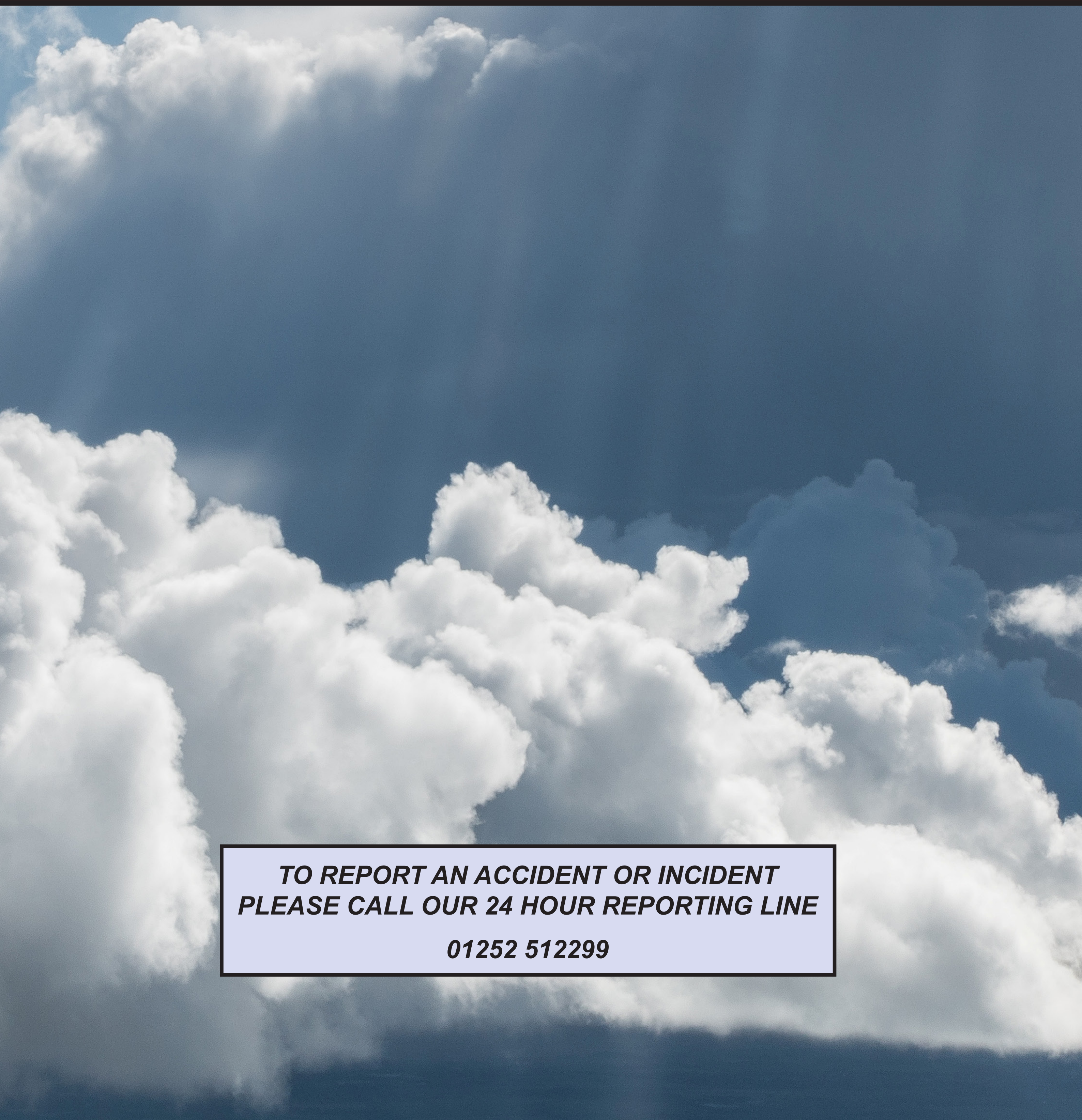
AAIB
Air Accidents Investigation Branch

AAIB Bulletin 4/2018



TO REPORT AN ACCIDENT OR INCIDENT PLEASE CALL OUR 24 HOUR REPORTING LINE

01252 512299

Air Accidents Investigation Branch
Farnborough House
Berkshire Copse Road
Aldershot
Hants GU11 2HH

Tel: 01252 510300
Fax: 01252 376999
Press enquiries: 0207 944 3118/4292
http://www.aaib.gov.uk

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The sole objective of the investigation of an accident or incident under these Regulations is the prevention of future accidents and incidents. It is not the purpose of such an investigation to apportion blame or liability.

Accordingly, it is inappropriate that AAIB reports should be used to assign fault or blame or determine liability, since neither the investigation nor the reporting process has been undertaken for that purpose.

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http://www.aaib.gov.uk

This bulletin contains facts which have been determined up to the time of compilation.

Published 13 April 2018

Cover picture courtesy of Stephen R Lynn
(www.srlynnphotography.co.uk)

ISSN 0309-4278

Published by the Air Accidents Investigation Branch, Department for Transport
Printed in the UK on paper containing at least 75% recycled fibre

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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: 1/2018

This report was published on 22 March 2018 and is available in full on the AAIB Website www.gov.uk

Report on the accident to
Sikorsky S-92A, G-WNSR
West Franklin wellhead platform, North Sea
on 28 December 2016

Registered Owner and Operator:	CHC Scotia Ltd
Aircraft Type:	Sikorsky S-92A
Nationality:	British
Registration:	G-WNSR
Location of accident:	West Franklin wellhead platform, North Sea Latitude: N 56° 57' 47" Longitude: E 001° 48' 22"
Date & Time:	28 December 2016 at 0844 hrs (All times in this report are UTC)

Introduction

The Air Accidents Investigation Branch (AAIB) became aware of the accident during the morning of 5 January 2017. In exercise of his powers, the Chief Inspector of Air Accidents ordered an investigation into the accident to be carried out in accordance with the provisions of Regulation EU 996/2010 and the UK Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 1996.

In accordance with established international arrangements, the National Transportation Safety Board (NTSB) of the USA, representing the State of Design and Manufacture of the helicopter, appointed an Accredited Representative to participate in the investigation, supported by advisers from the helicopter manufacturer and the Federal Aviation Administration (FAA). The helicopter operator, the European Aviation Safety Agency (EASA) and the UK Civil Aviation Authority (CAA) also assisted the AAIB.

The sole objective of the investigation of an accident or incident under these Regulations is the prevention of accidents and incidents. It shall not be the purpose of such an investigation to apportion blame or liability.

Summary

The helicopter was being operated from Aberdeen on a contract on behalf of an offshore oil and gas company. On 27 December 2016, during a flight on the day prior to the accident, the Health and Usage Monitoring System (HUMS) recorded vibration data which contained a series of exceedences related to the tail rotor pitch change shaft (TRPCS) bearing. Routine maintenance was carried out overnight which included a download and preliminary analysis of the HUMS data. Whilst an anomaly for tail rotor gearbox (TGB) bearing energy was

detected by the maintenance engineer, the exceedences were not identified, in part, due to the way they were presented in the analysis tool; the helicopter was released to service without further investigation.

On 28 December 2016, during the first sector of the day, the HUMS recorded further exceedences but these were not scheduled to be downloaded and reviewed until the helicopter returned to Aberdeen; there was no method in place for either the flight crew or maintenance personnel to be made aware of these further exceedences until then.

During lift off on the second sector, the helicopter suffered an uncommanded right yaw through 45° and the flight crew re-landed. The helicopter was again lifted into the hover and responded normally to the controls, so the event was attributed to a wind effect and the helicopter departed en route.

The five-minute flight to the West Franklin wellhead platform was uneventful but, in the latter stages of landing, yaw control was lost completely and the helicopter yawed to the right. The crew landed the helicopter expeditiously, but heavily, on the helideck. The helicopter continued to rotate to the right and the crew closed the throttles before it came to rest near the edge of the helideck having turned through approximately 180°. There were no injuries.

The investigation determined that the TRPCS bearing had degraded and failed. As a consequence, the tail rotor pitch change servo was damaged resulting in uncommanded and uncontrolled inputs being made to the tail rotor (TR). The manner in which the servo was damaged had not been previously identified.

The investigation identified the following causal factors to the loss of yaw control:

- The TRPCS bearing failed for an undetermined reason.
- The TRPCS bearing failure precipitated damage to the tail rotor pitch control servo.

The investigation identified the following contributory factors:

- Impending failure of the TRPCS bearing was detected by HUMS but was not identified during routine maintenance due to human performance limitations and the design of the HUMS Ground Station (GS) Human Machine Interface (HMI).
- The HUMS GS software in use at the time had a previously-unidentified and undocumented anomaly in the way that data could be viewed by maintenance personnel. The method for viewing data recommended in the manufacturer's user guide was not always used by maintenance personnel.

Despite being unable to determine the exact cause of the bearing failure, the helicopter manufacturer has identified and introduced a number of changes intended to reduce the risk of a recurrence including: introducing HUMS software with enhanced diagnostic capabilities and improved user interfaces, tighter control of bearing manufacturing and assembly tolerances, consistency in lubricating grease quality and its application, and inservice temperature monitoring.

In this report, the AAIB makes two Safety Recommendations concerning the timeliness of acquiring, accessing, analysing and promulgating Vibration Health Monitoring (VHM) data, to enhance the usefulness of VHM data for the timely detection of an impending failure.

Findings

1. The helicopter was equipped with HUMS and its use by the operator as part of its maintenance programme satisfied the regulatory requirements for helicopter VHM.

2. The operator's HUMS procedures stipulated a maximum of five flying hours between HUMS downloads rather than the maximum of 25 flying hours required by the UK Regulations, but even this reduced interval would not necessarily provide timely warning of impending TRPCS bearing failure.

3. The IMD GS software was in two distinct parts that had different interface characteristics for identifying and alerting exceedences to the user which led to a situation whereby an exceedence was missed.

4. Checks of the TGB bearing energy CI were routinely carried out by the maintenance personnel despite the omission of this step in the flowchart within the operator's documented HUMS S-92A download procedures.

5. The HUMS detected a failing TRPCS bearing.

6. The time between detectable degradation of the bearing by HUMS and failure of the bearing was four flying hours.

7. Due to an anomaly in the way that exceedences are viewed in the main IMD GS software and the GS ToolBar by maintenance personnel, coupled with the limitations in human performance, the HUMS exceedence was not identified during routine maintenance and the helicopter was released to service.

8. By the time that the HUMS data was reviewed by a second organisation the TRPCS bearing had already failed.

9. The pilots were properly licensed, qualified and sufficiently rested to conduct the flight.

10. There was no in-flight indication to the crew of the impending bearing failure before the landing on the Elgin.

11. During the departure from the Elgin helideck, the helicopter did not respond as expected to the commander's yaw pedal inputs, including the use of full left yaw pedal. Following a satisfactory check of the yaw control response, this was attributed to a wind effect and the final opportunity to terminate the flight was missed. However, it was established during the investigation that the event was due to the degraded condition of the TRPCS bearing.

12. A review of the historic S-92 fleet data by the manufacturer established that the use of full yaw pedal is a rare event in flight.

13. The TRPCS bearing failed whilst the helicopter was in flight.

14. The TRPCS bearing failure precipitated damage to the TR servo. This damage manifested itself during the landing on the West Franklin helideck.

15. The TR servo primary piston fractured within the secondary piston sleeve and not, as previously anticipated, in the threaded portion of the clevis.

16. The fracture of the servo primary piston disconnected the feedback pivot of the walking beam, resulting in loss of control of the TR servo.

17. The flight crew reacted expeditiously to an uncontrollable yaw whilst landing on the West Franklin helideck.

18. The helideck surface was punctured during the abnormal landing, but this did not adversely affect the outcome of this accident.

19. There were no injuries.

20. If the loss of yaw control had occurred at an earlier stage of the flight, the helicopter would most likely have made an uncontrolled descent into the North Sea.

21. The helicopter operator filed an MOR with the CAA on the day of the accident. However, when further evidence became available as to the seriousness of the event, it was not reported to the AAIB as it should have been.

22. The helideck operator was unaware of their responsibility to report an accident to the AAIB.

23. The TRPCS bearing was too badly damaged to determine the reason for its failure.

24. Additional inspections on in-service TRPCSs were introduced and, as a result, a number were returned to the manufacturer for further investigation. Of those bearings, 18 did not exhibit unusual or advanced wear or degradation, but one exhibited roller wear and unusual indications on the outer race.

25. Despite extensive and prolonged testing of the returned TRPCSs, the manufacturer could not reproduce a TRPCS bearing failure.

26. The current VHM regulatory requirements for the maximum interval between data downloads (and analysis) are ineffective for detection of imminent in-service component failures.

27. The yaw event on the Elgin was not captured by HUMS.

28. The low frequency of data capture from individual VHM sensors means that, for the majority of the time, they are not utilised and opportunities to detect problems are missed.

Safety Recommendations

The following Safety Recommendations have been made:

Safety Recommendation 2018-006

It is recommended that the European Aviation Safety Agency commission research into the development of Vibration Health Monitoring data acquisition and processing, with the aim of reducing the data set capture interval prescribed in the Acceptable Means of Compliance to CS 29.1465 and thereby enhancing the usefulness of VHM data for the timely detection of an impending failure.

Safety Recommendation 2018-007

It is recommended that the European Aviation Safety Agency amend the regulatory requirements to require that Vibration Health Monitoring data gathered on helicopters is analysed in near realtime, and that the presence of any exceedence detected is made available to the flight crew on the helicopter; as a minimum, this information should be available at least before takeoff and after landing.

