AAIB
Air Accidents Investigation Branch

AAIB Bulletin 11/2018

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(ALL TIMES IN THIS BULLETIN ARE UTC)

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.

SERIOUS INCIDENT

Aircraft Type and Registration:	DHC-8-402 Dash 8, G-ECOE
No & Type of Engines:	2 Pratt & Whitney Canada PW150A turboprop engines
Year of Manufacture:	2008 (Serial no: 4212)
Date & Time (UTC):	11 January 2018 at 1632 hrs
Location:	Belfast City Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 4 Passengers - 44
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	60 years
Commander's Flying Experience:	14,122 hours (of which 464 were on type) Last 90 days - 91 hours Last 28 days - 39 hours
Information Source:	AAIB Field Investigation

Synopsis

After takeoff from Belfast City Airport, shortly after the acceleration altitude and at a height of 1,350 ft, the autopilot was engaged. The aircraft continued to climb but pitched nose-down and then descended rapidly, activating both the "DON'T SINK' and "PULL UP" TAWS (EGPWS) warnings. The commander disconnected the autopilot and recovered the aircraft into the climb from a height of 928 ft. The incorrect autopilot 'altitude' mode was active when the autopilot was engaged causing the aircraft to descend toward a target altitude of 0 ft. As a result of this event the operator has taken several safety actions including revisions to simulator training and amendments to the taxi checklist.

History of the flight

Introduction

The crew were to complete a four-sector duty period; the first two sectors were from Glasgow Airport to Belfast City Airport and then return to Glasgow. The aircraft commander had been called in from standby and travelled by taxi from Aberdeen to Glasgow Airport where he met the co-pilot. They had not operated together before, and both had limited experience of Belfast City Airport. They briefed for the flight and, due to the weather being forecast to deteriorate at Belfast, they agreed that the commander would act as Pilot Flying (PF) for the first two sectors.

The first sector was uneventful, and the aircraft landed on Runway 22 at Belfast City. While it taxied clear of the runway, the co-pilot carried out the 'after-landing' checks which included setting the autopilot selected altitude to zero. The aircraft was parked on stand, five minutes ahead of schedule.

The weather at 1620 hrs was: wind from 110° at 4 kt, good visibility, clouds FEW at 800 ft, BKN at 1,000 ft, temperature +5˚C, dew point +4˚C and QNH 1023 hPa.

The incident flight

The commander carried out the external turnaround checks whilst the co-pilot programmed the Flight Management System (FMS) for the return flight. There were changes to the payload and this required a new load sheet to be produced. The commander stated that to save time before pushback he had set the autopilot Flight Director (FD) modes to Go-Around (GA), Heading (HDG) and Altitude Select (ALT SEL) but without first setting a selected altitude. When ATC issued the clearance, he set the selected altitude to the 3,000 ft cleared. He stated that 3,000 ft was set on the Primary Flight Displays (PFD), but neither of the crew noticed that the autopilot modes were set to HDG and Altitude Hold (ALT), and this condition was confirmed by the recorded FDR parameters. The vertical FD bar had also moved from the nose-up GA position to the aircraft symbol, corresponding to a pitch attitude of about 0°.

The crew briefed for the departure and also a Delayed Engine Start (DES) taxi but did not discuss where the second engine was to be started. The revised load sheet was completed and provided. At push back, the aircraft was three minutes behind schedule.

As the aircraft was pushed back the right engine was started. After engine start, FLAP 5 was selected. As the aircraft taxied towards holding point A1, it was cleared to enter Runway 22 to backtrack and position for takeoff. The aircraft entered the runway, and shortly after the co-pilot started the left engine; it is normal practice to have started the engine prior to entering the runway.

Approaching the turning circle at the threshold of Runway 22, the commander confirmed the takeoff clearance was "THREE THOUSAND WITH ALT SEL"; the selected FD modes were set to HDG and ALT. A few seconds later, the aircraft reached the beginning of the runway and the commander started to make a 180° right turn to position for takeoff. This coincided with the completion of the taxi checklist. The various radio calls, cabin secure and after-start checks meant that there was a high level of flight deck activity at this time, which added to the level of urgency as the crew also believed that there may have been another aircraft on the approach. The commander then referred to the Flight Mode Annunciator (FMA) modes, stating "GO-AROUND, HEADING, ALT….WHY ISN'T IT ALT SEL….THAT'S BETTER, YEAH", which coincided with the co-pilot selecting the ALT SEL mode.

Whilst the aircraft was turning, the crew carried out the 'line up' check list, which was interrupted by ATC providing the takeoff clearance. When the final item on the check list was reached which was to check the FMA and Caution and Warning Panel (CWP), the commander stated the FD modes were set to "GO-AROUND, HEADING AND ALT SEL". However, the selected modes were subsequently found to be have been set to ALT, HDG and ALT SEL.

A few seconds later the crew commenced the takeoff roll. Shortly after becoming airborne the landing gear was retracted and the FD lateral navigation (LNAV) mode was selected; the aircraft pitch was initially maintained at about 15° nose-up[1] before being reduced to about 10° nose-up.

After reaching the acceleration altitude (1,000 ft aal) the flaps were retracted, which was shortly followed by the autopilot being engaged. The aircraft was now in IMC and at a height of 1,350 ft agl and its airspeed was 163 KIAS. Following the autopilot engagement the aircraft started to gradually pitch nose-down at a rate of about 1.2° per second from a height of 1,500 ft agl. During the next 15 seconds, whilst the crew were completing the 'after takeoff' checklist, the aircraft descended at an increasing rate with the pitch attitude reducing from about 10° nose-up, to 8° nose-down.

At a height of about 1,300 ft agl, an EGPWS Mode3[2] "DON'T SINK" caution was activated. The commander responded almost immediately, disconnected the autopilot and applied nose-up pitch to arrest the rate of descent, which had reached a maximum of 4,300 ft/min. Engine power was also simultaneously reduced, with the airspeed having increased to 235 KIAS. The aircraft continued to descend for a few more seconds, during which a EGPWS "PULL UP" warning was triggered. The aircraft then transitioned to a climb, having reached a minimum height of 928 ft agl and a maximum airspeed of 241 KIAS (V_{MO}[3] below 8,000 ft amsl is 245 KIAS); the crew subsequently reported that they had become visual with the ground during the recovery.

As the aircraft climbed, the commander stabilised the pitch attitude to about 8° nose-up and the airspeed at 200 KIAS, with engine power gradually increased to the climb setting.

When the aircraft was at about 1,900 ft agl, the autopilot was re-engaged, however, the aircraft started to gradually pitch down and the commander disconnected the autopilot, stating "IT'S GOING TO ALT HOLD AGAIN, IT'S GOING TO PITCH DOWN". The commander then selected the FD indicated airspeed (IAS) mode, which deselected the ALT mode, and set the target airspeed to 210 kt. The autopilot was then re-engaged and the commander confirmed to the co-pilot that everything was now normal, with the aircraft subsequently levelled at 3,000 ft. Shortly after, ATC inquired if everything was okay, having observed the aircraft on radar descend and deviate slightly from the planned track. The co-pilot responded, stating that they had experienced a problem with the autopilot, but that it was now resolved.

The aircraft continued to Glasgow where it made an uneventful landing. After landing, the crew briefly discussed the incident, but neither were certain why the aircraft had descended when the autopilot had been initially engaged.

Footnote

1 This higher pitch attitude allows the IAS to gradually increase without exceeding the flap limiting speed and leaving the GA mode provides a good pitch reference in the event of engine failure.
2 Altitude loss after takeoff.
3 V_{MO} is the maximum operating speed for the aircraft.

Aircraft information

Automatic Flight Control System (AFCS)

The aircraft is equipped with an AFCS that includes an FD function that provides lateral and vertical guidance to fly the aircraft, either manually or automatically, and a single autopilot that couples the FD guidance for automatic control of the aircraft. FD guidance is presented on the pilots PFD as vertical and lateral bars.

Autopilot engagement and associated selection of FD modes, that include HDG, ALT SEL and ALT, are made using push buttons on the Flight Guidance Control Panel (FGCP) that is located on the upper instrument panel (Figure 1). The FD GA mode is selected by buttons on the power levers.

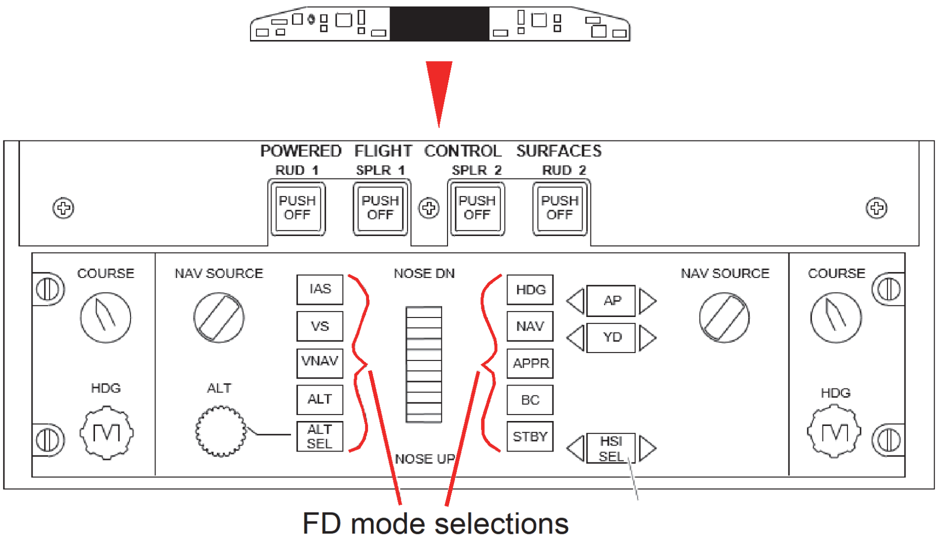


Figure 1

FMGC Panel

Selection and engagement status of the autopilot and FD modes are permanently indicated on the FMA block located at the top of the commander and co-pilot PFDs. Active FD modes are displayed in green text and armed modes are displayed in white text.

The ALT SEL mode provides FD commands to acquire and maintain the selected altitude that is set on the FGCP and displayed on the PFD. When the aircraft approaches the selected altitude, the FD automatically transitions to the altitude capture mode (ALT*), which provides guidance to level off. When the selected altitude has been captured, the FD automatically transitions to the ALT mode.

The ALT mode provides FD commands to maintain a target altitude. If the ALT mode is activated automatically, using the ALT SEL mode, the target altitude is set to the altitude set on the FGCP and displayed on the PFD.

If the ALT mode is activated manually using the push button on the FGCP, the target altitude is set to the aircraft's current altitude, rounded to the nearest 100 ft.

The AFCS logic enables the ALT and ALT SEL modes to be simultaneously selected when the aircraft is on the ground or in flight. The ALT mode will be the active mode and ALT SEL will be the armed mode.

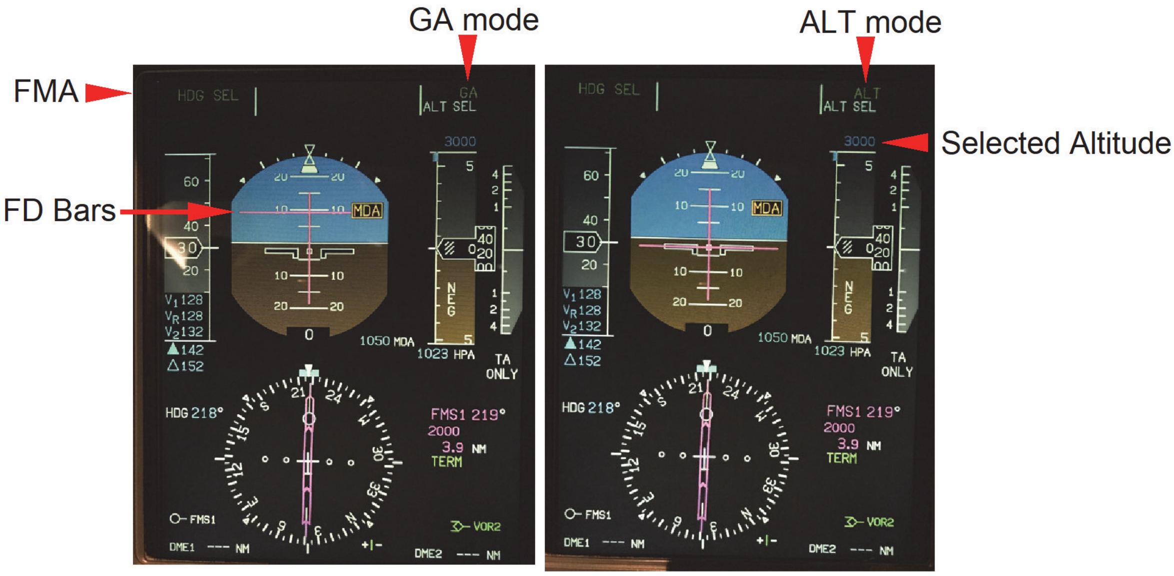
The GA mode sets the FD vertical bars to a fixed pitch angle of about 10° nose-up, and the HDG mode commands the FD lateral bars to maintain the target heading selected on the FGCP.

Incorrect setting of the FD guidance modes prior to takeoff

Selection of the ALT mode when the aircraft is on the ground sets the FD vertical bars to a pitch attitude of about 0° and the target altitude to the aircraft's current altitude, ie the airfield elevation amsl. Selection of the ALT SEL mode, when the ALT mode is also selected, does not alter the target altitude unless the ALT mode is deselected.

If the HDG, ALT SEL and ALT modes are selected on the ground, subsequently as the aircraft climbs after takeoff above the target altitude, the FD vertical guidance bar will progressively move to a nose-down pitch attitude. Upon engagement of the autopilot, the aircraft will pitch down to follow the FD vertical guidance bar to descend to the target altitude. For this incident this target altitude would have been set to about 0 ft amsl.

Figure 2 shows the FMA and FD vertical bar positions displayed on the PFD when the FD modes are selected in accordance with the operator's procedures prior to takeoff (GA, HDG and ALT SEL) and those selected during the incident takeoff (HDG, ALT SEL and ALT). Other than the FMA indicating that the ALT mode has been armed on the ground, there are no other indications to identify that the target altitude has been set to the airfield elevation amsl.



Normal setting Incident flight setting

Figure 2

PFD indications when GA, HDG and ALT SEL (left PFD) and HDG, ALT SEL and ALT (right PFD) are selected for takeoff

Sources of information

A record of the incident flight was available from the aircraft's 120 minute duration CVR and the 25 hour FDR. Information was also obtained from the two pilots. The CVR recording commenced at 1554 hrs when electrical power was applied to the aircraft as the crew prepared the aircraft for the flight, and the FDR recording commenced when the anti-collision light was selected by the crew, shortly before the first engine was started at 1624 hrs. The FDR parameters included the engagement status of the autopilot and FD modes, which included GA, HDG, ALT SEL and ALT. Figure 3 shows pertinent parameters during the incident takeoff.

As the FDR was not recording during the crew's preparations prior to the first engine start, it was not possible to validate the sequence in which the PF reported that he had initially set the FD modes and selected altitude. There was no reference by the crew to the selection of the FD modes on the CVR recording during this same period.

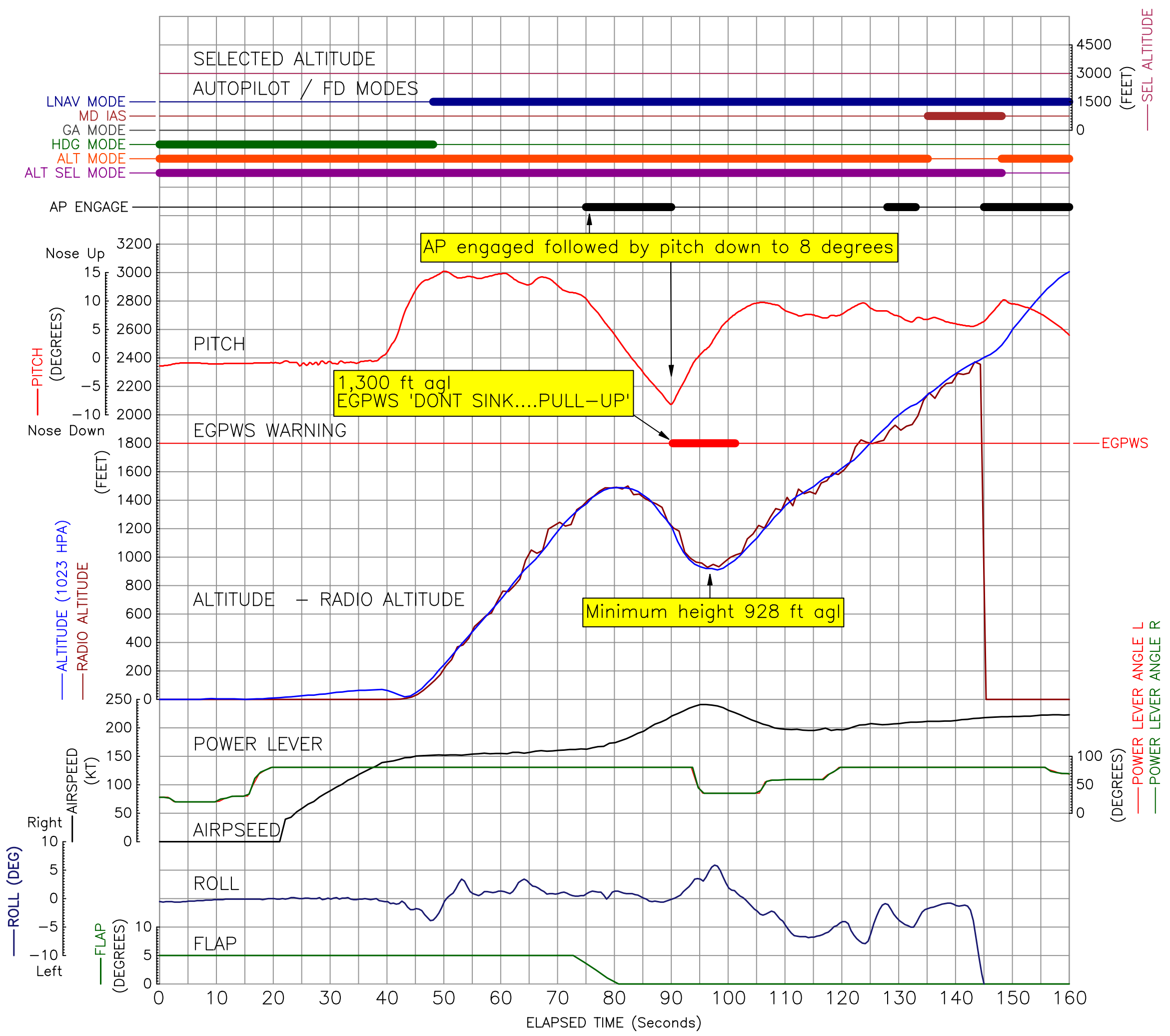


Figure 3

Descent following autopilot engagement

Previous occurrences of incorrect setting of the FD modes prior to takeoff

The operator of G-ECOE provided records of three previously reported occurrences of incorrect setting of the FD modes at takeoff on its DHC-8-402 fleet of aircraft. The details of these were:

- G-JECK operating from Glasgow to Belfast City on 3 January 2017. The FD modes were set to HDG and ALT SEL. When the autopilot was engaged, the aircraft pitched nose-down and descended by 150 ft to a height of 1,400 ft agl.
- G-FLBC operating from Edinburgh to Southampton on 12 May 2017. The FD modes were set to HDG, ALT SEL and ALT. When the autopilot was engaged, the aircraft descended by 130 ft to a height of 1,350 ft agl.
- G-JECM operating from Exeter to Manchester on 19 July 2017. The FD modes were set to HDG, ALT SEL and ALT. The crew noticed the mis-setting after takeoff and selected GA mode, which deselected ALT mode, before engaging the autopilot.

The Air Safety Reports for two of these previous incidents stated that contributory factors to mis-setting the FD included *'rushed line up checks due to an expeditious departure"* and *"possibly caused by rushing to mitigate a delay'*.

Altitude and mode selection on G-ECOE

Testing of autopilot mode selection on G-ECOE was carried out as part of the investigation, and the sequence of selecting the FD modes and departure clearance altitude on the FGCP was established as being important. If the FD modes are selected to GA, HDG and ALT SEL before setting the selected altitude to an altitude greater than that of the aircraft, the ALT SEL mode will transition to the ALT mode and the GA mode was automatically deselected, leaving HDG and ALT as the selected modes.

During the tests it was established that if GA and HDG were selected, and then ALT was selected instead of ALT SEL, then the GA mode transitioned from GA to ALT, leaving HDG and ALT modes selected.

The operator included details in its LPC training on the importance of setting the departure clearance altitude on the FGCP before the FD modes, with information that the *'aerodrome elevation may be captured as the cleared altitude'*. However, this information provided to crews did not include specific details as to the change of the FD mode from ALT SEL to ALT.

Flight Data Monitoring (FDM)

The operator of G-ECOE monitored the operation of its fleet of DHC-8-402 aircraft using an FDM programme. At the time of the incident, the system was not programmed with an event[4] to detect if FD modes were set correctly prior to takeoff.

The operator has since introduced an FDM event to monitor for incorrect selection of FD modes at takeoff.

Crew duty periods

The commander had 10 days leave before commencing his duty period, which was scheduled to be block standby, but he was rostered to fly.

On Sunday 7 January 2018, he flew four sectors from his home base of Aberdeen starting at 1145 hrs and finishing at 2133 hrs. The following day he positioned as a passenger to Southampton via Belfast starting at 1055 hrs and finishing at 1613 hrs, staying overnight at a hotel some 30 minutes taxi ride from the airport. On Tuesday 9 January 2018, he flew four sectors starting at 0550 hrs and finishing at 1415 hrs, which included a short taxi ride to the hotel in Cardiff. The next day he flew two sectors starting at 0555 hrs before positioning as a passenger by taxi from Southampton to Birmingham and as a passenger to Aberdeen, finishing at 1710 hrs. On the day of the incident, he was called prior to the start of his Standby Duty and was scheduled to fly four sectors from Glasgow which required a taxi ride from Aberdeen to Glasgow starting at 1040 hrs and arriving at 1355 hrs for a 1510 hrs departure. The second two sectors were cancelled due to having been involved in the incident and he returned to Aberdeen by taxi.

The co-pilot was based in Glasgow and was not required to position for flights during the days preceding the event.

The crew duty hours for both the crew were within the EASA permitted Flight Time Limitations (FTL).

Analysis

The flight crew had an uneventful flight from Glasgow to Belfast City Airport, and after landing, the co-pilot set the selected altitude to zero as part of the after-landing checks. The aircraft was ahead of schedule when it parked on the stand and a normal turn around followed until changes with the payload required a new load sheet. This caused a delay during which the crew prepared the aircraft for the next sector to minimise delay.

The crew's lack of familiarity with operating from Belfast City, combined with the delay due to the revised loadsheet, caused the PF to carry out as many tasks as he could before the

Footnote

[4] The core analysis function used within FDM systems is known as 'event' detection. Each event is typically developed to monitor a specific aspect of an aircraft's operation or its systems by using algorithms to identify if the data exceeds pre-defined trigger thresholds. The basis for many events and their trigger thresholds is the flight manual, operator's SOPs and principles of good airmanship.

pushback to save time. This included setting the autopilot FD modes, which the PF stated that he had selected GA, HDG and ALT SEL, before entering the cleared altitude of 3,000 ft amsl. Subsequent testing showed that this sequence will result in the ALT SEL mode changing to the ALT mode and the GA mode being deselected. At the time, this functionality was not known to the crew and neither noticed that the FD modes were set to HDG and ALT as the aircraft was pushed back.

During the DES taxi, the second engine should have been started before the aircraft entered the runway, but it was not started until during the backtrack of Runway 22. This created an increased level of activity on the flight deck and a sense of urgency, as the crew believed that there may have been another aircraft on the approach. Checks were completed but interrupted by an ATC transmission clearing takeoff and cabin crew confirming the cabin was secure. Despite this high level of activity, the 'Line Up' checks did cause the PF to identify that ALT SEL was not selected but he did not see that ALT was active instead of GA. The PF was also expecting to pitch the aircraft to about 15º nose-up instead of the 10º nose-up that the FD bar would have indicated with GA mode selected. It is possible that this was a reason why he did not notice that the FD bars were showing about 0º pitch on the PFD.

If the HDG, ALT SEL and ALT modes are selected on the ground, subsequently as the aircraft climbs after takeoff above the target altitude, the FD vertical guidance bar will progressively move to a nose-down pitch attitude. Upon engagement of the autopilot, the aircraft will pitch down to follow the FD vertical guidance bar to descend to the target altitude. For this incident this target altitude would have been set to about 0 ft amsl.

When the aircraft pitched down as the autopilot was engaged, neither pilot initially noticed the change in pitch attitude but the "DON'T SINK" and "PULL UP" EGPWS warnings alerted the crew to the situation. The PF reacted promptly in accordance with the trained sequence of actions and returned the aircraft to a safe flight path. During the event the aircraft lost about 500 ft in 18 seconds, with a maximum rate of descent of 4,300 ft/min and having reached a minimum height of 928 ft agl.

When the autopilot was re-engaged, the aircraft again pitched nose-down but this was identified by the crew. They engaged IAS mode which replaced the ALT mode and with ALT SEL also selected the aircraft climbed and levelled at the cleared altitude of 3,000 ft.

Conclusion

Prior to pushback, the crew had selected the FD modes without entering a target altitude. This caused one mode to default to ALT instead of ALT SEL, which was not detected by the crew.

Due to the DES being carried out whilst backtracking the runway, there was reduced time available in which to complete all required checks which, when combined with a sense of urgency, led to the crew not seeing the incorrect FD modes displayed on the FMA.

During the line-up checks, the PF noticed that ALT SEL was not displayed on the FMA. When ALT SEL was selected, the crew did not confirm that GA, HDG, and ALT SEL were displayed on the

PFD. Instead ALT mode was active and displayed which led to a target altitude of 0 ft amsl being set, resulting in a descent when the autopilot was engaged. Timely warnings of the hazardous flight path were provided by the EGPWS, and prompt corrective action by the PF returned the aircraft to safe flight.

Safety actions

As a result of this incident the operator has taken several safety actions as follows:

1) Issued an Operational Notice to flight crews in which it describes the incident and sets out the policy for the flight deck actions once ATC clearance has been obtained.

2) Amended the Taxi Checklist to include:

   'PF to review clearance including:

   Confirming FMA selections (the heading bug should be adjusted for the expected drift).'

3) Updated the operator's simulator training within the operator's recurrent training and testing programme.

ACCIDENT

Aircraft Type and Registration:	1) Cessna 152, G-WACG 2) Guimbal Cabri G2, G-JAMM
No & Type of Engines:	1) 1 Lycoming O-235-L2C piston engine 2) 1 Lycoming O-360-J2A piston engine
Year of Manufacture:	1) 1982 (Serial no: 152-85536) 2) 2017 (Serial no: 1185)
Date & Time (UTC):	17 November 2017 at 1201 hrs
Location:	Near Waddesdon, Buckinghamshire
Type of Flight:	1) Training 2) Training
Persons on Board:	1) Crew - 2 Passengers - None 2) Crew - 2 Passengers - None
Injuries:	1) Crew - 2 (Fatal) Passengers - N/A 2) Crew - 2 (Fatal) Passengers - N/A
Nature of Damage:	Both aircraft destroyed
Commander's Licence:	1) Commercial Pilot's Licence 2) Airline Transport Pilot's Licence (H)
Commander's Age:	1) 27 years 2) 74 years
Commander's Flying Experience:	1) 419 hours (of which around 400 were on type) Last 90 days - n/k hours Last 28 days - 19 hours 2) 25,000+ hours (of which n/k were on type) Last 90 days - n/k hours Last 28 days - n/k hours
Information Source:	AAIB Field Investigation

Synopsis

The Cessna 152 and the Cabri G2 helicopter collided in mid-air when both were engaged on training flights. They were operating in Class G airspace[1] and neither aircraft was receiving an ATC service. The opportunity for the occupants of either aircraft to see the other was limited because, although they were in proximity for some time, they were both following a similar track and were not in each other's field of view.

Work is ongoing, led by the CAA, to promote the development and use of compatible Electronic Conspicuity (EC) aids to help mitigate the well-known limitations of 'see and avoid'.

Footnote

[1] A brief description of UK airspace can be found at: https://www.nats.aero/ae-home/introduction-to-airspace/ [Accessed 21 September 2018].

The flying club which operated G-WACG has issued an Instructor Notice to highlight the importance of maintaining an effective lookout throughout flight, and the need to carry out a regular change of heading during a prolonged descent, to check that the area ahead is clear.

History of the flights

Cessna 152, G-WACG

During the morning of the day of the accident, the instructor completed a training flight in G-WACG with another student. The signing out sheet at the flying club indicated that the detail had comprised Exercise 7.2 (best angle of climb, cruise climb, climbing with flap) and Exercise 8.2 (effect of power, speed and flap on descent).

The accident flight, about one hour later, was the instructor's second instructional flight of the day. The flight was recorded on the club signing out sheet as Exercise 7.1 (best rate of climb) and Exercise 8.1 (glide descent).

At 1138 hrs the student requested taxi clearance for a local flight. The aircraft was instructed to taxi to holding point A3 (Figure 1) and later, at 1146 hrs, G-WACG was given clearance to take off from asphalt Runway 24.

