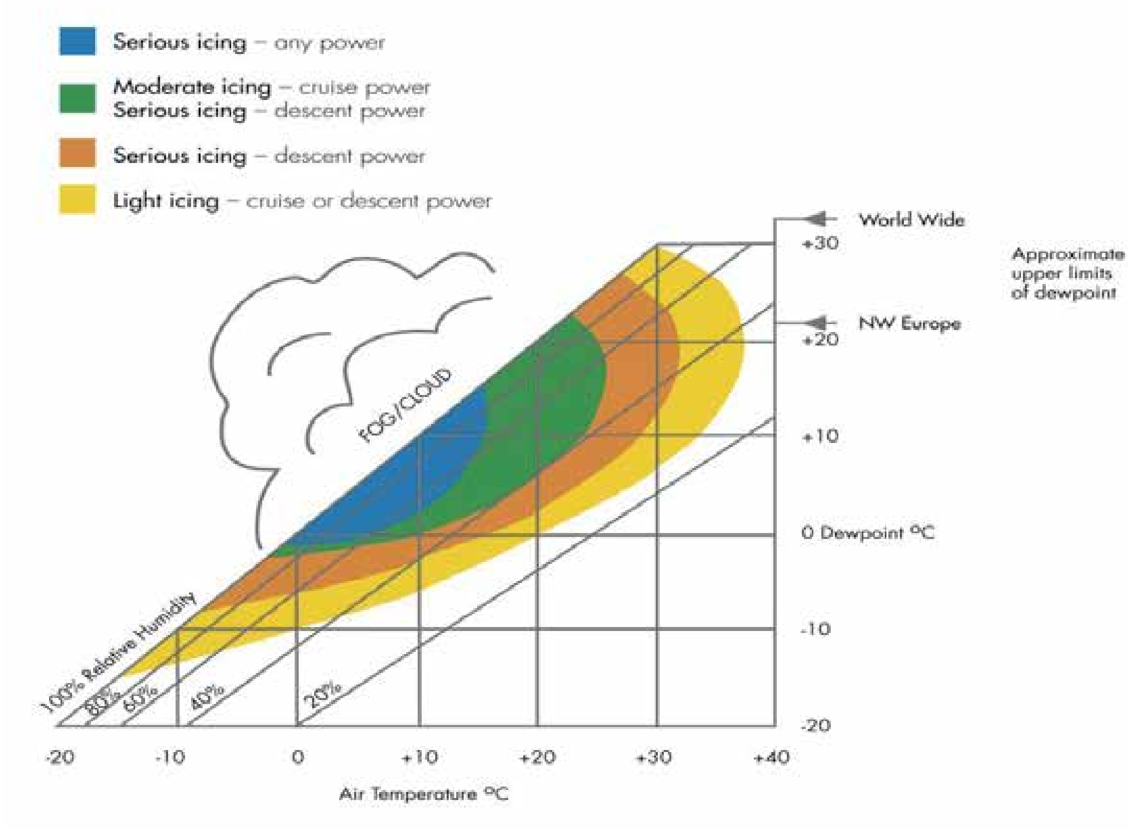

Figure 3

Carburettor icing chart for piston engines

and:

> *'Attempting to turn back without sufficient available energy has killed many pilots and passengers.'*

Piper PA-38 Pilots' Operating Handbook (POH)

The Piper PA-38 POH states that the magnetos should be checked at an engine speed of 1,800 rpm. A maximum reduction of 175 rpm is permitted when each magneto is selected and a maximum difference of 50 rpm is permitted between the resulting engine speeds.

Section 3.7 of the POH, '*Engine Inoperative Procedures'*, states:

> *'At low altitudes with a failed engine, turns should not be attempted, except for slight and gentle deviations to avoid obstacles. A controlled crash landing straight ahead is preferable to risking a stall which could result in an uncontrolled roll and crash out of a turn.'*

Section 4.21 of the POH, *Before Takeoff,* states that the carburettor heat control should be set to COLD for takeoff. During flight, the POH states that carburettor heat should be selected to HOT if the engine begins to run roughly.

Section 4.29 of the POH, *Approach and Landing,* states that, during the approach and landing phase:

> *'Carburettor heat should not be applied unless there is an indication of carburettor icing, since the use of carburettor heat causes a reduction in power which may be critical in case of a go-around. Full throttle operation with carburettor heat on can cause detonation.'*

Analysis

The damage to the aircraft and the ground marks were consistent with the aircraft stalling and dropping the left wing at a relatively low height while close to the threshold of Runway 21. Evidence from examination of the wreckage indicated that the engine was producing little or no power at impact.

G-BGBN was one of a number of aircraft owned and operated by the flying school and flown on a Certificate of Airworthiness (C of A) issued by the CAA. Safe operation of aircraft, and the validity of a C of A, is dependent on an aircraft being maintained in an airworthy condition. This requires an aircraft to be operated on an approved fuel, maintained at the intervals specified in its maintenance programme, and for work to be correctly documented and carried out by qualified individuals. This investigation discovered that two of the flying school's aircraft operated on fuel that is not approved by the CAA. With regard to G-BGBN, it appeared that flying hours, defects and rectification had not been recorded in the log books and technical records, and an individual carried out maintenance on G-BGBN who did not hold the required approvals.

Fuel

The fuel tests indicated that fuel containing ethanol had been used in two of the flying school's aircraft, one of which was G-BGBN. However, G-BGBN had operated from Cranfield in the 11 days prior to the accident during which it had uplifted 300 ltr of Avgas 100LL, which is approximately 2.5 times the aircraft's useable fuel capacity. Any ethanol in the fuel would have been significantly diluted and, therefore, it is unlikely that the trace amounts detected would have made the probability of vapour lock or carburettor icing more likely during the accident flight. Moreover, a detailed examination of the aircraft fuel system detected no evidence of any deterioration that might have occurred as a result of using an unapproved fuel; there was also no evidence of any restrictions in the fuel system.

The fuel selector valve was in the right tank position and the fuel that the emergency services reported leaking out of a pipe for twenty minutes after the accident could only have come from the right fuel tank that was still connected to the aircraft. Therefore, the aircraft did not run out of fuel.

Ignition

The ignition switch was found in the LEFT position instead of the required position which was BOTH. The switch might have turned during the impact sequence but this seemed unlikely because the key and switch were undamaged. Alternatively, the key might have been turned immediately after the accident by the emergency services although there were no reports of this having been done. Had only the left magneto been selected during the flight, the engine should still have been able to operate, albeit with a slight reduction in power. Both magnetos and their spark plugs were tested and found to be serviceable and the aircraft took off and flew a circuit before the accident with no reported problems. While there was no evidence that there was a fault in either ignition system, the possibility could not be completely excluded that there was a fault in the left ignition system that caused the rough running.

Maintenance

The possibility was considered that the undocumented and unauthorised maintenance, carried out on the aircraft immediately before the accident flight, might have contributed to the loss of power. While the engine had been badly damaged, the investigation determined that the spark plugs had been correctly fitted and could identify no mechanical reason why the failure should have occurred. Moreover, the instructor and student carried out a power check at the start of the accident flight, during which the engine behaved normally, and the aircraft subsequently flew a circuit and touch-and-go landing (rather than a full-stop landing), suggesting that the engine was operating normally.