Summary of safety actions

AAIB Special Bulletin

The AAIB published Special Bulletin S1-2017 which provided the initial facts of this investigation. The Special Bulletin and this report present the following safety actions:

Safety action by the helicopter operator

The operator subsequently introduced a number of measures to further strengthen the ability to detect impending bearing degradation. These included: a review of all HUMS data to ensure no anomalies, fleet-wide borescope inspections and a requirement for HUMS to be serviceable before flight. The operator also reviewed their HUMS processes and analytical procedures, correcting the omission in the documentation of the use of the IMDHUMS ToolBar analysis tools. They also introduced a requirement for an additional assurance check to be carried out by a second licensed engineer prior to releasing the helicopter to service.

Safety action by the helicopter manufacturer

On 31 December 2016 the helicopter manufacturer issued to all operators an 'All Operators Letter' (AOL), CCS-92-AOL-16-0019, which described the event. It emphasised the use of the HUMS Tail Gearbox Bearing Energy Tool, provided on the ground station, to detect a TRPCS bearing that is experiencing degradation, and recommended that this tool was utilised as often as reasonably possible.

ASB 92-64-011 was issued by the manufacturer on 10 January 2017 and introduced a once-only inspection of the TRPCS and bearing assembly for ratcheting, binding, or rough turning. It also called for a review of the HUMS Tail Gearbox Bearing Energy Tool. The manufacturer recommended that compliance was essential and to be accomplished prior to the next flight from a maintenance facility; three flight hours are allowed in order to return directly to a maintenance facility. The once-only inspection was mandated by FAA Airworthiness Directive (FAA AD) 2017-02-51 issued on 13 January 2017 and added a requirement to carry out a 10-hourly borescope inspection of the bearing in situ until further notice.

Concurrent with the release of ASB 92-64-011, the manufacturer published Temporary Revision 45-03 to require operators to use S-92A HUMS ground station software to review Tail Rotor Gearbox energy analysis CIs for alert conditions on a reduced flight hour interval. CIs in excess of published alert levels required inspection of the pitch change shaft and bearing.

The manufacturer developed a temperature sensing plug which could be retrofitted to in-service TRPCSs to establish fleet-wide trends. The temperature sensing plug installation was carried out under the authority of ASB 92-64-012, issued on 9 March 2017 with a scheduled compliance date of 13 April 2017.

On 24 March 2017 the manufacture issued All Operators Letter CCS-ALL-AOL-17-0008 to remind users of the IMD software of the approved zoom and undo zoom commands for interrogating the HUMS CI data. It also informed users that the IMD software would be obsolete in the near future and that the maintenance manual revisions for the SGBA were now available.

The helicopter manufacturer has worked with the bearing manufacturer to identify and implement a number of improvements to the bearing manufacturing process. An improved end play measuring tool has been introduced in order to carry out more accurate measurement and bearing setting up during assembly. The grease is now drawn from sealed cartridges and injected into the races using a syringe to ensure a more consistent distribution. The bearing is also now weighed before and after grease application.

Safety action by the helideck operator

Since the accident the '*Helicopter Occurrence - Communication Process*' procedures for the helideck operator's UK operations have been revised to include a requirement to report an accident or serious incident to the AAIB.

Helideck certification safety action

The Helideck Certification Agency will bring this case to the attention of the CAA and the ICAO HDWG to consider whether the assumptions used in the regulations remain valid in the light of this accident.

AAIB Field Investigation Reports

A Field Investigation is an independent investigation in which AAIB investigators collect, record and analyse evidence.

The process may include, attending the scene of the accident or serious incident; interviewing witnesses; reviewing documents, procedures and practices; examining aircraft wreckage or components; and analysing recorded data.

The investigation, which can take a number of months to complete, will conclude with a published report.

INCIDENT

Aircraft Type and Registration:	Airbus A319-111, G-EZIM
No & Type of Engines:	2 CFM56-5B5/P turbofan engines
Year of Manufacture:	2005 (Serial no: 2495)
Date & Time (UTC):	31 March 2017 at 1723 hrs
Location:	Isle of Man Airport, Isle of Man
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 6 Passengers - 124
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	34 years
Commander's Flying Experience:	7,800 hours (of which 7,543 were on type) Last 90 days - 164 hours Last 28 days - 76 hours
Information Source:	AAIB Field Investigation

Synopsis

Shortly after takeoff the flight crew experienced a smell and smoke/mist in the cockpit. The cabin crew also reported smoke in the cabin. The commander decided to return to land and while approaching the end of the downwind leg the smoke began to dissipate. The landing was uneventful. The aircraft had been dispatched with a seized Air Cycle Machine (ACM) in Pack 1, and in accordance with the Minimum Equipment List it had been activated in 'heat exchanger mode' after takeoff. It is probable that, in this mode, the air flowing through the damaged ACM produced the smell and smoke/mist.

Background to the flight

On 26 March 2017 an overheat defect was reported in G-EZIM for Air Conditioning Pack 1 (AIR PACK 1 OVHT). The pack was made inoperative and a FL370 altitude restriction was applied. The following day, troubleshooting maintenance activity resulted in new sensor parts being ordered and on 31 March, the morning of the incident, further maintenance resulted in the determination that the Air Cycle Machine[1] (ACM) in Pack 1 had seized. This was based on there being no airflow at the Pack 1 ram-air outlet. A new ACM was ordered and Pack 1 was reinstated for in-flight use only in 'heat exchanger mode', in accordance with the aircraft manufacturer's Minimum Equipment List (MEL) 21-52-01G '*Air cycle machine failed*'. 'Heat exchanger mode' means only operating the pack in flight when the total air

Footnote

[1] An ACM consists of a turbine-driven compressor and fan.

temperature (TAT) is less than, or equal to, 12°C. This results in the pack using cool ram air but the air still passes through the ACM.

History of the flight

The aircraft departed from Bristol Airport for the Isle of Man Airport and the flight crew operated Pack 1 in accordance with MEL 21-52-01G. The flight was uneventful. On the return flight, about 90 seconds after takeoff from Runway 26 at Isle of Man Airport, the commander noticed what looked like mist coming from the vent above his windshield. He described it as being light grey and that it was followed almost immediately by an "acrid burning smell much akin to a match just being struck." He turned to the co-pilot to ask if he could smell anything and noticed that the mist behind his seat was dense enough to highlight rays of sunshine entering the cockpit.

The cabin manager (CM) reported that, about 30 seconds after liftoff, he and another cabin crew member seated at the front of the aircraft noticed that the cabin smelt of burning and seconds later the cabin began to fill with "grey/hazy smoke".

The commander asked the co-pilot to transmit a MAYDAY call to ATC of "smoke in the cockpit" and requested a level-off at FL50. The commander then handed control to the co-pilot and noticed that the cabin attendant light was flashing on the Audio Control Panel on the centre pedestal, indicating that the cabin crew were trying to call them. The buzzer had probably been drowned out during the initial radio exchange with ATC. He gave the "Attention crew at stations" call over the public address (PA) which is a standard call to indicate to cabin crew that the flight crew are aware of a potential emergency situation but are unable to respond immediately due to cockpit workload.

The flight crew discussed their options but the density of the mist was sufficient to convince the commander that an ECAM warning, most likely for 'AVIONICS SMOKE', was almost inevitable. They advised ATC that they intended to return to the Isle of Man and were given a downwind heading. The co-pilot retained control while the commander spoke to the CM over the interphone, who confirmed that smoke was present in the cabin and that the passengers were anxious. The commander gave the CM a NITS[2] briefing, including that there might be a slim possibility of an evacuation should the situation worsen. He then made a similar announcement to the passengers over the PA stating than an evacuation was unlikely.

While approaching the end of the downwind leg for a tight base turn the smoke began to dissipate but the smell remained so the crew elected to continue with the MAYDAY instead of downgrading to a PAN. The commander resumed control at about 2,000 ft and an uneventful landing was made to a full stop on the runway. He made contact with the fire service who stated that they could not see anything unusual so they escorted the aircraft to the stand. The total flight time was about 11 minutes.

Footnote

2 The NITS briefing is an emergency briefing given to cabin crew; it stands for Nature, Intention, Time, Special Instructions.

Commander's comments

The commander stated that the co-pilot had selected Pack 1 on after reaching 1,000 ft aal and Pack 2 about 10 seconds later. The occurrence of the smoke was not soon enough after selecting the packs ON for him to associate this as being a possible cause. The smoke visually dispersed after about 2 to 3 minutes but the acrid smell remained. He commented that his main concern was the possibility of receiving an avionics smoke message on the ECAM which would have resulted in needing to consider setting the emergency electrical configuration. This would have increased the landing distance required while the landing distance available at the Isle of Man was only 1,613 m. He said they had insufficient time to troubleshoot or consult the Quick Reference Handbook and he was surprised at how quickly the 11 minutes passed. It was only after landing that the flight crew discussed the faulty pack as being a possible cause.

Description of the Air Cycle Machine

The ACM is installed between the fan plenum and the condenser of the air conditioning pack (Figure 1). The ACM contains a rotary body which is composed of three wheels connected by a tie-rod (Figure 2). The three wheels are a fan, a compressor and a turbine, which are encased in a fibreglass plenum diffuser. The shaft of the rotary body is supported by two self-acting foil-air bearings and a double self-acting air-thrust bearing. These bearings are located in closed chambers which are supplied with cool and pressurized air from the turbine stage. In the case of a significant air leakage to or from those chambers, or an increase of temperature of the cooling air, the air bearing can fail which eventually leads to ACM seizure.

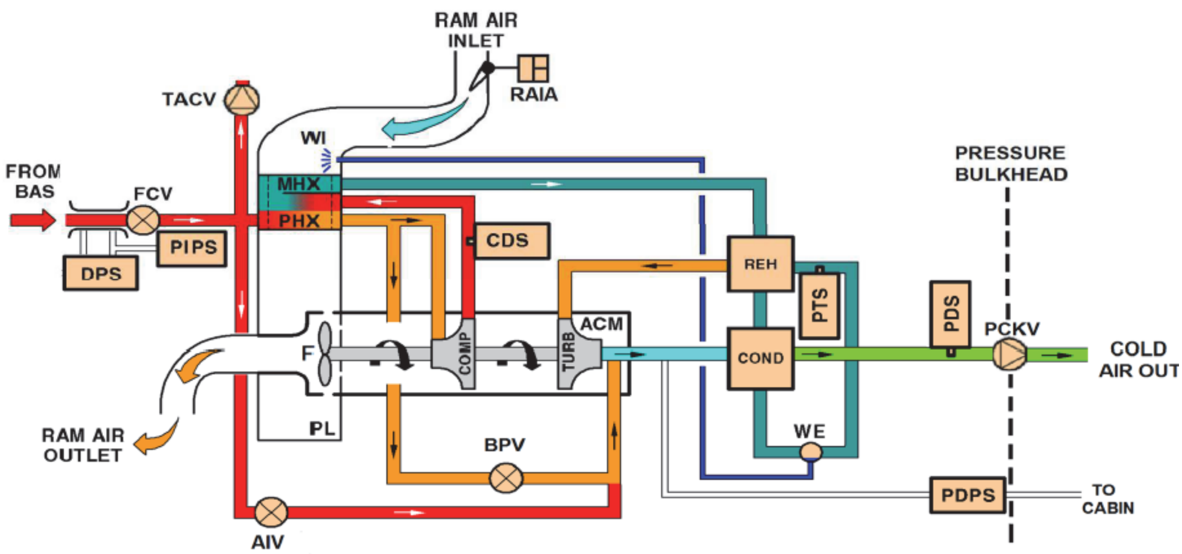


Figure 1

Schematic of the air flow through the Pack. ACM shown in the centre

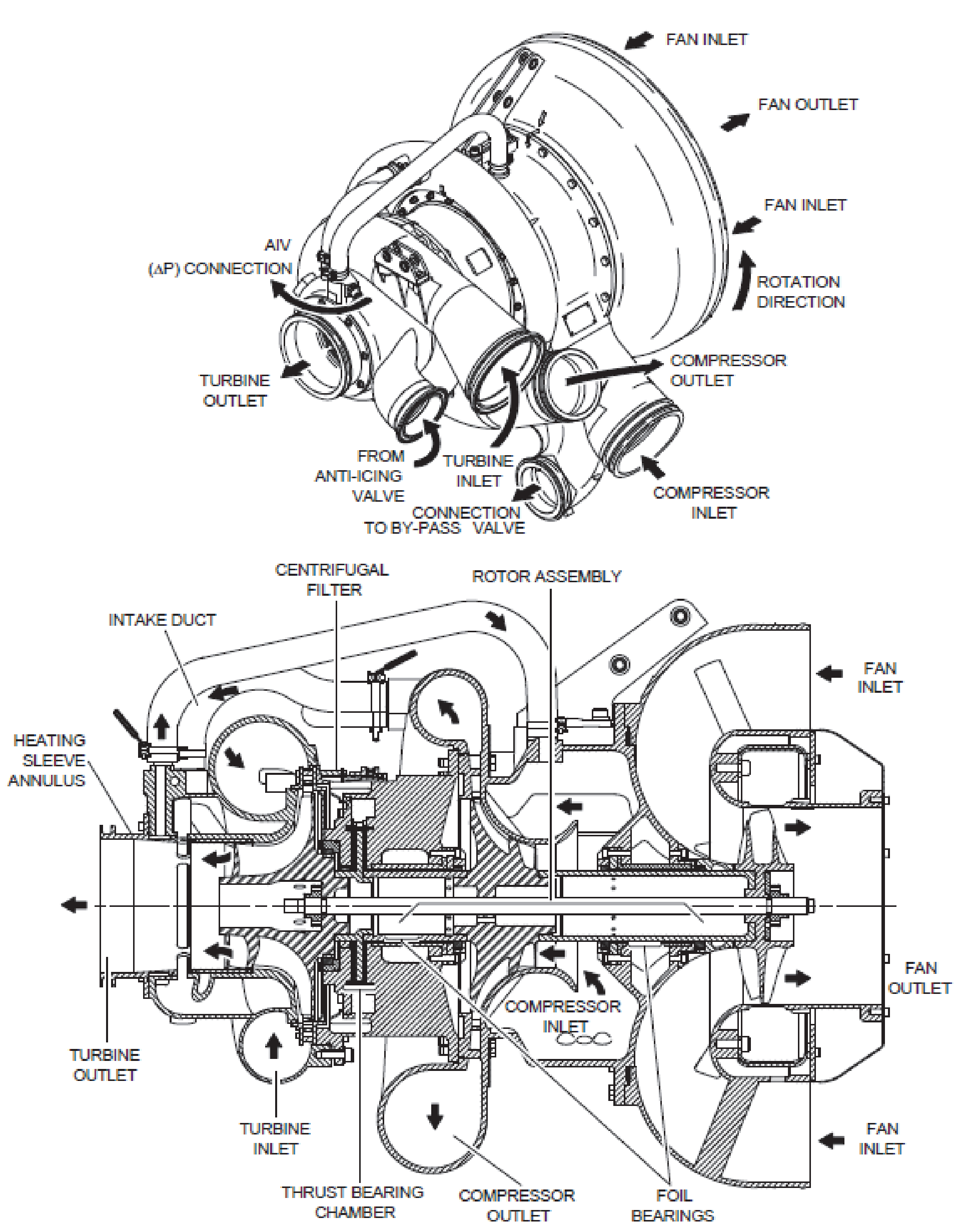


Figure 2

Schematic of ACM

Aircraft examination

During the aircraft troubleshooting process, Pack 1 ACM was suspected to be the cause of the smoke so Pack 1 was deactivated (by closing the pack flow control valve) and an operational test of Pack 2 was performed using bleed air from engines 1, 2 and the APU in turn, with no apparent smoke or smells. The ACM from Pack 1 was replaced and the aircraft returned to service. As of 29 June 2017 the aircraft had accumulated a further 903 hours and 541 cycles without any reports of further smoke or smells.