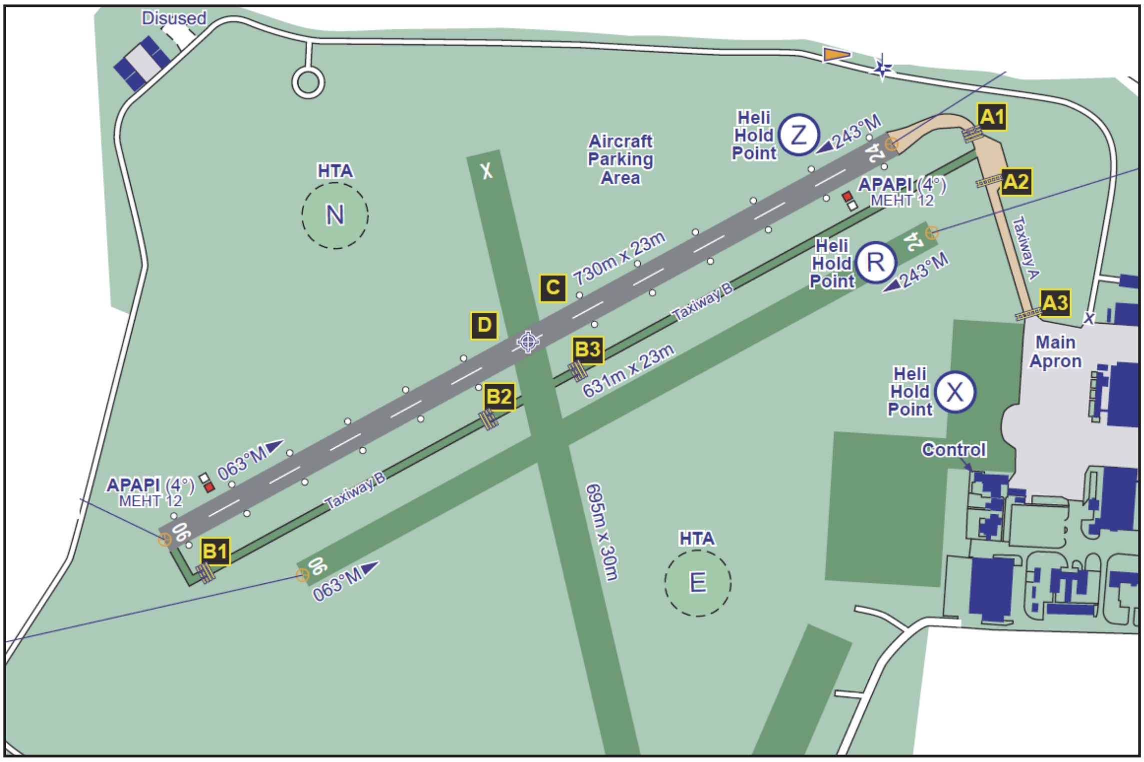


Figure 1

Wycombe Air Park/Booker, location of runways and holding areas

G-WACG took off and climbed steadily up to an altitude of 2,000 ft before turning on course to the local training area northwest of the aerodrome. At 1150 hrs G-WACG confirmed with Wycombe Tower that they had left the circuit area; there were no further radio communications from the aircraft. G-WACG reached 4,000 ft, turned left onto a steady north-westerly course and then commenced a sustained descent which continued until the point of collision. The collision occurred 14 minutes after takeoff from Wycombe.

A more detailed description of the relative positions of the two aircraft throughout their flights is provided in the recorded data section of this report.

Guimbal Cabri G2, G-JAMM

The instructor had completed one training detail in G-JAMM during the morning of the day of the accident; a navigation exercise in the local area to the north-west of Wycombe, routing via Silverstone and return. The second detail was planned as a repeat navigation exercise with a different student, so it is likely that the accident flight was intending to follow a similar track (Figure 2).

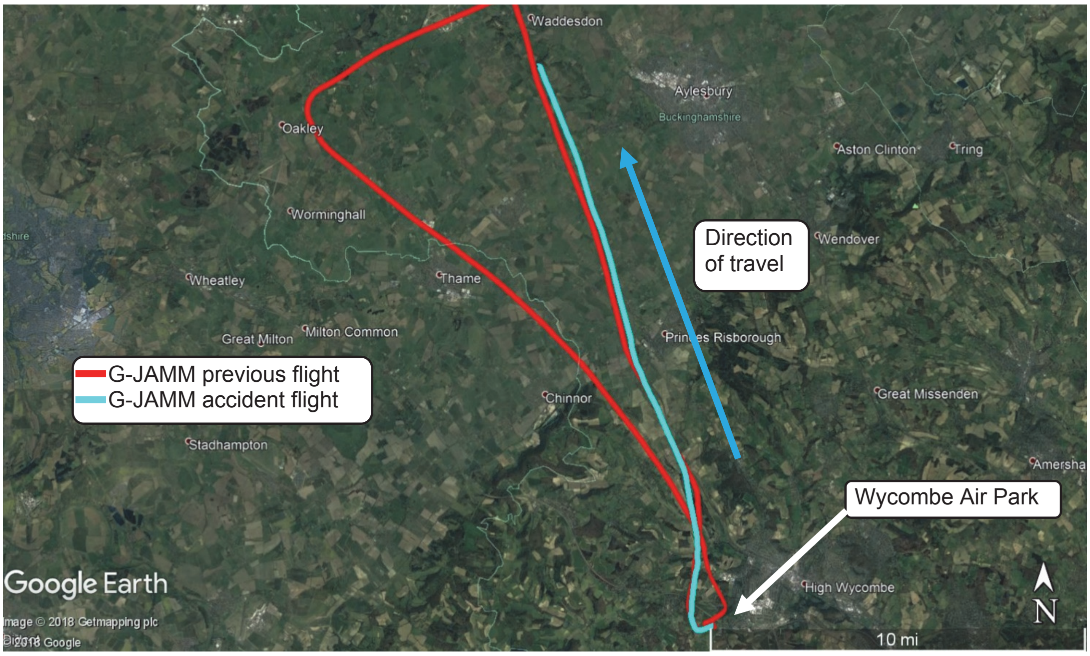


Figure 2

Radar-derived tracks of G-JAMM on 17 November 2017
(First flight red, accident flight blue)

At 1145 hrs G-JAMM was cleared to lift and taxi to holding point ‘X’ and subsequently to holding point ‘R’ to hold short of Runway 24. As G-JAMM was waiting at ‘R’, G-WACG took off from Runway 24. G-JAMM was then cleared to cross Runway 24 to helicopter training area ‘N’. G-JAMM departed at 1147 hrs, climbing initially to the south-west, before turning north and then north-west on track to Silverstone. The instructor in G-JAMM advised Wycombe Tower they were leaving the circuit to the north; there were no further radio communications from the helicopter. G-JAMM climbed to and maintained an altitude of around 1,500 ft amsl until the point of the collision.

Witness information

There were no witnesses to the flight paths of the two aircraft before the collision.

One witness, about 0.5 nm to the south-west, saw the two aircraft immediately before the collision in close proximity, estimated at around 20 m apart. He described both as flying fairly low and observed that "the plane was gliding down slightly" and the helicopter "was directly underneath the plane and seemed to be rising underneath it."

Recorded information

The position of each aircraft and Mode C/S altitude information throughout the flights was recorded by four NATS[2] radar heads. In addition, a number of ADS-B receivers recorded G-JAMM's position and altitude; the data was provided to the AAIB by NATS.

The recorded altitude from the aircrafts' transponders used a pressure datum of 1013 hPa. This has been corrected to the reported QNH on the day of 1029 hPa and all altitudes quoted in this report are amsl.

The period when G-JAMM and G-WACG collided was recorded on all four of the radar heads, the closest to the accident site being Bovingdon radar, 16 nm to the south-east. This recorded altitude and position every five seconds. Heathrow and Stansted radars, which were further away, recorded position every four seconds and the aircrafts' tracks from all radars were similar. On the accident flight and the earlier flights, both aircraft were squawking 7000, the conspicuity squawk.

Accident flights

G-WACG

G-WACG was fitted with a transponder which was transmitting aircraft pressure altitude to the nearest 100 ft (ie ± 50 ft). NATS radar first recorded G-WACG at 1147:02 hrs just after takeoff from Runway 24. The aircraft tracked on the runway heading for approximately 2 nm, climbing to 2,000 ft before turning 90° to the right towards the Stokenchurch Mast (Figure 3).

At the mast, G-WACG turned to a heading of approximately 015°, descended briefly to 1,430 ft before commencing a climb at 1154:43 hrs. This climb continued over the next 3 minutes 49 seconds, to a maximum altitude of 4,130 ft. This altitude was maintained for approximately 13 seconds before the aircraft began descending at 1158:44 hrs. Approximately seven seconds later, G-WACG turned left onto approximately 340°T.

G-WACG remained on this approximate track throughout the descent, which continued for the next two minutes and seven seconds, at which point the recorded altitude was 1,530 ft. The average vertical speed for this descent was -1,228 ft/min and radar-derived groundspeed ranged between 79 kt and 85 kt. Primarily due to the accuracy of the radar

Footnote

[2] NATS is the UK national Air Navigation Service Provider (ANSP).

data, but also its sampling rate, it was not possible to ascertain whether or not shallow turns were performed before or during the descent.

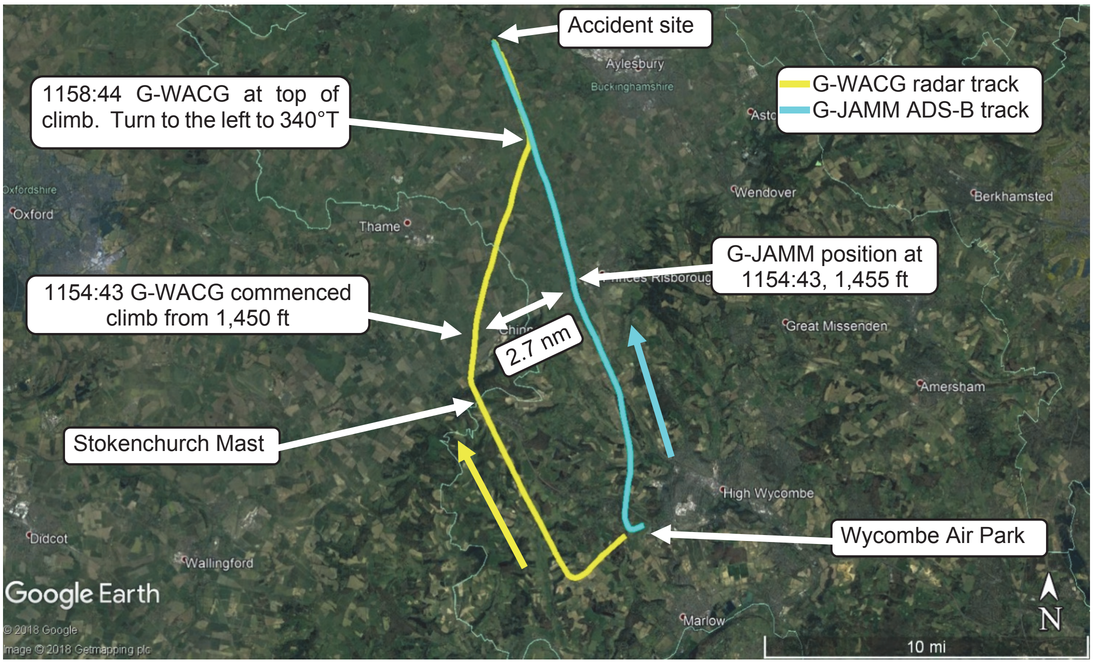


Figure 3

G-WACG and G-JAMM position information

G-JAMM

G-JAMM was fitted with a Garmin GTX335 Mode S transponder. This device not only responded to radar interrogation but also periodically transmitted ADS-B out[3], allowing the helicopter's position, derived from an internal GPS, to be received and recorded by appropriate equipment. The transmissions also included pressure altitude to the nearest 25 ft. As GPS position tends to be more accurate than radar-derived position, the recorded ADS-B data has been used in this report for G-JAMM.

G-JAMM was first recorded at 1147:04 hrs when it was on the ground at Wycombe. After takeoff, the helicopter turned to the right, climbing to approximately 1,500 ft, initially heading north before turning on to a track of approximately 340°T (Figure 3). Throughout the remainder of the flight, the altitude varied between 1,380 ft and1,555 ft and groundspeed between 60 kt and 73 kt.

Relative positions

Recorded positions of both aircraft commenced within two seconds of each other during departure from Wycombe. At this time, G-WACG was airborne at approximately 730 ft amsl, just beyond the end of Runway 24; G-JAMM was on the ground.

Footnote

[3] Automatic Dependant Surveillance-Broadcast (ADS-B) – a surveillance technology which allows aircraft to transmit GPS position, pressure altitude and other parameters.

During the first six minutes of flight, the distance between the aircraft increased up until the point where G-WACG turned to the right at the Stokenchurch Mast. Just prior to G-WACG commencing its climb, the aircraft were at a similar level, approximately 2.7 nm apart with G-WACG slightly behind and to the left of G-JAMM (Figure 3).

As G-WACG climbed, the tracks converged. When G-WACG then turned to track 340°T, the recorded positions show both aircraft following an almost identical path over the ground, albeit initially separated by over 2,500 ft vertically. At 1159:10 hrs, G-WACG, with a higher groundspeed, was approximately 0.5 nm behind G-JAMM and 1,950 ft above. A minute later, G-WACG was 750 ft above and approximately 1,000 ft behind. The vertical and horizontal separation progressively reduced to the point of the collision (Figure 4).

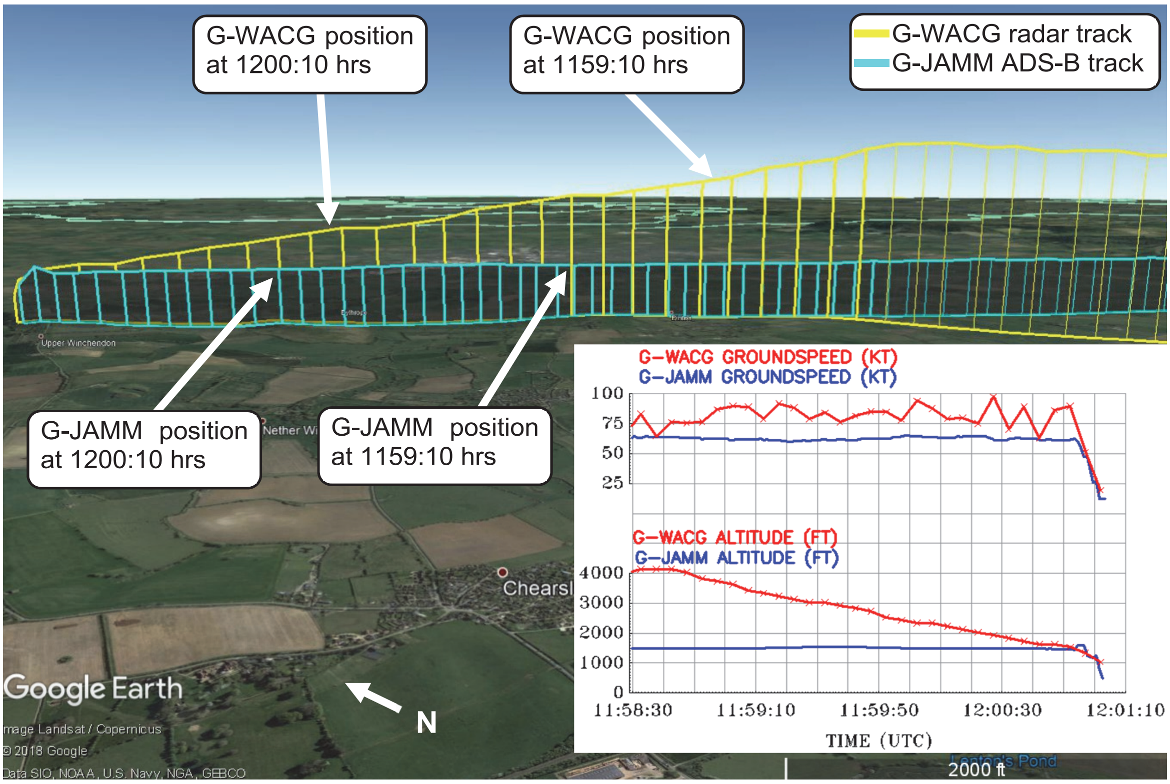


Figure 4

G-WACG and G-JAMM position information, looking to the north-east

The exact time and location of the collision could not be established due to the altitude resolution and the sampling rate of the radar. At 1200:45, G-WACG was at 1,630 ft, approximately 175 ft above G-JAMM. At 1200:53, G-WACG's recorded altitude was 1,500 ft and G-JAMM's was 1,455 ft. Just after this, the recorded radar altitudes of both aircraft started to decrease.

The final recorded radar position for G-WACG was at 1201:02 hrs, at 1,030 ft. The ADS-B recording from G-JAMM continued until 1201:03 hrs. Following the collision, some of the ADS-B altitude data was unreliable, but the final recorded altitude was almost at ground level. The accident site elevation was approximately 450 ft amsl.

Accident site

Both aircraft came down in the grounds of Waddesdon Estate and there was a debris trail approximately 300 m in length in a direction of approximately 312ºM. There were five areas of interest (Figure 5) and, apart from area 1, the wreckage from both aircraft was contained within an area of woodland.

Figure 5

Key areas of interest (area 1 highlighted in grey)

Debris recovered from area 1 consisted of small, lightweight items that were identified to be from the right wing of G-WACG. This included the navigation light, sections of fibreglass from the wingtip and parts of the right aileron and outer wing skin. Paper pages from a Cessna Pilot Operating Handbook were also recovered from this area. The aircraft's empennage, including both elevators and the rudder, was found in area 2.

G-WACG's fuselage and wings were found in area 4, having come to rest upside down opposing the direction of travel. There was no evidence of fire. The right wingtip and approximately 0.6 m of the outboard section of the right wing were missing. The right mainwheel was found adjacent to the wreckage, having broken off its axle; the nosewheel and left mainwheel remained attached to the fuselage. The leading edge of the right wing showed compression damage across its span caused by multiple impacts with the trees but the left wing was less damaged. The flaps were up.

The wreckage of G-JAMM was found mainly in area 3. It had come to rest upright, in the direction of travel and it had sustained considerable damage when it struck and descended through the trees. Some components, including the right door and fragments of the windscreen, were found several metres from the main wreckage. Most of the composite fuselage had been consumed by a post-crash fire and one of the main rotor blades was missing. The two rotor blades that remained in-situ were extensively damaged but unburnt. The tail boom and tail rotor remained attached but the structure was badly disrupted. The main rotor blade that had detached from the helicopter was found in area 5.

The wreckage was recovered to Farnborough for detailed examination and analysis by the AAIB.

Aerodrome information

Both aircraft were based at Wycombe Air Park/Booker (WAP). WAP is a busy general aviation airfield with fixed wing, rotary and gliding activity. A single asphalt runway is orientated 24/06 and there are two grass runways. Gliders use an open grass area on the south side of the aerodrome; there are designated training areas and holding points for helicopters north and east of the runways.

Communications

WAP Air Traffic Control (ATC) operates on frequency 126.55 MHz, callsign 'Wycombe Tower'. The communications are recorded and a copy of the recording was provided to the AAIB. On the morning of the accident the frequency was busy; between 1137 hrs and 1225 hrs there were multiple simultaneous/overlapping transmissions. G-WACG and G-JAMM each contacted ATC to request taxi clearance respectively and their exchanges continued until departure from the Aerodrome Traffic Zone. Neither aircraft advised ATC of a change to another frequency and no evidence was found of either aircraft having contacted any other Air Traffic Service.

Airspace

The area where the collision occurred is in Class G airspace. NATS publication '*Introduction to Airspace*[4]' advises:

> *'In class G airspace, aircraft may fly when and where they like, subject to a set of simple rules. Although there is no legal requirement to do so, many pilots notify Air Traffic Control of their presence and intentions and pilots take full responsibility for their own safety, although they can ask for help.'*

Footnote

4 https://www.nats.aero/ae-home/introduction-to-airspace/ [Accessed 21 September 2018].

The United Kingdom Aeronautical Information Publication (AIP) states:

> *'Within Class G airspace, regardless of the service being provided, pilots are ultimately responsible for collision avoidance….'*

Civil Aviation Publication (CAP) 1434 and CAP 774 provide guidance to pilots on the types of Air Traffic Service that are available within Class G airspace. A 'Basic Service' relies on pilots avoiding other traffic unaided by a controller; the Air Traffic Service provider is not required to monitor the flight. A 'Traffic Service' is surveillance-based, whereby the controller provides specific surveillance-derived traffic information to assist pilots in avoiding other traffic.

The area to the north-west of WAP, where many training flights operate, is partly covered by Farnborough North Lower Airspace Radar Service (LARS), Figure 6. Farnborough LARS provides Air Traffic Services outside controlled airspace to pilots flying under or around the London Terminal Manoeuvring Area. The type of service available depends upon the request made by the pilot and the capacity of the unit. The 'Farnborough LARS Guide' published online by NATS includes the following note:

> *'Please note that Farnborough cannot provide a TS[5] below an altitude of 1,500 feet due to radar performance.'*

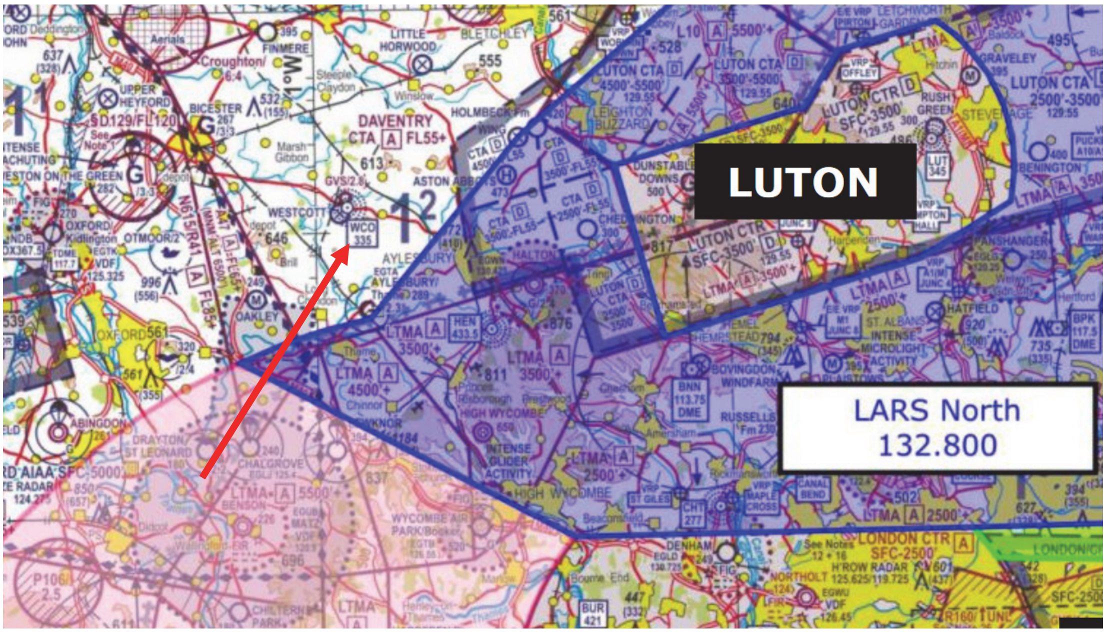


Figure 6

Accident location (indicated by arrow) relative to Farnborough LARS North

The area to the west of the Farnborough North LARS boundary is covered by Brize Norton LARS. London Oxford Airport is also radar equipped and pilots flying in the vicinity may call Oxford Approach; a Listening Squawk of 4517 is utilised for flights in the vicinity who may not wish to call ATC but want to highlight their position.

Footnote

[5] (TS) Traffic service.

The Future Airspace Strategy VFR Implementation Group (FASVIG) published online a '*Register of VFR Significant Areas*'[6] which includes an overlay facility for display on Google Earth. This document provides information on areas of significant general aviation activity but also on traffic densities for gliding and paragliding activity. The collision occurred in the zone named the Brize Norton-Heathrow-Luton Gap, information on flying training activity within this area is reported:

> *'Intensive private and commercial licence training area for Oxford, Wycombe, White Waltham and other airfields/airstrips in the area, plus helicopter training from RAF Benson.'*

Aircraft information

Cessna 152

The Cessna 152 is a two-seat, single-engine, high-wing aircraft, popularly used for flying training. It has dual flying controls and the student normally occupies the left seat, which is equipped with a more comprehensive set of instruments. The aircraft has a fixed tricycle landing gear and conventional flying controls actuated by metal control rods and cables. The aircraft is of semi-monocoque construction meaning that an element of its structural integrity is derived from its outer skin. Exhaust gases from the engine pass through a muffler assembly before being discharged overboard. The muffler has a shroud around the outside, which forms a heating chamber for carburettor heat and cabin heater air; exhaust gases are not mixed with cabin air.

The aircraft has a normal cruise speed of 90 kt to 100 kt and a best glide speed of 60 kt. The rate of descent at idle power and 60 kt is around 650 fpm to 750 fpm. At higher airspeeds the rate of descent increases. While descending at idle power it is recommended to warm the engine periodically by applying power for a few seconds.

Information defining the pilot's field of view from a Cessna 152 is limited to basic angular data from the manufacturer that is '*approximate based on eye location for an 85th percentile human male.*' Nevertheless, the data was sufficient to explore the opportunities for seeing the helicopter.

G-WACG was manufactured in 1982 and had accrued 14,180 flying hours. It had a valid Certificate of Airworthiness and a 50-hour scheduled check was completed on the day of the accident. There were no outstanding faults recorded.

G-WACG was painted predominantly white with a light blue underbelly and a red stripe along the length of the fuselage side, Figure 7. It was fitted with red, green and white navigation lights, a red anti-collision beacon on the vertical fin and a landing light in the engine cowling beneath the propeller spinner.

The technical log indicated that 80 litres (21 USG) of fuel was onboard prior to takeoff.

Footnote

6 http://docs.fasvig.info/Projects/MAS01/20170930-MAS01-0002-FASVIG-VSA-V2.pdf [Accessed 21 September 2018] This document has not been endorsed by the CAA.

Figure 7

G-WACG in the colour scheme when the accident occurred
(Photograph used with permission)

Guimbal Cabri G2

The Guimbal Cabri G2 is a two-seat helicopter with a single piston engine. It has dual controls and is flown from the right seat.

The field of view from the Guimbal Cabri G2 is predominantly forwards and sideways; rearward visibility is severely restricted because of the engine and main rotor gearbox.

The main rotor has three blades with a diameter of 7.2 m, turning in a clockwise direction when viewed from above. The nominal rotor speed is 530 revolutions per minute, which equates to approximately 26 blade passes per second, or about 0.04 seconds between blades. The helicopter has a shrouded tail rotor with a diameter of 0.6 m.

G-JAMM was manufactured in 2017 and had accrued 160 flying hours. It had a valid Certificate of Airworthiness and a 50-hour check was completed in November 2017. There were no outstanding faults recorded.

G-JAMM was painted predominantly metallic red with the upper and rearmost section of the tail boom being white (Figure 8). The main rotor blades were painted light grey with yellow tips.

The aircraft technical log indicated that 68 lbs (30 kg) of fuel was onboard prior to takeoff.

Figure 8

G-JAMM in the colour scheme when the accident occurred
(Photograph used with permission)

Aircraft examination

G-WACG

Debris recovered from area 1 was identified to be from the outer section of the right wing including parts of the aileron, wingtip and navigation light. Two-dimensional reconstruction of the outboard section of the wing identified multiple cuts in the trailing edge and aileron. Distortion adjacent to the cuts showed that the wing had been struck from underneath and the angle between one of the cuts and the wing upper surface was measured to be approximately 110º.

The rear empennage had separated from the aircraft in flight. Examination showed a single cut through the upper half of the fuselage, the dorsal fin and the elevator UP control cable. The cut was approximately 56° to G-WACG's vertical axis and originated on the right side of the aircraft. The lower half of the fuselage was buckled and distorted with numerous tears along the rivet lines and through the skin. The flying control cables in this lower section of the fuselage had broken due to overload.

The flying controls showed no evidence of any disconnects prior to the collision. Examination of the exhaust and shroud assembly found no evidence of any pre-existing cracks or damage.

G-JAMM

The tail boom and tail rotor assembly had been extensively damaged but there was no evidence they had been struck by the main rotor blades or any part of G-WACG.

The post-crash fire consumed most of the composite fuselage and the extent of the damage prevented a full assessment of the flying controls.

Damage to the main rotor blades showed evidence of multiple hard object impacts and anti-corrosive compound from the internal structure of the Cessna had been transferred to the blades. The fracture face of the detached blade showed evidence of a failure in overload. Witness marks and damage on the blade indicated that it struck the rear fuselage of G-WACG.

Meteorology

The weather conditions were clear with good visibility. A photograph of the inflight conditions taken by a pilot of another aircraft operating in the area ten minutes before the accident and travelling in the same direction as the accident aircraft is shown at Figure 9.

Figure 9

En route weather conditions at location of accident
(Photograph used with permission)

Pilot information

The Cessna instructor had been flying for seven years and instructing for one year, all at the same flying club. He held a Commercial Pilot's Licence with instructor rating and a current Class 1 medical certificate with a 'VDL' endorsement that required corrective lenses be worn and a spare set carried.

The Cessna student pilot was enrolled on an Air Transport with Commercial Pilot Training university course. He had recorded a total of three hours of flight time; the accident occurred on his fifth flight. He held a Class 1 medical certificate.

The helicopter instructor's logbook was not available for the investigation. He is reported to have flown in excess of 25,000 hours and was an experienced instructor. He held a Commercial Pilot's Licence (Helicopter) with a Class 1 medical certificate (not valid for single crew flying[7]) and held a type rating for the Cabri Guimbal helicopter.

The helicopter student held a Civil Aviation Authority of Vietnam Airline Transport Pilot's Licence with an endorsement for the Cabri G2 helicopter and a Class 1 medical certificate. He had completed 23 hours of training on the Flight Instructor Course.

Medical information

A carboxyhaemoglobin (COHb) level of 50% is considered to be the fatal threshold for a fire death and a level of 30% is considered to be incapacitating. Symptoms for a COHb level of 20% include; slight headache, fatigue and breathlessness. More serious symptoms, including significant shortness of breath, impairment of vision during exercise and general performance decrement, generally occur with rapid onset at levels of COHb around or above 25% to 35%. COHb is excreted through the lungs and the half-life is considered to be 4 to 5 hours[8].

Post-mortem examinations were carried out on the occupants of both aircraft. The post-mortem reports indicated that cause of death was multiple injuries in each case. A toxicological report noted an elevated level of COHb of 24% for the instructor in G-WACG; the COHb for the student was less than 5% (normal for a non-smoker). The report concluded that the elevated level of 24% suggested that the instructor may have survived for a short period after the accident.

It was noted in the investigation that, although all four pilots held Class 1 medical certificates, the post-mortems revealed that the instructor in G-JAMM and the student in G-WACG both showed signs of significant coronary disease.

The accident was not considered to be survivable.

Footnote

[7] The helicopter student was qualified as a pilot on the Guimbal Cabri G2.

[8] Aviation Toxicology in Aviation Medicine 3rd Edn. Eds Ernsting, J. Nicholson, A. Rainford, D. Butterworth-Heinemann 2000.

Organisational information

The flying school operating G-WACG was conducting a programme of pilot training as part of a university course towards a BSc degree in Air Transport with Commercial Pilot Training. The student pilot was enrolled on the course.

