Air Accidents Investigation Branch

AAIB Bulletin 10/2017

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

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AAIB investigations are conducted in accordance with Annex 13 to the ICAO Convention on International Civil Aviation, EU Regulation No 996/2010 and The Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 1996.

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

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(ALL TIMES IN THIS BULLETIN ARE UTC)

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AAIB Special Bulletins and Interim Reports

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

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AAIB Air Accidents Investigation Branch

AAIB Bulletin S2/2017 *SPECIAL*

SERIOUS INCIDENT

Aircraft Type and Registration:	Boeing 737-86J, C-FWGH
No & Type of Engines:	2 CFM56-7B26E turbofan engines
Year of Manufacture:	2011 (Serial No: 37752)
Location:	On takeoff from Belfast International Airport
Date & Time (UTC):	21 July 2017 at 1539 hrs
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 6 Passengers - 179
Injuries:	Crew - None Passengers - None
Nature of Damage:	Light fitting on runway damaged
Commander's Licence:	Canadian Airline Transport Pilot's Licence
Commander's Age:	38
Commander's Flying Experience:	8,234 hours (of which 2,817 were on type) Last 90 days - 170 hours Last 28 days - 45 hours
Information Source:	AAIB Field Investigation

Introduction

On 21 July 2017 at 1539 hrs, C-FWGH took off from Belfast International Airport with a thrust setting which was significantly below that required for the conditions of the day. Preliminary evidence indicated that, after the aircraft lifted off from the runway, one of the aircraft tyres struck a runway approach light, which was 35 cm high and 29 m beyond the end of the runway.

The event was not reported to the AAIB by the aircraft commander, aircraft operator or the tour operator on behalf of which the flight was being undertaken, although it was reported to the Transportation Safety Board in Canada by the aircraft operator. At 2053 hrs on 21 July 2017,

This Special Bulletin contains facts which have been determined up to the time of issue. It is published to inform the aviation industry and the public of the general circumstances of accidents and serious incidents and should be regarded as tentative and subject to alteration or correction if additional evidence becomes available.

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ATC personnel at the airport filed a Mandatory Occurrence Report (MOR) and sent a signal using NATS's Aeronautical Fixed Telecommunications Network (AFTN), and the AAIB was one of the addressees on the signal. This system is only monitored by the AAIB during office hours and the message was not read until 0713 hrs on 24 July 2017 at which time an investigation was begun. The delay introduced by these circumstances meant that Flight Data Recorder (FDR), Cockpit Voice Recorder (CVR) and other recorded data sources were unavailable to the investigation.

This Special Bulletin contains preliminary information on this serious incident, clarification about the reporting of accidents and serious incidents and two Safety Recommendations relating to Flight Management Computer (FMC) software updates.

History of the flight

The aircraft was registered in Canada but was operating on behalf of a UK tour operator. The Canadian operator supplied the aircraft and flight crew to support the tour operator for the summer season.

The aircraft was departing for a flight from Belfast International Airport to Corfu, Greece. The crew boarded the aircraft and completed their pre-flight preparations before pushing back, intending to depart from Runway 07. After pushing back, the ground crew noticed that one of the tyres on the nose landing gear was worn and the aircraft returned to the stand. After both nose landing gear tyres had been changed, the aircraft once again pushed back and taxied out for departure.

The crew were cleared for takeoff on Runway 07 from Taxiway D (Figure 1), which gave a Takeoff Run Available (TORA) of 2,654 m. During the takeoff, at around 120 to 130 kt, the crew realised that the aircraft was not accelerating normally. They estimated, during post-flight interviews, that they reached V_1[1] with around 900 m of the runway remaining and rotated shortly afterwards. The aircraft was seen, by multiple witnesses, during rotation and took a significant time to lift off before climbing at a very shallow angle.

After the takeoff, airport operations staff conducted a runway inspection and a runway approach light for Runway 25 was found to be broken. Preliminary evidence indicated that the aircraft struck the light, which was 35 cm high, 29 m beyond the end of the runway in the stopway[2].

After takeoff, the crew checked the aircraft's FMC which showed that an N_1[3] of 81.5% had been used for the takeoff. This figure was significantly below the required N_1 setting of 93.3% calculated by the operator and shown on the pre-flight paperwork.

Footnote

1 V_1: The maximum speed in the takeoff at which the pilot must take the first action to stop the aeroplane within the accelerate-stop distance. It is also the minimum speed in the takeoff, following a failure of the critical engine, at which the pilot can continue the takeoff and achieve the required height above the takeoff surface within the takeoff distance (European Aviation Safety Agency).

2 Stopway: Defined rectangular area on the ground at the end of the runway in the direction of takeoff prepared as a suitable area in which aircraft can be stopped in case of abandoned takeoff.

3 N_1: Engine fan or low pressure compressor speed.

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Recorded data

The aircraft had flown for 16 sectors before the AAIB became aware of the event and, when the FDR was downloaded, it was found that the data from the incident flight had been overwritten by subsequent flights. The aircraft was also fitted with a Quick Access Recorder, but the operator was troubleshooting this installation and the memory cards contained no data. The CVR installed on the aircraft had a 30 minute recording capability and would have been overwritten due to the elapsed time since the event so was not removed from the aircraft.

The radar installation at Belfast International Airport tracked the aircraft along Runway 07 and during initial climb-out, when altitude data also became available from the aircraft's transponder. The radar returns allowed groundspeed for the aircraft to be calculated which was supplemented by both groundspeed and altitude data transmitted from the aircraft over its ADS-B[4] data link. This data is shown in Figure 1 for the ground roll, where the text in yellow represents calculated groundspeed data from the radar track and, in green, the received ADS-B groundspeeds. Orange lines show the approximate position where the aircraft achieved airspeeds equivalent to V_1 and V_R,[5] taking into account a 7 kt headwind component.

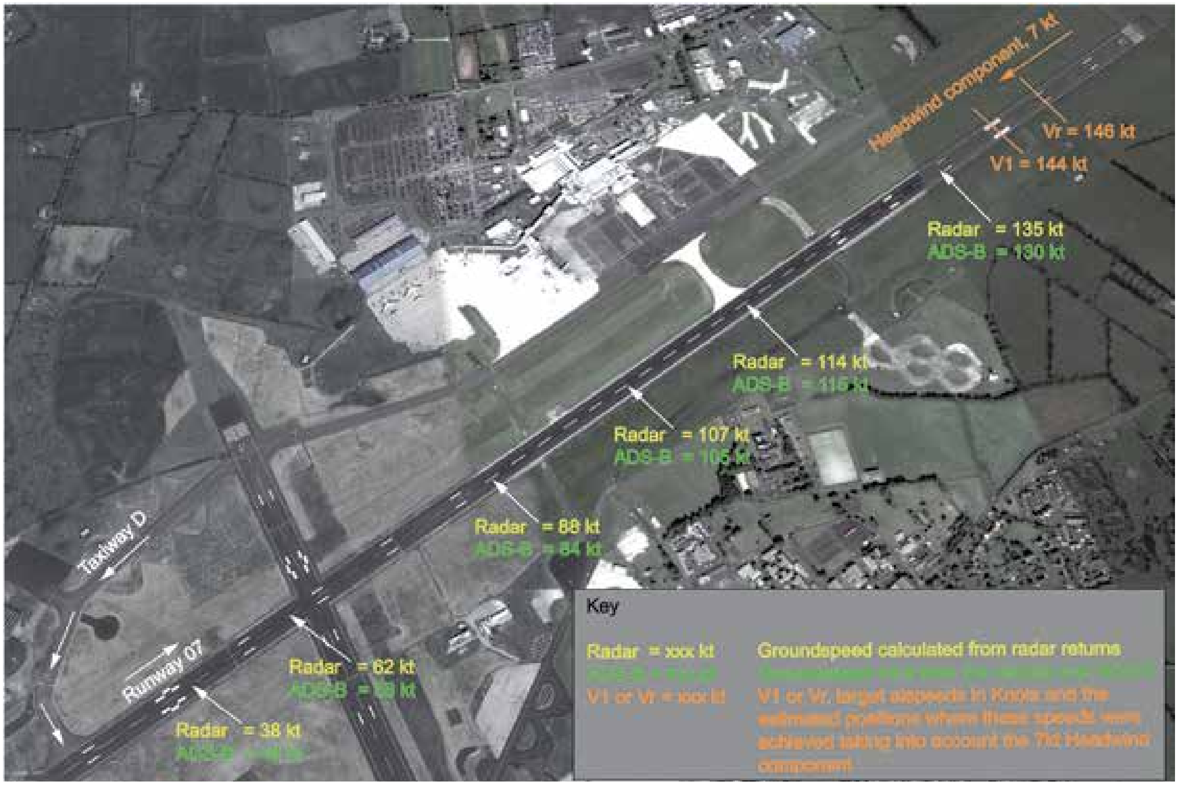

Figure 1

Groundspeed data for the takeoff in relation to V_1 and Vr

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Footnote

4 Automatic Dependent Surveillance – Broadcast: a technology whereby an aircraft broadcasts its location and other information enabling it to be tracked.

5 V_R: The speed at which the handling pilot rotates the aircraft in pitch during the takeoff.

Figure 2 shows spot heights above the elevation of Belfast International Airport (268 ft amsl) for the aircraft's initial climb, derived from the aircraft's ADS-B reports (these heights are annotated 'above airfield level' (aal)). At no time during the climb-out was the aircraft's Enhanced Ground Proximity Warning System Mode 3 aural alert ("DON'T SINK") triggered[6].

Figure 2

Vertical profile for the initial climb-out

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Passing the upwind end of the runway the aircraft's ACARS[7] sent a takeoff report, which confirmed that the engines were at an N_1 of approximately 81.5%. Other ACARS messages confirmed that the correct weights for the aircraft had been entered into the FMC.

The aircraft's auto-throttle BITE[8] history showed two messages generated during the climbout. Both messages were consistent with the crew having manually advanced each throttle to a power setting above an N_1 of 81.5% when the aircraft was approximately 800 ft aal.

The Electronic Flight Bags (EFB) used by the crew to calculate the performance figures for entry into the FMC were provided to the AAIB. Initial examination of these devices indicated that the correct figures were calculated by the EFB performance software prior to the aircraft's departure.

Footnote

6 A Mode 3 aural alert is triggered by excessive altitude loss after takeoff or go-around.
7 Aircraft Communications Addressing and Reporting System: a digital datalink for the transmission of short messages.
8 Built-in Test Equipment.

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Simulator assessment

The AAIB and operator carried out independent assessments of how the incorrect thrust setting might have been programmed into the FMC. Both assessments concluded that the only credible way to achieve a grossly low N_1 setting was to enter an extremely low value into the outside air temperature (OAT) field on the N1 LIMIT page. It was found that the takeoff N_1 setting used on the flight (81.5%) would be calculated by the FMC if:

a. The expected top-of-climb outside air temperature (OAT) was entered into the OAT field on the N1 LIMIT page instead of the OAT at the airport (a figure of - 52°C as opposed to +16°C); and

b. The correct assumed temperature[9] of 48°C was entered into the FMC.

No other combination of data entries was found which would achieve the same result.

During the simulation carried out by the AAIB, the aircraft's performance was assessed following an engine failure immediately prior to V_1, with the pilot making a decision by V_1 to either abandon or continue the takeoff. In the simulator, the aircraft was able to stop in the runway remaining following a decision to abandon the takeoff, but was unable to climb away safely following a decision to continue the takeoff.

Erroneous FMC entries of OAT

As a result of previous events involving erroneous OAT entries during FMC programming, Boeing published a Flight Crew Operations Manual Bulletin in December 2014. This document discussed three events where incorrect values for OAT had been entered into, and accepted by, the FMC. In two of these cases, the incorrect OAT had been sent to the FMC via datalink, but in the third case the crew made a manual entry error. The bulletin stated:

> *'An incorrect reduced thrust target may result in slower acceleration to V1, which may invalidate the takeoff performance calculations and/or result in decreased obstacle clearance margins after liftoff.'*

The bulletin also states that:

> *'flight crews should verify the OAT entry on the N1 LIMIT page is correct.'*

It then described how this check was to be carried out.

In addition, from revision U12.0 of the FMC software, a crosscheck was added that compares the OAT entered by the crew against either that fed to the Electronic Engine Controls or, on older Boeing 737s, sensed by the aspirated Total Air Temperature probe (if fitted)[10].

Footnote

9 The assumed temperature, which is higher than the actual OAT, limits the target takeoff thrust when entered into the FMC.

10 Aspirated Total Air Temperature probes are not fitted to all Boeing 737s that predate the B737NG series of aircraft.

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The crosscheck runs once, approximately one minute after engine start, and establishes whether a difference of more than 6ºC exists between the value entered into the FMC and that sensed by the external temperature sensor. If the difference is more than 6ºC it rejects the OAT entry, deletes the takeoff reference speeds and indicates on the FMC displays that the reference speeds have been deleted. C-FWGH, and the simulator used for the AAIB trial, had an earlier revision of FMC software installed, U10.8A, which did not include this crosscheck. Revision U12.0 of the FMC software became available in February 2016[11], but the crosscheck functionality also required Next Generation Boeing 737 (B737NG) aircraft to have the Block Point[12] 15 (BP15) standard of the Common Display System[13] (CDS) installed, which became available in January 2017[14].

Analysis

The aircraft took off from Runway 07 with a thrust setting significantly below that required to achieve the correct takeoff performance, and struck a Runway 25 approach light shortly after lifting off.

The N_1 required to achieve the required takeoff performance was 93.3% but 81.5% was used instead. Independent assessments by the AAIB and operator showed that the only credible way for this to have happened was for an error to have been made whilst entering the OAT into the FMC. If the top-of-climb OAT was mistakenly inserted into the OAT field on the N1 LIMIT page (a figure of -52°C as opposed to +16°C), and the correct assumed temperature of 48°C was entered, the FMC would have calculated a target takeoff N_1 of 81.5%. The investigation will consider how such a data entry error could have been made, and whether actual aircraft performance matched that which would be expected given the N_1 power setting used.

The simulator trial examined aircraft performance following an engine failure immediately prior to V_1 with the pilot making a decision to either abandon or continue the takeoff. Although the simulator results cannot be considered definitive, and aircraft performance will be investigated further with the manufacturer, they suggest that, in similar circumstances on the incident flight:

a. Had the pilot decided to abandon the takeoff, the aircraft could have stopped in the runway remaining.

b. Had the pilot decided to continue the takeoff, the aircraft might not have had sufficient performance to climb away safely.

Footnote

11 Boeing Service Bulletin 737-34-2600 refers; this was originally released in February 2016 but was then revised in January 2017 to recommend compliance within 24 months.

12 A Boeing term used to reference a set of changes that are packaged together and applied to an aircraft as one update, bringing either new functionality, fixes to the aircraft's systems or a combination thereof.

13 Common Display System: This consists of 6 Display Units and their associated electronics on the Boeing 737NG; two for each pilot to show the Primary Flight Display and Navigation Display and a further two for Engine and System status information.

14 Boeing Service Bulletin 737-31-1650 refers; this was released in January 2017 and also recommended compliance within 24 months.

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The FMC software fitted to C-FWGH, U10.8A, predated revision U12.0, which features the crosscheck between the OAT entered by the crew and that sensed by the external temperature sensor. In this event, had C-FWGH been updated with U12.0 and CDS BP15, the entry of a top-of-climb OAT instead of the ambient OAT at ground level would have been prevented, the crew would have received feedback on their erroneous entry, and the serious incident would have been prevented. The updates to the CDS and FMC software are offered by Boeing as upgrade service bulletins at nominal cost. Fleet embodiment of software revision U12.0 (or later revision incorporating the outside air temperature crosscheck) would reduce the likelihood that this type of data entry error was repeated. Therefore:

Safety Recommendation 2017-016

It is recommended that the Federal Aviation Administration, mandate the use of Flight Management Computer software revision U12.0, or later revision incorporating the outside air temperature crosscheck, for operators of Boeing 737 Next Generation aircraft.

Flight Crew Operations Manual Bulletins are inserted by aircraft operators into the Flight Crew Operations Manual (FCOM) upon receipt, but are temporary in nature and removed when the FCOM is next updated as part of the regular FCOM revision cycle. In this particular case, the operator's FCOM had been revised and incorporated the text showing how the flight crew should verify the OAT entry. However, the removal of the whole Bulletin meant that the background material about the reasons for the existence of this check was no longer present. Given the serious potential consequences of this type of data entry error, it was considered important to inform Boeing 737 operators of this event (including operators of aircraft which are not 'Next Generation'). Therefore:

Safety Recommendation 2017-017

It is recommended that The Boeing Company promulgates to all 737 operators the information contained within this Special Bulletin and reminds them of previous similar occurrences reported in the Boeing 737 Flight Crew Operations Manual Bulletin dated December 2014.

Reporting accidents and serious incidents

The reporting requirements for accidents and serious incidents flow from provisions within Annex 13 to The Convention on International Civil Aviation (Chicago Convention), and are brought into UK law through Regulation (EU) 996/2010 and The Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 1996.

Annex 13, Attachment C defines a serious incident as:

'involving circumstances indicating that there was a high probability of an accident.'

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It gives a list of examples of serious incidents which includes:

> *'Gross failure to achieve predicted performance during take-off or initial climb.'*

This is mirrored in EU and UK regulations.

When informed of this event, the AAIB considered the worst credible outcome, had the event escalated, and the barriers which remained between the actual event and that outcome. It was considered that, in slightly different circumstances, this event could have resulted in the loss of the aircraft with multiple fatalities. Examples of such circumstances considered were: the same event taking place on a slightly shorter runway than was actually the case with the aircraft unable to lift off before the end of the runway; obstacles or terrain in the takeoff path; or engine failure just after V_1 with a decision by the commander to continue the takeoff. It was also considered that, once the thrust had been set for takeoff, there were no effective barriers in place to prevent the worst credible outcome above. This was because, once an incorrect thrust is set, there is no performance monitor which will highlight the error during the takeoff, and previous similar events suggest that pilots often do not notice the aircraft's slow acceleration and do not apply maximum thrust during the takeoff run. The seriousness of the potential outcome, and the lack of barriers remaining to prevent it had the event escalated, persuaded the AAIB that this was a significant event requiring an in-depth investigation.

The event was reported by air traffic control personnel at Belfast International Airport who filed an MOR and sent a signal using the AFTN. The AAIB has access to this system but only monitors it during working hours because it maintains a 24-hour reporting line as the primary means for reporting accidents and serious incidents. The fact that the AAIB became aware of this event only through the AFTN signal delayed its response by 58 hours and meant that some sources of recorded data from the aircraft were unavailable. This has been detrimental to the investigation and may hinder the identification of all the safety issues. It was considered necessary, therefore, to use this Special Bulletin to highlight reporting obligations within the UK for accidents and serious incidents.

Regulation (EU) 996/2010, Article 9, *Obligation to notify accidents and serious incidents* is directly applicable in the UK. It states:

> '*Any person involved who has knowledge of the occurrence of an accident or serious incident shall notify without delay the competent safety investigation authority of the State of Occurrence thereof.'*

The Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 1996 states that, should an accident or serious incident occur:

> *'the relevant person and, in the case of an accident or a serious incident occurring on or adjacent to an aerodrome, the aerodrome authority shall forthwith give notice thereof to the Chief Inspector by the quickest means of communication available…'*

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It goes on to define relevant person to mean:

> *'in the case of an accident or serious incident occurring in or over the United Kingdom or occurring elsewhere to an aircraft registered in the United Kingdom, the commander of the aircraft involved at the time of the accident or serious incident.'*

Civil Aviation Publication (CAP) 493, *The Manual of Air Traffic Services (MATS) Part 1,* contains in Section 6, Chapter 3 information on how Air Navigation Service Providers should meet their obligations to report accidents and serious incidents. Following an accident or serious incident at an aerodrome, the senior controller is required to telephone the Area Control Centre (ACC) Watch Manager and, subsequently, submit an MOR. On receiving a report of an accident or serious incident, the Operational Supervisor at an ACC is required to telephone the AAIB.

Further guidance on the AAIB website lists the people who must notify the AAIB without delay if they have knowledge of an aircraft accident or serious incident which occurred in the UK, a UK Overseas Territory or a Crown Dependency. These include the crew, and the owner and operator of the aircraft. In circumstances where there is doubt about whether or not an incident should be classified as serious, and therefore reported, the AAIB recommends that it is reported.

Further information is available at: https://www.gov.uk/guidance/report-an-aircraft-accident-or-serious-incident.

The AAIB 24-hour reporting line number is:

01252 512299

(+44 1252 512299 from outside the UK).

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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.

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ACCIDENT

Aircraft Type and Registration:	North American P-51D Mustang, G-MSTG
No & Type of Engines:	1 Packard Motor Car Co Merlin V1650-7 piston engine
Year of Manufacture:	1945 (Serial no: 124-48271)
Date & Time (UTC):	2 October 2016 at 1434 hrs
Location:	Topcroft Farm Airstrip, near Hardwick Airfield, Norfolk
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Serious) Passengers - 1 (Fatal)
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	58 years
Commander's Flying Experience:	1,965 hours (of which 760 were on type) Last 90 days - 21 hours Last 28 days - 6 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft was returning to a private airstrip and, on landing, bounced twice before attempting to go around. The aircraft had been subjected to a crosswind from the right during its approach and on go-around flew a flight path increasingly diverging to the left, away from the airstrip. It remained at low level until it struck a tree close to the airstrip. The passenger was fatally injured and the pilot survived with serious injuries.

There was no evidence of any aircraft system failure or malfunction which could have contributed to the accident. The accident was most likely a result of loss of directional control due to a combination of crosswind and effects of applying go-around power whilst the aircraft was at low speed.

The investigation identified other aspects concerning the safety clothing to be worn in ex-military aircraft.

History of the flight

The pilot had flown on the morning of the accident in G-MSTG with a passenger, with no problems being reported.

Later on the same day a different passenger arrived at Topcroft Farm Airstrip with members of his family for a flight to overfly a number of World War II (WWII) United States Army Air

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Force (USAAF) airfields around Norfolk. The pilot briefed the passenger who was then assisted to climb into the aircraft and strap in.

The aircraft took off from Runway 28 at approximately 1348 hrs and flew north-west towards The Wash. It then flew inland to turn onto a south-easterly track near March, turning west of Eye towards Bungay and then back towards Hardwick (Figure 1).