The ACM was sent to a repair and overhaul organisation but it was not tagged as being the subject of an air safety investigation; therefore, no detailed report or photographs of its examination were available. However, the overhaul organisation stated that '*the machine* *was tested faulty with rotary body seized*'. The repair documentation revealed that the turbine wheel was found damaged by friction on the turbine scroll and the rotary tie rod was also found damaged by friction, so the whole rotary body was replaced. The fan housing was not replaced, which indicates that the fan wheel had probably not touched the housing, and so the fan wheel had probably not been damaged.

The ACM had accumulated 25,000 flying hours. The ACM does not have a life limit but there is a repair scheme that is dependent on flying hours and cycles. It had previously been in a workshop for repair in April 2014 at 7,885 flying hours.

Aircraft manufacturer's MEL procedures

The aircraft manufacturer's Minimum Equipment List (MEL) contained the following entry for a failed ACM. The procedure allowed for the pack with the failed ACM to be operated in '*Heat Exchanger Cooling Mode only'* providing certain alerts were not present, which were not present in the case of G-EZIM. This mode allows the pack to be operated in flight when the TAT is less than or equal to 12°C.

21-52-01G Air cycle machine failed

Repair Interval	Nbr Installed	Nbr Required	Placard
C	2	1	No

(o) One may be operated on heat exchanger cooling only (air cycle machine failure) provided that:

1. The following alerts:
   AIR COND CTL 1(2)-A FAULT
   AIR COND CTL 1(2)-B FAULT
   associated with the operative pack are not displayed on the EWD, and
2. The affected pack outlet temperature indication is operative on the BLEED SD page .

Reference(s)

(o) *Refer to OpsProc 21-52-01G Air Conditioning Pack (One Air Conditioning Pack in Heat Exchanger Cooling Mode only)*

The aircraft manufacturer confirmed that it was the intention of MEL 21-52-01G to allow the pack to be operated in the air when the ACM had seized. They did not have any records from other customers reporting that a seized ACM had started turning again in flight. Based on the findings from this investigation the manufacturer stated:

> *'In the absence of evidence further to the ACM examination, it was not possible to determine the root cause of the ACM failure and its condition at the time of the event. Therefore, the aircraft manufacturer is not in position to propose any safety action at this stage.'*

Aircraft operator comment

The aircraft operator had stated that it had applied MEL 21-52-01G to three other A320 series aircraft following inoperative ACMs in the previous 12 months, with no adverse effects. However, it was not known if any of these involved ACM seizures.

The operator is reviewing what action should be taken in the future when an ACM is found to be seized. The aircraft manufacturer's manuals do not provide the option of dispatching with one pack turned off. The pack either has to be disabled, which means that the flight crew cannot turn it on if the other pack fails, or they have to operate the pack in 'heat exchanger mode'.

Analysis

In this event on G-EZIM, the smells and smoke/mist experienced by the flight crew and cabin crew occurred after Pack 1 was turned on, which was believed to contain a seized ACM. Turning the pack on in 'heat exchanger mode' results in air flowing through the ACM and it is possible that this airflow caused the ACM to turn, but due to a problem with the air bearings there was friction which generated heat and smells. This scenario does not explain why the symptoms did not occur on the earlier flight. However, the ACM in Pack 1 was found to be damaged and replacing it has resulted in no further occurrences of smells or smoke/mist, which increases the likelihood that the ACM was the cause.

The manufacturer's manuals permit an air-conditioning pack to be operated in 'heat exchanger mode' when the ACM has seized. Operating a pack in 'heat exchanger mode' with an ACM in such a condition could result in the airflow being sufficient to turn what was considered to be a seized ACM. The friction from this operation could then produce undesirable smells and potential smoke/mist into the cabin and cockpit air systems. The aircraft operator is reviewing what action should be taken in the future when an ACM is determined to be seized.

SERIOUS INCIDENT

Aircraft Type and Registration:	DHC-8-402, G-PRPH
No & Type of Engines:	2 Pratt & Whitney Canada PW150A turboprop engines
Year of Manufacture:	2010 (Serial no: 4323)
Date & Time (UTC):	26 May 2017 at 1030 hrs
Location:	On descent into Manchester Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 4 Passengers - 53
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	33 years
Commander's Flying Experience:	4,000 hours (of which 330 were on type) Last 90 days - 185 hours Last 28 days - 40 hours
Information Source:	AAIB Field Investigation

Synopsis

Towards the end of the flight the Central Warning System indicated an oil pressure loss on the No 2 engine. The engine was shut down and an uneventful single engine landing was carried out. It was found that a cap locating the propeller overspeed governor test solenoid had detached, allowing most of the oil from the No 2 engine lubrication system to be lost. Investigation of the component revealed that the four cap securing bolts had failed, predominantly in fatigue. Extensive investigation failed to identify conclusively the root cause of the bolt fatigue damage. Although three similar in-service failures of these bolts have occurred on other aircraft types utilising this design of governor, no others have been recorded on DHC-8-400 types and all those that have occurred have been on units of an earlier modification state.

History of the flight

The commander reported that, whilst descending through FL120, the warning system emitted a 'triple chime' with a red Central Warning System indication of No 2 engine oil pressure low. He checked the engine display and noted an indicated oil pressure of 17 psi, which was decreasing. He reduced power, although being in the descent the engine was already operating at close to the flight idle setting. As the oil pressure continued to drop, he elected to shut down the No 2 engine, taking over the flying of the aircraft from the co-pilot before doing so. The flight crew carried out the Vital Actions and ran through the QRH. The commander communicated with the cabin crew, carried out a 'NITS[1]' brief, informed ATC and obtained the destination weather. He then addressed the passengers. A normal landing was carried out following radar vectoring to the ILS.

Aircraft information

The propellers on the DHC-8-400 are each controlled by a hydraulic system incorporating an overspeed governor (Figure 1). This increases blade pitch should excessive propeller speed be detected. The function may be tested at a lower engine speed by operating a solenoid valve on the overspeed governor, controllable from the flight deck. Operation of the solenoid causes movement of a hydraulic nose, realigning hydraulic ports and enabling the overspeed governor to perform its function, but at a reduced propeller speed which is within the normal operating range. All propeller control functions are achieved utilising the same oil supply as used for lubrication of the engine bearings and reduction gear.

Functional testing of the overspeed governor is carried out on the first flight of the day by most DHC-8-400 operators.

During examination of the No 2 engine on G-PRPH after the landing, it was observed that the propeller overspeed governor ground reset solenoid valve cap had separated from the body of the unit. Engine oil had therefore leaked under pressure until most of the system contents were lost.

Figure 1

General view of propeller overspeed governor unit

Footnote

1 The NITS briefing is an emergency briefing given to cabin crew; it stands for Nature, Intention, Time, Special Instructions.

Overspeed governor unit examination

The No 2 engine overspeed governor unit was removed from the reduction gearbox and sent to the AAIB. Examination showed that the cap over the ground reset solenoid had detached as a consequence of failure of the four ultra-high tensile steel bolts securing it to the body of the governor unit (Figure 2). The hydraulic nose had fractured approximately in the plane of the bolt failures. The component was examined by the manufacturer in the presence of the AAIB. It was noted that considerable fretting was present on the shim under the end cap and on the mating faces. The separated heads of the four bolts remained joined in pairs by wire locking and were recovered.

The failed bolts were forwarded to a specialist laboratory for examination. One bolt showed evidence of predominant fatigue failure, a second started as fatigue then changed to serial overload. The third started in fatigue in the reverse direction to the previous two, whilst the fourth was a complex fracture, probably indicating this was the last of the four to fail. Attempts at fatigue striation counting indicated that one of the bolts had suffered in excess of 7,000 cycles to failure. The numbers of cycles to initiation are not known.

Examination of the wire locking that both secured the bolt heads and joined them in pairs indicated that, though not in conflict with the production drawings, the orientation on this unit resulted in different pairs being joined from the norm. Consequently, the length of wire locking between two of them was greater and the routing was less direct.

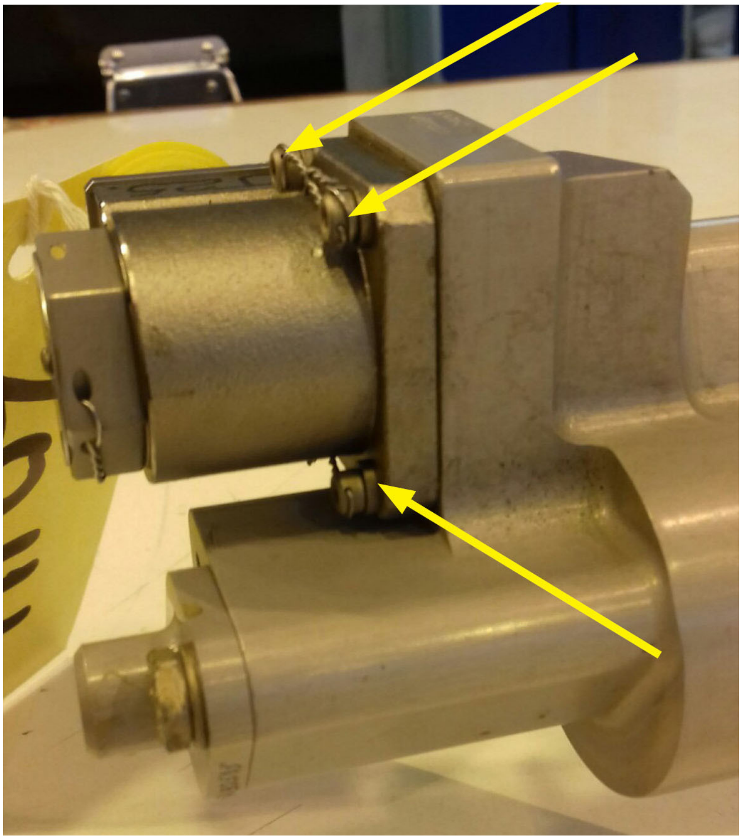


Figure 2

Arrows showing position of bolt group which failed on G-PRPH

Further analysis indicated that such alternative locking wire orientation was necessitated, on infrequent occasions, when dictated by the final rotational position of locking wire holes in the bolt heads once correctly torque tightened. It is possible that a significant number of units in service have this orientation of wire locking.

No 2 engine overspeed governor history

The component manufacturer's records indicate that no workshop activity involving disturbance of the four bolts had occurred since 2011, when the unit was built.

It was determined from build records that, at the time this unit was built, a shortage of the correct bolts had necessitated a Production Permit to be obtained for use of an alternate type of bolt. The principal difference between the alternative bolt type and that specified on the original manufacturing drawings was that the former utilised machined, rather than rolled threads. The creation of a Production Permit required the suitability of the substitute component to be assessed by the manufacturer's stress office. The alternative bolt has now been utilised for a considerable period and it was determined that a substantial number of units have been dispatched with the bolts having machine cut threads.

Other information

The component manufacturers supplied the information that significant tensile loading on the bolts as a result of internal pressure only occurs when the solenoid is energised to function the overspeed governor. They also reported that they were aware of three other instances of this type of failure. All were to units on different (earlier) aircraft/engine combinations, and all were on units manufactured before a shim was introduced to compensate for the solenoid's central core standing proud of the coil housing with adverse tolerances.

The governor operates in a vibratory environment with the potential for inflicting fatigue damage to components such as the cap attachment bolts.

Discussion

Functional testing of the governor is carried out regularly by flight crew, generally on a first flight of the day basis. Exact policies on the frequencies of these operational tests, however, differ between operators. Consequently, given the limited number of overspeed tests likely to have been carried out in the life of the unit, it is unrealistic to presume that a significant proportion of the fatigue damage observed during laboratory examination (over 7,000 cycles) was sustained as a result of such tests during service.

The amount of fretting of mating surfaces below the cap of the failed unit indicates that reduced tension in the bolts had been present for an extended period of operation. The fatigue damage to the bolts is also consistent with a reduced tension being present, along with cyclic loading. Since the striation count on the most fatigued of the failed bolts demonstrates a number of load cycles significantly in excess of the likely number of operational loadings, it is presumed that the vibratory environment accounted for the cyclic loading and hence the fatigue damage.

