AAIB
Air Accidents Investigation Branch

AAIB Bulletin 6/2023

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

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

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

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(ALL TIMES IN THIS BULLETIN ARE UTC)

AAIB Field Investigation Reports

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

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

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

ACCIDENT

Aircraft Type and Registration:	Aeroprakt A32 Vixxen, G-ENVV	
No & Type of Engines:	1 Rotax 912ULS piston engine	
Year of Manufacture:	2019 (Serial no: LAA 411-15611)	
Date & Time (UTC):	19 July 2022 at 1920 hrs	
Location:	Newtownards Airfield, County Down	
Type of Flight:	Private	
Persons on Board:	Crew - 2	Passengers - None
Injuries:	Crew - 2 (Fatal)	Passengers - N/A
Nature of Damage:	Extensive	
Commander's Licence:	See pilot information section	
Commander's Age:	See pilot information section	
Commander's Flying Experience:	See pilot information section	
Information Source:	AAIB Field Investigation	

Synopsis

On the evening of 19 July 2022, two pilots were flying circuits around Newtownards Airport in G-ENVV an Aeroprakt Vixxen. After approximately 20 mins of circuits they flew a low pass parallel to Runway 03 followed by a steep right turn passing over several people on the ground. Recorded data showed the aircraft passed over the people with 70° angle of bank at 72 ft above the ground. During this turn the aircraft was seen to descend and hit the ground.

The investigation could not determine exactly why the aircraft descended in the turn but no defects could be found with the aircraft or engine. There was evidence that the aircraft's electronic displays lost power before the accident and this could have caused a distraction. However, it was being flown in a manner that exposed the aircraft, the occupants and the people on the ground to a high risk of an accident.

The investigation identified several shortcomings in the build process and the registration of the ballistic parachute recovery system, which did not contribute to the outcome. The LAA and CAA have taken action to address these.

During an inspection carried out immediately before the accident the CAA identified shortcomings in the aerodrome's safety management system, which the CAA stated have now been addressed.

History of the flight

The accident occurred whilst two pilots (one male and one female) were flying circuits around Newtownards Airport (near Belfast) in G-ENVV, an Aeroprakt A32 Vixxen. It is not known who was flying the aircraft; the male pilot was seated in the left seat and the female pilot was seated in the right. The accident occurred after the airport's normal operating hours so there was no air/ground radio service. No other aircraft was flying at or near the airport at the time of the accident flight.

Shortly before the accident flight the two pilots had been flying together in a Van's RV-8A aircraft. They landed from this flight at 1840 hrs. Prior to this flight the male pilot had flown the RV-8A with a different pilot. Another pilot had flown G-ENVV just before the accident flight. He reported that the aircraft had no problems and was flying well.

Figure 1

Newtownards Airport showing the accident and witness locations

Several people, who were at the airport preparing for an open day due to take place the following weekend, saw parts of the accident flight. When the accident occurred, they were stood by a vintage bus on the main apron (Figure 1). Many other people in the local area witnessed parts of the flight.

Data recorded on the aircraft's electronic displays showed the aircraft started to taxi from the apron on the north-west side of the airport at 1859 hrs and took off from Runway 33 at 1901 hrs. Witnesses saw the aircraft taxi out, complete normal power checks then takeoff. The aircraft flew a left-hand circuit to a touch-and-go back on Runway 33 (Figure 2 – Point 1). This was followed by another left-hand circuit to a full stop landing on Runway 26 (Figure 2 – Point 2). The aircraft then backtracked the runway and took off again from Runway 33.

Several witnesses reported the aircraft was flying lower and closer to the aerodrome than they typically saw aircraft flying. It was reported that the aircraft was flying inside Scrabo Hill (Figure 3) during each circuit. Several people reported that the engine sounded as though it was struggling during these circuits. After taking off again, the aircraft made a spiral climb to 1,600 ft above the airport. It then made a spiral descent, completing several orbits to land on Runway 33 (Figure 2 – Point 3). At 1907 hrs one of the people at the airfield, who had a handheld radio, heard the female pilot make a comment about the wind over the radio which the witness thought was referring to the approach and landing the aircraft had just completed. The aircraft took off again and completed another left-hand circuit back to Runway 33 (Figure 2 – Point 4). The recorded data showed the aircraft's angle of bank was around 30° during most of the turns up to this point in the flight, although it reached 47° during one descending turn.

The aircraft then took off again and flew an 'S' turn to approach Runway 03 (Figure 2 – Point 5). During this turn the angle of bank reached 59° with the aircraft at 370 ft agl. The aircraft then flew a low pass parallel to Runway 03 at approximately 70 ft above the ground. At the end of the runway the aircraft made a right turn passing over the people stood next to the vintage bus. Witnesses estimated the aircraft's bank angle was over 60°. One witness described the aircraft "travelling more in the direction of its belly rather than forward". It was reported that the engine sounded "normal" and was at "full power". The last data point, recorded as the aircraft turned right, showed the aircraft was at 72 ft agl, with 71° angle of bank, travelling at an indicated airspeed of 86 kt and a normal acceleration[1] of 1.91 g.

Figure 2

Flight path of accident flight

Footnote

1 'Normal Acceleration' is the head to foot acceleration experienced by the pilot.

Seconds after the aircraft passed over the bus it appeared to be out of control and descended rapidly to the ground. Witnesses reported it happened very quickly and accounts of exactly what happened varied. However, witnesses described the aircraft “spiralling”, “turning wing over wing” and “tumbling”. One witness reported that the aircraft “made a steep bank to its right before it pitched up. The aircraft partially turned over on itself, continued along the trajectory of its initial banking turn but it was losing altitude”. Another witness described seeing the aircraft yaw markedly into the turn as it lost control. No one reported any abnormal noises from the aircraft or its engine. Witnesses also confirmed that the aircraft did not collide with any other object.

The aircraft struck the ground on the airfield boundary just to the south of the flying club and airport cafe buildings. Witnesses ran to the accident site and airport staff collected the airport fire vehicle. They reached the aircraft within a few seconds but there was no sign of life from the occupants. A fire started on the right side of the fuselage but this was extinguished by the airport fire crew and the local fire service, who arrived shortly after the accident.

Accident site

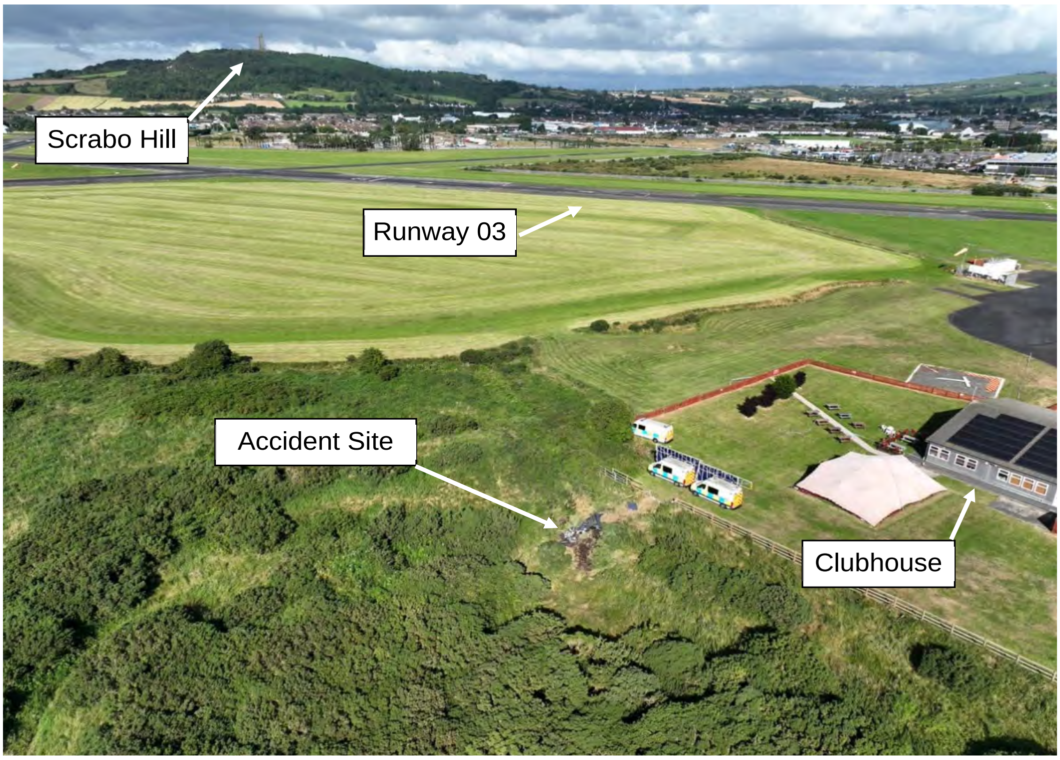


Figure 3

Accident site location

G-ENVV struck a wooden fence on the boundary of the airfield close to the clubhouse and its outside eating area, continuing through the fence before coming to rest, inverted, over a gorse bush (Figure 3). There were no apparent ground marks from impact prior to the fence line.

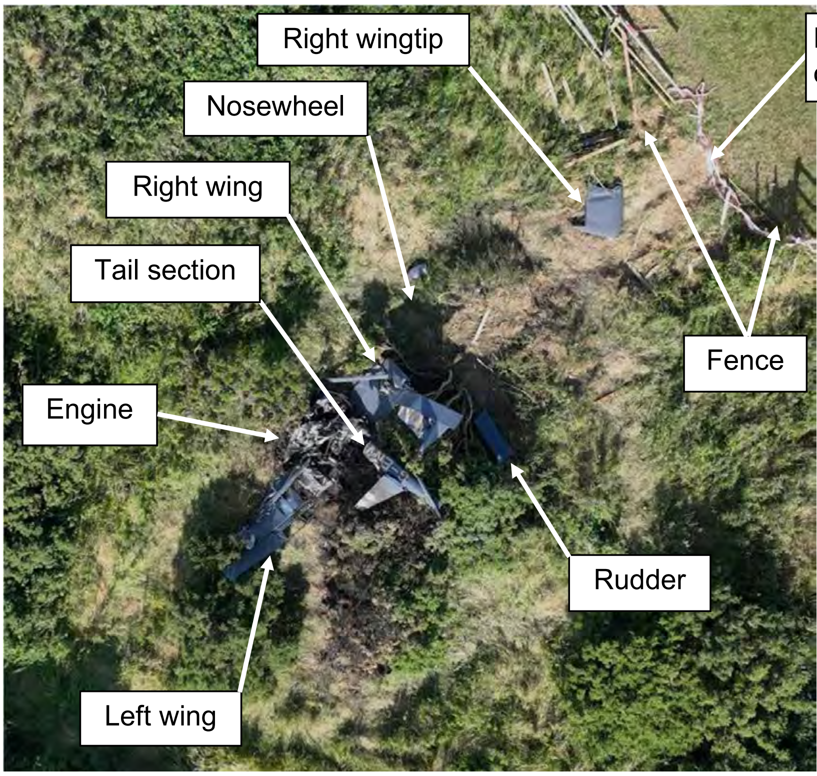


Figure 4
Accident site

Witness marks matching G-ENVV's paint were found on the fence posts. The right wingtip, some glazing from the windows, and the nosewheel were detached at the point of impact with the fence (Figure 4). The rudder became detached at the point of impact with the gorse bush, and was undamaged by the post-impact fire. The remainder of the right wing, left wing, tail section, fuselage, engine and propeller were all located at the final accident site.

Recorded information

The aircraft was fitted with two EFIS avionic units that display and independently record flight, position, engine, and fuel data at a sampling rate of 1 Hz. The recorded data ends about nine seconds before the accident, based on the last recorded speed and estimated ground track (Figure 2).

Figure 5 plots some of the data from both EFIS units, starting from when the aircraft was flying parallel to Runway 03 at about 72 ft (22 m) above the ground, and ending when the recordings stopped. The close alignment of data between the two units, seen in the figure, indicates that each unit was sampling data to within a fraction of a second of the other. The figure also shows that the recording from the left EFIS stopped six seconds before the end of the recording from the right EFIS. The manufacturer of the units stated that the data is buffered for six seconds before being stored in memory, implying that the left EFIS stopped working up to six seconds before the last data point recorded by the right EFIS at time 19:19:32. (The buffer is volatile memory, so its contents are lost when the unit's power is turned off or disrupted.)