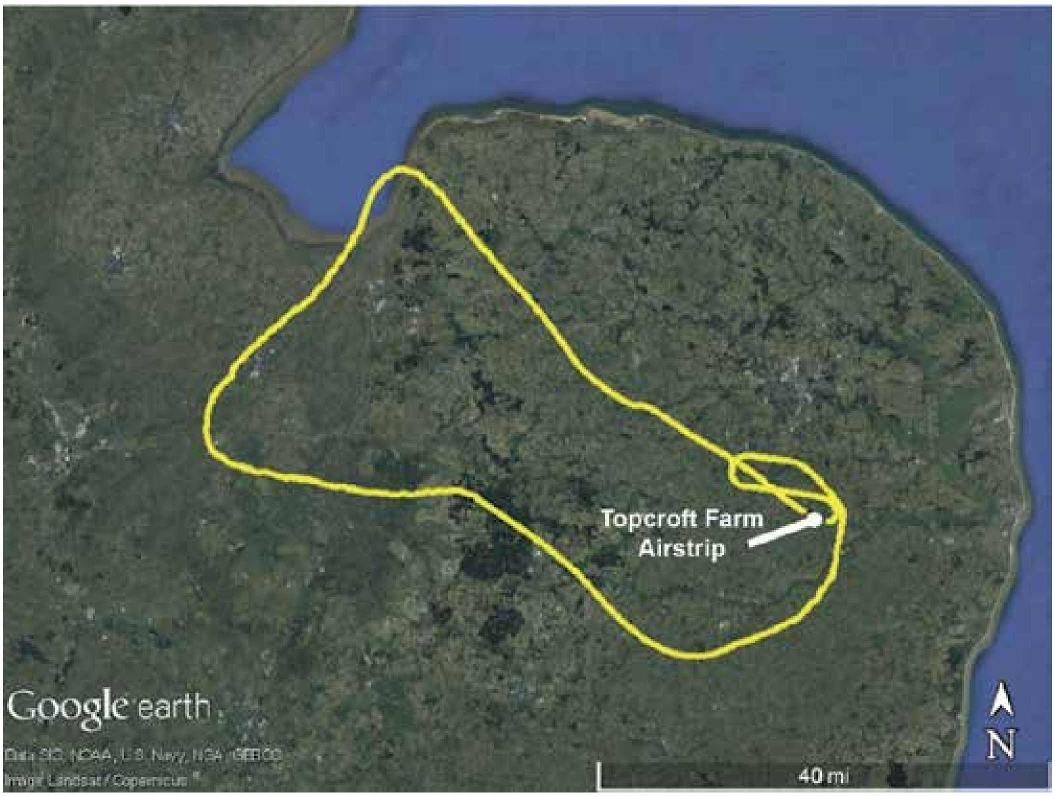

Figure 1
Radar track of G-MSTG

The aircraft neared Hardwick at approximately 1433 hrs and entered a holding pattern north-west of the airfield before joining downwind for a right hand circuit to Runway 28. The pilot then flew a continuous descending turn onto approximately a 1 km final approach. The wind at the time was reported as being from north-west/north-north-west at about 13 kt with a maximum recorded gust from north-west at 22 kt.

A witness on the airfield, standing approximately halfway along and slightly to the south of the runway, videoed the final approach and initial part of the landing. From a visual assessment of the video, the aircraft approached with its landing gear extended and flaps appearing to be fully down. The final approach seemed stable however there appeared little, if any, attempt to compensate for the crosswind by either side-slipping into wind or flying with the into-wind wing (the right wing) slightly down.

The video showed the aircraft achieve a three-point touch down and bounce back into the air. The aircraft appeared to be approximately aligned with the runway and to drift left

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towards the runway edge. At the same time there was a small amount of left roll which was corrected with ailerons. The aircraft then touched down again and bounced a second time; an engine rpm increase being heard on the video shortly after this touchdown. Again, the aircraft appeared to remain approximately aligned with the runway when touching down but, when airborne again, continued to drift towards the runway edge and also yawed to the left.

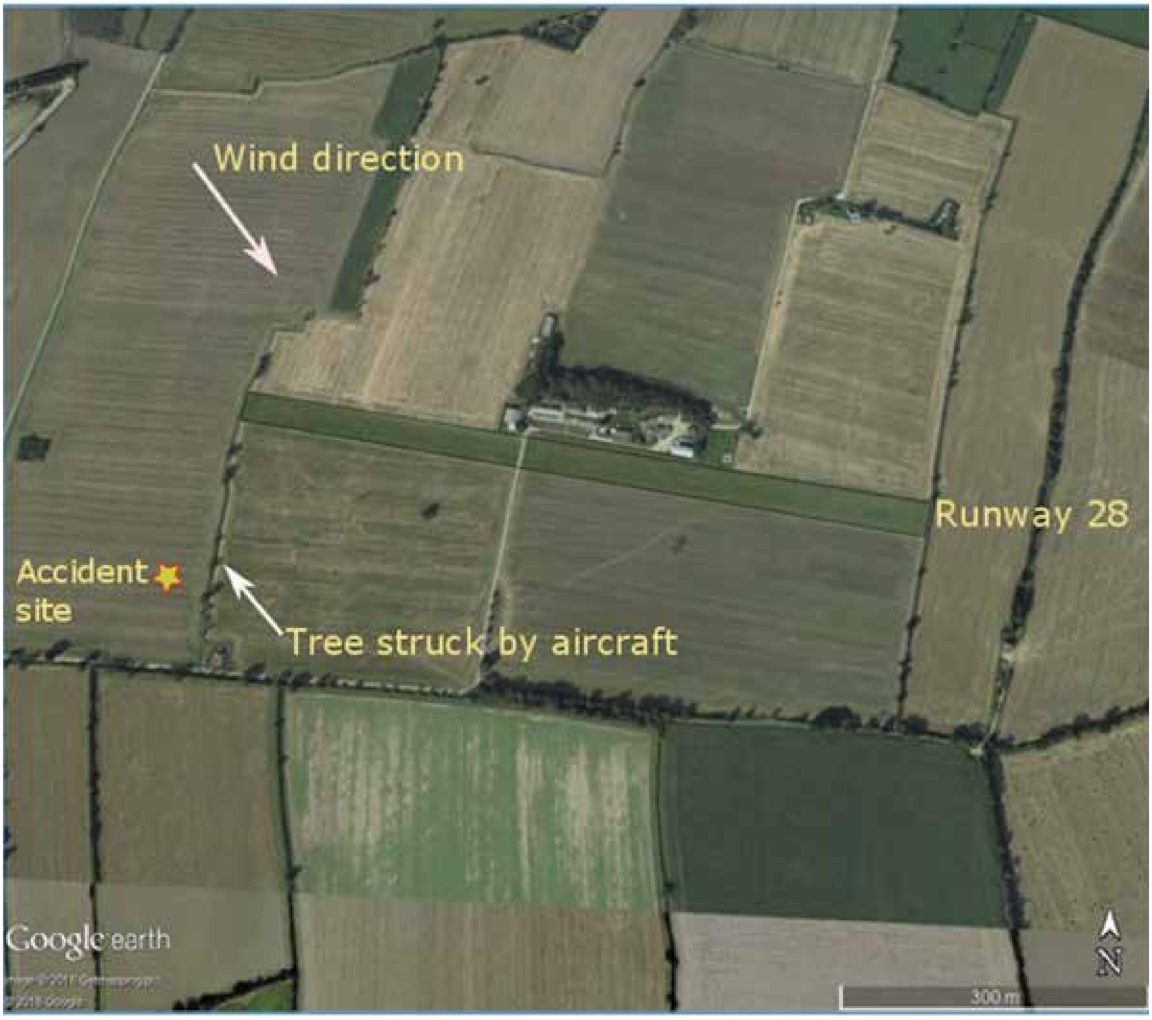

Figure 2

Topcroft Farm Airstrip

It was not possible to establish the rudder position from the video. The camera tracked the aircraft until it started to drift over the side of the grassed strip at which point the aircraft was no longer in frame, although it could still be heard in the recording.

The aircraft was seen to fly increasingly to the left of the runway, narrowly missing a tree standing in the adjacent field to the south of the airstrip. It remained at low level until it collided with a tree at the boundary of the field causing the aircraft to impact the ground. The emergency services were called and arrived on site shortly afterwards. The pilot was seriously injured and the passenger received fatal injuries.

Accident site

Figure 3
Accident site

The aircraft had struck a mature oak tree on the boundary between two fields with marks showing that one of the propeller blades had been the first point of impact. This had been rotating with sufficient power to slice upwards through the trunk and into a bough of the tree which detached and fell away. The tip of this blade was left deeply imbedded in the remainder of the trunk. After the propeller had hit the tree, the aircraft continued onward with the tree passing along the left side of the fuselage. The inner section of the left wing was struck by the tree causing the wing to detach, before the left tailplane then detached as it was also hit by the tree.

Figure 4
Tree strike in direction of aircraft travel

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There was a 57 m debris trail on a bearing of 225° leading from the tree to the main wreckage. The aircraft had come to rest upright in the field beyond the tree, resting on its right mainwheel and tail wheel, with the trailing edges of the wing and tailplane tips dug into the soil.

The right wing fuel cap was in place and the tank contained approximately 25 Imp gal of fuel. Lubricating oil had seeped into the ground around the front of the aircraft and there was evidence of coolant seeping out from the underside of the fuselage.

Other than small amounts of soil residue on some of the equipment on the right side of the cockpit, all the instrument switches and controls were undamaged. The significant controls and switches were set as follows: the flap lever was set at 30 and the carburettor air control levers were set at UNRAMMED FILTERED AIR and NORMAL. The landing gear lever was set at DN and the flying control trim settings were: neutral roll, 5 units TH (tail heavy) and 2 units right rudder.

Both the throttle and rpm levers were in the fully forward position. The mixture control was set at the EMERG.F.RICH position. The supercharger switch was set to LOW, the booster pump was set to ON and the ignition (magneto) switch was set to BOTH. The fuel shut off lever was set to ON and the fuel tank selector was set to MAIN TANK LH. The RADIATOR AIR CONTROL switches for COOLANT and OIL were in the neutral OFF position. The altimeter subscale was set to 1010 hPa.

The engine was partially detached from the fuselage but bent downwards resting on the ground on the remains of the reduction gearbox. The engine bearers were broken and distorted and the engine control cables and rods were still connected but had been pulled forward and were under tension. Various oil and coolant flexible pipes had been split or had parted from their rigid pipe connections. Figure 7 shows the partial detachment of the engine and the effect on the engine control linkages.

The propeller had detached from the engine along with its drive gear and was lying in the wreckage trail close to the aircraft. All but one of the blades were complete but all were heavily distorted.

Figure 5 (right)
Propeller damage

The left tailplane was lying in a ditch near the base of the tree and the left flap and elevator was lying a short distance further on. The left wing was lying upside down in the field 65 m from the tree away from the main wreckage. The left main landing gear was still attached to the wing but was in the retracted position.

Figure 6

Left wing

The canopy had also detached and was approximately two thirds the way along the wreckage trail. Although its frame was in one piece there were signs of breakage and melting of the canopy Perspex.

Although the fuselage and engine showed little or no signs of fire, the remains of the left self-sealing fuel tank and a large portion of the tree had evidence of a brief but intense fire.

Figure 7

Engine control linkages under tension

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Ground marks

The initial touchdown point of the main wheels on the airstrip could not be accurately located, however, there was a faint mark, probably from the tailwheel, 104 m in from the threshold of Runway 28 and 11 m from the left edge. There was another mark from the tailwheel 200 m further on, and 1.4 m from the runway edge at its start, running approximately 15º off the runway heading towards the left edge.

There were more wheel marks on the ploughed surface of the field next to the runway. These marks started with a tail wheel imprint and then the left mainwheel, the mainwheel mark being curved slightly to the left and approximately 100 m in length. About 29 m along the mark there was a parallel mark made by the right mainwheel. Both marks ceased as they approached the concrete track which ran across the field. There was another left mainwheel mark 100 m further on in the field on the other side of the concrete track. This mark was approximately 30 m long and was very distinctive as if the tyre had been running at an angle to the direction of travel, gouging the soil. There were no more ground marks up to the impact point with the tree. Figure 8 shows the final ground mark and the position of the tree hit by the aircraft.

Figure 8

Final tyre mark and impact tree

Aircraft background information

G-MSTG was a Mustang P51D single-engine, long-range escort fighter which was built at the end WWII in 1945 by North American Aviation. It was powered by a Packard-built Rolls Royce Merlin V1650-7 engine. It was originally delivered to the Royal New Zealand Air Force on 24 August 1945 where it remained in service to 1955. In 1958 it passed into private ownership and remained in New Zealand where it changed hands twice but was

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not in flying condition. In 1997, it was purchased by the pilot and entered on the CAA register as G-MSTG. The pilot oversaw a comprehensive four and a half year restoration and the aircraft had its first flight since 1958 in July 2001. The aircraft had an ANO exemption to display authentic USAAF markings ‘414419 LH-F’ rather than G-MSTG.

As is common with other privately owned Mustangs, the fuselage fuel tank behind the pilot had been removed and replaced with an approved passenger seat, harness and intercom connection; there were no flying controls or instruments fitted in this position.

G-MSTG was classified as an Annex II aircraft and certified in its current configuration on a CAA permit to fly, valid to 19 August 2017.

Aircraft description

The P51D is an all-metal, low-wing monoplane with conventional mechanical flying controls. The landing gear is of a tail drag design and all three gear wheels are retractable.

One of the engine types used to power the P51D was the Packard Merlin V12 supercharged engine, which is rated at 1600 HP. The engine controls consist of three levers - throttle, mixture and propeller pitch (rpm) - fitted on the left side of the cockpit. The engine drives a Hamilton Standard hydromatic four-bladed 11 feet 6 inch diameter constant-speed metal propeller through a reduction gearbox. The propeller rotates in a clockwise direction when viewed from the cockpit.

The flying controls consist of pushrods, cables and pulleys actuating conventional ailerons, rudder and elevator. The aircraft is also fitted with a mechanical trim system for all three axes. Control inputs are made using a joystick and reach-adjustable rudder pedals.

The aircraft has inboard trailing edge flaps, controlled by a six-position flap handle on the left side of the cockpit. The full down position is marked 50° with other markings at 10° increments until the full up position is reached. The 20° setting is marked TAKE OFF.

The pilot’s seat is of metal construction and can be adjusted vertically to suit the occupant. The seat is designed to accommodate a parachute as the seat cushion and a kapok filled seat back cushion may be used as a life preserver. Shoulder straps and lap belt are attached to the seat and secured in a quick release safety fastener.

The type of passenger seat fitted to G-MSTG is of a very simple design with a leather covered seat and back rest fitted with a four-point harness. The seat position is not adjustable.

The cockpit is enclosed and covered by a clear Perspex sliding tear-drop canopy which extends over both the pilot and passenger. The aircraft can be flown with the canopy partially open.

Fuel is carried in integral self-sealing tanks within the inboard section of each wing. There is the facility to carry additional tanks on the underwing pylons. These tanks were not fitted on G-MSTG. The integral tank useable fuel capacity is 90 US (76.5 imp) gallons.

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The cockpit instruments and controls were in their original configuration although the owner had fitted a modern transponder and GPS navigation system.

Aircraft examination

The aircraft wreckage was recovered to the AAIB for detailed examination. The cockpit instruments and switches were undamaged and, except for the battery and generator switches which had been switched to the OFF position at the accident site, were in the same configuration as they were at the time of the accident. All the instruments had decayed to their null or neutral readings when power had been switched off and produced no useful information to the investigation. Switches and levers controlling fuel, engine and landing gear were also as they had been during the accident.

The damage to the left wing, tailplane, engine bay and underside of the fuselage around the radiator scoop resulting from the impact with the tree and subsequent collision with the ground was severe, but localised. The left aileron control cables were severed at the wing root but the pulleys, levers and bellcranks up and downstream of the damage were intact. Despite this, the trim and control systems for all three axes (pitch, roll and yaw) could be examined and full range and control continuity could be demonstrated in all cases.

The fuel supply system was also badly damaged, particularly in the engine bay and the left wing tank. However, with the fuel valve and selectors as they were found, unrestricted fuel flow to the carburettor could be demonstrated. No fuel was present in the system as it had drained away through various breaches in the pipework.

The right main landing gear was down and locked but the left main gear was fully retracted within the separated wing. However, the left gear hydraulic extend and retract ram assembly had completely detached during impact with the tree and was found at the base of the tree. This allowed the left main gear to pivot freely into its retracted position in the upside down wing due to gravity.

The engine had to be removed at the accident site in order to stabilise the wreckage. Closer examination found severe distortion and fracture of the engine bearers and large cracks in the supercharger casing. The carburettor air box had parted and the throttle and mixture control linkages were severely disrupted. The air intake duct and carburettor were free from foreign objects or blockage. The reduction gearbox casing had split open and the propeller had detached along with its drive gear and main bearing. Both magnetos were in intact and all 24 high tension leads were in place and connected, although there was minor damage to the leads in the vicinity of some of the spark plug heads. There was no evidence to suggest an engine malfunction and an examination of the plugs and exhaust stubs showed the engine to be in a good state with no evidence of excessive carbon, misfire or oil leakage from any of the cylinders.

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Meteorology

The Met Office provided an aftercast of conditions at the time of the accident. It stated that visibility was good and there was no low cloud. At the AAIB's request, the report particularly focused on the wind:

> *'At 1420Z the Norwich METAR reported 330 degrees at 11KT with a variation between 290 degrees and 020 degrees in the previous 10 minutes, while the Lowestoft METAR reported 320 degrees at 12KT with a variation between 290 degrees and 010 degrees in the previous 10 minutes; both within the bounds set by their respective TAFs. However the 1450Z METARs at both sites reported gusts within the previous ten minutes, of 20KT at Norwich and 21KT at Lowestoft.*
>
> *'[this data] suggests the wider area was exposed to some gust effects at the time of the accident. These observations also show that the wind direction was varying between west to north-westerly and northerly through the time of the accident. Through the rest of the afternoon, this variation continues with a westerly extreme of 270 degrees and a north to north-easterly extreme of 020 degrees.*
>
> *'…while the prevailing winds were north-westerly at the time of the accident, there was sufficient variation between west to north-westerly and northerly winds for it to be reported in the METARs/AutoMETARs from the surrounding stations, and that there were gusts in the general area, reaching the low 20KTs at Lowestoft on the coast and Norwich, approximately 12 miles inland. Furthermore, the variation in the wind remained through the rest of the afternoon.'*

Additionally, the airfield has a small weather station which recorded data, including the average and maximum wind speed and their directions for each half-hour period. Between 1430 hrs and 1500 hrs, the average direction was north-north-westerly and the average speed, 13 kt; the maximum wind was 22 kt from the north-west which equated to a maximum crosswind component at the landing strip of approximately 18 kt.

In discussion with the pilot of G-MSTG, and other pilots familiar with the Mustang, the crosswind experienced on the day of the accident was not considered excessive for a pilot of his experience on type.

Airfield information

The private farm strip used by the aircraft owner consisted of a grass runway, orientated 10/28, 825 m long and which varied in width between 37 m at its middle and 45 m at either end. There was a low hedge running across either end of the strip. On the day of the accident the runway was firm, dry and in good condition with grass cut to approximately 6 cm in length.

For noise abatement, all circuits to the airstrip are flown to the north.

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There was a windsock situated on the northern side of the strip next to some farm buildings and an aircraft hangar. The field to the south of the strip had been ploughed up to a concrete track which ran perpendicular to the runway about 500 m from the threshold of Runway 28. Beyond the track the field had been cultivated presenting a soil surface with small regular grooves approximately two to three cm in depth. Figure 9 shows an aerial view of the airfield and the surrounding area.

Figure 9
Topcroft Farm Airstrip

Recorded information

Aspects of the accident flight were recorded by radar systems, an on-board GPS unit and the witness video camera.

Radar coverage in the area did not extend to ground level in the area of the airstrip, however, radar recordings provided an overview of the flight (Figure 1).

The GPS unit recovered from the aircraft was set to log position, track and heading at 30 second intervals which was insufficient to allow analysis of dynamic events. The last recorded GPS point was recorded just before the aircraft's initial touchdown point and indicated the aircraft touched down to the left of the centre line at a speed of 99 mph.

The video was recorded from a position to the south of the runway in the vicinity of the path that crosses the runway. Audio analysis of the video recording enabled an assessment of the engine rpm (Figure 10). The analysis had to take into account the Doppler shift, due to the aircraft moving relative to the position of the video camera, to derive an accurate assessment of the propeller rotational speed[1].

The Doppler shift itself, assuming steady ground speed and engine speed, indicated that the aircraft passed the camera position with a speed of between 74 and 83 mph.

The audio signatures from the propeller were analysed and calculations indicated an engine speed of approximately 2,300 rpm just prior to initial touchdown. The audio signatures at this point were not prominent, indicating the engine was at low power. Just after the second touchdown, the signatures became prominent again indicating increased engine power and increasing engine speed. The engine speed was calculated to be approximately 2,800 rpm as the aircraft passed the camera, assuming the engine speed and ground speed were approximately constant as it passed. Six seconds before impact with the tree, the propeller speed rose again reaching a maximum after 1.5 seconds and then steadily reducing until the point of impact.

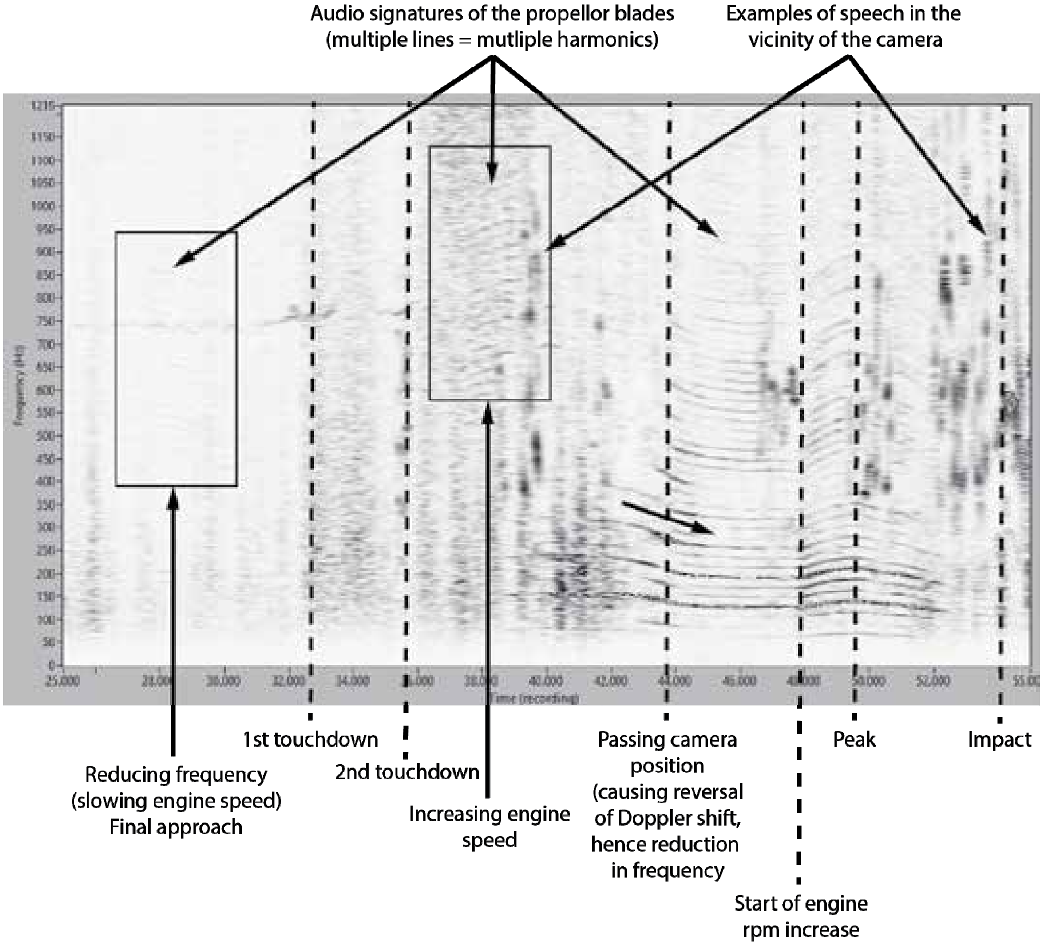

Figure 10

Spectrum Analysis of video audio

Footnote

1 Doppler shift is the apparent shift in frequency of a sound if the source is moving towards or away from the listener. An example of this is the apparent drop in tone of sirens on emergency vehicles as they change from coming towards you to going away from you when they pass.