The manufacturer determined that the use of machined thread bolts rather than rolled thread bolts should not result in a reduced life in this application. In addition, a significant proportion of units manufactured have now been assembled using such bolts, with no adverse consequences in service. Hence it does not appear that the choice of bolt type has influenced this failure.

In the absence of an obvious cause for the failure, the possibilities are as follows:

1 Environmental
- (a) Impact of the solenoid during transit, installation or maintenance
- (b) Excessive vibration

2 Tampering
- (a) Removal of the solenoid since original unit manufacture

3 Assembly
- (a) Inadequate or incorrect bolt wire locking
- (b) Excessive torque application
- (c) Insufficient torque application

There was no evidence of damage sustained by an impact and there have been no reports of excessive vibration on aircraft equipped with this particular governor during recent years of service.

Undocumented removal of the solenoid is unlikely, since it would serve no useful purpose that could not be served by removal of the complete overspeed governor.

The slightly unusual, but not incorrect, wire locking was originally suspected to be significant but this was ruled out following further consideration as the wire locking was still effective.

Excessive bolt torque application tends not to create a fatigue condition unless thread damage occurs, whereas a low assembly torque creates the conditions for fatigue failure of bolts working in tension and subjected to cyclic loading. It was not possible to establish if incorrect torque application on the assembly was a factor, as low bolt torque leaves no conclusive evidence.

Conclusion

The loss of oil pressure on the No 2 engine was because a cap locating the propeller overspeed governor test solenoid had detached due to failure of the attachment bolts, predominantly in fatigue. The cause of the bolt group fatigue failure was not established, but the possibility that a lower than specified assembly torque tightening figure was used on one or more bolts during assembly could not be ruled out.

ACCIDENT

Aircraft Type and Registration:	Europa, G-MIME
No & Type of Engines:	1 Rotax 912 ULS piston engine
Year of Manufacture:	2001 (Serial no: PFA 247-12850)
Date & Time (UTC):	28 September 2017 at 1500 hrs
Location:	Grove Farm, Wolvey, Warwickshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Fatal) Passengers - 1 (Fatal)
Nature of Damage:	Aircraft destroyed
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	55
Commander's Flying Experience:	546 hours (of which 48 were on type) Last 90 days - 12 hours Last 28 days - 1 hour
Information Source:	AAIB Field Investigation

Synopsis

The aircraft landed a significant distance down the runway at Grove Farm and was unable to stop before the end. The aircraft passed through a hedge and caught fire before coming to rest in the field beyond the end of the runway. Although both the pilot and passenger survived the accident, both subsequently died of the burns they sustained.

History of the flight

The pilot and passenger arrived at Grove Farm, where the aircraft was kept in a hangar, just after 1400 hrs. Witnesses stated that the purpose of the flight was to fly over a local site where both the pilot and passenger were working. There were no witnesses to the preparation or flight of the aircraft. It was picked up by radar for the first time at 1443 hrs and for the last time at 1445 hrs, and the radar track indicated that it took off from Runway 29, flew a circuit and made an approach back to Runway 29.

Just after 1500 hrs witnesses saw the pilot and passenger in the yard of the farm on which the strip is located; both were severely burnt. The aircraft had passed through the hedge at the end of Runway 29 after landing and come to rest in the field beyond. It was severely disrupted and had suffered significant damage from fire. Both the pilot and passenger subsequently died of the burns they sustained.

Accident site

The aircraft wreckage was located close to the western end of the runway. It had overshot the runway, passed through a thick, four-feet high hedge and a shallow ditch before coming to rest approximately 10 m past the hedge (Figures 1 and 2). Evidence indicated that the aircraft was on the ground and turning slightly left when it contacted the hedge. As a result, the right wingtip contacted the hedge before the left wingtip and this slewed the aircraft back more in line with the runway centreline.

The internally mounted flap drive crosstube and its hinge attachments were found close to the hedge suggesting they had become detached as the aircraft passed through the hedge; the first signs of fire were visible on the ground in the vicinity. The engine and firewall forward section of the fuselage remained upright but the remainder of the aircraft was found inverted and the fuselage was substantially disrupted in the cockpit area; both doors were present. A post-impact fire, which burnt for over 30 minutes, consumed or severely damaged large parts of the aircraft including almost all the fuselage and empennage, but also the inboard parts of the wings and flaps.

The engine cowlings and engine were also severely damaged by the fire. All three blades of the propeller had broken off and were found close to the main wreckage; the nature of their damage and location indicated they were not under power when the aircraft passed through the hedge.

Figure 1

General view of accident site from the end of the runway through the hedge

Figure 2

General overhead view of the accident site (from AAIB UAS)

The runway was examined and it was in good condition with short grass and a reasonably firm surface. A touchdown mark from the single mainwheel was found close to the centre line of the runway approximately 73 m from the start of the runway (Figure 3). It indicated the aircraft had made a firm touchdown after which it became airborne again. Although there were more ground markings approaching the hedge, the subsequent touchdown point could not be identified.

Figure 3

View in direction of landing (from AAIB UAS)

Recorded information

None of the aircraft's avionics survived the post-accident fire and no aircraft recorded data was recovered; however, a limited amount of radar data was recorded that tracked the aircraft in a left-hand circuit for Runway 29. Transponder Mode C altitude information, corrected to the QNH of 1017 hPa and the runway elevation of 380 ft, indicated that the circuit was flown at a height of 485 ±50 ft aal (Figure 4).

Figure 4

Circuit ground track from radar data

Aircraft information

General

The Europa is an amateur built side by side two-seat light aircraft of conventional layout and composite construction. It is available with either a tricycle undercarriage or as a mono-wheel version with a single mainwheel, tailwheel and outriggers on the wings.

It is sold in kit form and, in the UK, its construction is overseen by the Light Aircraft Association (LAA) through a network of approved inspectors. Once inspections and flight tests confirm the aircraft has been completed to the required standard, a Permit to Fly can be issued.

G-MIME was completed as a mono-wheel version in 2001 and had since flown approximately 500 hours. The accident pilot purchased the aircraft from its second owners in May 2016.

Engine

This aircraft was fitted with the recommended Rotax 912 ULS engine with an optional carburettor heat system modification which used hot coolant from the cooling system to heat the carburettor bodies and thereby prevent carburettor ice formation.

The electrically controlled variable-pitch propeller was driven via the engine's reduction gearbox.

Fuel system

The fuel tank was fitted in the fuselage behind the seats and was saddle-shaped to fit around the pitch and flap control push rods. The two sides of the tank were configured to provide a main tank of approximately 60 litres and a reserve tank of approximately 8 litres.

In 2003, this aircraft had been fitted with an approved modification which installed two electric fuel pumps in parallel instead of the normal single electric fuel pump in series with a mechanical engine driven fuel pump. The system also included a feature which provided an automatic changeover of the fuel supply to the reserve tank in the event of a loss of fuel pressure from the main fuel tank feed. Because of this modification, the LAA had agreed that a fuel vapour vent return line was not required as this system design and installation, which had been validated by testing, mitigated the risk of fuel vapour formation. This modification also approved the replacement of some flexible fuel pipes with stainless steel corrugated pipes.

The aircraft did not have water drain valves fitted to the fuel tank outlets but did have a gascolater[1] in the fuel supply line to the engine.

The aircraft was being operated using E5 MOGAS[2] which required inspection and certification documents to approve its use.

Electrical system

A system consisting of a battery and an integral engine generator provided electrical power for the aircraft. The battery was located behind the cockpit area along with an external power connection socket. Various cables, switches and circuit breakers were installed to distribute the electrical power.

Relevant maintenance history

The aircraft had been issued with a Permit to Fly and the date of expiry of its Certificate of Validity was 21 October 2017.

The aircraft, engine and variable-pitch propeller logbooks were inspected and contained records of the regular maintenance and inspection work that were required.

Footnote

1 A drainable filter and water collector.
2 E5 MOGAS is regular forecourt unleaded petrol which meets EN228 Standard and can contain up to 5% ethanol.

Inspections and a test flight relating to the renewal of the Certificate of Validity had been undertaken during September 2017 but the completed form had not been submitted to the LAA. The LAA inspector who carried out the Annual Inspection reported that the aircraft was "nice and well looked after."

No inspection and certification documents approving the use of E5 MOGAS could be located.

Aircraft examination

Due to the extent and severity of the post-accident fire, the extent of any inspection was limited as most components had been consumed or were melted by the fire; mainly steel parts survived along with the core of the engine and the outer portions of the wings.

The remains of the engine were taken to the UK Agent for inspection. The engine core was disassembled and inspected. No anomalies were identified that would have affected the performance of the engine. Inspection of the engine ancillary components, such as the ignition system or fuel system carburettors, was not possible as they were too severely damaged by the fire.

The propeller was inspected and found to be in the fine pitch position. This is the normal position for takeoff and landing.

Survivability

Both the pilot and passenger survived the accident but suffered extensive burns in the subsequent fire which was not survivable.

The pilot

The pilot undertook some flying training in 1980 and 1981, resumed training in 1999 and gained a PPL(A) in 2000. Much of his experience had been gained on microlights with the conversion to the faster and heavier Europa aircraft being within the previous 14 months. At the time of the accident, he was operating under the privileges of an NPPL(A). He was familiar with operating a microlight from Grove Farm but less so in the Europa, although his conversion to the aircraft included a visit to the strip with an instructor before he moved the aircraft there permanently. The instructor commented that he felt the pilot had adapted well to the Europa and to operating it from short strips.

According to witnesses who knew the pilot and had flown with him from Grove Farm, he tended to have the radio in the aircraft tuned to Coventry Airport Air Traffic Control (ATC) to obtain local weather and traffic information. On the day of the accident, however, he did not contact Coventry ATC, and no distress call was heard on any frequency.

Toxicology

The results of the Forensic Toxicology Report on the pilot were negative except for drugs consistent with his medical treatment after the accident. The test for carbon monoxide poisoning was also negative.

Airfield information

Grove Farm is a grass farm strip orientated 110°/290°M which is 350 m long and at an elevation of 380 ft amsl. Circuits are flown at 500 ft agl. Airfield guides include a warning about a 4 ft hedge on approach to Runway 11 (departure end of Runway 29). This is a substantial hedge made up mainly of hardwood species such as hawthorn.

There are numerous large trees close to the strip which do not interfere with the approach directly but, with a southerly wind, might generate some turbulence or wind effects on short finals to Runway 29.

Weight and balance

The investigation could not confirm how much fuel was loaded on G-MIME and therefore could not calculate the actual weight and balance of the aircraft.

The maximum takeoff and landing weight of the aircraft is 621 kg. It was possible to estimate the minimum takeoff weight of the aircraft on the day of the accident as follows. The aircraft empty weight was 392 kg, and the combined weight of the two occupants was 189 kg. A reasonable minimum fuel load for the intended flight would have been 30 litres (22 kg) (including a 30-minute reserve). Although the actual fuel load could not be verified, these figures suggested that the aircraft weight would have been close to its maximum.

Aircraft performance

The length of the strip at Grove Farm was adequate for the Europa at maximum operating weight, allowing for the performance factors recommended for landing in Civil Aviation Authority (CAA) General Aviation Safety Sense Leaflet 7c – '*Aeroplane Performance'* (15% for dry grass and a further 43% as a safety margin).

Meteorology

There are no weather reporting facilities at Grove Farm. Birmingham International Airport is 15 nm to the west and was reporting a southerly wind of 8 kt, with visibility greater than 10 km, few cloud above 3,000 ft aal and a temperature of 18°C. The QNH was reported as 1017 hPa. Images from a police helicopter that attended the scene shortly after the accident indicated that the wind speed and direction were similar to those at Birmingham and perpendicular to the runway at Grove Farm.

Analysis

The aircraft passed through a hedge at the end of Runway 29 on landing at Grove Farm strip and caught fire immediately. Ground marks showed that the aircraft touched down some distance from the beginning of the runway and bounced before touching down again with insufficient distance to stop before the hedge.

The ground marks indicated that the aircraft was on the ground at the end of the runway and evidence from the propeller indicated the engine was at low power. As the aircraft passed through the hedge and the shallow ditch beyond, the fuselage was disrupted, particularly in the area behind the cockpit. This most likely caused damage to the fuel system that allowed fuel to escape which was then ignited by a spark from the damaged electrical system.

There were no witnesses to the preparation or flight of the aircraft and no distress calls were heard on the radio.

The technical examination was limited by the severity and extent of the post-accident fire but, within these limitations and after a review of the maintenance documentation, no anomalies that may have contributed to the accident were identified.

The aircraft was eligible for approval to use E5 MOGAS fuel, but the inspections and checks of the fuel system required for approval had not been completed. These verify that the fuel system design and installation is compatible with the use of E5 MOGAS to avoid issues associated with its use such as chemical compatibility of components, vapour locking, carburettor icing and water absorption. Carburettor icing was considered unlikely during the accident flight because the aircraft had a permanent carburettor heat system fitted. It could not be determined whether the other issues associated with this type of fuel had an adverse effect on the accident flight.

It was not determined why the pilot decided to fly a circuit before attempting to land rather than completing the local flight as intended. He had significant experience of operating into the strip and would have been familiar with the need to touch down close to the beginning of the runway. A technical fault, or a change of plan for some other undetermined reason may have led to the pilot's decision to immediately return to land and, if so, this distraction might have contributed to the touchdown point being significantly further down the runway than intended. However, no cause for such a distraction was identified during the investigation.

It is likely that there was turbulence in the final stages of the approach caused by the southerly wind crossing the trees immediately south of the Runway 29 threshold. It is possible that this affected the aircraft's touchdown point.