Since the accident, the flying club who operated G-WACG have carried out a comprehensive internal review of their operating procedures and published Instructor Notice 001-2018 which highlights the importance of maintaining an effective lookout throughout flight and includes the information:

> *'With particular reference to exercise 8(1) and 8(2), but applicable whenever descending is taking place, pilots should avoid commencing a descent wings-level, or maintaining a prolonged straight descent. At the commencement of the descent and at regular intervals during the maintenance of the descent (every 500 feet or so) the aircraft heading should be changed sufficiently to clear the airspace below.'*

The WAP Aerodrome Operator's Safety Committee met in January 2018. It was agreed that a common approach between operators based at the aerodrome towards the adoption of Electronic Conspicuity (EC) aids would be beneficial. Research was undertaken into the existing equipment fitted to operator's aircraft and to other available solutions. At the next meeting of the committee, in April 2018, it was decided that an effective system that would work with a significant number of aircraft was not yet available and that, in the interim, a procedural review should be undertaken to facilitate the flow of traffic in and out of the Aerodrome Traffic Zone.

Tests and research

A research study '*Helicopter Rotor Conspicuity*' conducted in 2004 by The Centre for Human Sciences, QinetiQ, explored the potential enhancement to visual conspicuity afforded by different main rotor blade colour schemes. The study acknowledged there was a particular challenge presented by helicopters, especially when viewed against the low reflectance terrain background typical of a rural area.

Following a series of tests using model helicopters the study concluded that there was a significant advantage to be gained from a colour scheme where a rotor disc contained whole blades of markedly different contrasting colours. The report noted:

> *'Contrasting whole blade schemes proved superior to uniform grey, uniform white, spiral and annular schemes throughout. The best results were obtained when white and black blades were together; the benefits were substantial in comparison with uniform schemes and appeared across a wide range of background reflectances.'*

Other information

Lookout technique

The European Aviation Safety Agency (EASA) Part-FCL – Subpart C provides a syllabus of flight instruction for a Private Pilot's Licence (PPL) and includes the note: '*Each of the exercises involves the need for the applicant to be aware of the needs of good airmanship and look-out, which should be emphasised at all times*.' Specific details concerning the use and interpretation of the syllabus is the responsibility of the National Licensing Authority, in the UK this is the Civil Aviation Authority (CAA).

CAA Safety Sense Leaflet 13, '*Collision Avoidance*'[9] provides comprehensive guidance on the importance of lookout for pilots operating under Visual Flight Rules (VFR). It includes information on physical limitations of the human eye and on visual scanning techniques. Training for the Private Pilot's Licence also includes advice to pilots on the importance of lookout and guidance for lookout technique.

Elementary Flying Training for the Royal Air Force has been conducted on the Grob Tutor aircraft. The associated Tutor Training Manual introduces the 'work cycle' approach of *Lookout-attitude-instruments* for all phases of flight. It also provides guidance, specific to each training detail, on lookout technique. The advice given for the Glide Descent is:

> *'Lookout. As always lookout, is vital. Before descending you must ensure the area ahead, behind and below the aircraft is clear. When in the descent, you will see that the flightpath ahead is obscured under the aircraft's nose and so, in a long visual descent, you will be taught to clear this area in a gentle weave similar to that used in the climb.'*

The United States Federal Aviation Administration issued an Advisory Circular '*Pilots' Role in Collision Avoidance*' (AC No: 90-48D[10]) in June 2016 highlighting the importance of lookout. Section 4.3.1 Pilots' Responsibilities advises that:

> *'Pilots should: During climbs and descents in flight conditions which permit visual detection of other traffic, execute gentle banks left and right at a frequency which permits continuous visual scanning of the airspace about them.'*

See and avoid

CAP 1391[11] published by the CAA states:

> *'Aircraft operating under Visual Flight Rules (VFR) in Class G (uncontrolled) airspace are not required to carry or use a radio, transponder or, other EC system, or communicate with Air Traffic Control. Instead, pilots and other airspace users*

Footnote

9 http://publicapps.caa.co.uk/docs/33/20130121SSL13.pdf [Accessed 21 September 2018].
10 https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_90-48D_CHG_1.pdf [Accessed 21 September 2018].
11 https://publicapps.caa.co.uk/docs/33/CAP1391_E2_APR2018.pdf [Accessed 21 September 2018].

> *rely on visual scanning to detect and avoid other traffic: this is known as the "see and avoid" principle. Visual scanning can however be affected by a variety of issues including: environmental conditions, aircraft design, pilot training and the limitations of the human eye.'*

A research report by The Australian Transport Safety Board (ATSB)[12] entitled '*Limitations of the See-and-Avoid Principle*', first published 1991 but still pertinent today, states:

> *'Numerous limitations, including those of the human visual system, the demands of cockpit tasks, and various physical and environmental conditions combine to make see-and-avoid an uncertain method of traffic separation.'*

The report concludes that *'the see-and-avoid principle in the absence of traffic alerts is subject to serious limitations*' and that reliance on '*see-and-avoid*' as a means of traffic separation should be minimised.

The United States National Transportation Safety Board (NTSB) issued a Safety Alert '*Prevent Midair Collisions: Don't Depend on Vision Alone -- Augment your reality to help separate safely'* (SA-058 November 2016[13]). This is aimed at encouraging pilots to adopt the use of available technology to assist them in the detection of other aircraft.

Collision avoidance systems

In addition to the see and avoid concept, a number of systems are available to enhance a pilot's mental picture of the traffic situation. These devices are collectively referred to as EC which the CAA defines in CAP 1391 as:

> *'Electronic Conspicuity (EC) is an umbrella term for a range of technologies that can help airspace users to be more aware of other aircraft in the same airspace. It includes transponders and radios. At the most basic level, aircraft equipped with an EC device effectively signal their presence to other airspace users, turning the 'see and avoid' concept into 'see, BE SEEN, and avoid'.'*

When an aircraft is fitted with a transponder, position can be determined by a radar head interrogating this transponder and using the response to calculate distance and direction from the radar head. Depending on the transponder fit, the radar head can also receive a 4-digit octal identifier (Mode A), altitude (Mode C/S) and/or a unique 24-bit identifying address[14]. This unique address enables an aircraft to be identified from a database of information (registration, aircraft type etc). If a transponder is equipped with an extended squitter and a GPS input, it can also transmit ADS-B out; a system designed to allow position, altitude and other information to be periodically transmitted without the need for radar interrogation.

Footnote

[12] https://www.atsb.gov.au/publications/2009/see-and-avoid/ [Accessed 21 September 2018].
[13] https://www.ntsb.gov/safety/safety-alerts/Documents/SA_058.pdf [Accessed 21 September 2018].
[14] State of Registry assigns each aircraft a unique 24-bit identifying address.

Transponders with extended squitters are not prevalent in general aviation aircraft largely due to cost and in some cases power and size constraints. A device capable of ADS-B out does not have to be part of a transponder but, if it is, this enables the transponder's Mode S and ADS-B transmissions to be synchronised.

ADS-B traffic information can be received and displayed in a number of ways including on some flight planning and navigation software.

Both G-JAMM's and G-WACG's transponders transmitted their pressure altitude and aircraft ident of 7000. In addition, G-JAMM was Mode S and extended squitter equipped, transmitting its 24-bit aircraft identifying address and ADS-B out. Neither aircraft was equipped with an EC device that could receive and display ADS-B data to its pilots.

Although both aircraft were fitted with EC aids, neither could receive relative position and altitude information for each other. Consequently, the pilots of both aircraft relied on 'see and avoid' for collision avoidance.

Development of EC systems

In April 2018, the CAA published the second edition of CAP 1391 '*Electronic conspicuity devices.*' This document represented the outcome of a CAA-led initiative to define a standard for low-cost EC devices for light aircraft. The document stated that the CAA:

> *'…viewed ADS-B extended squitter technology as the most practical solution, due to the possibility of lower transmit power levels leading to lower power consumption, lower costs and the potential for interoperability with other ground and air users.'*

A standalone EC device containing an extended squitter separates it from the transponder which can reduce its cost, size and complexity.

By defining this standard, the aim is to encourage manufacturers to adopt this common standard and develop low-cost solutions for general aviation pilots to implement on a voluntary basis. This would allow pilots to enhance their situational awareness, providing additional cues to a visual scan.

CAP 1391 requires EC devices to have a Declaration of Capability and Conformance which is granted by the CAA. At the time of writing, seven devices had been granted declarations which are all listed on the CAA website[15]. These devices operate using 1,090 MHz which is a frequency which lies within the aviation protected spectrum. However, the CAP also prohibits simultaneous use of separate transponder and ADS-B out EC devices to ensure coordination of transmissions; thus, if a transponder is in use, the separate EC device must be switched off.

Footnote

15 https://www.caa.co.uk/General-aviation/Aircraft-ownership-and-maintenance/Electronic-Conspicuity-devices/ [Accessed 21 September 2018].

Additional devices are also available which do not conform to the CAP1391 standard and so are not listed by the CAA, but they are widely used and have been shown to be effective in some circumstances. The frequencies used are not within the aviation protected spectrum and, if these devices do not transmit ADS-B out, the aircraft's transponder can be used at the same time.

Sense and avoid

The integration of Unmanned Aerial Systems (UAS) into civilian airspace provides additional challenges in collision avoidance. Some of these systems already use 'sense and avoid'[16] technology, but at present their effectiveness is limited in terms of detection range and closure rate. Future developments in this field may be applicable to manned aircraft.

Previous accidents and incidents

The United Kingdom Airprox Board collates and analyses information on all reported UK Airprox events and publishes an annual report[17]. Every event is attributed a risk rating and the effectiveness of identified safety barriers in avoiding a mid-air collision is also assessed. For 2016, 'see and avoid', outside of controlled airspace, was attributed a weighting of 20% as a safety barrier. Analysis of 71 events, in all airspace[18], indicated that 'see and avoid' was only fully effective in 35% of cases and partly effective in 49%.

In September 2017, the AAIB reported on a fatal mid-air collision which occurred in December 2016[19] in Class G airspace. Both aircraft were fitted with a type of EC aid but differing technologies meant that they did not communicate with each other. Since then the wider fitment and use of EC devices and the adoption of a common standard has been promoted by the CAA through the publication of CAP 1391.

Industry activity

Electronic Conspicuity Working Group (ECWG)

In 2009, the AAIB investigated a fatal mid-air collision in Class G airspace between a Grob G115E and a glider. The report[20] made Safety Recommendations to the CAA regarding EC and, as a consequence, the ECWG was set up in 2014. This Group consists of a number of industry representatives, who continue to meet to progress the development of EC.

CAA

While CAP 1391 defined the CAA's preferred EC standard, it also noted that further work was required on the subject. Since CAP 1391, the CAA has engaged in a number of trials including one investigating the effects of simultaneous use of a transponder and a separate

Footnote

[16] The capability to see, sense or detect conflicting traffic or other hazards and take the appropriate action.
[17] http://www.airproxboard.org.uk/uploadedFiles/Content/Standard_content/Analysis_files/Book%2032-final.pdf is the report for 2016 [Accessed 21 September 2018].
[18] Both controlled and uncontrolled airspace.
[19] https://www.gov.uk/aaib-reports/aaib-investigation-to-szd-51-1-junior-glider-g-cljk-and-cessna-150l-g-csfc [Accessed 21 September 2018].
[20] https://www.gov.uk/aaib-reports/5-2010-g-byxr-and-g-ckht-14-june-2009 [Accessed 21 September 2018].

EC device, both operating on the same frequency. The outcome of this trial is due towards the end of 2018 which the CAA will use to focus the next stage of progressing EC devices, including whether the restriction on simultaneous EC device and transponder usage is required to continue.

EASA

In November 2017, the EASA published the European Plan for Aviation Safety (EPAS) 2018-2022. Part 5.5.4 focusses on 'Preventing mid-air collisions' and includes:

> ***'SPT.089 European Safety Promotion on Mid-air collisions and airspace infringement:***
>
> *Develop and implement a pan-European Safety Promotion campaign on preventing airspace infringement and reducing the risk of MAC* [Mid-Air Collisions] *including awareness of airspace complexity and the use of technology such as ADS-B out.'*

The EASA has requested that the CAA and EUROCONTROL[21] consider the similarities and differences in their current approaches to general aviation surveillance. This activity is currently underway; the CAA has reported that they consider *'an ADS-B solution with across Europe buy in is achievable.'*

Analysis

Communications and airspace

Air Traffic Services are available in the area of the accident but the location is on the boundary of several different providers, thus, an aircraft manoeuvring on a typical training flight within the accident area would probably need to keep changing frequencies. External communications can create an additional distraction and increase the workload during an instructional flight, which may be why neither instructor attempted to contact an Air Traffic Service other than 'Wycombe Tower'.

The collision was outside of the promulgated area for Farnborough North LARS and was below their 1,500 ft amsl altitude restriction for provision of a Traffic Service. The busy airspace and restricted radar coverage in the area was such that any of the possible service providers would probably only have been able to offer, at best, a Basic Service.

Collision

As neither aircraft was electronically conspicuous to the other, the only available method of collision avoidance between the two aircraft was 'see and avoid.' There are considerable and well understood limitations to 'see and avoid' and there was no evidence to suggest that the occupants of either aircraft had seen each other in time to avoid the collision.

Footnote

[21] EUROCONTROL is a European organisation for the safety of air navigation.

G-WACG was descending from above G-JAMM on a similar course and gaining ground. The planned exercise was 8.1 Glide Descent, however, G-WACG was descending at a higher average rate of descent and airspeed than would be expected for a best angle glide, so it is possible that a higher airspeed was used, with a corresponding increased rate of descent. The angle at which the aircraft were closing was such that neither was in the field of view of the other, until perhaps a few moments before the collision.

G-WACG

The damage sustained by G-WACG indicated that the initial contact with G-JAMM was between the right wing of the aircraft and the main rotor blades of the helicopter. The number of cuts and their orientation indicated that the wing was struck from underneath by multiple rotor blades that were retreating ie travelling aft. Without precise attitude data it was only possible to determine the relative geometry of the two aircraft, and the cuts in the wing suggested that G-WACG was slightly ahead of G-JAMM immediately before the collision. The angle between one of the cuts and the upper surface of the wing indicated that the relative angle between G-WACG and the helicopter's rotor blades was approximately 110°. This suggests that one or both aircraft may have been manoeuvring immediately prior to the collision and the possibility of sudden evasive action cannot be discounted.

Following the initial impacts on the right wing, G-WACG was struck by a single rotor blade that cut through the upper half of the rear fuselage, passing from right to left at an angle of approximately 56° to G-WACG's vertical axis. The blade cut through the elevator UP control cable, which is routed through the upper half of the rear fuselage. The empennage, including both elevators and the rudder detached because of the combined effects of aerodynamic loading and the loss of structural integrity. The aircraft could not sustain controlled flight following the loss of the empennage.

Examination of G-WACG identified no evidence of any flying control disconnections that were not attributable to the accident, indicating that the aircraft was controllable prior to the collision.

G-JAMM

G-JAMM was severely damaged in the accident and post-crash fire. It was not possible to examine the flying controls in their entirety but the radar data showed no evidence of anything untoward prior to the collision and the crew did not report any anomalies. The damage sustained during the collision and the loss of a main rotor blade would have rendered the helicopter uncontrollable.

Witness marks on the detached rotor blade indicate that this was probably the blade that struck the rear fuselage of G-WACG.

See and avoid

Fixed wing aircraft with forward mounted engines have a restricted view ahead and below the flightpath. As a consequence, to see into the blind spots and to determine that the area into which it is descending is clear, an aircraft would have to be manoeuvred, generally by conducting a series of shallow turns.

Radar data indicated that, when G-WACG was 1,950 ft above G-JAMM, it was only 0.5 nm behind it. A simple assessment indicates that, if G-WACG was straight and level with zero pitch angle at 2,000 ft above G-JAMM, it would have to have been at least 1.9 nm behind for the pilot to have had any opportunity of detecting a possible conflict without additional manoeuvring (Figure 10). In the absence of a turn, the pilot would need to have pitched the aircraft at least 24° nose-down to have had any chance of observing the helicopter. The situation, whereby additional manoeuvring would have been required by G-WACG to bring the helicopter into view, would have persisted up to the point of collision.

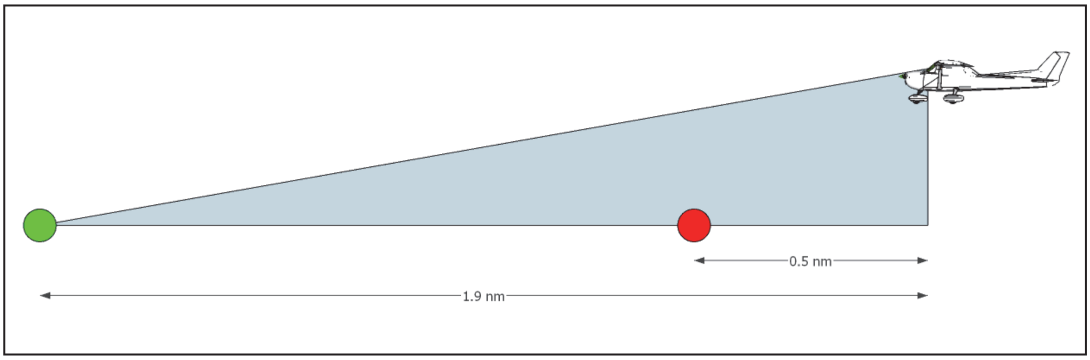


Figure 10

Forward visibility from G-WACG
(grey area is obscured from vision,
red circle indicates the radar position of G-JAMM,
green circle indicates the minimum distance at which
G-JAMM would have been visible)

The limitations of radar data are such that it was not possible to determine whether the pilots in G-WACG carried out any additional manoeuvring. Even if they did bring the helicopter into their field of view the chance of seeing it would have been limited; the conspicuity of a small helicopter against an unreflective background such as open fields and trees, is very low. The main rotor blades were of a uniform grey colour with yellow tips and would have been very difficult for the pilots of G-WACG to see against the land surface.

It would have been impractical for the pilots of the helicopter, in which visibility to the rear is obscured, to search the area behind them.

It is widely acknowledged that 'see and avoid' has a limited effectiveness in the prevention of mid-air collisions. The opportunity for a pilot to see another aircraft may be enhanced by the adoption of a good and regular scanning technique, as well as manoeuvring the aircraft regularly to clear unsighted areas. Similarly, the visual conspicuity of aircraft may be improved by high-visibility paint schemes, lighting and, specifically for a helicopter, by having one rotor blade of a contrasting colour.

Despite these possible enhancements a more effective method of collision prevention is likely to be through compatible EC aids on all aircraft which could draw a pilot's attention to the presence of other aircraft.

Medical aspects

The investigation noted from the toxicological analyses that that there was an elevated level of COHb for the instructor of G-WACG. This remains unexplained. The different levels between the two occupants and the evidence of the undamaged exhaust system indicate it was not as a result of an aircraft exhaust entering the cabin. Other possible explanations for the discrepancy are exposure to carbon monoxide (CO) prior to flight, exposure to CO post-accident and sample quality.

Exposure prior to flight is considered unlikely given the probable elapse of at least several hours since exposure, together with the rate of half-life decay of 4 to 5 hours. These factors would require the COHb to have been at a level considered to be incapacitating and clearly discernible to self or others in the period leading up to the accident flight. Also, there is no evidence to suggest an incapacitating exposure to CO in the one hour before the accident flight as the effects would have been apparent prior to commencement of that flight. It is more likely therefore that the exposure was as a result of a short survival period post-accident, as concluded in the toxicological report.

Although not identified at their respective Class 1 medical examinations, one pilot on each aircraft suffered from a medical condition which could have resulted in a sudden incapacitation. However, given the circumstances, it is unlikely that it was a factor in this accident.

Medical aspects were not considered to have been a factor in the accident.

Ongoing CAA work

The CAA work to help prevent the number of mid-air collisions in GA aircraft in uncontrolled airspace primarily involves the promotion of EC. The results of the simultaneous transponder and EC use trial will provide a useful insight to those who wish to fit a CAP 1391 EC device alongside their transponder. A number of EC-specific CAA activities are underway on which the CAA will report with a view to progressing the uptake of EC devices.

The operators based at Wycombe Air Park/Booker have agreed that a common approach towards the adoption of EC aids would be beneficial but recognise the current absence of an effective system that would work with a significant number of aircraft.

Conclusion

The geometry of the flight paths was such that the opportunity for the occupants of the two aircraft to 'see and avoid' each other was very limited. The damage sustained to each aircraft was such that neither could continue in controlled flight.

It is not known whether shallow turns were made during G-WACG's descent from 4,000 ft and G-JAMM's main rotor paint scheme would not have enhanced visual conspicuity when viewed from above.

As the separation between the two aircraft gradually reduced over several minutes, the use of compatible EC devices could have improved situational awareness such that avoiding action could be taken.

CAP 1391 defines a standard for EC, using ADS-B out, which has been adopted by some manufacturers. Other manufacturers have created and sold cost-effective devices, using a different standard and frequency, which are widely used and can be operated at the same time as the aircraft's transponder. With a growing uptake in EC devices, interoperability between systems and frequencies is vital to ensure its success in preventing mid-air collisions.

Safety action

Following previous Safety Recommendations, work is ongoing, led by the CAA, to promote the development and use of compatible Electronic Conspicuity (EC) aids to help mitigate the well-known limitations of 'see and avoid'.

The flying club which operated G-WACG has issued an Instructor Notice to highlight the importance of maintaining an effective lookout throughout flight, and the need to carry out a regular change of heading during a prolonged descent, to check that the area ahead is clear.

ACCIDENT

Aircraft Type and Registration:	Skyranger Nynja 912s(1), G-CGWL
No & Type of Engines:	1 Rotax 912ULS piston engine
Year of Manufacture:	2011 (Serial no: BMAA/HB/601)
Date & Time (UTC):	9 December 2017 at 1233 hrs
Location:	Plaistow Farm Airfield, Hertfordshire
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Fatal) Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Student Pilot
Commander's Age:	58
Commander's Flying Experience:	39 hours (of which 28 were on type) Last 90 days - 10 hours Last 28 days - 4 hours
Information Source:	AAIB Field Investigation

Synopsis

A student pilot had completed a successful dual circuit check with his instructor and was departing for a planned solo flight. After takeoff the aircraft was seen to climb steeply to a height of 100-300 ft agl before the left wing dropped. The aircraft then struck the ground in a steep nose-down attitude. The pilot was fatally injured. It is considered the accident was caused by the aircraft stalling, although a cause for this could not be determined.

History of the flight

The student pilot arrived at Plaistow Farm Airfield on the morning of the accident for a planned flying lesson. He met with his instructor who briefed him for a dual flight conducting circuits to be followed by a short solo general handling flight in the local area if the dual flight was satisfactory. The instructor stated that the brief included discussion of the increased aircraft performance the student would experience when flying solo due to the reduction in aircraft weight.

At approximately 1145 hrs, the student and instructor took off and completed four circuits, one of which included a practice engine failure. The instructor reported that the student's flying was good throughout and that the instructor did not need to make any inputs or corrections.

After the final circuit, the aircraft was taxied clear of the runway and the engine left running whilst the instructor re-briefed the student for the solo flight, as previously planned. The instructor exited the aircraft and at approximately 1230 hrs the student taxied to the threshold of Runway 30 and took off.

Five witnesses watched the aircraft at some stage during its takeoff and initial climb. The instructor reported seeing the aircraft appear to rotate normally before he lost sight of it behind some buildings. Others reported seeing the aircraft climb steeply and that at between 100 - 300 ft agl the left wing dropped and the aircraft turned to the left. The nose then dropped and the aircraft descended towards, and then struck, the ground in a steep nose-down attitude. None of the witnesses remember any unusual engine noises or hearing the engine stop. They quickly arrived at the accident site to provide help, but the student had been fatally injured in the impact.

Accident site

The aircraft had struck the ground within the airfield on Runway 15/33 (Figure 8), approximately 130 m from the threshold of Runway 15. Prior to the arrival of the AAIB, the aircraft had been moved several metres and the wreckage disturbed by the first responders.

A photograph taken by a witness immediately after the accident showed the aircraft nose-down in a near vertical attitude with its Brauniger Multi-Functional Display (MFD) and broken perspex from the canopy on the ground in front of the aircraft. There were no other items from the cockpit on the ground around the aircraft. Other photographs showed that following the accident the pilot's flight bag, headset, fire extinguisher, map and other personal items had been removed from the aircraft. The aircraft battery had also been removed and the fuel tank selector valve had been moved to the OFF position.

From the impact marks, it was established that the aircraft struck the ground on a heading of 140° (M). Both wings were level and there was no evidence of the aircraft rotating or spinning. The aircraft structural tubes supporting the engine mountings had failed during the impact and the floor tubes had been driven into the ground at an angle of 50° to the horizon (Figure1). There was a significant amount of oil in the area of the engine and two of the three propeller blades had broken off and were lying next to the hub. There was also a strong smell of fuel in and around the aircraft.

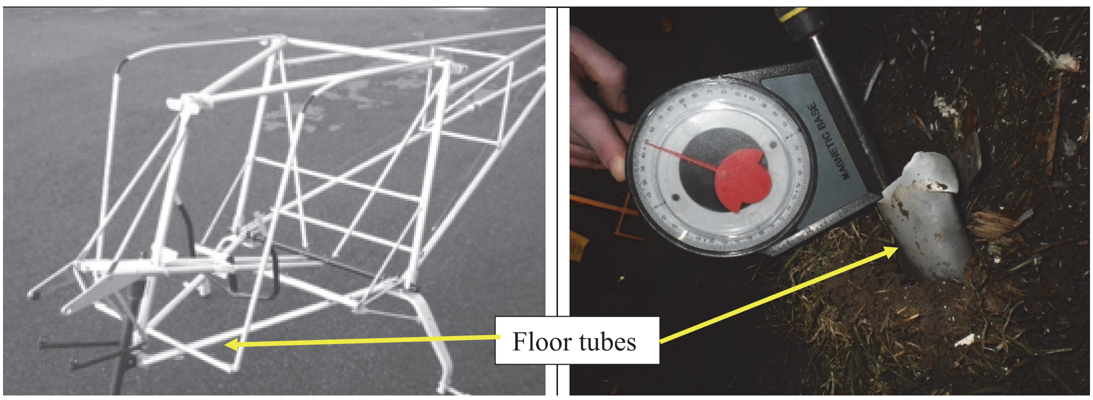


Figure 1

Floor tubes driven into the ground

Aircraft information

General

The Skyranger Nynja (Figure 2) is a high-wing, three-axis microlight aircraft certified in the UK to the requirements of British Civil Airworthiness Requirements (BCAR) Section S. It is fitted with conventional flying controls, three-stage flaps and a fixed landing gear with nosewheel steering. It has two seats with the occupants sitting side-by-side, each secured by a four-point harness. A luggage bag, with a zipped flap access, is fitted above the fuel tanks behind the pilot's seat.

The aircraft is supplied as a prefabricated kit, containing all the required components ready for assembly. It is constructed of straight aluminium tubes that are bolted together and the wings and fuselage are braced with cables (Figure 3). The wings and empennage are covered with Xlam laminate fabric and the fuselage with non-structural glass fibre panels.

Figure 2
Skyranger Nynja G-CGWL

G-CGWL

G-CGWL was registered on 21 February 2011 and operated on a CAA Permit to Fly, administrated by the British Microlight Aircraft Association (BMAA). The last Permit Certificate of Validity was issued on 9 May 2017 and was valid until 7 May 2018. As part of the Permit to Fly Revalidation, a flight test was undertaken on 7 May 2017 during which the following parameters were recorded:

Engine Max Static rpm	*4,900 rpm*
Climb rate @ 445 kg	*1,200 fpm*
Stall speed flaps up	*<32 kt*
Stall speed flaps down	*<32 kt*
Approach and Landing	*Satis*

G-CGWL was initially constructed for use in competition flying and the BMAA had authorised[1] several changes to the standard configuration, a number of which were aimed at saving weight. These modifications included the introduction of a single set of rudder pedals, single throttle, a fuel flow computer, smaller instrument panel and a Pegasus and Mainair fuel leaning modification. On 28 March 2016, at 484 airframe hours, the standard Nynja dual rudder pedals and throttle were installed to allow the aircraft to be used for pilot training.

Figure 3

Aircraft structure (Image from Aircraft Build Manual)

Flying controls

The flying controls were operated by cables and control rods with a single control column mounted on the structure between the seats. The rudder pedals controlled the movement of the rudder, via cables, and the nosewheel steering, by torque tubes connected to the nose landing gear leg. The aircraft was also equipped with three-stage flaps (up, takeoff and landing), which were manually operated and locked in place by a latch mounted on the operating lever. The aircraft could be manually trimmed in pitch by a lever mounted on a tube between the seats. Movement of the trim lever was transmitted through a cable to a trim tab on the right elevator which was reacted by springs attached to the elevator.

Engine and aircraft fuel system

G-CGWL was fitted with a Rotax 912 ULS four stroke piston engine, which powered a Kiev three-blade fixed pitch propeller through a reduction gearbox. The engine was fitted with twin Bing carburettors which, for competition purposes, had been modified to allow the fuel mixture to be leaned in flight.

The aircraft fuel system consisted of two 30 litre polyethylene fuel tanks, one mounted behind each seat. Fuel was fed from each tank through a three-position tank selector valve (OFF, LEFT, RIGHT) and an in-line fuel filter to the engine-driven fuel pump. An anti-vapour lock, fuel return line was fitted between the outlet side of the fuel pump and the carburettors

Footnote

1 Microlight Airworthiness Approval Note (2348) on 15 April 2011.

through a restrictor to the right fuel tank. For competition flying, G-CGWL had been fitted with a fuel computer and an additional fine fuel filter installed in the aircraft fuel system downstream of the inline fuel filter. A bypass valve situated between the seats allowed the fuel to bypass the computer and fine filter. The standard practice at the flying school was to fly with the bypass valve OPEN so that the fuel from the tanks did not flow through the computer or additional fuel filter.

Brauniger Alpha Multi-Function Display (MFD)

G-CGWL was equipped with a digital MFD fitted to the centre of the instrument panel in the cockpit. The MFD used a Liquid Crystal Display (LCD) to provide the pilot with the following information:

- fuel quantity
- aircraft airspeed
- altitude
- vertical speed
- engine rpm
- engine oil temperature
- water coolant temperature
- cylinder head and exhaust gas temperatures
- oil pressure

The airspeed and vertical speed were presented as analogue indicators; the altitude, engine speed, temperatures and pressure were displayed as numerical values; and the fuel quantity as a bar graph.

Figure 4

Brauniger Alpha Multi-Function Display showing vertical speed and airspeed

The MFD provided a visual alert to the pilot if the airspeed or engine parameters exceed set limits. If an engine exceedance was detected, a red warning light located at the top left of the MFD and the associated temperature readout on the LCD, slowly flashed. If the airspeed was either below or above set limits, the red warning light flashed more quickly. The MFD also had the ability to provide an audible alert that accompanied the visual alert. This audio function was not installed on G-CGWL.