Pilot information

The pilot obtained a PPL (A) in May 1989, which was current with a valid single engine piston (SEP) endorsement and a Class II medical certificate at the time of the accident. He had been flying historic aircraft for a number of years, including flying at air displays.

The pilot owned G-MSTG and ran a small private 'living' aircraft museum based at Topcroft Farm Airstrip, near to the old WWII Hardwick Airfield. The museum consisted of several other historic aircraft including, until recently, another P51D Mustang which the pilot had also owned. Both Mustangs had been restored and maintained through an engineering company owned by the pilot. The company was approved by the CAA in accordance with BCAR Section A, Sub-section A8.

The pilot had no recollection of the accident. He was however able to describe his usual technique for landing the aircraft and going around.

He would normally land with full flap selected and would not consider it necessary to reduce the degree of flap selected if landing in a strong crosswind. He would also open the canopy during the approach to facilitate evacuation from the aircraft in case an emergency egress was required.

Survival information

Both the pilot and passenger had remained securely strapped in their seats during the accident.

Pilot

The pilot survived the impact but suffered a number of serious injuries, particularly to his neck and burns to his face and neck. He had been wearing cotton overalls over a polyester cotton shirt. He had also been wearing a composite flying helmet with integrated headphones, microphone and visor. A small amount of soil had become trapped under the helmet visor, which was found in the up position, and there were signs of light sooting on the outer surface of the helmet.

The pilot has no recollection of the flight.

Passenger

The passenger was fatally injured with significant injuries to his head and neck. He had been wearing normal clothing and although he was wearing a headset, he had not been wearing a helmet or any other form of head protection. Medical assessment of the injuries sustained was that it was unlikely that the wearing of a helmet would have changed the outcome.

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CAA guidance

The CAA offers guidance regarding clothing suitable and recommended for flying high performance ex-military aircraft in CAP 632, Flying Clothing, Chapter 7 Paragraph 17, 18 and 19, and Appendix E. The salient points are:

> *'7.17 The CAA requires that all occupants flying jet aircraft shall wear protective helmets equipped with suitable visors. For occupants of other aircraft, such helmets are considered to be highly desirable.*
>
> *7.18 The pilots, crew and any passengers flying in ex-military aircraft should, in addition to wearing a suitable helmet equipped with visor, wear a fire-retardant flying suit, leather gloves and suitable boots. When flying in coastal areas a life jacket capable of withstanding aircraft abandonment should be worn. This should be capable of being inflated during a parachute descent. The wearing of an immersion suit and carriage of a life-raft is recommended in the appropriate circumstances.*
>
> *7.19 Further guidance regarding appropriate flying clothing is given at Appendix E.*
>
> ***Appendix E***
>
> *Guidance on appropriate flying clothing and safety equipment (dress to survive)*
>
> ***Flying clothing***
>
> *E1 Use of the correct flying clothing is an important factor in the safe operation of ex-military aircraft. This class of aircraft, even the older piston engine types, are capable of operating at speeds and heights well in excess of the average light aircraft and in-service experience has led to the development of specifically designed flying clothing. Military aircrew are equipped and trained to survive accidents and incidents: civilian operators of ex-military aircraft are strongly encouraged, and in certain circumstances, required, to follow the survival best practice developed by the services.*
>
> ***Flying suits***
>
> *E2 Flying suits are the only practical garment for flying in ex-military aircraft. In addition to protection, they also assist with the storage of maps and documents and prevent loose articles falling into the cockpit, particularly important in aircraft without cockpit floors or storage areas, such as the Spitfire, the Corsair or even the Harvard.*
>
> *E3 Flying suits offer protection in the case of abandonment or ejection and, if properly fireproofed, in the case of fire. Given the possible close proximity between fuel and the pilot, particularly in piston engine ex-military aircraft, wearing of a fire resistant flying suit such as those made of Nomex is very desirable and highly recommended.*

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Flying boots

E4 The use of correctly sized boots specifically designed to give good ankle support is particularly important in the abandonment or ejection scenario. Good ankle support is very beneficial in a parachute landing and it is important that, in the case of an ejection, the boots are not lost on ejection.

Flying helmets

E5 Flying helmets are required for flying in all jet aircraft and highly recommended for all other ex-military aircraft.

E6 The helmet clearly offers protection during abandonment, ejection and the subsequent parachute landing. However, it also has an important head protection role during a forced landing and, with an adequate visor in the down position, in the event of a bird strike. Given the speeds of ex-military aircraft, even when limited to 250 knots, a bird strike in the cockpit area can, and has in the past, caused pilot incapacitation.

Flying gloves

E7 Cape leather or USAF style flying gloves offer considerable protection against cockpit fires and should be worn for all flights.'

Passenger flying regulations

The CAA has in place a number of regulations and issued guidance as to the conduct of passengers flying in historic Annex II aircraft which are being flown under a permit to fly. It sets out the airworthiness compromises made in order to enable historic aircraft to fly and requires these to be brought to the attention of passenger(s).

Information provided by the passenger's family suggest that the flight was being conducted on a cost-sharing basis.

Factors potentially affecting directional control

Torque roll

The P51D has a fast responding engine mounted on the aircraft centreline giving large torque in relation to the aircraft weight. This makes the aircraft liable to torque roll, an effect where should the throttle be opened quickly it causes the aircraft to roll in the opposite direction to the propeller rotation. On G-MSTG, this would result in a roll to the left. An aircraft is particularly susceptible to this during a go-around from an approach when power is increased from, or close to, flight idle and the aircraft is less controllable due to its low speed.

The USAAF P51D Flight Handbook warns not to 'jam' the throttle forward as 'torque will cause loss of control.' The handbook reiterates this in the go-around advice stating that the throttle should be opened smoothly.

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Corkscrew effect

This is the name given to the effect of the propeller slipstream which spirals around the aircraft fuselage. At low airspeeds and high propeller rpm this produces compact spirals which can exert a strong sideways force on the aircraft's vertical tail surface. On G-MSTG, due to the direction of its propeller's rotation, this causes a yawing moment around the vertical axis to the left.

Gyroscopic action

The rotating propeller has properties similar to that of a gyro. When a force is applied to a gyro, the resultant force acts at 90° ahead of, and in the direction of, rotation. Any action on the aircraft causing the propeller to change its plane of rotation also results in a force creating a pitching moment, a yawing moment, or a combination of both depending on the point at which the force was applied.

This action is more prominent in tailwheel aircraft and most often occurs when the tail is being raised during takeoff, or a go-around. This change in pitch attitude has the same effect as applying a force to the top of the propeller's plane of rotation, creating on G-MSTG a yawing effect to the left.

Asymmetric blade effect

When an aircraft is flying at a high angle of attack, the downward moving propeller blade is more effective than the upward moving blade. On G-MSTG, this moves the centre of thrust to the right side of the propeller disc, causing a yawing moment to the left.

Landing performance

The approximate aircraft takeoff and landing weights were calculated as 8,213 lb and 7,893 lb respectively. The weight calculations relied on estimated fuel quantities (as no fuel records were kept) based on the quantity of remaining fuel found in the undamaged right wing tank.

A table in the Flight Handbook for the P51D details the landing performance figures. At a landing weight of 7,893 lb the landing distance required to clear a 50 feet obstacle is stated as 1,650 feet (503 m). With the application of the CAA Safety Sense Leaflet 7c on performance the landing distance required is increased by a factor of 1.15 due to the grass surface and an additional safety factor of 1.43. This gives a total landing distance required of 828 m.

Go-around

The USAAF P51D Flight Handbook provides the following instruction for a go-around.

1. *Open throttle smoothly; do not exceed 61 in. Hg 3,000 RPM.*
1. *Maintain wings level and nose straight.*
1. *Landing gear handle UP.*
1. *Raise flaps slowly when at least 200 feet above ground.*

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The Handbook also gives instructions for a go-around from a missed approach.

> 1. *Open throttle smoothly to 45 in. Hg.*
> 2. *Maintain wings level, nose straight.*
> 3. *Landing gear up.*
> 4. *Raise flaps when at least 200 feet above ground and sufficient airspeed is reached.*

The pilot reported he had carried out a number of go-arounds in the past. This included go-arounds from Topcroft Farm Airstrip, although it had been two of three years since he had last done so. He described his technique as applying about 40 inHG, keeping the aircraft close to the ground and reducing the flap by 10° to reduce drag. As speed increased he would then continue to raise the flaps one stage at a time until at a suitable speed to climb away, at which time he would raise the gear.

Analysis

Approach and go-around

During the approach the aircraft was subject to a crosswind from the right for which the pilot did not adequately compensate. The situation was compounded by the direction of the circuit, for noise abatement, which resulted in the aircraft being on the upwind side and therefore 'blown out' of the circuit as it joined the approach. This culminated in the aircraft landing to the left of the centreline.

The landing performance stated in the Flight Handbook when factored by the safety factors prescribed in the CAA Safety Sense Leaflet 7c giving 828 m made the landing distance available at Topcroft, of 825 m, marginal.

The aircraft touched down at the appropriate speed and attitude but bounced, which further subjected the aircraft to the effects of the crosswind. This was exacerbated by the small roll to the left, despite the pilot quickly applying corrective aileron.

As a result, the aircraft moved closer to the left edge of the airstrip before bouncing again. It is highly likely that the continued left sideslip would have meant that a subsequent touchdown would have been off the grass surface, something which would have been evident to the pilot. This, together with the length of the airstrip, would have provided good cause to go around.

The application of power and associated torque, corkscrew, gyroscopic and asymmetric effects, would have further increased the tendency for the aircraft to travel to the left. The ability to compensate with roll would have been limited, as the aircraft was close to the ground and over a cultivated surface. The direction of the wind would have led to the fuselage partially blocking the wind affecting the left wing, reducing its lift.

The wheel contact marks demonstrated that the aircraft was not climbing. The go-around procedure calls for a compromise between power application and controllability. The pilot's described technique differed from that in the aircraft manual. By leaving the gear down

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there would be an increase in drag, however the aircraft was too close to the ground to raise it safely. Equally, there is evidence that the pilot raised the flaps during the attempted go-around by 20° in an effort to reduce drag, but this would have resulted in a reduction of lift. The situation was compounded by the gear coming into contact with the cultivated ground which would have had a significant decelerating effect. The combined result was that the aircraft struggled to accelerate and remain airborne, and it veered approximately 30º to the left of the runway direction.

Final accident sequence

The magnitude and nature of the damage to the tree shows the engine was producing high power at the point of impact.

The nature and location of the damage show that the left wing root then hit the tree causing the left wing and flap to detach. The bending and distortion to the aircraft structure around the wing root and tailplane attachment suggest the aircraft was left wing low with a roll angle of approximately 60°.

As the aircraft continued forward, the remaining right wing would have produced rapid left rolling moment at which point the nose of the aircraft dipped and continued towards the ground. The rate of pitch and roll was substantial and close proximity of the ground meant the aircraft hit the ground on the upper left side of the fuselage. The canopy detached during this impact and landed nearby along with the remains of the left self-sealing fuel tank.

The aircraft then bounced on to its nose; the damage to the propeller spinner suggest the aircraft was at a near vertical attitude whilst rotating. The propeller was still under significant power at this point but detached during this impact. The aircraft inertia and rotation then caused the aircraft to carry on tail first to finally hit the ground pointing in the opposite direction to travel. The right wing and tailplane tips dug into the ground at this point bringing the aircraft to a stop. The damage to the engine bearers is likely to have occurred as a result of the torque shock as the propeller sliced through the tree. The impact at the left wing root released the self-sealing fuel tank from its bay rupturing its structure and fuel lines. The fuel in this tank was released and ignited. The majority of fire damage occurred in the remains of the tree bough and the ruptured tank. However, burning fuel appears only to have flashed over the front position of the cockpit just before or as the canopy detached.

Survivability

Although both occupants were strapped in and the cockpit remained largely intact, they were subject to considerable forces, sufficient to result in serious neck injuries. The passenger was not wearing the appropriate clothing or helmet recommended by the CAA. The passenger's head injuries were consistent with contact with a flat surface and is likely to have been caused by hitting the inside of the canopy in the first ground impact, prior to the canopy detaching. The injuries sustained were severe but it is unlikely that the outcome would have been different had he been wearing a helmet.

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Some of the flashover fire injured the pilot, although the melting damage to the outside of the canopy indicates the canopy prevented most of the fire entering the rear of the cockpit. The pilot's burns were consistent with his flying suit being open and loose around his neck whilst wearing a non-fire retardant shirt underneath.

Conclusions

The aircraft appeared to have been well maintained and in a good condition at the time of the flight. There was no evidence of any aircraft system failure or malfunction which might have contributed to the accident.

The pilot was experienced on the type and would have normally been capable of flying under the prevailing conditions. However, in this case directional control was lost during the go-around due to the handling effects of increased engine power at low speed and the crosswind from the right. This, and the inability to accelerate and climb away in the space available led to a collision with a tree during the go-around.

The crosswind during the approach and landing and the requirement to fly the circuit from the upwind side due to noise restrictions affected the positioning of the aircraft on the approach. The decision to go around, after the bounces, seemed logical and it is likely that had the aircraft been able to maintain directional control during the go-around, the pilot should have been able to accelerate and climb away.

The flight appears to have complied with the requirements for operating on a cost-sharing basis laid down in CAP 632. It is clear, however, that the suggested clothing standards, particularly for the passenger, had not been adhered to. Whilst the lack of a head protection is unlikely to have affected the outcome in this accident, it might well have made a considerable difference in a similar accident at a lower speed.

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ACCIDENT

Aircraft Type and Registration:	Piper PA-30 Twin Comanche, G-ATMT
No & Type of Engines:	2 Lycoming IO-320-B1A piston engines
Year of Manufacture:	1964 (Serial no: 30-439)
Date & Time (UTC):	15 January 2017 at 1427 hrs
Location:	Near Aston Rowant Nature Reserve, Oxfordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Fatal) Passengers - N/A
Nature of Damage:	Extensive
Commander's Licence:	Private Pilot's licence
Commander's Age:	64 years
Commander's Flying Experience:	10,673 hours (of which 2,140 hours were on type) Last 90 days - 3 hours Last 28 days - 0 hours
Information Source:	AAIB Field Investigation

Synopsis

G-ATMT was operating below 1,000 ft in an area where the Minimum Safe Altitude (MSA[1]) was 2,200 ft. It was likely that the aircraft flew in Instrument Meteorological Conditions (IMC[2]) below MSA for at least 1 minute 45 seconds before flying into some trees standing on a ridge of high ground. The aircraft was extensively damaged and the pilot, the only person on board, was fatally injured.

History of the flight

The pilot was carrying out a private flight from Turweston Airfield to Chalgrove Airfield to pick up two passengers for an onward flight. He arrived at Turweston Airfield at approximately 1315 hrs and studied the actual and forecast weather for RAF Benson (near Chalgrove Airfield) and East Midlands Airport (near his onward destination). He also considered other weather information available online before deciding that he would continue with the flight.

The aircraft departed from Runway 27 at Turweston Airfield at 1414 hrs. The surface wind was from between 300° and 320°M at less than 10 kt, and it was estimated that

Footnote

1 See the section *Minimum Height Rule* for an explanation of MSA.
2 See the section *Visual Flight Rules and Instrument Flight Rules* for an explanation of IMC.

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there was broken cloud at 800 ft agl (approximately 1,250 ft amsl) and a visibility of approximately 9,000 m. The aircraft turned right after takeoff, climbed to approximately 2,000 ft amsl, and turned onto a southerly track when east of the airfield (Figure 1). At 1419 hrs, as the aircraft passed approximately 3.5 nm east of Bicester, it began to descend to approximately 1,000 ft amsl, which it reached at 1423 hrs, 2.8 nm northeast of Chalgrove Airfield.

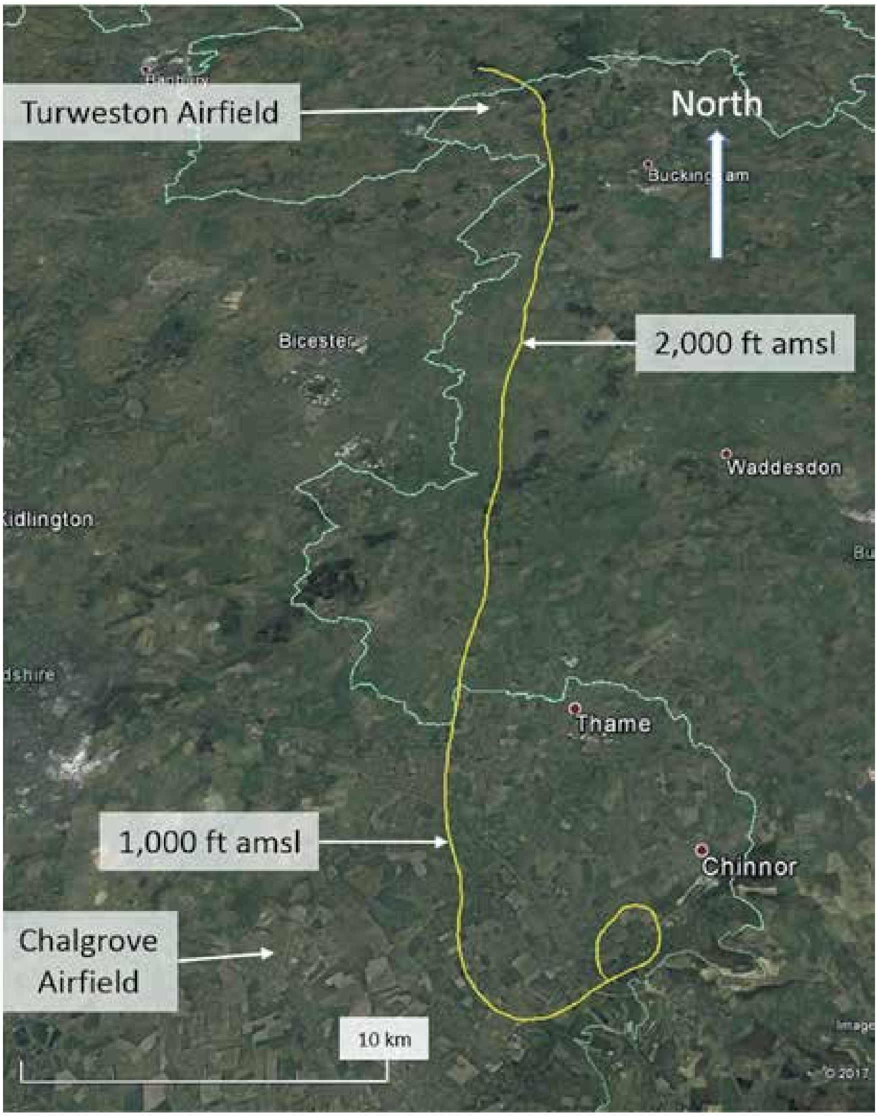

Figure 1

Track of the flight (©Google Earth)

The aircraft continued south until it was 2.7 nm east of Chalgrove Airfield, when it turned left onto a track of approximately 060°M. The turn took the aircraft from an area where the terrain was generally below 400 ft amsl towards a ridge of higher ground, with terrain up to approximately 850 ft amsl (Figure 2). The aircraft flew along the ridge for approximately 1.5 nm, at an altitude of approximately 1,100 ft amsl (equivalent to 300 to 400 ft agl), and then turned left through approximately 270°. The turn took the aircraft back over the lower ground and then towards the ridge again at between 400 ft and 500 ft agl. It continued

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to fly towards the rising ground until it struck the top of some trees at 920 ft amsl. The aircraft broke up as it descended through the trees and the pilot, who had been wearing a three point harness, was fatally injured during the accident sequence.

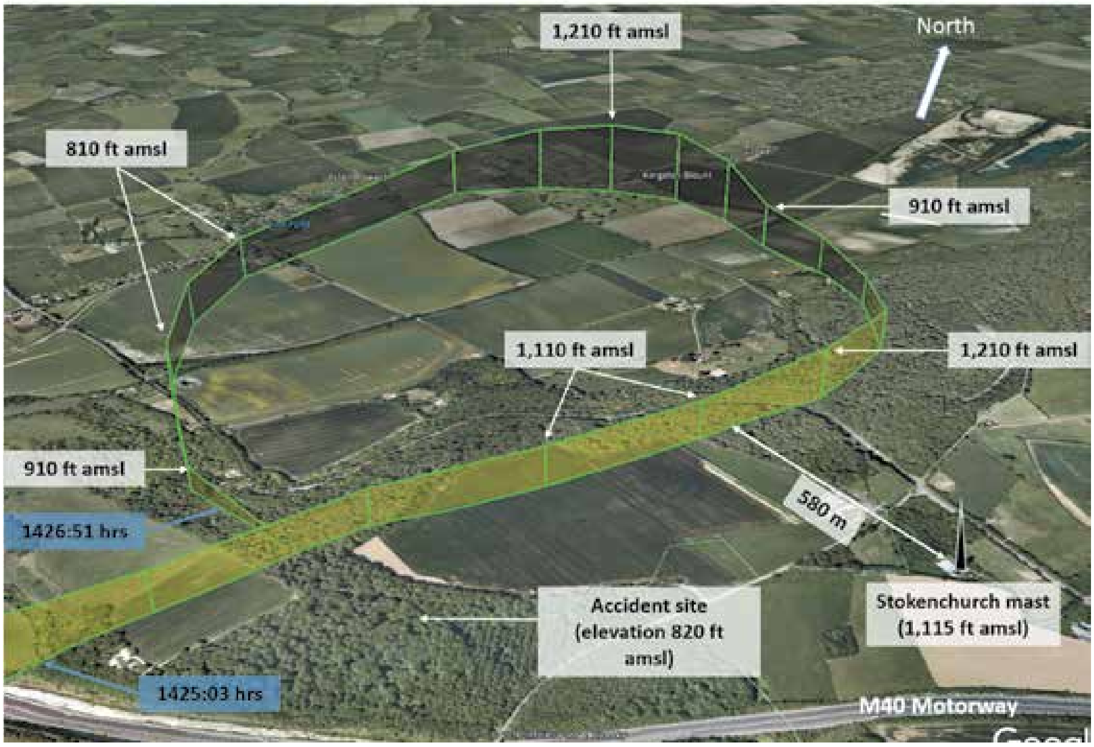

Figure 2

Final track of the aircraft (©Google Earth)

Witness information

Witnesses in the area of the accident at the time of impact reported that the weather was poor. One, who reported that the weather had been "foggy and miserable [with] non-existent visibility", heard the noise of an aircraft twice, with a gap of approximately two minutes.