Conclusion

The aircraft took off from Runway 29 at Grove Farm with a pilot and passenger on board who, according to witnesses, intended to fly into the local area. After takeoff, for a reason that was not determined, the aircraft was immediately positioned for an approach to land. The aircraft touched down beyond the threshold of the runway, bounced and touched down again with insufficient distance to stop before a hedge at the end of the runway. It passed through the hedge, caught fire and came to rest in the field beyond. Although both the pilot and passenger survived the accident, they subsequently died of the burns they sustained.

Safety actions/Recommendations

The aircraft was eligible to use E5 MOGAS, but no evidence could be found to show that the inspections and checks of the fuel system required for approval had been completed. Although it could not be determined whether the type of fuel being used was a contributory factor, this is the second recent accident where there was no evidence of the correct procedures being followed to approve the use of E5 MOGAS[3].

> The LAA agreed during discussions with the AAIB that it would remind all owners, via a Safety Spot article in their members magazine, of the importance of correctly following the published procedures to approve the use of E5 MOGAS in their aircraft.

This article was published in the January 2018 edition.

Footnote

[3] See report into the accident to Europa, G-NDOL in AAIB Bulletin 11/2017.

ACCIDENT

Aircraft Type and Registration:	Rockwell Commander 114, G-TWIZ
No & Type of Engines:	1 Lycoming IO-540-T4B5D piston engine
Year of Manufacture:	1978 (Serial no: 14375)
Date & Time (UTC):	1 August 2017 at 1243 hrs
Location:	Lydd Airport, Kent
Type of Flight:	Private
Persons on Board:	Crew -1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Left landing gear upper side-brace fractured, damage to left wing and left cabin access step
Commander's Licence:	Light aircraft pilot licence (LAPL)
Commander's Age:	79 years
Commander's Flying Experience:	469 hours (of which 347 were on type) Last 90 days - 1 hour Last 28 days - 1 hour
Information Source:	AAIB Field Investigation

Synopsis

The aircraft's left main landing gear (MLG) leg collapsed while landing at Lydd, following the fracture of the left MLG upper side-brace during retraction of the landing gear after takeoff. The upper side-brace had fractured under the application of landing gear retraction loads, due to the presence of a fatigue crack originating at a 'cold shut' casting defect. In response to this investigation the Type Certificate holder issued Service Bulletins applicable to the Rockwell Commander 112 and 114 aircraft models requiring inspection of the upper side-brace for cracking.

History of the flight

The commander took off from Runway 21 at Lydd Airport, with one passenger on board. During the climb the commander moved the landing gear selector lever to UP but he noted that the left MLG green light remained lit, indicating that this landing gear had not fully retracted. This situation was confirmed by Lydd Airport ATC by radio. The commander recycled the landing gear several times, but on each occasion when the landing gear was selected UP, the left mainwheel remained extended with the green light lit. When the landing gear was selected DOWN, all three landing gear green lights illuminated.

The commander decided to return to Lydd Airport and, on approach to Runway 21, ATC advised that all three landing gear legs looked down. The commander landed the aircraft normally, initially on all three wheels but as the aircraft slowed during the landing roll, the left MLG leg folded inwards. The commander turned the fuel selector and battery master switch to OFF before the aircraft stopped, and he guided the aircraft to the grass to the left of the runway. Once the aircraft came to rest, the commander and his passenger exited the aircraft without difficulty. The aircraft sustained damage to the left wing and left cabin access step. During the recovery of the aircraft it was discovered that the left MLG upper side-brace had fractured, preventing the left landing gear leg from retracting, or locking in the extended position.

Figure 1

G-TWIZ following the collapse of the left MLG (photo courtesy James Giller)

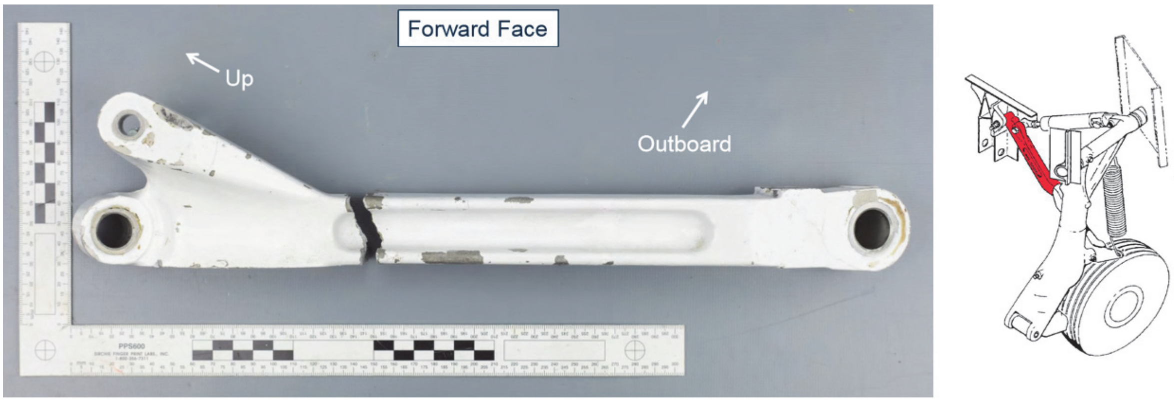
Aircraft information

The aircraft was manufactured in 1978 and had accumulated 2,543 airframe hours when the accident occurred. The last maintenance inspection, a six-monthly check, was carried out on 6 April 2017. The last annual inspection was carried out on 5 October 2016 at 2,522 airframe hours. A review of the aircraft's technical records did not reveal any evidence of the left MLG side-brace having been replaced since the aircraft was manufactured.

The left and right MLG side-brace components, part numbers 45304-1 and 45304-2 respectively, are common to both the Rockwell Commander 112 and 114 aircraft models. The MLG side-brace components are manufactured from aluminium alloy using a casting process.

Aircraft examination

The fractured landing gear upper side-brace, part number 45304-1, was removed from the aircraft and subjected to metallurgical examination.

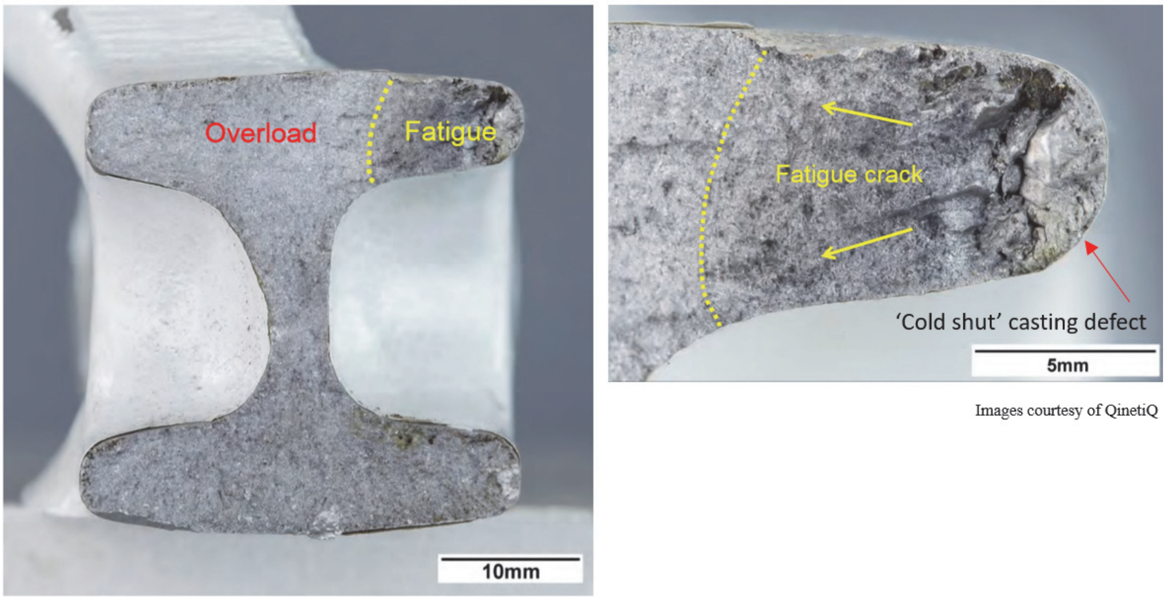


Images courtesy of QinetiQ and Commander Aircraft Corp.

Figure 2

Fractured left MLG upper side-brace

Ink markings on the surface of the casting, beneath the external paint layer, indicated that it had been manufactured in October 1977. The metallurgical examination indicated that a fatigue crack had initiated at the location of a 'cold shut[1]' casting defect. The fatigue crack and casting defect extended to approximately 14% of the cross-sectional area of the side-brace section. The remainder of the fracture surface consisted of ductile overload and no crack arrest marks were observed. The metallurgical analysis also revealed the presence of additional internal and surface-breaking casting defects and sand particles within the casting, adjacent to the fracture surface.



Images courtesy of QinetiQ

Figure 3

Casting defect and fatigue crack region

Footnote

1 A 'cold shut' casting defect occurs where a front of liquid metal within the mould solidifies prematurely during casting, leaving a weak spot in the cast component.

The upper side-brace casting drawing was supplied to the AAIB by the aircraft's Type Certificate holder, Commander Aircraft Corporation. This stated that the upper side-brace was required to be manufactured from 356-T6 aluminium alloy. Electrical conductivity measurements and qualitative energy-dispersive X-ray analysis of the elements present in the microstructure of the upper side-brace confirmed that the material was consistent with 356 aluminium alloy in the T6 heat-treatment condition. The casting drawing classified the upper side-brace casting as a '*Class 1A, Grade C*' casting in accordance with the MIL-C-6021 standard *'Castings, Classification and Inspection of'*. Class 1A castings must be individually inspected using radiographic (X-ray), dye penetrant and visual inspection techniques. Both the dye penetrant and radiographic inspection techniques specify that no cracks or 'cold shuts' should be present in the component.

The metallurgical examination determined that the casting defect that initiated the fatigue crack was large enough to be observed by radiographic inspection.

Maintenance requirements

The aircraft Maintenance Manual, at section 6 *'Landing gear, wheels and brakes',* contains the requirement to visually inspect the MLG side brace links for cracks. This task is to be performed at annual maintenance inspections:

> ***CLEANING, INSPECTION AND REPAIRS OF MAIN GEAR***
>
> *a. Clean all parts with a suitable dry type cleaning solvent.*
>
> *b. Inspect all bolts, bearings and bushings for excess wear, corrosion and damage*
>
> *c. Inspect gear trunnion and side brace links for cracks, bends or damage.*

Previous event

A search for previous similar events revealed only one other occurrence, involving a Rockwell Commander 114, serial number 14367, that occurred during landing in July 2004. This event was investigated by the NTSB[2] which determined that a MLG upper side-brace had fractured due to a fatigue crack originating at a casting defect. The Rockwell 112/114 Type Certificate holder stated that the side-brace castings were produced in batches of 50 and that after casting, a machining operation was performed on each casting to remove one of the cylinder attachment lugs to produce either a left (45304-1) or right (45304-2) side-brace component. Therefore a single casting batch produced sufficient components for 25 aircraft.

The close proximity in aircraft serial numbers between G-TWIZ (serial number 14375) and N114TS (serial number 14367) indicates that the defective side-brace components may have been produced from the same casting batch, although the Type Certificate holder could not locate the production records to confirm this hypothesis.

Footnote

2 NTSB investigation CHI04LA199; Rockwell 114 N114TS, right MLG collapse during landing at Gerald R. Ford International Airport, Grand Rapids, Michigan, USA on 28 July 2004.

A search of the FAA Service Difficulty Reporting System and the ECCAIRS[3] database did not reveal any further similar occurrences.

Analysis

The left MLG side-brace fractured during the landing gear retraction process following departure from Lydd Airport, causing the left MLG leg to remain extended but not locked in the down position. The left MLG therefore collapsed during the landing at Lydd Airport.

The side brace fractured due to ductile overload, following propagation of a fatigue crack originating at a ‘cold shut’ casting defect. This casting defect was large enough to be detected by radiographic (X-ray) inspection and the side brace component should have been inspected using this method during the manufacturing process, as required by the component’s Class 1A classification under the MIL-C-6021 standard.

This event is the second recorded incident of a MLG side brace failure due to propagation of a fatigue crack from a casting defect. It could not be confirmed whether both failed components were from the same manufacturing batch.

Conclusion

The aircraft’s left MLG leg collapsed during landing due to the fracture of the upper side-brace during retraction of the landing gear after takeoff. The upper side-brace fractured under the application of landing gear retraction loads due to the presence of a fatigue crack originating at a ‘cold shut’ casting defect. This casting defect was large enough to be detectable by radiographic (X-ray) inspection when the casting was manufactured and this inspection method was required according to the component’s classification under MIL-C-6021. This is the second occurrence of a Rockwell Commander 114 MLG collapse due to side-brace fracture originating at a casting defect within the side-brace.

Safety action

In response to this investigation the Type Certificate holder, Commander Aircraft Corporation, issued Service Bulletins SB-112-75 and SB-114-37, applicable to the Rockwell Commander 112 and 114 aircraft models respectively. These Service Bulletins require inspection of the upper side-brace for cracking in the area of the retraction cylinder attachment and replacement of the upper side-brace if it is found to be cracked and not repairable.

Footnote

[3] European Coordination Centre for Accident and Incident Reporting Systems.

AAIB Correspondence Reports

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

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

The accuracy of the information provided cannot be assured.

ACCIDENT

Aircraft Type and Registration:	Colibri MB2, G-HRLM	
No & Type of Engines:	1 Volkswagen 1834 piston engine	
Year of Manufacture:	1989 (Serial no: PFA 043-10118)	
Date & Time (UTC):	28 August 2017 at 0900 hrs	
Location:	Near Abbots Bromley Airfield, Staffordshire	
Type of Flight:	Permit Renewal Test Flight	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - 1 (Serious)	Passengers - N/A
Nature of Damage:	Aircraft destroyed	
Commander's Licence:	Commercial Pilot's Licence	
Commander's Age:	39 years	
Commander's Flying Experience:	16,702 hours (of which 7 were on type) Last 90 days - 259 hours Last 28 days - 87 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

The aircraft was on a test flight to renew its Permit To Fly following a protracted period of maintenance and had not flown for approximately five years. The pilot was approved by the LAA to undertake test flights. He reported that the aircraft engine started easily and warmed up satisfactorily, engine power checks were satisfactory, including functional checks of the magnetos, and the carburettor heat control operated correctly.