Carburettor icing

The CAA advises that carburettor heat should be applied during approach and touchdown in anticipation of carburettor icing with the caveat that there might be contrary information within the POH. The POH for this aircraft type advocates leaving the carburettor heat off until symptoms of icing are encountered. The atmospheric conditions were such that there was a risk of serious carburettor icing at all power settings. While the carburettor heat control was found in the COLD position, as would be expected following a touch-and-go, it could not be determined whether it had been applied during the approach. The instructor habitually selected carburettor heat to HOT while descending on base leg and, presuming this was done prior to the touch-and-go, much of the ice that had formed (if any) would probably have cleared before touchdown. It was not possible to determine if carburettor icing was present at the end of the approach or during the subsequent takeoff but the decision to continue with the touch-and-go suggests that the engine was performing correctly at the point the decision was made to apply power.

In the absence of evidence of alternative causes, carburettor icing appears to be the most likely cause of the rough running.

Aircraft handling

The POH advises that only gentle deviations from heading should be attempted at low level with a failed engine and this is common knowledge and teaching in regard to single-engine aircraft. The instructor stated that the aircraft was still able to climb following the first symptoms of rough running and so there was not a clear-cut power failure. He believed initially that the aircraft could be turned back towards Runway 21 and initiated a turn to the left. Had that turn been flown through 180º, the aircraft would have been displaced to the right of the Runway 21 centreline and the pilot would have had to continue to manoeuvre the aircraft in order to line up with the runway. It is possible that there would have been sufficient runway available to enable this course of action to lead to a successful landing but only if the engine continued to provide sufficient thrust to maintain level flight during the turn.

After he commenced the turn and the symptoms of rough running worsened, the instructor believed that all power might be lost and amended his plan so that the aircraft would turn only far enough to enable a landing to be made within the aerodrome boundary. It was not determined where in this turn the symptoms worsened but, before the instructor could roll out on his chosen heading, the aircraft stalled and departed controlled flight at a height that was insufficient to allow recovery.

AAIB comment

This accident reinforces the advice that following engine failure it is essential to maintain flying speed and control of the aircraft. It is the experience of the AAIB that a controlled crash landing straight ahead is preferable to stalling at low level.

ACCIDENT

Aircraft Type and Registration:	Replica Fokker EIII, G-CHFS
No & Type of Engines:	1 Warner Aircraft Corp Scarab 145 piston engine
Year of Manufacture:	2012 (Serial no: LAA 279-14805)
Date & Time (UTC):	27 April 2013 at 1552 hrs
Location:	Middle Wallop Airfield, Hampshire
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:	68 years
Commander's Flying Experience:	1,903 hours (of which 10 hours were on type) Last 90 days - 3 hours Last 28 days - 2 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft was taking part in a practice air display when, during a right turn, at a relatively low altitude, the aircraft began to descend, turning through an estimated two full rotations before striking the ground. It was considered probable that in the turn the aircraft entered a sideslip and developed a roll rate which could not be reversed by its wing-warping roll control system.

Background

The accident occurred during a practice air display involving a group of seven replica First World War aircraft. The group had been in existence since 1988 and had used Middle Wallop as a base for practice air displays since 1997. They had met at the airfield for such a training weekend prior to the 2013 display season.

History of the flight

The pilot of G-CHFS arrived at Popham Airfield, where the aircraft was based, at about 0800 hrs on the morning of the accident, where he met a colleague who was to fly a Fokker Triplane which was also based at Popham. They carried out pre-flight checks on both aircraft and pushed them out of the hangar before refuelling them. No problems were identified during any of the pre-flight preparations.

G-CHFS and the Fokker Triplane departed Popham together for the short flight to Middle Wallop. Five other aircraft participating in the training weekend arrived between

0800-0900 hrs. Once all the aircraft had arrived the pilots carried out a brief for about two hours, which included walking through the display sequence several times on the ground.

At 1141 hrs all seven aircraft took off from Runway 36 for their first practice. This went without incident and the aircraft landed again at Middle Wallop at 1155 hrs. The pilots debriefed the practice display and had lunch before briefing and walking through the display again for a further practice planned for that afternoon.

All the aircraft were airborne once more at 1549 hrs from Runway 36 for a second practice display. During the display, each aircraft flew in one of three allocated height blocks to ensure separation, the lowest of these being between 100-300 ft agl. G-CHFS was the fifth aircraft in the sequence to take off. It climbed, as planned, to occupy this lowest block with another aircraft, a BE2. With all the aircraft airborne and correctly positioned the display commenced with G-CHFS simulating quartering attacks on the BE2. This involved G-CHFS manoeuvring from side to side behind the BE2 whilst they flew in a southerly direction over the airfield. The pilot of the BE2 reported he was flying at a height of about 200 ft agl and a speed of about 65-70 kt during this part of the sequence.

A perimeter track on the airfield was being used as a simulated crowd line. The BE2 had already split to the left by the time that G-CHFS had reached the southern end of the airfield. G-CHFS then turned to the right to fly back up the simulated crowd line in a northerly direction. It was at an estimated height of about 200 feet when it was seen by witnesses to turn right through about 180º and then level its wings. It was then seen, by one of these witnesses, to turn again and finally align itself to fly parallel to the simulated crowd line.

Witnesses reported that after entering the final turn the aircraft continued in the turn whilst descending until it struck the ground. A pilot of one of the other aircraft in the display witnessed the turn from his position at a height of about 500 feet agl flying over the eastern side of the airfield. He reported that the bank angle seemed to remain constant whilst the nose pitched increasingly down. One of the display team who was observing the display from the ground reported that the bank angle appeared to increase whilst the aircraft's nose dropped. Another witness on the ground described seeing the aircraft in a steep descending turn 'slicing' through the air. The direction of the turn was reported as being to the left by some witnesses, and to the right by others. It was estimated that the aircraft completed two complete rotations before striking the ground in a near vertical attitude at the south-west end of the airfield. There was a significant post-crash fire. The time of the accident was approximately 1552 hrs.

Emergency response

The display team had contacted the airfield operations department to seek permission for the training weekend and provided the necessary information. The department, using a movement sheet[1], notified the fire section that a display team were visiting the airfield during

Footnote

1 A sheet prepared by the airfield operations department providing information on aircraft visiting the airfield out of hours.

the weekend. The movement sheet contained no details about the display team's intended activities during their visit.

On arrival at Middle Wallop, the display team leader contacted the fire section to inform them that they would be carrying out up to three practice displays each day, but could not provide precise timings on when these would take place due to variables such as weather, briefings and refuelling.

On the day of the accident, the aircraft involved in the display were parked close to the fire station. Firemen on duty at the time reported hearing the aircraft start and seeing them taxi towards the airfield, although they did not know that the aircraft would be conducting a display over the airfield.

Pilots in the display, on seeing G-CHFS crash, made distress calls on the Middle Wallop ATC VHF frequency. These included requests for the fire section to acknowledge their calls. The fire station control room was busy at the time as a shift change was in progress. No one reported hearing any of the calls being received at that time on the control room radio receiver.