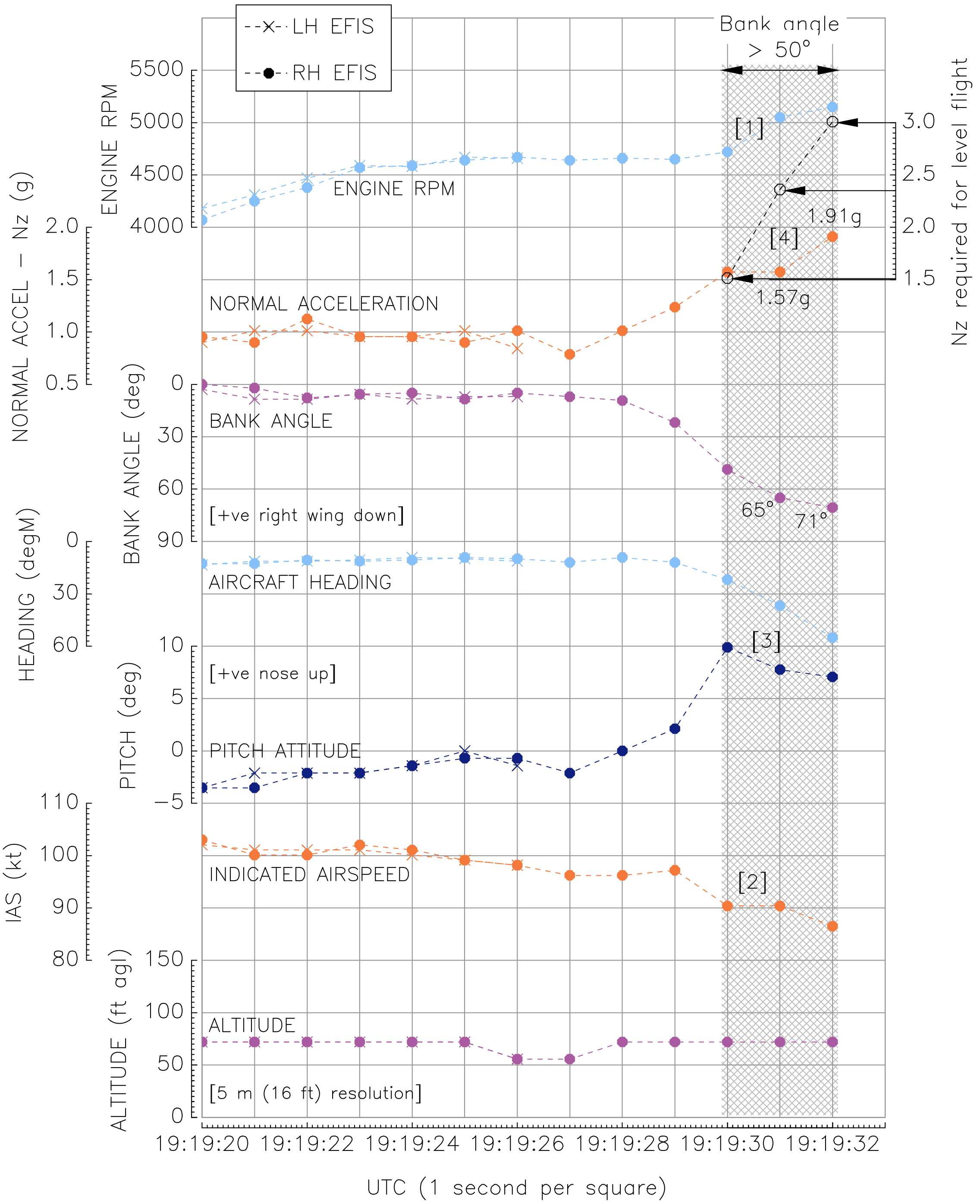


Figure 5

Last 13 seconds of recorded data

This absence of data indicates there may have been a loss of electrical power to the EFIS units before impact.

The last few seconds of the recorded data are highlighted by the shaded area in Figure 5 and correspond to when the aircraft was in the right turn with a bank angle greater than 50°. During this time, the engine speed increased by about 500 rpm [1]; the aircraft's airspeed reduced [2]; the pitch attitude reduced from 10° to about 7° [3]; and the normal acceleration was less than that required to maintain level flight at the bank angles flown [4]. No change in altitude was recorded; however, the resolution of the altitude data was 5 m (about 16 ft) so any changes less than this during these few seconds would not be seen in the data.

Aerodrome information

Newtownards Airport is a licensed aerodrome with three asphalt runways. Residential areas are located close to the airport to the west, north and east. Strangford Lough is to the south of the airport.

The airport's operating hours are 0900 hrs to 1700 hrs, during which an air/ground radio service is provided. Aircraft can fly outside the operating hours by prior arrangement.

The published circuit height is 1,000 ft aal.

Aircraft information

The Aeroprakt A32 Vixxen is a high-wing, two seat light aircraft fitted with a Rotax 912 ULS engine and Kiev 3-bladed ground adjustable propeller. It has an all-moving tailplane and flaperon flying controls. The construction is largely metal, with a mixture of metal and fabric-covered surfaces.

Figure 6

G-ENVV at Newtownards (image used with permission)

Build history

The A32 is supplied as a fast-build kit from the manufacturer to the UK importer, within the 51% owner-builder amateur requirements for a LAA Permit to Fly[2]. The fast-build kit is

Footnote

[2] At least 51% of the physical aircraft build must be completed by the amateur builder.
British Civil Airworthiness Requirements (BCAR) Chapter A3-7 '*Permit to fly Aircraft - Initial and Continuing Airworthiness*'.
Civil Aviation Publication (CAP) 659 '*Amateur Built Aircraft*'.
Light Aircraft Association LAA Technical Leaflet (TL) 1.02, section 18 '*Amateur Building Rules*'.

close to 49% complete in its supplied state, which precludes significant further work being completed by anyone other than the amateur owner-builder. G-ENVV was issued with a Permit to Fly in October 2019.

The aircraft arrived at Newtownards by road, requiring final assembly and avionic systems installation. Work, including fabric covering and external paint, had been done prior to its arrival. There was evidence of remunerated subcontracted work towards build completion having occurred at Newtownards. The address listed for build was not where the aircraft was finally assembled[3]. There were three interested parties in the aircraft's ownership at the point of build, of which one (the male accident pilot) was registered as the owner for the initial build. The investigation did not find evidence to substantiate that the owner was physically involved in the build of G-ENVV to qualify the build within the 51% owner-builder amateur requirements.

Maintenance history

The aircraft's airframe and engine logbooks were retrieved from the aircraft but neither had been updated since the last Permit to Fly revalidation inspection in October 2021, at 451 flying hours.

The A32 has a manufacturer's maintenance schedule published within its Aircraft Maintenance Manual, detailing the required maintenance at 50, 100 and 200-hour intervals. The LAA provides generic maintenance schedules for use when a manufacturer's schedule is either not available or is not mandated by the aircraft's Permit to Fly Operating Limitations. The LAA stated that the manufacturer's maintenance schedule was not mandated for G-ENVV, and the *'owner's tailored maintenance schedule'* was declared within the Certificate of Clearance form. It was stated by those carrying out maintenance on G-ENVV that a generic LAA schedule was followed. There were no workcards or maintenance documents to support airframe or engine logbook entries made before October 2021. There were no logbook entries or maintenance history to verify the status of the airframe or engine after October 2021.

Data subsequently retrieved from on board flight display systems logged 587 engine hours at the time of the accident.

Aircraft examination

Structure

The fuselage structure surrounding the passenger compartment was destroyed in the post-impact fire.

The aft section of the tail was mainly intact, had separated from the fuselage and suffered fire damage. There was some fire damage to the left all-moving tailplane but both left and

Footnote

[3] Light Aircraft Association LAA Technical Leaflet (TL) 1.02, section 4 *'Workshop and Storage Facilities'* specifies that the LAA inspector will check the suitability of where the aircraft will be built. Section 7 *'Frequency of Inspections'* details the in-person main inspection stages required for the project. Both require knowledge of where the aircraft is to be built.

right tailplanes were present and attached. The rudder had detached at final impact and was largely undamaged. The rudder at its uppermost attachment point to the tail structure showed evidence of having travelled beyond full deflection to both left and right sides before detaching from its base plate.

The right wing exhibited impact damage to the leading edge and internal structure corresponding to contact with the boundary fence. The right flaperon was partially attached to the wing, but damaged from impact with the gorse bush. The left wing had suffered significant disruption at its point of attachment with the fuselage and had become detached during impact with the gorse bush. The left flaperon was still attached. Both wings had considerable fire damage in the region of the internal fuel tanks.

The nosewheel had detached at the joint with the shock absorber, also corresponding to impact with the fence.

Flying controls

Flying control surfaces were activated via cable and pulley systems, from a central control stick located between the seats. Continuity was established between the rudder pedals to the rudder base plate, and control stick to the tailplane and left flaperon, with the cables free from restriction and intact after impact. The right flaperon cable was found to have broken in overload in the area of the wing to fuselage attachment point, consistent with damage sustained in this area during impact.

The flap lever was found in the 'UP' position. The lever is held in place with a locking pin, which is released by pulling the lever laterally to free the pin from its locating hole. There are three locating holes for each position of flap. Due to the force required to move the lever, it is likely that the flaps were 'UP' during flight immediately prior to impact.

The trim control was located between the seats at floor level. Control cable continuity and free movement from the control lever to the trim tab was established.

Avionics

The aircraft was equipped with flat-screen primary flight display systems. They were an additional item to the kit purchased by the owner and were installed during the initial build, except for an Attitude Heading and Reference System (AHRS) which was a later modification. The AHRS can display information including an artificial horizon, pitch and roll attitude, airspeed, and altitude. The flat-screen display system is customisable and capable of displaying comprehensive flight, engine, and navigation information, and is coupled to a data acquisition unit. Flight logs and aircraft parameters from those flights are stored within the system, and data from the accident flight was retrieved.

Two battery back-up supply units were installed; one for the flat-screen display system and one for the AHRS unit. The purpose of the battery back-up is to give up to 40 mins usage of the instrumentation if aircraft main power fails. The power supplies for the flat-screen display system were controlled by two toggle switches added to an existing row of switches on the centre console. Both switches were required to be ON for the screens to function.

The AHRS power was controlled from a single toggle switch at the top centre of the same console. None of the switches were labelled as to their function.

At the accident site, both flat-screen display system switches were found in the ON position and the AHRS switch was found in the OFF position, however, due to the disruption to the cockpit area that occurred upon impact, these switch positions cannot be confirmed to have been the same during flight.

An examination of the electrical system was conducted, but it was too badly damaged by the post-impact fire to determine system integrity or continuity.

Fuel

G-ENVV was fitted with optional larger fuel tanks, with total capacity of 114 l, 112 of which is usable. The A32 can be used with fuel meeting three different specifications[4]. It was not possible to determine the type of fuel used during the accident flight although witness accounts refer to the pilot purchasing UL91 fuel in drums that were stored in the aircraft's hangar.

It could not be determined how much fuel was on board at the start of the accident flight. The pilot who flew the aircraft on the previous flight estimated there was 20 litres remaining after his flight. However, it was not possible to determine if the aircraft had been refuelled immediately prior to the accident flight. It was reported that the aircraft typically consumed 15-20 l/hr. The length of pipework between the fuel tanks and engine could contain enough fuel for approximately 40 seconds of flight once the usable fuel had been consumed. Fuel quantity is displayed on two analogue dials in the central console, each with its own low fuel warning light. The electronic flight displays did not record fuel quantity.

Fire damage concentrated in the locations of the fuel tanks and fuselage indicated that the system contained fuel at impact. The A32 has two fuel supply handles, one for each wing tank. One of the fuel supply handles was retrieved and was in the 'open' position, but its position during flight could not be verified.

There was no fuel remaining for sampling or quantity analysis.

Engine

The Rotax 912 ULS had suffered significant fire damage, and it was not possible to determine if fuel remained within the carburettors or fuel manifold although recorded engine data showed it running at approximately 5,100 rpm immediately prior to the accident. The throttle levers remained connected to the carburettors after the accident.

The spark plug electrode gaps and colouration were within manufacturer limits. Two plugs were lightly coated with oil, but the engine was found inverted with an accumulation of oil

Footnote

4 Motor gasoline (Mogas), Aviation gasoline (Avgas 100LL), or a fuel that meets a minimum octane of 95 and has an Anti-Knock Index of 91. The latter specification includes fuel type UL91.

within this cylinder, which probably occurred post-impact. Borescope examination of the cylinders did not show any areas of excessive wear or build-up of combustion products for the engine's estimated hours.

Propeller

All three blades were found at the engine impact point. One blade was still attached to the propeller hub but cracked at its base, the second was partially attached and the third had completely detached. The blade damage was consistent with the propeller stopping within a single revolution upon impact. The Rotax 912 ULS engine is fitted with a clutch to protect the engine from damage caused by a propeller strike. It is possible that the clutch disconnecting the propeller from the engine, followed by multiple strikes with the fence and gorse before hitting the ground, could have slowed the propeller's rotation. Therefore, the power of the engine at impact could not be clearly determined.

Ballistic parachute recovery system

A ballistic parachute recovery system (BPRS) is a rocket-deployed parachute, used to recover a whole aircraft including occupants to the ground in an emergency situation.

G-ENVV was fitted with a Magnum 601 S-LSA BPRS located aft of the luggage compartment behind the seats. The system comprises a parachute packed into a soft case, launched by a separate rocket canister. The parachute exits the aircraft through a frangible hatch on the upper fuselage surface. The system is activated by a pull-handle cable located between the aircraft's seats. The pull-handle has a safety pin inserted into it to prevent unintended operation on the ground, which is required by the manufacturer to be removed before flight. The BPRS had not been activated by either occupant, and the safety pin was found inserted in the handle. It is not known if the occupants had inadvertently left the pin in place or if they routinely flew with the activation pin installed. CAA and LAA guidance[5,6] specifies a two-stage release control for BPRS to avoid inadvertent operation. BPRS installation approval for the A32 was based on that for the A22 Foxbat, where a 2.5 mm cable tie is used for the secondary release, not the activation pin. It is possible that the occupants regarded the activation pin as the secondary release mechanism or were not familiar with the two-stage release guidance for this aircraft type.

External warning placards are required[7] to be applied to aircraft fitted with a BPRS, to alert occupants upon entering the aircraft and emergency responders in the case of an accident. The presence of a BPRS must also be notified to the CAA (in this case via the LAA) for inclusion in the central aircraft register to provide safety information to those attending in an emergency. The requirement to notify the CAA at initial aircraft registration was introduced at the beginning of 2022 in response to an accident where BPRS was fitted but the CAA

Footnote

5 Civil Aviation Authority (CAA) CAP 482 *British Civil Airworthiness Requirements (BCAR) Section S – Small Light Aeroplanes, Sub-Section K, Issue 7. 'AMC S 2003 (Interpretive Material)*'.

6 Light Aircraft Association (LAA) *Technical Leaflet (TL) 3.27 Ballistic Parachutes, Issue 1, 27 March 2020 Section 4.3 'Miscellaneous Point*s'.