The pilot reported that the acceleration for takeoff, the lift-off and initial climb were all satisfactory. At a height of approximately 150 ft, the engine lost power, ran erratically for a few seconds and then stopped. The pilot initially turned right but, after considering the nature of the terrain ahead, reversed the turn to the left to attempt a forced landing. The area beyond the airfield boundary is constrained by a reservoir. The pilot, therefore, had few options and attempted a landing into a field of standing maize, hitting the crop in a left-banked attitude. The aircraft then struck the ground with the pilot suffering serious injuries and, subsequently, being taken to hospital by Air Ambulance. The aircraft was destroyed.

A video of the accident shows the engine power loss but the cause was not established by the AAIB.

ACCIDENT

Aircraft Type and Registration:	Piper PA-28R-200 Cherokee Arrow, G-RACO
No & Type of Engines:	1 Lycoming IO-360-C1C piston engine
Year of Manufacture:	1975 (Serial no: 28R-7535300)
Date & Time (UTC):	5 December 2017 at 1130 hrs
Location:	Manchester/Barton Airport
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Collapsed nose landing gear, damaged propeller and wings deformed around main landing gear mounts
Commander's Licence:	Private Pilot's Licence
Commander's Age:	74 years
Commander's Flying Experience:	1,441 hours (of which 0 were on type) Last 90 days - 2 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot was receiving instruction as part of a type conversion to the PA-28R, having previously flown Focke-Wulf P.149 and Yak-55 aircraft.

During the first circuit, the pilot configured the aircraft for landing and maintained a small amount of throttle once over the threshold. The pilot reported that when he flared the aircraft he realised he was too high and lowered the nose, as directed by the instructor. The aircraft pitched nose-down abruptly and struck the grass runway. The nose landing gear collapsed and the wing structure deformed around the main landing gear mounts (Figure 1).

The pilot assessed that he had stalled during the flare, causing the aircraft to pitch down abruptly. Conversely, the instructor considered that the pilot's forward input was too pronounced, causing the abrupt pitch down. The instructor stated that it was not possible to have reacted in time to avert the accident.

Both the pilot and the instructor considered that a contributory factor to the high flare was that most of the pilot's experience was on aircraft types with much higher seating positions than the PA-28R.

Figure 1
Deformation in wing around main undercarriage mounts

ACCIDENT

Aircraft Type and Registration:	Piper PA-44-180T Turbo Seminole, N440GC	
No & Type of Engines:	2 Lycoming TO-360-EIA6D piston engines	
Year of Manufacture:	1982 (Serial no: 44-8107065)	
Date & Time (UTC):	17 November 2017 at 1237 hrs	
Location:	Coventry Airport	
Type of Flight:	Private	
Persons on Board:	Crew - 2	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Lower nose structure and propellers damaged	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	63 years	
Commander's Flying Experience:	1,903 hours (of which 861 were on type) Last 90 days - 6 hours Last 28 days - 4 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

After takeoff from Coventry Airport, at approximately 800 ft, the pilot selected the landing gear UP. The landing gear IN TRANSIT light illuminated but the landing gear did not retract. The pilot recycled the landing gear several times but the landing gear still failed to retract. With the landing gear extended the pilot observed that, in addition to the three landing gear DOWN lights, the landing gear IN TRANSIT light was also illuminated. The pilot advised Coventry Airport ATC of the problem and of his intention to return to land. The landing was initially uneventful but, as the pilot applied the brakes, the nose landing gear (NLG) retracted and the aircraft's nose and propellers struck the runway.

An examination by the aircraft's maintenance organisation showed that the NLG downlock pivot bolt had bent, which had caused the downlock assembly to foul the gear doors and stop the retraction of the leg. The displacement of the downlock mechanism prevented the nose leg from achieving the fully locked position but allowed the activation of the microswitch that operated the DOWN light, while the NLG was unlocked. The reason for the distortion of the pivot bolt could not be identified.

SERIOUS INCIDENT

Aircraft Type and Registration:	PS-28 Cruiser, G-DTFT
No & Type of Engines:	1 Rotax 912ULS2 piston engine
Year of Manufacture:	2014 (Serial no: C0506)
Date & Time (UTC):	23 August 2017 at 1616 hrs
Location:	Leeds Bradford Airport
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	None
Commander's Licence:	Private Pilot's Licence
Commander's Age:	34 years
Commander's Flying Experience:	78 hours (of which 5 were on type) Last 90 days - 13 hours Last 28 days - 7 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

After losing directional control during the takeoff roll, the pilot realised the aircraft had achieved an acceptable speed and initiated an abrupt rotation. Once airborne the aircraft may have stalled but it completed a low-level orbit, passed close to buildings and almost collided with the ground, before the pilot regained control and established a climb.

History of the flight

The pilot was cleared to take off on Runway 32, from the intersection of Taxiway L, with a crosswind of approximately 9 kt from the left. He gradually applied full power and used right rudder to keep the aircraft straight as it accelerated but, at approximately 30 kt IAS, the aircraft began to veer left. He did not manage to correct this and saw the aircraft was heading towards the edge of the runway at approximately 50 kt IAS. He pulled back quickly on the control stick to initiate rotation and prevent the aircraft over-running onto grass.

As the aircraft rotated, the pilot was aware the climb-out path ahead was clear but he believed that he may have pulled back on the control stick too harshly, because he felt the left wing drop and thought the aircraft was stalling. His recollection of the next few seconds of flight was muddled but he remembered seeing that he was heading towards a hangar before the left turn tightened. He was not aware of making any control inputs but he did transmit a MAYDAY call on the radio and then found himself distracted when ATC asked for information.

At this time, the pilot believed that he was overflying the hangar area and he sensed the aircraft stalling again. He remembered hearing the stall warner sounding but could not recall if this happened immediately after takeoff or during the turn; it may have activated more than once. As the left wing dropped further, the pilot saw he was getting closer to the ground but believed he was too low to attempt a stall recovery. He is unsure how the aircraft avoided impact with the ground and was surprised to see the runway ahead. However, this helped him to re-orientate himself and he managed to regain control and to roll-out on the runway heading; having turned through 360º. From this position he entered a climb and joined the left hand visual circuit, subsequently landing without further difficulty.

Recorded data

A recording of the pilot's MAYDAY communications to ATC contained three discernible transmissions over an 11 second period. He firstly transmitted his abbreviated callsign and followed this by twice saying "MAYDAY, MAYDAY, MAYDAY". ATC responded to both distress calls by instructing the pilot to "PASS YOUR MESSAGE". Then, 13 seconds after his second MAYDAY call, the pilot stated "REQUEST RETURN TO…LEEDS, GOLF FOXTROT TANGO, NO EMERGENCY".

The takeoff and the low-level manoeuvres were recorded by several CCTV cameras and by a witness with a mobile phone. The recordings confirmed that when the aircraft approached the edge of the runway, south of Taxiway M (Figure 1), it rotated abruptly and rolled into a left turn but the pitch attitude then reduced and it made a short, shallow climb until it reached a height estimated to be no greater than 100 ft agl. At one point the aircraft appeared to start rolling out of the turn onto a south-westerly track, which might have taken it clear of the hangar area, but the angle of bank then increased suddenly.

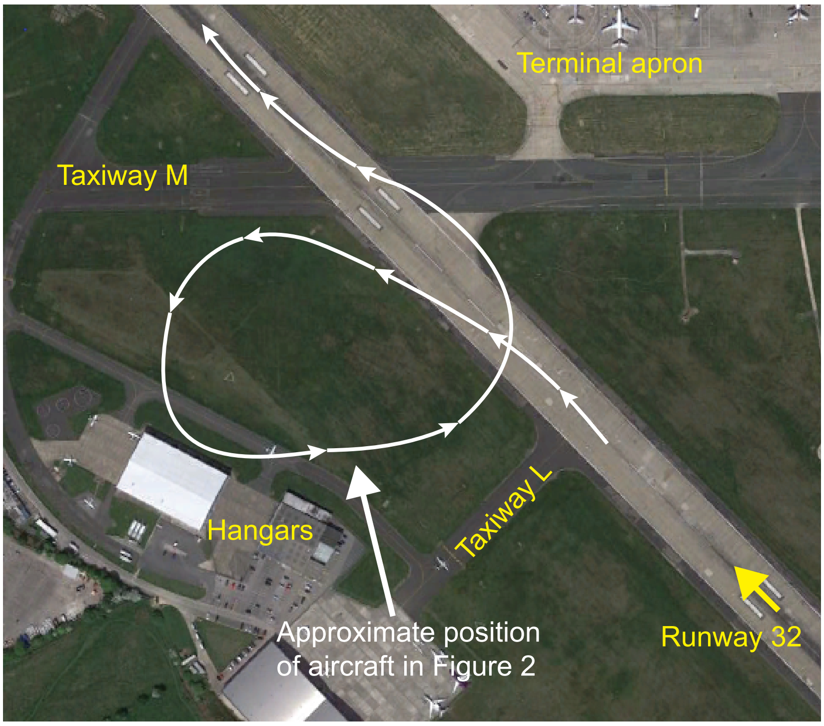


Figure 1
Aerial view of Leeds Bradford Airport (© 2018 Google, Image © 2018 DigitalGlobe)

The aircraft continued turning, while flying at approximately the same height as the roof of the tallest hangar. It appeared to remain over the area between the hangars and the runway, with its angle of bank estimated to reach 60º. Then, as the aircraft turned back towards the runway, it descended below the level of the hangar roofs and the angle of bank began to reduce (Figure 2) but the left wingtip almost touched the grass while still in a left turn towards the runway, with an estimated angle of bank of 40º. However, the aircraft then started climbing again and it rolled out of the turn in the vicinity of the runway while climbing towards the north-west.

Figure 2

G-DTFT with a bank angle exceeding 40º, shortly before the wingtip almost touched the grass
(Photograph courtesy of Mr D Firman)

Other information

The operator which hired the aircraft to the pilot and the airport operator both investigated this serious incident. The aircraft operator reported that the pilot had learnt to fly in Piper PA-28 aircraft and during early lessons he had difficulty applying sufficient right rudder after takeoff, but this was noted to be a problem often encountered at this stage in training. The pilot subsequently went solo at Leeds in October 2016 and passed his PPL skills test, at the first attempt, on 4 June 2017.

After gaining his PPL, the pilot undertook 2 hours 25 minutes dual conversion training on the PS-28 Cruiser, some of which was flown in gusty conditions, but it was not clear if he experienced a crosswind from the left while taking off under instruction. He made two solo flights in G-DTFT during the 10 days which preceded the serious incident.

On the day of the flight, the pilot had delayed his departure due to the strength of the wind; the maximum demonstrated crosswind for the PS-28 is 12 kt. He reported that, before advancing the throttle, he mentally reviewed his actions if he rejected the takeoff; to close the throttle, keep the aircraft straight and apply the brakes. However, rather than doing this when the aircraft deviated from the centreline, the pilot hastily pulled back on the control stick as he approached the edge of the runway, aware that the normal rotation speed had been achieved.

The aircraft operator reported that the PS-28 is lighter than the PA-28 and is more sensitive to control inputs and power changes. It was noted that directional control was only lost after power had been applied and therefore the crosswind from the left may have influenced the left turn, with insufficient right pedal being applied in response. The operator believed that throughout the low level orbit, the aircraft was flying in a partially stalled state until the pilot regained control close to the ground.

Inspection of the aircraft revealed no damage and there were no indications that the wingtip had made ground contact. The airport operator noted that it was fortuitous that the aircraft did not collide with a building or with the ground.

Following the operator's investigation, the pilot received further training and passed a check flight with the chief instructor but he was restricted to flying Piper PA-28 aircraft until he gained more experience.

ACCIDENT

Aircraft Type and Registration:	Reims Cessna F152, G-BHNA	
No & Type of Engines:	1 Lycoming O-235-L2C piston engine	
Year of Manufacture:	1980 (Serial no: 1683)	
Date & Time (UTC):	14 May 2017 at 1214 hrs	
Location:	Retford Gamston Airfield, Nottinghamshire	
Type of Flight:	Training	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - 1 (Serious)	Passengers - N/A
Nature of Damage:	Beyond economic repair	
Commander's Licence:	Student	
Commander's Age:	61 years	
Commander's Flying Experience:	62 hours (all on type) Last 90 days - 16 hours Last 28 days - 7 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB	

Synopsis

During the landing approach the aircraft was seen to pitch up, roll left and descend rapidly to the ground. The pilot could not recall what happened and differences between eyewitness accounts prevented a clear determination of what happened during the final approach, whether the final manoeuvre was initiated by a gust lifting the right wing, or by an initial pitch-up as part of an attempted go-around.

History of the flight

The student pilot had planned a solo navigation exercise which was to be his last before his qualifying cross country exercise. His instructor was happy with the plan and wanted to fly some circuits with him before sending him solo. The wind was 10 to 12 kt from 240° and some pilots had reported turbulence on final approach for Runway 21.

The pilot stated that on the first approach to Runway 21, they experienced "some lively turbulence which took a fair amount of control input to land safely." The instructor thought this turbulence was coming from a small wooded area on final approach so he asked the pilot to make a higher final approach and aim to 'land longer' on the next one. The pilot aimed to land beyond the '21' numbers; this time he did not encounter turbulence and made a good landing. He did one more circuit, again approaching higher and landing longer, and did not experience turbulence. His instructor was satisfied with his performance and sent him solo.