The alert thresholds set for G-CGWL were:

- airspeed less than 22 kt
- airspeed greater than 150 kt
- exhaust gas temperature (EGT) greater than 850 °C
- cylinder gas temperature (CHT) greater than 135 °C
- oil temperature greater than 130 °C
- water temperature greater than 120 °C
- engine speed above 5,800 rpm
- oil pressure less than 1.5 bar
- oil pressure greater than 6.0 bar

If external electrical power to the MFD was lost in flight, a back-up battery installed within the MFD automatically provided electrical power that enabled the unit to continue to operate for several hours. The voltage of the integral battery was tested each time the MFD was powered on. If the voltage was detected as being low, a warning was presented on the MFD. The battery from the MFD installed in G-CGWL was removed and tested and found to be within normal parameters.

Stall warner

As typical for this type of aircraft, G-CGWL was not fitted with, nor required to have, an artificial stall warning device.

Aircraft examination

An examination of the aircraft and engine was carried out by the AAIB at the accident site and at their facilities at Farnborough.

General

G-CGWL had been constructed and assembled to a high standard and appeared to have been well maintained.

The forward section of the aircraft and the cockpit area had been badly damaged in the impact. Both seats and the seat harnesses were intact, however, the tube which supported the forward edge of the seats had failed in overload. The student had been sitting in the left seat and the AAIB was advised that his harness had been unbuckled by the first responders. The harness on the right seat had been fastened and the straps fully shortened. The luggage bag was intact and was found by the AAIB with the access flap unzipped.

Due to the damage to the aircraft it was not possible to establish the integrity of the pitot-static system.

Structure

Several of the structural tubes had failed, or were bent, and some of the connecting bolts had sheared. Both forward wing struts had failed and the leading edges of both wings were bent rearwards with distortion around several of the bolt holes. The right wing had sustained slightly more damage than the left wing with its trailing edge tube also being bent rearwards. One bracing wire in the right wing had failed in overload. The right main landing gear had rotated rearwards as a result of the steel torque tube in the fuselage having buckled during the impact.

All the structural damage was consistent with the impact and there was no evidence of any pre-existing failures.

Flying controls

With the exception of the right rudder cables, all the flying control cables were still connected. The rudder pedals had been badly distorted in the accident and the torque tubes that connect the rudder pedals to the nosewheel steering tube had buckled. The head of the bolt that secured the rudder and stop cable to the right rudder pedal had sheared. Damage to the rudder steering torque tube indicated that it was the distortion of the torque tube during the accident that caused the head to shear from the bolt.

All the control cables and rods moved freely and there was no visual damage to indicate that a control restriction had occurred prior to the accident.

The elevator trim control lever and cable were still intact and the lever was found in the forward (nose-down) position. However, the lever may have been inadvertently moved by the first responders.

The flap operating lever had failed in overload as a result of a force having been applied from the left side of the lever. Marks on the front of the lever were consistent with normal operating wear marks. However, there was a fresh scratch in the paint on the right side of the lever, adjacent to the second flap latching position (Figure 5).

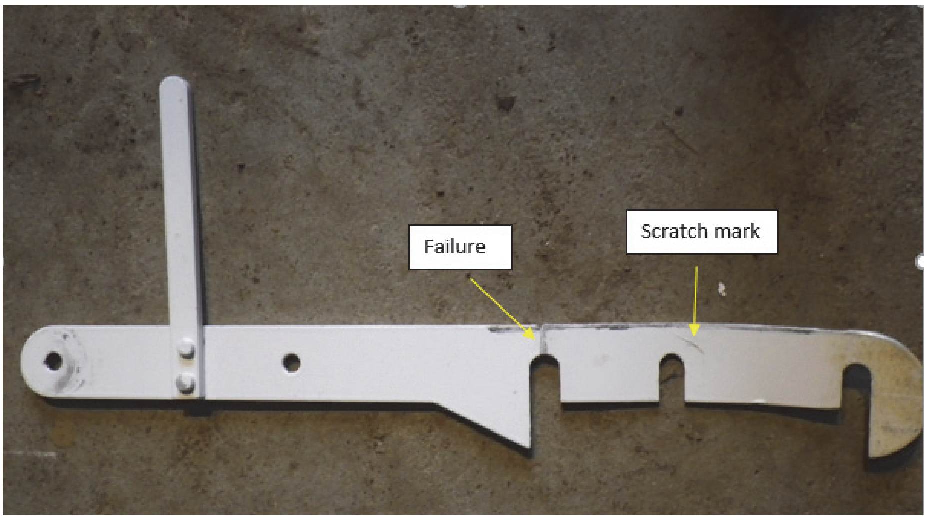


Figure 5

Flap operating and latching lever

The scratch mark on the flap operating lever aligned with the edge of the latching bracket, which corresponded with the flaps being at the takeoff (Flap 15°) position (Figure 6).

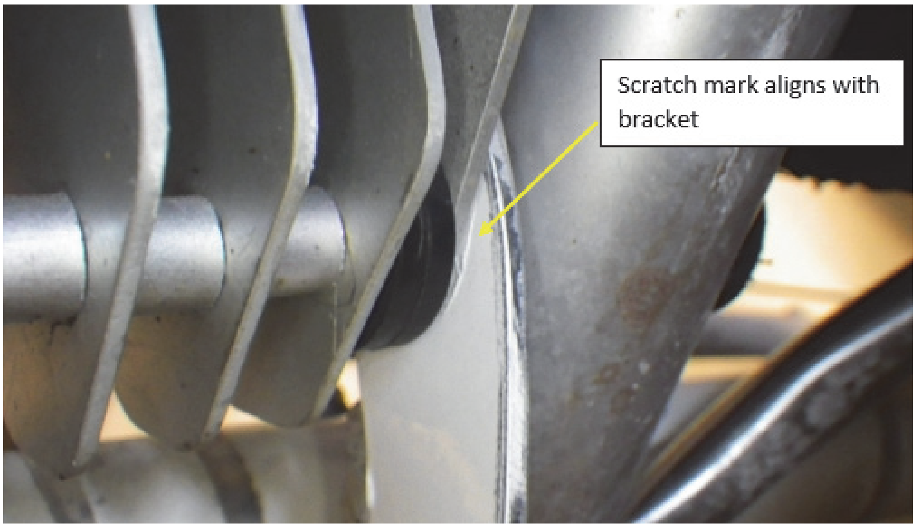


Figure 6

Alignment of the scratch on the flap operating lever with the latching bracket

Fuel system

The AAIB was advised that the fuel tank selector valve was moved to the OFF position following the accident. The fuel computer bypass valve was found in the OPEN position. Both fuel tanks had been punctured during the impact, nevertheless, 2.5 litres of fuel were recovered from the left fuel tank which was tested and found to contain approximately 4.5% ethanol (by volume) which is within the permitted specification for Mogas.

The in-line and fine fuel filters contained a small amount of debris that was considered normal. Fuel was found in all the fuel lines, both carburettor bowls and the fuel pump. The diaphragm in the fuel pump was intact and the pump ejected fuel, under pressure, when manually operated.

Engine

The engine could not be turned by hand and some components and wiring on the outside of the engine had been damaged during the impact.

Following the removal of the reduction gearbox and spark plugs, the engine was free to rotate by hand and the valve assemblies, water and oil pumps all operated normally. The engine was disassembled and clean lubricating oil was found throughout the engine. All the components were in a satisfactory condition and the colour of the cylinder heads and spark plugs indicated that the engine had been operating normally. Both carburettors had been damaged externally, however, the throttle valves and pistons were free to move and the jets were clear of debris. Visually, all the electrical components, harnesses and spark plug leads appeared to have been in a good condition prior to the impact. There was no significant debris in the oil filter and the small amount of debris captured by the magnetic plug in the sump was considered to be normal.

There was a small amount of debris between five of the teeth on the small gear in the reduction gearbox which was used to drive accessories such as a vacuum or hydraulic pump, however, this drive was not used on this engine. The sides of the teeth had a polished appearance which corresponded with a polished area on the engine casing that extended across an arc of approximately 80° (Figure 7). It was assessed that this damage occurred during the impact because of the propeller drive shaft being pushed into the reduction gearbox, causing the sides of the teeth to contact the engine casing. It was this contact, and possible distortion of the reduction gearbox casing, that had prevented the engine from being rotated by hand during the initial inspection.

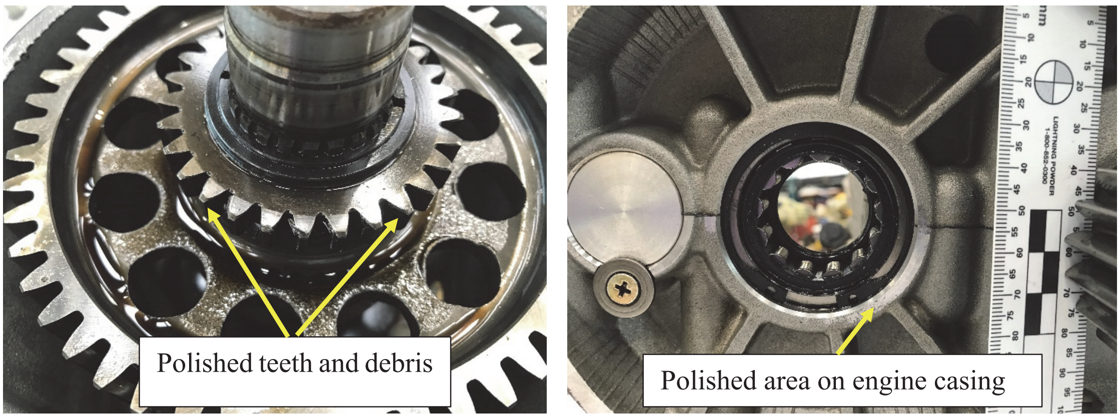


Figure 7

Contact between accessary drive gear and engine casing

Propeller blades

Two of the three propeller blades had failed at the hub and were damaged part way along their span. While the failure of both blades was consistent with the engine contacting the ground at a steep angle, there was no physical evidence of the propeller being driven under power when it struck the ground. This may be explained by the low inertia of the engine.

Recorded information

The MFD had an internal recording function which monitored engine rpm, altitude and airspeed to determine the start and end of a recording period. Each recording started once the engine has been running for one minute and the MFD detected an increase in altitude of about 75 ft, indicating that the aircraft had taken off. The recording ended once the engine had stopped with an airspeed less than about 27 kt and with no change in altitude detected for a subsequent period of approximately 30 seconds.

The MFD recorded flight duration reflected the time that the aircraft had climbed above 75 ft and the airspeed remained above 27 kt.

Recorded information was recovered from the MFD for the accident flight and the 23 previous flights dating back to 3 October 2017. This data provided a peak value of airspeed, altitude, vertical speed and engine parameters (except oil pressure). The recording logic meant that the four previous circuits and the accident flight were combined into one recording period. It was not possible to determine at what point peak values occurred during the recording period.

The data for the previous dual circuit check and accident flight indicates that the engine had been running for a total of 40 minutes, including 17 minutes of flight. The engine was started at approximately 1150 hrs and the first takeoff was logged at 1157 hrs. Table 1 provides the peak values recorded during the period of the four circuit flights and the accident flight.

Rate of climb ft/min	Rate of Sink ft/min	CHT °C	EGT Sensor 1 / 2 °C	Water temperature °C	Oil temperature °C	Engine rpm	IAS kt	Altitude ft
+1,000	-1,000	63	776 / 785	59	65	4,980	72	806

Table 1

Peak parameter values recorded during the circuit flights and accident flight

The maximum recorded altitude of 806 ft and airspeed of 72 kt were consistent with the reported circuit altitude and speed provided by the instructor from the circuit check flight with the student. The maximum recorded rate of climb of 1,000 ft/min was within the climb rate range recorded on previous flights of between 950 -1,950 ft/min.

None of the recorded engine data, including that of accident flight, had exceeded the pre-set alert thresholds.

Personnel

Student pilot

The student had started training for a BMAA National Private Pilot Licence (NPPL) at Plaistow Farm Airfield in April 2017. His logbook recorded that prior to this date he had completed three dual flights, totalling 2.5 hours, in a Skyranger microlight at another airfield. A separate logbook discovered after the accident recorded that the pilot had also previously completed 16 hours of dual instruction on a Cessna 152 between February and September 2016, again at a different airfield.

The student's training was to the BMAA NPPL syllabus and he had completed 40 training flights at Plaistow Farm Airfield totalling 36.5 hours. Nine flights had been completed on a Eurostar EV97 and the remaining 31 flights on G-CGWL, the Skyranger Nynja involved in the accident. He had flown with two instructors during his training at the airfield who both described him as a good student.

The student's training records show normal progress through the syllabus. He first flew solo on 19 November 2017 after completing 33.5 hours of training, which his instructor considered normal for a student pilot of his age. His logbook recorded that on this occasion he flew three circuits, totalling 35 minutes.

The student's only other solo flight was on 2 December 2017, seven days before the accident, when it was recorded that he had flown a 30-minute flight consisting of circuits and general handling.

The student's training records show he completed a stalling lesson in April 2017 on the Eurostar EV97 which was revised in a further lesson in May 2017 on the Skyranger Nynja. The AAIB was informed that other stall revision might have be included as part of subsequent lessons conducted, as for instance would be the case for practice engine failures.

Instructor

The instructor had held a UK NPPL with a microlight rating since November 2013, prior to which he had flown microlights overseas. He had held a UK Flight Instructor Rating (microlight) since April 2014 and had instructed at Plaistow Farm Airfield since that time. His logbook showed he had completed 1,628 hours as pilot in command, including 1,290 hours as an instructor at the time of the accident.

Medical

The student had completed an appropriate medical self-declaration, valid at the time of the accident. The post-mortem did not reveal any medical issues which may be considered to have contributed to the accident.

Meteorology

Witnesses described the weather conditions at the time of the accident as good, with no significant cloud, good visibility and a crosswind on Runway 30 of 3 - 4 kt from the right. None of the witnesses described any significant wind gusts at the time of the accident.

The Met Office provided an aftercast (extract below) of the likely conditions in the area of the airfield at the time of the accident which was consistent with the witness descriptions.

> *'A light to moderate west-northwesterly surface wind, with mean speeds likely to be in the region of 8-10 kt, with the possibility of isolated gusts up to 20 KT at times. Initially, conditions were clear with nil cloud, but cold with a possible grass frost. The visibility associated with these conditions would have been good, potentially as much as 30 KM, but in excess of 10 KM at the very least. Conditions were dry throughout the period of interest, however cloud amounts began to increase by midday, with few amount of cloud with bases most likely to be around 2000 FT AMSL, and occasionally broken bases well above 5000FT.'*

Aircraft handling

Takeoff

The aircraft operator's manual describes the normal takeoff technique as:

> *'When lined up and rolling straight smoothly apply full power. Keep straight with rudder, ailerons neutral and with the elevator slightly up to reduce the weight on the nosewheel. When the airspeed rises to 45 knots CAS rotate and lift off and adopt a shallow climb attitude. Allow the airspeed to rise to 60 knots CAS and adopt a climbing attitude to hold this airspeed.'*

The flying school trained students not to focus solely on the airspeed as a reference during takeoff, but to hold the stick neutral, or slightly aft of neutral (elevator up), during the takeoff roll and that the aircraft would then naturally lift off at approximately 45 kt. Students were further taught that once airborne they should allow the aircraft to accelerate to the climb speed of 60 kt before increasing pitch sufficiently to maintain this speed as they climbed away.

The aircraft required right rudder to be applied during the takeoff roll and initial climb to counter the slipstream and torque effect created at full power.

Pitch trim

For takeoff, pitch trim was required to be set in the mid-range position. During landing, balanced flight normally resulted in a fully aft trim position. If the aircraft takes off with fully aft trim applied this is likely to result in the aircraft lifting off at a lower speed than normal and a tendency to climb at a higher pitch angle, unless the forces are counteracted by the pilot.

Slow flight and stall

An aircraft stalls when one or both wings' angle of attack exceeds a critical angle causing the separation of airflow over the wing and a loss of lift. For a fixed pitch angle, the angle of attack increases as the airspeed reduces. Thus, during slow flight an aircraft is more susceptible to stalling.

The operator's manual described the characteristics of slow flight as:

- Lightening of controls accompanied by reduced effectiveness
- Reduced airflow noise (most noticeable at low power settings)
- High nose attitude (most noticeable at high power settings)
- Rearwards position of control stick and back pressure
- Strong pitch buffet as the incipient stall is entered
- A tendency to roll or wing rock accompanying the buffet

The stall was described as:

> *'Wings Level, Power Off*
>
> *Max pitch attitude is 45^0, and stall warning is given about 2 knots above the stall by buffet. Stall is normally marked by a mushing descent in heavy buffet or nose drop.*
>
> *Wings Level, Power On*
>
> *Characteristics are similar to the power off case. An additional warning of the approaching stall is the attitude of the aircraft. With full power set the aircraft stalls at a very high nose attitude.*
>
> *Because of the increased slipstream and torque effect at high power settings considerable rudder deflection may be required to keep in balance as the stall is approached. Stalling out of balance can result in considerable wing drop.'*

Aircraft Checklist

The aircraft was not supplied with a type-specific checklist, although the operator's manual contained information on generic checks.

It is common practise for microlight pilots to memorise mnemonic checklists. The training school produced a printed checklist for students to memorise for this purpose. It was noted during the investigation that there was no reference in this checklist to the flaps under the pre-takeoff checks. The instructor stated that students were taught to incorporate a check of the flap position as part of the trim check that was listed.

There was also no specific after-landing check documented in the operator's manual, or used by the flying school. Due to the nature of the airfield, touch-and-go landings were not performed and, after landing, aircraft were taxied back to the threshold if taking off again. Students were taught to re-configure the aircraft for takeoff during the taxi to the threshold, however this was done without reference to the pre-takeoff check mnemonic.

Airfield information

Plaistow Farm Airfield is an unlicensed airfield used primarily by microlight aircraft. The airfield has two intersecting grass runways: Runway 12/30 (329 m x 20 m) and Runway 15/33 (357 m x 20 m) (Figure 8).

Figure 8

Plaistow Farm Airfield, Runways 12/30 and 15/33 with accident site marked

Circuits are flown to the south of the airfield at 800 ft agl. The prevailing winds are westerly with Runway 30 normally used for takeoff as, although it is the shorter runway, it does not have a significant upslope. Runway 33 has an upslope and, due to this and its longer length, is normally used for landing. After takeoff from Runway 30 aircraft have to make a slight turn to the right to avoid powerlines which run close to the southwest of the airfield to a height of 200 ft agl. There is also a number of trees close to the airfield boundary which can affect the approach.

Aircraft performance

The aircraft operator's manual stated that:

> *'the Nynja can be flown with any permitted fuel, pilot and passenger weights without falling outside of its permitted CG limits.'*

The estimated take-off weight for the accident flight was 360 kg, which was within the permitted MTOW of 450 kg. This was approximately 18% lighter than the take-off weight during the previous flight, significantly enhancing performance. During the initial climb, the aircraft would have been able to climb more rapidly and would have had to adopt a higher nose attitude to maintain the recommended climb speed.

Demonstration flight

A flight conducted by a BMAA test pilot in a Skyranger Nynja similar to G-CGWL demonstrated that if the aircraft was stalled, with Flaps 15 and full power set in balanced flight, it did not have any tendency to drop a wing. However, if the aircraft was stalled in the same configuration but with insufficient right rudder applied, the aircraft would drop the left wing and turn to the left. Typical height loss to recover was approximately 100 ft.

Analysis

The ground marks and damage to the aircraft indicate that the aircraft struck the grass runway in a nose-down attitude at an angle of 50° to the horizon on a heading of 140° (M), the aircraft having turned through approximately 160°. The right wing and main landing gear sustained slightly more damage than the left side of the aircraft, however, there was no physical evidence that the aircraft had been rotating or spinning on impact.

Witness descriptions of the aircraft were consistent with it stalling shortly after takeoff. Take off requires right rudder to be applied and it was demonstrated that if insufficient right rudder is applied, a stall can lead to the left wing dropping and the aircraft turning to the left.

A number of factors were considered in trying to establish the cause of the aircraft stalling or if any other situation might have led to the aircraft behaving as described.

Aircraft engine and structure

The aircraft had been built to a good standard and there had been no reported problems with either the aircraft or engine. The instructor who flew the four circuits with the student prior to the accident flight stated that the aircraft and engine had been operating normally. Witnesses also reported that the engine sounded normal during the accident flight. The data download from the MFD did not identify any unusual engine parameters and an examination by the AAIB could not identify any reasons why there might have been a loss of power. There was sufficient fuel on the aircraft to complete the flight, the fuel filters were clean, the fuel valves were open and the ethanol content of the fuel was within acceptable limits for the engine. The lack of rotational damage to the propeller blades can be explained by the attitude that the engine struck the ground. The damage to the sides of the five teeth in the reduction gearbox accessory gear drive and the engine casing is evidence that the engine had been rotating when the propeller hub struck the ground.

It was assessed that the flying controls were intact prior to the impact and there was no evidence of a control restriction or failure. The wreckage had, however, been disturbed and personal items of equipment removed by the first responders prior to the arrival of the AAIB. It was therefore not possible to exclude the possibility that an item of personal equipment had restricted the movement of the flying controls.

Aircraft configuration

It was considered possible that the student had not re-configured the aircraft appropriately after landing for the subsequent takeoff, which may have caused the aircraft to rotate early at low speed and to have climbed more steeply than normal. This would have made it susceptible to stalling.

Evidence from the aircraft wreckage however indicates the aircraft took off with the correct flap setting and the instructor stated he believed the rotation appeared normal. The position of the trim lever during takeoff could not be determined and it is therefore not known whether this had contributed to the aircraft's subsequent steep climb.

The flying school considered their students were all adequately trained to configure the aircraft properly prior to takeoff. In order to reinforce this they have now updated their printed checklist to specifically include the flaps and have added '*Subsequent Takeoff Checks'* to be completed between landing and the next takeoff.

Medical

The post-mortem revealed no evidence of the student suffering any medical incapacitation and the pilot appeared well during his time at the airfield. It remains possible however that any incapacitation remained undetectable.

Weather

The weather conditions reported at the time of the accident were suitable for the flight and are unlikely to have contributed to the aircraft stalling.

Aircraft handling

The student was considered to fly to a good standard and had just demonstrated to his instructor his ability to fly circuits without the need for any intervention. Whilst this was only his third solo flight, he had previously conducted a number of solo circuits. The last occasion he flew solo was only a week before the accident giving him recent experience of the aircraft's reduced takeoff weight and relative increase in performance. These flights had gone apparently without incident.

Despite this, and whilst there is no objective means of determining how he handled the takeoff, it is possible that the increased aircraft performance created by flying solo led to the student climbing more steeply than normal; sufficiently so to cause the aircraft to stall. Had insufficient rudder been applied at the time to counter the effects of the full power applied at takeoff, this could have then led to the wing drop, as witnessed.

The student had received training in both recognising and recovering from the stall. The last lesson recorded was however some seven months before the accident. It would seem sensible to ensure stall training is revised at appropriate intervals although as this needs to be fitted in alongside other training priorities, defining what is appropriate remains subjective. Had the student received more recent stall training, it is still likely that as the apparent stall occurred so soon after takeoff it would have taken him by surprise. The demonstration flight indicated that even had the stall been recognised, it is probable that there was insufficient height available for recovery.

Conclusion

The investigation did not identify any technical faults with either the aircraft or engine. It is probable the accident was caused by the aircraft climbing sufficiently steeply after takeoff to induce a stall. The cause of the steep climb could not be determined. The possibility of incorrect trim setting, control restriction or incapacitation could not be fully eliminated. It is possible insufficient right rudder had been applied to counteract the effects of the high power set and that this led to the left wing dropping as the aircraft stalled. It is likely the aircraft was too low for a stall recovery to be possible.

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:	DHC-8-402 Dash 8, G-JECX
No & Type of Engines:	2 Pratt & Whitney Canada PW150A turboprop engines
Year of Manufacture:	2007 (Serial no: 4155)
Date & Time (UTC):	17 April 2018 at 1205 hrs
Location:	Newquay Airport, Cornwall
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 4 Passengers - 55
Injuries:	Crew - 1 (Minor) Passengers - None
Nature of Damage:	Damage to several skin panels, frames and stringers and the aft pressure bulkhead
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	46 years
Commander's Flying Experience:	7,200 hours (of which 1,065 were on type) Last 90 days - 70 hours Last 28 days - 26 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquires by the AAIB

Synopsis

The crew were operating their third sector of a four-sector day from Manchester to Newquay. Weather at Newquay included low cloud, light rain and a moderate wind. On the second approach to Runway 12 the aircraft developed a high sink rate below 50 ft. The pilot flying reacted to the sink by increasing the pitch attitude, which resulted in the aircraft tail striking the runway before the main landing gear.

History of the flight

The flight crew reported at Manchester Airport for a departure at 0610 hrs flight to Amsterdam Schipol Airport. They were rostered to operate four sectors in G-JECX: to Amsterdam, back to Manchester, to Newquay Airport and finally return to Manchester. The first two sectors to Amsterdam were uneventful but the return flight was delayed by one hour and ten minutes due to a problem with the load sheet. The third sector from Manchester to Newquay departed one hour and twenty minutes late. The forecast weather at Newquay was for overcast cloud at 400 - 500 ft with a gusty crosswind of approximately 20 kt. The co-pilot was pilot flying for the Newquay sector.

The takeoff, cruise and descent were uneventful. During the cruise the commander obtained updated weather via the ATIS for Newquay, which gave landing Runway 12, the surface wind 210/16 and cloud broken at 400 ft. The flight crew briefed for the approach, discussing the threat of turbulence on final and the potential for a go-around. The pilots planned to use flap 15 for the final approach because no gusts were reported on the ATIS, and to set the propeller condition levers to MAX in case a go-around was required[1].

The aircraft was established on final for Runway 12 at 8 nm and the co-pilot disconnected the autopilot at approximately 500 ft. At approximately 400 ft, the aircraft became displaced from the runway centreline and the co-pilot elected to go around. The go-around was uneventful and the aircraft was repositioned for a second approach. During the downwind leg the commander made a PA to reassure the passengers then briefed the co-pilot to keep the autopilot engaged until slightly later in the approach and to ensure the speed remained between the V_{REF} and V_{CLIMB} speed bugs[2].

The second approach was stable until approximately 50 ft. The tower gave the surface wind as 190º/20 kt. At approximately 50 ft the co-pilot reduced power to flight idle to control the airspeed, although neither pilot was aware that the power had been reduced this much. At approximately 30 ft above the runway, the aircraft started to sink rapidly and the commander called "power, power, power". The co-pilot increased power and pitched up to arrest the rate of descent, but the aircraft landed firmly, striking its tail on the runway. The aircraft bounced and the commander took control. Observing the 'TOUCHED RUNWAY' light he elected to continue the landing. The aircraft landed and taxied to the gate without further incident.

Subsequently one cabin crew member reported minor back pain. No other injuries were reported.

Recorded information

The FDR and CVR contained recordings of the event. The pertinent data from the FDR is shown in Figure 1.

At approximately 100 ft, engine torque reduced corresponding to an increase in airspeed. Torque increased at approximately 80 ft as the airspeed started to reduce. Torque reduced at approximately 40 ft to idle and the airspeed reduced further. The data suggests that this corresponded with a reduction in headwind, although the sample rate is too low to determine this exactly. At approximately 20 ft power increased markedly and pitch attitude increased.

The aircraft tail touched the runway at 2.1g with the aircraft at a pitch attitude of 10º nose up. The main wheels touched down 4.8 seconds after the tail touched.

Footnote

1 Propeller rpm is normally set to 850 rpm to reduce noise but can be set to 1,020 rpm (MAX) to give quicker engine response.

2 V_{CLIMB} is the minimum safe single engine climb speed.

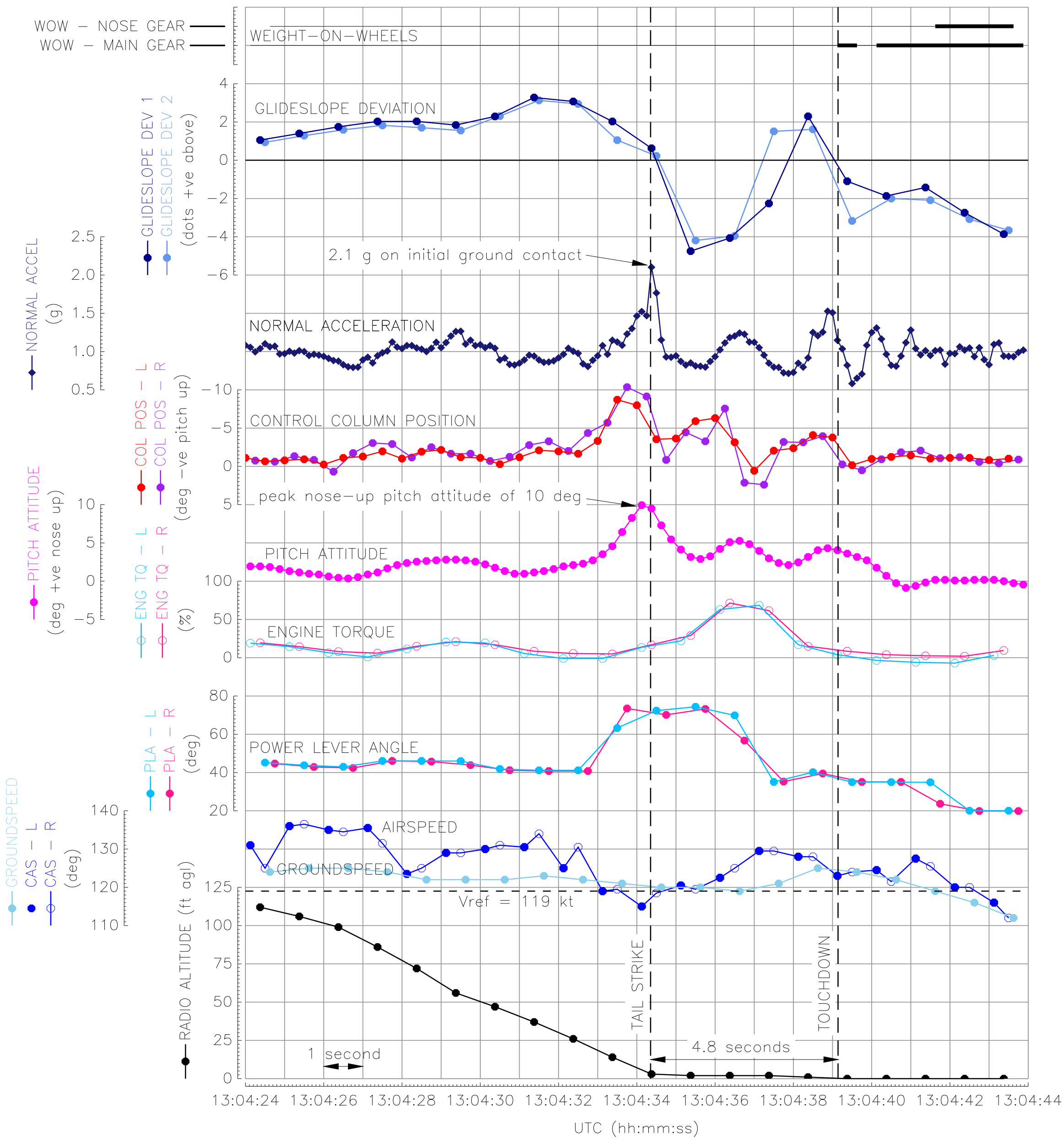


Figure 1

Selected information from FDR

Aircraft information

The engines of the DHC-8-402 are mounted on the wing. In this configuration, airflow over the wing behind the propellers will affect the total lift produced. Consequently, a decrease in selected torque, producing less airflow behind the propellers, will decrease lift, even if the airspeed remains the same.