Two witnesses walking together heard an aircraft overhead as it flew north-east along the ridge. They saw the "shadow" of the aircraft but not the aircraft itself because of the fog. They also heard the aircraft a second time "as if it had doubled back."

One of the passengers waiting to be picked up from Chalgrove Airfield was a pilot. He described the visibility at the time of the accident as being good under a cloudbase which would have permitted visual circuits to have been flown at Chalgrove. He could see the ridge over which G-ATMT had flown and stated that it "was in cloud from about 100 ft from the top. The M40 'cut' was visible albeit not the top section of it"[3].

Footnote

3 The M40 motorway can be seen at the bottom of Figure 2. It traverses the ridge in this location through a cutting in the escarpment.

A National Police Air Service (NPAS) helicopter operating near Reading[4] was tasked to attend the accident scene at approximately 1430 hrs. The pilot reported that, as he transited towards the low-lying ground to the west of the accident location, the cloudbase lowered from approximately 800 ft to 600 ft amsl and the visibility deteriorated from approximately 10 km to 6,000 m. The low cloud, which was sitting on the ridge, prevented him from reaching the accident site.

Accident site

The aircraft crashed into a wood on the edge of Aston Rowant National Nature Reserve, on the northern edge of the Chilterns escarpment, approximately 1.5 nm west of Stokenchurch.

The wood in the area of the accident site was very dense and the aircraft initially made contact with the tops of trees just over 100 ft tall, situated on top of the escarpment. The tops of the trees were approximately 920 ft amsl and the initial impact point was 0.6 nm from the 326 ft tall Stokenchurch telecommunication tower, the top of which is 1,115 ft amsl.

The wreckage trail extended for approximately 120 m, on a track of 120º(M). The start of the wreckage trail consisted of freshly cut branches and many small pieces of Perspex from the aircraft windows and light wreckage from the nose of the aircraft. As the aircraft continued along the track, it sank lower into the trees, severing branches up to 18 cm diameter and sections of the outer part of the left wing, including the wingtip tank, which were subsequently found on the ground and in the trees. The remainder of the left wing and the outer section of the right wing were found close to the centre section of the aircraft, which was at the end of the wreckage trail. Both engines had detached from the wings and were found, with their propellers, approximately 7m further along the trail. All the fuel tanks had been badly damaged and were empty but there was a strong smell of fuel throughout the wreckage trail.

The centre section of the aircraft had come to rest in an inverted position. The cockpit was badly disrupted and items from the cockpit and pages from the technical log were found scattered around the accident site.

Aircraft information

The PA-30, Twin Comanche, is a twin-engine, low-wing aircraft equipped with flaps and retractable landing gear. It has a conventional control system operated by a system of pulleys and rods. The flaps and landing gear are electrically controlled and operated by screw jacks. The fuel is stored in metal wingtip tanks and flexible (bladder) tanks located in each wing. The engine-driven fuel pumps and an electrical auxiliary fuel pump draws the fuel from the fuel tanks, through a selector switch, to the engines.

G-ATMT was equipped with analogue flying instruments, a GNS430 communication and navigational unit, and a Skyforce GPS.

Footnote

4 Reading is approximately 12 nm south of the accident site.

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Maintenance and aircraft documentation

The technical records, which were in the aircraft, were destroyed during the accident. It was established that the Airworthiness Review Certificate was issued on 28 April 2016 at 6,187 flying hours. The maintenance organisation, which carried out the annual inspection at the same time, reported that there were no known technical problems with the aircraft. There was a note in the aircraft log book, dated 8 April 2016, stating that the ADF, DME and No 2 glideslope were shown by placard to be inoperative.

The next scheduled maintenance inspection (6 month check) was due on 19 October 2016 or at 6,237 flying hours. No record could be found of this check having been carried out, although the owner of the aircraft stated that the pilot normally carried out this inspection.

Aircraft examination

The aircraft was extensively damaged during the accident sequence. Nevertheless, it was possible to establish that the damage to the airframe was consistent with the aircraft impacting the trees in a wings level, relatively flat attitude. There was no evidence of any pre-impact damage to the aircraft and it was assessed that the flying control systems had been intact, with no evidence of a control restriction. The position of the landing gear and flap screw jacks were compared with another aircraft and it was established that they were both in the retracted position. Both engines were free to rotate and the colour of the spark plugs was normal. The fuel selector switches were found selected to the main wing tanks and the altimeter subscale was set to 1012 hPa.

The damage to the aircraft was such that the accident was not considered to be survivable.

Pilot information

The pilot held an EASA Private Pilot's Licence (PPL(A)) with a Multi-engine Piston Rating and Instrument Rating (Restricted) (IR(R)), valid until 31 May 2017, and had a Class 2 Medical Certificate, valid until 17 June 2017. An IR(R) is the UK IMC Rating as it appears in a UK-issued Part-FCL licence. The privileges of the rating are given in the Air Navigation Order 2016, Schedule 8:

> *'An instrument meteorological conditions rating (aeroplanes) entitles the holder to act as pilot in command … of an aeroplane flying under Instrument Flight Rules …'*

Records indicated that, on 14 August 2011, the pilot had a total of 10,400 flying hours of which 2,000 hours were on the Piper PA-30 Twin Comanche. Pilot and aircraft logbook records suggested that, since August 2011, he had flown 273.5 hours, all as PIC, of which 140.5 hours were on the PA-30. The pilot's flying logbook contained no entries after 25 February 2016. The owner of the aircraft recalled that the pilot flew on 8 and 29 November 2016 for a combined total of 2 hours 35 minutes.

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Visual Flight Rules (VFR) and Instrument Flight Rules (IFR)

Minimum visibility and distance from cloud

A flight may be operated under VFR or IFR. For a flight to operate under VFR, it must remain in Visual Meteorological Conditions (VMC) which are defined in terms of minimum visibility and distance from cloud. The aircraft was operating below 3,000 ft amsl in Class G (uncontrolled) airspace, and EU Regulation No 923/2012, SERA.5001, states that, in such circumstances, the minimum flight visibility is 5 km and the aircraft must remain clear of cloud and with the surface in sight. SERA.5001 allows Member States to reduce the flight visibility requirement to 1,500 m for aircraft operating at speeds of 140 kt or less. The CAA permits this reduction in minimum visibility in Official Record Series 4 No.1067, *Standardised European Rules of the Air – Visual Meteorological Conditions (VMC) and Distance from Cloud Minima.*

During the first part of the flight the aircraft's IAS was, on average, greater than 140 kt (based on groundspeeds calculated from radar data, adjusted to account for a wind of 290º at 10 kt). A similar calculation showed that, while the aircraft was manoeuvring before impact, its average IAS was below 140 kt.

Minimum height rule

The VFR minimum height is detailed in SERA.5005(f)(2) but it is modified in the UK by the CAA in Official Record Series 4, No.1174, *Standardised European Rules of the Air – Exceptions to the Minimum Height Requirements.* Aircraft are not permitted to be flown under VFR closer than 150 m (500 ft) to any person, vessel, vehicle or structure.

If in-flight conditions deteriorate below VMC minima, a flight may not continue under VFR and must operate under IFR. SERA.5015, *Rules applicable to all IFR flights,* states:

> *'Except where necessary for take-off or landing … an IFR flight shall be flown at a level … which is at least 1,000 ft above the highest obstacle located within 8 km of the estimated position of the aircraft.'*

The altitude calculated in accordance with this rule is known as the MSA. The highest obstacle within 8 km of the accident site was the Stokenchurch telecommunication tower, the top of which is 1,115 ft amsl (Figure 2), so the MSA was 2,200 ft amsl.

Meteorological information

Figure 3 shows the Met Office forecast for weather below 10,000 ft, valid for the time of the flight.

The flight was conducted largely in zone A1. The visibility was expected to be 15 km but occasionally it was expected to be as low as 2,000 m in mist, rain and drizzle, and there would be occasional areas of hill fog. Broken or overcast cloud was forecast with a base between 1,500 ft and 2,500 ft amsl, and there would be occasional broken cloud with a base of 400 ft to 1,000 ft amsl. The cloud base would be at ground level in any hill fog.

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RAF Benson (elevation 203 ft amsl) is 3.5 nm south of Chalgrove and 6.5 nm southwest of the accident site. At 1350 hrs, the wind at RAF Benson was from 290º at 7 kt, there was more than 10 km visibility and broken cloud at 800 ft agl, equivalent to approximately 1,000 ft amsl. At 1450 hrs, the cloud base was reported to be 600 ft agl.

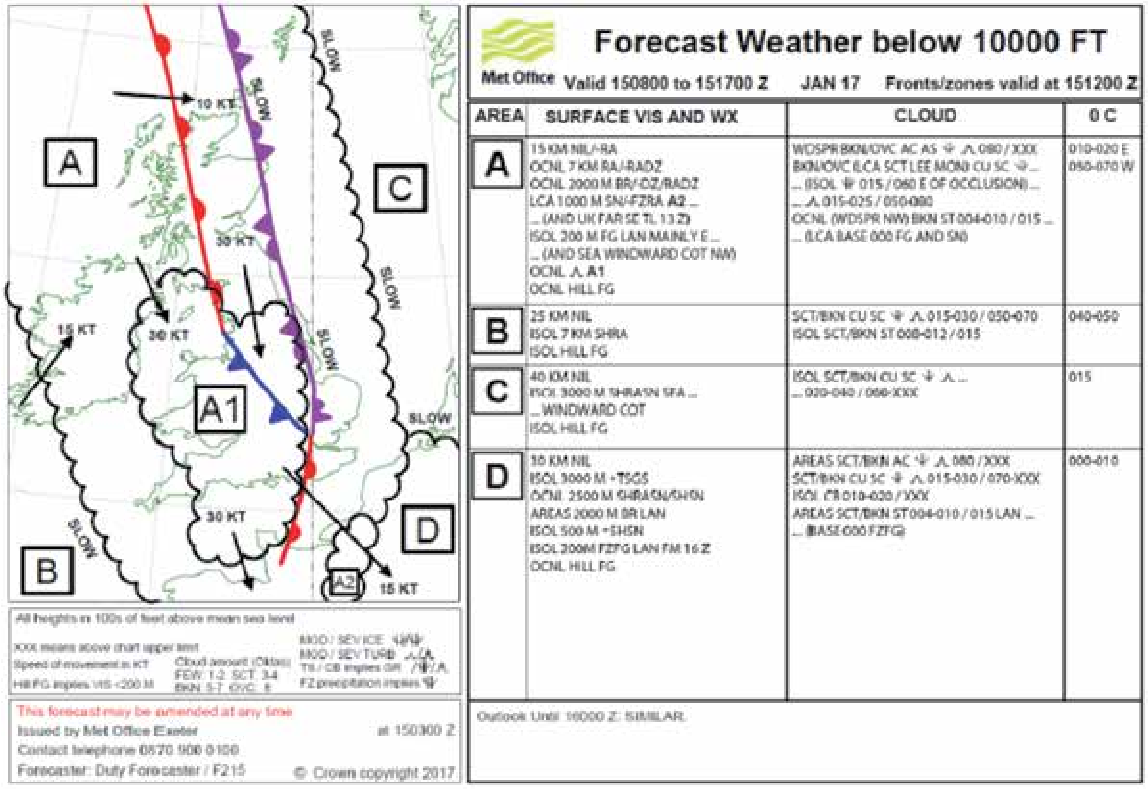

Figure 3

Forecast weather below 10,000 ft amsl (Met Office)

The Met Office produced an aftercast report into the weather conditions prevailing at the time and location of the accident. The report indicated that cloud, which covered much of the UK, was most solid across the south-east of England. There was widespread precipitation across the region and there were likely to have been thick layers of frontal cloud from near the surface to between 10,000 ft and 15,000 ft amsl. The report stated:

> *'The moist north-westerly wind blowing up the steep incline towards the accident site is the ideal mechanism for producing stratus clouds that could hide the hill tops. Overall,* [the evidence] *suggests that the cloud base would have intersected the hills at around 500-800 ft amsl in the vicinity of the crash.'*

Recorded data

The only sources of data that tracked the aircraft flight path were the NATS radar systems at Bovingdon and Heathrow. The radar data included pressure altitude information, recorded with a resolution of 100 ft, which was corrected for ambient conditions to give altitudes above mean sea level. Details from the recordings were provided earlier in the report in the history of the flight. There were no RTF recordings associated with the flight.

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The aircraft was fitted with a GNS430 GPS/NAV/COM unit. The active radio frequency was found set to 125.400 MHz (Chalgrove Radio), with the standby frequency set to 120.900 MHz (Benson Approach). The active VLOC frequency was 116.40 MHz (Daventry – referenced in documentation for Turweston), with the standby set to 112.80 MHz (Gamston – the destination for the subsequent flight). The unit does not record a track but does record its last position which was in the vicinity of the accident site, indicating the system was operational leading up to the accident.

The GN430 unit did not have the terrain display features which are present in later build standards of this unit.

Decision making by pilots

CAA Safety Sense Leaflet

CAA Safety Sense Leaflet 23, *Pilots – It's Your Decision,* discusses factors which affect decision making by pilots. It states:

> *'Pilots who fly into terrain, under full control of their aircraft … continued flying into adverse weather conditions, and/or ignored their MSA (if indeed one had been calculated).*
>
> *Pilots who had fatal CFIT[5] accidents were typically … very experienced. Of all CFIT accidents, 82% included unwise reaction to weather conditions (such as continuing to fly into worsening weather) and 64% had not adhered to their MSA, trying to get 'below the weather' or hoping to confirm their position.'*

Academic study – decision making

Madhavan (2006)[6], citing Jensen (1982)[7], showed that there are both cognitive and motivational aspects to making a decision. The former *'describes the processes by which pilots establish and evaluate alternative [options]'* and the latter included *'gains and losses associated with decision outcomes and social and personal pressures.'* Research by Mather and Lighthall (2012)[8] revealed that, when under stress, people making decisions are likely to give more weight to information supporting the possibility of a positive outcome while discounting contrary information.

Academic study - rule vulnerability

VMC minima mark the boundary between an ability to choose to fly under VFR and a requirement to fly under IFR. If the boundary is approached, a pilot must decide whether to change the aircraft course and/or altitude to remain in VMC and continue under VFR,

Footnote

5 CFIT: Controlled Flight Into Terrain.
6 Madhavan, P., Lacson, Frank C (2006). Psychological factors affecting pilots' decisions to navigate in deteriorating weather. *North American Journal of Psychology,* 8(1) pp 47-62
7 Jensen, R., (1982). Pilot Judgment: Training and Evaluation. *Human Factors,* 24(1) pp 61-73
8 Mather, M. and Lighthall, N. R. (2012). Risk and Reward are Processed Differently in Decisions Made Under Stress. Current Directions in Psychological Science, 31 January 2012, pp. 36-41

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or to cross the boundary into IMC and operate above MSA under IFR (if suitably qualified and in a suitably equipped aircraft). This rule-based decision is designed to keep the risk of collision with obstacles or other aircraft as low as reasonably practicable and it therefore acts as a risk control measure.

Clewley and Stupple (2015)[9] published a study into 'rule vulnerability' using the Stable Approach Criteria (SAC)[10] rule as a vehicle for their work. Although the SAC rule is not relevant to this accident, the underlying issues of human behaviour which the study examined are related. It was hypothesised that increasing complexity (uncertainty and dynamism) in a system would increase the likelihood of unintentional rule-based error. They wrote that '*the SAC rule ... acts as a system defence and provides a safe decision pathway for certain system states.'*

The study argued that rules may be easy to apply when circumstances are clear-cut but more difficult to apply in marginal and uncertain circumstances where they might have the most benefit. In summarising their study, the authors commented:

> *'The results suggest … high uncertainty and dynamism constrain rule-based response, leading to rules becoming vulnerable, fragile or failing completely.'*

Continuing with an original plan in changing circumstances

In his book, *The Field Guide to Understanding 'Human Error',* Dekker (2014[11] pp. 93-94) discussed why people continue with their original plan after circumstances have changed. He argued:

> *'Conditions often deteriorate gradually and ambiguously, not precipitously and unequivocally. In such a gradual deterioration, there are almost always strong initial cues that suggest that the situation is under control and can be continued without increased risk. Later cues that suggest the plan should be abandoned … even while people see them and acknowledge them, often do not succeed in pulling people into a different direction.*
>
> *Operational decisions are not based on a 'rational' analysis of all parameters that are relevant to the decision. Instead, the decision, or rather a continual series of assessments of the situation, is focused on elements in the situation that allows the decision maker to distinguish between reasonable options. The psychology of decision making is such that a situation is not assessed in terms of all applicable criteria (certainly not quantitative ones), but in terms of the options the situation appears to present.'*

Footnote

9 Clewley, Richard, Stupple, Edward J.N. (2015) The vulnerability of rules in complex work environments: dynamism and uncertainty pose problems for cognition, *Ergonomics*, 58 (6):935

10 Stable approach criteria are designed to help a pilot decide whether to continue an approach below, typically, 1,000 ft agl or to go around.

11 Dekker, S. (2014). *The Field Guide to Understanding 'Human Error'.* Farnham, Surrey, UK: Ashgate Publishing Limited.

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Analysis

The aircraft's track took it to a point east of its intended destination of Chalgrove Airfield at an altitude of approximately 1,000 ft amsl. The radio was found tuned to the destination frequency, and the altimeter (which was found set to 1012 hPa) would have read approximately zero ft agl on the runway at the destination[12]. Had the aircraft slowed down and turned right it would have been in a good position to join the extended centreline of Runway 31 at Chalgrove Airfield in preparation for landing. Instead, however, it turned left towards a ridge of high ground (the Chilterns) at approximately 1424 hrs (Figures 1 and 4).

Figure 4

G-ATMT's track relative to the extended runway centreline at Chalgrove Airfield (©Google Earth)

The weather reported at RAF Benson at 1350 hrs was broken cloud at 800 ft agl, equivalent to 1,000 amsl, which lowered to 800 ft amsl by 1450 hrs. The Met Office reported that the cloud base was probably 500 to 800 ft amsl near the accident location. Witness evidence showed that weather conditions in the area near Chalgrove Airfield were better than those in the vicinity of the ridge near Stokenchurch, and yet the pilot turned away from his destination towards the poorer conditions. It was concluded that the aircraft was probably in IMC at 1,000 ft amsl when it turned towards the ridge and the pilot was unaware of the slightly better conditions on his right, near his intended destination. It was also considered likely that the pilot was uncertain of his position relative to Chalgrove Airfield.

12 The QNH at RAF Benson was 1021 hPa (QNH: the altimeter sub-scale setting to show airfield elevation with the aircraft on the runway). The QFE at Chalgrove would have been approximately 1012 hPa based on the RAF Benson QNH adjusted for Chalgrove's elevation (240 ft) (QFE: the altimeter sub-scale setting to show zero ft agl with the aircraft on the runway).

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The aircraft flew northeast along the ridge at approximately 1,100 to 1,200 ft amsl, below the MSA and equivalent to approximately 300 ft to 400 ft agl. As it turned left, back towards the ridge, it was at about 400 ft to 500 ft agl (approximately 800 ft to 900 ft amsl). The aircraft then flew approximately level over rising ground until it struck the top of a tree at 920 ft amsl (100 ft above the local ground level). According to the Met Office, the cloud base would have intersected the hills at an elevation of approximately 500 to 800 ft amsl, in the vicinity of the accident. Witness evidence was of poor visibility and cloud (fog) on the ridge and that, when it flew overhead, the "shadow" of an aircraft could be seen, but not the aircraft itself. If the aircraft was 400 ft above the witnesses and only visible as a shadow, it suggests that the forward visibility was significantly below 1,500 m[13].

The passenger waiting at Chalgrove Airfield stated that the top of the ridge was in cloud at about the time of the accident. Also, the NPAS helicopter was unable to reach the accident site approximately 30 minutes after the accident because of low cloud sitting on the ridge. It was concluded, therefore, that G-ATMT was in IMC as it flew northeast along the ridge and as it approached the ridge for the second time.

No evidence was found that the aircraft was subject to a technical failure which could have contributed to this accident. Physical evidence from the accident site suggested that the aircraft struck the trees in a wings level, flat attitude consistent with controlled flight. Radar data (Figure 2) showed slightly erratic altitudes during the turn back towards the ridge, just before the accident, but they remained within a band of approximately 400 ft and it was considered likely that this indicated that the pilot was making conscious inputs to the flying controls. It was concluded that the pilot was probably consciously flying the aircraft as it flew into trees at the top of rising ground.

Rule-based decision making – flight from VMC to IMC

G-ATMT took off in weather conditions estimated to be broken cloud at 800 ft agl (1,250 ft amsl) and a visibility of 9,000 m, and climbed to 2,000 ft amsl. The aircraft therefore departed in VMC and was permitted to operate under VFR but, at some point before flying northeast along the ridge, the aircraft crossed the boundary from VMC to IMC. The aircraft was operating within Class G airspace and, in this environment, pilots must make rule-based decisions if they encounter deteriorating weather:

a. If the conditions deteriorate towards VMC minima, change course and/or altitude to maintain VMC.

b. If the conditions deteriorate below VMC minima, continue the flight under IFR[14].

Footnote

13 The applicable minimum visibility for flight under VFR at or below 140 kt IAS was 1,500 m.

14 Option b. requires the pilot to be suitably qualified, and the aircraft suitably equipped, to operate under IFR. Should VFR-only pilots inadvertently enter IMC, the only realistic option is to turn through 180°, a manoeuvre which is taught in the PPL syllabus but which also carries the risk of collision in the turn.

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The VMC rule therefore acts as a system defence intended to guide pilots into making a decision which minimises risk (in this case, the risk of collision).

Clewley and Stupple argue that '*poorly defined and uncertain system states'* increase the likelihood that rules will fail. In the case of VFR flight, with the system state defined as either VMC or IMC, the boundary between the two is uncertain: it is not easy for a pilot to differentiate between 4.8 km and 5.2 km visibility, or 1,400 m and 1,600 m. Dekker (2014) argues that, often, a gradual deterioration of conditions, even when noticed, does not cause people to change their plan. A decision is often the result of a series of re-assessments of the situation none of which are likely to account for all criteria, especially quantitative criteria. It is possible that this partly explains why some pilots, perhaps including the pilot of G-ATMT, faced with a gradual reduction in visibility below the quantitative (and difficult to assess) VMC limits, cross the boundary into IMC.