One of the display pilots was able to land quickly close to G-CHFS after the accident and attempted to tackle the fire with the small fire extinguisher carried in his aircraft. Another member of the team also managed to land nearby to offer assistance, but the fire was too intense for them to extinguish or attempt a rescue of the pilot.

The accident site was at the opposite end of the airfield and hidden by a drop in the ground so it was not in direct view of the fire station. However, some of the fireman saw smoke. There were occasionally fires burned in an area off the airfield in the same relative direction from the fire station and they initially thought the smoke was from another of these fires. The firemen were, however, sufficiently concerned that they treated it as an emergency, deploying a fire tender and crew to investigate at 1556 hrs. The fire station log records the fire being tackled at 1600 hrs, at about which time an air ambulance, which had been flying in the area at the time of the accident, landed at the airfield. They were then joined by the civilian fire, ambulance and police services which had been deployed in response to a 999 call from a witness on the airfield and arrived at about 1609 hrs.

Aircraft general description

The aircraft was a full-scale replica of a Fokker Eindecker EIII that was built to be as close as possible to the original design which entered military service in 1915. The plans for the aircraft were based on contemporary records and measurements of the only surviving original example, which is housed in the Science Museum in London.

The fuselage was constructed of a welded steel tube lattice braced internally with wires, whilst the wings consisted of wooden spars and ribs, steel compression struts and wire cable bracing. The tail surfaces and landing gear were made from welded steel tube. The fuselage and flying surfaces were covered with linen sealed with dope and varnish.

Figure 1

general view of the aircraft
(picture courtesy of Philip Whiteman)

The original design was fitted with an Oberursel rotary engine producing 100 hp but G-CHFS was fitted with a more modern Warner 145 Scarab radial engine producing 145 hp.

The aircraft was fitted with an all-flying fin and tailplane for yaw and pitch control respectively. Roll control was achieved by a wing warping system. Forces from the pilot's controls were transferred to the flying surfaces by a series of torque tubes and cables. The wing warping system used control cables, attached to the lower surface of the rear spar of each wing, which physically warped the wings. As cables from the pilot's control pulled the rear spar on one wing down, transfer cables attached to the top surface of each wing, via a pulley on the upper cabane strut, pulled the rear spar of the other wing up. This caused the wings to twist in opposite directions producing unequal lift and therefore roll.

The aircraft did not possess a conventional means of trimming the flight controls, although it was fitted with a variable clamp mechanism to add friction to the pitch-control movement of the control column. This was operated by the pilot by means of a lever to relieve stick loads in flight.

Accident site

The aircraft wreckage was located inside and close to the south-west boundary of the airfield. The ground marks and disruption to the wreckage indicated that the right wingtip had struck the ground first whilst the aircraft was steeply banked to the right in a nose-down attitude. The main wreckage was approximately 18 m from the first ground marking. Damage to the propeller indicated that it had been under power when it struck the ground. The fuel system was ruptured and there was an extensive post-accident fire which had consumed the forward fuselage area and most of the wing structure. The wreckage was recovered to the AAIB facilities for detailed examination.

Detailed engineering examination

The cockpit area and wing structure was severely disrupted as a result of the accident and burnt in the post-crash fire and therefore it was not possible to examine fully all aspects of the aircraft structure and flying controls, including the variable clamp mechanism. The severity of the fire suggested that significant quantities of fuel were present. However, it was possible to determine that all the primary bracing and control connections were intact. The magneto switch in the cockpit was in the 'BOTH' position. The spark plugs were of a normal colour and in good condition and the engine could be turned by hand after damaged components were removed.

Weather

The area was under the influence of an unstable northerly airflow with showers, some heavy, occurring during the day.

The automatic METAR observation for the airfield at 1150 hrs, the time of the first display, reported a northerly wind of 12 kt, good visibility, FEW clouds at 3,100 feet agl, a temperature of 8°C, dewpoint of -2°C and a QNH of 1016 hPa.

The 1550 hrs observation, covering the time of the second display, reported a northerly wind of 8 kt, good visibility, FEW clouds at 7,000 feet agl, a temperature of 9°C, dewpoint of 1°C and a QNH of 1015 hPa.

Airfield details

Middle Wallop is a military airfield used by the Army Air Corps for flying training. It is home to the Army Aviation Centre and houses a number of buildings, including aircraft hangars, workshops and various administration and accommodation blocks.

During normal operating hours, and at other times when military training is taking place, movements on the airfield are controlled by a dedicated air traffic control service. Outside these times, the airfield has no air traffic control service, although blind calls are required on the airfield VHF frequency.

The airfield has a fire station equipped to deal with aircraft fires anywhere on the airfield, as well as providing fire cover for the buildings on the estate. When military flying operations are not taking place, the fire station remains manned but at a reduced level in order to continue to provide cover for the buildings. The fire station has a control room and the primary means of notification of an emergency is by telephone. There is a direct telephone line from the air traffic control tower to the fire station which is used in the case of an aircraft accident when air traffic control is in operation.

The control room is equipped with a radio receiver which can be switched between the airfield's UHF and VHF[2] frequencies. The status of the receiver at the time of the accident could not be ascertained. The receiver is intended to provide some background information

Footnote

[2] Military aircraft normally operate on UHF, but can switch to VHF if required. Civilian aircraft normally only have the facility to operate on VHF and all the display team aircraft were equipped with VHF radios only.

on operations on the airfield and has no facility to transmit. Its existence is not mandated, so it is not officially funded and there is no formal training provided for its use, its monitoring being on an ad hoc basis.

The airfield is available to civilian general aviation by obtaining prior permission from the Airfield Manager during normal working hours. This is normally for use of the airfield during non-operational hours. The Army Flying Association (AFA) also operates a flying club with aircraft based on the airfield. Members may operate from Middle Wallop without prior permission. The display team pilots were all members of the AFA.

AFA members must adhere to the airfield's Flying Orders, Section MW2501.213.1, Paragraph d of which states:

> *'Notification of Flight. A list of known movements is to be forwarded to the fire section by stn ops at cease (sic) work each day and on Friday for the weekend. Before departure pilots are to contact the fire section to check on possible conflicting movements & inform them of flight details. Pilots are also to contact the Fire Section after landing to confirm arrival/sortie completion. Failure to do so will result in overdue action being taken.'*

Paragraph f of the same section concerns non-training, flight tests and operational tasks. Sub-paragraph 2 states:

> *'(2) The ac comd is to ensure that the fire section is made aware of the movement, specifically the departure and arrival times and consideration is to be given to deploying a fire appliance to monitor aircraft starts. The fire section is to maintain a listening watch on their receiver.'*

Visiting pilots who are not members of the AFA are provided with a comprehensive brief once permission had been granted to visit the airfield. The brief does not mention a requirement to report to the fire station on arrival or departure, although it does state that the fire section must be notified of any out of hours changes to movements. At the time of the accident the fire section had no responsibility for flight following for such flights.

Pilot's background

The pilot gained his private pilot's licence in 1984. He then gained a basic commercial pilot's licence in 1991, although in 2006 he chose to revert to the privileges of his private pilot's licence. He had an engineering background and had previously manufactured and flown other World War One replica aircraft. He conceived the idea to build a replica of the Fokker EIII in 2006 and commenced building G-CHFS in 2008.