7 Civil Aviation Authority (CAA) CAP 482 *British Civil Airworthiness Requirements (BCAR) Section S – Small Light Aeroplanes, Sub-Section K, Issue 7. S 2041 'Markings and Placards*'

was not informed[8]. There was no evidence of placards on the aircraft and the presence of a BPRS was not shown in G-ENVV's CAA database record. The only reference found to a BPRS fitted to G-ENVV was within the weight and balance record completed at initial permit application. No entries were found within the aircraft's build record, modification record or Permit to Fly application paperwork, nor subsequent annual Permit to Fly revalidations. LAA members and inspectors associated with G-ENVV's build and maintenance did not appear to have a good understanding of the relevant requirements.

Survivability

The manufacturer of the BPRS specifies a minimum deployment altitude for safe rescue of 200 m, with some documented rescues down to 80 m. This allows sufficient time for safe parachute opening and aircraft stabilisation during which altitude is lost. G-ENVV was flying at an altitude of approximately 80 ft (24 m) at the point where departure from controlled flight occurred. If the BPRS had been activated at this moment, there would not have been enough time for the parachute to deploy and effectively arrest the aircraft's descent.

G-ENVV was fitted with four-point harnesses at both seats. There was extensive fire damage to the harness webbing but the buckles from both seats were found fastened. A lack of heat and smoke damage to the interior of the buckles indicated that they were both fastened correctly prior to impact.

Weight and balance

The aircraft had two occupants on board, a partial fuel load and no luggage, and would have been within its maximum takeoff weight of 600 kg and centre of gravity limits.

Aircraft performance

The Pilot's Operating Handbook (POH) gives the aircraft's 1g stall speed at maximum takeoff weight, with flaps up, as 32 KIAS. The POH does not give the stall speed for level flight with different bank angles. However, based on data supplied by the manufacturer, the stall speed in level flight at 70° angle of bank would be approximately 68 KIAS[9]. A load factor of 2.92 g is required to maintain level flight with 70° angle of bank.

The aircraft is certified as non-aerobatic and its operating handbook specifies a maximum bank angle of 60°. It has a maximum positive load factor of +4.0g.

Meteorology

Weather reports are not recorded at Newtownards Airport outside aerodrome hours. Belfast City Airport (7 nm west-north-west) reported, at the time of the accident, a surface wind from 350° at 6 kt varying between 300° and 020°, visibility greater than 10 km, cloud overcast at 3,200 ft, temperature 16°C and a sea level pressure of 1022 hPa.

Footnote

8 AAIB investigation to Silent 2 Electro, G-CIRK, 23 April 2021 https://www.gov.uk/aaib-reports/aaib-investigation-to-silent-2-electro-g-cirk [Accessed February 2023]

9 The indicated stall speed at this angle of bank is higher than might be estimated from increased load factor alone, due to indication errors at increased angle of attack.

A pilot who took off from Newtownards approximately 40 minutes before the accident estimated the wind at the airfield was from the north-west at 8 - 12 kt but he commented that the wind increased markedly in the climb.

Pilot information

The female pilot was 44 years old and held a Private Pilot's Licence which was issued in October 2020. She held a Single Engine Piston rating which was valid until 31 October 2022 and also held a night rating. She had a valid Class 2 medical.

She had been undertaking training for a restricted instrument rating (IR(R)) and it was reported that she had been studying to take the ATPL ground exams.

The last entry in her logbook was on 21 October 2021 which was an IR(R) training flight in a Cessna 172. Her last flight as pilot in command in G-ENVV was recorded on 13 October 2021. The logbook gave a total flight time of 204.6 hours. Flying club technical log dockets were found relating to 14 further flights between 23 October 2021 and 19 February 2022 totalling 12.1 hours but these were not recorded in her logbook. A notepad was also found containing notes about three flights on 7, 14 and 20 May 2022.

An instructor commented that she had been a "competent and knowledgeable student" who flew with "caution and diligence". However, he had noticed a change in her flying in the months preceding the accident. After observing several tight approaches with sharp turns onto final approach he felt compelled to speak to her about the risks involved in manoeuvring close to the ground. He spoke to her informally, advising her to be more cautious.

The male pilot was 50 years old and held a National Private Pilot's Licence which was issued in June 2018. He had held Microlight and Simple Single Engine Aeroplane (SSEA) ratings but the Microlight rating lapsed on 31 May 2022 and the SSEA rating lapsed on 31 October 2021. There was no evidence that either rating had been renewed. He had a valid self-declared medical.

His logbook was in the aircraft when the accident occurred and was significantly fire damaged. A photograph was found of a page of his logbook which showed that in November 2021 he had accumulated 421 flying hours. His logbook contained five further completed pages (55 flights) but the logbook was too damaged to read the details of these flights.

Several qualified pilots who knew him well commented that "he liked to push the boundaries" and "he enjoyed the more exciting side of flying". It was reported that he was "a very capable pilot" but he enjoyed "flying low approaches and very tight circuits". A commercial pilot who had recently flown with him in G-ENVV commented that he felt "uncomfortable" with the tight circuit the pilot had flown. He had recently purchased a Van's RV-8A aircraft and had been flying aerobatic manoeuvres, although he had no formal training or qualification in aerobatics.

Organisational information

The airfield is operated by a flying club. The flying club incorporates a Declared Training Organisation (DTO). Flying club members can fly the club aircraft but some members also hangar their own aircraft at the airfield. The flying club is managed by a committee of volunteers.

The accident flight occurred in a privately owned aircraft being flown by two qualified pilots[10]. It was therefore outside the oversight of the DTO. It also occurred outside the aerodrome's published hours, which limited oversight by the flying club.

The Aeronautical Information Publication entry for the airfield states that flying outside the licensed hours is allowed '*by arrangement*'. The club website refers to an out-of-hours indemnity form which should be completed to fly outside licensed hours but the investigation found that no such form existed. The investigation did not find any record of who was authorised to fly outside hours or any arrangements by which this was managed.

Some committee members reported that there had been previous reports of low flying and excessively tight circuits being flown by other pilots outside licensed hours. They reported that during licensed hours, with a duty instructor on duty and with considerable flight training activity taking place, there was sufficient oversight, but that outside hours there was no oversight. Several years previously, the committee had tried to report to the CAA another pilot who was observed low flying, but they had not been able to provide sufficient robust evidence, so the CAA was unable to take any action. This resulted in the committee feeling they were unable to tackle future similar issues.

The flying club standard operating procedures set out the requirement for all incidents to be reported in writing and posted in the reporting box in the flying club. Despite several previous incidents being mentioned to the AAIB during this investigation, no evidence was found of any previous incident reports being made to the flying club. The aerodrome manual describes the club safety management system (SMS). It states that '*an aerodrome safety committee meets a minimum of twice per year to review any safety related issues, accident and incident reports*'. The investigation did not find any evidence that these meetings had ever happened.

On the day of the accident and the previous day the CAA was conducting an oversight audit at the airport. The audit finished before the accident and made five Level 2 findings[11]. One of these related to the SMS and stated:

Footnote

10 The male pilot's flying licence was not valid at the time of the accident.

11 A Level 2 finding means it been identified that the Aerodrome is not in full compliance with the aerodrome licensing requirements set out in either the Air Navigation Order, the Aerodrome Licence, ICAO Annex 14, Civil Aviation Publication (CAP) 168 or the Aerodrome Manual. Rectifying action must be taken within the agreed timescales.

'The safety management system was found not to be operating as described in the aerodrome manual:

1) Current records could not be found for the committee monthly meeting or the 6 monthly Airport Safety Group meeting,

2) No evidence of internal audits could be found,

3) The SMS should include reference to "just culture",

4) Current monthly reports could not be found'.

The auditor also observed a runway incursion during the audit and made the following finding:

'The aerodrome does not have effective procedures to prevent runway incursions. An incursion was witnessed during the audit when an individual riding a motorbike entered the aerodrome and crossed runways 03/21 and 15/33 to access hangars across the airfield but without making radio calls. An MOR needs to be filed for this event and adequate procedures implemented (covering access, driving rules and procedures and RTF procedures) to enable this activity to be completed safely.'

When asked about the safety culture at the flying club several people reported to the AAIB that it was poor. It was reported that there was a small group of pilots who often operated outside normal aviation convention, but this had not been addressed by the committee.

Analysis

Accident flight

The accident occurred whilst the aircraft was making a low altitude steep turn, which occurred above people and buildings.

There was no evidence of any construction anomaly, failure or malfunction in the airframe or flying controls that could have contributed to the accident. Data recovered from the aircraft's avionics suggested the engine was performing normally during the accident flight. The exact fuel quantity on board could not be determined. However, the previous pilot reported there was at least 20 litres remaining after his flight and, if that were the case, there would have been sufficient fuel onboard for the 20 minutes flight. It is possible that the steep angle of bank could have caused the fuel supply to the engine to be interrupted but the fuel pipework was of sufficient capacity that had it contained fuel it could have sustained the engine for approximately 40 seconds.

An absence of recorded data from the EFIS units indicates they may have lost power before impact, although it could not be determined why this occurred as battery back-up systems were installed. Had such a failure occurred, it is possible that it captured the pilot's attention and briefly distracted the pilot from the primary task of flying the aircraft.

The aircraft exceeded its 60° bank angle limit in the last 1.5 seconds of recorded flight. It was not possible to determine if this was intentional.

It was not possible to determine the exact sequence of events which led to the aircraft losing height and striking the ground. The last recorded data point showed the aircraft had a normal acceleration of 1.91 g. If sustained, this would be insufficient to maintain level flight with a 70° bank. It is possible that the accident was caused by over banking and descending in the turn with insufficient altitude for the pilot to recover, but witness accounts are more consistent with a departure from controlled flight. The stall speed with 70° bank and level flight is approximately 68 KIAS. At the last data point the aircraft was flying at 86 KIAS, but the speed was reducing and the application of nose-up elevator intended to arrest a descent might cause a stalling angle of attack.

The aircraft was flown at 72 ft above people and buildings. The rules of the air[12] state that the pilot in command should '*not fly in a manner that would endanger either people or property*' and should '*not fly closer than 500 ft to any person, vessel, vehicle or structure unless necessary for taking off or landing'*. It is likely the pilot in command was breaching both rules.

It is not known which pilot was flying the aircraft when the accident occurred. Both pilots had previously been seen flying steep turns at low altitude. The male pilot had recently purchased a Van's RV-8A aircraft and it was reported that he had been flying aerobatic manoeuvres in that aircraft. The investigation did not find any evidence that either pilot had been trained in aerobatic flight.

Choosing to fly excessive manoeuvres close to the ground increases the opportunity for error and reduces the room for recovery, placing occupants and the public at unnecessary risk.

Pilot's licence

The male pilot did not have a valid flying licence. His Microlight and SSEA ratings had expired. It is likely that he would have had sufficient flying hours to revalidate by experience but he had not had his licence signed by an examiner[13]. Once the ratings had lapsed he would have needed to complete a proficiency test to renew the ratings.

It is possible that he was not aware that his ratings had lapsed. The CAA does not provide a reminder service for when ratings and licenses lapse. However, all pilots must ensure their licence is valid before flying. If unsure about the requirements advice can be sought from an instructor, examiner, flying club or the CAA.

Footnote

[12] Guidance on the Rules of the Air can be found in the Skyway Code (CAP1535) available at The Skyway Code | Civil Aviation Authority (caa.co.uk) (accessed 22 November 2022).

[13] It could not be determined if he had completed a flight with an instructor which is required to revalidate by experience but the 55 flights in his logbook suggests he would have achieved the 12 hours required.

Aircraft build and maintenance

It was not possible to ascertain the exact build and maintenance status of G-ENVV due to a lack of detail within the aircraft's build, maintenance and logbook paperwork. This is likely, in part, due to the low level of owner involvement during build completion compared to third party assistance, regarding the 51% amateur builder requirements. It is possible that as a result the aircraft did not conform to the requirements to qualify for a Permit to Fly, indicating this aspect of the process for fast-build kits that would benefit from a higher level of oversight. The LAA is exploring ways to improve oversight of the build process relating to the 51% rule, looking to include, but not limited to, more frequent and better targeted auditing of build projects.

There was nothing to indicate to those attending the accident site that G-ENVV was fitted with a BPRS. CAA registration of G-ENVV occurred in 2019, before the introduction in 2022 of a point in the registration process to verify that BPRS and compliant placarding was fitted. There was no point within the LAA Permit to Fly issue or annual Permit to Fly revalidation process to verify that BPRS and relevant compliant placarding had been fitted, other than by relying on inclusion in the aircraft's modification record during the build process. It also appears there was no reliable way to ensure this information was included in the CAA's central aircraft register. Permit to Fly issue and annual revalidations presented three opportunities at which this could have been identified for G-ENVV. To ensure future visibility of BPRS installations the following safety actions have been taken:

> The CAA has amended form CA1 *Application for Aircraft Registration or Change of Ownership*, introducing a field to indicate whether an emergency ballistic device such as BPRS is fitted.
>
> The LAA has amended form CA3 *Permit to Fly Application*, introducing a field to indicate whether an emergency ballistic device is fitted, which is flagged to the CAA Aircraft Registration Team to subsequently update the GINFO database.
>
> Retrospective installations of BPRS must be notified to the LAA by an application to install BPRS as a new modification to the aircraft type, or notification that BPRS has been installed as a manufacturer's standard option. The LAA will then notify the CAA of the installation.

There was a lack of knowledge regarding regulations for BPRS installation, placarding and notification to the appropriate authorities amongst LAA inspectors and members. It is becoming increasingly popular amongst the general aviation community to fit BPRS, which are offered as an option or retrofit on many microlight and general aviation aircraft. To improve awareness among LAA inspectors and members, the following safety actions have been taken:

> The LAA has included the requirements for BPRS markings and notification of installation to the CAA for inclusion on G-INFO register in articles within the *'Engineering Matters'* section of the member publication *Light Aviation*.