The operator uses two landing flap settings: Flap 15 or Flap 35. Its operations manual states that the preferred landing flap is Flap 15, and it requires Flap 35 to be used if the landing distance available is less than 1,800 m.

The aircraft crosswind landing limit is 32 kt. Co-pilots, having completed their first recurrent simulator check and demonstrated competence in crosswind landing, can operate to this limit.

The normal pitch attitude for a Flap 15 approach is approximately 3º with an engine torque of 13-15%. During the landing flare the pitch attitude should be increased by 1-2º. The operator requires the pilot monitoring to make a warning call of "PITCH FIVE" if the pitch attitude reaches 5º during the flare. Its operations manual states:

> *'A pitch attitude greater than 6º on touchdown can lead to a tail strike. If the pitch attitude reaches 6º nose-up or if a non-normal sink rate develops on short finals, the pilot flying (PF) is required to respond with "correcting" and shall correct with an increase in power with no further increase in pitch attitude. An increase in power provides an immediate increase in lift to arrest the descent.'*

Following several tailstrike events the aircraft manufacturer issued a Flight Operations Service Letter DH8-400-SL-00-020, dated 11 September 2008, to remind operators of the importance of pitch attitude awareness during the flare. The letter states *'Descent rate control, below 200 ft agl, must be through power lever management rather than adjusting pitch'.* The letter recommends that operators should provide initial and annual recurrent pitch awareness training for flight crew.

Aircraft examination

The aircraft was examined by the manufacturer. Damage was found to several skin panels, frames, stringers and aft pressure bulkhead.

Figure 2

Damage to aft fuselage

Weight and balance

The aircraft landing weight was approximately 25,000 kg, 3 tonnes below the maximum landing weight of 28,009 kg. Its centre of gravity was within limits.

Aircraft performance

The required landing distance in the prevailing conditions was 1,173 m.

Meteorology

During the descent the flight crew obtained the latest airfield weather, which reported: landing Runway 12, surface wind 210/16, visibility 3,500 m in light rain, cloud broken at 400 ft and temperature 12°C.

Airfield information

Newquay's Runway 12 has a landing distance available of 2,637 m. The commercially available airport chart used by the pilots contained a warning note:

> *'Possibility of terrain induced turbulence and wind shear effects when landing on Runways 12 & 30.'*

Organisational information

The operator's operations manual defines the criteria to achieve a stable approach. If these criteria are not met and maintained a go-around must be flown. The operator's criteria are divided into two distinct gates; an "Approach Gate" at 1,000 ft ARTE[3] and a "Landing Gate" at 500 ft RA[4].

At the Approach Gate, the aircraft must be on the correct vertical and lateral profile with airspeed 150 kt or less, landing gear down and Flap 15 or greater.

At the Landing Gate, the aircraft must be on the correct vertical and lateral profile with only small changes in heading, pitch and speed required to maintain the correct flight path. The power must be appropriate to the configuration, airspeed less than V_{REF}+15 kt and vertical speed no greater than 1,000 fpm. The landing checks must be complete.

Previous similar events

A similar event occurred at Newcastle Airport in January 2017, reported in AAIB Bulletin 10/2017[5].

In October 2016, the Australian Transport Safety Board published a study into two similar events[6].

Footnote

3 Above Runway Threshold Elevation.
4 Radio Altitude.
5 https://www.gov.uk/aaib-reports/aaib-investigation-to-dhc-8-402-g-ecoj (accessed September 2018).
6 https://www.atsb.gov.au/media/5771758/ao-2013-201-final-report.pdf (accessed September 2018).

Analysis

During the first approach the aircraft became displaced from the centreline in the turbulent conditions. The co-pilot decided to go around as he was concerned the approach no longer met the operator's stable approach criteria.

The second approach met the stable approach criteria until approximately 50 ft. At this point the co-pilot reduced power to flight idle in response to increase airspeed, although neither pilot was aware that the power had been reduced this much. The reduction in power, probably combined with a reduction in headwind, resulted in a significantly increased rate of descent. The co-pilot reacted instinctively by increasing power and pitch attitude. The pitch attitude increased to 10º, which resulted in the aircraft tail contacting the runway before the main wheels. The increase in power did not take effect before the tail contacted the runway. The commander reacted to the increased rate of descent by calling for more power in accordance with the operator's and manufacturer's guidance. The time from pitch attitude increasing beyond 5º to the tail contacting the runway was less than one second, giving very little time for the commander to take any corrective action. After the tail strike the commander took control and elected to continue the landing as he was concerned the aircraft may be damaged.

Conclusion

The tailstrike occurred because the pilot flying reacted instinctively to the high sink rate by increasing pitch attitude and power, rather than increasing power only. The aircraft manufacturer recommends that operators provide annual recurrent training in pitch awareness for flight crew to establish the correct response to high sink rate near the ground.

SERIOUS INCIDENT

Aircraft Type and Registration:	Jetstream 4100, G-MAJW
No & Type of Engines:	2 Garrett AiResearch TPE331-14GR-807H turboprop engines
Year of Manufacture:	1993 (Serial no: 41015)
Date & Time (UTC):	27 February 2018 at 1200 hrs
Location:	Aberdeen Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 3 Passengers - 18
Injuries:	Crew - None Passengers - None
Nature of Damage:	Overwing emergency exits during evacuation
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	37 years
Commander's Flying Experience:	3,830 hours (of which 2,325 were on type) Last 90 days - 183 hours Last 28 days - 66 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

On the approach to Sumburgh Airport, the primary and standby landing gear status indicators showed that the nose landing gear was not extended and downlocked. The crew aborted the approach, elected to return to Aberdeen and after unsuccessfully attempting to resolve the issue, declared a MAYDAY. The aircraft landed safely at 1235 hrs and the occupants evacuated via the overwing exits after the aircraft stopped on the runway.

A subsequent ground inspection of the aircraft confirmed that the nose landing gear was 'down and locked' but the primary indication wiring harness had failed and the standby indication microswitch was out of position. Safety actions have been taken by the manufacturer and the operator to improve the reliability of the system and the clarity of the Emergency and Abnormal Checklists.

History of the flight

After an uneventful charter flight from Aberdeen Airport, the aircraft was on approach to Runway 09 at Sumburgh Airport at 1038 hrs when the crew selected the landing gear down. The primary landing gear status indicator (Figure 1) showed the nose landing gear (NLG) was not extended and downlocked (left and right-hand main landing gear (MLG) indications GREEN, NLG indication RED). The standby indicator showed GREEN for the MLG but no light for the NLG and shortly afterwards the selector lever indicator illuminated

RED. The crew aborted the approach to troubleshoot the issue using the Emergency and Abnormal Checklist Card 48 '*Landing Gear Not Locked Down'*. The crew verified there was no loss of electrical or hydraulic power, reset the landing gear control circuit-breakers and recycled the landing gear (retraction followed by re-extension). When the landing gear was selected UP, both indication systems displayed all the landing gears 'up and locked'. The next checklist action was to extend the landing gear using the emergency system, after which an in-flight retraction would have no longer been possible. The crew declared a PAN and elected to return to Aberdeen Airport at 1052 hrs with the landing gear retracted.

The aircraft entered the hold above Aberdeen Airport at 1126 hrs and the flight crew completed the actions on Card 48. They used the emergency extension system and applied small manoeuvres at the normal and maximum permissible speeds to release the NLG, all of which failed to achieve a GREEN indication. At 1138 hrs the crew declared a MAYDAY and prepared for landing, following Card 49 '*Nose Landing Gear Not Locked Down'*.

The crew flew two passes along the runway, one at 3,000 ft, a second at 1,500 ft and visual confirmation was given that the NLG was down but no assessment of the downlock status could be made. The flight crew evaluated the risk of a NLG collapse on landing as extremely likely, so decided they would evacuate the passengers via the overwing exits after landing and briefed the cabin crew, passengers and ATC accordingly.

The aircraft landed at 1235 hrs with the NLG remaining in the down position and stopped on the runway. Card 96 '*Emergency Evacuation'* states the evacuation command should be issued once the propellers have stopped turning but, in this instance, the first command for evacuation was issued by the cabin crew once the aircraft had stopped. They immediately noticed the propellers were still turning and told the passengers to wait until the propellers had stopped before opening the overwing exits. Once the propellers had stopped, subsequent commands for evacuation were issued by both the flight crew and cabin crew. All the passengers and crew then evacuated as planned, with no injuries and were transferred to the terminal by bus.

Aircraft information

The Jetstream 41 has a tricycle landing gear with two wheels on each landing gear leg which retract forwards into either the fuselage (NLG) or the engine nacelle (MLG). The hydraulically-operated extension and retraction system is commanded by a selector lever in the cockpit. It uses 2,000 psi hydraulic pressure to maintain the landing gear in the extended or retracted position with secondary mechanical downlocks and uplocks on each leg. There is an emergency extension system if hydraulic power is lost.

Landing gear position is primarily indicated by illuminated captions on the landing gear selector-panel by RED or GREEN captions (Figure 1). A GREEN caption denotes the associated landing gear is 'down and locked' whereas a RED caption denotes either the gear is unlocked or in transit. When the landing gear is retracted and locked, no caption is lit. Microswitches on the downlocks and uplocks are used to control the cockpit display indicators and there are two on each downlock and one on each uplock. On the right-hand side console are three standby indicators which illuminate GREEN when the associated gear is 'down and locked'. The selector lever will illuminate RED when the landing gear transit time, from unlock to lock, exceeds 15 seconds.

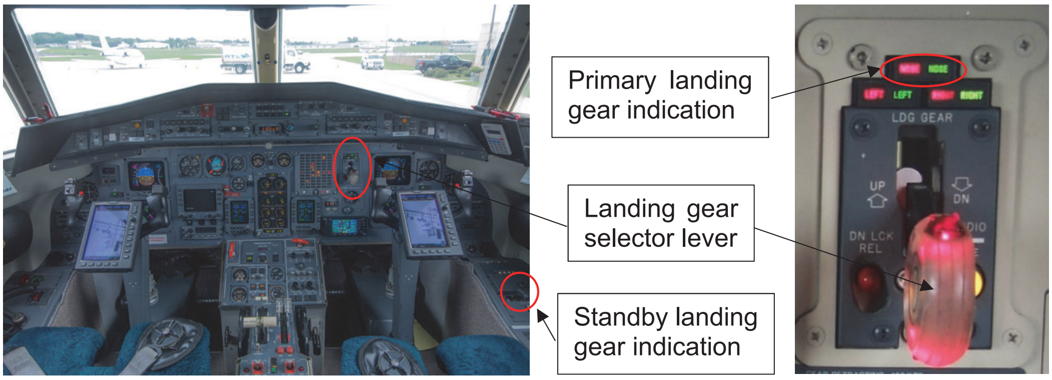


Figure 1
Location of the landing gear indicators

Aircraft examination

Following the incident, the aircraft structure was inspected, and the overwing emergency exits were found damaged from ground contact during the evacuation. A systems check identified a fault with the primary NLG downlock microswitch harness and the NLG standby microswitch was found out of position.

Downlock microswitches

Primary downlock microswitch

The NLG primary downlock microswitch and its associated wiring harness were removed from the aircraft for further examination (Figure 2). No visual defects were identified but movement could be felt between the wiring harness and the microswitch which was due to damaged and broken wires in the harness.

Figure 2
Primary down lock microswitch

The harness had been fitted to the aircraft during scheduled maintenance of the downlock assembly on 6 May 2016 and the aircraft had since completed 2,291 flight cycles. The harness was to the latest modification standard, the protective boots and sheathing were in good condition and with adequate moisture-inhibiting compound present. In response to this incident, the operator has introduced a 600 flight hours repetitive inspection of both indication systems and during the initial fleet-wide inspection, no further harness failures were found.

Standby downlock microswitch

The NLG standby microswitch was in a serviceable condition but there was a gap between the microswitch plunger and the downlock pin resulting in the switch not operating when the landing gear was 'down and locked' (Figure 3). This condition could have resulted from being rigged incorrectly at the last maintenance interval, the microswitch support bracket having moved in-service, or a combination of both.

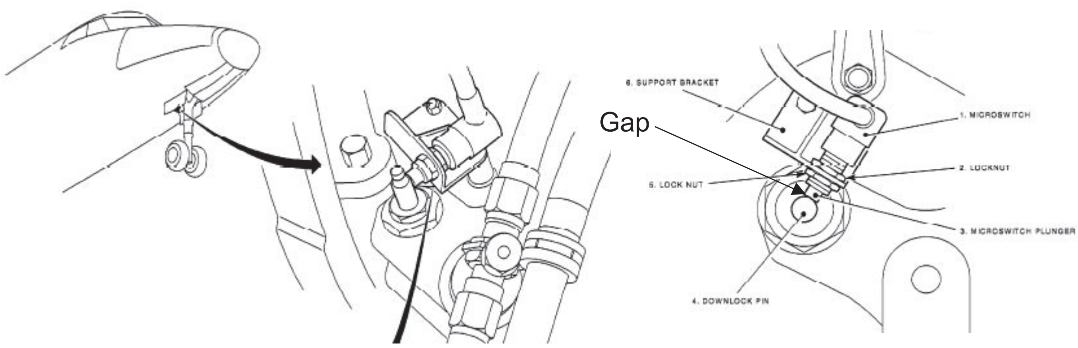


Figure 3

Standby downlock microswitch

In response to this incident, the operator has performed a fleet-wide 'one-off' inspection of the position of the standby microswitches. Of the 12 aircraft inspected; five were correctly positioned, five were marginally out of position but with no effect on operation and two were only just engaged with the downlock pin.

A further outcome of this inspection was to highlight an issue with the task '*Adjust the NLG downlock microswitch*' in the Aircraft Maintenance Manual (AMM). The task states it is '*applicable to the normal* [primary] *and the standby microswitches. The adjustment of one microswitch is given*'. However, this task is actually specific to the primary system as it only refers to the selector panel indicators, whereas the standby microswitch controls the standby panel indicators. The manufacturer has issued a Technical Operation Response to clarify the AMM task, on which indicators are used during the adjustment of the standby microswitch, and is revising the AMM to reflect this clarification.

Emergency and Abnormal Checklists

Following the indications that the NLG was not 'down and locked' during the approach to Sumburgh Airport, the flight crew referred to the Emergency and Abnormal Checklists (E&AC) to troubleshoot the problem. The E&AC cards are a series of checklists produced by the manufacturer to enable the flight crew to efficiently and safely manage a wide range of emergencies and abnormal events. Operators may customise the checklists to suit their own standard operating procedures and this operator had done so.

In an emergency or abnormal event, the flight crew select from the contents page the most appropriate card. Some cards share a very similar title but fulfil different functions. For instance, Card 48 is for aircraft system-level troubleshooting whereas Card 49 (and 50 & 51) is the checklist applicable to landing. Figure 4 shows an extract from the contents page for the operator's E&AC cards related to the landing gear. It is noted that Card 50 '*One Main Landing Gear Not Locked Down, Nose Gear Up or Down'* was not included.

HYDRAULICS		
Emergency extension of landing gear	-47	
Landing gear not locked down	-48	
Unable to raise Landing Gear – Selector Lever Immovable	-48A	
Landing Gear Selector Lever Up – Landing Gear Not Locked Up	-48B	
Nose landing gear not locked down	-49	
Both main landing gear not locked down, nose landing gear up or down	-51	
Emergency extension of flaps	-52	
Hydraulic system low pressure	-53	_LO PRESS
Hydraulic pump low pressure	-54/1	
Hydraulic fluid high temperature	-54/2	HI TEMP
Reservoir contents in amber sector	-55	
Emergency reservoir low quantity	-56	EMER QTY
Low brake pressure	-56	LO MAIN / EMERG
Loss of normal braking	-57	
Anti-skid fault	-57	A-SKID

Figure 4

Operator's list of Emergency and Abnormal Checklists – Landing gear

During the investigation there were two cases identified where sections of one card were duplicated on another but with some information changed or missing. Mid-way through Card 48 the emergency extension procedure is reproduced, however, there are several notes missing from Card 48 which are included on Card 47. These are:

> *'WARNING: To prevent the loss of hydraulic fluid, do not operate the emergency hand pump in flight with the emergency selector set to NORMAL.*
>
> *CAUTION: Nosewheel steering may not be available after the landing gear has been extended by the emergency system.*
>
> *NOTE 3: The flaps may be extended before the landing gear, but flap extension will stop if the [EMERG QTY] caption comes on.*
>
> *NOTE 4: The emergency system can still be used to extend the landing gear after the [EMERG QTY] caption comes on.'*

At the top of Card 49 it states that:

> *'NOTE: This procedure must only be applied if the nose gear green light is not illuminated after completing Card 47: EMERGENCY EXTENSION OF LANDING GEAR.'*

In this incident, the crew had completed an emergency extension whilst on Card 48 but they had sufficient time prior to landing to study all the related E&AC cards and were therefore aware of the additional notes on Card 47.

The second example of duplication is on Cards 49 '*Nose Landing Gear Not Locked Down*' and 96 '*Emergency Evacuation*'. In this case the actions to shut off the engines are required '*On touchdown*' when following Card 49 but after aircraft stop on Card 96. Card 49 states that the fire extinguishers are to be used once the aircraft has stopped and then to proceed to Card 96. However, Card 96 details the evacuation procedure before finally stating fire extinguishers to be used, if required.

A report by the operator concluded that, had there been time pressure or different circumstances, errors or confusion may have occurred due to duplication and the format of the E&AC Cards.

Analysis

Downlocks

It is probable that the failure of the primary downlock harness was due to vibration as the environmental protection was in good condition. To verify the condition of the fleet, the operator has inspected all the other harnesses fitted to their aircraft and no other failures were found, so they are considering it an isolated event.

The gap condition between the standby microswitch and the downlock pin could have resulted from incorrect rigging, movement of the support bracket, or a combination of both. The flight crew stated that the standby indication system was working prior to the incident flight, which they had verified in accordance with their standard operating procedures, and the standby system is further checked by a maintenance programme task every 300 flight hours. The indicator system is designed that only one system needs to confirm the landing gear is 'down and locked'. However, if a crew is unaware the standby system is not working, it becomes a 'dormant' failure, and should the primary system subsequently fail, the crew will be unable to determine whether it is an indication system fault or a landing gear fault.

The investigation carried out by the operator highlighted the potential for misunderstanding the AMM procedure for rigging the standby downlock microswitch, however it was concluded that it was unlikely to have caused the microswitch to be out of position.

Emergency and abnormal checklists

A comprehensive report by the operator concluded that, had there been time pressure or different circumstances, errors or confusion may have occurred due to duplication, formatting and titles of the E&AC Cards. These findings did not detrimentally influence this specific incident as the crew had sufficient time to review all the cards and construct their own landing plan, but it increased their workload. The manufacturer will review all the E&AC cards to resolve any variations in duplicated procedures and to review all the card titles to ensure they accurately and efficiently reflect the intention of the card.

Emergency evacuation

During their initial troubleshooting the crew had verified that the electrical and hydraulic systems were functioning normally and had GREEN indications for the MLG. By observation made during the flypasts, they knew that the NLG was extended and concluded there was a NLG downlock fault. They did not consider an indication fault due to the perceived improbability of a double failure of the indication system. The crew stated they used a "Threat and Error Management" approach to evaluate different landing scenarios with either a NLG collapse during landing or after the aircraft had come to a stop. To minimise the risk of passenger injury they briefed the passengers to evacuate the aircraft only using the overwing exits and not to use the forward main exit with integral steps. However, they did mention the rear exit. The crew also considered whether a NLG ground downlock pin could be inserted prior to a rapid disembarkation but they considered the risk of injury too high if the NLG were to collapse and decided to evacuate at the earliest opportunity.

Conclusion

On approach to Sumburgh Airport the primary indication system for the NLG did not indicate 'down and locked' due to a failure between the microswitch and the wiring harness. The failure of the standby indication system to illuminate was because the microswitch was out of position relative to the downlock pin.

Based upon the information from two indication systems that the NLG was not 'down and locked', the crew reviewed possible landing scenarios and planned their actions based upon a landing with a NLG collapse. This did not happen; the crew followed their plan and successfully evacuated all passengers and crew through the overwing exits with no injuries.

Safety actions

The manufacturer has taken a Safety Action to amend the AMM and a further Safety Action to thoroughly review all Emergency and Abnormal Checklist cards to ensure that the correct card is actioned efficiently without confusion.

- Revision to AMM to clarify NLG down lock microswitch rigging procedure.
- Review the Emergency and Abnormal Checklists to improve clarity and efficiency of application.

Three Safety Actions have been taken by the operator to improve the reliability of the landing gear indication systems and to implement the latest revision of the Emergency and Abnormal Checklist cards.

- 'One-off' inspection - Nose landing gear standby micro switch check.
- 'One-off' inspection - NLG down lock and primary and standby microswitch inspection.
- Repeat inspection every 600 flight hours - Landing gear indication system check.
- Update all Emergency and Abnormal Checklists in accordance with manufacturers latest revision.

ACCIDENT

Aircraft Type and Registration:	Aerostar YAK-52, G-CCJK
No & Type of Engines:	1 Ivchenko Vedeneyev M-14P piston engine
Year of Manufacture:	1996 (Serial no: 9612001)
Date & Time (UTC):	21 August 2018 at 0915 hrs
Location:	East Hoe Manor private strip, Hambledon, Hampshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to cowling, propeller and wing leading edges
Commander's Licence:	Private Pilot's Licence
Commander's Age:	57 years
Commander's Flying Experience:	1,271 hours (of which 372 were on type) Last 90 days - 64 hours Last 28 days - 20 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

G-CCJK overran the runway whilst landing on a private farm strip. The pilot subsequently discovered that the runway surface was slippery due to the combination of hard surface, new grass and morning dew.

History of the flight

The pilot was flying G-CCJK from White Waltham Airfield to East Hoe Manor; a private farm strip near Hambledon, which is a 460 m long, grass and orientated south-west north-east. Approaches are only possible from the south-west due to high trees at the north-east end.

After an uneventful flight the pilot flew over the airfield to inspect the runway and observed the windsock was showing a very light wind from the south-west. He made a "short field" approach which he described as using full flap and an airspeed of 130 km/hr. On landing the pilot applied the brakes, but the wheels immediately locked and the aircraft started to skid. He corrected the skid but was unable to slowdown. With people and a parked aircraft on the right of the runway and a fence to the left he decided the only option was to continue straight ahead and overrun the end of the runway.

The pilot turned the fuel and forward magnetos OFF. The rear magnetos remained ON, as there was no one in the rear cockpit where the switches are located, so the propeller continued to rotate. The aircraft overran the runway at approximately 10 mph and collided with a fence. It came to a stop a few metres beyond the fence and the pilot was able to exit the aircraft unaided (Figure 1).

Figure 1
G-CCJK after the accident

The collision with the fence caused damage to both leading edges, the right lower cowling and the propeller (Figure 2).

Figure 2
G-CCJK showing fence post damage to both leading edges and propeller

After the accident the pilot inspected the runway and found the surface was very hard, with new shoots of grass and damp with dew. He believed that this combination of conditions made the surface slippery. He reported that the YAK 52's normal ground roll was approximately 150 m, but on this occasion it had used over 380 m. He reflected that he should have checked the runway surface conditions before departing.

The CAA Safety Sense Leaflet 12 – '*Strip Flying*'[1] describes the hazards of flying to unlicensed aerodromes and provides advice to mitigate the risk. The leaflet states *'short wet grass should be treated with the utmost caution, it can increase landing by 60% - it's like an icy surface!*'. The CAA Safety Poster – '*Airstrips*'[2] (Figure 3) reminds pilots to check length, obstructions, slope, surface and animals.

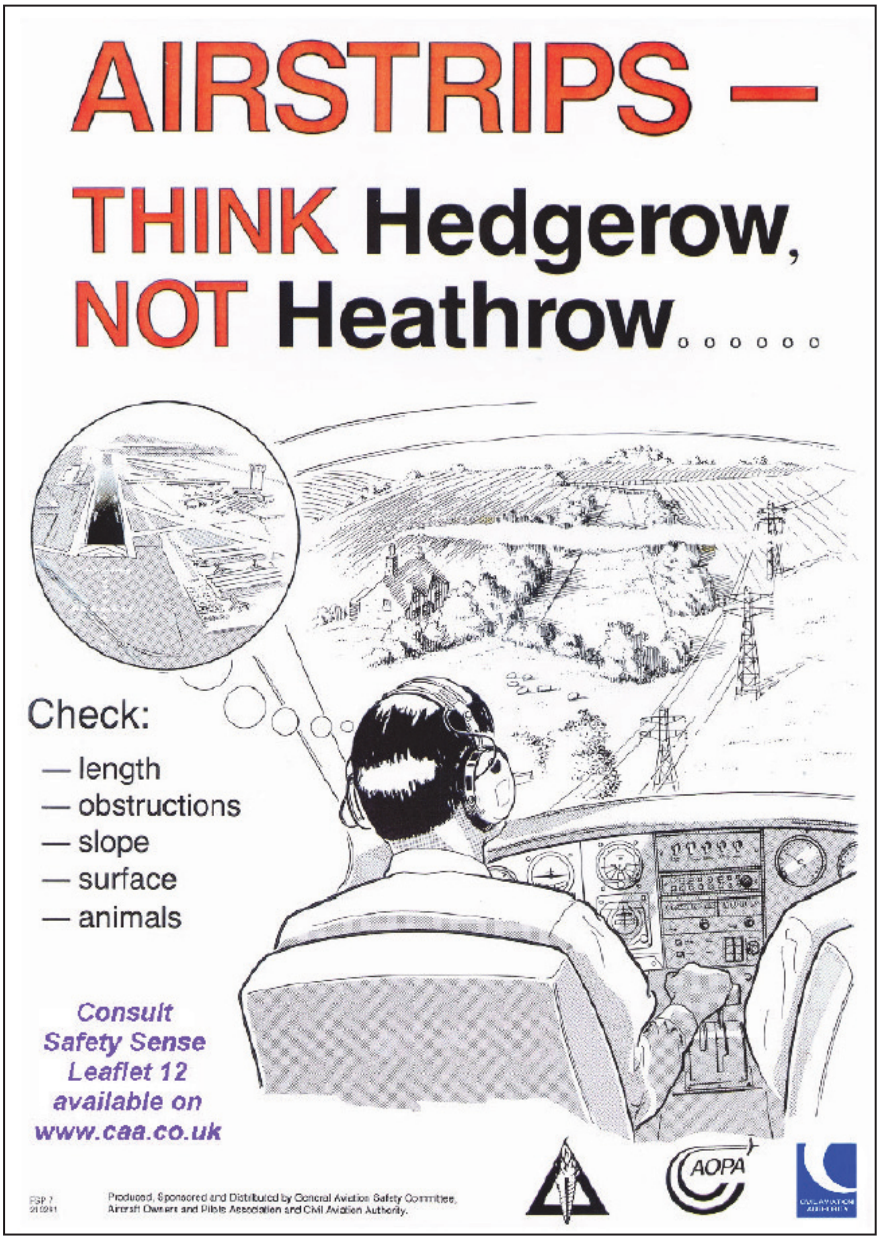


Figure 3

CAA Safety Poster – Airstrips

Footnote

1 http://publicapps.caa.co.uk/docs/33/20130121SSL12.pdf (accessed on 7 September 2018).
2 http://publicapps.caa.co.uk/docs/33/srg_gad_airstrip_poster.pdf (accessed on 7 September 2018).

ACCIDENT

Aircraft Type and Registration:	Aerotechnik EV-97 Eurostar SI, G-CGPS
No & Type of Engines:	1 Rotax 912 ULS piston engine
Year of Manufacture:	2010 (Serial no: LAA 315B-14987)
Date & Time (UTC):	3 June 2018 at 1700 hrs
Location:	Sittles Farm, Lichfield, Staffordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to right wing, landing gear, canopy and propeller
Commander's Licence:	Private Pilot's Licence
Commander's Age:	67 years
Commander's Flying Experience:	1,500 hours (of which 300 were on type) Last 90 days - 6 hours Last 28 days - 6 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and enquires by the AAIB

G-CGPS was returning from a local flight to land on Runway 09 at Sittles Farm. Runway 09 is an unlicensed grass runway approximately 500 m long and 30 m wide with a slight upslope. On the day of the accident mature rape seed crop lined both sides of the runway. The weather was reported as good visibility, very little cloud, temperature 24°C and a 5 kt wind giving a slight tailwind and crosswind from the right for Runway 09.

The pilot reported that he selected the first stage of flap as he turned onto the base leg and the second stage of flap as he turned onto final. He recalled he was slightly fast on final but on the normal flight path. He reported that, when he flared, the aircraft floated and "felt like it did not want to settle". The pilot tried to "force" the aircraft onto the runway causing it to touch down firmly and bounce. The aircraft then started to drift to the left. When it touched down again, the pilot applied firm braking, but the left wing contacted the crops on the left edge of the runway. The aircraft swung to the left causing the right landing gear to collapse and damage to the right wing. The pilot and passenger exited the aircraft without injury.

After the accident the pilot observed that only one stage of flap was selected. He believed that when he selected the second stage of flap, the flap lever did not engage, causing the flaps to return to the first stage. He thinks this is why the aircraft floated on landing. He reflected that he should have gone around either when the aircraft did not touch down at the expected point or when the aircraft bounced.

ACCIDENT

Aircraft Type and Registration:	Aviat A-1B Husky, G-GGZZ
No & Type of Engines:	1 Lycoming O-360-A1P piston engine
Year of Manufacture:	2000 (Serial no: 2078)
Date & Time (UTC):	6 June 2018 at 1600 hrs
Location:	Sherlowe Airstrip, Shropshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to right wing, struts, main landing gear, propeller and engine
Commander's Licence:	Private Pilot's Licence
Commander's Age:	76 years
Commander's Flying Experience:	8,470 hours (of which 1,200 were on type) Last 90 days - 63 hours Last 28 days - 27 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

On final approach, the aircraft was forced to land in a field because the engine did not respond when the throttle was advanced.