The navigation exercise to Grimsby and back was uneventful. About an hour after departure, the pilot re-entered the circuit at Gamston using a 'deadside' overhead join. He was mindful to make a high final approach and land long as he had done earlier. On final, he felt that his approach and height were good. He had the flaps set to 20° which was his normal flap setting for landing[1]. The wind reported by the tower did not cause him concern and he was not experiencing turbulence or crosswind. He remembered seeing an aircraft holding short at holding point 'Bravo' (Figure 1). From then onwards he had a poor recollection of events. However, he did later have recollections of a "tremendous force" hitting the side of the plane and tipping it over, and that with all his strength and full yoke and rudder input he was unable to control the aircraft, followed by a sense of cartwheeling.

The aircraft struck the ground and came to rest close to the final recorded GPS point from the pilot's SkyDemon track log, to the left side of the runway (Figure 1). The pilot was seriously injured and transported to hospital by air ambulance.

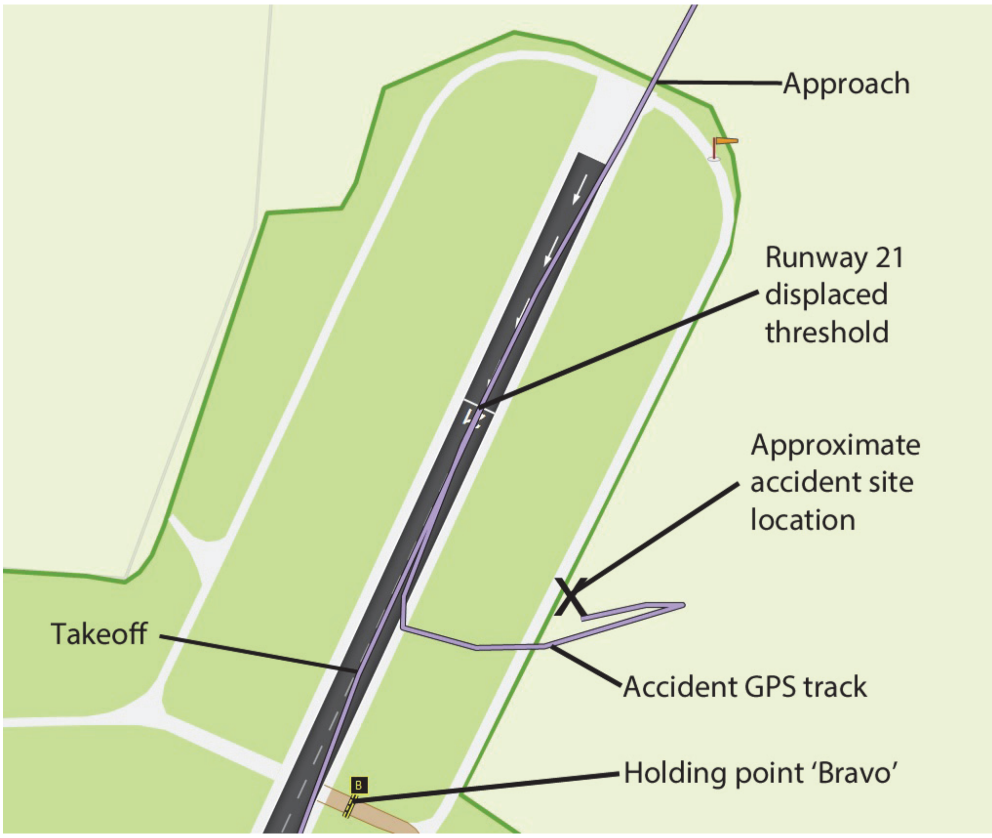


Figure 1

Recorded GPS ground track from SkyDemon log showing the takeoff and the final accident track (underlying image ©SkyDemon)

Footnote

1 He had not landed with full (30°) flap while flying solo before. He had only landed with full flap on a few occasions with his instructor while practising short-field landings.

Pilot's comments

The pilot later stated that he felt that he was a safe and competent pilot and he had had every confidence in his ability to undertake the flight. He commented that because of his lack of recall of the accident, he could only speculate as to the cause, but he thought that wake turbulence from a helicopter might have been a possible cause as the airfield was used for helicopter training. His partner who was waiting for him at the airfield commented on how busy the helicopter operation was that day.

The pilot commented that he had last practised go-arounds around the time of his first solo flight in September 2016. He believed he had not performed a "low-level go-around" before. He said he had made a mental note to request some more go-around practice but had not acted on it.

Eyewitness accounts

The pilot who was in the aircraft holding short at 'Bravo' recalled seeing G-BHNA on short final and a "mighty gust of wind lift the right wing". He recalled that the pilot then added full power with flap extended, the aircraft turned left 180° in a very tight space and stalled.

The A/G radio operator at the time of the accident reported that he saw G-BHNA on a normal approach and then at about 60 to 70 ft agl the left wing stalled and the aircraft entered a spin. He was too far away in a triple-glazed control tower to hear anything. Gamston is used for helicopter training but the radio operator could not recall whether any helicopters had been on approach shortly beforehand. In the 14 years he had been working there he had not seen any issues with helicopter wake turbulence.

The pilot's instructor, who had sent him solo, heard the pilot on the radio as he was returning so he went outside to watch. He said that the approach looked stable to 100 ft agl but then as the aircraft rounded out, it pitched up "violently" to a nose-high attitude before banking "violently to the left" and enter a steep spiral descent or spin. He was confident that the nose had pitched up first before the wing dropped. He did not recall seeing a helicopter shortly beforehand and he was not aware of any issues with helicopter wake turbulence in the two years he had worked at Gamston.

The instructor said that the pilot was proficient in go-arounds and that they might have practised one the day before the accident, but if not, he believed it was at least within the previous two weeks. He said he was instructing about 20 students at this time.

Accident site

A loss adjustor attended the accident site (Figure 2). He reported that the aircraft appeared to have hit the ground vertically in a steep nose-down attitude. He checked the flight controls and did not find any defects. The left flap was down, the right flap was up, the flap selector was up but the flap indicator showed 30°. However, the flap lever could have easily moved in the impact sequence and the mismatch between the flap indicator and the right flap showed that the flap mechanism was disrupted and therefore this indication could not be relied upon as a valid pre-impact position. If the flaps had been asymmetric as found it would have caused a right roll instead of the left roll that occurred. Therefore it is highly likely that the flap mechanism was damaged in the impact.

Figure 2
G-BHNA accident site

Meteorological information

Wind information was not recorded at Gamston. The nearest airfields, Waddington and Scampton, were reporting respectively 12 kt from 240° and 13 kt from 250° around the time of the accident. The reports did not include a value for gust which meant that any gusts were less than 10 kt above the mean speed.

The air ambulance pilot who transported the pilot to hospital described the conditions as a “challenging day”. He landed about 100 m from the accident site about 6 minutes after the accident. He said that conditions were “bouncy and blustery” with “turbulence across the runway” due to the trees on the western side. He estimated the wind at 15 kt, gusting to 20 or 25 kt on the approach end of Runway 21.

Recorded data

The GPS data recovered from the SkyDemon track log revealed that the approach groundspeed from about 500 ft agl until crossing the beginning of the paved surface varied between 56 and 61 kt. With a headwind component of 10 kt this would equate to an airspeed between 66 and 71 kt. The normal approach speed in a Cessna 152 with full flap is 55 to 65 KIAS. The pilot recalled his instructor telling him to use 70 KIAS on final approach due to the turbulent conditions.

The GPS groundspeed and altitude where the aircraft crossed the beginning of the paved surface were 60 kt and 190 ft amsl, with a displaced runway threshold elevation of 82 ft amsl. Over the runway numbers, the groundspeed was recorded as 59 kt and the altitude 83 ft amsl but the GPS altitude is not accurate enough to show whether the aircraft touched down; it could still have been at 50 ft agl or more. As the aircraft veered left from the runway, the GPS data showed a brief climb and reducing groundspeed, consistent with the eyewitness accounts.

Flying training record

The flying school provided a copy of the student pilot's flying training record. In the remarks section, it stated that go-arounds were practised on 10 September 2016, the day before the pilot's first solo flight, and then practised again on 30 September 2016. In the subsequent 31 dual flights and 8 solo flights, over a period of seven months, there were no remarks of go-around practice. For the entry on 13 May 2017 (the day before the accident) it stated: '*Lesson spent revising circuits including flapless and go around.*'

Go-arounds are performed at the end of practice forced landings away from an airfield. According to the pilot's flying training record, practise forced landings (Exercise 16, '*Forced landing without power'*) had been performed on one flight, on 14 October 2016.

Radar data for the day before the accident flight

There was no recorded GPS data for the dual flight on 13 May 2017, but the radar data was obtained. This data revealed that five circuits were carried out to Runway 21 and the approach and climb-out profiles were almost identical for the first four, with the last one ending in a full-stop landing. The lowest recorded altitudes on each of the first four approaches was 47 ± 50 ft (corrected for QNH) and the runway elevation was between 72 and 87 ft. This data indicated that the first four were probably normal touch-and-go landings but it is possible that at least one was actually a very low go-around, from almost touchdown height, although a higher and earlier initial rate of climb would be expected from a go-around than a touch-and-go.

Figure 3

Radar data from G-BHNA's flight on the day before the accident, 13 May 2017

Additional information

The Cessna 152 flight manual states that:

> *'in a balked landing (go-around) climb, the wing flap setting should be reduced to 20° immediately after full power is applied.'*

20° corresponds to two stages of flap. In this instance, the pilot's recollection was that he was landing with flaps 20°.

Analysis

There were differences in the reports of the three eyewitnesses to this accident. The pilot at 'Bravo' and the A/G operator thought that the aircraft's left wing had dropped first, while the instructor thought that the aircraft had pitched up first before the left wing dropped. The GPS data showed that the aircraft likely rolled left after passing the runway numbers but the altitude data was not sufficiently accurate to determine at what height this occurred or whether it had climbed first before rolling.

If the instructor's account is correct then it would suggest that a go-around was initiated and that the aircraft pitched excessively nose-up. In this aircraft type, applying full power when the aircraft is trimmed with 20° of flap can cause a significant pitch-up if the pilot does not react quickly by pushing the yoke forwards. Applying full power will also cause a yaw and roll to the left if it is not countered with right rudder. It is thus possible that the pilot allowed the pitch-up to continue until the aircraft stalled, causing the left wing to drop and a rotation to the left.

Alternatively, it is possible that the aircraft encountered a strong gust first which caused the left wing to drop, as described by the pilot at 'Bravo'. The air ambulance pilot stated that the conditions were challenging with turbulence near the approach end of Runway 21. A sudden wing drop, low to the ground, may have startled the pilot and caused him to execute a go-around which he was unable to complete that close to the ground.

Helicopter wake turbulence was also considered as a trigger for the upset but none of the eyewitnesses could recall a helicopter operating ahead.

The pilot did not recall having practised go-arounds since around his first solo, seven months previously. The flying training record supported his recollection, apart from the entry of go-around practice on the day before the accident. The radar data showed that if a go-around had been practised on the day before the accident, it was very close to touchdown height, followed by a delayed or shallow climb-out. However, the pilot was confident that he had never performed a "low-level go-around" before.

Conclusion

In this accident, the differences between the eyewitness accounts prevented a clear determination of what happened during the final approach, whether the final manoeuvre was initiated by a gust lifting the right wing, or by an initial pitch-up as part of an attempted go-around. In either case, this accident is a reminder of the value of well-taught go-around manoeuvres during pilot training as the low-level go-around can be a challenging manoeuvre to perform, especially for a low-time solo pilot who may not be expecting to do one and who has not practised it many times.

ACCIDENT

Aircraft Type and Registration:	Robinson R22 Beta, G-CTRL
No & Type of Engines:	1 Lycoming O-360-J2A piston engine
Year of Manufacture:	2004 (Serial no: 3601)
Date & Time (UTC):	30 January 2018 at 1045 hrs
Location:	Nottingham Heliport
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Extensive damage, beyond economic repair
Commander's Licence:	Student
Commander's Age:	62 years
Commander's Flying Experience:	41 hours (of which 41 were on type) Last 90 days - 9 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The helicopter rolled onto its right side when the student pilot attempted to lift into the hover to make his first solo flight. The instructor was watching from nearby and witnessed the helicopter rotate around the right skid and fall on its side due to dynamic rollover.

History of the flight

After a satisfactory training flight lasting 55 minutes, which incorporated numerous takeoffs and landings, the instructor assessed that the student pilot had handled the helicopter competently and was ready for his first solo flight. He reminded the student pilot that, with no instructor occupying the left seat, the helicopter's Centre of Gravity (CG) would move right and aft, so the cyclic stick would have to be positioned to the left and forward to compensate, and that gentle control movements should be made during lift off.

The instructor moved away to a safe distance before signalling the pilot to lift off. When the pilot saw this signal, he adjusted the cyclic stick to what he thought was the correct position and raised the collective lever. He stated that he used the available visual cues and made appropriate control adjustments, but was unable to prevent the helicopter rolling quickly onto its right side. The instructor reported that the pilot kept the helicopter straight through correct use of the yaw pedals but did not apply sufficient left cyclic control to compensate for the change of CG. He saw the helicopter roll onto its right side with the rotor blades stopping when they hit the grass (Figure 1).

Figure 1

G-CTRL after the accident with the front transparencies broken and the left door open

The instructor approached the helicopter and found the pilot trapped in his seat with minor injuries to his hands, so he helped him climb out through the left doorway, prior to arrival of the heliport rescue service. The instructor then switched off the fuel and electric supplies to the helicopter. His assessment was that the accident occurred as a result of dynamic rollover; a phenomenon the pilot had been briefed about in the classroom and pre-flight.