New LAA Inspector induction briefings given by the LAA Chief Inspector now include a specific topic explaining BPRS installations and associated aircraft marking requirements.

Organisation

Members of the flying club committee were aware that low flying was taking place outside the aerodromes licensed hours in the months before the accident, but no action had been taken to prevent it. It was reported that the committee had not found an effective way to manage flying outside licensed hours.

The CAA conducted an audit at the airfield just before the accident which found that the SMS was not functioning as described in the aerodrome manual. During the investigation of this accident the AAIB found a lack of safety reporting within the club and received several reports of a poor safety culture. The CAA audit made several findings which the CAA stated the aerodrome operator has now addressed.

Conclusion

The accident occurred when the aircraft was flown at low altitude and a high angle of bank over people and buildings. There was insufficient evidence to determine the precise cause. No defects were found with the aircraft or engine which could have contributed to the accident. There was evidence that the electronic displays in the aircraft lost power before impact and it is possible that this caused a distraction. However, the aircraft was being flown in a manner which exposed it, the occupants and the people on the ground to a high risk of an accident.

The investigation identified several shortcomings in the build process and the registration of the BPRS system. The LAA and CAA have taken action intended to address the registration of BPRS systems. The LAA is exploring ways to improve oversight of the build process within the 51% amateur building rules.

Published: 18 May 2023.

ACCIDENT

Aircraft Type and Registration:	Mudry Cap 10B, G-BXBU
No & Type of Engines:	1 Lycoming AEIO-360-B2F piston engine
Year of Manufacture:	1980 (Serial no: 103)
Date & Time (UTC):	12 August 2021 at 0920 hrs
Location:	Lower Colley Farm, Buckland St Mary, Somerset
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Fatal) Passengers - 1 (Fatal)
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	69 years
Commander's Flying Experience:	1411 hours (of which 648 were on type) Last 90 days - 15 hours Last 28 days - 4 hours
Information Source:	AAIB Field Investigation

Synopsis

The pilot found himself stuck above cloud during a cross-country flight under Visual Flight Rules. After contacting the Distress & Diversion Cell for assistance he was transferred to the radar frequency of a nearby airport, at which the cloud base was below the minimum required for the approach offered. The pilot, who was not qualified to fly in cloud, lost control of the aircraft during the subsequent descent and the aircraft was destroyed when it hit a tree. Both occupants were fatally injured.

The investigation found that air traffic service providers did not obtain or exchange sufficient information about the aircraft and its pilot to enable adequate assistance to be provided. There was an absence of active decision making by those providers, and uncertainty between units about their respective roles and responsibilities.

Seven Safety Recommendations are made to address shortcomings identified in the provision of air traffic services in an emergency.

History of the flight

G-BXBU departed Watchford Farm in Somerset, which was the aircraft's home base, at 0704 hrs on 12 August 2021 with the pilot and one passenger on board. Their intention was to fly to St Mary's on the Isles of Scilly for a day trip before returning to Watchford Farm later that afternoon. At the time of departure, the local weather was described by witnesses as clear skies with good visibility.

After departure, the aircraft flew south-westerly as planned towards Cornwall. As the aircraft passed north of Culdrose, it began a descent to 1,000 ft over the sea before turning right to head east away from the planned destination. It continued in a north-easterly direction, passing to the north of Torquay then out over Lyme Bay. While over the sea, the aircraft reached a minimum of 320 ft momentarily before completing three 180º turns and two 360º orbits. It then began to fly north from Lyme Regis toward Watchford Farm climbing to a peak altitude of 8,200 ft amsl (Figure 1).

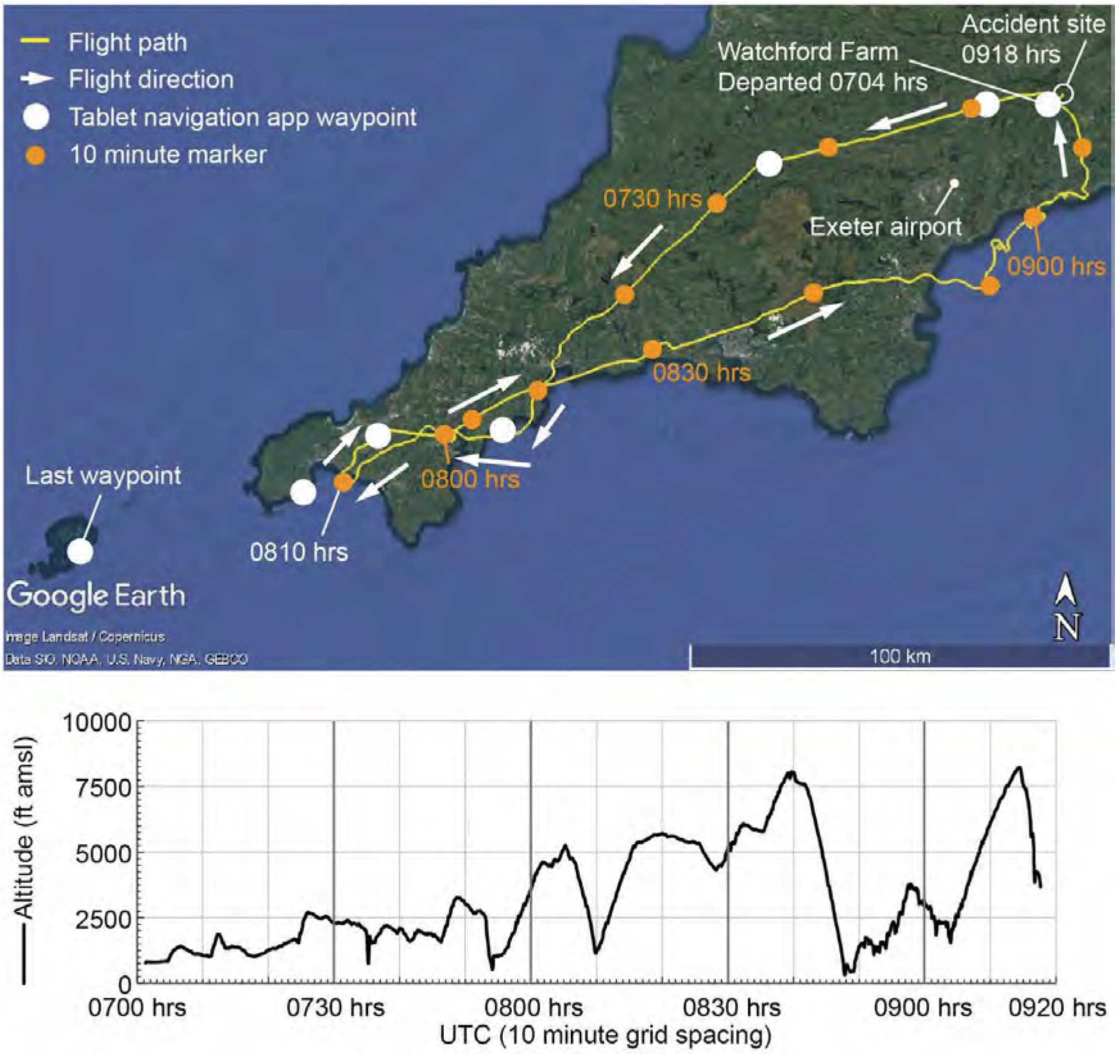


Figure 1

Aircraft planned route and flight path

At approximately 0905 hrs the pilot called Dunkeswell Radio, using the words "PAN, PAN, PAN" (indicating urgency), asking about the weather conditions at the airfield and stating that he was unable to land at Watchford Farm because he was stuck above cloud. The A/G operator at Dunkeswell replied that the weather at the airfield was poor – the cloud base was 'on the deck' and the visibility was 400 m. He suggested the pilot contact Exeter Radar or the Distress and Diversion (D&D) Cell on the emergency frequency 121.5 MHz.

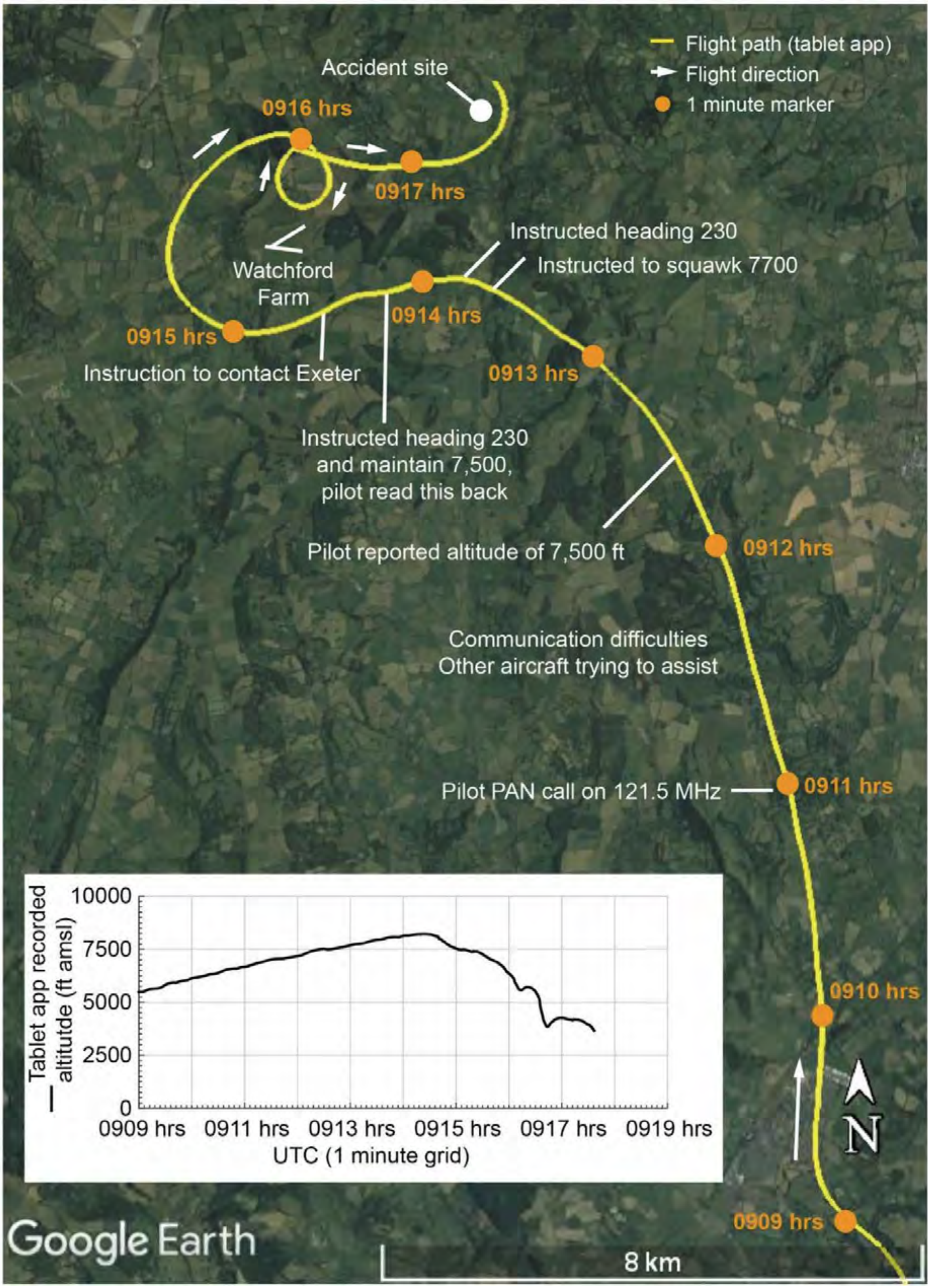


Figure 2

Flight path during D&D communications
(Note that this is not a comprehensive listing of the RT)

The pilot made another PAN call on 121.5 MHz at 0911 hrs, stating he was in "REAL TROUBLE" as he was stuck above thick cloud and he didn't know what to do (Appendix 2). He finished his radio transmission by stating "I NEED TO DIVERT TO SOMEWHERE ER CLOSE TO ME WHERE I CAN LAND". Several witnesses in other aircraft who heard the call described the pilot sounding anxious and stressed. The PAN call was initially acknowledged by two commercial aircraft in the vicinity prior to a response from the D&D controller who stated "... YOUR PAN IS ACKNOWLEDGED...". In response, the pilot stated his altitude was 7,500 ft and that he had a fuel endurance of 1.5 hours. The transponder on G-BXBU had not been used throughout the flight, but at the request of the D&D controller the pilot switched it on and set the emergency squawk of 7700.

At the time G-BXBU declared an emergency, there was a military jet holding in the vicinity of Exeter Airport where the jet had departed 28 minutes earlier. The aircraft had experienced a technical fault after takeoff which was subsequently resolved. The aircraft was holding to burn fuel and reduce its landing weight, prior to returning to land at Exeter. The military jet did not declare an emergency at any point. G-BXBU had been seen by controllers on Exeter's primary radar but there was no altitude information displayed as the transponder was not switched on. Exeter ATC were concerned about a potential conflict with the military jet, which was holding between 3,000 and 4,000 ft. The military jet was not moved clear of G-BXBU's primary return despite the lack of altitude information. However, altitude data recovered from the tablet from G-BXBU showed that the aircraft were sufficiently far apart to discount proximity as a factor in this investigation.

While G-BXBU's initial contact with the D&D controller was ongoing, a phone call between the Exeter Radar assistant and the D&D support controller took place between 0912 hrs and 0914 hrs (full transcript):

09:12:00 *D&D support*[1]*:* "D AND D SUPPORT"

09:12:01 *Exeter assistant:* "HELLO IT'S EXETER"

09:12:02 *D&D support:* "YEP"

09:12:03 *Exeter assistant:* "HI, HAS ANYONE UPDATED YOU FIRSTLY ABOUT THE [MILITARY JET]?"