The pilot last flew with an instructor in September 2011 when he completed a satisfactory licence revalidation check flight in a PA18. All his flying since this revalidation check, prior to air testing G-CHFS, was in a Fokker DR1 replica and a Flybaby 1A[3], both of which are

Footnote

3 The aircraft had been built to look like a World War One Junkers CL 1.

single seat aircraft. He then flew G-CHFS between 13 September and 12 December 2012, recording a total of 15 flights over 8 hours 30 minutes in his log book. He then did not fly G-CHFS for three months until 28 March 2013 when he flew the aircraft for 55 minutes during its final air tests. He did not fly G-CHFS again until the day of the accident.

The pilot's ability, both as an engineer and a pilot, were well respected by his peers. Officials within the LAA who were aware of the pilot's background were confident he possessed the necessary skills to fly the Fokker EIII.

Medical

A post-mortem report revealed the pilot died of severe multiple injuries sustained when the aircraft struck the ground. These would have been instantaneously fatal. Toxicology revealed no evidence of carbon monoxide or any other likely contributory factors. There was no pathological evidence that the pilot had experienced a medically incapacitating event prior to the impact, although this could not be totally excluded.

The pilot was wearing a four-point harness, but the crash forces were considered to have been such that no additional or alternative safety equipment would have been likely to alter the outcome.

Airworthiness

Permit to Fly

Notwithstanding the international requirement for an aircraft to have a Certificate of Airworthiness, there are many aircraft in the recreational, ex-military, vintage and amateur-built categories that are not able to qualify for the issue of a Certificate of Airworthiness. In such cases, the CAA may issue a Permit to Fly which allows aircraft to fly within United Kingdom airspace. This document confirms that an aircraft is fit to fly having regard to its overall design, construction and maintenance. Due to the reduced airworthiness status, to ensure that an adequate level of safety is maintained, additional limitations and conditions are placed upon the operation of these aircraft.

For this aircraft, the airworthiness approval process was conducted by the Light Aircraft Association who, once satisfied, made a recommendation to the CAA for the issue of the Permit to Fly.

Light Aircraft Association (LAA)

The LAA are the principal representative body for amateur-built and vintage light aircraft in the UK and are structured as a not-for-profit association, owned its members. Airworthiness services in terms of design, construction and maintenance are provided for its 8,000 members under direct delegation from the UK's CAA.

General Approval process for new designs

A builder initially notifies preliminary design information to the LAA and, if the concept is generally agreeable, the project is allocated a number and a record of the type is opened.

As the design develops the builder is required to demonstrate that it is airworthy in a detailed dossier; usually compliance with an appropriate design code needs to be shown. A number of inspections by an LAA approved inspector are conducted as construction progresses to ensure the aircraft has been built to the design drawings and to an acceptable standard. Once complete the new design will be inspected by an LAA Design Engineer to ensure the design and construction details are satisfactory. A Permit to Test will then be issued to allow the flight characteristics to be verified. A final flight test will be conducted by an LAA Test Pilot.

Design approval process for this aircraft

The approval process for G-CHFS followed the normal process and a detailed stress analysis of the aircraft was conducted to demonstrate that the main structural elements met the requirements of design code CS-VLA. In addition, the Chief Engineer of the LAA was in regular communication with the builder and the stress engineer. This included many visits to view the aircraft as it was being constructed, to review and agree design details.

As is normal with a replica aircraft, the standard detail design practices were typical for an aircraft of its vintage. Only where experience has shown these to be unacceptable were modern features adopted in accordance with normal aviation practice. Examples of this would be the inclusion of a firewall between the engine bay and cockpit and improved wing wire bracing attachments.

Construction and Maintenance

Construction of the aircraft had been carried out to a high standard and had been inspected in stages by an LAA Approved Inspector. Following a recommendation from the LAA, the CAA issued a full Permit to Fly on 12 April 2013 and granted an exemption that allowed the aircraft not to display its registration mark. The Federal Republic of Germany had been contacted and they had informed the builder that they did not object to the aircraft carrying the period military colour scheme.

The aircraft had only flown about 11 hours since new and no maintenance was due. No defects had been recorded in the aircraft log books.

Flight test

The LAA cleared the aircraft for flight testing on 12 September 2012 for the purpose of issuing a Permit to Fly. In the absence of a specific certification basis, CS-VLA (Amendment 1, dated 5 March 2009) and BCAR Section S (Issue 5, dated 21 October 2009) were used as the basis for the tests. A number of test flights were flown between 13 September 2012 and 12 December 2012. The aircraft was not flown again until 28 March 2013 when air testing was completed. The aircraft log book records 24 flights taking place during this period totalling 10 hours and five minutes. They were flown by the pilot who had constructed G-CHFS and by a LAA test pilot, who compiled a formal flight test report on 6 April 2013.

Handling qualities

The investigation obtained copies of the notes made by the pilot after his first flight and also the flight test report carried out by the LAA. This was to confirm that the aircraft had acceptable handling and performance characteristics to allow it to gain a full LAA permit to fly.

In the first flight notes, the pilot reported that he was finding it easy to fly out of balance. Additionally, he commented that the force required to roll the aircraft was a lot greater than one would expect due to the wing warping mechanism.

In the general handling section of the flight test report it states:

> *'The second unusual lateral characteristic was a reduced level of stability produced by little dihedral effect and a tendency for large slip angles to develop. This quality was brought about by the relaxed directional stability that allowed the aircraft's nose to slice through the air if attention was not paid to keeping the slip ball centred combined with the reduced dihedral effect. In this condition the outside wing was moving faster than the inside wing, which caused a roll towards the inside wing. Care had to be taken not to allow so much roll[4] to build up that it could overpower the roll reversing capability of the wing-warping system'.*

This section of the report went on to describe the use of the control column clamp:

> *'Pitch control was very sensitive if the control column clamp was not used. The aircraft was not so sensitive that it could not be flown and landed with the clamp off but the pitch characteristics were much better with the clamp engaged. Indeed, it was possible to fly 'hands-off' for a short period (to fold maps, etc) using the clamp. The technique was to adjust the clamp to add friction to the control column to a sufficient extent to add the desired artificial 'feel' in the pitch axis.'*

The section on general handling concluded:

> *'Overall, the handling qualities of the aircraft were unusual when compared with modern types and clearly would not comply with modern Requirements (sic). However, having compared reports of the original Eindekker, it appears to be a reasonably authentic representation of how the original Type (sic) flew. Also, once experience was gained, the actual flying qualities were reasonably benign as long as the aircraft was flown within the limitations of the wing-warping system.*
>
> *Overall, the handling qualities of G-CHFS were considered acceptable for this type of aircraft.'*

Footnote

[4] The test pilot clarified that this referred to roll angle.

No limitations on the wing-warping system were defined in the report.