History of the flight

The pilot was flying a circuit using short takeoff and landing techniques, with the aircraft's owner observing from the rear tandem seat. The circuit was flown below 500 ft aal, because of an adjacent military airfield, and on the base leg the pilot selected full flap, before slowing to an indicated speed of 45 mph. He then turned onto the final approach, aiming to touchdown approximately 50 m beyond the downwind end of the runway but, at less than 100 ft aal, the aircraft descended below the desired approach angle.

With the engine running slightly above idle, the pilot advanced the throttle steadily but the engine failed to respond, so the pilot was forced to try and land the aircraft in a field of rapeseed adjacent to the airstrip. The right main landing gear collapsed on ground contact and the aircraft abruptly decelerated to a halt, some 30 m short of the runway, with its right wingtip resting on the ground. The occupants vacated the aircraft without assistance.

Following the accident, the owner reported that he had practised numerous landings over a period of several weeks, because he was preparing to take part in a competition. On a couple of occasions the engine had not responded when, to cushion his touchdown, he rapidly advanced the throttle from idle. After discussing this with engineers, he concluded that his rapid advancement of the throttle had caused a rich cut[1] and, although the issue did not recur in the three weeks prior to the accident flight, he did brief the pilot about this before they flew. The pilot had, therefore, been careful to avoid a rich cut, by keeping the engine running above idle and by avoiding rapid movement of the throttle.

No evidence of a technical malfunction was found during the post-accident inspection, and the engine was due to be stripped-down and rebuilt during the aircraft's repair.

Pilot's comments

The pilot has considerable type experience and, although the reason for the engine's lack of response to throttle movement is unknown, he does not believe that carburettor (induction) icing was the cause, as this is not a problem he has found this aircraft type to be prone to and because he thought it was unlikely to occur on a flight of such a short duration. In his view the accident highlights that if an aircraft exhibits an intermittent fault, it is prudent to initiate an appropriate technical investigation at the earliest opportunity.

Footnote

[1] A rich cut occurs when a piston engine suddenly loses power because the fuel mixture is too rich.

ACCIDENT

Aircraft Type and Registration:	Cessna 152, G-BUEG	
No & Type of Engines:	1 Lycoming O-235-L2C piston engine	
Year of Manufacture:	1977 (Serial no: 152-80347)	
Date & Time (UTC):	8 July 2018 at 1441 hrs	
Location:	Rochester Airport, Kent	
Type of Flight:	Training	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Nose landing gear collapsed and aircraft damaged due to coming to rest inverted	
Commander's Licence:	Student Pilot	
Commander's Age:	46 years	
Commander's Flying Experience:	78 hours (of which 78 were on type) Last 90 days - 5 hours Last 28 days - 1 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot and additional information from the airfield	

The student was returning to the airfield after a solo navigation flight. His instructor reported that the final approach appeared to be satisfactory, but the aircraft bounced on landing and the student decided to go-around.

A witness at the airfield saw the aircraft before its second landing and he noticed that the nose landing gear was "damaged and bent backwards". It collapsed after the landing and the aircraft came to rest inverted.

The instructor reported that the student had not flown for about three weeks before the accident, but they had just completed a circuit together, during which he had assessed the student's performance, including an approach and landing, to be satisfactory.

ACCIDENT

Aircraft Type and Registration:	DH82A Tiger Moth, G-ANRM
No & Type of Engines:	1 De Havilland Gipsy Major 1H piston engine
Year of Manufacture:	1943 (Serial no: 85861)
Date & Time (UTC):	30 June 2018 at 1725 hrs
Location:	Sywell Aerodrome, Northamptonshire
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Minor) Passengers - 1 (Minor)
Nature of Damage:	Wings, propeller, forward fuselage and rudder damaged
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	58 years
Commander's Flying Experience:	5,230 hours (of which 856 were on type) Last 90 days - 119 hours Last 28 days - 63 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and enquiries made by the AAIB

Synopsis

During the flare the aircraft was caught by a gust of wind. This caused a roll to the left that the pilot could not correct. The left wing struck the ground and the aircraft nosed over. The pilot stated he was unable to correct the roll due to poor aileron authority at low speed.

History of the flight

The aircraft was flown on behalf of an operator that provides vintage flying experiences. The pilot flew the aircraft to Sywell from its home base at Duxford on the afternoon before the incident. He then completed one short air experience flight. Both previous landings were on the grass Runway 03R and were uneventful.

On the third flight, whilst on short final for Runway 03R, the pilot received information from Sywell that the wind was 040º at 15 kt. The approach proceeded normally. During the approach the pilot looked at the windsock at the far end of the runway. He concluded the wind was approximately 10º to the right of the runway heading and decided to use a 3-point landing technique. This was his preferred technique for landing when there was no significant crosswind. The pilot reported that during the flare a sudden gust caused the aircraft to roll to left. He attempted to correct the roll and initiate a go-around but the left wing struck the ground. The aircraft rotated to the left and overturned. It contacted the ground with the nose and right-wing, and came to rest inverted and facing opposite to the landing direction (Figure 1). Both occupants were restrained by their 4-point harnesses and suffered only minor injuries. They were helped to evacuate by the aerodrome rescue and firefighting service.

Figure 1

G-ANRM at the accident site (photograph used with permission)

The wind and windsock indications

Over the course of the evening, the wind had varied between 030º to 050º at 12 to 18 kt. The maximum gust recorded was 20 kt. Around the time of the incident, Sywell Information briefly observed an anemometer reading of 070º at 18 kt. They reported that this reading differed from the direction indicated by the windsock nearest to the incident. The chief pilot for the aircraft operator investigated the accident and visited Sywell. During the visit, he found that the indications provided by the two windsocks differed from each other and from the wind information provided by Sywell (Figure 2).

The original pilot's notes for the aircraft do not include any wind limitations. The operator's guidelines recommend not to fly the Tiger Moth in crosswinds over 15 kt.

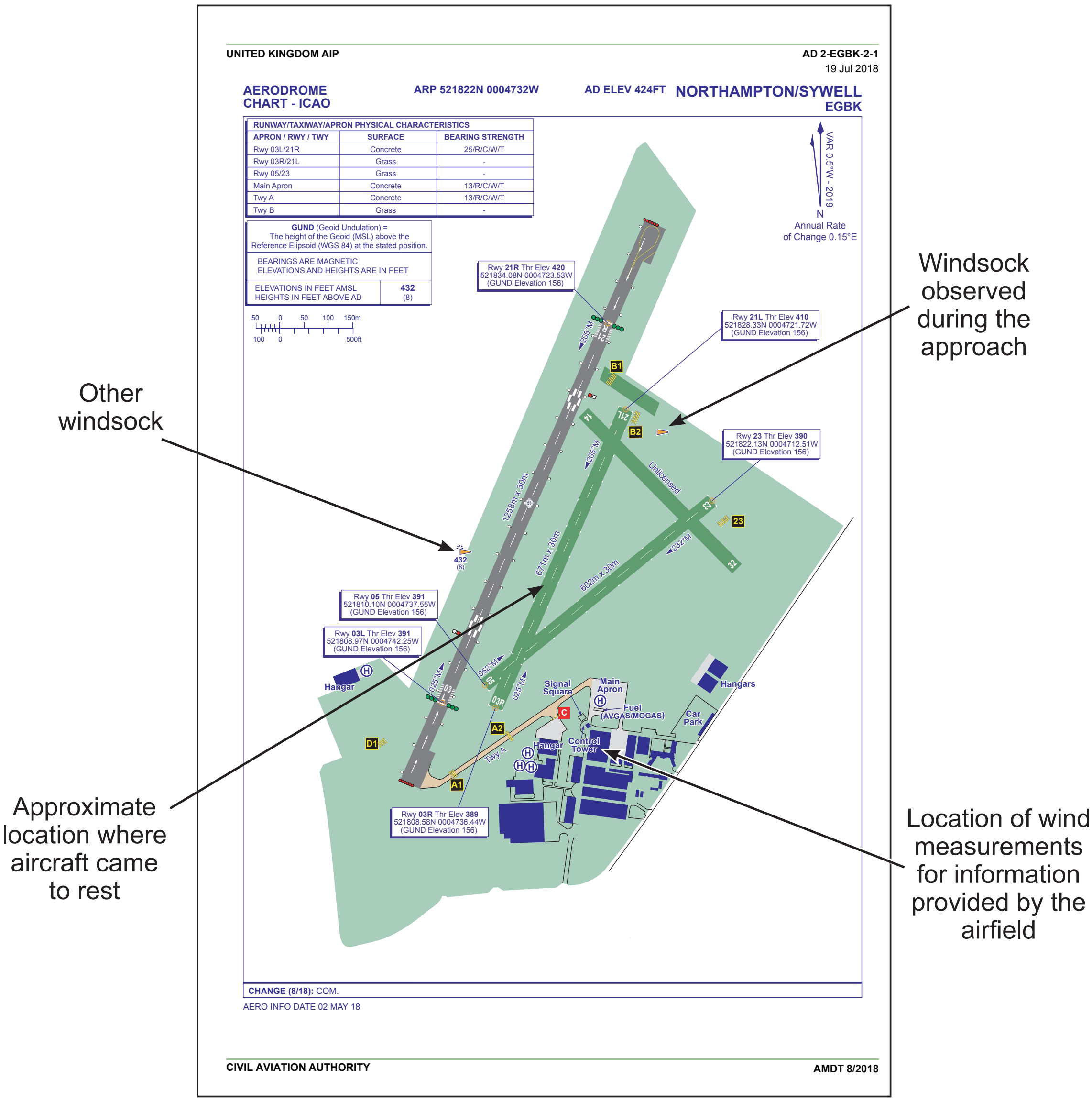


Figure 2

Aerodrome chart (amended and used with permission from NATS aeronautical information service)

The pilot's comments

The pilot stated the gust during the flare was "sudden and unpredictable" and that the Tiger Moth is susceptible to gusts due to its low wing loading. He concluded that he was unable to prevent the wing contacting the ground due to poor aileron authority at low speeds.

The chief pilot's comments

The chief pilot stated that the wind had been within the operator's recommended limits for Runway 03R. However, pilots had received a brief to use Runway 03R or Runway 05 depending on approach conditions. The chief pilot commented that using Runway 05 may have been preferable because of the tendency for gusts to veer and strengthen, especially in the evening.

ACCIDENT

Aircraft Type and Registration:	DH87B Hornet Moth, G-ADLY	
No & Type of Engines:	1 De Havilland Gipsy Major 1C piston engine	
Year of Manufacture:	1935 (Serial no: 8020)	
Date & Time (UTC):	7 May 2018 at 0757 hrs	
Location:	Earls Colne, Essex	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Damage to the right landing gear struts and a small tear to the underside of the lower right wing fabric	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	56 years	
Commander's Flying Experience:	747 hours (of which 7 were on type) Last 90 days - 4 hours Last 28 days - 4 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB	

Synopsis

On takeoff, from Earls Colne, G-ADLY deviated from the runway centreline and contacted the PAPIs causing damage to the landing gear struts and wing fabric.

History of the flight

The previous day the aircraft had an uneventful flight from Langham, Norfolk to Earls Colne, Essex following completion of its annual maintenance check. On the day of the accident the aircraft was prepared for a flight to Goodwood, West Sussex. The sky was clear and wind calm.

The pilot taxied to the holding point of Runway 24 and commenced takeoff on the asphalt insert, which preceded normally for approximately 30 m. The tail began to rise as the aircraft accelerated. The pilot recalled making a right rudder and right differential brake input to maintain the aircraft heading, but described the right brake "snatching", causing the aircraft to veer right and pitch nose down. The pilot applied full left rudder and aft stick to correct this, which resulted in a large swing to the left taking the aircraft onto the grass to the south of the asphalt. The pilot regained directional control approximately 10 m into the grass and, having reached flying speed, was able to climb away. Before lifting off, the pilot felt a slight "bump" which he thought was the right landing gear contacting the edge of the asphalt runway.

The remainder of the flight to Goodwood was uneventful. On first contact with Goodwood the pilot requested the fire service attend the aircraft on landing because of the brake issue on takeoff. The landing was uneventful and the pilot brought the aircraft to a halt to the left of the runway.

On inspection, part of the PAPI structure from Earls Colne was found embedded in the right-wing root. The right undercarriage struts were damaged and there was a small tear in the underside of the bottom right wing fabric.

Aircraft information

The De Havilland Honet Moth is a single-engine biplane designed in 1934.

Each main wheel is fitted with a drum brake. Symmetric braking is achieved with a hand brake lever. Differential braking is achieved with rudder pedal deflection. As rudder pedal deflection increases it will begin to apply differential braking. Full pedal deflection will normally cause the brake to lock.

Airfield information

The grass Runway 06/24 at Earls Colne is 939 m long and 30 m wide, and has a 10 m wide asphalt insert.

Discussion

The pilot commented that the incident occurred because he over-corrected with left rudder and differential brake, causing the aircraft to deviate to the left.

The pilot elected to take off on the narrow asphalt insert because he had been advised that the grass was soft. However, after the accident he thought it would have been safer to take off on the grass where he had landed the previous day. The aircraft response to control inputs would have been slower on the grass and there is more space to manoeuvre.

The pilot had limited experience on the Hornet Moth but considerable tail wheel experience on the Pitts Special. He reflected that if he had been flying the Pitts Special he would have abandoned the takeoff, but, having never abandoned a takeoff in the Hornet Moth he did not consider this option.

ACCIDENT

Aircraft Type and Registration:	Hapi Cygnet SF-2A, G-BRZD
No & Type of Engines:	1 Volkswagen 2078 piston engine
Year of Manufacture:	1995 (Serial no: PFA 182-11443)
Date & Time (UTC):	1 August 2018 at 1400 hrs
Location:	Nayland Airfield, Essex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Substantial damage to wings, landing gear, fuselage and tailplane
Commander's Licence:	Light Aircraft Pilot's Licence
Commander's Age:	66 years
Commander's Flying Experience:	Approximately 600 hours Last 90 days - 22 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During final approach to Runway 32 at Nayland Airfield, the engine failed and a restart attempt proved unsuccessful. The aircraft was manoeuvred to avoid tall trees but collided with a hedge, causing substantial damage to the aircraft and the pilot sustained a minor leg injury. The cause of the engine failure was not determined.

History of the flight

The aircraft had been recently returned to flying condition following a lengthy period of storage. Following its return to service, it had been purchased by the pilot, who was also the LAA Inspector that conducted the LAA Permit to Fly renewal inspection. After completing two uneventful 10-minute local flights from Thame Airfield, the pilot flew the aircraft from Thame Airfield to Nayland Airfield where the aircraft was to have been based. The aircraft had been refuelled to full for the flight, which provided a fuel endurance of four hours.

The pilot reported that the one-hour flight to Nayland Airfield was uneventful and that the engine temperature and pressure indications were normal. The aircraft was fitted with a carburettor temperature gauge and the pilot stated that the gauge showed no risk of carburettor icing at any stage of the flight. The aircraft was positioned to the final approach for Runway 32 at Nayland, which is 530 m long with a steep upslope partway along its length and has tall trees approximately 100 m from the runway threshold. The pilot stated that the short runway required a low approach over these trees to allow the aircraft to touch down on the upward-sloping section of the runway.

On short final, at approximately 140 ft above the ground, as the throttle was advanced the engine abruptly stopped. The pilot attempted to restart the engine by engaging the electric starter and the engine ran for a few seconds before stopping again as the throttle was advanced. By this time the aircraft had descended below the level of the trees on the approach and the pilot determined that he could not clear them, nor land in the available area before the trees. He turned right approximately 20°, flew beneath a set of power lines and aimed for a low hedge to cushion the impact. The aircraft came to rest in the hedge, Figure 1. The pilot, who was wearing a four-point harness, sustained a minor leg injury in the accident but was able to vacate the aircraft using the cockpit door. The aircraft sustained substantial damage to the wings, landing gear, fuselage and tailplane.

Figure 1
Accident site

Aircraft information and examination

The Hapi Cygnet SF-2A is a two-seat light aircraft with a tailwheel landing gear. It is powered by an air-cooled Volkswagen 2078 piston engine driving a fixed-pitch propeller. G-BRZD's engine was overhauled prior to the aircraft's return to service and a new Lectron carburettor had been installed.

The pilot examined the aircraft following the accident but was unable to determine the cause of the engine failure. He stated that in his opinion, the most likely cause of the failure was mis-adjustment of the carburettor, as the engine failure occurred as the throttle was advanced during the final approach.

Conclusion

The engine failure occurred whilst the aircraft was positioned on the final approach with no viable undershoot available. The decision to turn away from the tall trees directly on the final approach path probably reduced the severity of the resulting accident.

ACCIDENT

Aircraft Type and Registration:	Jodel DR1050-M1 Sicile Record, G-CIYB
No & Type of Engines:	1 Continental Motors Corp O-200-A piston engine
Year of Manufacture:	1965 (Serial no: 605)
Date & Time (UTC):	8 June 2018 at 1045 hrs
Location:	Private airstrip, Gilford, County Down
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:	62 years
Commander's Flying Experience:	546 hours (of which 424 were on type) Last 90 days - 4 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The pilot lost control of the aircraft when it struck a hedge while approaching to land on a short runway at his private airstrip. The aircraft struck the ground and incurred extensive damage. Following this accident, the pilot intends to remove the hedge from the runway undershoot and hopes to increase the length of the airstrip.

History of the flight

The pilot approached Runway 36 at his private airstrip, having estimated the wind strength as 5 kt, from a variable direction. No turbulence was apparent during the approach but, as the aircraft neared the boundary hedge, it suddenly encountered sinking air and the pilot was unable to prevent the left main landing gear from striking the hedge. He lost control and the aircraft struck the ground and travelled along the runway for a few metres. When the aircraft came to rest it had rotated left through approximately 180º, the landing gear had collapsed, the left wing had detached and the right wing and forward fuselage were extensively damaged (Figure 1). The occupants used the normal access doors to vacate the aircraft without assistance.

Figure 1

The aircraft was pointing back towards the threshold of Runway 36 when it came to rest. The uphill slope of the runway is apparent in the background

Pilot's comments

The pilot stated that, prior to the accident, he had successfully operated from this 275 m grass strip for more than 20 years. Because the runway slopes down from the northern end of the airstrip[1] he always took off downhill and landed uphill, and that he avoided flying from there if there was any component of tailwind. By restricting his payload, he was confident that his ground roll did not exceed 150 m, during both takeoff and landing. However, he did not refer to the takeoff and landing data provided in the aircraft manual, because he believed the propeller fitted to his aircraft offered better performance than the propellers detailed in the manual.

Prior to operating from the airstrip, the pilot had measured the ground roll his aircraft required while taking off and landing at another airfield. He did not consider the distance required to clear a 50 ft obstacle after takeoff or before landing and he did not apply safety factors to the ground roll distances which he had estimated.

Performance calculations

The UK Aeronautical Information Circular (AIC) relating to '*Take-off, Climb and Landing Performance of Light Aeroplanes*'[2], states:

> *'Obstacles – it is essential to be aware of any obstacles likely to impede either the take-off or landing flight path and to ensure there is adequate performance available to clear them by a safe margin.'*

Footnote

1 Estimates made using Google Earth data indicates the airstrip slopes down approximately 2.6º, from the highest elevation of 64 m, close to the threshold of Runway 18, to 52 m, close to the threshold of Runway 36.

2 The UK Aeronautical Information Circular titled '*Take-off, Climb and Landing Performance of Light Aeroplanes', AIC 127/2006,* is available at www.ais.org.uk (accessed September 2018).

And also:

> *'The pilot should always ensure that after applying all the relevant factors including the safety factor the landing distance required from a height of 50 ft (LDR) does not exceed landing distance available.'*

The safety factors recommended in the AIC, and also by the Civil Aviation Authority (CAA)[3] are 1.43 for landing calculations and 1.33 for takeoff calculations. Therefore, prior to landing, pilots are expected to ascertain the landing distance required from 50 ft, multiply this by 1.43 and ensure that the available landing distance is no less than the calculated figure.

The aircraft manual held by the pilot did not include performance data for the landing distance required from 50 ft but it did have tables for the distance required to clear a 50 ft obstacle during takeoff. At the reduced weight quoted by the pilot for his takeoffs, the manual indicated an unfactored takeoff distance required of 348 m (at 15ºC), with 70% of this distance (244 m) relating to the ground roll. The AIC does not specify any reduction factor for downhill takeoffs (or for uphill landings), but multiplying the figures from the manual by the recommended safety factor suggests that a distance of 462 m should be allowed to clear a 50 ft obstacle, with the ground roll accounting for 324 m of this.

Light Aircraft Association (LAA) comment

This aircraft was operating on a Permit to Fly administered by the LAA and the propeller replacement had been appropriately authorised. The LAA notes that, aside from some individual cases, it treats each aircraft as individual, rather than as one of a type, and has no requirement for a 'certified' Pilot's Operating Handbook, containing performance data compiled by the manufacturer. However Permit to Fly aircraft must be operated in accordance with an Operating Limitations document, which forms part of each individual aircraft's Permit to Fly documentation.

Establishing aircraft performance figures is a lengthy process, which tends to require specialist knowledge, and no formal testing of this aircraft had taken place to establish new data after the propeller had been replaced, so the data in the aircraft manual held by the pilot was still applicable.

The LAA recommends that before pilots operate from an airstrip, they ensure they are conversant with the CAA's Safety Sense Leaflet 12 '*Strip Flying*'[4]. Currently, the LAA is reviewing the training support it offers its members in regard to flight training as well as technical matters, such as pilot maintenance and engineering management. It believes that its members have an increasing need for this support.

Footnote

[3] The CAA Safety Sense Leaflet 7C '*Aeroplane Performance*' provides detailed guidance on takeoff and landing performance to pilots of light aircraft and is available at http://www.caa.co.uk/safetysense (accessed September 2018).

[4] The CAA's Safety Sense Leaflet 12 '*Strip Flying*' is available at http://www.caa.co.uk/safetysense (accessed September 2018).

Safety action

The pilot intends to remove the hedge along the airstrip's southern boundary and will only operate a similar aircraft from here if he succeeds in lengthening the runway.

ACCIDENT

Aircraft Type and Registration:	Jodel D120 (Modified), G-AVYV
No & Type of Engines:	1 Continental Motors Corp C90-14F piston engine
Year of Manufacture:	1964 (Serial no: 252)
Date & Time (UTC):	3 June 2018 at 1255 hrs
Location:	Sandown Airfield, Isle of Wight, Hampshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Left wing, engine, landing gear and fuselage damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	51 years
Commander's Flying Experience:	331 hours (of which 143 were on type) Last 90 days - 9 hours Last 28 days - 9 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

The engine failed at 200 ft during a go-around and the pilot made a forced landing without serious injury on an adjacent golf course. The cause of the engine failure could not be determined but may have been carburettor icing or fuel vapour interrupting the fuel flow.

History of the flight

On 3 June, the pilot planned to fly G-AVYV from Shifnal Airfield, Shropshire, where the aircraft is based, to Sandown, Isle of Wight. The pilot had originally planned to fly to Dunkeswell Airfield, Devon, but changed his plan due to the weather forecast in that area.

The pre-flight, taxi and power checks at Shifnal were all normal. The grass was wet so the pilot selected carburettor heat HOT for a prolonged period during the power check to clear any of ice before the takeoff.

The aircraft took off at approximately 0955 hrs. At approximately 400 ft, the engine started to run roughly so the pilot reduced power slightly and applied carburettor heat, the engine returned to normal and the pilot continued the climb. The remainder of the flight towards the Isle of Wight was uneventful, flying initially at 3,000 ft and later at 2,500 ft due to lowering cloud base.

After crossing the Solent at 1,600 ft the pilot climbed the aircraft to 2,000 ft to join overhead Runway 05 at Sandown. Once overhead he selected the fuel pump ON and carburettor heat HOT, descended on the dead side[1] then positioned downwind. As the pilot commenced his downwind checks, he noticed the engine running slightly rough. He confirmed the mixture was rich, both magnetos and fuel pump were ON and the carburettor heat was selected HOT. To locate the fault, he tried increasing rpm slightly and selected the fuel pump OFF. These actions appeared to return the engine to smooth operation. The pilot did not recall switching the fuel pump back ON.

The pilot continued the approach, reducing speed to 50 kt to maintain spacing behind another aircraft. At 150 ft agl he selected the carburettor heat to COLD. On landing the aircraft bounced on first contact and floated along the runway. As the aircraft touched down again, it hit a bump and "jumped" back into the air. The pilot decided to execute a go-around, applied full power and started to climb away.

At approximately 200 ft agl, the engine rpm rapidly reduced and then stopped. The pilot applied carburettor heat and the engine briefly recovered before stopping again. He lowered the nose and identified a suitable strip of grass on rising ground to the right. He made a brief radio call then focused on the landing. The aircraft landed firmly and skidded for approximately 20 ft before stopping. The pilot selected the master switch OFF and exited the aircraft unaided.

The pilot later returned to the aircraft to switch the fuel and magnetos off.

Accident site

The aircraft landed on the fairway of the 8th hole at the Shanklin and Sandown golf course, on sloping ground bounded on several sides by wooded areas (Figure 1).

There was significant damage to the left wing, undercarriage, fuselage and engine (Figure 2).

Aircraft information

The Jodel D120 is a two-seat, tailwheel aircraft of wooden construction, powered by a Continental C90 engine. The fuel system has an engine driven fuel pump and an electrical fuel pump. G-AVYV used Mogas[2].

Aircraft examination

The aircraft was recovered by the insurance company to a maintenance facility. The maintenance company confirmed that the engine rotated freely, there was fuel in the fuel tank, fuel filters were clean and both fuel pumps were full of fuel.

Footnote

1 The side of the runway opposite that of the normal circuit. A diagram published by the CAA is available at: https://publicapps.caa.co.uk/docs/33/ga_srgwebStandardOverheadJoinPosterJan09.pdf (accessed on 7 August 2018).

2 Automotive gasoline.

Figure 1

Aircraft and initial impact marks

Figure 2

G-AVYV after the accident

Weight and balance

The aircraft took off with approximately 105 litres of Mogas giving a takeoff weight of 561kg. The pilot estimated there were 60 litres of fuel remaining when the accident occurred.

Meteorology

METARs for RAF Cosford, Gloucester, Southampton and Bournemouth airports were obtained at the approximate time G-AVYV was passing these airfields. Weather information was not available for Sandown.

RAF Cosford (EGWC) 030950Z 03003KT 9999 FEW025 20/// Q1020
Gloucester (EGBJ) 031050Z 00000KT 9999 SCT020 21/16 Q1019
Southampton (EGHI) 031150Z VRB02KT 9999 FEW035 23/12 Q1018
Bournemouth (EGHH) 031150Z 17009KT 9999 FEW032 23/13 Q1018

Other information

Use of Mogas

The LAA publish guidance on the use of Mogas in technical leaflet TL 2.26 – '*Procedures for use of E5 Unleaded MOGAS to EN228*'.

Analysis

After a long floating landing and second bounce at Sandown the pilot's decision to go around was logical. The engine failed at approximately 200 ft. With limited time and wooded areas ahead and to both sides the pilot selected the only available clear landing site. The pilot's focus on flying the aircraft first assisted a safe outcome.

The pilot believed the engine failure occurred due to ice forming in the carburettor during the landing. This possibility is consistent with the engine briefly recovering on selection of carburettor heat. He reflected that having experienced carburettor icing during the descent to circuit height he should have left the carburettor heat selected ON for longer during the final descent. Weather reports from Southampton and Bournemouth indicated a temperature of 23°C and a dew point of 12-13°C. CAA Safety Sense Leaflet 14 – '*Piston Engine Icing*'[3] includes a chart indicating that, at this temperature and dew point, moderate icing is likely at cruise power and serious icing is likely at descent power. Carburettor icing is more likely with Mogas. However, the pilot did follow the guidance given in a Safety Sense Leaflet for use of carburettor heat during the approach.

It is also possible that fuel vapour formed in the fuel system. Engines running on Mogas fuel can be susceptible to fuel vapour particularly in warm weather. The pilot selected the electric fuel pump OFF whilst diagnosing the rough running engine on the downwind leg. The reduction in fuel pressure without the electric fuel pump would increase the likelihood of fuel vapour interrupting fuel flow. The pilot noted that he was careful where he purchased fuel to ensure it had a low ethanol content and added fresh fuel before each flight as recommended in the LAA guidance.

Footnote

3 http://publicapps.caa.co.uk/docs/33/20130121SSL14.pdf (accessed on 7 August 2018).

Conclusion

The cause of the engine failure could not be determined, but may have been carburettor icing or fuel vapour interrupting the fuel flow. The CAA provides guidance on carburettor icing, and the LAA provides information about the increased likelihood of carburettor icing and fuel vapour-lock when using Mogas.

ACCIDENT

Aircraft Type and Registration:	Jodel D120 Paris-Nice, G-DIZO	
No & Type of Engines:	1 Continental Motors Corp O-200-A piston engine	
Year of Manufacture:	1965 (Serial no: 326)	
Date & Time (UTC):	2 June 2018 at 1045 hrs	
Location:	Dunkeswell Aerodrome, Devon	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Left landing gear and wing damage	
Commander's Licence:	National Private Pilot's Licence	
Commander's Age:	73 years	
Commander's Flying Experience:	497 hours (of which 397 were on type) Last 90 days - 10 hours Last 28 days - 8 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB	

G-DIZO was flying from a farm strip near Southampton, where it was based, to Dunkeswell airfield for an LAA 'fly-in' event. After an uneventful flight the aircraft made an approach to Runway 22. Weather conditions were good with a light headwind. The aircraft made a three-point landing, touching down at approximately 40 kt. On the roll-out the aircraft started to drift to the right of the centreline and the pilot tried to correct with left and then right rudder, but the aircraft continued to the right turning through 180º. The left landing gear collapsed and the aircraft came to rest with the left wingtip on the grass.

The pilot believed he initially corrected with left rudder but then countered this with too much right rudder, and was not quick enough with his feet to keep the aircraft straight. He reflected that the accident was caused by relaxing too soon after the initial landing and being out of flying practice, having not flown much during the winter.