Rule-based decision making – the IFR minimum height rule

From the evidence available, G-ATMT was in IMC as it passed over the accident location, heading northeast, until impact, a time of approximately 1 minute 45 seconds (Figure 2). It had probably also been in IMC from the time it turned towards the ridge. Aircraft operating in IMC are subject to the IFR minimum altitude rule, which acts as a system defence against collision by guiding pilots to make a safe decision to stop a descent at MSA (if VMC has not been achieved) or climb to MSA (if entering IMC below MSA).

The pilot took neither of these options but appears to have remained in IMC below the MSA of 2,200 ft amsl. It was considered highly unlikely that he did not realise he was flying in IMC, given his experience and qualifications, and there should have been no uncertainty as to whether or not the flight could continue under VFR. In these circumstances, a rule-based decision to climb to MSA might have been straightforward and yet the aircraft did not climb or turn through 180º and route back towards the north.

The CAA has stated that, in 64% of all CFIT accidents, the pilots did not adhere to the MSA. A corollary of this is that pilots who do not adhere to the MSA put themselves at significant risk of flying into terrain. Apparently, this risk (if considered), along with other cues suggesting that the pilot of G-ATMT should climb to MSA (even if they were seen and acknowledged), did not outweigh the considerations used to justify continued flight at low level in IMC.

Decision making – continued flight below MSA

Having taken off in VMC, it was not determined when the pilot passed into IMC or why, having done so, he remained below MSA. However, CAA Safety Sense Leaflet 23 confirms that some pilots do, in fact, remain below MSA after flying inadvertently from VMC into IMC. Some considerations which might explain a decision not to climb above MSA are discussed below, although it was not possible to determine whether any of them were applicable to the pilot of G-ATMT.

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a. Although in IMC, pilots might be able to see the ground immediately beneath their aircraft leading to an impression that the visibility ahead of them, which is difficult to gauge, is better than it actually is, and the risk of collision with an obstacle is correspondingly low.

b. If a destination airfield has no instrument landing procedure, a decision to climb to MSA would amount to an acknowledgment that the aircraft would probably not be able to land at its destination and the aim of the flight would not be achieved.

c. Pilots might be concerned that they would encounter icing conditions in a climb to MSA with an attendant degradation of aircraft performance and handling qualities.

d. Flight in IMC below MSA is stressful – especially if lost – because of the risk of collision. Research[15] suggests that stress can cause people to over-emphasise cues suggesting a positive outcome. It is possible that this tendency influences pilots' decisions to remain below MSA.

Conclusions

The aircraft was on a private flight from Turweston Airfield to Chalgrove Airfield and climbed to approximately 2,000 ft amsl after departure. Shortly after reaching 2,000 ft amsl, the aircraft descended to approximately 1,000 ft amsl and, at a point where a right turn would have been appropriate for a visual approach to its destination, turned left towards high ground which was in cloud. It was not determined when the aircraft transitioned from VMC to IMC but it flew in IMC below MSA for at least 1 minute 45 seconds before flying into trees on the top of rising ground. It was not established why the pilot turned away from his destination or remained below MSA while flying in IMC.

Research suggested that, when there is a gradual deterioration of weather conditions from VMC to IMC, it can be difficult to identify when the boundary between the two has been crossed, and this might explain why VFR pilots sometimes enter IMC inadvertently. Information from the CAA showed that, after entering IMC inadvertently, some pilots do not climb to MSA. Although this seems inexplicable, given the risk of collision, research into human performance provides some insight:

a. When under stress, people tend to place a greater emphasis on positive outcomes when making decisions.

b. When conditions deteriorate gradually, cues suggesting that a course of action be abandoned often fail to change that course.

Footnote

[15] Mather and Lighthall (2012).

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This indicates that, if intending to remain in VMC, it is better to anticipate the need to avoid the boundary between VMC and IMC than to fly towards it and, perhaps inadvertently, across it.

CAA Safety Sense Leaflet 1e, *Good Airmanship,* Leaflet 5e, *VFR Navigation,* and Leaflet 23, *Pilots – It's Your Decision*, provide guidance for pilots operating VFR in the lower levels of Class G airspace and in poor weather.

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.

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ACCIDENT

Aircraft Type and Registration:	Dassault Falcon 7X, VQ-BSO	
No & Type of Engines:	3 Pratt & Whitney Canada PW307A engines	
Year of Manufacture:	2009 (Serial no: 64)	
Date & Time (UTC):	24 November 2016 at 1450 hrs	
Location:	London City Airport	
Type of Flight:	Commercial Air Transport (Passenger)	
Persons on Board:	Crew - 3	Passengers - 1
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Minor abrasions to the right winglet	
Commander's Licence:	Airline Transport Pilot's Licence	
Commander's Age:	43 years	
Commander's Flying Experience:	7,900 hours (of which 2,687 were on type) Last 90 days - 65 hours Last 28 days - 37 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

Synopsis

The aircraft was taxiing into the General Aviation apron under the guidance of a marshaller, who was being assisted by two 'wing walkers' monitoring the aircraft wing tip clearance. During a turn to the left, the right winglet of the aircraft, struck the nose of another aircraft which was parked, causing it damage.

History of the flight

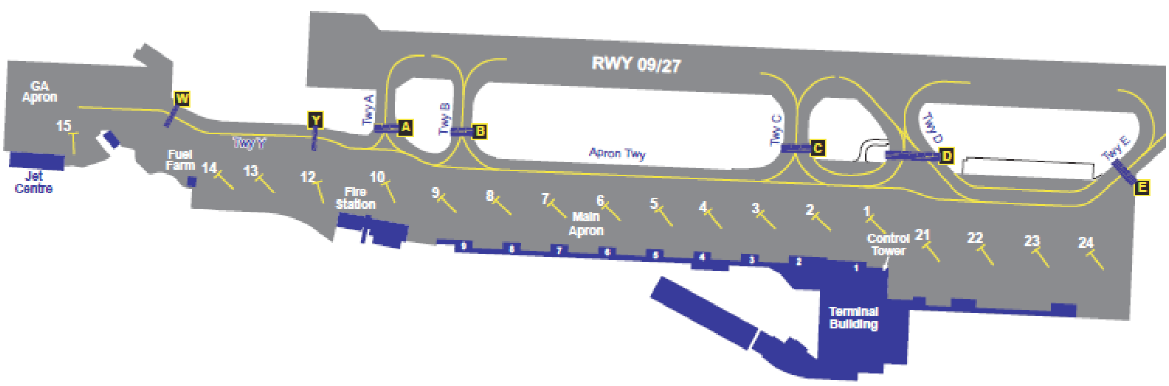

Figure 1

London City Airport Parking/Docking Chart

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The aircraft had arrived from Rotterdam on a private flight. The weather was good and the airport's apron surface was dry. The intention of the ground handling staff was to park the aircraft on the General Aviation (GA) apron, located at the western end of the airport (Figure 1), 'nose in' to the 'Jet Centre' terminal building.

Other aircraft were parked on the apron and a marshaller and two 'wing walkers' were in position to guide VQ-BSO between two parked aircraft - their approximate positions on the apron and the intended taxi route for VQ-BSO are shown at Figure 2. VQ-BSF was parked on the western end of the apron further forward than normal and its flight crew were in their seats, as they were shortly due to depart. Another Falcon 7X was parked on Stand 15, facing approximately north.

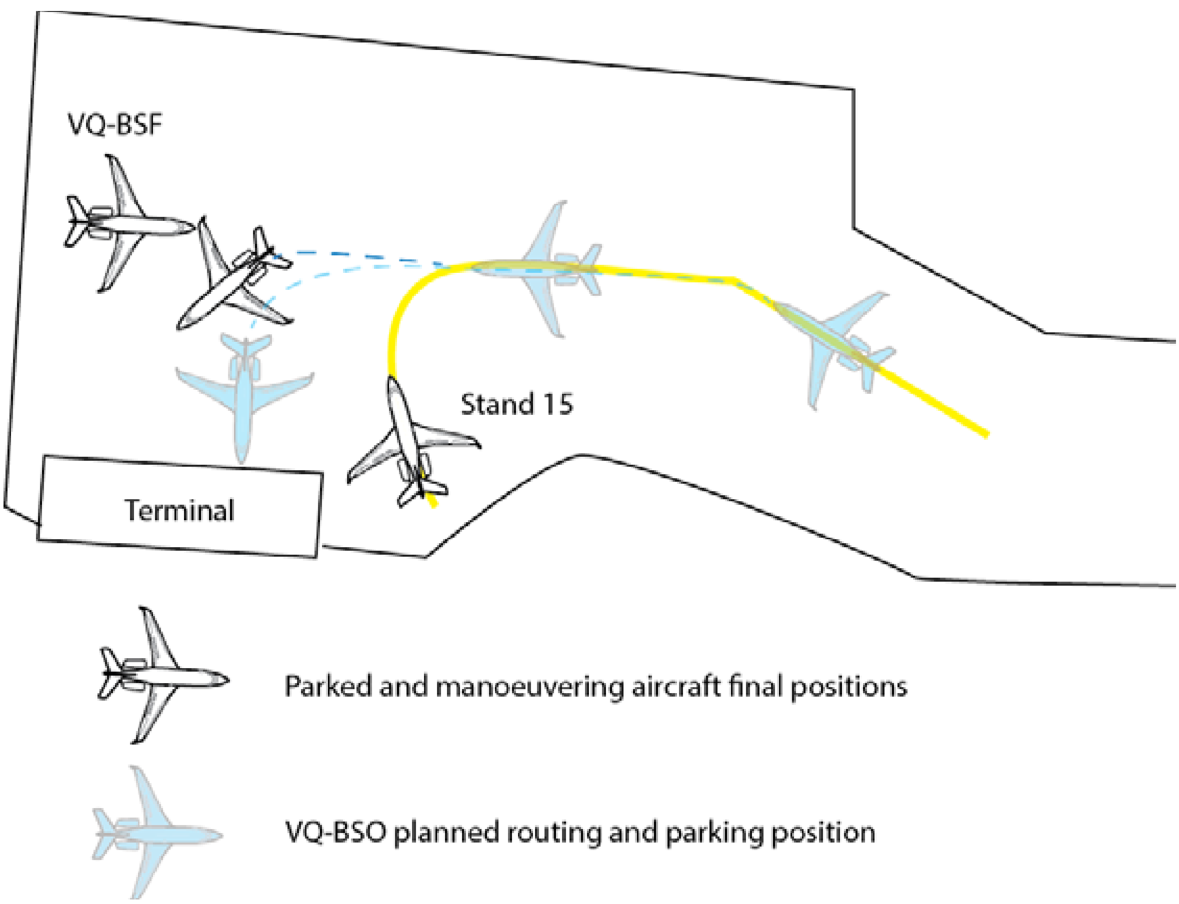

Figure 2 (not to scale)

Diagram of the intended and actual routing of VQ-BSO, and the parked aircraft

The commander of VQ-BSO was occupying the right pilot's seat[1], with the co-pilot, as the handling pilot, in the left seat taxiing the aircraft. Initially, the co-pilot followed the taxi line into the parking area and then, having identified the marshaller, followed his signals, whilst the commander monitored the right wing walker. The aircraft was marshalled ahead until

Footnote

[1] The operator's standard operating procedure is for the pilot handling to fly from the left seat. All pilots are qualified to fly from either seat.

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clear of the parked aircraft on its left and beyond what the handling pilot, who had parked on the GA apron at London City before, thought was the normal turning point. The co-pilot remarked on this to the commander and, shortly afterwards, the marshaller indicated a left turn towards the terminal. The handling pilot followed the signals whilst the commander monitored the right wing tip. The marshaller then indicated a tighter left turn and both flight crew watched his signals. As the turn tightened, the speed of the right wing tip increased and the wing walker monitoring the right wing tip realised, at a late stage, that there was insufficient clearance. He crossed his arms in front of his chest, in a STOP signal, instead of above his head, but this was not seen by the marshaller, who, at that point, was looking to his right. The impact of the right winglet of VQ-BSO on the nose of VQ BSF was felt by VQ-BSO's flight crew, who brought the aircraft to a stop. The damage caused by the collision is shown below at Figure 3.

Figure 3
Damage caused by the collision

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Although the damage to the radome and radar antenna of VQ-BSF was significant, the winglet of VQ-BSO only suffered minor abrasions and, following an engineering inspection, required no maintenance action. There were no injuries to persons on board either aircraft or on the ground.

Organisational information

*London City Airport GA Apron procedures***.**

The London City GA apron is used to park private, corporate aircraft of varying sizes and, apart from the apron entry line and Stand 15, which is located on the south-eastern corner of the apron, there are no ground markings for parking or taxiing on the concrete surface.

Both the UK AIP and the operator's Jeppesen aeronautical charts instruct pilots taxiing on the apron to follow the marshaller's instructions.

Clearance distances

London City Airport was certified under the EU Aerodrome Regulation (EU.139/2014) in February 2016. With a wingspan of 26.21m, the Falcon 7X aircraft is classed as a code C aircraft, for which the minimum clearance distance should be at least 4.5m. The relevant regulation is set out below:

'CS ADR-DSN.E.365 Clearance distances on aircraft stands

(a) The safety objective of clearance distances on aircraft stands is to provide safe separation between an aircraft using the stand and any adjacent building, aircraft on another stand and other objects.

(b) An aircraft stand should provide the following minimum clearances between an aircraft entering or exiting the stand and any adjacent building, aircraft on another stand and other objects:

Code Letter	*Clearance*
A	*3 m*
B	*3 m*
C	*4.5 m*
D	*7.5 m*
E	*7.5 m*
F	*7.5 m*

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London City Jet Centre Ramp Instructions

This document contains the airport's procedures for marshalling aircraft and covers the staff requirements, procedures and signals to be used when marshalling aircraft at the airport. All the ground handling staff had received the required training and were in date with their qualifications.

The following paragraphs are of relevance to the incident:

> *'Care must be taken to ensure that the aircraft is protected during marshalling manoeuvres. On some types of aircraft, the pilot may not be able to see the aircraft wingtips; therefore, it is essential that precise signals are required to inspire confidence in the marshaller's ability. A wing tip marshaller should be used at all times.*
>
> *Particular attention must be paid to the effect of 'wing growth' during turns, this is where due to swept back nature of some aircraft types the wings appear to grow during turns, particularly where the turn is near an obstruction.*
>
> *Marshallers should lead the aircraft with signals, indicating aircraft changes in direction with steady signals rather than a rapid change of signal which may induce an over-reaction from the pilot.*
>
> *When marshalling in a congested area marshallers MUST ensure that the aircraft path is clear from any obstruction.*
>
> *There may be a need to manoeuvre aircraft in close proximity to other aircraft whilst on the Jet Centre ramp. This can prove very dangerous and must be approached with caution. It is the responsibility of the staff member marshalling/towing the aircraft to ensure they have sufficient numbers of wingmen present when manoeuvring aircraft in close proximity.*
>
> *Whilst operating during times of restricted vision such as night time/fog the use of reflective wands must be used during all aircraft movements to ensure full vision is obtained by the crew and clear signals throughout.'*

Wing growth

Wing growth is peculiar to swept-wing aircraft, such as the Falcon 7X. When moving in a straight line, the width of the area over which the wing structure passes equates to the wingspan. In the case of the Falcon 7X this is 26.21m. When a sharp turn is made to the left around the stationary left wheel, the radius of turn is from the left main wheel to the right wing tip, the arc of which subtends a greater distance out from the centre of the fuselage. This increase in radius or wing growth is illustrated at Figure 4.

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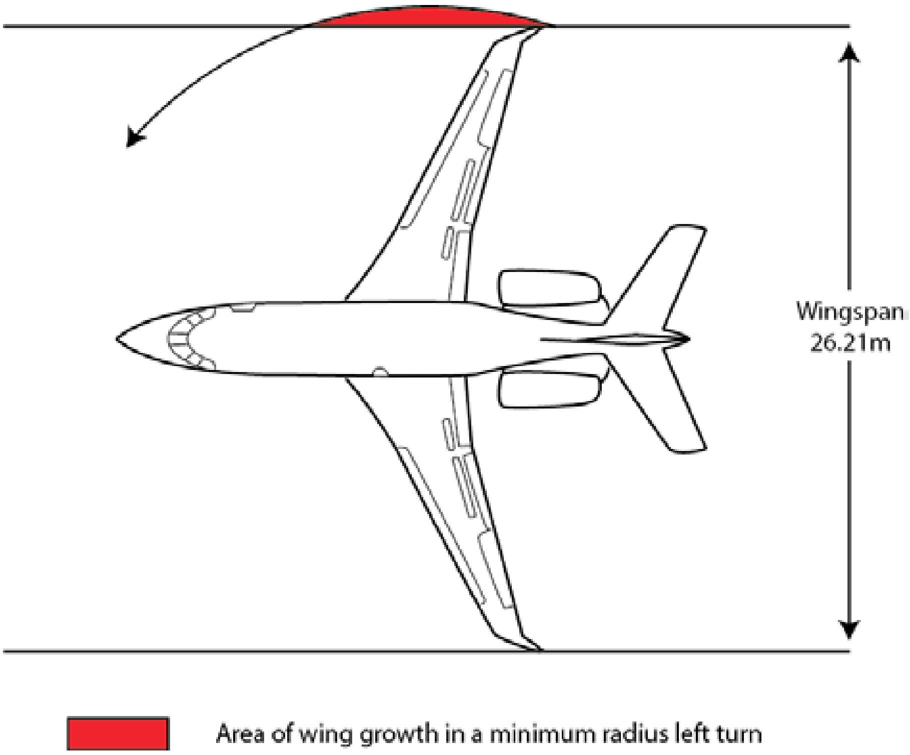

Figure 4

Wing growth

The aircraft operator

The aircraft was one of a fleet of Falcon 7X aircraft operated by a major company, which carried out an internal investigation and provided a copy of its report to the AAIB.

The report identified six areas where safety action could be taken and made the following recommendations:

> ‘*1. The Corporate Fleet should review the ‘Bowties’ under development to assess, in the light of the findings of this report, the robustness of the barriers and then introduce them as soon as possible.*
>
> *2. To carry out a review of the most frequented destinations to determine which present the highest risk, and then conduct formal risk assessments of those identified as requiring one, and include the findings in the Company Rout Guide.*
>
> *3. The London City Jet Centre should conduct a further risk assessment and hazard identification of its apron operations taking a view of ‘what, when and if’ activities should take place and what enhanced mitigations can be put in place to reduce risk. Conducting this with the involvement of The Fleet is recommended, and it should include future potential aircraft types – such as the Falcon 8X.*

> 4. *Whilst acknowledging that Recommendation 3 may result in findings that include this one, it is recommended independently that the London Jet Centre establish a suitable position, and then paint, a ground marking on the west side of the apron that defines the limit for parked aircraft to project.*
> 5. *London City Jet Centre should determine whether the use of a dedicated radio channel is feasible and potentially a safety enhancement for ground operations on their apron.*
> 6. *The Fleet should include in its recurring CRM training an increase in emphasis on the concepts of 'group think'/'risky shift' and the fact that generally when a sense of unease is experienced it is with good cause and should be acted upon.'*

The airport operator

The London City Airport operator also carried out an internal investigation. Their assessment of the cause of the accident was the failure of the marshaller to observe the non-standard STOP signals given by the right wing walker when VQ-BSO's winglet became close to the nose of VQ-BSF, the parked aircraft. At that moment, the marshaller was watching the left wing tip walker to his right. The flight crew were watching the marshaller and the rate of the left turn had also increased the speed of the right wing tip, which gave the right wing walker less time to initiate the STOP signal.

The airport operator listed the following contributory factors:

> '1. *The parking of 2 large aircraft (Dassult Falcon 7X) on Stand 15 and position 2, which left limited space for another aircraft of the same type to manoeuvre through. Additionally the aircraft on position 2 was not parked up to the jet blast barrier and was parked further forward leaving a lesser gap.*
> 2. *The late initiation of a left turn instructed by the marshaller.*
> 3. *The marshaller focussing on one side of the aircraft more than the other, due to the belief that the aircraft's left wing would be more at risk of losing clearance than the right wing.*
> 4. *The right 'wing walker' not providing clear marshalling signals in accordance with ICAO; no use of wands.*
> 5. *No equipment was used as a further control measure to hand signals by the 'wing walkers'.'*

Recorded information

Airport CCTV recorded the incident and was made available to the investigation. It clearly showed the events described in the History of the flight, especially the increase in speed of the right winglet during the tightened turning manoeuvre.

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Analysis

Corporate aircraft vary significantly in size and London City Airport has a relatively small parking area on the GA apron on which to accommodate them. To mark the surface with parking stands accommodating the larger corporate aircraft and taxi lines to occupy those stands, whilst ensuring the 'CS ADR-DSN.E.365 Clearance distances', would limit the number of parking positions available. For that reason, aircraft can be parked using a marshaller to optimise the use of the parking area in order to provide the maximum number of parking places, consistent with the size of the aircraft occupying the area.

The marshaller and wing walkers were all trained and qualified to carry out their duties and equipped in accordance with the airport requirements. The incident occurred due to the late left turn of VQ-BSO and the marshaller not seeing the stop signal given by the right wing walker. This was compounded by the increase in wingtip speed due to the tightening of the turn and the resulting 'wing growth'.

Safety actions

London City Airport identified the following safety actions:

'1. *The parking positions for the Falcon 7X should be identified and the position of their main and nose wheels marked on the apron surface.*
2. *All the Jet Centre's marshallers should receive refresher training on the correct ICAO marshalling signals.*
3. *Marshalling wands must be used for all manoeuvring not just at night or in reduced visibility.*
4. *Initially, marshallers and 'wing walkers' would be equipped with belt mounted horns to provide an audio STOP signal. This would subsequently be replaced providing digital radios on a dedicated frequency.*
5. *A new supervisory level appointment would be created to oversee all parking.'*

Conclusion

The collision occurred due to the late left turn directed by the marshaller and him not seeing the STOP signal from the right wing walker, due to his attention being focussed on the left wing walker. The effect of 'wing growth' also contributed to the collision.

Both the aircraft and airport operators have identified safety actions intended to prevent reoccurrence, which they are in the process of implementing.

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SERIOUS INCIDENT

Aircraft Type and Registration:	DHC-8-402 Dash 8, G-ECOJ
No & Type of Engines:	2 Pratt & Whitney Canada PW150A turboprop engines
Year of Manufacture:	2008
Date & Time (UTC):	9 January 2017 at 1959 hrs
Location:	Newcastle Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 4 Passengers - 56
Injuries:	Crew - 1 (Minor) Passengers - None
Nature of Damage:	Damage to tail strike switch/sensor fairing
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	36 years
Commander's Flying Experience:	4,732 hours (of which 4,559 were on type) Last 90 days - 221 hours Last 28 days - 68 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and the operator's internal investigation report

Synopsis

In the final stages of landing, the aircraft developed a high nose-up pitch attitude with a high sink rate. Intervention by the commander failed to prevent a firm landing and the rear fuselage contacted the runway. The damage was confined to the tailstrike switch/sensor fairing.