The comments in the report regarding the controllability of the aircraft were included in the aircraft's pilot's notes that were produced as part of the LAA's permit to fly process. These were also referred to in the LAA's operating limitations document, which stated:

> *'This aircraft does not comply with modern handling requirements and must not be flown without the pilot having familiarised him/herself with the contents of 'Pilot's Notes Fokker Eindekker EIII Replica G-CHFS 'dated 12/4/13, or in circumstances likely to result in a departure from controlled flight.'*

Weight and balance

The report contained information on the aircraft's weight and balance. It is considered that G-CHFS was within its weight and balance limits at the time of the accident.

Stalling

The flight test report stated that stall handling was reasonably benign in all configurations, including turning and accelerated stalls. The report also commented:

> *'During turning and accelerated stalls, the slip ball had to be kept central as there was a tendency for it to 'wander' if allowed. It was also possible to build up roll rates from the aircraft's slipping characteristics rather than due to its stalling characteristics.'*

Analysis

The aircraft had been constructed to a high standard and no pre-accident defects or failures were identified. Evidence suggested that the engine was operating normally at a reasonably high power setting when it contacted the ground. Evidence from the accident site supports witness reports of the aircraft in a steep nose-down turn to the right just prior to impact.

The use of the control clamp, while making a positive contribution to the handling characteristics, could have caused the aircraft to maintain a turn unless the pilot was able to make a deliberate movement to reduce the pitch input. There was, however, no means of discerning whether this had been the case from examination of the wreckage.

There was no evidence that the pilot had suffered any medical incapacitation that might have affected his ability to fly the aircraft, although it remains possible that any incapacitation was not subsequently detectable.

When considering operational aspects, the investigation found that, unless attention was paid to the slip indicator, the aircraft could easily enter sideslip without this being obvious to the pilot. Furthermore, should sideslip develop, then roll rates could develop and a roll angle achieved that could not be reversed by the wing-warping roll control system fitted to the aircraft. Flying in a practice air display with other aircraft would have exerted a number of demands on the pilot's attention. This would have been exacerbated by the pilot's lack of recency and experience on the aircraft. The pilot had apparently been aligning the aircraft with the practice crowd line just prior to the accident and it is possible that his attention would have been outside the cockpit during the turn in order to fly the correct line. Based on the limited evidence available, this is considered the most likely scenario and one which may have led the aircraft to enter a sideslip and subsequently developing a roll which could not be reversed by the wing-warping roll control system.

Emergency response

The fire section, whilst aware of the display team's presence at Middle Wallop, did not know that the team would be performing a practice display over the airfield at the time of the accident. Whilst the display team leader had not provided exact timings of the practice displays, the proximity of the parked aircraft to the fire station made it seem self-evident to the display team that the fire section would have been aware of their arrival and departure for their various flights.

When the accident occurred, the radio calls to the military fire station were not heard. The status of the receiver at the time of the accident was not known and it cannot therefore be determined whether the messages were audible to those in the fire station control room, or whether they simply went un-noticed due to the distractions of the shift hand-over going on at the time.

The firemen were conditioned to respond to emergency call-outs by phone and the radio receiver was not routinely monitored. This reflected the stated unofficial nature of its existence, although this seems to contradict the statement in the airfield Flying Orders that the fire section maintained, when necessary, a listening watch on the receiver. The requests from the pilots that the fire section acknowledge their calls also suggests the pilots did not realise that the fire station was not equipped, nor the firemen qualified, to transmit on the airfield radio frequency.

The military fire service was delayed in responding to the crash because they were unaware it had occurred. Once they had cause for concern, after seeing smoke, they reacted quickly and that no actions by any party could have averted the fatal outcome to the accident.

Safety Actions

As a result of the accident, all out-of-hours visiting aircraft are now required to report to the fire station upon arrival and departure and the fire section conducts 'flight following' on all visiting aircraft. The Flying Orders have also been reviewed to amend references to the monitoring of radios.

ACCIDENT

Aircraft Type and Registration:	Eurocopter AS350B3e Squirrel, G-ECUK
No & Type of Engines:	1 Turbomeca Arriel 2D turboshaft engine
Year of Manufacture:	2012 (Serial no: 7491)
Date & Time (UTC):	19 June 2013 at 1840 hrs
Location:	Private helicopter landing site near Oxford
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (serious) Passengers - None
Nature of Damage:	Substantial damage to airframe, rotor blades and dynamic components
Commander's Licence:	Private Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	224 hours (of which 8 were on type) Last 90 days - 10 hours Last 28 days - 8 hours
Information Source:	Field Investigation

Synopsis

The pilot lost yaw control of the helicopter as it approached the final stage of a decelerating transition to a hover. Examination of the helicopter established that hydraulic fluid leaked from two unions securing hydraulic pipes to the tail rotor hydraulic servo. The leak depleted the hydraulic contents to the extent that a loss of system pressure occurred.

History of the flight

The helicopter, with the pilot and his son on board, was in the late stages of an approach to a private helicopter landing site when the accident occurred. The weather conditions were fine, with good visibility and calm wind.

The pilot reported that he carried out a detailed Check A of the aircraft before flight, which revealed no abnormalities. In particular, there were no signs of fluid on the helicopter skins or on the hangar floor. The early stages of the flight were uneventful and the pilot returned to the same landing site after about 20 minutes. He flew an approach to an open grass field adjacent to the landing pad, crossing electricity cables at the field boundary at about 30 ft and 40 kt. In the latter stages of the approach at about 15 ft and 20 kt, the pilot increased collective pitch a little and began a slight flare. At about the same time he made a left pedal input to make a track correction. As he did so, he experienced what he described as a slight jolt, followed by an immediate and violent yaw to the left.

The pilot believed that he instinctively applied more collective pitch in order to avoid ground contact, and the left yaw rate increased, causing him to believe that a tail rotor malfunction had occurred. He reported trying to control the yaw with pedal input, but without effect. He therefore reduced collective and the yaw rate reduced, but by this time he felt the "control forces were extreme". The helicopter made two or three more complete rotations before contacting the ground. The right skid collapsed, causing the main rotor blades to strike the ground. The pilot secured the aircraft, and both occupants vacated through their respective side doors. The pilot was subsequently found to have suffered three broken vertebra.

The pilot reported that his full attention was directed at controlling the sudden and unexpected yaw, particularly as the helicopter was at such a low height. He initially stated that, because of the difficulty controlling the helicopter, he could not recall whether there had been any cockpit warning lights or sounds before it struck the ground. After later consideration, he was certain there had been none.

Pilot information

The pilot had previously flown Hughes 369 and Enstrom 480 helicopters. He commenced flying training for an AS350B3e type rating on the 8 May 2013 and passed a Licence Skills Test on 30 May 2013, all training being conducted on G-ECUK. The accident flight was the pilot's first in the helicopter since that date.

Aircraft examination

An initial examination of the helicopter was carried out at the accident site by a field service representative of Eurocopter UK. The examination confirmed that the helicopter had suffered significant damage to the airframe, rotor blades and dynamic components. During the examination, evidence of a hydraulic leak at the base of the tail boom was observed. Further examination confirmed that hydraulic fluid had been leaking from two unions which secured hydraulic pipes to the tail rotor hydraulic servo and load compensator. Both unions could be easily rotated on their threads using finger pressure. After righting the helicopter the level of hydraulic fluid remaining in the tank was found to be approximately 130 ml above the hydraulic fluid supply pipe.