09:12:07 *D&D support:* "ER, NO"

09:12:08 *Exeter assistant:* "OK ER JUST TO LET YOU KNOW THAT [MILITARY JET CALLSIGN] IS STILL INTENDING TO LAND AT EXETER, HE'S GOT A NORMAL UNDERCARRIAGE INDICATION NOW"

09:12:16 *D&D support:* "OK"

09:12:17 *Exeter assistant:* "AND ALSO, HAS A LIGHT AIRCRAFT CALLED YOU IN THE DUNKESWELL AREA?"

Footnote

1 The 'D&D support' controller in this event provided support to D&D controllers equivalent to that provided by an air traffic control assistant (ATCA) to a civil controller when interacting with civil ATSU's. The D&D support controller was not permitted to conduct a radar handover.

09:12:21	*D&D support:* "YES, WE ARE CURRENTLY DEALING WITH THAT SITUATION"
09:12:23	*Exeter assistant:* "EXCELLENT, HE'S RIGHT IN THE WAY OF ER OF [MILITARY JET CALLSIGN] WOULD YOU, WHAT'S HE, WHAT'S HIS INTENTIONS AND HIS LEVEL?"
09:12:29	*D&D support:* "ER, DON'T KNOW HIS LEVEL BUT HE IS CURRENTLY ABOVE CLOUD AND WANTING TO DIVERT TO THE NEAREST AERODROME"
09:12:37	*Exeter assistant:* "WELL THAT WOULD BE US"
09:12:38	*D&D support:* "ER.."
09:12:40	*Exeter assistant:* "EXETER"
09:12:41	*D&D support:* "I THINK…"
09:12:44	*Exeter assistant:* "HE'S BASICALLY FLOWN ALL THE WAY UP THE COAST AND THEN ACROSS OUR EXTENDED CENTRELINE TWICE IN FRONT OF ER, A [MILITARY JET]"
09:12:49	*D&D support:* "YES"
09:12:50	*Exeter assistant:* "ER.. DO YOU WANT TO PUT HIM OVER TO US?"
09:12:54	*D&D support talking to D&D controller offline:* "EXETER ARE ASKING IF ER, MAYBE WE WANT TO, SHE ASKED TO PUT IT OVER TO THEM?....... THEY ARE WONDERING IF ER… THEY WANT TO TAKE OVER."
09:13:14	*D&D support:* "STANDBY, WE ARE JUST TALKING TO THE AIRCRAFT"
09:13:15	*Exeter assistant:* "OH OK, ALRIGHT" *(offline)*: "HE'S WORKING D AND D THAT AIRCRAFT"
09:13:21	*D&D support (offline):* "EXETER ARE WILLING TO TAKE THE AIRCRAFT"
09:13:22	*Exeter assistant:* [UNINTELLIGIBLE]
09:13:48	*D&D support:* "EXE.. ER WE ARE PUTTING HIM ON AN EMERGENCY SQUAWK, IS THERE A FREQUENCY THAT WE CAN PUT HIM ON TO?"
09:13:52	*Exeter assistant:* "ER... ONE.. ONE.. HANG ON"
09:13:55	*Exeter assistant (offline):* "WHICH ONE OF YOU WANTS TO WORK THIS AIRCRAFT INBOUND, DO YOU WANT TO [NAME] OR SHALL [NAME] TAKE IT? THE INBOUND. FOR WEATHER. THE ONE THAT'S BEEN IN THE WAY FOR THE LAST TEN MINUTES. YEAH. YEAH?"
09:14:10	*Exeter assistant:* "YEAH, IF YOU PUT IT THROUGH ONE TWO THREE FIVE EIGHT ZERO"
09:14:14	*D&D support:* "ONE TWO THREE FIVE EIGHT ZERO"
09:14:17	*Exeter assistant:* "AND WHAT'S HIS CALLSIGN?"

09:14:18 *D&D support:* "ER, CALLSIGN IS…"

09:14:21 *Exeter assistant:* "OH WE'VE GOT IT, WE'VE GOT IT IT'S OK."

09:14:23 *D&D support:* "YOU'VE GOT..."

09:14:25 *Exeter assistant:* "YEP, ALRIGHT THEN."

09:14:26 *D&D support:* "ALRIGHT THEN, BYE."

09:14:27 *Exeter assistant:* "THANKS CHEERS, BYE."

The D&D controller understood the D&D support controller to mean that the Exeter Air Traffic Service Unit (ATSU) had assessed that aerodrome as suitable for a diversion by the pilot of G-BXBU. He believed Exeter heard the 'PAN PAN' call on 121.5 MHz and that the reason for Exeter's phone call was solely to offer help to G-BXBU. He was not aware of their concern of a potential conflict with the military jet, nor that the D&D support controller was speaking to an assistant. When the D&D support controller told the D&D controller that Exeter was willing to take G-BXBU, the D&D controller advised the pilot of this one second later (Appendix 2). The location of the D&D controller and the D&D support controller was such that the controller could not overhear the conversation with the Exeter assistant directly. The Exeter assistant did not identify herself as such during the phone call, contrary to operating procedures[2].

The D&D controller informed the pilot of G-BXBU that his aircraft was identified on radar and operating under a deconfliction service.

CAP 1434 states that a deconfliction service is,

> *'only available to IFR flights in Class G airspace. An ATCO will use radar to provide you with detailed traffic information on specific conflicting aircraft and advice on how to avoid that aircraft. However, the pilot retains responsibility for collision avoidance; you can opt not to follow the ATCO's advice[3].'*

Although the emergency squawk of 7700 was visible on the radar controller's screen, G-BXBU was transferred to Exeter before anyone with controlling authority at that aerodrome had been made aware the aircraft was diverting in an emergency. There was no formal radar handover[4] from the D&D controller and the suitability of Exeter, in particular the weather conditions at the airfield, were not discussed at any point by either the Exeter assistant, D&D support controller or the D&D controller.

Footnote

[2] Manual of Air Traffic Services Part 2 (Exeter Airport) states '*When ATCOs [controllers] use the mediator or direct lines they shall identify themselves as "Exeter Radar" or "Exeter Tower", ATCAs [assistants] add the suffix "Assistant".*

[3] Civil Aviation Publication (CAP) 1434 - *'UK Flight Information Services'.*

[4] A radar handover is designed to ensure the safe transfer of responsibility of aircraft between ATSU. RA 3233 contains the details required to be included in a radar handover from controller to controller. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/974521/RA3233_Issue_3.pdf [accessed April 2023].

The Radar South controller at Exeter, who had come on duty at 0900 hrs but was not yet on frequency, agreed to accept G-BXBU on a separate frequency. At the time, Exeter Radar North was active and had only the military jet on frequency. There was no discussion as to the nature of the diversion in the context of the weather conditions at the airport, nor was consideration of the pilot or aircraft capability expressed.

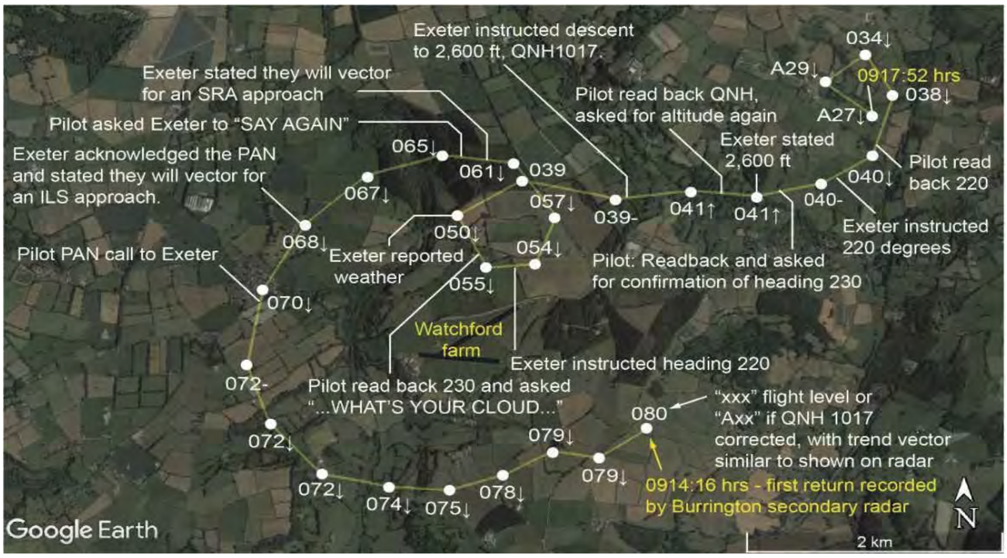


Figure 3

Flight path and flight level / altitude radar during Exeter communications
(Note that this is not a comprehensive listing of the RT)

When the pilot of G-BXBU made initial contact with the Exeter controller he confirmed his emergency 'PAN' status and stated, "HAVE BEEN DIVERTED". The controller initially advised she would give him vectors for an ILS approach for Runway 26 at Exeter. The pilot asked her to repeat her transmission and in her response the controller advised she would give vectors for a Surveillance Radar Approach (SRA), instructing him to fly a radar heading of 220°. The controller recalled that this change in clearance was prompted by input from a colleague who was in the room and witnessed her communications with G-BXBU. The pilot asked her to confirm the cloud base at Exeter, to which she replied the visibility was 6 km and the cloud was broken at 500 ft. The controller commented that she was surprised to be asked about the weather conditions at this point, as she would have expected the pilot to have this information before diverting.

At 0914 hrs the controller observed the aircraft descending and not maintaining the assigned heading. At 0916 hrs the radar track showed the aircraft levelling briefly around 4,000 ft. Without having noticed this, the controller instructed G-BXBU to descend to 2,600 ft, which was the minimum safe altitude[5], aiming to prevent the aircraft descending below that.

Footnote

[5] The minimum safe altitude in this sector was 2,600 ft.

The last radio transmission from the pilot was "DESCENDING TWO THOUSAND SIX HUNDRED, YOU WANT ME ON TWO THREE ZERO?". The last radar return was at 0917 hrs and showed the aircraft at 2,700 ft.

Several ear witnesses nearby described a loud engine noise prior to an impact.

At 0920 hrs, Devon and Cornwall Police received a report of an aircraft accident. First responders found that both occupants had been fatally injured.

Accident site

The accident site was a field approximately 1.2 km north-west of Buckland St Mary in Somerset. The aircraft struck the boughs of an oak tree and then the ground in the northern end of the field (Figure 4). Around the tree and from the ground impact there were large amounts of debris scattered on a southerly path. Running east-west midway across the field was a concrete single track road bounded on both sides by a single strand, wire fence supported on wooden posts. The wire had been broken and a piece of wire was caught in the tail wheel. The engine, cockpit instrument panels and rear fuselage were approximately 40 m to the south of the roadway and had been arrested by the wire fence. The left landing gear wheel was found in a sunken stream at the southern end of the field, approximately 235 m from the tree.

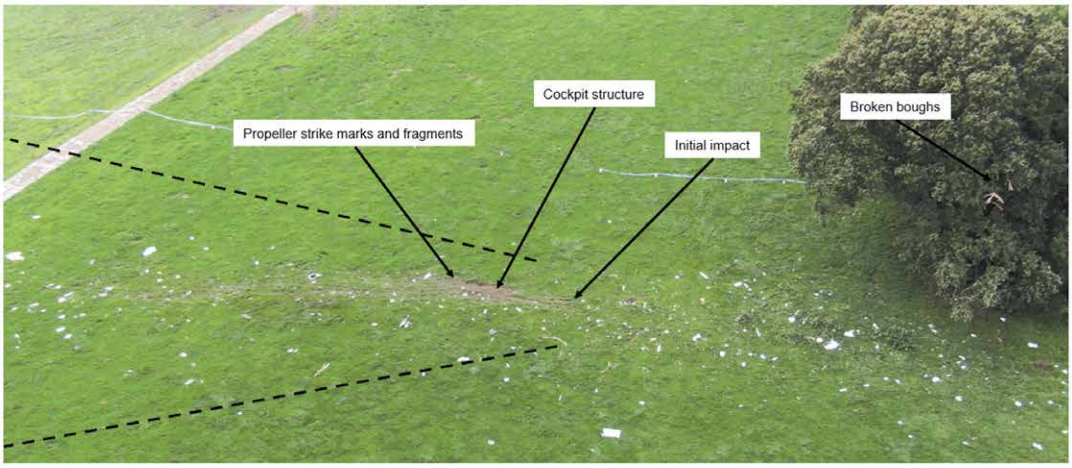


Figure 4
Ground impact marks

The oak tree at the northern end of the accident site was approximately 20 – 25 m tall with a large swathe cut through it at about 15 m from ground level. Several large boughs had been broken and some pieces of wreckage were lodged in the tree. The ground to the south and east contained broken branches and further wreckage, including wing and fuselage structure, shards of clear plastic from the canopy, and fragments of the propeller (Figure 5).