History of the flight

The crew were operating a scheduled flight from Southampton to Newcastle; the co-pilot was the handling pilot for the sector. The co-pilot completed his type conversion in November 2016 and had conducted 49 sectors on the aircraft as pilot flying at the time of the incident.

Weather conditions at Newcastle were reported as fine with a westerly wind of 13 kt. The crew briefed for an ILS approach to Runway 25 at Newcastle, with a planned Flap 15 landing. This was in accordance with the operator's recommendation of Flap 15 for runways of length greater than 2,000 m; the Landing Distance Available (LDA) for Runway 25 is 2,125 m.

The approach was flown with the autopilot engaged. Flap15 was selected and, at 1,000 ft and 500 ft aal, the required stable approach criteria were met. VREF for the approach was 118 kt.

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The autopilot was disconnected at 200 ft aal. At 100 ft aal power was reduced on each engine from 15 % torque to 8 % torque. Over the next four seconds the speed reduced from 124 kt to 113 kt and the pitch attitude increased from 3.7° to 7.6°. The commander, sensing the aircraft sinking, advised the co-pilot to increase power and at 8 ft aal advanced the power levers himself. The aircraft touched down and bounced, the 'TOUCHED RUNWAY' caption illuminated and a triple warning chime sounded. The commander, aware that the tail had struck the runway, took control and landed the aircraft on the remaining runway.

The aircraft taxied to a parking stand where the passengers disembarked. Air traffic control were not immediately advised of the runway contact but were notified subsequently. The aircraft was inspected and minor damage to the Tail Strike Switch fairing was discovered. A subsequent engineering inspection revealed no structural damage.

Aircraft information

The Dash 8-400 aircraft has a high wing configuration with engines mounted on the wing. Three flap configurations are available for normal landing; 10°, 15° and 35°. The operator's policy for flap setting was stated in their Operations Manual (OM):

> *'15° Flap is recommended as the standard setting for a two-engined approach and landing for runways of 2000 m LDA or more. For runways of less than 2000 m LDA, 35° Flap is recommended and is mandatory when 1800 m or less.'*

An approach at Flap 15 will typically result in a touchdown attitude of 5° nose-up; tail contact with the runway will occur at between 6.9° and 7.5° nose-up, depending on the degree of main gear oleo compression. The operator's Standard Operating Procedure (SOP) requires the monitoring pilot to announce "PITCH FIVE" if the pitch attitude reaches 5° nose-up during the flare. If the pitch attitude reaches 6° nose-up or the aircraft starts to sink the expected response would be for the pilot flying to announce '*correcting*' and correct by increasing power and ensuring there is no further increase in pitch attitude, or to execute a go-around.

The high wing configuration of the aircraft is such that the power setting affects the airflow over the wing behind the propellers. A decrease in power will directly decrease lift, even if the airspeed remains the same. The operator's training guidance is to maintain a torque of 15% once established on the glideslope.

The OM contains a note concerning Reference Landing Speed (V_{REF}):

> *'Apart from short term fluctuations, the speed on the final approach must not be below VREF.'*

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The OM contains specific guidance on the avoidance of tailstrikes during landing:

> *'Deviation from the normal landing procedure is the main cause of tail strikes. The most*
> *common mistakes are:*
> *• Allowing the airspeed to decrease well below VREF.*
> *• Inappropriate reduction in power.*
> *• Prolonging the flare for a smooth touchdown.*
> *• Starting the flare too high.'*

The aircraft is fitted with a touched runway detection system that includes a frangible switch/sensor located on the underside of the aft fuselage. In the event of a tail strike, a TOUCHED RUNWAY warning light illuminates on the Central Warning Panel. The Quick Reference Handbook action in the event of this warning occurring on landing is to '*Advise ATC and airport operations of the fuselage / runway contact',* this is due to the possibility of runway debris.

Following several in-flight tailstrike events the aircraft manufacturer issued Flight Operations Service Letter (FOSL) DH8-400-SL-00-020, dated 11 September 2008, to remind Operators of the importance of pitch attitude awareness for the Q400 during the landing flare and touchdown phase of flight. This letter advised:

> *'Descent rate control, below 200 feet agl, must be through power lever management rather than adjusting pitch.'*

In addition to DH8-400-SL-00-020 the manufacturer made available to operators a training video concerning the avoidance of tailstrike.

Organisational information

In November 2016 the operator reviewed the recent history of high pitch events through their Flight Data Monitoring (FDM) programme. Power management was identified by their analysis as the strongest factor during the 'high pitch on landing' events over the previous 6 months.

Previous similar events

The Australian Transport Safety Bureau (ATSB) reported on two occurrences of tailstrike during landings of DHC-8-402 aircraft, both of which occurred in late 2013[1]. A finding from the investigation was:

> *'The use of Flap 15 for landing results in a margin of 1.9° between the nominal landing flare angle and the tail strike angle, compared to a margin of 3.9° when using Flap 35 and a typical margin for other transport aircraft of over 5°.'*

Footnote

1 https://www.atsb.gov.au/publications/investigation_reports/2013/aair/ao-2013-201/

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The ATSB found that in both cases in the last 50 ft of the approach to land the aircraft were in a declining energy state which induced the pilot to pitch up to control the descent rate, thereby exceeding the pitch attitude limit.

Analysis

The approach and landing took place in the hours of darkness, a time when there are reduced peripheral visual clues to judge height above the runway. When the aircraft was at around 100 ft aal the PF, who was relatively inexperienced on the aircraft, reduced torque to 8%, a level below the minimum of 15% recommended during approach. This put the aircraft into a low energy state leading to an increasing descent rate and a loss of airspeed. In order to counter perceived sink the PF increased the nose-up pitch instead of adding power, probably an instinctive reaction. The commander's verbal intervention in asking the co-pilot to increase power was not effective and his own action to advance the power levers was too late to prevent the tailstrike.

On the Dash 8-400 aircraft there is a relatively small margin between a normal flare angle and the tailstrike angle. Thus, if a pilot senses the aircraft is sinking in the final stages of landing the instinctive action to increase pitch attitude is likely to result in aft fuselage runway contact. Engine power management is critical on this aircraft during flare and landing because of its direct effect on the airflow over the wing and thereby on the available lift. Training programmes to address this emphasise the use of power to control rate of descent and not pitch attitude. However, inexperienced pilots are likely to take time to acquire the skill to judge landings and under pressure may revert to an instinctive response of increasing nose-up pitch when close to the ground.

Conclusion

The tailstrike occurred because of an inappropriate reduction in power during the latter stages of the approach which put the aircraft into a reduced energy state. When it started to sink the instinctive response of the pilot flying was to increase the pitch attitude, instead of the recommended trained response of increasing power.

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ACCIDENT

Aircraft Type and Registration:	North American P-51D Mustang, G-TFSI
No & Type of Engines:	1 Packard Motor Car Co Merlin V1650-7 piston engine
Year of Manufacture:	1944 (Serial no: 124-44703)
Date & Time (UTC):	9 July 2017 at 1522 hrs
Location:	Duxford Aerodrome, Cambridgeshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Aircraft sustained structural damage
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	55 years
Commander's Flying Experience:	21,000 hours (of which 9 were on type) Last 90 days - 160 hours Last 28 days - 68 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquires by the AAIB

Synopsis

The engine stopped without warning during the latter stages of an air display and after it restarted and stopped several times, the pilot concluded he would be unable to return to the airfield. The aircraft sustained damage after a forced landing in a cornfield, but the pilot was uninjured. The cause of the engine stopping was not known at the time of publication of this report.

History of the flight

The aircraft was part of a formation of 'Warbirds' approaching the end of their display sequence. The pilot reported he had been airborne for approximately 25 minutes without incident when he did an engine health check and changed the fuel selection to the right wing tank. The formation continued downwind, completed a flypast and separated onto three crosswind legs, climbing to approximately 1,000 ft. As the pilot applied additional power the engine stopped without warning.

The engine restarted and ran at the commanded power setting for a few seconds before stopping for a second time. The pilot climbed away from the formation, transmitted a PAN call and prepared for a forced landing. The engine started and stopped several times, allowing a gradual descent. He reselected the left fuel tank and auto-leaned the mixture, at which point the engine ran for between 10 and 15 seconds before stopping again.

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With the aircraft in a tight downwind position at approximately 500 ft and 150 mph, the pilot selected 20º of flap and the landing gear down. He commenced a turn onto the base leg, but it became evident that the aircraft had insufficient energy and would not make the runway. Turning in the direction of a cornfield to the east of the M11 motorway, the pilot selected the landing gear up and the flaps to 30º just before landing at approximately 120 mph. The aircraft remained upright and the pilot was uninjured.

Figure 1

G-TFSI after the accident

(Image reproduced with the permission of the pilot)

Aircraft information

G-TFSI was delivered in 1945 as a single-seat Mustang and remained in service with the United States Air Force until 1956. In 2001, work commenced on overhauling the aircraft and converting it to a two-seat trainer with dual controls. The work was completed in May 2007 and the aircraft was relocated to its permanent base at Duxford Aerodrome.

Conclusion

At the time of publication of this report, the aircraft was being returned to the overhaul facility in the USA for investigation and repair. The cause of the engine stopping was not known, but based upon the reported symptoms, the maintenance agency suspected it to be carburettor related.

The pilot's recognition of the need to make a forced landing and configuring the aircraft in time for the landing ensured a successful outcome.

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SERIOUS INCIDENT

Aircraft Type and Registration:	Reims Cessna F406 Caravan II, G-RVLX
No & Type of Engines:	2 Pratt & Whitney Canada PT6A-112 turboprop engines
Year of Manufacture:	1991 (Serial no: F406-0054)
Date & Time (UTC):	1 June 2017 at 2015 hrs
Location:	En route from East Midlands Airport to Kristiansund, Norway
Type of Flight:	Commercial Air Transport (Cargo)
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to emergency exit door, frame and surrounding structure
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	25 years
Commander's Flying Experience:	1,543 hours (of which 119 were on type) Last 90 days - 80 hours Last 28 days - 40 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The pilot's emergency exit door opened in flight. This may have been due to the door operating handle being inadvertently disturbed and a secondary safety latch not operating correctly. Several safety actions are being taken by the operator.

History of the flight

Whilst cruising at FL100 a door warning light illuminated. The pilot noticed the P1 emergency exit main handle was slightly away from its locked position and instinctively went to pull the door inwards and the emergency exit handle towards its closed position. Within 1 to 2 seconds the door "popped out with an extremely large amount of force". It remained attached to the aircraft. The pilot declared a MAYDAY and returned to Newcastle without further incident.

Investigation by the operator

The operator conducted an investigation in conjunction with the aircraft manufacturer. This concluded that, whilst checking or operating a portable oxygen bottle, the pilot may have inadvertently disturbed the emergency exit main handle and then, when it was almost overcentre, vibration and the action of a spring in the mechanism caused the handle to move

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to the fully open position, illuminating the door warning light. A secondary latch initially held the door closed, but due to low friction in its mechanism and lost motion due to a migrated roll pin in its operating lever, it did not secure the door closed and the door opened into the slipstream.

Safety actions

The operator is taking the following safety actions:

- *An email was sent to all crew to notify them of the event and to highlight correct door operation and security*
- *A fleet check of aircraft fitted with a similar door was carried out to ensure that both primary and secondary locks operated correctly.*
- *Placarding of the secondary handle will be improved to clearly identify when it is the LOCKED position.*
- *A strap will be fitted to the emergency exit main handle to minimise the likelihood of it being inadvertently disturbed.*

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ACCIDENT

Aircraft Type and Registration:	1) DH82A Tiger Moth, G-ANNG 2) Avions Pierre Robin CEA DR300/180R, G-BVYM
No & Type of Engines:	1) 1 De Havilland Gipsy Major I piston engine 2) 1 Lycoming O-360-A4M piston engine
Year of Manufacture:	1) 1942 (Serial no: 85504) 2) 1972 (Serial no: 656)
Date & Time (UTC):	13 May 2017 at 1315 hrs
Location:	Old Sarum Airfield, Wiltshire
Type of Flight:	1) Training 2) Private
Persons on Board:	1) Crew - 1 Passengers - 1 2) Crew - 1 Passengers - 1
Injuries:	1) Crew - None Passengers - None 2) Crew - None Passengers - None
Nature of Damage:	1) G-ANNG, damage to leading edge of left wing 2) G-BVYM, damage to leading edge of left wing, propeller, spinner and engine cowl
Commander's Licence:	1) Airline Transport Pilot's Licence 2) Unknown
Commander's Age:	1 56 years 2) Unknown
Commander's Flying Experience:	1) 7,460 hours (of which 75 were on type) Last 90 days - 183 hours Last 28 days - 73 hours 2) Unknown
Information Source:	Aircraft Accident Report Form submitted by the pilot of G-ANNG and additional enquiries made by the AAIB

G-ANNG was parked to the northern side of Runway 06/24. Runway 24 was in use and the wind was from 210º at 16 kt, requiring the pilot to turn left from his parking position to taxi towards the active runway.

After he had started the engine, the pilot reported that a fair amount of power was required to start the aircraft rolling across the grass surface, which was firm and dry, leaving an excess of speed as he commenced his turn. During the turn, the aircraft continued turning to the left towards an area of parked aircraft, and the pilot attempted to use a burst of power and

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full right rudder to avoid a collision. However, this was insufficient to turn the aircraft, which had a tailskid and was not equipped with brakes. The pilot switched the engine off before G-ANNG rolled into a stationary Robin DR300 aircraft. The Robin's engine was not running as the two people on board were conducting pre-start checks. The occupants of both aircraft were uninjured and were able to vacate their aircraft normally without assistance.

The pilot of G-ANNG attributed the accident to taxiing with a quartering tailwind and the application of full nose-right rudder having the opposite effect to that intended, combined with the minimal braking or steering provided by the firm and dry ground.

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ACCIDENT

Aircraft Type and Registration:	Cessna P120N, N210UK	
No & Type of Engines:	1 Continental TS10-520-P piston engine	
Year of Manufacture:	1978	
Date & Time (UTC):	31 May 2017 at 1915 hrs	
Location:	Kilfinichen, Isle of Mull, Argyll and Bute	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Wingtip, nose gear and doors, propeller, spinner and lower cowling	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	49 years	
Commander's Flying Experience:	1,650 hours (of which 30 were on type) Last 90 days - 38 hours Last 28 days - 21 hours	

The aircraft took off from Wellesbourne Mountford for a flight to a private airstrip on the Isle of Mull in Scotland. The destination grass runway had a prounounced upslope of 5º with which the pilot was familiar. The pilot described a normal approach and a touchdown in a three-point attitude which was "not particularly hard." Approximately 100 m from touchdown, the nose landing gear collapsed and detached. The propellor contacted the ground, followed by the left wingtip and the aircraft came to a halt. The pilot was wearing a lap and diagonal harness and was uninjured.

Further examination revealed that the nose landing gear had failed at the fork, leading to detachment of the nosewheel and then the nose gear attachments. The grass runway was described as soft in places and the pilot did not consider that this was a particularly hard landing. The aircraft was not examined by the AAIB and the reason for the failure of the fork is unknown.

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ACCIDENT

Aircraft Type and Registration:	DH82A Tiger Moth, G-AXXV	
No & Type of Engines:	1 De Havilland Gipsy Major 1C piston engine	
Year of Manufacture:	1944 (Serial no: 85852)	
Date & Time (UTC):	27 May 2017 at 1530 hrs	
Location:	Dunkeswell Airfield, Devon	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 1
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Right main landing gear, right wingtip and right aileron	
Commander's Licence:	Airline Transport Pilot's Licence	
Commander's Age:	71 years	
Commander's Flying Experience:	18,800 hours (of which 1,500 were on type) Last 90 days - 111 hours Last 28 days - 43 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

A temporary grass runway had been designated to the left side of, and parallel with, tarmac Runway 22 at Dunkeswell Airfield. Whilst on approach, the pilot noticed that a freshly mown strip on the right hand side of the grass landing area, immediately adjacent to the tarmac runway, was a different colour from the rest. Believing that this mown strip was the only useable part of the runway, he aimed to land there.

During landing, the pilot reported that a 7 kt crosswind from the left caused the aircraft to drift further right towards the tarmac runway. Its right main landing gear then struck a runway side light and control box, and collapsed. The right wing and aileron tips scraped along the tarmac, and the aircraft came to rest half on the grass and half on the tarmac.

The pilot assessed that the accident was caused by a handling error, as he had been looking out to the left, and not the right, when the aircraft touched down.

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ACCIDENT

Aircraft Type and Registration:	Europa, G-BWIJ
No & Type of Engines:	1 Mid-West GIAE11OR-CA piston engine
Year of Manufacture:	2011 (Serial no: PFA 247-12513)
Date & Time (UTC):	24 June 2017 at 0920 hrs
Location:	Croft Farm Airstrip, Defford, Worcestershire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Propeller and minor damage to airframe
Commander's Licence:	Private Pilot's Licence
Commander's Age:	70 years
Commander's Flying Experience:	673 hours (of which 138 were on type) Last 90 days - 6 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The pilot carried out a go-around after a bounced landing. During the go-around there was vibration and a lack of power so he decided to land in a nearby field. The field was short and in attempting to make use of all the available length he undershot, landing in a field of maize.

History of the flight

This Europa aircraft was built and owned by the pilot; it has a monowheel landing gear and outriggers on each wing. The pilot stated that he had not been able to keep in regular flying practice for a 14 month period before the accident, but had recently started flying again.

The pilot went on a short local flight from Milson Airstrip, Shropshire, to Croft Farm Airstrip, Worcestershire. The weather conditions were fine with good visibility and a westerly wind of 10 kt. He was familiar with the airfield and made his approach to grass Runway 27, which is 570 m in length and 18 m width. When on the approach he realised he was high and fast and considered making a go-around, but thought that the landing would be manageable. On touchdown the aircraft bounced and he applied power to go around. As the aircraft started to climb it became obvious that there was something wrong because there was vibration and a lack of power. He decided to land in a nearby field to his left. The target field appeared quite short so he aimed to touch down at its start. He reduced power at what he thought was the right time but the aircraft dropped and touched down short, into a

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standing maize crop. The aircraft stopped quickly and remained upright; he was wearing a full harness and was able to vacate the aircraft unassisted.

The pilot inspected the aircraft afterwards and found that during the bounced landing the propeller had struck the runway and been damaged. He attributed the cause of the accident to his shortage of flying practice over the preceding 14 months, in particular circuit flying, which had led to his misjudgement of the landing.

The pilot, when asked, stated that it had crossed his mind to continue the flight and attempt to fly a circuit but had thought that it would be 'stupid' and so he decided to put down in an available field.

Analysis

The pilot felt vibration and a partial loss of power and decided to make a precautionary landing. Decision making in these circumstances, where some engine power is available, can be more complicated than for a complete engine failure. There may be a temptation to continue flight and turn back towards the airfield, when it may not be the best option. The power may be unreliable and there have been many occasions where an attempt to return to an airfield with reduced power has led to a loss of control and a serious or fatal accident. On this occasion the pilot decided to commit to a forced landing and the outcome was successful with no injury and relatively minor damage.

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ACCIDENT

Aircraft Type and Registration:	Jodel D117, G-BDIH
No & Type of Engines:	1 Continental Motors Corp C90-14F piston engine
Year of Manufacture:	1958 (Serial no: 812)
Date & Time (UTC):	3 June 2017 at 1207 hrs
Location:	Bedlands Gate Airfield, Cumbria
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Collapsed fuselage, damage to the wing, engine, lower engine cowl and propeller
Commander's Licence:	Light Aircraft Pilot's Licence
Commander's Age:	67 years
Commander's Flying Experience:	517 hours (of which 131 were on type) Last 90 days - 19 hours Last 28 days - 7 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and additional inquiries made by the AAIB

The pilot arrived overhead Bedlands Gate Airfield at 1200 ft aal and, noting that the windsock indicated that the wind was from 180 degrees at 15 kt, elected to fly an approach to land on grass Runway 16. The pilot was aware that Runway 16 is only 390 m long and also had a slight downhill slope and so he intended to land 50 m beyond the threshold.

He established a stable descent using 1500 rpm for a 60 kt approach, before further reducing power to 1200 rpm and 50 kt airspeed just prior to the airfield's boundary. At this point, he encountered turbulence which rapidly pitched the nose of the aircraft up and the stall warner sounded. The pilot immediately lowered the nose and didn't apply engine power due to the close proximity of the ground, but instead cautiously attempted to raise the nose to flare the aircraft and land. However the nose, lower engine cowling and main wheels impacted the ground first, before the aircraft bounced and landed again on main wheels and tailwheel. It rolled a further 20 m, slewing left off the runway into long grass, before coming to rest on its nose.

The uninjured pilot, who was wearing a full harness, switched off the fuel and electrical system before vacating the aircraft through the left canopy door and a break in the fuselage.

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ACCIDENT

Aircraft Type and Registration:	Piper PA 24, N7456P
No & Type of Engines:	1 Lycoming 250 piston engine
Year of Manufacture:	1961
Date & Time (UTC):	21 July 2017 at 1055 hrs
Location:	Retford (Gamston) Airport, Nottinghamshire
Type of Flight:	Private
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Landing gear collapsed causing damage to underside panels and propeller; engine shock-loaded
Commander's Licence:	Private Pilot's Licence (Federal Aviation Administration, USA)
Commander's Age:	59 years
Commander's Flying Experience:	1,257 hours (of which 388 were on type) Last 90 days - 1 hour Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

Downdraughting air, or windshear, was encountered shortly before touchdown and the pilot was unable to prevent the aircraft landing heavily, with consequential collapse of the landing gear.

History of the flight

The aircraft departed Leeds East Airport and flew to Retford (Gamston) Airport where the pilot intended to execute a touch-and-go landing, before returning to Leeds East. His passenger, in the front right seat, was a qualified Federal Aviation Administration Flight Instructor who was observing the pilot for the purpose of a Flight Review, in accordance with Federal Aviation Regulations. Before departure the pilot obtained a forecast surface wind for Retford which was from 180º at 14 kt. The flight proceeded in a southerly direction at heights between 1,000 ft and 2,000 ft agl and light to moderate turbulence was experienced. Prior to landing at Retford the wind was reported to be from 160º at 10 kt, with no associated warnings of possible turbulence or windshear.

As the asphalt Runway 21 was in use, the pilot approached using an intermediate flap setting (two stages of flap) and increased the airspeed slightly to allow for the crosswind component. The instructor confirmed that the approach appeared to be "fairly stable", with

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the landing gear down and flaps set, until approximately 100 ft agl when he noticed the airspeed temporarily reduce by approximately 10 kt. The pilot recalled that the turbulence increased at this height and that he felt the aircraft sink, but that he was able to correct for this. Then, at approximately 20 ft agl, he experienced further sink which he attempted to correct by increasing the power, but the stall warner sounded and he responded by pushing forward on the control column. However, he was unable to escape the downdraughting air and the aircraft struck the runway “fairly hard” and nose first.