AS350B3e Squirrel hydraulic system

The AS350B3e Squirrel is fitted with a hydraulic system to provide assistance to the pilot's control inputs. The system consists of three main rotor servo actuators, a tail rotor servo actuator, a hydraulic fluid tank and a mechanically driven hydraulic pump. Loss of system pressure is indicated to the pilot by a warning chime and a HYD caption on the Caution and Warning Panel (CWP).

The hydraulic tank has a useable fluid capacity of three litres. In the event of a loss of hydraulic system pressure the AS350B3e is fitted with load compensators (accumulators) on the main rotor servo actuators which provide hydraulic assistance for a short time after the loss of pressure. This variant of the AS350 was not originally fitted with a load compensator on the tail rotor servo actuator; tail rotor or yaw control assistance was provided by additional chin weights fitted to the tail rotor blades.

As a result of in-service experience, Eurocopter published a Service Bulletin (SB), AS350-01.00.66, to remove the additional tail rotor blade chin weights and fit a load compensator to the tail rotor servo actuator.

Maintenance history

At three flying hours from new, the helicopter was modified in accordance with SB AS350-01.00.66. The modification was completed by a team dispatched from the helicopter manufacturer in France. At the time of the accident the helicopter had accumulated approximately 15 flying hours. No further work, other than routine inspections, had been carried out on the helicopter prior to the accident.

Detailed examination

After recovery of the helicopter, a detailed examination was carried out by specialists from the helicopter manufacturer under the supervision of the AAIB.

Examination of the tail rotor control circuits confirmed that there was no evidence of a pre-impact restriction and that all of the circuits were correctly connected and rigged. After tightening of the load compensator/tail rotor servo hydraulic unions the tail rotor hydraulic system was tested and found to operate normally. Pressure decay checks confirmed that both the hydraulic low pressure warning chime and the HYD caption operated within the required tolerances. Function tests of the hydraulic switch on the collective and the accumulator test function showed that they operated normally.

A number of additional tests were carried out in order to determine the potential rate of leakage from the hydraulic system as a result of the loose load compensator unions. When the unions were correctly torqued, then 'backed off' by one turn, a leak rate of approximately one litre per hour was measured. The maximum leak rate achieved was approximately six litres per hour which occurred when the union connecting the hydraulic pressure supply line was loosened. The leak rates achieved during the tests therefore indicated that, if the hydraulic system was full, it could lose all pressure within 30 minutes of the unions becoming loose. With the hydraulic leak from the loose unions, a change in attitude of the helicopter in flight, such as during the landing flare, could result in the exposure of the hydraulic supply pipe and loss of system pressure before all the useable fluid had been lost.

The manufacturer carried out a review of the aircraft maintenance task cards associated with the mounting of the load compensator and associated unions. This identified that the task cards allowed the possibility of orienting load compensator and hydraulic unions in a way which would place the unions under load. This could result in the unions becoming loose in operation leading to a hydraulic fluid leak.

The manufacturer confirmed that no other events of hydraulic unions becoming loose in operation had been reported to them.

Analysis

Prior to the accident, no evidence of a hydraulic fluid leak had been observed by either the pilot or maintenance personnel, so it is reasonable to assume that the unions became loose at some point during the accident flight. When hydraulic system pressure was lost, the loose unions would have allowed the pressure within the tail rotor load compensator to dissipate. This would have resulted in an immediate loss of assistance to the yaw controls and an increase in the force required by the pilot to maintain directional control. The presence of fluid within the hydraulic system would have prevented the loss of pressure in the main rotor load compensators, allowing hydraulic assistance of the main rotor controls to be maintained for a period.

Detailed testing established that full control of the tail rotor remained available albeit without hydraulic assistance. The higher control loads associated with an immediate and unexpected loss of hydraulic power to the tail rotor servo probably led the pilot to believe that tail rotor control had failed.

Both the warning systems designed to alert the pilot to a loss of hydraulic pressure were found to operate normally. As the hydraulic system pressure dropped, the warnings would be expected to activate. The pilot was fully occupied in controlling the helicopter at a critical moment close to the ground, so may not have perceived the warnings.

No other such events have been identified on the AS350B fleet which indicates that the unions, if correctly torqued, are unlikely to become loose. The only maintenance which was carried out on the tail rotor servo actuator was as a result of the incorporation of the Eurocopter SB AS350-01.00.66. It is therefore probable that, while carrying out this SB, the load compensator and hydraulic unions were orientated in such a way as to apply a load to the unions. This resulted in the unions becoming loose, causing a loss of hydraulic fluid and ultimately system pressure.

Safety action taken by the manufacturer

As a result of this accident the manufacturer has introduced a number of changes to the work cards used during the incorporation of SB AS350-01.00.66 and maintenance to the tail rotor load compensator to ensure that the load compensator and hydraulic unions are oriented in such a manner as to minimise the loading on the unions.

In addition, the manufacture has carried out an inspection of all other affected helicopters to ensure that the hydraulic unions are correctly orientated. No abnormalities were found during these inspections.

AAIB correspondence reports

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

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

The accuracy of the information provided cannot be assured.

INCIDENT

Aircraft Type and Registration:	Boeing 767-31K, G-TCCB
No & Type of Engines:	2 General Electric Co CF6-80C2B7F turbofan engines
Year of Manufacture:	1997 (Serial no: 28865)
Date & Time (UTC):	14 September 2013 at 1500 hrs
Location:	Shortly after departure from Manchester Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 11 Passengers - 320
Injuries:	Crew - None Passengers - None
Nature of Damage:	Oven insert
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	44 years
Commander's Flying Experience:	10,340 hours (of which 8,200 were on type) Last 90 days - 200 hours Last 28 days - 75 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enguires by the AAIB

Synopsis

Whilst airborne, shortly after the rear galley ovens had been switched on, a strong acrid burning smell was noticed emanating from the No 3 oven. The oven was switched off and associated circuit breakers opened. As the acrid smell became more intense a fire extinguisher was discharged into the oven and the aircraft diverted safely.

The oven meal insert tray was damaged and too big for the oven. The oven pin, which prevents the insert tray from touching the exposed elements at the back of the oven, was also found to be bent. This allowed the oven insert to contact the exposed heating elements of the oven.

History of the flight

The aircraft was on a scheduled flight from Manchester Airport to Antalya Airport Turkey. About 10 minutes after takeoff the cabin crew switched on the ovens in the rear galley. Approximately three minutes later they noticed a strong acrid burning smell emanating from No 3 oven. The oven was switched off and associated circuit breakers opened. The cabin crew informed the Senior Cabin Crew Manager (SCCM) who then briefed the commander, adding that fire fighting had not yet been initiated.

The acrid smell became more intense and the cabin crew saw "wispy white smoke" emanating from the sides and top of the oven. A fire extinguisher was discharged into the oven on two separate occasions and the SCCM informed the commander that fire fighting had been initiated. On being advised that the acrid smell and smoke was not decreasing the commander declared a PAN, completed the '*Smoke, Fire or Fumes'* checklist and initiated a diversion to East Midlands Airport.