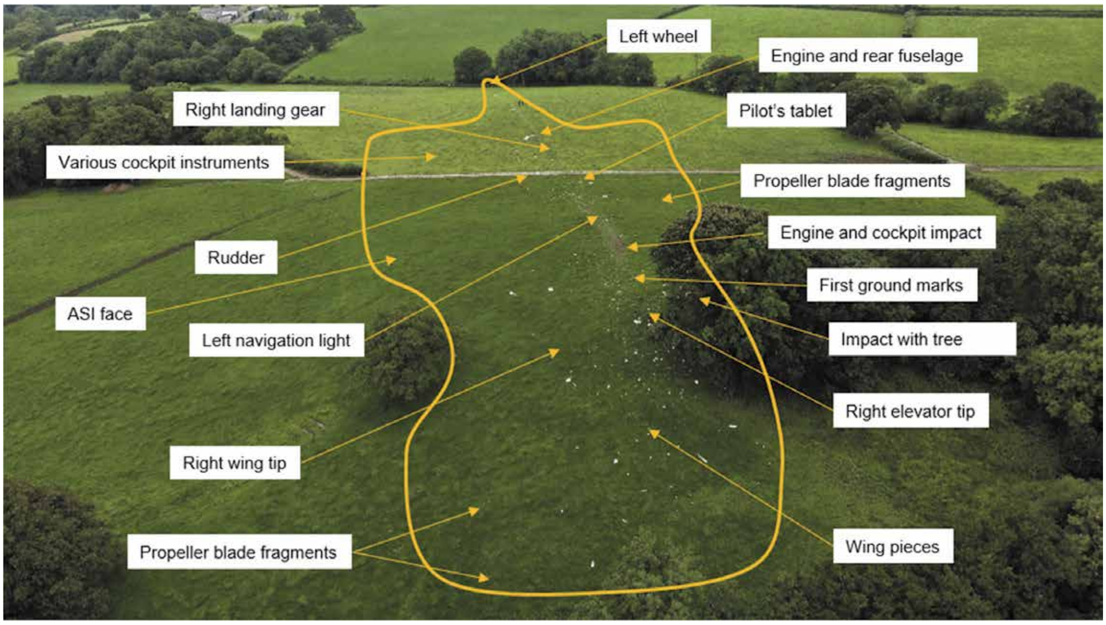


Figure 5

Accident site looking from the north showing wreckage distribution and boundary

To the south of the concrete roadway was the engine and rear fuselage (Figure 6). The engine was attached to the cockpit instrument panels and rear fuselage by flight control and electrical cables. The primary fuel tank had ruptured and was empty whereas the auxiliary fuel tank was intact and still contained a small quantity of fuel.

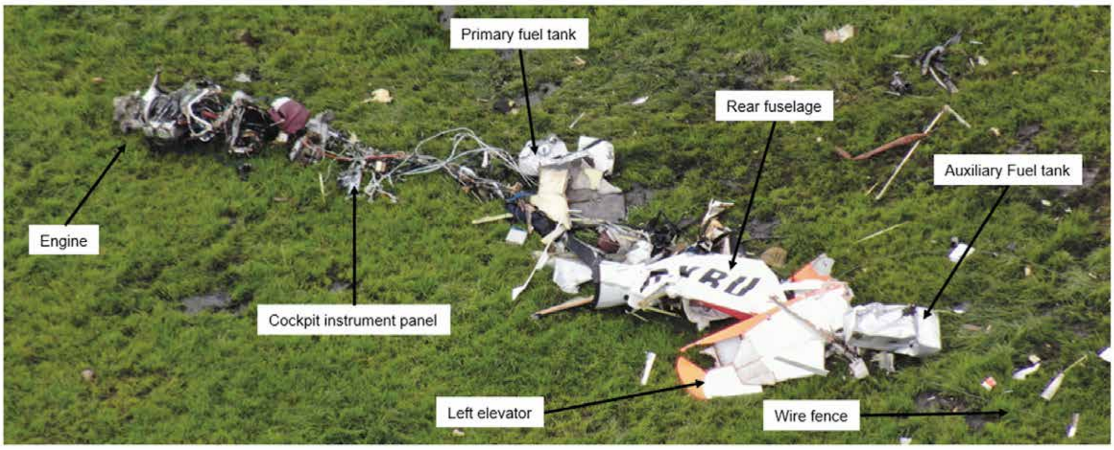


Figure 6

Engine and rear fuselage

Inspection of the seat belts revealed they were still done up and that all the structural attachments had either failed in overload or become detached from the structure so that they were no longer capable of restraining the occupants. The right landing gear leg was found close to the rear fuselage section and was complete including a small section of wing spar (Figure 7).

Figure 7
Main landing gear wheels

Recorded information

The aircraft's avionics did not have any recording capability.

A mobile phone was recovered from the accident site by the police and passed to the AAIB. The contents indicated that it was not used to check for weather and not used in flight. There was a change of one of its internal settings recorded at 0917:57 hrs, likely associated with the time of the accident.

A heavily damaged tablet device was recovered from the aircraft. The main logic board had become twisted with a part of it ripped off. Some of the integrated circuits had been damaged and some detached. Damage was largely focused on one end of the board and included a distorted circuit board with the left narrow part detached, a detached chip and a cracked chip (Figure 8). Despite the damage, a specialist organisation was able to recover data from the item.

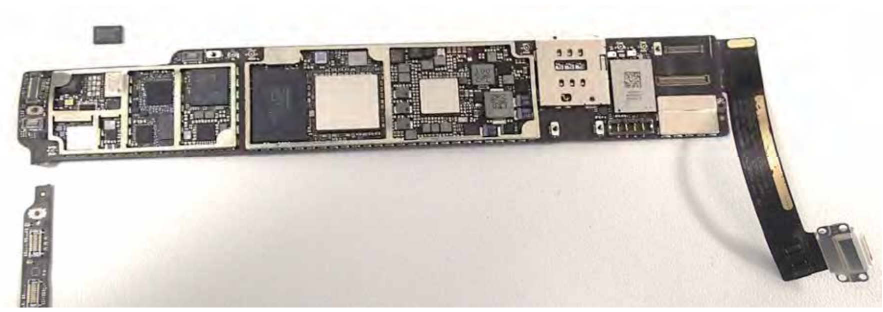


Figure 8
Tablet logic board

The tablet contained an aviation navigation application ("app"), from which route information, flight path and app settings were recovered. The waypoints and path are shown in Figure 1.

A function enabling the app to access the internet in flight was selected OFF. Therefore, there was no access to the latest weather information from within the app once airborne.

The weather information was last updated the day before the accident. The NOTAM information was last updated approximately 17 minutes before the end of the accident flight. Given that internet access was off, preventing an update, this indicates that the pilot had changed which NOTAMs were hidden or unhidden.

The recorded track of the aircraft stopped an estimated 27 seconds before the final impact. This was during the start of a turn to the left, close to the accident site. The recorded file showed that tracking was not stopped due to user input. The app company stated that there was no explanation for the loss of this period associated with the app itself. However, it also stated that any buffering delays of the underlying tablet operating system were not known.

The data from the tablet was reviewed for other relevant activity outside of the use of the app. It showed that at 0519 hrs on the day of the accident, weather information for St Mary's (Isles of Scilly), Sidmouth, Bodmin and Exeter was checked on a BBC website. The tablet contained a screenshot of the weather information for Exeter taken at 0519 hrs (Figure 9). As the information is not intended for aviation use, it provided insufficient cloud information for aviation use, summarising the weather as "*Light cloud and a moderate breeze*".

Figure 9

Screenshot from the tablet – (times are UTC +1)

Radar

Primary radar data from airfield installations along the flown route were provided by the respective airfield ATC units. The operator of enroute radar facilities found primary radar tracks for large parts of the flight path, aiding the investigation early on and corroborating track data later recovered from the navigation app.

The aircraft was fitted with an ATC transponder but was not detected by secondary radar until the D&D Cell asked the pilot to switch the transponder on. The secondary radar recordings from Clee Hill and Burrington radar facilities were provided. Burrington radar provided the most complete recording of the end of the flight but stopped approximately 2,000 ft above the accident site. Figure 10 shows the data for the duration of the secondary radar recording and data from the navigation app over the same period.

Burrington's radar antennas swept the area every 8 seconds. The next sweep after the last recorded radar return did not detect the aircraft, either because the transponder antenna was obscured by an unusual aircraft attitude, or because the aircraft had rapidly descended below the line of sight of the radar. Such a descent would have required a loss of approximately 1,700 ft in 8 seconds, equating to a descent rate in excess of 12,750 ft/min.

Radio transmissions

RT recordings were obtained from the NATS Swanwick facility where the D&D Cell is located and from Exeter ATC. The recordings included telephone conversations between the two facilities associated with the aircraft, pertinent extracts of which are provided in the *History of the flight* section of this report.

Aerodrome logs and recordings showed no communication with the aircraft other than those described in the *History of the flight* section.

CCTV

CCTV from a local farm did not show the aircraft but provided evidence of the visual conditions before, during and after the accident (Figure 11). The times shown compensate for errors in the embedded timestamps.

The tree line that is about 360 m from the camera was clearly visible in the recorded image an hour before the accident but was no longer visible in the period leading up to and after the accident. Trees about 170 m from the camera also became hazy at about the time of the accident. Ground level visibility significantly improved over the next hour.

The CCTV camera recordings included audio. Audio from one of the cameras captured the sound of the aircraft propellor intermittently for about 90 seconds before the aircraft contacted the ground. The pitch of the audio varied in this period, reflecting a combination of a higher propellor speed due to airspeed or throttle changes, and distortion of the pitch by travelling towards or away from the audio recording device.

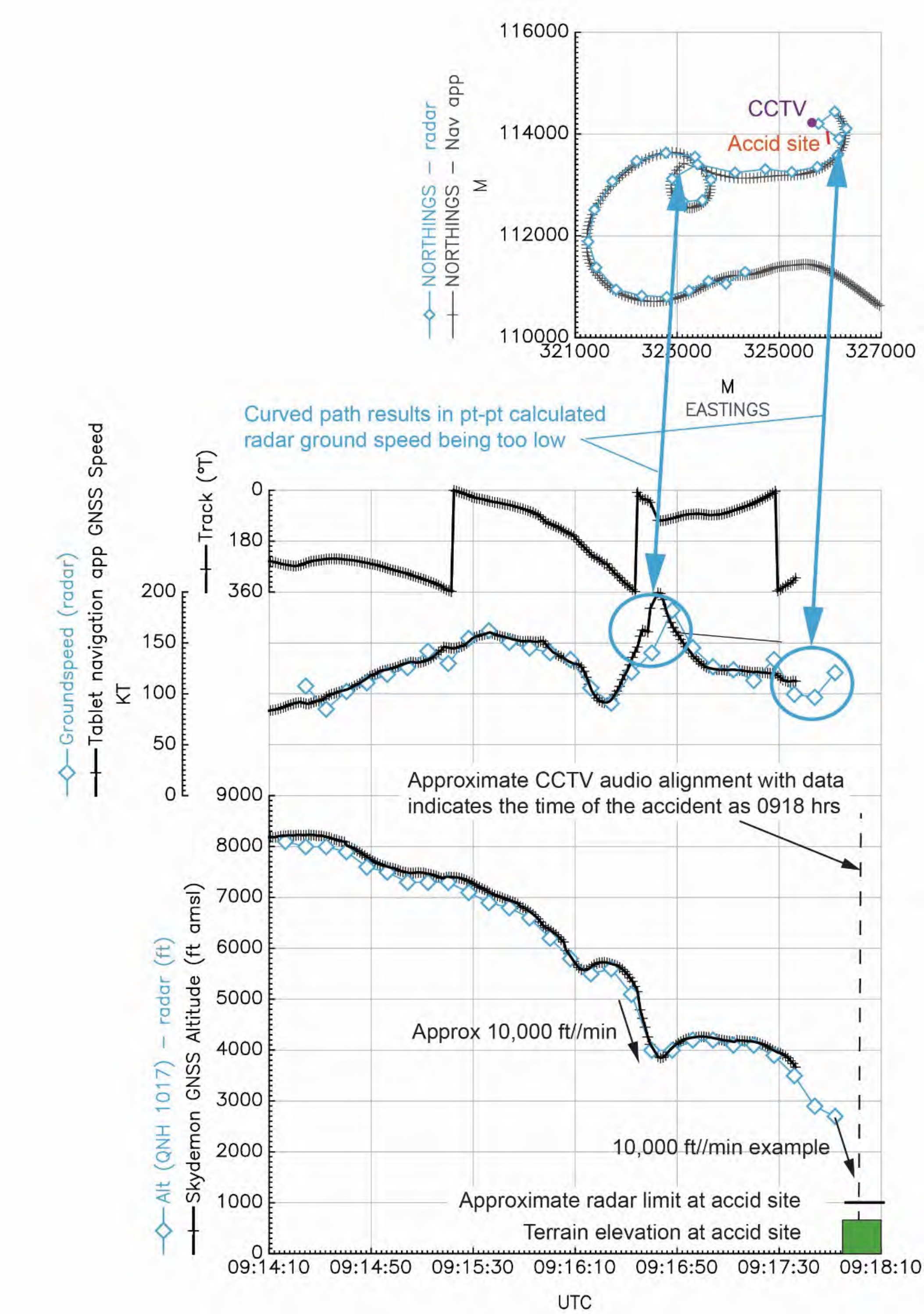


Figure 10

End-of-flight radar, navigation app data and CCTV audio signature data

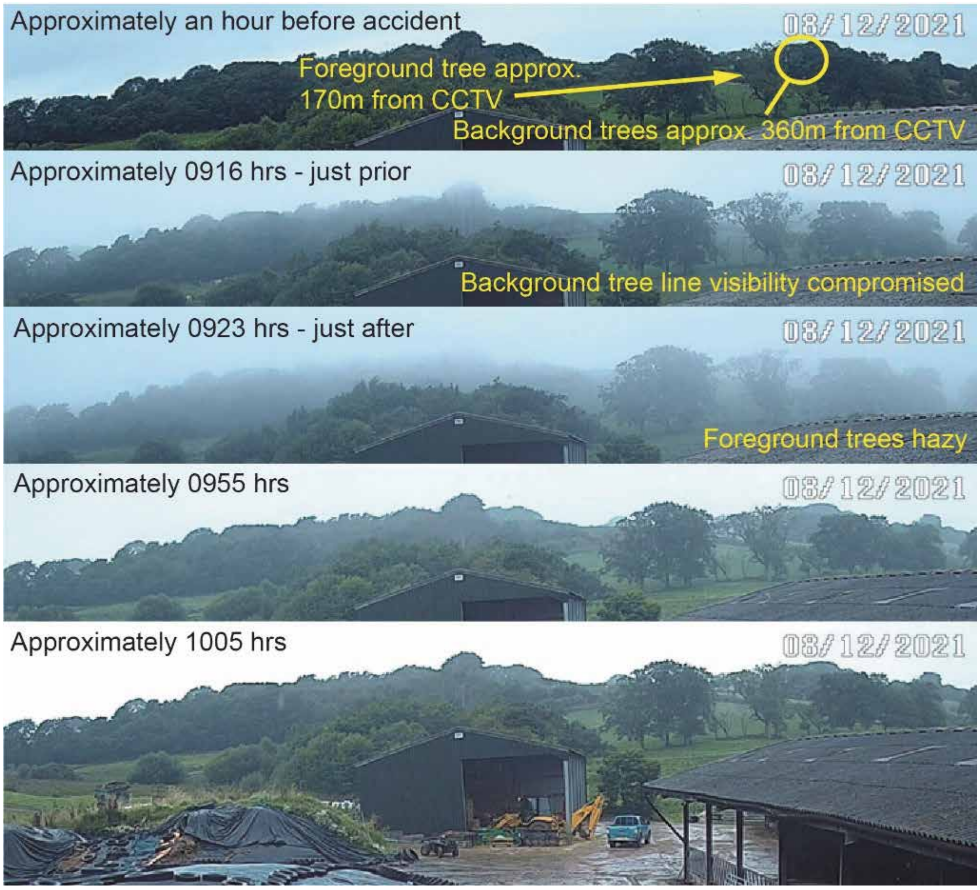


Figure 11

Cropped snapshots from one of the CCTV cameras on a local farm showing changing visibility in the area