According to the passenger, the nose landing gear collapsed on impact and the aircraft skidded along the runway with the propeller striking the surface and causing the engine to stop. The main landing gear collapsed before the aircraft came to a halt. The pilot then turned off the master switches and the fuel while the passenger opened the door and moved the mixture control to CUT OFF. The two occupants evacuated the aircraft (Figure 1) without injury, prior to the arrival of the airport’s rescue service.

Figure 1

View of N7456P shortly after the crew evacuated

(Photograph courtesy of Dave Grimsdale – Photographer - Retford (Gamston) Airport)

Pilot’s observations

The pilot reported that he had been landing at and taking off from Retford for 24 years. He had previously experienced worse conditions of windshear, on both available runways, than those encountered during the accident flight. He commented that, because the conditions did not seem bad during the early stages of the approach, he was probably not mentally prepared for the downdraughts which affected the aircraft shortly before touchdown.

When reviewing the accident conditions, the pilot realised that when he experienced the downdraughts he was more or less in the lee of a long line of airport buildings and tall trees, so they may have created some rotor effect. He noted that when the reported wind was passed to him by radio, he was still some three miles from the airfield so, in hindsight, it may have been worthwhile if he had requested a further wind report when he was closer. After the accident, the airport’s rescue service recorded the surface wind as being from 150° at 17 kt.

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AAIB Comment

The International Civil Aviation Organisation (ICAO) has published a '*Manual on Low-level Windshear*' (ICAO Doc 9817) which states that buildings such as hangars and fuel storage tanks commonly cause low-level windshear, particularly at smaller aerodromes. It notes that even when such buildings are not especially tall, they tend to have large lateral dimensions and to be grouped together, thus presenting:

> *'a wide and solid barrier to the prevailing surface wind flow. The wind flow is diverted around and over the buildings causing the surface wind to vary along the runway. Such horizontal wind shear, which is normally very localized, shallow and turbulent, is of particular concern to light aircraft operating into smaller aerodromes but has also been known to affect larger aircraft.'*

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ACCIDENT

Aircraft Type and Registration:	Piper PA-24-250 Comanche, N673SA	
No & Type of Engines:	1 Lycoming 0-540 engine	
Year of Manufacture:	1959 (Serial no: 24/2240)	
Date & Time (UTC):	19 May 2017 at 1740 hrs	
Location:	Firs Farm Airfield, Newbury, Berkshire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 1
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Left landing gear collapsed	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	77 years	
Commander's Flying Experience:	1,366 hours (of which 866 were on type) Last 90 days - 16 hours Last 28 days - 7 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

The aircraft made an approach to a grass airfield during a heavy shower of rain. The approach speed was high and the pilot touched down with approximately 400 m of runway remaining. Aircraft performance tables give a corrected landing distance for a wet grass surface of 309 m. This figure is based on 'short field technique' which assumes the application of maximum braking. In this case the pilot braked hard but encountered wheel locking and was forced to reduce brake pressure to prevent a skid. The landing distance required would therefore have been significantly increased. Without short field technique applied the manufacturers documents indicate that landing distance might be doubled. At the end of the runway the prospective overrun had been planted with crops and so the pilot attempted a turn with higher than normal speed. During the turn the aircraft skidded and slid off the operating surface into the crops. The left hand undercarriage leg collapsed but both those on board exited the aircraft without injury. The pilot reported that, given the high speed and the incorrect touchdown point, he should have executed a go-around. CAA Safety Sense Leaflet 7c contains very useful information for GA performance planning.

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ACCIDENT

Aircraft Type and Registration:	Piper PA-28-140, G-ATVO
No & Type of Engines:	1 Lycoming O-320-E2A piston engine
Year of Manufacture:	1966 (Serial no: 28-22020)
Date & Time (UTC):	30 March 2017 at 1450 hrs
Location:	Shoreham-by-Sea, West Sussex
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Aircraft submerged in seawater
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	48 years
Commander's Flying Experience:	8,303 hours (of which 4,000 were on type) Last 90 days - 8 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

On departure from Shoreham Airport, as the aircraft climbed through 450 ft, the engine abruptly stopped producing power and the aircraft was ditched a short distance from the beach at Shoreham-by-Sea. Despite a detailed examination of the aircraft, the cause of the abrupt power loss during the takeoff was not established.

History of the flight

The aircraft was being used for a training flight to convert a PPL(A) holder to the aircraft type. The accident flight was the first flight of the day. The aircraft had been refuelled the previous day to 'tabs'[1] on both the left and right wing fuel tanks and the aircraft contained sufficient fuel for more than three hours of flight. After being refuelled, the aircraft had been kept outside and the weather had been dry, with no rainfall. The PPL(A) holder conducted the daily check, including draining half of a sampling tube of fuel from both the left and right wing fuel tank drains and from the firewall gascolator. He stated that each of these three samples consisted of blue-coloured AVGAS, which he confirmed by smelling the samples. He also stated that none of the samples contained any visible water droplets or bulk water in the bottom of the sampling tube.

Footnote

[1] An internal metal 'tab' in the PA-28-series wing fuel tanks marks the fuel level at which each wing tank contains 17 US gal of fuel.

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The PPL(A) holder, who was the handling pilot, was sitting in the left cockpit seat and the commander occupied the right seat. The commander stated that the left fuel tank was selected for engine start and for taxiing to the holding point for Runway 20, before the PPL(A) holder then switched to the right fuel tank for engine run-up and pre-takeoff checks. The engine run-up checks were completed without any abnormal magneto rpm drops on either magneto and with no evidence of carburettor ice during the carburettor heat check. As part of the pre-takeoff checks the electric fuel pump was switched ON and the fuel primer was locked closed.

As a demonstration to the PPL(A) holder, the commander requested that the aircraft be configured for a short-field takeoff, with two stages of flap selected. He stated that having lined up on Runway 20, full power was applied for five seconds and he noted the static propeller rpm was 2,400 prior to brake release, which was normal for this aircraft. The takeoff and initial climbout were normal, with the engine running smoothly and the flaps were retracted one stage as the aircraft climbed through approximately 350 ft. As the aircraft crossed the coast heading southwest, whilst climbing through 450 ft, the engine abruptly lost power although the propeller continued to windmill. The PPL(A) holder passed control of the aircraft to the commander, who lowered the nose to maintain best glide speed and turned the aircraft 150º to the left, towards the shoreline. During the descent the commander confirmed that the fuel was selected to the right tank, that the magneto switch was set to BOTH, the primer was locked closed and the electric fuel pump switch was ON. He 'pumped' the throttle to exercise the carburettor accelerator pump, but the engine did not respond.

As the engine continued to windmill without producing power, the commander realised that a ditching was inevitable so he turned the aircraft 60º right to track parallel to the shoreline and made a MAYDAY radio transmission to Shoreham ATC. He selected two stages of flap and opened the cabin door. The sea was calm with a slight swell and the aircraft ditched approximately 10 m from the shoreline. The aircraft remained upright and both crew were able to exit the aircraft without difficulty and swam to the shore. The aircraft subsequently sank, but was later recovered with no significant damage other than from being immersed in seawater.

Following the accident the airport operator confirmed that the fuel sample from the batch used to refuel G-ATVO had passed the normal fuel quality examination, and that no other aircraft receiving fuel from the same batch had reported any fuel-related problems.

Aircraft examination

The aircraft was recovered from the ditching site by the owner with the assistance of an aircraft recovery company and was dismantled prior to an examination by the AAIB. The aircraft's fuel system had been contaminated by the ingress of seawater and no reliable fuel samples were obtained. The fuel selector valve was found selected to the right wing tank. There was no evidence of a fuel leak and no obstructions were evident within the fuel system's tanks, vents, filters, fuel lines, gascolator and electric and mechanical fuel pumps. The carburettor was inspected and no defects were noted; the accelerator pump functioned normally when tested. The mechanical fuel pump was tested and found to function normally.

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The aircraft's engine was inspected following its disassembly at an engine overhaul facility; the engine has accumulated 1,126 operating hours since its last overhaul. There were no failures evident that would account for an abrupt and complete loss of engine power, although it was noted that the camshaft lobes 2, 5 and 6 were significantly worn, Figure 1. The respective bearing faces of the tappet bodies were also heavily worn, with extensive surface spalling, Figure 2.

Figure 1

Worn camshaft removed from G-ATVO

Camshaft lobes 2 and 5 operate the inlet valves on the forward and aft pair of cylinders respectively. Camshaft lobe 6 operates the exhaust valve on the left rear cylinder.

The engine's oil filter had been removed from the engine during the aircraft's dismantling and had been lost, and therefore was not available for inspection. The aircraft owner confirmed that the contents of the oil filters removed during the previous three 50-hour maintenance checks, following his acquisition of the aircraft, had been examined for debris. He stated that apart from one instance where three small metal 'whiskers' were noted on the filter element, no other metallic debris had been visible during these examinations.

The engine's exhaust system was examined and no blockages or loose internal baffles were observed. The magnetos and ignition harness were not in a condition to be functionally tested due to seawater contamination.

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Figure 2

Tappet bodies removed from G-ATVO, showing spalling of the tappet faces

Meteorology

The weather conditions reported at the time the accident occurred were no cloud below 5,000 ft and a visibility of more than 10 km. The wind was from 120ºM at 10 kt, the temperature was 15 ºC and the dew point was 10 ºC. The carburettor icing chart published by the CAA[2] indicates the possibility of a serious risk of carburettor icing at all power settings, Figure 3.

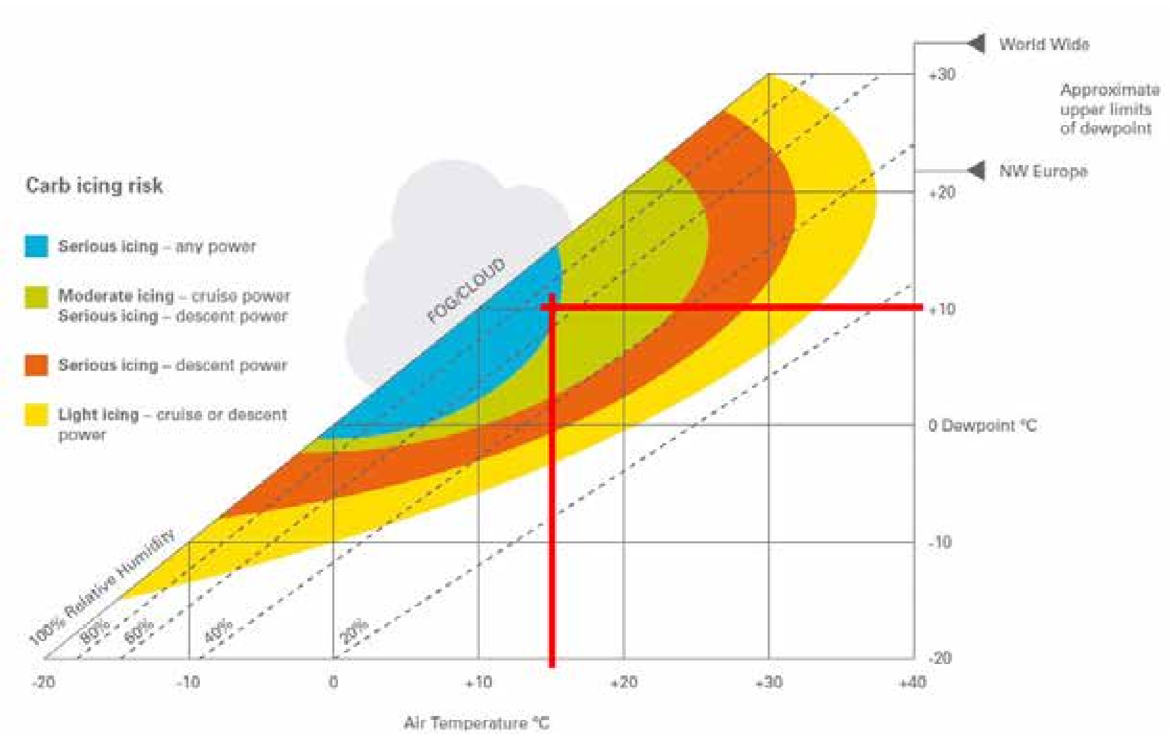

Figure 3

CAA carburettor icing chart

Footnote

2 http://www.caa.co.uk/General-aviation/Safety-information/The-Skyway-Code/

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Tests and research

A ground test was conducted by the AAIB using a PA-28-161 Warrior, which has a marginally more powerful Lycoming O-320 engine than that fitted to G-ATVO. Whilst the engine was running, the fuel selector valve was moved to the OFF position and the engine continued to run for 44 seconds before stopping due to fuel starvation. During this period the normal engine run-up and pre-takeoff checks were completed before the engine was then run at full power until it stopped.

The volume of fuel in the fuel line between the fuel selector valve and the right wing tank was estimated by measuring the length and internal diameter of the fuel line. This volume was calculated to be 0.136 litre, sufficient for the engine to run at full power for a further 16 seconds. Therefore should contaminated fuel be drawn into the fuel system from the right tank, following its selection, a period of approximately one minute may elapse before the contaminated fuel can reach the engine causing a sudden power loss.

Analysis

The absence of any engine rough-running immediately before the abrupt power loss indicates that the cause was probably not due to a fault with the dual-independent ignition systems. The commander described carrying out a carburettor icing check as part of the engine run-up checks prior to departure, with no carburettor ice detected. Given the ambient weather conditions, carburettor icing was more likely to form at low power settings rather than the wide-open throttle setting used for takeoff. Therefore if carburettor icing had occurred, it would probably have been detected after the period of ground taxiing to the Runway 20 holding point rather than during takeoff, which itself occurred shortly after carburettor heating had been applied as part of the carburettor icing check.

The worn camshaft lobes would cause a loss of engine power output due to reduced inlet valve travel on all four cylinders and changes in valve timing. However, despite the level of camshaft lobe wear, the engine continued to run smoothly and produced sufficient power to allow the aircraft to take off and climb to 450 ft prior to the loss of power. When the engine was disassembled, no mechanical failures were apparent that could account for a sudden power loss.

It is possible that the power loss may have been caused either by contaminated fuel being drawn into the engine from the right fuel tank, or by a restriction in fuel flow by an unidentified obstruction within the fuel system. Tests conducted by the AAIB showed that once the right tank had been selected, if contaminated fuel was present in the right tank the engine could have run for approximately one minute prior to engine stoppage. The PPL(A) holder who conducted the daily fuel drain check did not report finding any contamination in the samples drained from fuel tanks, and it was not possible to later determine whether any fuel contamination had occurred due to seawater ingress into the fuel system after the aircraft had ditched. The cause of the engine power loss was therefore not established.

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Conclusion

On departure from Shoreham Airport, as the aircraft climbed through 450 ft, the engine abruptly stopped producing power and the aircraft was ditched a short distance from the beach at Shoreham-by-Sea. The cause of the abrupt power loss during the takeoff was not established.

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ACCIDENT

Aircraft Type and Registration:	Piper PA-28-161 Cherokee Warrior II, G-BNZZ
No & Type of Engines:	1 Lycoming O-320-D3G piston engine
Year of Manufacture:	1982 (Serial no: 28-8216184)
Date & Time (UTC):	19 June 2017 at 1050 hrs
Location:	East Kirkby Airfield, Lincolnshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to landing gear and structure
Commander's Licence:	Private Pilot's Licence
Commander's Age:	63 years
Commander's Flying Experience:	279 hours (of which 49 were on type) Last 90 days - 43 hours Last 28 days - 6 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

East Kirkby is an unlicensed airfield within the Coningsby Military Aerodrome Traffic Zone. The airfield has an unmarked landing strip that is part grass and part concrete. Online advice recommends that:

> *'the concrete should only be used for emergency run off and it is best for you to land entirely on the grass.'*

Having been cleared by ATC to descend at his discretion, the pilot noted that he was slightly north of the extended runway centreline. He corrected his course and observed a vehicle turning away from him on the concrete at the far end of the runway. On touching down, he "sensed that the distance would be tight", but decided against a touch-and-go because of reduced climb performance due to the high ambient temperature and the proximity of personnel and vehicles. Unable to stop on the grass, the aircraft was damaged when it struck a raised kerb at the transition with the concrete. The pilot and his passenger were uninjured.

The pilot attributed the accident to a combination of a high approach and landing long and to the left of the unmarked strip; he also commented that the "airfield plate" was ambiguous.

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ACCIDENT

Aircraft Type and Registration:	Piper PA-28-161 Cherokee Warrior II, G-BSBA
No & Type of Engines:	1 Lycoming O-320-D3G piston engine
Year of Manufacture:	1980 (Serial no: 28-8016041)
Date & Time (UTC):	17 August 2017 at 1230 hrs
Location:	Sandown Airfield, Isle of Wight
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 2
Injuries:	Crew - None Passengers - None
Nature of Damage:	Right fuel tank, left wing leading edge and cowling. Damage to wooden post of barbed wire fence
Commander's Licence:	Private Pilot's Licence
Commander's Age:	60 years
Commander's Flying Experience:	108 hours (of which 108 were on type) Last 90 days - 4 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot and two passengers were flying from Fairoaks Airport to Sandown Airfield. The pilot reported that on the final approach for grass Runway 23, the aircraft was 'fairly high', but decided to continue with the approach with the intent of landing slightly 'further down the runway', which the pilot considered would help avoid 'chop' whilst overflying trees on the approach. The reported wind was from 240° at 15 kt. As the pilot flared the aircraft for touchdown, she realised that she had initiated the manoeuvre too early and that the aircraft was still several feet above the runway and at a low airspeed. The aircraft then descended and bounced, at which point the pilot applied engine power to attempt to go around. The aircraft did not climb and veered to the left, departing the left side of the runway. It did not respond to attempts to bring it back towards the runway. At this point the passenger in the right front seat, who was also a pilot, took control and manoeuvred the aircraft onto the adjacent taxiway where it was brought to a stop after striking a wire fence and wooden post.

Bulletin Correction

Prior to publication online final three sentences of this report were amended. The amendment was in order to provide clarification as to when the other aircraft occupant took control.

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ACCIDENT

Aircraft Type and Registration:	Piper PA 32R-301T, N88NA
No & Type of Engines:	1 Lycoming TIO-540-S15AD piston engine
Year of Manufacture:	1984 (Serial no: 32R8529005)
Date & Time (UTC):	18 May 2017 at 1700 hrs
Location:	White Waltham Airfield, Berkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Propeller and nosewheel
Commander's Licence:	Private Pilot's Licence
Commander's Age:	24 years
Commander's Flying Experience:	265 hours (of which 69 were on type) Last 90 days - 26 hours Last 28 days - 23 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft was being taxied from its grass parking position to a hangar at White Waltham Airfield, via a newly built concrete apron. As N88NA approached the apron's east side, its nose landing gear sunk into soft ground immediately adjacent to the concrete, and collapsed. The propeller then struck the concrete.

The pilot reported that he discovered after the accident that entry to the apron was permitted from the west side only. He reported that the east side had originally been marked as unusable with orange gates. However, due to on-going ground-work, a marker had been removed leading him to believe that entry to the concrete was permitted at that location.

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ACCIDENT

Aircraft Type and Registration:	Piper PA-38-112 Tomahawk, G-BMVM
No & Type of Engines:	1 Lycoming O-235-L2C piston engine
Year of Manufacture:	1979 (Serial no: 38-79A0025)
Date & Time (UTC):	14 June 2017 at 0930 hrs
Location:	Brimpton Airfield, Berkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Propeller, engine, fuselage, nosewheel, wings
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	72 years
Commander's Flying Experience:	15,000 hours (of which 34 were on type) Last 90 days - 1 hour Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

While taking off from Runway 25 at Brimpton Airfield the aircraft did not accelerate sufficiently to achieve takeoff speed and overran the end of the runway. The pilot considered that the variable wind conditions may have led to a tailwind component, resulting in a required takeoff distance greater than that which was available.

History of the flight

The pilot intended to fly from Brimpton Airfield to Thruxton Airfield. He stated that the weather for the departure from Brimpton was forecast to be good, however prior to departing he observed that the wind was gusting at approximately 8 to 10 kt with an estimated mean direction of 180°, and varying by approximately 30° in each direction. He considered that this favoured a departure from Runway 25 and he described the grass runway surface as being dry and well cut. However, the grass on the 50 m runway starter extension had not been cut and as the extension has a significant upslope, he elected not to use it, instead commencing the takeoff from the Runway 25 threshold.

The pilot reported that the initial takeoff roll on Runway 25 appeared normal, but as the takeoff progressed, the aircraft did not achieve the expected acceleration. He commented that there is a hump at the mid-point of the runway, by which point he normally expects the aircraft's speed to be 50 kt. On this occasion the pilot observed the speed to be 45 kt, but he fully expected the aircraft to achieve the 55 to 60 kt required for takeoff before reaching

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the end of the runway. However, there was no further acceleration and the aircraft overran the runway, coming to rest nose-down in a crop field approximately 10 to 15 m beyond the runway end. The pilot was uninjured and exited the aircraft without assistance. He attributed his lack of injury to the fact that he had been wearing a full harness.

Another pilot at the airfield, who had elected not to fly his own aircraft after observing the local weather conditions, witnessed the accident. He noted by reference to the airfield anemometer and windsock, that the wind direction was varying between 220º and 050º, with a strength of approximately 2 to 4 kt, occasionally increasing to 8 kt. He also noted the temperature as 24 ºC and QNH as 1016 hPa. Concerned about a possible tailwind and the implications on takeoff performance of his own aircraft, he elected not to fly and was closing up his aircraft when he saw G-BMVM commence its takeoff roll. He reported that by the mid-point of the runway it was evident to him that the accident aircraft had insufficient speed to take off and had expected to see it brought to a stop, but instead it continued and subsequently overran the end of the runway.

Discussion

The aircraft was based at Brimpton and regularly operated from there without any takeoff performance issues. The accident pilot retrospectively carried out an approximate takeoff performance calculation which indicated that, at maximum weight, the takeoff distance required on a grass runway would be 519 m, and the presence of a 5 kt tailwind component would increase that to 621 m. Although the aircraft weight at the time of the accident was 190 lb less than the maximum takeoff weight, which would have somewhat reduced the actual takeoff distance required, Runway 25 at Brimpton is 520 m long. Given the ambient conditions on the day, the presence of a tailwind would have meant that adequate takeoff performance could not be assured.

The pilot considered that the wind may have changed direction during the latter part of the takeoff roll giving a tailwind component, which required a greater takeoff distance than that which was available.

The CAA publication Safety Sense Leaflet 07C *'Aeroplane Performance'* includes useful advice on aircraft takeoff performance planning.