Prior to landing, having ascertained that the intensity of the smoke was no longer increasing, the commander briefed the SCCM that following a normal landing the aircraft would be stopped on the runway as a precaution. The landing was uneventful, with the Rescue and Fire Fighting Service (RFFS) in attendance. After consulting the SCCM and the RFFS the commander positioned the aircraft onto the taxiway where it was stopped and shut down. The RFFS boarded the aircraft using ladders at the rear left door and secured the oven and galley area. The oven was removed by the RFFS; no evidence of burning on, in or around it was evident. The aircraft was then towed to stand where the passengers disembarked. There were no injuries.

Aircraft ovens and meal insert trays

The oven meal insert trays are controlled and installed into the aircraft's ovens by an independent ground services company. The inserts come pre-loaded with the passengers' meals for the flight.

The compartment and wiring of oven No 3 was inspected on G-TCCB. No smoke or fire damage was evident. However, the oven pin, which prevents the insert from touching the exposed elements at the back of the oven, was found to be bent. This allowed the oven insert to contact the exposed heating elements of the oven.

All the aircraft's other ovens were operated at their maximum heat for 20 minutes after which no smells or smoke were observed. Air extraction grilles above the ovens were found to be blocked with dust, and were subsequently cleaned. The oven insert tray, found to be in a bad state of repair and misshapen, was probably the initiator for the smoke.

As a result of this incident the operator checked all ovens and meal tray inserts on its UK fleet. One oven was found unserviceable, and several insert trays were found to be distorted and were replaced.

Two types of ovens were fitted to the operator's Boeing 767s (B767) with one being 11 mm narrow than the other. After testing with a serviceable, but slightly dented insert tray, it was discovered that the trays could be loaded easily into the larger oven, and with force into the narrower oven.

Safety actions

The operator has identified a new insert which will be compatible with both of their B767's ovens.

ACCIDENT

Aircraft Type and Registration:	Cozy, G-BXDO
No & Type of Engines:	1 Lycoming O-235-C2C piston engine
Year of Manufacture:	1998 (Serial no: PFA 159-12032)
Date & Time (UTC):	31 August 2013 at 1733 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:	Underside of nose fuselage and retractor gear wheel
Commander's Licence:	Private Pilot's Licence
Commander's Age:	62 years
Commander's Flying Experience:	374 hours (of which 4 were on type) Last 90 days - 6 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft was landing at Perth Airport but the pilot was unable to extend and lock the nose landing gear (NLG) fully. The NLG collapsed on touchdown and some abrasion damage to the nose of the aircraft was incurred. It is believed that damage to the NLG extension/retraction mechanism caused in a previous heavy landing had probably prevented full travel of the leg into the downlock position.

History of the flight

The Cozy is a canard 'pusher' amateur-built design, which features a retractable nose landing gear (NLG) and a fixed main gear. The nose leg is manually wound up or down by the pilot using a handle in the cockpit which rotates a worm and gear mechanism; an overcentre device locks the NLG in the DOWN position when fully extended.

The aircraft was inbound to Perth and, at about 5 miles out, the pilot rotated the mechanism to lower the NLG but, instead of stopping when the gear was fully down, the handle kept rotating and no green light was illuminated to indicate it was locked. He checked the viewing window and the gear appeared to be fully extended; he then throttled back the engine and heard the horn sound to warn that the NLG was not locked down. Despite several attempts, it was not possible to get the gear to move in either direction and the pilot decided to land, anticipating that the NLG might collapse. He initially made his approach to Runway 21 as it was the longest but decided against this because of a crosswind and the fact that, should he encounter serious problems on the runway, he would not be visible from the flying club building. He continued to make radio calls about his position and intentions because, although the airfield was now out-of-hours and the tower unmanned, there was a radio in the clubhouse which someone might be monitoring.

As he touched down on Runway 27, aided by a steady 20 kt headwind, the pilot gently lowered the nose and felt the NLG slowly collapse. At a speed of about 10-15 kt, he steered the aircraft onto the grass where it stopped and he vacated in the normal manner. Damage to the aircraft was limited to minor abrasion damage to the nose but it was noted that a large number of teeth on the gear of the NLG mechanism were stripped. After discussion with others who have seen the components, the pilot believes that damage to one or two teeth may have been caused by an earlier landing which he recalled had been "flat and heavy". This damage would have prevented the NLG extending fully into lock and, as the leg collapsed under the landing loads, the remaining teeth also stripped.

ACCIDENT

Aircraft Type and Registration:	Piper PA-18-150 (Modified) Super Cub, G-BJIV
No & Type of Engines:	1 Lycoming O-360-A3A piston engine
Year of Manufacture:	1965 (serial no: 18-8262)
Date & Time (UTC):	27 August 2013 at 1520 hrs
Location:	Sutton Bank Airfield, Yorkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to landing gear, propeller, cowling and left wing
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	645 hours (of which 154 were on type) Last 90 days - 22 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

During the aircraft daily inspection prior to conducting glider towing, the right front bolt securing the landing gear suspension arm was found to be bent. The aircraft was considered safe to fly pending fitment of new bolts, which was accomplished at about 1330 hrs. It was thereafter flown until 1645 hrs, when it was refuelled and a different pilot commenced the next session of glider tows.

Returning from a glider tow, the pilot landed on Runway 20 at a speed of 60 kt in nil wind conditions. During the ground roll the aircraft hit a small bump and became airborne before landing again in a manner which he "did not consider a heavy landing". The right landing gear partially collapsed due to failure of an attachment bracket and the aircraft started to slew to the right. Whilst still in motion, the pilot shut down the engine and electrics. The aircraft then encountered a rut which collapsed the right gear completely, followed by the left gear.

The pilot reported that several cracked components were subsequently found in the landing gear structure; it is not known whether this damage was pre-existing or the result of the gear collapse.

ACCIDENT

Aircraft Type and Registration:	Piper PA-28-161 Cherokee Warrior II G-BTNV
No & Type of Engines:	1 Lycoming O-320-D3G piston engine
Year of Manufacture:	1978 (Serial no: 28-7816590)
Date & Time (UTC):	11 December 2013 at 1437 hrs
Location:	Manchester Barton Airport
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Propeller, nose landing gear leg and left wing
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	70 years
Commander's Flying Experience:	220 hours (of which 220 hours were on type) Last 90 days - 14 hours Last 28 days - 7 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft was flying 10 kt faster than usual when it was flared for touchdown. It floated a few feet above the surface before touching down approximately halfway along the runway. The aircraft overran the runway and tipped forward when it encountered soft ground.

History of the flight

The pilot reported that he extended the downwind leg to avoid other circuit traffic and, when he turned onto the base leg, he could no longer see Runway 27L because of poor, hazy visibility. He turned onto final approach but when he was closer to the airfield and could see the runway again, realised that he was above the normal vertical approach path and not on the runway centreline. He manoeuvred the aircraft to regain the runway centreline and vertical profile but as he passed the beginning of the runway, he was at approximately 70 kt instead of 60 kt.