Final descent

The audio characteristics, proximity of the first left turn to the accident site, the altitude above the terrain and the expected radar line of sight capability in the area, indicate that the aircraft flew another tight left turn after the end of the radar recording. If there were no significant changes to throttle settings, the audio indicates that the final turn was associated with higher speeds than the previous 10,000 ft/min / 200 kt descent, followed by a brief reduction in speed before impact with the terrain.

Other traffic

There was military jet activity east of Exeter during the later stages of G-BXBU's flight. Comparison of the recorded aircraft paths showed that this traffic was not close enough laterally or vertically to have influenced the accident aircraft directly. The recorded radio communications with the accident pilot did not suggest the traffic had interacted in any way that had affected the controllability of G-BXBU.

Aircraft information

The Mudry Cap 10B is a low wing aerobatic aircraft predominantly constructed from wood and powered by a Lycoming AEIO-360 four-cylinder engine with a fixed pitch, wooden propeller. The pilot and passenger sit side-by-side and it is certified for flight under VFR only.

The wing is a single piece with a main spar of spruce and birchwood. It is covered with 2 mm thick plywood and fabric. The fuselage is a spruce lattice structure covered with fabric with the vertical fin an integral part.

There were two fuel tanks, each having a capacity of 20 gallons, located within the fuselage. The primary tank was forward of the instrument panel and behind the engine firewall. The auxiliary tank was under the baggage compartment to the rear of the cockpit. The tanks were constructed from thin gauge aluminium sheet and secured to the aircraft structure by steel straps.

Each seat was fitted with a five-point harness which was attached the aircraft structure; the lower fixings to the main spar and the shoulder straps to the upper cockpit structure. In addition, a secondary lap strap belt was also provided which was secured to the main spar.

Aircraft examination

The aircraft was recovered to the AAIB facilities where it was laid out to confirm that all the aircraft had been at the accident site. No significant items were missing. Along with the identifiable structural items, the flight control systems were also laid out and examined to verify continuity (Table 1).

System	Components	Breaks	Comments
Ailerons	Cables, push pull rods, bell cranks	Yes	Push pull rods broken through bending
Elevator	Cables, push pull rod	Yes	Push pull rod broken through bending
Elevator trim	Cable	No	
Rudder	Cables	Yes	Cables cut during aircraft recovery
Flaps	Push pull rods, bell cranks	Yes	Push pull rods broken through bending

Table 1

Flight control continuity

The AAIB determined that the damage to the engine was probably sustained during the impact and no evidence was found of any anomalies that would have prevented normal operation.

Meteorology

METAR and TAF information is shown in Appendix 1. A TAF was available for St Mary's from 0629 but not all relevant en route or alternative aerodromes had begun reporting for the day. However, the pilot lived 35 minutes from Watchford Farm and while some weather forecasts for relevant aerodromes had become available by the time the flight departed, it may not have been practical for the pilot to access them after he left home. There was a weather forecast for below 10,000 ft published at 0312 hrs by the Met Office (Figure 12). Although this forecast was valid at 1200 hrs, it was available before G-BXBU departed and indicated the weather conditions which were expected along the planned route.

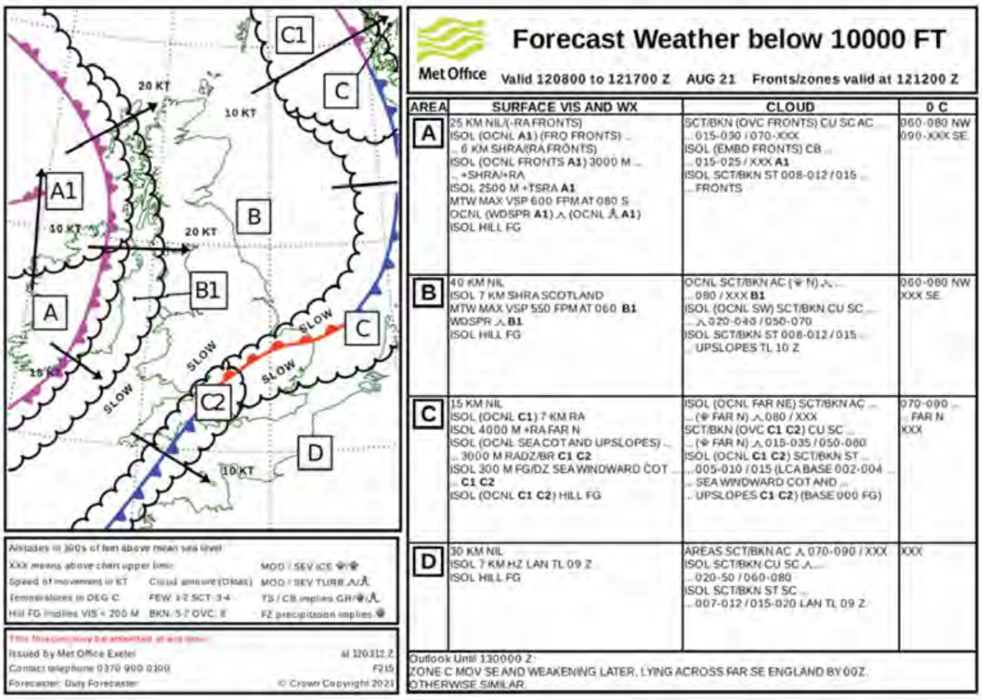


Figure 12
Met Office forecast for below 10,000 ft

During the investigation the Met Office provided the following interpretation of forecast conditions in south-west England:

> *'Conditions [in area C2] were expected to be generally 15KM visibilities* [sic]*, but occasional areas of rain with 7000 m visibilities, isolated (occasional for upslopes) areas of rain and drizzle or mist with visibilities of 3000 m, and occasional areas of hill fog. There were expected to be isolated areas of scattered/broken altocumulus with bases of 8000 ft and tops of 10000 ft or above, overcast cumulus or stratocumulus cloud with bases 1500-3000 ft and tops of 5000-8000 ft, occasional areas of scattered or broken stratus with bases 500-100 ft and tops 1500 ft, locally bases of 200-400 ft on upslopes and at the surface in the hill fog. The freezing level was expected to be at or above 10,000FT.'*

Approximately 30 minutes before the aircraft departed from Watchford Farm, several METAR's and TAF's relevant to the planned route to St Mary's were published, indicating a deterioration in weather conditions, locally and at the planned destination.

The navigation app used for flight planning the previous evening displayed the then most recently published METAR and TAF weather information for the airfields along the planned route. There was no evidence the app was used to assess the weather on the day of the accident flight. The screenshot of Exeter weather which was accessed through the news website indicated cloudy conditions, with the temperature increasing throughout the day.

It was not possible to reproduce exactly what weather would have been presented on the app at a particular time. However, it probably generated weather for Yeovilton Naval Air Base, Exeter Airport, Newquay Airport, Culdrose Naval Air Base, Land's End Airport and St. Mary's Airport. The actual and forecast conditions for these aerodromes available at 0600 hrs, 0630 hrs and 0900 hrs are available in Appendix 1. These weather reports show a marked deterioration in the conditions as the morning progressed; the extent of the poor weather was not evident in the early morning reports.

Witnesses who were flying locally at the time of the accident described the weather conditions as 'intermittent IMC' with areas of VMC between 3,000 ft and 4,000 ft. Figures 13 and 14 shows satellite imagery of the cloud cover along the south coast.

Figure 13
Satellite image at 0700 hrs

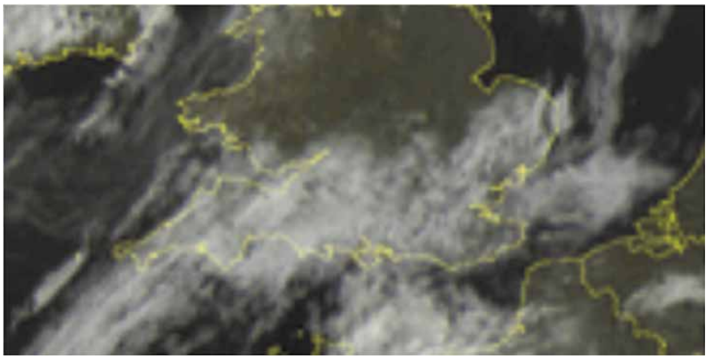


Figure 14
Satellite image at 0915 hrs

Both Birmingham Airport and Gloucestershire Airport were within 90-minutes flying time of the aircraft's position during the emergency. Both reported 1-2 octas of cloud and good visibility; conditions that were suitable for flying a visual approach.

Aids to navigation

Although not required for the planned flight, G-BXBU was fitted with a pressure altitude reporting Secondary Surveillance Radar (SSR) transponder. The transponder was not switched on during the flight until requested by the D&D controller, after the pilot had declared an emergency.

The UK Aeronautical Information Publication (AIP) states that, where fitted, pilots shall operate the transponder to the full extent of its capabilities. The retention by the UK of the relevant EU Regulations means that the Standardised European Rules of the Air (SERA) apply to aircraft operating in UK airspace. SERA.13001[6] states:

> '1. *When an aircraft carries a serviceable SSR transponder, the pilot shall operate the transponder at all times during flight, regardless of whether the aircraft is within or outside airspace where SSR is used for ATS purposes.*
>
> 2. *Pilots shall not operate the IDENT feature unless requested by ATS.*
>
> 3. *Except for flight in airspace designated by the competent authority for mandatory operation of transponder, aircraft without sufficient electrical power supply are exempted from the requirement to operate the transponder at all times.'*

Aerodrome information

Watchford Farm has two grass strips, 08/26 and 04/22, both of which are 400 m long and 20 m wide. The airfield elevation is 840 ft amsl.

Exeter Airport is an international airport with one runway, 08/26. The landing distance available on Runway 26 is 2,036 m. The airport has regular commercial traffic and has various instrument approaches available for both runways.

Personnel

Background

The pilot had a total flight time of just over 1,400 hrs. He held a valid PPL(A) with a valid Single Engine Piston (SEP) rating issued by the CAA, and his medical was in date. He had completed a total of 1.5 hrs of instrument flying during his initial PPL training 21 years earlier.

Footnote

[6] The retention by the UK of the relevant EU Regulations means that the SERA apply to aircraft operating in UK airspace *'Standardised European Rules of the Air'* Annex: Rules of the Air Section 13, available at https://www.easa.europa.eu/en/document-library/easy-access-rules,https://www.easa.europa.eu/en/document-library/easy-access-rules/online-publications/easy-access-rules-standardised-european?page=20 accessed 1 November 2022.

The pilot had owned G-BXBU since 2014 and it had been hangered at Watchford Farm since 2015. He was described by flying acquaintances as a 'fair weather' flyer. It was reported that he did not routinely request an ATC service, nor did he operate the aircraft's transponder.

The passenger had no flying experience but was known to have flown previously as a passenger in G-BXBU.

Pre-flight planning

The day before the accident, the pilot contacted St. Mary's Airport by telephone to make a prior permission request for his flight the following day. During that call, the pilot indicated that he intended to land at Bodmin Airfield should the weather at St. Mary's not be suitable.

Air traffic control

Air traffic control assistants

Air traffic controllers may delegate some of their responsibilities, including duties which are closely associated with the safety of aircraft (such as phone calls regarding flight data), to adequately trained support staff such as air traffic control assistants (ATCAs). The responsibilities which can be delegated must not require an air traffic control licence. The Exeter assistant and D&D support controller were not licenced to make decisions concerning the diversion of G-BXBU.