ACCIDENT

Aircraft Type and Registration:	Morane Saulnier Rallye 150ST, G-BDWH	
No & Type of Engines:	1 Lycoming O-320-E2A piston engine	
Year of Manufacture:	1976 (Serial no: 2697)	
Date & Time (UTC):	21 August 2018 at 1247 hrs	
Location:	Blackpool Corner, Dorset	
Type of Flight:	Private	
Persons on Board:	Crew - 2	Passengers - None
Injuries:	Crew - 2	Passengers - N/A
Nature of Damage:	Aircraft destroyed	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	77 years	
Commander's Flying Experience:	700 hours Last 90 days - 6 hours Last 28 days - 1 hour	
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB	

Synopsis

An uncontained fire, from a fuel leak, started in the aircraft's engine compartment shortly after the aircraft had departed Pymore Farm airstrip on a flight to Dunkeswell Airfield. The aircraft was flying over an area of small fields in undulating terrain, and the pilot's approach to his selected field resulted in an overshoot. The aircraft collided with a hedge in the resulting forced landing, and despite being injured, both occupants were able to vacate the aircraft. The aircraft was destroyed in the accident. The source of the fuel leak within the engine compartment was not established due to fire and impact damage of the fuel system components.

History of the flight

The pilot had intended to fly the aircraft from Pymore Farm airstrip, Dorset, to Dunkeswell Airfield in Devon with a passenger, who also held a PPL(A). The aircraft had not undergone any recent maintenance activity and the previous six-month check had been completed in April 2018. The pilot had last flown the aircraft on 22 July 2018, during which it had performed normally.

After checking the fuel quantity in the wing fuel tanks, which totalled approximately 56 litres of AVGAS 100LL fuel, he conducted a daily inspection of the aircraft without noting any abnormalities. The engine start, pre-departure and run-up checks were completed normally and the aircraft took off and climbed to an altitude of approximately 1,200 ft. Weather conditions were good, with no low cloud and a visibility in excess of 10 km.

Approximately five minutes after takeoff the pilot noticed smoke entering the cabin from beneath the instrument panel. He unlatched the canopy and slid it open slightly to vent the smoke. The pilot recalled that the engine instruments displayed readings consistent with normal operation of the engine. Suspecting an electrical fire, he switched the electrical master switch OFF, and about this time the engine stopped but the propeller continued to windmill. The pilot switched the fuel selector valve from the right tank to the left tank, but the engine did not restart; he could not recall whether he then switched the fuel valve OFF. The aircraft was flying above an undulating area of small fields and woodland and the pilot selected a field to land in but was too high and had to overshoot towards a solar farm that lay beyond his selected field. The aircraft was too low to clear the solar farm into another field beyond and the aircraft landed within the solar farm complex, avoiding contact with the solar panels and a sub-station building but colliding with the boundary hedge (Figure 1). A witness who saw the accident confirmed that it was on fire during the final stages of the flight.

The pilot and his passenger were injured in the accident but managed to extract themselves from the aircraft, with the passenger providing assistance to the pilot. The aircraft continued to burn until the fire was extinguished by the emergency services.

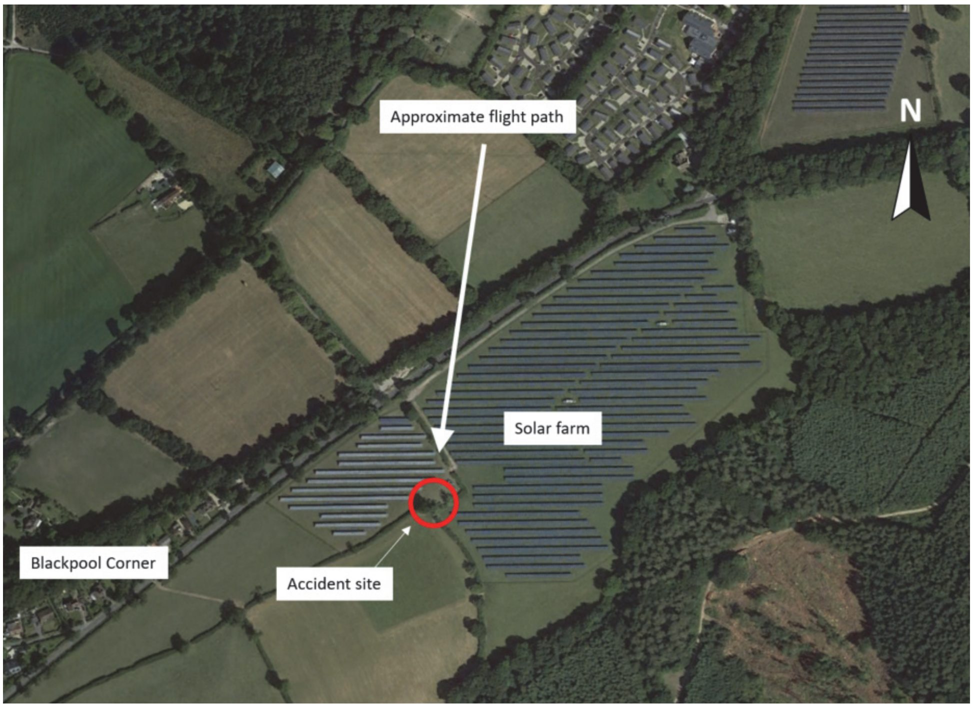


Figure 1
Accident location (courtesy Google Earth)

Accident site and wreckage examination

The aircraft touched down shortly before the boundary hedge with a very short ground roll that was consistent with the aircraft flying at, or close to, the stall prior to touchdown (Figure 2). The AAIB conducted an examination of the wreckage prior to its recovery in order to try to establish the cause of the fire.

Figure 2
Accident site

The majority of the fuselage and the engine compartment had been severely damaged by the fire. The crankcase had partially melted, exposing the sump and no oil remained in the engine. The remains of the engine compartment fuel hoses and their connections to the electric boost pump, engine-driven fuel pump and carburettor were identified in the wreckage, however fire-damage prevented assessment of their condition and security prior to the fire. It was observed that the fuel hose between the engine-driven fuel pump and the carburettor had detached from the carburettor, although this may have occurred during the ground impact.

The right wing's fuel tank had ruptured in the ground impact and no fuel remained within the tank. The left wing's fuel tank had remained intact and 28 litres of AVGAS 100LL were recovered from it.

Analysis

The normal operation of the engine prior to the start of the fire, including the oil temperature and pressure indications, indicates that the fuel source for the fire was likely to be leaking fuel rather than oil from the engine. The engine continued to run for a short period after the first signs of smoke from the fire, which is consistent with fuel being drawn from the carburettor float bowl despite a leak elsewhere in the engine's fuel system. The engine's hot exhaust system would have provided sufficient heating of any leaking fuel to allow its auto-ignition in the absence of any other ignition sources. Damage to the engine's fuel system sustained during the fire and accident impact prevented identification of the source of the leaking fuel.

The pilot was faced with a hazardous situation whilst flying over an area of small fields in undulating terrain. Once it became clear that he was overshooting his chosen field, his remaining landing options were limited. The aircraft's low airspeed at impact minimised the resulting deceleration during the collision with the solar park boundary hedge, probably limiting the extent of the injuries sustained by the pilot and his passenger.

Conclusion

Leaking fuel within the aircraft's engine compartment led to an uncontained fire shortly after the aircraft had departed Pymore Farm airstrip. The aircraft was damaged in the resulting forced landing, and the pilot and passenger both sustained injuries but were able to vacate the aircraft after the accident. The cause of the fuel leak was not established.

ACCIDENT

Aircraft Type and Registration:	North American/Aero Classics P-51 Mustang, N51BS
No & Type of Engines:	1 PKRD-ROLL V1650 series
Year of Manufacture:	1958 (Serial no: 44-73822)
Date & Time (UTC):	25 May 2018 at 1340 hrs
Location:	Woodchurch Airfield, Kent
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Left gear leg detached, and damage to propeller, wing, flap and tail wheel
Commander's Licence:	Private Pilot's Licence
Commander's Age:	54 years
Commander's Flying Experience:	625 hours (of which 4 were on type) Last 90 days - 40 hours Last 28 days - 40 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot reported that he was experienced in operating historic military aircraft and had completed P-51 training one year before the accident. He explained that N51BS was heavier than other P-51s he had flown because it had been restored to its original configuration, which included heavier materials and inert weaponry.

The accident occurred during takeoff from Woodchurch Airfield. The runway was 750 m long and the pilot reported that its grass surface had become soft due to rain. He commented that he did not apply full power immediately to avoid causing the aircraft to roll in the opposite direction to propeller rotation. As the aircraft moved, its wheels sank into the ground and it did not reach the desired speed for takeoff. At the end of the runway the pilot turned the aircraft to avoid a ditch. It struck a fence and came to rest approximately 180 m beyond the end of the runway.

The pilot stated that because he had successfully operated a different P-51 from another grass strip of similar dimensions to Woodchurch he did not perform a performance calculation. He reflected that he had not experienced the ground becoming as soft as it was on this occasion, and he had not considered the higher weight of N51BS.

ACCIDENT

Aircraft Type and Registration:	1) Pierre Robin DR400/180R Remorqueur, G-LGCC 2) Schleicher ASK 21, G-CFYF
No & Type of Engines:	1) 1 Lycoming O-360-A4M piston engine 2) None
Year of Manufacture:	1) 1975 (Serial no: 1021) 2) 1990 (Serial no: 21470)
Date & Time (UTC):	8 June 2018 at 1502 hrs
Location:	Dunstable Airfield, Bedfordshire
Type of Flight:	1) Private 2) Training
Persons on Board:	1) Crew - 1 Passengers - None 2) Crew - 1 Passengers - 1
Injuries:	1) Crew - None Passengers - N/A 2) Crew - None Passengers - None
Nature of Damage:	1) Top of fin sliced off, rudder detached 2) Full depth gash in outboard section of right wing
Commander's Licence:	1) EASA Private Pilot's Licence (Aeroplanes) 2) BGA Glider Pilot's Licence with Full Instructor Rating
Commander's Age:	1) 62 years 2) 69 years
Commander's Flying Experience:	1) 2,825 hours (of which 1,238 were on type and 1,324 were in gliders) Last 90 days - 23 hours Last 28 days - 8 hours 2) 1,670 hours (of which 785 were on type) Last 90 days - 15 hours Last 28 days - 6 hours
Information Source:	Aircraft Accident Report Forms submitted by the pilots, gliding club investigation report and further AAIB enquiries

Synopsis

During the recovery to Dunstable Downs Airfield (DDA) after conducting a successful aero-tow launch, the pilot of the tug aircraft, G-LGCC, became aware of a glider ahead of him at close range. The pilot bunted to pass underneath the glider but had insufficient time to avoid a collision. The top of G-LGCC's fin struck the outboard leading edge of the glider's right wing. Despite suffering major damage, both aircraft remained controllable and landed without further incident.

History of the flight

G-LGCC, an aero-tow tug aircraft based at DDA and operated by the gliding club there, had conducted an aero-tow launch to the north of the field. Having released its towed glider at 2,000 ft, the tug was positioned for a right-hand downwind join to land on the north easterly grass strip (Figure 1).

G-CFYF, a 2-seater glider also operated by the gliding club, was conducting a training flight for the front-seat occupant. After winch launching to the north-east the glider followed a thermal southwards. On reaching the southern airspace boundary the pilots elected to reposition to the north over Dunstable Downs prior to joining the circuit for landing.

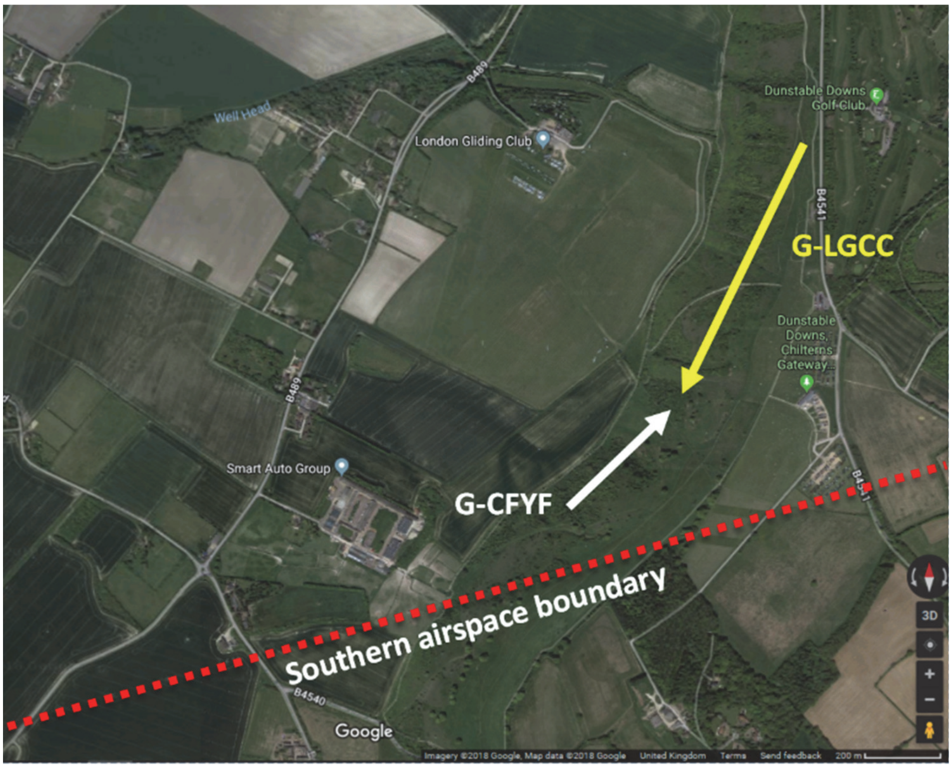


Figure 1
Tracks of G-LGCC and G-CFYF just prior to collision

The tug aircraft

As the tug pilot was descending southbound over Dunstable Downs[1] at approximately 100 kt, his attention was momentarily drawn to an airliner on his left on the approach to Luton Airport (LTN). On looking back to the front, the pilot saw a glider at very close range, directly ahead and slightly below him. With insufficient time available to turn away, he bunted to take his aircraft and its tow cable below the glider. As the aircraft passed one another, the top of G-LGCC's fin struck the outboard leading edge of the glider's right wing, penetrating the structure and slicing through to the spar. During the collision the top of the

Footnote

[1] National Trust owned heathlands on a north-south escarpment adjoining the eastern boundary of the gliding site.

tug's tail fin detached along with the rudder (Figures 2 and 3). Stress marks found on the tug's right wing were consistent with damage discovered on the inner lower surface of the gilder's right wing.

Figure 2

G-LGCC after the accident with rudder missing and damage to top edge of the fin

Following the collision, the tug pilot used gentle control inputs and flew a slack base turn onto final approach. Having lost the rudder, as its speed reduced the tug became less directionally stable. Increasing speed made the aircraft more controllable so the tug pilot elected to land faster than normal.

Figure 3

Damage to tail section of G-LGCC

The glider

Immediately prior to the accident the glider was tracking north easterly at 50 kt and approximately 900 ft agl[2]. Neither occupant saw the tug aircraft and the first they knew of the collision was a loud bang accompanied by the glider yawing violently to the right. The instructor in the rear-seat took control of G-CFYF to make an initial damage assessment. Looking to the right he could see significant disruption to the wing structure (Figures 4 and 5), but the wingtip angle looked normal, implying that the spar was intact.

Figure 4

Damage to the upper surface of G-CFYF's right wing

The glider was still flying and responding normally to control inputs. With members of the public below and the aircraft under control, the instructor elected to continue recovering to the field rather than risk a low-level abandonment. The glider landed without further incident.

Figure 5

Damage to the lower surface of G-CFYF's right wing

Footnote

2 Approximately 1,200 ft above the airfield.

Airfield information

DDA is an undulating grass airfield occupying approximately 110 acres and has been home to the gliding club since the early 1930s. Over time, the expansion of nearby LTN means that the airfield now sits within Class D airspace. A Letter of Agreement between NATS[3] and the operators of DDA provides for procedural separation between aircraft operating from LTN and Dunstable; the latter have restricted freedom of manoeuvre east and south of the field.

On the day of the accident, flight operations were taking place from the north-east run (Figure 6). In this configuration, aero-tow aircraft operate from the west side of the launch point and track northwards on departure, winch-launched gliders depart to the north-east. All aircraft aim to land to the right of, and parallel with, the winch launch track.

Figure 6

Satellite image of Dunstable Downs Airfield with north-east run depicted

While generic tug routings are known to the Dunstable gliding community, aero-tow aircraft returning to the field do not fly a set daily flightpath. Ground tracks are chosen to expedite recovery to the field and varied to distribute the tugs' noise nuisance footprint more evenly.

The airfield operates a single VHF radio frequency, primarily as a safety channel for control of the winch launching operation; it does not offer an air-to-ground radio service. To avoid

Footnote

[3] The Air Navigation Service Provider at LTN.

winch safety calls being missed, transmissions for other than emergency situations are discouraged. Not all gliders carry a radio and for those that do, limited battery life can be an issue.

Meteorological information

At the time of the accident weather conditions were good, there was a gentle north-easterly breeze, very little cloud and visibility of more than 30 km.

Human factors

The tug pilot reported that there was a slight haze at height and that he was heading into sun. He believes that these factors, coupled with the distraction caused by the LTN inbound traffic, may have contributed to his difficulty in seeing the glider at range. The instructor in the glider reported that reflections in the canopy had compromised his lookout from the rear cockpit.

Other information

General collision avoidance procedures

The guiding principle for collision avoidance during VFR[4] flights, such as those undertaken at Dunstable, is 'see-and-avoid'. This concept places the onus on pilots to visually acquire conflicting traffic without third party assistance. Having detected a potential collision, pilots must then take appropriate avoiding action to prevent it. Pilot training, aircraft design and operational procedures are some of the passive measures designed to mitigate the risk of mid-air collision, but each has its limitations and cannot eliminate the risk entirely.

Avionics systems, such as TCAS[5] and FLARM[6], have been developed to further help pilots detect and avoid collisions. One of the limitations of FLARM is that it only works between aircraft fitted with the same system; unless both conflicting aircraft are using it, neither will receive an alert. Technological advancements such as PowerFLARM, with an improved display and the ability to detect FLARM, ADSB-Out[7] and transponder equipped aircraft, appear to offer enhanced capability over legacy electronic conspicuity (EC) systems.

Unlike with TCAS in commercial aviation, there is currently no agreed international standard for electronic collision avoidance or EC devices for General Aviation (GA) aircraft or gliders. The regulators of UK gliding operations do not specify a minimum level of collision avoidance equipment for participating aircraft.

Footnote

4 Visual Flight Rules, whereby pilots fly the aircraft using visual references and take responsibility for avoiding collisions with other aircraft.
5 Traffic Collision and Avoidance System.
6 A proprietary traffic awareness and collision avoidance system for General Aviation, light aircraft, and UAVs. FLARM uses audio cues coupled with a basic polar display to alert pilots to potential collisions with other FLARM-equipped aircraft.
7 Automatic Dependent Surveillance Broadcasting. A system that transmits information about the aircraft's location and flight parameters to other suitably equipped aircraft or ground systems.

UK Civil Aviation Authority Electronic Conspicuity Working Group

In response to safety recommendations made in a 2010 AAIB report[8] following a mid-air collision between a light aircraft and a glider, the UK Civil Aviation Authority (CAA) established the Electronic Conspicuity Working Group (ECWG). The remit of the ECWG was to examine how increased use of EC could improve safety in uncontrolled airspace. The ECWG published its findings in April 2018 (CAP 1391[9]), acknowledging the potential safety benefits of enhanced situational awareness through increased use of EC and stating:

> *'There is a perception that the use of EC could reduce the risk of mid-air collision (MAC) in Class G Airspace[10].'*

A target outcome for the ECWG was to define an industry standard for EC devices designed for the UK market. Their aspiration was that by standardising EC technology, equipment costs would reduce, leading to wider adoption of such systems across the GA and gliding communities.

Visual conspicuity

Fibreglass gliders are usually white and, with narrow cross-sections, it can be challenging for the human eye to detect them at distance, especially when head-on. Using darker colours could enhance visual conspicuity but would increase solar heating of the airframe which can adversely affect the aircraft's structural integrity. Solar heating does not affect the structural integrity of aircraft constructed of more traditional materials, such as wood and metal, to the same degree.

Gliding club investigation

The gliding club was authorised by the British Gliding Association (BGA) to conduct its own investigation into this accident and concluded that:

> *'The accident occurred because the pilots did not see each other's aircraft in sufficient time to take effective avoiding action.'*

As part of the investigation they also considered how electronic collision avoidance systems may have helped in this instance and reported that:

> *'FLARM fitment … may have helped to prevent this accident.'*

While acknowledging the potential benefits of FLARM, the Club's report expressed reservations about mandating it for all DDA-based aircraft. They were concerned that, with the high traffic density often encountered at the airfield, FLARM might generate high a level

Footnote

[8] Formal Report AAR 5/2010. Report on the accident between Grob G115E (Tutor), G-BYXR and Standard Cirrus Glider, G-CKHT at Drayton, Oxfordshire on 14 June 2009 https://www.gov.uk/aaib-reports/5-2010-g-byxr-and-g-ckht-14-june-2009 (accessed 6 September 2018).

[9] Civil Air Publication 1391. https://publicapps.caa.co.uk/modalapplication.aspx?appid=11&mode=detail&id=7275 (accessed 6 September, 2018.

[10] Class G is the least restrictive of 8 airspace classifications described in ICAO Annex 11.

of nuisance alerts, leading to distraction rather than benefitting deconfliction. The Club had previously decided that mandating the use of high intensity LED landing lights on tug aircraft would be a more useful mitigation for tug-versus-glider collisions than FLARM. Due to increased radio interference on some tug aircraft when the LED lights were illuminated, not all tug pilots at Dunstable observed this policy.

The gliding club's investigation made safety recommendations related to the use of landing lights on tug aircraft as well as proposing reviews into the fitment of FLARM and improved battery technology on their aircraft.

The Club also instigated an informal review of tug operations to explore potential procedural changes which could enhance flight safety.

Further incident

On 4 August 2018 there was a further incident at DDA between an aero-tow aircraft and a glider. On this occasion the tug was recovering to the airfield when the free end of its tow cable struck, and broke the canopy of, the other aircraft. There were no reported injuries and this incident was referred to the BGA.

Analysis

Collision avoidance

With the airfield having been subsumed into Class D airspace, gliding at Dunstable is restricted on two sides. Limited freedom to operate east and south of the field leads to a higher traffic density in the remaining available airspace than might otherwise be the case. Concentrating a high level of activity into a smaller area inevitably increases the challenge of safely deconflicting flight operations using the see-and-avoid principle.

See-and-avoid is a long-established basis for collision avoidance that works satisfactorily provided at least one of the pilots involved sees the other aircraft sufficiently early to take effective avoiding action. On this occasion, and the subsequent incident on 4 August 2018, it did not provide an adequate safety margin. The limitations of see-and-avoid are well-documented and the residual risk of mid-air collision is a concern for the GA and gliding communities as well as for the BGA and CAA. Employing optional additional mitigation measures, such as EC systems and procedural deconfliction, invariably adds cost and is left to the discretion of pilots and operators. The CAP 1391 definition of an industry standard for EC devices could lead to reduced equipment costs and consequent wider deployment of the technology on GA and glider aircraft. (See report G-JAMM/G-WACG in this Bulletin.)

Tug operations

As highlighted by this accident and the subsequent incident, an aero-tow tug and its cable is a relatively un-manoeuvrable threat to other aircraft. Anything that enhances their conspicuity or increases others' situational awareness (SA) of their whereabouts would be a safety benefit. The gliding club's policy to fit high-intensity LED landing lights is extra mitigation for head-to-head collisions, although it did not prevent the second incident. The solar heating risk to structural integrity for fibreglass gliders means that painting them in more conspicuous colours is not an option, although this could be a course of action worthy of consideration for tug aircraft.

Full freedom for tug pilots to vary their recovery routings facilitates a more efficient aero-tow operation but does not help SA for other pilots. Adhering to more prescriptive routes, that could be briefed to those launching from DDA, would help glider pilots understand where the tug threat is greatest. Formalising daily tug routing would also allow for noise to be distributed in a planned, rather than arbitrary, manner. A downside, might be that tug efficiency would reduce leading to increased costs which would have to be balanced against the potential safety benefit.

Due to the risk of critical winch safety calls being missed, the DDA radio frequency is not routinely used for aircraft deconfliction. While not all gliders have radio capability, brief transmissions by tug aircraft recovering to the airfield could alert those on frequency to their presence. Timing their calls judiciously to avoid the critical phase of a winch launch, tug pilots could add to general SA by broadcasting their recovery intentions without compromising safety. Such a procedure would only benefit aircraft with functioning radios and would not have helped in this accident.

FLARM

The gliding club previously assessed that the benefits of FLARM are outweighed by the potential distraction of multiple alerts in a congested circuit area and, therefore, only fit it to their cross-country gliders. Ongoing technological advancements in the EC field appear to offer enhanced capabilities worthy of consideration when the gliding club conducts its review of its FLARM equipage policy. Other clubs use FLARM more extensively and lessons learnt from their operations could help inform the Club's deliberations.

Conclusion

Using see-and-avoid as the basis for collision avoidance is an accepted aviation risk which became a reality on this occasion. A late sighting gave insufficient time to avoid a collision and it was only through providence that there were no fatalities.

Gliding is a popular leisure pursuit that relies on participation for it to survive, anything that adds cost poses a threat to its viability. Visual deconfliction is a fundamental tenet of the sport but it has its limitations. Technological solutions are available to support see-and-avoid but, unless mandated by regulators, they can appear to be non-essential luxuries when money is tight.

Regulators can encourage operators to supplement see-and-avoid, but the lack of an international agreement on capability standards undermines this strategy; people are wary of investing in expensive equipment if it risks being made obsolescent by future regulatory change. While not directly addressing the lack of international agreement, CAP 1391 removes a degree of uncertainty and seeks to promote wider adoption of EC technology within the UK's GA and gliding communities.

Safety actions

To reduce the risk of mid-air collisions between aero-tugs and gliders, the gliding club decided to:

- Publicise and enforce the policy of using landing lights on their tug aircraft during normal towing operations.
- Resolve the issue of radio interference generated by LED landing lights on the Club's aero-tow aircraft.
- Review the policy on FLARM fitment for Club owned aircraft.
- Investigate the possibility of fitting extended life batteries to all Club aircraft with the aim of enabling radio use for all flights and supporting a growth path for wider use of electronic conspicuity systems.

SERIOUS INCIDENT

Aircraft Type and Registration:	Piper J3C-65 Cub, G-CGIY
No & Type of Engines:	1 Continental Motors Corp C90-12F piston engine
Year of Manufacture:	1943 (Serial no: 11535)
Date & Time (UTC):	12 May 2018 at 1300 hrs
Location:	En route from Gamston Airport to Leeds East Airport
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Upper rudder hinge pin missing, lower hinge lugs distorted and elevator ribs damaged
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	71 years
Commander's Flying Experience:	7,870 hours (of which 136 were on type) Last 90 days - 108 hours Last 28 days - 55 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and inquiries made by the AAIB

Synopsis

The aircraft was en route from Gamston Airport near Retford to Leeds East Airport when the pilot noticed a vibration on the rudder pedals. This was followed by an uncommanded yaw and a jolt through the pedals. Several seconds later the pilot heard a loud bang with a violent nose-down pitch. The pilot slowed the aircraft, regained control and, looking behind, observed that the rudder appeared to be displaced. He informed Leeds East of the problem and landed without further incident. The partial rudder detachment and the resultant handling difficulties were caused by the loss of the rudder upper hinge pin and bushes. It is not known how the pin and bushes worked loose but their loss would have been prevented had the specified upper washer been in place.

History of the flight

The pilot was carrying out a local flight between Gamston and Leeds East in good weather conditions. He had just changed radio frequency from Doncaster to Leeds East when he noticed a vibration through the rudder pedals. This was shortly followed by an uncommanded yaw and violent jolt through the pedals. A few seconds later there was a loud bang and the aircraft pitched nose down. The pilot regained control and level flight, but experienced heavy stick forces and had to maintain a constant pressure on the rudder pedals to arrest their movement back and forth. He glanced back and saw that the rudder appeared to be displaced to the right and detached from its upper hinge. Nearing Leeds East, he informed ATC of the problem and was offered either Runway 16 or 24. There were obstacles in the undershoot and vicinity of Runway 16 so he chose Runway 24, accepting a slight crosswind of 180°/4kt. He landed the aircraft, taxied clear and shut down without further incident.

Engineering investigation

On inspection the pilot found that the rudder upper hinge pin and bearings were missing and the lower hinge lug (cylindrical portion through which the pivot pin passes) had detached from the leading edge of the rudder. The rudder was therefore held in position only by its control cables attached to the left and right control horns. There was distortion to the inboard edge frame of both elevators adjacent to the rudder. Despite this, the elevators functioned correctly, albeit with some restriction and an increased stick loading. Figure 1 is a general view of the aircraft and Figures 2 and 3 show the condition of the rudder upper hinge and elevators.

Figure 1
General view of G-CGIY

Figure 2
Upper rudder hinge separation, pin and bushes missing

Figure 3
Damage caused to the elevator inboard edge frames

Discussion

The damage to the elevator shows the rudder had been oscillating in the aircraft slipstream, hence the pilot describing how he had to physically restrain the rudder pedals from moving back and forth. Without the upper hinge support, the oscillation overloaded the lower hinge lug and caused it to part from the rudder leading edge frame. This left the rudder attached to the aircraft by its two control cables only. In this unusual state the rudder was not able to provide yaw control effectively. There was also a risk that the elevator could have been jammed by the loose rudder and pitch control lost as a result.

Rudder hinge assembly

The upper and lower rudder hinge assemblies consist of tubular lugs welded to the fin trailing edge tube and the rudder leading edge tube. Within the lugs there are non-ferrous interference-fit bushes through which the steel pivot pin is fitted, locked in place by a split pin. According to the illustrated parts catalogue, there should be a washer fitted directly under the head of the pivot pin and a second washer fitted between the split pin and hinge. The pin should always be fitted with its head uppermost. During the pre-flight walk around the pilot noticed nothing unusual about the rudder or its hinges. It is not known why the bushes worked loose.

Despite the damage to the lower hinge, the pin and bushes remained in place and it appears that there was no washer fitted directly under the head of the pivot pin. However, there was a correctly fitted washer at the lower end of the pin above the split pin as shown in Figure 4.

It is likely that the upper hinge had been assembled in the same way. However, the diameter of the pivot pin head is slightly less than that of the outer diameter of the bushes. Without the upper washer there would be nothing to stop the pin and bushes ‘working’ out of the rudder hinge as appears to have happened in this case.