The passenger, a qualified pilot with a Commercial Pilot's Licence, "mentioned a go-around" but the pilot reported that he considered a safe landing was still possible. He flared the aircraft but it floated just above the surface and, with a calm wind, did not touch down until approximately half way along the runway. The pilot still assessed that there was sufficient runway available to stop but, although he "braked hard", the aircraft decelerated slowly, the result, the pilot believed, of the grass being damp. The aircraft overran the end of the runway onto soft ground, and tipped forward and to the left such that the propeller and left wing touched the ground.

The pilot considered on reflection that, when he realised he was above the vertical profile and not on the runway centreline, he might have positioned the aircraft onto the dead side of the runway and rejoined the circuit.

Civil Aviation Authority (CAA) Safety Sense Leaflet 7c, Aeroplane Performance

CAA Safety Sense Leaflet 7c considers the takeoff and landing performance of light aircraft. Paragraph 7, *Landing – Points to Note* states:

> *'If you've misjudged [the landing], make an early decision to go around – don't float half way along the runway before deciding.'*

ACCIDENT

Aircraft Type and Registration:	EV-97 TeamEurostar UK, G-CGZF
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	2011 (Serial no: 3928)
Date & Time (UTC):	26 August 2013 at 1600 hrs
Location:	Membury Airfield, Berkshire
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to propeller, nose landing gear and fuselage
Commander's Licence:	Private Pilot's Licence
Commander's Age:	27 years
Commander's Flying Experience:	1,200 hours (of which 200 were on type) Last 90 days - 200 hours Last 28 days - 70 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The instructor and his student were engaged in Exercises 12 and 13 (Introduction to Takeoff) of the Private Pilot's Licence syllabus. It was the student pilot's fifth assisted takeoff and, with full power applied, some right rudder pedal pressure was necessary to keep the aircraft straight. Although the instructor was providing some assistance, he felt that everything was satisfactory until, at a speed of about 30-35 mph, the student suddenly pushed the left pedal hard down and froze. The instructor shouted "I have control" but the student did not appear to hear and the instructor could only oppose the student's input sufficient to centre the rudder. The student then closed the throttle whilst the instructor attempted to apply full power to fly away but again the student prevailed and the aircraft veered off the runway to the left and stopped in a ploughed field.

The student later stated that he had some hearing difficulties but could not offer an explanation for the erroneous pedal input. The instructor feels that more time may have been required for briefing this student but, as the student had successfully completed takeoffs before, the instructor may have been lulled into a false sense of security about the student's ability.

Miscellaneous

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

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

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

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

Published May 2010.

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

Published May 2010.

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

Published September 2010.

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

Published September 2010.

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

Published November 2010.

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

Published November 2010.

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

Published December 2010.

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

Published September 2011.

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

Published November 2011.

1/2014 Airbus A330-343, G-VSXY at London Gatwick Airport on 16 April 2012.

Published February 2014.

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GLOSSARY OF ABBREVIATIONS

aal	above airfield level
ACAS	Airborne Collision Avoidance System
ACARS	Automatic Communications And Reporting System
ADF	Automatic Direction Finding equipment
AFIS(O)	Aerodrome Flight Information Service (Officer)
agl	above ground level
AIC	Aeronautical Information Circular
amsl	above mean sea level
AOM	Aerodrome Operating Minima
APU	Auxiliary Power Unit
ASI	airspeed indicator
ATC(C)(O)	Air Traffic Control (Centre)(Officer)
ATIS	Automatic Terminal Information System
ATPL	Airline Transport Pilot's Licence
BMAA	British Microlight Aircraft Association
BGA	British Gliding Association
BBAC	British Balloon and Airship Club
BHPA	British Hang Gliding & Paragliding Association
CAA	Civil Aviation Authority
CAVOK	Ceiling And Visibility OK (for VFR flight)
CAS	calibrated airspeed
cc	cubic centimetres
CG	Centre of Gravity
cm	centimetre(s)
CPL	Commercial Pilot's Licence
°C,F,M,T	Celsius, Fahrenheit, magnetic, true
CVR	Cockpit Voice Recorder
DFDR	Digital Flight Data Recorder
DME	Distance Measuring Equipment
EAS	equivalent airspeed
EASA	European Aviation Safety Agency
ECAM	Electronic Centralised Aircraft Monitoring
EGPWS	Enhanced GPWS
EGT	Exhaust Gas Temperature
EICAS	Engine Indication and Crew Alerting System
EPR	Engine Pressure Ratio
ETA	Estimated Time of Arrival
ETD	Estimated Time of Departure
FAA	Federal Aviation Administration (USA)
FIR	Flight Information Region
FL	Flight Level
ft	feet
ft/min	feet per minute
g	acceleration due to Earth's gravity
GPS	Global Positioning System
GPWS	Ground Proximity Warning System
hrs	hours (clock time as in 1200 hrs)
HP	high pressure
hPa	hectopascal (equivalent unit to mb)
IAS	indicated airspeed
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
IP	Intermediate Pressure
IR	Instrument Rating
ISA	International Standard Atmosphere
kg	kilogram(s)
KCAS	knots calibrated airspeed
KIAS	knots indicated airspeed
KTAS	knots true airspeed
km	kilometre(s)
kt	knot(s)
lb	pound(s)
LP	low pressure
LAA	Light Aircraft Association
LDA	Landing Distance Available
LPC	Licence Proficiency Check
m	metre(s)
mb	millibar(s)
MDA	Minimum Descent Altitude
METAR	a timed aerodrome meteorological report
min	minutes
mm	millimetre(s)
mph	miles per hour
MTWA	Maximum Total Weight Authorised
N	Newtons
N_R	Main rotor rotation speed (rotorcraft)
N_g	Gas generator rotation speed (rotorcraft)
N_1	engine fan or LP compressor speed
NDB	Non-Directional radio Beacon
nm	nautical mile(s)
NOTAM	Notice to Airmen
OAT	Outside Air Temperature
OPC	Operator Proficiency Check
PAPI	Precision Approach Path Indicator
PF	Pilot Flying
PIC	Pilot in Command
PNF	Pilot Not Flying
POH	Pilot's Operating Handbook
PPL	Private Pilot's Licence
psi	pounds per square inch
QFE	altimeter pressure setting to indicate height above aerodrome
QNH	altimeter pressure setting to indicate elevation amsl
RA	Resolution Advisory
RFFS	Rescue and Fire Fighting Service
rpm	revolutions per minute
RTF	radiotelephony
RVR	Runway Visual Range
SAR	Search and Rescue
SB	Service Bulletin
SSR	Secondary Surveillance Radar
TA	Traffic Advisory
TAF	Terminal Aerodrome Forecast
TAS	true airspeed
TAWS	Terrain Awareness and Warning System
TCAS	Traffic Collision Avoidance System
TGT	Turbine Gas Temperature
TODA	Takeoff Distance Available
UHF	Ultra High Frequency
USG	US gallons
UTC	Co-ordinated Universal Time (GMT)
V	Volt(s)
V_1	Takeoff decision speed
V_2	Takeoff safety speed
V_R	Rotation speed
V_{REF}	Reference airspeed (approach)
V_{NE}	Never Exceed airspeed
VASI	Visual Approach Slope Indicator
VFR	Visual Flight Rules
VHF	Very High Frequency
VMC	Visual Meteorological Conditions
VOR	VHF Omnidirectional radio Range

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