Aircraft information

The Pilots' Operating Handbook and Rotorcraft Flight Manual for G-CTRL contains Robinson Helicopter's Safety Notice SN-9 which discusses dynamic rollover. The notice was revised in June 1994 and it states:

> *'A dynamic rollover can occur whenever the landing gear contacts a fixed object, forcing the aircraft to pivot about the object instead of about its own center of gravity…Once started, dynamic rollover cannot be stopped by application of opposite cyclic alone…Quickly applying down collective is the most effective way to stop dynamic rollover.'*

The SN advises how to avoid dynamic rollover, including:

> *'Always use a two-step liftoff. Pull in just enough collective to be light on the skids and feel for equilibrium, then gently lift the helicopter into the air.'*

This is the lift off technique which the EASA requires its training providers to teach.

Other information

The AAIB has reported on four other accidents in the last 10 years that have involved dynamic rollover. Three of these occurred during a student pilot's first or second solo flight in a Robinson R-22 Beta (G-SBUT - AAIB Bulletin 3/2009; G-BYCF - AAIB Bulletin 7/2014; G-DEFY - AAIB Bulletin 2/2016), while the fourth accident occurred during a student pilot's first solo flight on type, in a Robinson R-66 (G-LROK - AAIB Bulletin 2/2016).

The European Helicopter Safety Team (EHEST) has produced a number of educational leaflets which can be accessed on the EASA website. EHEST leaflet HE-1 '*Safety Considerations*'[1] includes a section concerning dynamic rollover and techniques to avoid it.

Footnote

[1] Leaflet HE 1 is available via the following link https://www.easa.europa.eu/system/files/dfu/Leaflet_EHSIT_Training_final.pdf

ACCIDENT

Aircraft Type and Registration:	Aerotechnik EV-97 Eurostar, G-TIVV
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	2005 (Serial no: PFA 315-14435)
Date & Time (UTC):	20 October 2017 at 1520 hrs
Location:	Perth Airport
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to propeller and aircraft structure
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	67 years
Commander's Flying Experience:	450 hours (of which 118 were on type) Last 90 days - 4 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

This was the aircraft's first flight after repairs following a previous takeoff accident with the same pilot at the controls (AAIB Bulletin 7/2017 refers).

The pilot reported that as the aircraft achieved flying speed it rotated normally, but then failed to climb as expected. He attempted to abort the takeoff, but was unable to control the aircraft and it bounced two or three times before coming to rest to the left of the runway with the engine still running. The pilot was uninjured.

Examination by an LAA Inspector revealed that the instrument static line in the left wing was disconnected and a test flight using a similar aircraft showed that the airspeed indicator would over-read in such a condition.

The LAA is reviewing the procedures for the management of repairs and subsequent release of aircraft for a return to service check flight.

ACCIDENT

Aircraft Type and Registration:	Dynamic WT9 UK, G-WIGS
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	2007 (Serial no: DY200)
Date & Time (UTC):	15 June 2017 at 1130 hrs
Location:	Bagby Airfield, North Yorkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Nose gear leg collapsed and propeller destroyed
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	294 hours (of which 105 were on type) Last 90 days - 14 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Following a local area flight in good weather conditions, the pilot returned to land on Runway 24 at Bagby and was informed that the wind was from 255º at 19 kt. He aimed to touch down approximately halfway along the 710 m runway, having previously found that an approach to this area minimised the turbulence encountered in a strong wind. However, although conditions on the final approach were relatively smooth initially, once he passed the threshold they became noticeably rougher, and the subsequent touchdown was described as "hard". With hindsight, he realised that he should have gone around when he encountered the turbulence during the last part of the approach.

The pilot believed that all three wheels contacted the grass runway at the same time. The nose gear leg then collapsed, causing the propeller to contact the ground. After the aircraft came to rest, on the left side of the runway, the pilot was able to exit normally. He reported that when the aircraft was subsequently repaired a modified nose gear leg was fitted with a stronger internal sleeve.

ACCIDENT

Aircraft Type and Registration:	Rotorsport UK Calidus, G-CIYU	
No & Type of Engines:	1 Rotax 914-UL piston engine	
Year of Manufacture:	2016 (Serial no: RSUK/CALS/029)	
Date & Time (UTC):	11 September 2017 at 1135 hrs	
Location:	RAF Scampton, Lincolnshire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 1
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Damaged beyond economic repair	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	68 years	
Commander's Flying Experience:	11,800 hours (of which 106 were on type) Last 90 days - 20 hours Last 28 days - 5 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot and enquiries made by the AAIB	

Synopsis

A loss of control during takeoff led to the gyroplane pitching nose-up rapidly and the retreating rotor blade struck the runway. The gyroplane rolled onto its left side and skidded to a halt on the runway. The occupants were unable to open the canopy to escape. Rather than attempt to break out using their emergency hammer, they awaited the arrival of the airfield's Rescue and Fire Fighting Service (RFFS), who righted the gyroplane, allowing the canopy to be opened.

History of the flight

The pilot was cleared to take off from Runway 22 at RAF Scampton, with the wind from 240º at 10 kt. After pre-rotating the rotor to approximately 200 rpm he released the brakes and the gyroplane accelerated quickly. At an estimated speed of 40-50 mph the machine pitched nose-up rapidly, rolled onto its left side and skidded along the tarmac until it came to a halt at the eastern edge of the runway. The occupants were uninjured and they quickly unlatched the canopy but could not open it because it was bearing some of the gyroplane's weight.

An emergency hammer was available to break the canopy but the pilot reported afterwards that he was not confident he could exert enough force to achieve this while trapped on his side. As there was no obvious danger he waited for assistance, and his recollection was that the RFFS arrived quickly and righted the gyroplane, allowing the canopy to be opened and for himself and his passenger to climb out uninjured.

Figure 1

G-CIYU after righting and with the canopy open
(Photograph MoD/Crown Copyright)

After the accident, both the pilot and his experienced passenger recalled that the control stick was positioned fully back in the normal manner before the takeoff run commenced. The pilot suspected that the rapid pitch-up was caused by a problem with the flight controls so, at his request, the manufacturer recovered the gyroplane and checked the systems, but no fault was found.

Recorded information

A video recording of the takeoff attempt suggested that the gyroplane was pre-rotated normally before the brakes were released and engine power was increased. It was apparent that the rotor did not tilt back until immediately prior to the gyroplane pitching nose-up. Before that happened, the groundspeed increased quickly, something the pilot attributed at the time to being on a damp asphalt runway which sloped downhill slightly, rather than the grass strip he normally used. After studying the video, he realised that the rotor was not tilted back during the takeoff roll so the resulting drag force was absent, allowing the gyroplane to accelerate more quickly than normal but without the rotor rpm increasing as a result of autorotation.

When the gyroplane began to pitch nose-up, the rotor was not rotating with sufficient speed to produce the lift needed to support the machine’s weight, while extra drag would have resulted from the pitch-up. At this stage the video recording showed the gyroplane pitching nose-up until only the trailing edge of the tailplane was touching the ground. The gyroplane then began to roll left; probably due to dissymmetry of lift, with the advancing blade on the right side producing more lift than the retreating blade on the left side.

When the gyroplane began to roll left it was in such a nose-high attitude that the retreating blade struck the ground, to the left and rear of the machine. This caused the rate of roll to increase, while the nose dropped and hit the runway, resulting in separation of the nose landing gear. Next, the rotor which had been deformed, struck the propeller, causing debris to scatter across the runway before the gyroplane fell onto its left side and started to decelerate. After travelling approximately 50 m on its side, the gyroplane came to rest at the eastern edge of the runway, eight seconds after the accident sequence began and with its nose pointing left of the runway orientation.

The first RFFS vehicle was on the scene 2 minutes and 30 seconds later, by which time the crew had unlatched the canopy and one person had approached the gyroplane but had been unable to do anything to help. Approximately one minute after arrival, five firefighters manually righted the gyroplane onto its mainwheels, allowing the canopy to open normally and the occupants to step out.

Pilot's assessment

The pilot had logged more than 100 hours in gyroplanes but most of his previous flying experience (11,700 hours) had been on conventional, fixed-wing aircraft. He was confident that he always followed the correct takeoff procedure in a gyroplane and pulled the control stick back after pre-rotating the rotor and before releasing the brakes. However, having seen the video evidence, he realised that on this occasion he apparently released the brakes and then applied power. The video shows that the rotor disc did not begin to tilt back until the accident sequence began; suggesting that the pilot may have attempted to rotate the gyroplane, as if it was a fixed-wing aircraft, by moving the control stick back once the gyroplane had gained groundspeed.

The pilot noted that he normally flew his gyroplane from a grass strip, rather than a large asphalt runway but that, several years previously, he had been based at RAF Scampton and had flown military aircraft from there. He surmised that, given the environment, his "muscle memory" may have subconsciously caused him to revert to a fixed wing takeoff technique.

When he viewed the video, the pilot was surprised to realise how much time elapsed between the gyroplane coming to rest and the arrival of the RFFS.

Previous accidents

This accident was the result of inappropriate control movement during an attempted takeoff. The AAIB has reported eight previous accidents that involved Calidus gyroplanes toppling onto one side, while attempting to takeoff or land, and in general these all appear to have been caused by an inappropriate control input.

Only one serious injury was reported in any of these accidents (G-ETOJ, AAIB Bulletin 1/2013) and there have been no reports of a post-accident fire. However, there is evidence that the pilots of four of these gyroplanes could not open the canopy normally[1]. Two of these were righted by rescuers, allowing the canopies to be opened. The two people who arrived at G-CGMD were unable to right it, so the pilot used the emergency hammer to create a hole and, with the help of his rescuers, a space was cleared for him to crawl through. The pilot later stated that he found it difficult to use the hammer while on his side in the confined space and learnt through trial and error that a wrist action, rather than a whole arm action was needed. He estimated that without external assistance it might have taken more than two minutes to break his way out.

Survivability

This Calidus was operating on a UK CAA Permit to Fly, issued in accordance with British Civil Airworthiness Requirements, Section T Light Gyroplanes, with the cockpit '*designed as to provide occupants with unimpeded and rapid escape in emergency*'. The plexiglass 'bubble' canopy has a latch mechanism with a locking handle on the right side of the cockpit. The handle is lifted to unlock the latch and the canopy opens towards the left side, where it is hinged. An emergency hammer is available on the right side of the cockpit, for use by either occupant, and the Pilot's Handbook states that this can be used to break the plexiglass.

In 2011, as part of demonstrating compliance to Section T, the UK manufacturer proved the emergency hammer's effectiveness when an employee broke his way out of a test machine that was placed on its right side with the canopy closed. A video recording showed the employee knock a hole in the canopy and crawl through it.

The manufacturer acknowledged that if a Calidus topples over, because of an accident, some of the gyroplane's weight is likely to be borne by the canopy and the occupants may have difficulty escaping. This is why an emergency hammer is provided. Consideration has been given to incorporating a 'quick release' mechanism for the canopy hinges but such a modification is assessed to be impractical and it might not be effective in all possible post-accident attitudes.

In light of this accident, and comments from the pilot of G-CGMD, the manufacturer intends to provide additional information concerning the emergency hammer in the '*Emergency Procedure*' section of the Pilot's Handbook.

Footnote

1 G-CGMD AAIB Bulletin 9/2013, G-PCPC AAIB Bulletin 7/2015, G-GRYN AAIB Bulletin 9/2017, G-CPTR AAIB Bulletin 12/2017.

ACCIDENT

Aircraft Type and Registration:	Thruster T600T 450 JAB, G-BZTD	
No & Type of Engines:	1 Jabiru 2200A piston engine	
Year of Manufacture:	2001 (Serial no: 0021-T600T-049)	
Date & Time (UTC):	22 September 2017 at 1115 hrs	
Location:	Membury Airfield, Berkshire	
Type of Flight:	Training	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Structural damage, left main wheel distorted and right main wheel suspension bent	
Commander's Licence:	National Private Pilot's Licence	
Commander's Age:	53 years	
Commander's Flying Experience:	78 hours (of which 3 were on type) Last 90 days - 17 hours Last 28 days - 4 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

The pilot, who was quite new to the aircraft type, had expected to fly with an instructor on arrival at the airfield. This was not the case and he instead embarked on a solo flight.

After completing one circuit, he had to abandon his first approach because of an aircraft near the edge of the runway and went around. On the second attempt he bounced on landing, so he applied full power to go around again. The aircraft then veered to the left, before departing the runway and colliding with trees. The pilot was uninjured and vacated the aircraft using the door.

A witness to the accident described the aircraft as ground looping. The pilot suggested that the accident might not have occurred if he had spent more time in the aircraft with an instructor.

Miscellaneous

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

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

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

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

Published February 2014.

2/2014 Eurocopter EC225 LP Super Puma G-REDW, 34 nm east of Aberdeen, Scotland on 10 May 2012 and G-CHCN, 32 nm south-west of Sumburgh, Shetland Islands on 22 October 2012.

Published June 2014.

3/2014 Agusta A109E, G-CRST Near Vauxhall Bridge, Central London on 16 January 2013.

Published September 2014.

1/2015 Airbus A319-131, G-EUOE London Heathrow Airport on 24 May 2013.

Published July 2015.

2/2015 Boeing B787-8, ET-AOP London Heathrow Airport on 12 July 2013.

Published August 2015.

3/2015 Eurocopter (Deutschland) EC135 T2+, G-SPAO Glasgow City Centre, Scotland on 29 November 2013.

Published October 2015.

1/2016 AS332 L2 Super Puma, G-WNSB on approach to Sumburgh Airport on 23 August 2013.

Published March 2016.

2/2016 Saab 2000, G-LGNO approximately 7 nm east of Sumburgh Airport, Shetland on 15 December 2014.

Published September 2016.

1/2017 Hawker Hunter T7, G-BXFI near Shoreham Airport on 22 August 2015.

Published March 2017.

1/2018 Sikorsky S-92A, G-WNSR West Franklin wellhead platform, North Sea on 28 December 2016.

Published March 2018.

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

http://www.aaib.gov.uk

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 Service
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
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)
FDR	Flight Data Recorder
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)
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
UAS	Unmanned Aircraft System
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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