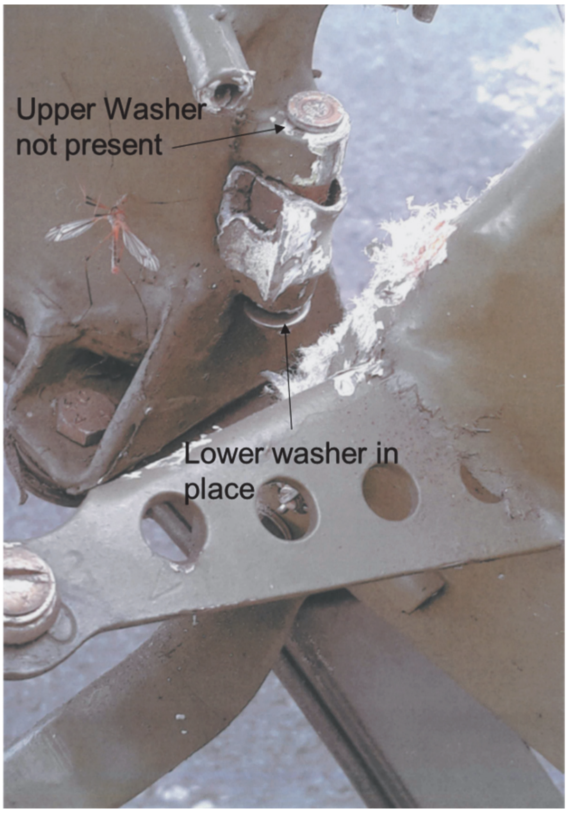


Figure 4
Lower rudder hinge assembly

AAIB inquiries

During this investigation it was observed that from a random small sample of other J3 Cub and Cub derivatives, two aircraft were missing their upper washers from the hinge assemblies. This incident and the two random sample aircraft suggests that there may be an airworthiness issue concerning the correct assembly of the rudder hinges in the J3 Cub and derivative fleet.

Safety action

The CAA have been informed and are considering an appropriate safety action to inform owners and operators. In addition, the LAA has published a comprehensive article in the Safety Spot section in the association magazine with advice to Cub owners regarding the assembly and integrity of the rudder hinge pins.

ACCIDENT

Aircraft Type and Registration:	Reims Cessna FRA150M Aerobat, G-BEKN
No & Type of Engines:	1 Continental Motors Corp O-240-E piston engine
Year of Manufacture:	1977 (Serial no: 318)
Date & Time (UTC):	7 May 2018 at 1615 hrs
Location:	Peterborough Sibson Airfield, Cambridgeshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Nosewheel and steering arms detached, bent propeller, lower engine cowling damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	51 years
Commander's Flying Experience:	97 hours (of which 58 were on type) Last 90 days - 20 hours Last 28 days - 6 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot was returning to Peterborough Sibson Airfield from Fenland Aerodrome where he and his passenger had stopped for a coffee. The approach into Sibson was made with 30º of flap and what the pilot thought was 80 mph but was in fact 80 kt (92 mph). The wind was light and variable. The aircraft touched down hard and bounced back onto the air. On the next bounce the pilot described the aircraft almost "porpoising". With tall trees beyond the end of the runway fast approaching, the pilot thought it would be safer to continue landing rather than to go around. However, during the third and final bounce, the nosewheel leg broke before the aircraft came to a stop.

The pilot's assessment of the accident was that most of his previous flying was in Cessna 150s with ASIs marked in mph rather than knots, and that he had misread his approach airspeed.

ACCIDENT

Aircraft Type and Registration:	Reims Cessna FR172K, Reims Hawk XP, G-YIPI
No & Type of Engines:	1 Continental Motors Corp IO-360-KB piston engine
Year of Manufacture:	1977 (Serial no: 616)
Date & Time (UTC):	18 May 2018 at 1545 hrs
Location:	Perranporth Airfield, Cornwall
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damaged beyond economic repair
Commander's Licence:	Light Aircraft Pilot's Licence
Commander's Age:	79 years
Commander's Flying Experience:	500 hours (of which 190 were on type) Last 90 days - 6 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot reported that he approached to land on Runway 05 at Perranporth Airfield at 70 kt with flaps FULL. The wind was from about 360° at 8 kt. After crossing the threshold, the pilot flared the aircraft, which landed heavily and bounced. After the subsequent landing the pilot was aware that the aircraft had been damaged so vacated the runway and shut down. There was severe damage to the front of the aircraft, including its propeller and nosewheel.

The pilot believed he may have flared the aircraft late. Given the level and nature of the damage it is also possible that the aircraft landed too fast, leading it to touchdown nosewheel first.

ACCIDENT

Aircraft Type and Registration:	Rotorway Executive 90, G-BZES
No & Type of Engines:	1 Rotorway RI 162 piston engine
Year of Manufacture:	1994 (Serial no: 6191)
Date & Time (UTC):	1 July 2018 at 1430 hrs
Location:	Fenland Airfield, Lincolnshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Extensive
Commander's Licence:	Private Pilot's Licence
Commander's Age:	36 years
Commander's Flying Experience:	71 hours (of which 18 were on type) Last 90 days - 11 hours Last 28 days - 0 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and subsequent enquiries by the AAIB

Synopsis

The pilot lost control whilst descending in a downwind direction. The helicopter developed a rate of descent which the pilot was unable to arrest, and it struck the ground heavily and rolled over.

Background information

A public event was planned at the airfield on the day of the accident. Areas were therefore allocated for public access; these extended to include an apron area in front of a row of hangars near the north end of the airfield, orientated east-west. Owners of aircraft parked in the hangar area were informed of the event in advance and were advised to move their aircraft to other parts of the airfield, not allocated for public access, if they wished to fly them on the day of the event.

The hangar area had recently been extended to the east and the final surfacing of the apron area in front (to the south) of the new section had not been completed. It was judged that irregularities in the incomplete surface would be a trip hazard to pedestrians, so the area was roped off for their protection.

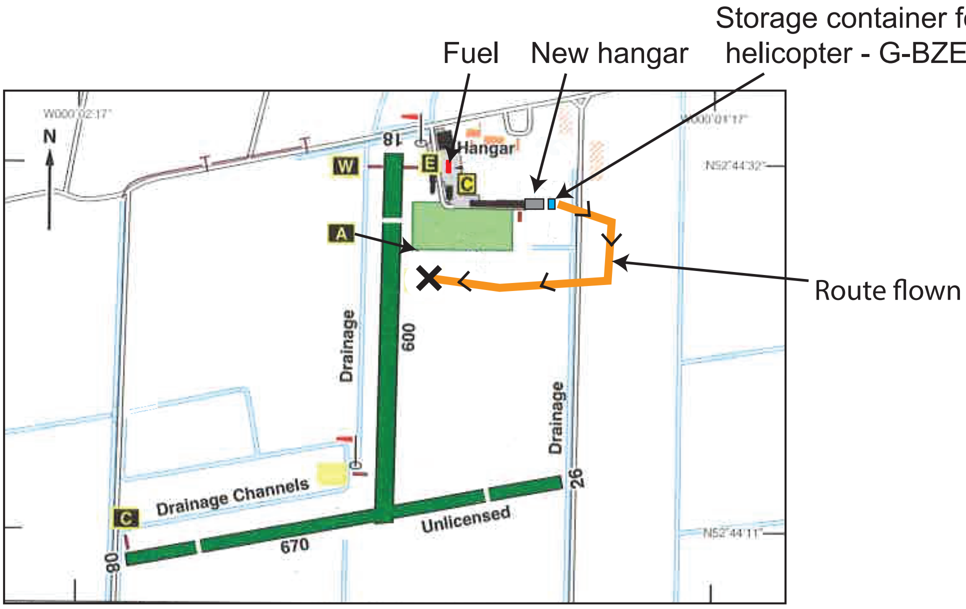


Figure 1

Diagram of accident flight path, as provided by the pilot, superimposed on amended plate from Pooleys Flight Guide

History of the flight

The pilot stated that he wished to refuel the helicopter which was stored at the eastern end of the hangars, within the roped-off area. The refuelling facility was to the north-west of the hangar complex (Figure 1). He arranged with an airfield steward to keep bystanders well away whilst he was starting up and preparing to lift.

In order to access the refuelling facility, the pilot found it necessary to fly to Holding Point 'A', to the west-south-west of the point of departure. He planned to remain there in the hover whilst he established movement information from the Air-Ground radio and confirmed that it was acceptable to fly over the northern end of Runway 18/36, not in use that day, but where aircraft were parked.

The wind was reported as being easterly, at 12 kt. The pilot lifted off and departed in an approximately easterly direction, before turning onto a southerly heading, remaining just outside the airfield boundary. He then turned onto an approximately westerly heading towards Holding Point 'A'. Thus, he was initially travelling into-wind, before turning crosswind and then proceeding downwind. In subsequent discussion, he stated that he did not go to a great height.

The pilot also stated that, during the final leg, he forgot that he was now travelling downwind. As he descended towards Holding Point 'A', the helicopter initially handled correctly, but as he approached the ground it seemed to suddenly increase its descent rate, despite his efforts to prevent this. It struck the ground heavily with the rear skid, before pitching forward. The main skids and main rotor then struck the ground and the helicopter rolled over. The pilot, secured by a full harness, was not injured and was able to exit via the passenger door.

Discussion

A descending approach carried out in a tailwind, using normal visual cues and aiming to use the normal approach profile, will result in reduction of airspeed to zero and then to a negative value, whilst the helicopter is still proceeding forwards and descending towards the point of the intended hover. As airspeed becomes negative, the helicopter will experience directional instability, necessitating more attention to operation of the yaw pedals and higher pilot workload.

The absence of airspeed will also result in loss of translational lift. In addition, with the helicopter flying downwind, more power will be required to decelerate to a stationary condition than in an into-wind approach. A small helicopter will not benefit from ground effect until very close to the ground. In such circumstances, considerably more power is required to bring the helicopter to the hover. If a significant descent rate has developed, insufficient power may be available in a low powered helicopter to arrest the descent. In this case, the selection of a landing direction which, inadvertently, was orientated in a downwind direction, created conditions that were challenging to a pilot of limited experience and lack of recency and may also have required greater power than the engine could produce.

Conclusion

Inadvertent selection of a downwind approach created a high pilot workload and probably created conditions which required more engine power to arrest the descent than the helicopter could produce.

ACCIDENT

Aircraft Type and Registration:	Escapade 912(1), G-ESKA	
No & Type of Engines:	1 Rotax 912-UL piston engine	
Year of Manufacture:	2005 (Serial no: BMAA/HB/371)	
Date & Time (UTC):	3 August 2018 at 1230 hrs	
Location:	Near Cranmore, Somerset	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Loss of wheel and undercarriage, wing tip and propeller damaged	
Commander's Licence:	National Private Pilot's Licence	
Commander's Age:	59 years	
Commander's Flying Experience:	797 hours (of which 120 were on type) Last 90 days - 17 hours Last 28 days - 7 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

The pilot was landing away from his home airfield using a field strip he had visited previously. He had flown a standard 500 ft agl circuit and was completing his approach to land when the aircraft speed suddenly decreased and despite adding power the pilot was unable to arrest the rate of decent. The aircraft struck the ground heavily causing damage to the right main landing gear, which collapsed. This caused the right wingtip and the propeller to strike the ground. The aircraft slewed around and came to rest on the right wingtip and left main landing gear. Figure 1 shows the aircraft after the accident.

The day of the accident was warm, and the pilot had noted the presence of significant thermal activity at his home airfield. He considered it likely that the final stages of the approach had been through rising air across a sloping field but as he crossed the boundary hedge he exited the thermal and the aircraft began to sink with the speed decreasing. He was surprised by the sudden loss of lift and was unable to stop the aircraft striking the ground hard.

Figure 1
Aircraft resting on the right wingtip

ACCIDENT

Aircraft Type and Registration:	EV-97 Teameurostar UK, G-CEZF
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	2007 (Serial no: 3205)
Date & Time (UTC):	1 July 2018 at 1200 hrs
Location:	Strathaven Airfield, South Lanarkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Collapsed nosewheel and propeller strike
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	61 years
Commander's Flying Experience:	576 hours (of which 576 were on type) Last 90 days - 25 hours Last 28 days - 8 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot reported that he had made a straight in approach to Runway 09 and the aircraft's airspeed and touchdown point were appropriate. When the aircraft was approximately 150 m into the landing roll, it encountered a series of ridges in the runway surface which set up a bouncing motion that the pilot was unable control. The nose landing gear then collapsed and the propeller struck the ground.

The pilot suggested that "landings must be very precise in speed and touchdown to negate the ridges on [the] runway".

ACCIDENT

Aircraft Type and Registration:	Ikarus C42 FB80, G-CDYO
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	2006 (Serial no: 0604-6810)
Date & Time (UTC):	10 June 2018 at 1830 hrs
Location:	Membury Airfield, Berkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to the nose landing gear and propeller
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	65 years
Commander's Flying Experience:	156 hours (of which 107 were on type) Last 90 days - 4 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot was returning from a local flight to land on Runway 05 at Membury Airfield. The weather was CAVOK, wind northerly at 5 kt and temperature 25°C. The pilot reported that he was slightly higher and faster than normal on approach. Another aircraft was waiting to depart at the holding point so the pilot of G-CDYO planned to land half way down the runway to allow plenty of space between the two aircraft. On landing, G-CDYO bounced twice and on the third touchdown the nosewheel collapsed and the propeller struck the runway. The aircraft came to a halt on the left-hand edge of the runway (Figure 1).

After the accident the pilot reflected that he should have gone around when he realised he was high and fast on the approach and was not going to land at the start of the runway or after the first or second touchdown.

Figure 1
G-CDYO with collapsed nosewheel and propeller damage

ACCIDENT

Aircraft Type and Registration:	Jabiru UI-450, G-JUDD
No & Type of Engines:	1 Jabiru 2200A piston engine
Year of Manufacture:	2000 (Serial no: PFA 274A-13570)
Date & Time (UTC):	16 July 2018 at 15:10 hrs
Location:	Clench Common Airfield, Wiltshire
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Nose leg failure, damage to lower cowl and firewall
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	64 years
Commander's Flying Experience:	12,508 hours (of which 272 were on type) Last 90 days - 128 hours Last 28 days - 40 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft was being flown by a student on conversion training with an experienced instructor. The student had completed several landings during the flight and was making a further approach on Runway 26 with a light wind down the runway. As the aircraft touched down it bounced, and the instructor told the student to maintain the attitude and allow the aircraft to touch down again. Despite attempting to maintain the attitude, on the second touchdown the aircraft landed flat on all three undercarriage legs and the nose leg failed. The aircraft lower cowls, firewall and nose leg were damaged.

The instructor commented that, in hindsight, he felt should have taken control and gone around from the bounce.

ACCIDENT

Aircraft Type and Registration:	Mainair Blade, G-CCZW
No & Type of Engines:	1 Rotax 582-2V piston engine
Year of Manufacture:	2004 (Serial no: 1368-0904-7-W1163)
Date & Time (UTC):	20 May 2018 at 1900 hrs
Location:	Headon Airstrip, near Gamston, Nottinghamshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Minor damage to the left wing and to the pod/ trike unit
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	51 years
Commander's Flying Experience:	71 hours (of which 71 were on type) Last 90 days - 4 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and Airstrip details provided by the Airstrip owner

Synopsis

While attempting to land from an offset approach, the pilot lost control, and the left wing struck a hedge which was adjacent to the runway.

History of the flight

At the end of a local flight, the pilot flew an offset approach to Runway 14 at Headon, to avoid a noise sensitive area downwind of the threshold. He aimed towards a point on the runway centreline, upwind of the threshold, and flew over the northern airstrip boundary on a heading of 170-180º, before initiating a left turn to line up with the runway. Although he initially judged that he had rolled out of the turn above the centreline, he soon realised that the aircraft was "skidding" right and was above a tall crop of rapeseed adjoining the southern edge of the runway. The pilot, therefore, made a correction to the left and the aircraft turned back towards the runway, where it landed heavily and then veered towards the boundary hedge. The left wingtip struck the hedge, causing the aircraft to spin around to the left before it stopped, at which point the pilot shut the engine down and he and his passenger vacated normally.

Most of the pilot's previous takeoffs and landings had taken place at Headon but he had not landed on Runway 14 until the previous day. The airstrip owner, who is also a flight instructor, had indicated that the pilot had accumulated sufficient experience to fly the offset approach to Runway 14, which is intended to keep aircraft clear of obstacles and noise sensitive areas. With the flight instructor accompanying him, the pilot had completed two landings and then, on a later flight with a passenger, he had landed on Runway 14 a third time. However, prior to this third landing, he had gone around from his first two approaches, because he had not established his aircraft on the centreline before reaching the midpoint of the runway.

Following the accident, the pilot observed that he had been distracted by the tall crop to the right of the runway and that he felt restricted by it and by the tall boundary hedge to his left. He noted that the runway widens beyond the halfway point and the sight of this wider runway ahead influenced him when he made a “split second” decision to continue his approach. He believes that he probably tried to turn too tightly, to regain the runway, and that this may have caused the wing to stall, meaning he lost control prior to touchdown. As a result of this experience, the pilot believes he has become a more cautious aviator and he will be more inclined to go around from an approach, if he has any doubts concerning the outcome.

Airstrip information

Runway 14 at Headon is 540 m long and pilots are expected to avoid obstacles and nearby noise sensitive areas on the approach and consequently disregard the first 140 m of the runway when landing. The runway widens after its midpoint and there is an uphill slope towards the threshold of Runway 32.

In view of the local noise sensitive areas, the airstrip owner’s website recommended an offset approach to Runway 14, and highlighted the presence of trees along the northern boundary. A diagram on the website had superimposed numerals, which indicated a displaced threshold for use following a 40º offset approach (Figure 1), but a video on the website showed the approach which a microlight pilot should aim for. This suggested flying a track of 170º, so offset 30º left of the centreline, until just prior to crossing the boundary hedge, where aircraft should start turning left (towards 140º). The video showed an aircraft which touched down slightly beyond the midpoint of the runway.

The text accompanying the video stated:

> *‘…be very careful on this approach as there are obvious dangers of making a turn on to the centre line at low level and I think you will have to make a judgement yourself as to whether it is in your comfort zone or ability. The last thing we or you want is an accident. If you are not comfortable with it then either use a different runway if conditions allow or save the flight for another day. Anyone with less than maybe 100 hours then definitely don’t fly it.’*

Figure 1

Part of the website diagram, with areas to avoid shown in red and with a blue line representing the suggested offset approach towards the superimposed ‘14’ numerals. The numerals painted on the ground are in reality not as large and are nearer the northwestern end of the runway.

© 2014 Google, Image © 2014 Getmapping pic

Safety actions

The airstrip owner states that since this accident occurred, the trees on the northern boundary have been removed and the recommended approach has been modified to reduce the offset angle to 20º or less. The website is to be amended accordingly and a new video added in due course.

The field to the south of Runway 14 belongs to the airstrip owner and he only grows a rapeseed crop there every third year. In future he will ensure the crop close to the narrowest section of the runway does not reach a height that is likely to distract pilots.

ACCIDENT

Aircraft Type and Registration:	Pegasus Quantum 15-912 Quantum, G-BYRJ
No & Type of Engines:	1 Rotax 912 piston engine
Year of Manufacture:	1999 (Serial no: 7548)
Date & Time (UTC):	31 August 2018 at 0820 hrs
Location:	Redlands Airfield, Wiltshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Nose landing gear and pod damage
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	56 years
Commander's Flying Experience:	41 hours (of which 41 were on type) Last 90 days - 20 hours Last 28 days - 7 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

After a 10-minute local flight, the pilot and passenger were returning to the grass airfield and commenced a low, powered approach. The wind was from 070° at 6 kt and as the aircraft cleared a high hedge prior to the threshold of Runway 08 north, the pilot felt a change in wind direction and the aircraft lost height. The resulting touchdown point was much "shorter" than anticipated and the aircraft landed heavily on the nose landing gear.

The hard landing damaged the nose landing gear and the pod. Both occupants exited the aircraft unaided and without injury. The pilot stated that the low approach was a poor choice as it did not allow sufficient height to correct the landing approach following a change in wind conditions.

ACCIDENT

Aircraft Type and Registration:	Quik GT450, G-CFEX
No & Type of Engines:	1 Rotax 912ULS piston engine
Year of Manufacture:	2008 (Serial no: 8362)
Date & Time (UTC):	16 August 2018 at 1033 hrs
Location:	Shobdon Airfield, Herefordshire
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Extensive
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	64 years
Commander's Flying Experience:	328 hours (of which 268 were on type) Last 90 days - 62 hours Last 28 days - 15 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft was being used for circuit training. On the first circuit, the instructor was demonstrating a glide approach to a touch-and-go landing. On touchdown, the nosewheel collapsed. This was followed by the collapse of the front forks, which caused full throttle to be applied due to the position of the throttle pedal pivot. The aircraft began to accelerate and skidded on its nose off the runway before the engine could be stopped. The aircraft fibreglass pod was damaged as the aircraft skidded without a nosewheel, and several large stones impacted on one of the three propeller blades. Figure 1 shows the final position of G-CFEX off the runway. Inspections also revealed that the trike keel had suffered some deformation. The instructor and student, who were wearing helmets and lap straps were unhurt. G-CFEX had recently returned to flying after repairs to the front end of the aircraft from damage sustained in a forced landing[1].

Footnote

[1] AAIB Bulletin 9/2018.

Figure 1
G-CFEX off the side of the runway

ACCIDENT

Aircraft Type and Registration:	Thruster T600N 450, G-CCDV
No & Type of Engines:	1 Jabiru 2200A piston engine
Year of Manufacture:	2003 (Serial no: 0034-T600N-082)
Date & Time (UTC):	1 August 2018 at 1500 hrs
Location:	Myerpole Farm, Lancashire
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - 2 (Minor) Passengers - None
Nature of Damage:	Severe
Commander's Licence:	Private Pilot's Licence
Commander's Age:	62 years
Commander's Flying Experience:	16,201 hours (of which 888 were on type) Last 90 days - 124 hours Last 28 days - 39 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

At approximately 200 ft agl, after takeoff on an instructional sortie, the engine power setting was reduced from 3,000 rpm to 2,800 rpm and the electric fuel pump was selected OFF. This was routine. Shortly thereafter, at approximately 300 ft agl, the engine suffered a significant power loss. The Instructor took control and reselected the electric fuel pump to ON. However, the scale of the power loss meant that level flight was impossible and a forced landing was necessary. The instructor chose what he felt was a suitable field and manoeuvred toward it. On final approach the Instructor noticed low power lines running across his path. He was concerned that the aircraft would strike the power lines and aware of the inherent risks in reducing airspeed in an attempt to increase glide distance. Therefore, he made a left turn for a landing in rougher ground which was closer than his initial choice of field. On touchdown, the nose landing gear failed, the nose dug into the ground and the aircraft turned over. Both occupants were restrained by their harnesses and were able to exit via their doors. They both suffered minor injuries.

An examination of the engine indicated that the mechanical drive to the camshaft had failed.

ACCIDENT

Aircraft Type and Registration:	Thruster T600N 450, G-CCUZ	
No & Type of Engines:	1 Jabiru 2200A piston engine	
Year of Manufacture:	2004 (Serial no: 0044-T600N-102)	
Date & Time (UTC):	18 August 2018 at 1150 hrs	
Location:	Foston, Lincolnshire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 1
Injuries:	Crew - 1 (Minor)	Passengers - 1 (Minor)
Nature of Damage:	Aircraft destroyed	
Commander's Licence:	Commercial Pilot's Licence	
Commander's Age:	48 years	
Commander's Flying Experience:	1,740 hours (of which 106 were on type) Last 90 days - 17 hours Last 28 days - 1 hour	
Information Source:	Aircraft Accident Report Form submitted by the pilot and inquiries made by the AAIB	

Synopsis

The aircraft was taking off from Foston Airfield when the engine lost power and caused the aircraft to descend. The pilot was faced with limited choices for a forced landing, so used a nearby Leylandii hedge as an energy absorber. After the aircraft came to a stop, the pilot and his passenger were able to vacate the aircraft having sustained minor injuries. The aircraft was severely damaged in the accident. The was no evidence of a mechanical failure within the engine. However, a build-up of soot within the engine suggests it had been running with an overly rich fuel air ratio, which, in most circumstances, would result in a reduction of power.

History of the flight

The pilot had been contracted to carry out some instructional work for a syndicate based at Foston Airfield. After discussion with the aircraft owner, it was agreed that the pilot would conduct a short type-refamiliarisation flight in the left seat, with another pilot in the right seat. The start was uneventful, however, the pilot observed that the rpm gauge appeared to be under reading and noted that this would require rectification. He also observed the magneto test did not appear to result in an rpm drop, but when he reduced the throttle and carried out a dead-cut[1] check, the magnetos were isolating normally.

Footnote

[1] A dead-cut check ensures that each magneto can be isolated by earthing the circuit. This check is usually carried out as part of the engine shutdown checks to ensure the ignition does not remain live when the engine is stopped.

Content to continue, he then carried out a high-power taxi along the runway before back tracking to position ready for takeoff.

The pilot accelerated the aircraft along the runway and became airborne at about 35 kt, approximately 150-200 m along the 418 m runway. He then set a climb attitude and speed of 55 kt with an estimated rate of climb of 400-600 ft/min. As the aircraft passed the end of the runway, thought by the pilot to be at about 100 ft agl, there was a loss of thrust and the climb stagnated. The pilot decreased the climb speed to 45 kt, established a reduced rate of climb and altered his course slightly to the right, where there was gap in a row of nearby houses. However, there was then a further loss of thrust and the aircraft commenced a rapid descent. The pilot prepared for a forced landing but was aware his options were limited by the houses, their gardens and a large Leylandii hedge. With little choice, he decided to try to stall the aircraft to “pancake” onto the hedge. This he did, hitting the hedge just below the top. There was a loud bang and the aircraft came to a stop. The aircraft was extensively damaged but the pilot and passenger were able to vacate the aircraft unaided having suffered minor injuries.

Engineering investigation

The aircraft was fitted with a Jabiru 2200A four-cylinder horizontally-opposed piston engine. The engine controls consist of a throttle and choke. The carburettor mixture is set during the engine maintenance tuning procedures on the ground and is not adjustable from within the cockpit. Ignition is by two solid-state magnetos with two side-by-side spark plugs per cylinder. At the request of the AAIB the engine was examined to establish the cause of the loss of power. No faults were found with the ignition, carburation or choke systems. A cylinder compression check was carried out and it was found that one of the exhaust valves had a slight leak, although this did not have any significant effect on the cylinder concerned. Overall, the compression in all the cylinders was within manufacturer’s limits. The was no evidence of a mechanical failure within the engine. However, there was a build-up of carbon soot within the cylinders, exhausts and spark plug electrodes.

Observations made by the pilot

Prior to the flight the pilot discussed recent maintenance carried out on the aircraft with one of its owners and reviewed its documentation. Overall, he considered all in order and the aircraft to be in a good maintenance state with, in his opinion, some minor non-urgent details which could be addressed in due course.

There was no pilot’s operating handbook, so the pilot used his own notes by which to configure and start the aircraft. The pilot recalls the start as being normal and the engine “started easily”. He noted the rpm gauge apparent under-read and the difficulty in carrying out the magneto drop check. To satisfy himself that the magnetos were working correctly he carried out the ‘dead-cut’. In addition to verify that all was well, and to assist in familiarising himself with the aircraft, he carried out a full power taxi along the runway followed by a back-track before lining up and taking off.

After getting airborne, as the power loss started to manifest itself, the pilot described how "it dawned on me that I had very limited options, I chose the least worst, the hedge". He also described how he adjusted the airspeed to 45 kt "the best glide speed". His flying experience meant that at no stage did he consider turning the aircraft back towards the airfield. He steered the aircraft about 30° to the hedge line, intersecting it from the left.

In the pilot's opinion choosing the hedge as an energy absorber, and the fact he and his passenger were wearing four-point safety harnesses, prevented more serious injuries or a worse outcome.

Other evidence

A video of the aircraft taking off showed the initial climb during which the engine can be clearly heard. Although at first the climb appears normal, and was as described by the pilot, as the aircraft passes over the end of the runway the aircraft stops climbing and eventually starts to descend. The engine tone appears to change slightly just before the aircraft stops climbing and there appears to be a short burst of misfiring during the descent. At this point the video stops. Based on the video, in particular the aircraft dimensions when compared with features on the ground, the aircraft appears to be lower than the pilot's estimation as the aircraft passed over the end of the runway, possibly as low as 60 ft agl.

Discussion with a third party, familiar with the engine and its installation in Thruster aircraft, described the rpm indication system as being relatively simple. Crankshaft rotational speed is sensed by a Hall-effect sensor which drives a small gauge. It was also suggested that experience has found that these gauges can be unreliable. Their experience also suggests that the rpm change, when carrying out a magneto drop test, is low, between 10 and 30 rpm.

Analysis

The rapid onset of events meant the pilot had no time to understand what was causing the power loss, so just concentrated on landing the aircraft. From the video evidence the height of the aircraft as the engine lost power can be estimated and this supports the fact he had very little time in which to react. As he said, faced with limited options "the hedge was the least worse option". The type of hedge along with the four-point harnesses probably prevented a worse outcome in this accident.

The pilot had not attempted to turnback towards the airfield. AAIB experience, during numerous previous investigations, has found that there is a high risk of loss of control during a turnback in engine power loss situations. In many cases this has resulted in accidents with fatal injuries.

There is no evidence of a component failure or malfunction which could have led to the power loss. However, the heavy 'sooting' of the cylinders, plugs and exhausts suggests an overly-rich fuel air mixture, such as could have been caused by carburettor settings or by running the engine with the choke set. The pilot was sure that he had opened the choke after his engine starting process but, in the stressful circumstances of the accident, he could not exactly recall the aircraft configuration.

The rpm gauge under reading and the magneto drop test are not likely to have caused the loss of power. In the Jabiru engine the rpm drop is very small, maybe as little as 10 to 30 rpm. This is because the two spark plugs are close together in the cylinder head, so the ignition points to set off the flame front are close together. In other engines, where the plugs are opposite each other, two separate flame fronts are initiated and this has a greater effect on the rpm when one plug ceases to spark. Therefore, the loss of one spark in the Jabiru engine has less effect on the ignition characteristics, thus the effect on rpm is less marked. Not having a reliable rpm gauge meant that magneto drop test was not clearly discernible. The reduced ability to monitor the rpm may have also influenced an assessment of whether the engine was achieving full power.

Conclusion

There was no evidence of a component failure or malfunction that could have led to the engine power loss. The build-up of soot within the engine suggests it had been running with an overly rich fuel air ratio, which, in most circumstances, would cause a reduction of power. This resulted in the aircraft not being able to sustain a satisfactory climb and then descend. The pilot was left with no practical choice other than to carry out a forced landing, the severity of which was somewhat reduced by the hedge and the four-point harnesses he and his passenger were wearing. The decision not to turnback probably also reduced the risk of a more serious outcome.

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
PM	Pilot Monitoring
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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Air Accidents Investigation Branch