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ACCIDENT

Aircraft Type and Registration:	Rans S6-ES Coyote II, G-SBAP
No & Type of Engines:	1 Jabiru 2200A piston engine
Year of Manufacture:	2013 (Serial no: LAA 204-14991)
Date & Time (UTC):	7 May 2017 at 1130 hrs
Location:	Belle Vue Airfield, North Devon
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Fuselage, left wing and engine damaged beyond economic repair
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	54 years
Commander's Flying Experience:	152 hours (of which 31 were on type) Last 90 days - 31 hours Last 28 days - 15 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

During takeoff from Runway 08 at Belle Vue Airfield the aircraft suddenly pitched up and starting rolling to the left. The pitch-up was possibly caused by a bump in the runway or a sudden gust of wind. The pilot attempted to correct the pitch and roll but was unable to stop the aircraft hitting a fence beside the runway. The port wing struck first, followed by the undercarriage and propeller spinning the aircraft around so it came to rest facing the beginning of the runway. Neither the pilot nor the passenger were injured although the aircraft was damaged beyond economic repair.

The pilot felt that his attempt to stop the aircraft rolling further to the left at such a slow speed may well have exacerbated the situation causing the aircraft to pitch and roll faster as if stalled.

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ACCIDENT

Aircraft Type and Registration:	Taylor Monoplane, G-BEYW	
No & Type of Engines:	1 Volkswagen 1834 piston engine	
Year of Manufacture:	1984 (Serial no: PFA 055-10279)	
Date & Time (UTC):	15 August 2016 at 1201 hrs	
Location:	Manchester Barton Airport	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - 1 (Serious)	Passengers - N/A
Nature of Damage:	Aircraft destroyed	
Commander's Licence:	Not established	
Commander's Age:	Not established	
Commander's Flying Experience:	Not established	
Information Source:	AAIB enquiries	

Synopsis

The aircraft collided with trees while the pilot was attempting to execute a forced landing in a field outside the airport boundary, following a loss of engine power during takeoff. The pilot suffered serious injuries in the accident. The reason for the loss of power was not established.

History of the flight

Witnesses reported that the aircraft engine seemed to lose power at about 100 ft while taking off from Runway 08R at Manchester Barton Airport. The pilot attempted to execute a forced landing, turning slightly left from the runway heading to avoid a built-up area. However, the aircraft collided with trees during the final stages of the approach to a field and crashed in a wooded area, just outside the airport perimeter fence. The aircraft became lodged in the trees, trapping the pilot who required assistance from firefighters to exit the wreckage. The pilot sustained serious but not life-threatening injuries in the accident, but his health subsequently deteriorated after suffering post-operative complications. The aircraft was destroyed in the impact.

A video recording of the takeoff showed the aircraft initially climb and then descend and level off, before continuing a shallow climb and turning left towards trees as it reached the end of the runway. The video ended as the aircraft was turning left from the runway heading, at which point the engine tone was still audible on the recording.

At the time of the accident the aircraft was undergoing an annual test flight for the renewal of the Certificate of Validity for its Permit to Fly. The flight had been logged with Air Traffic

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Control as a test flight. As the previous Certificate of Validity had expired, the aircraft was being flown under a Permit Flight Release Certificate which had been 'signed off' by an LAA Inspector. The LAA Inspector reported that pilot was in good spirits prior to the flight.

Prior to the test flight the pilot had undertaken some maintenance on the aircraft's engine. This included removal of the four cylinder heads in order to re-seal the pushrod tubes. This work had been inspected by the LAA Inspector and engine ground runs had been conducted, before authorising the test flight.

The pilot had originally planned to conduct the test flight a few days prior to the accident flight. However, he had instead spent that day carrying out maintenance on the aircraft and conducting multiple ground runs and fast taxi tests. Personnel at the airfield were aware that the pilot had been experiencing engine problems with the aircraft. The pilot had not informed, nor sought assistance from, his LAA Inspector when it became apparent that the engine was not performing well.

Aircraft and engine examination

The engine and firewall had detached from the aircraft during the impact. The fibreglass fuel tank had also detached from the airframe and been ruptured. The engine and fuel system were subsequently moved to a workshop for examination by the LAA Inspector.

During this examination it was noted that both wooden propeller blades had broken off at the hub, indicating that the engine had been developing at least some power at impact. After removing some components that had been damaged during the impact, the engine rotated freely, exhibiting good compression on all cylinders and valve operation was observed to be normal.

No anomalies were noted with the spark plugs, ignition timing or operation of the magnetos, when tested. The carburettor float chamber was clean and free from contamination, but contained no trace of fuel. The float valve operated normally, no inlet restrictions were noted and the carburettor jets were free from blockage. The LAA Inspector considered that the locking wire on the carburettor fuel inlet may have been altered. During the recent inspection for issue of the Permit to Fly the wire locking on the carburettor had been replaced by a professional, and its appearance post-accident was not consistent with this.

When the engine had been moved to the workshop, a large amount of oil was released from the crankcase breather, which suggested that the engine may have lain upside down at some point following the accident, possibly accounting for the lack of fuel in the carburettor.

There was no fuel remaining in the fuel tank, any fuel having likely leaked out due to the damage sustained in the accident. There were no other anomalies observed with the various components of the fuel system and the fuel pump operated satisfactorily when tested.

Discussion

Witness evidence indicated that the aircraft's engine had not been performing well in the days prior to the accident flight; however, the pilot did not discuss these issues with his LAA

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Inspector prior to conducting the test flight. It was not established what maintenance activity had recently been performed on the engine by the pilot, however there was some evidence that the maintenance activity may have involved accessing the carburettor fuel inlet. The pilot was not able to assist the AAIB with its enquiries. A post-accident examination of the engine and fuel system by an LAA Inspector did not reveal any anomalies which could have accounted for the loss of power during takeoff. Carburettor icing or fuel vaporisation, which can occur when using MoGAS, could not be ruled out.

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SERIOUS INCIDENT

Aircraft Type and Registration:	Vans RV-4, G-RVER
No & Type of Engines:	1 Lycoming O-360-A1A (MODIFIED) piston engine
Year of Manufacture:	1991 (Serial no: 497)
Date & Time (UTC):	2 May 2017 at 1330 hrs
Location:	Bute Airfield, South Lanarkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Propeller and engine shock-loaded and tailwheel damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	42 years
Commander's Flying Experience:	340 hours (of which 269 were on type) Last 90 days - 15 hours Last 28 days - 9 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

On arrival at Bute there was no wind and the aircraft was parked facing west. Approximately an hour and a half later the pilot returned and, after the normal pre-flight checks, started up. During start-up the control column was held fully aft, which is normal. In order to taxi forward, while still holding the control column aft, the pilot applied some power along with right rudder and brake to initiate a turn. At this point the tail rose and, although the right brake was released, the tail continued to rise until the propeller struck the ground and stopped the engine after approximately 4-5 full revolutions. After shutting down the pilot realised the wind had picked up and was from the east, at approximately 12 kt. There was therefore a tailwind affecting the taxi out and he reported that it would have been more appropriate to hold the control column neutral or slightly forward.

A subsequent examination of the aircraft showed damage to the outer four inches of both propeller blades, and the tailwheel spring retaining bolt hole was elongated with the retaining bolt bent.

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ACCIDENT

Aircraft Type and Registration:	Eurofox 912(1), G-ONIK
No & Type of Engines:	1 Rotax 912UL piston engine
Year of Manufacture:	2015 (Serial no: BMAA/HB/665)
Date & Time (UTC):	16 June 2017 at 1342 hrs
Location:	Cobbs Cross Airstrip, Worcestershire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Significant damage to airframe
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	65 years
Commander's Flying Experience:	309 hours (of which 187 were on type) Last 90 days - 38 hours Last 28 days - 26 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot returned to land at his home airstrip and assessed the wind strength and direction from the windsock as he flew overhead. He joined the circuit downwind and then flew a stable final approach into an estimated steady 7 kt wind. The pilot reported that approximately 200 m from the runway threshold, he noticed that the windsock had dropped and was now hanging down. He arrived at the threshold slightly faster than normal, resulting in the aircraft bouncing and then floating. The pilot elected to go around but as he did so a strong gust from the right lifted the wing, reducing the airspeed and pushing the aircraft to the left of the runway. The left wing then clipped a tree causing the aircraft to slow further, at which point it stalled and fell to the ground. The pilot was uninjured, but the aircraft was significantly damaged.

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ACCIDENT

Aircraft Type and Registration:	Falcon 8 Trinity Asctec, (UAS) BAS-02	
No & Type of Engines:	8 x electrical motors	
Year of Manufacture:	2016	
Date & Time (UTC):	17 April 2017 at 11:55 hrs	
Location:	North Sea	
Type of Flight:	Commercial	
Persons on Board:	Crew - None	Passengers - None
Injuries:	Crew - N/A	Passengers - N/A
Nature of Damage:	Submerged in sea water	
Commander's Licence:	CAA UAS Permission	
Commander's Age:	27 years	
Commander's Flying Experience:	202 hours (of which 200 were on type) Last 90 days - 7 hours Last 28 days - 7 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

The Unmanned Air System (UAS) was operating from a ship in the North Sea to carry out inspection work. After takeoff, when the Unmanned Air Vehicle (UAV) was approximately 20 m away from the ship and at a height of approximately 20 m, the pilot successfully carried out hover checks, in accordance with the operator's standard operating procedures. He then switched the UAS into GPS mode and the UAV held position, indicating to the pilot the system was functioning correctly. He started flying the UAV onto task, but when it was about 30 m from the ship, the UAV appeared to enter its emergency 'Come Home High' mode, indicating a loss of link. The pilot attempted to regain control by switching first to height mode and then to manual mode, but the UAV remained uncontrollable and descended into the sea.

The UAV floated for a few seconds before sinking, although the operator was able to recover it back to the ship.

The UAS was returned to the manufacturer to try to establish the cause of the lost link. Tests on the software, UAV and ground station were unable to identify any faults.

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ACCIDENT

Aircraft Type and Registration:	Rotorsport UK MT-03, G-TELC
No & Type of Engines:	1 Rotax 914-UL piston engine
Year of Manufacture:	2008 (Serial no: RSUK/MT-03/028)
Date & Time (UTC):	7 May 2017 at 1427 hrs
Location:	Near Carrickmore Airfield, Co Tyrone
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Minor) Passengers - 1 (Minor)
Nature of Damage:	Damaged beyond economic repair
Commander's Licence:	Private Pilot's Licence (A) and (G)
Commander's Age:	59 years
Commander's Flying Experience:	539 hours (of which 173 were on type) Last 90 days - 11 hours Last 28 days - 9 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The gyroplane was departing from Runway 26 at Carrickmore Airfield. After lifting off, the pilot lowered the nose attitude to accelerate and then, as the end of the runway approached, the gyroplane started to sink. It descended into trees in a ravine beyond the end of the runway.

History of the flight

There was a fly-in at Carrickmore Airfield over the weekend of 6 May to 7 May 2017. The pilot and passenger had flown there from Glasgow on the day of the accident; the flight was uneventful.

For the return flight to the UK mainland the pilot planned to fly first to Newtownards, Co Down, to refuel, before continuing across the sea to Kirkbride Airfield, Cumbria. The pilot reported that the gyroplane had 25 kg of fuel on board and a calculated takeoff weight of 445 kg, 5 kg below the Maximum Authorised Takeoff Weight. Weather conditions were clear with a surface wind from 010º at 9 kt and a temperature of 18 ºC. Runway 26 was in use, which has an asphalt surface of 375 m length and 6 m width.

The airfield was busy; there were a number of aircraft departing after the fly-in and a Robinson R44 helicopter was carrying out local pleasure flights. The pilot lined up on Runway 26 and, mindful that the runway was relatively short, added an extra 50 rpm to the

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normal rotor pre-rotation speed of 200 rpm before starting to move along the runway. The takeoff run appeared normal. After lifting off the pilot lowered the nose to maintain a level attitude and the gyroplane started to accelerate and then to climb.

Towards the end of the runway the pitch attitude increased slightly and two seconds later the gyroplane started to sink. The pilot could not prevent the sink and turned slightly left, then right attempting to follow lower lying ground. The gyroplane descended into trees in a ravine beyond the end of the runway. It came to rest on a steep slope with the forward fuselage having struck a large tree stump.

The pilot and the passenger were both wearing full four-point harnesses, robust outdoor clothing and helmets. Both occupants were unconscious for a period of time after the impact and commented that they considered the helmets had protected them from more severe injury. Rescuers on foot, and subsequently the emergency services, arrived at the scene some minutes after the accident and assisted the pilot and the passenger. They were both flown to a nearby hospital.

Airfield information

Carrickmore Airfield is situated at an elevation of 541 ft amsl on the side of a valley where the ground rises from the north to the south. Runway 26 has a hard surface of 375 m length, with a downslope. Immediately north of the airfield, alongside and below Runway 26, is a line of trees which shelters the runway in northerly wind conditions. At the western end of Runway 26 the ground falls away into a steep wooded ravine. An aerial image of the runway at Carrickmore is at Figure 1.

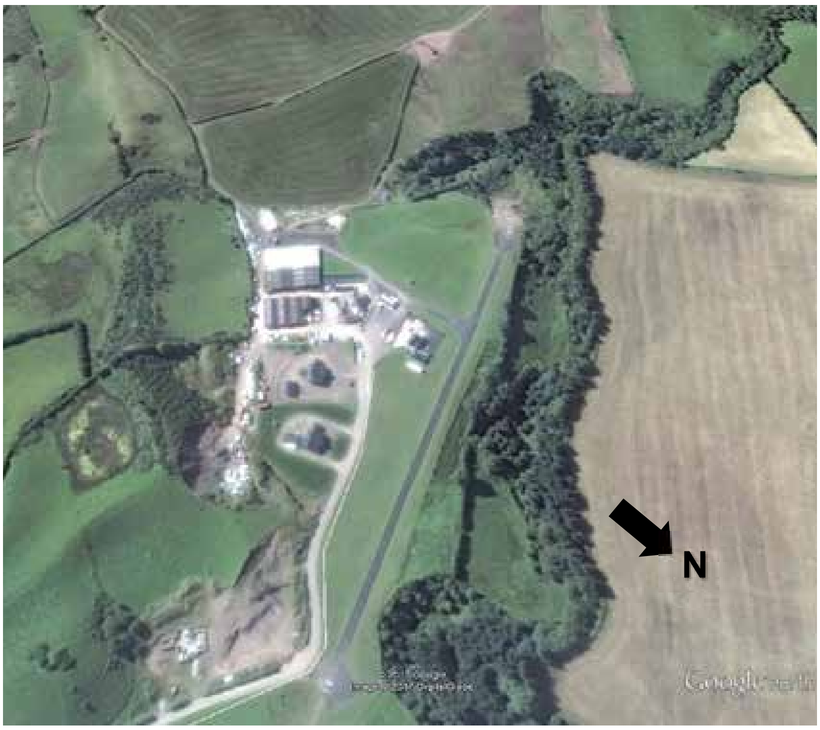

Figure 1

Airfield at Carrickmore in 2016, Runway 26 threshold at bottom of image

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Aircraft information

The Flight Manual for the MT-03 at 450 kg Maximum Takeoff Weight indicates that a takeoff roll of between 20 m and 170 m would be expected, and a takeoff distance (to 18 m /50 ft) of 320 m under standard conditions would be required. A note in the Flight Manual advises: '*If possible always take off into wind.*'

Other information

Shortly before the gyroplane took off another aircraft had departed ahead from Runway 26 and then a Robinson R44 helicopter crossed the runway from north to south at about the mid-point. The pilot reported afterwards that he may have felt under some pressure to depart quickly so as not to delay other aircraft.

A video of the takeoff and initial climb, up to the point where the gyroplane started to sink, was available for the investigation. The gyroplane reached a height estimated as between 50 ft and 100 ft above the runway before it started to sink; no change of engine note was apparent.

The UK Civil Aviation Authority publication '*Handling Sense Leaflet 4, Gyroplane Handling and Performance'* is intended to share knowledge and information for pilots in an effort to improve the safety record of gyroplanes. Pilots' understanding of the takeoff performance of a gyroplane in the conditions prevailing on the day is identified as a key area for improvement.

The publication notes:

> *'Bringing the stick back without sufficient airspeed will simply increase the rotor drag and even with 100% engine power the gyroplane will descend, nose high, to the ground.'*

and

> *'If you bring the stick back before you have airspeed, you will fly "behind the power curve" and instead of climbing, you will slow down and sink to the ground.'*

Analysis

There was no evidence to suggest that any other aircraft movements around the time of the accident had any effect on the performance of the gyroplane.

The reported surface wind from 010° at 9 kt would have given a small tailwind component on the runway of 2 kt to 3 kt. As the gyroplane climbed above the runway it would have lost the benefit of ground effect. At the same time it would have lost the shelter provided by the trees and been exposed to an increasing wind strength, and therefore tailwind. These two factors are likely to have had an adverse effect on the airspeed and performance. In a gyroplane, airspeed is a critical element of climb performance. Raising the nose attitude prematurely will cause a reduction of airspeed and lead to a reduction in available power for

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climb, perhaps causing the gyroplane to sink. Any attempt to counter the sink by raising the nose will make the situation worse.

The gyroplane took off from a relatively short runway and climbed above a sheltering tree line. The increasing wind strength with tailwind component would have had an adverse effect on the climb performance, it is also possible that the gyroplane encountered a downdraft downwind of the tree line. It is likely that either or both of these factors caused a reduction in airspeed and the gyroplane started to sink. A slight increase in pitch attitude was observed two seconds before the sink, this may have been as a result of a pilot input or the wind conditions. There was insufficient height to lower the nose and accelerate to regain climb speed.

Conclusion

The gyroplane was taking off from a short runway with a tailwind. During the transition, it started to climb above the shelter of a line of trees upwind of the runway and may have lost airspeed as a result of encountering sinking air or an increasing tailwind. The gyroplane started to sink in a position from where there was not sufficient height to recover.

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ACCIDENT

Aircraft Type and Registration:	Rotorsport UK MTOsport, G-CGPG
No & Type of Engines:	1 Rotax 912ULS piston engine
Year of Manufacture:	2010 (Serial no: RSUK/MTOS/032)
Date & Time (UTC):	27 July 2017 at 10:30 hrs
Location:	Crouch Farm Strip, Swanley, Kent
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Severe damage to rotor blades, rotor mast and propeller and minor damage to tail fin
Commander's Licence:	Private Pilot's Licence
Commander's Age:	72 years
Commander's Flying Experience:	323 hours (of which 323 were on type) Last 90 days - 10 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

While landing, the gyroplane veered left and the pilot was unable to prevent the rotor from striking the ground. The pilot's assessment is that he experienced windshear at low level and this was caused by an adjacent crop.

History of the flight

The pilot took off from Crouch Farm for a short flight to Rochester Airport but decided to return due to a radio problem. Before landing on the grass Runway 28, he looked at the windsock and assessed that the wind had not changed since his departure, when it was from 230° at 12 kt. Just before touchdown the gyroplane veered left, and the pilot believes that he then moved the control stick too much and either there was not enough airflow over the rudder to maintain directional control or his input to the rudder was insufficient. Consequently the rotor blades struck the ground and the rotor mast broke and collapsed, but the gyroplane remained upright and came to rest near the edge of the runway (Figure 1).

As the rotor blades slowed to a halt, one of them dropped gently into the pilot's lap, without injuring him, and he was able to lift it, unstrap and step out (Figure 2). All three propeller blades were damaged and the pilot assumes they made contact with the rotor during the accident.

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Figure 1

Rear view of G-CGPG after it came to rest at the edge of the runway, next to a crop

Figure 2

View showing broken rotor mast and rotor blade resting across the pilot’s seat

The pilot later assessed that he had probably experienced low-level windshear, caused by a crop approximately two feet tall which was adjacent to the runway. Usually, if he is unsure of the wind conditions, he makes an assessment during a low level pass along the runway and, had he done this, he may have realised there was a problem. He also noted that he had little recent flying practice and, if he had pressed harder on the rudder pedal and added some power to maintain rudder authority, he could probably have straightened the gyroplane and avoided the accident.

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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).

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

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

Published November 2011.

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

Published February 2014.

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.

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

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GLOSSARY OF ABBREVIATIONS

aal	above airfield level
ACAS	Airborne Collision Avoidance System
ACARS	Automatic Communications And Reporting System
ADF	Automatic Direction Finding equipment
AFIS(O)	Aerodrome Flight Information Service (Officer)
agl	above ground level
AIC	Aeronautical Information Circular
amsl	above mean sea level
AOM	Aerodrome Operating Minima
APU	Auxiliary Power Unit
ASI	airspeed indicator
ATC(C)(O)	Air Traffic Control (Centre)(Officer)
ATIS	Automatic Terminal Information System
ATPL	Airline Transport Pilot's Licence
BMAA	British Microlight Aircraft Association
BGA	British Gliding Association
BBAC	British Balloon and Airship Club
BHPA	British Hang Gliding & Paragliding Association
CAA	Civil Aviation Authority
CAVOK	Ceiling And Visibility OK (for VFR flight)
CAS	calibrated airspeed
cc	cubic centimetres
CG	Centre of Gravity
cm	centimetre(s)
CPL	Commercial Pilot's Licence
°C,F,M,T	Celsius, Fahrenheit, magnetic, true
CVR	Cockpit Voice Recorder
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)
mb	millibar(s)
MDA	Minimum Descent Altitude
METAR	a timed aerodrome meteorological report
min	minutes
mm	millimetre(s)
mph	miles per hour
MTWA	Maximum Total Weight Authorised
N	Newtons
N_R	Main rotor rotation speed (rotorcraft)
N_g	Gas generator rotation speed (rotorcraft)
N_1	engine fan or LP compressor speed
NDB	Non-Directional radio Beacon
nm	nautical mile(s)
NOTAM	Notice to Airmen
OAT	Outside Air Temperature
OPC	Operator Proficiency Check
PAPI	Precision Approach Path Indicator
PF	Pilot Flying
PIC	Pilot in Command
PNF	Pilot Not Flying
POH	Pilot's Operating Handbook
PPL	Private Pilot's Licence
psi	pounds per square inch
QFE	altimeter pressure setting to indicate height above aerodrome
QNH	altimeter pressure setting to indicate elevation amsl
RA	Resolution Advisory
RFFS	Rescue and Fire Fighting Service
rpm	revolutions per minute
RTF	radiotelephony
RVR	Runway Visual Range
SAR	Search and Rescue
SB	Service Bulletin
SSR	Secondary Surveillance Radar
TA	Traffic Advisory
TAF	Terminal Aerodrome Forecast
TAS	true airspeed
TAWS	Terrain Awareness and Warning System
TCAS	Traffic Collision Avoidance System
TGT	Turbine Gas Temperature
TODA	Takeoff Distance Available
UHF	Ultra High Frequency
USG	US gallons
UTC	Co-ordinated Universal Time (GMT)
V	Volt(s)
V_1	Takeoff decision speed
V_2	Takeoff safety speed
V_R	Rotation speed
V_{REF}	Reference airspeed (approach)
V_{NE}	Never Exceed airspeed
VASI	Visual Approach Slope Indicator
VFR	Visual Flight Rules
VHF	Very High Frequency
VMC	Visual Meteorological Conditions
VOR	VHF Omnidirectional radio Range

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