Management of emergencies

The Manual of Air Traffic Services (MATS) Part 1 contains procedures, instructions and information intended to form the basis of air traffic services in the United Kingdom. Section 5 *'Emergencies'* states that pilots should contact an ATSU as soon as it becomes apparent that an emergency situation exists[7], to allow the ATSU to provide the necessary priority and assistance as appropriate to the emergency. There are two states of emergency which are classified and declared as follows:

> *'Distress: defined as a condition of being threatened by serious and/or imminent danger and of requiring immediate assistance. Distress is indicated by the words "MAYDAY MAYDAY MAYDAY" being spoken on the RTF.*
>
> *Urgency: defined as a condition concerning the safety of an aircraft or other vehicle, or of some person on board or within sight, but does not require immediate assistance. Urgency is indicated by the words "PAN PAN, PAN PAN, PAN PAN" being spoken on the RTF.'*

Annex 10 to the International Civil Aviation Convention (Annex 10) Volume V states that the emergency channel 121.5 MHz shall only be used for genuine emergency purposes

Footnote

[7] 'Manual of Air Traffic Services (MATS) - Part 1' Section 5 Chapter 1 4.1 – Civil Aviation Publication (CAP) 493.

and when normal channels are being utilised by other aircraft, although the UK has filed a difference for the purpose of pilots conducting practice PAN radio calls.

Annex 10 Volume II states that aeronautical stations shall guard and maintain a continuous listening watch on the emergency channel 121.5 MHz during the hours of service of the units at which it is installed[8]. Civil Aviation Publication (CAP) 413[9] states that this ICAO requirement is not applied in the UK. ICAO Annex 10 Vol II further states that the station addressed by an aircraft in an urgency or distress condition will normally be that station communicating with the aircraft or in whose area of responsibility the aircraft is operating, until it is considered better assistance can be provided elsewhere.

MATS Part 1 states:

> *'controllers **shall** offer as much assistance as possible to any aircraft that is considered to be in an emergency situation, including weather information, availability of aerodromes and associated approach aids'. It further states that 'before transferring an aircraft, controllers should obtain sufficient information from the pilot to be convinced that the aircraft will receive more assistance from another unit.'*

The United Kingdom AIP states that distress and urgency communications within the UK Search and Rescue Region (SRR) are in accordance with standard international procedures[10]. It also states that the D&D Cell exercises 'executive control' over emergencies in the London and Scottish FIRs, which encompasses the airspace covering England, Scotland, Wales and Northern Ireland.

The Distress and Diversion Cell

General

The D&D Cell is a military air traffic unit based at the London Area Control Centre at Swanwick. The service the D&D Cell provides is a collaboration between military operators and civil providers – the unit is exclusively operated by Royal Air Force personnel who use equipment owned by a civil air navigation service provider (ANSP). The service provided is described in CAP 413 as unique to the UK.[11]

The minimum requirement to be a D&D controller is to hold a valid area control endorsement (AC EMerg), meaning they are qualified to control air traffic in an area environment. Prior practical experience is not a requirement to become a D&D controller. The D&D Cell commonly receives 'practice PAN' calls and the general aviation community is encouraged to practice these calls during training. Pilots have reported comparatively higher levels of transmission on 121.5 MHz in UK airspace than in other jurisdictions, primarily involving 'practice PAN' calls.

Footnote

8 'International Civil Aviation Organisation' (ICAO) Annex 10, Vol II 5.2.2.1.3 & Vol II 5.3.1.5, Vol V 4.1.3.1.1.
9 CAP 413 – *'Radiotelephony Manual'.*
10 'UK AIP' - GEN 3.6.6.1 Search and Rescue, accessed at https://www.aurora.nats.co.uk/htmlAIP/Publications/2021-12-02-AIRAC/html/index-en-GB.html on 2 December 2021.
11 CAP 413 – *'Radiotelephony Manual'*, Chapter 8.7.

The role of the D&D Cell is to provide military and civil pilots with emergency communication and aid, a position fix service, and a search and rescue alerting service[12] within the Scottish and London FIRs. It achieves this in part by providing pilots with the weather and operational status of an aerodrome, selecting a suitable aerodrome, and providing a steer toward that aerodrome. D&D utilises two boards to display all current military aerodrome weather 'colour codes'[13] across the UK in order to select a suitable diversion. It also has access to a limited number of electronic weather reports from civil aerodromes around the UK; it stated that 51 of the 558 civil airfields are potentially able to provide electronic weather. Details from the other 507 are obtained by calling the aerodrome or farm strips on a landline. The unit may be contacted by civil pilots on the VHF emergency frequency 121.5 MHz and by military pilots on UHF frequency 243.0 MHz, all day and every day.

The D&D Cell has the facility to detect emergency SSR squawks automatically. It can also locate an aircraft's position using VHF Direction Finding[14] (VDF), subject to the aircraft's position and altitude. The service uses the callsign 'London Centre' and the AIP states that it provides coverage over the greater part of the UK above 3,000 ft[15].

According to the structure in place at the time of the accident, when the D&D Cell receives an emergency call directly on 121.5 MHz, it automatically assumes executive control and operational control of the emergency. MATS Part 1 states:

> *'Once D&D hand the aircraft to another unit they pass-over Operational Control but retain Executive Control. This means that D&D do not give up all responsibility for an emergency once the aircraft is working another unit. They retain responsibility for overall management until the emergency ends.'*[16].

Operational control is control by an ATSU directly issuing instructions and support to the emergency aircraft, which should be consistent with the executive control objectives determined by the D&D Cell. The D&D Cell transfers operational control when it completes a handover of the traffic to another ATSU. Guidance for D&D controllers states they are to '*verify before handing Operational Control to another agency, that the receiving controller has been given all the details'*.

If pilots experiencing an emergency are already in communication with a military or civil ATSU, they should request assistance directly from them. Air traffic controllers should inform the D&D Cell of an aircraft emergency[17], at which point the D&D controller assumes executive control. The D&D controller normally delegates operational control back to the ATSU, but this may depend on the circumstances of the event. MATS Part 1 also provides controllers with guidance on selecting the most appropriate controlling agency for managing

Footnote

12 CAP 413 – *'Radiotelephony Manual'*, Chapter 8.5.
13 Military METAR reports also display a colour state according to cloud base and visibility.
14 VDF provides information on the position from which a VHF transmission was made.
15 'UK AIP' GEN 3.4 Section 3.2.5 – *Emergency Telecommunications Services*, accessed at https://www.aurora.nats.co.uk/htmlAIP/Publications/2021-12-02-AIRAC/html/index-en-GB.html [accessed December 2022].
16 CAP 493 – *'MATS - Part 1'* Section 5 Chapter 1 9.1.
17 CAP 493 – *'MATS - Part 1'* Section 5 Chapter 1 2.5.

an emergency aircraft[18]. The executive control and associated responsibility for managing the aircraft held by the D&D Cell persists until the emergency ends[19].

MATS Part 1 section 5, 9.2 states:

> *'D&D controllers have a detailed knowledge of minor aerodrome availability within their area as well as a comprehensive database that enables rapid communication with aerodromes, Aircraft Operators, ATSUs, and the SAR organisation including Police Air Support Units and the regional emergency services. The D&D Cell can assist a pilot of an aircraft in an emergency and the civil ATSU to select the most suitable diversion aerodrome.'*

MATS Part 1 also states that the D&D Cell do not have detailed knowledge of the local airspace, terrain or obstacles surrounding aerodromes, and may seek guidance on local minimum safe altitudes to serve emergency aircraft. MATS Part 1 further states that ATSUs should not transmit on 121.5 MHz without the authorisation of the D&D Cell, unless the pilot in distress calls a specific local ATSU, or if it is apparent that the D&D Cell is not responding to an emergency transmission.

Responsibility and oversight

The Department for Transport is responsible for the overall provision of the national aeronautical search and rescue (SAR) operations. The initial response to and coordination of aeronautical SAR is integrated with maritime response and is fulfilled by HM Coastguard.

Before 2016, SAR helicopters were operated by the military and organisationally the D&D Cell sat within the military SAR operation. In 2016, SAR operations were transferred to HM Coastguard and since then the Aeronautical Rescue Coordination Centre based at the National Maritime Operations Centre in Fareham coordinates all helicopter and fixed wing SAR assets. These aircraft are operated by civilian contractors.

The responsibilities held by the D&D Cell remained following this transfer of SAR provision from the military to HM Coastguard. The AAIB was not provided with evidence of any agreement documenting the responsibilities with which the D&D Cell was tasked under these new arrangements.

MATS Part 1 is a CAA publication which contains several references to the D&D Cell. However, as a military unit, the D&D Cell is not subject to oversight from the CAA, despite providing a service to the civil aviation community in the UK. The responsibility to ensure the D&D Cell is providing the required level of service, detailed in ICAO Standards and Recommended Practices, is delegated by the Department for Transport to the Ministry of Defence. The D&D Cell is therefore subject to operational oversight by the Military Aviation Authority (MAA).

Footnote

[18] CAP 493 – *'MATS - Part 1'* Section 5 Chapter 1 8.1.
[19] CAP 493 – *'MATS - Part 1'* Section 5 Chapter 1 9.1.

The MAA issues Regulatory Articles (RA's), which provide the framework of policy, rules, directives, standards, and processes; and the associated direction, advice and guidance that govern military aviation activity and against which air safety is assessed. RA 3311[20] details the actions expected of a controller once an aircraft has declared an emergency:

> *'Regulatory Article RA 3311 (1) Controllers Emergency Actions Rationale: Air Systems with emergencies need to be afforded special attention by controllers RA 3311(1) Controllers **shall** offer as much assistance as possible to any Air System that is considered to be in an emergency situation.*
>
> *AMC 3311 (1) On notification that an Air System is suffering an emergency, controllers **should**:*
>
> *a. Inform the pilot of the most suitable aerodrome, considering weather conditions (including winds), terrain and obstructions. The pilot can be offered navigational assistance.*
>
> *b. Coordinate actions with Distress and Diversion and other Air Traffic Control (ATC) units as required and alert crash and rescue facilities.*
>
> *c. Advise other Air Systems of the emergency in progress and, where possible, keep them off the frequency being used by the Air System in distress. If possible, avoid changing the frequency of the Air System in distress once suitable contact is established'.*

In contrast to the description of executive control in MATS Part 1, the D&D Cell has described its executive control as 'administrative'.

Civil Air Navigation Service providers

<u>Responsibility</u>

Although the D&D Cell assumes executive control of all emergencies declared in the London and Scottish FIR's, some aerodromes can also offer civil pilots an effective emergency communications and aid service on 121.5[21]. These airports are listed in ICAO European Air Navigation Plan, Volume I Part II. Exeter Airport is included on this list.

ICAO guidance for air traffic management states that when an emergency is declared by an aircraft, the ATSU should take appropriate and relevant action[22], including:

> *'Take all necessary steps to ascertain aircraft identification and type, the type of emergency, the intentions of the flight crew as well as the position and level of the aircraft; …*

Footnote

[20] 'Regulatory Article (RA) 3311': controllers emergency actions accessed at https://www.gov.uk/government/publications/regulatory-article-ra-3311-controllers-emergency-actions on 2 December 2021.

[21] 'UK AIP' – GEN 3.6.5, accessed at https://www.aurora.nats.co.uk/htmlAIP/Publications/2021-12-02-AIRAC/html/index-en-GB.html on 3 December 2021.

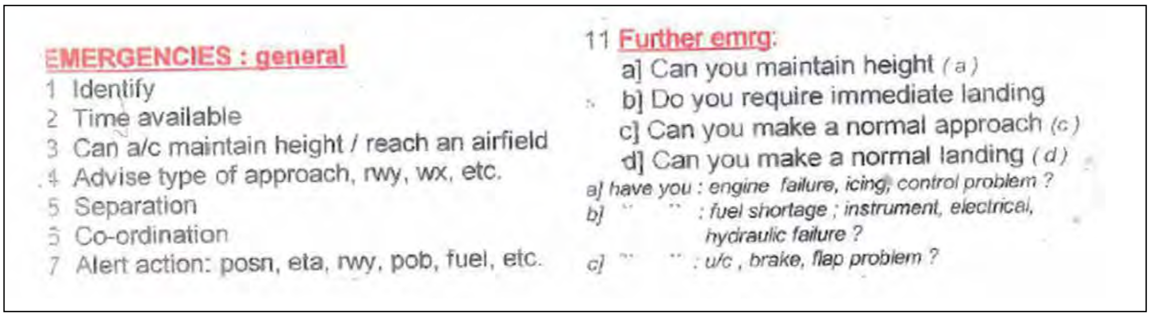
[22] Doc 4444 '(16th ed) – *'Procedures for Air Navigation Services - Air Traffic Management'* (PANS-ATM) Chapter 15.1.1.2.

… 'Decide upon the most appropriate type of assistance which can be rendered'…

…. 'Provide the flight crew with any information requested as well as any additional relevant information, such as details on suitable aerodromes, minimum safe altitudes, weather information;' …

The CAA defines abnormal and emergency situations (ABES) as situations, including degraded situations, which are not routinely or commonly experienced and for which automatic skills have not been developed, and serious and dangerous situations requiring immediate actions. ABES training is included in refresher training programme for ATCOs and should include dealing with aircraft emergencies[23]. Training to prepare controllers to react to ABES events are outlined in CAP 584 – '*Air Traffic Controllers – Training*'.

Exeter Airport did not have a procedure specifically for dealing with VFR traffic stuck above cloud, but the *'Emergencies: general'* aid memoire was available to controllers (Figure 15).


EMERGENCIES : general
1 Identify
2 Time available
3 Can a/c maintain height / reach an airfield
4 Advise type of approach, rwy, wx, etc.
5 Separation
5 Co-ordination
7 Alert action: posn, eta, rwy, pob, fuel, etc.

11 Further emrg:
a] Can you maintain height (a)
b] Do you require immediate landing
c] Can you make a normal approach (c)
d] Can you make a normal landing (d)
a] have you : engine failure, icing, control problem ?
b] " " : fuel shortage ; instrument, electrical, hydraulic failure ?
c] " " : u/c , brake, flap problem ?

Figure 15

Exeter Airport *'Emergencies: general'* and *'Further emergency'* procedures

The controller on Radar South did not utilise a specific ABES procedure or checklist prior to accepting G-BXBU or during her transmissions with the pilot. She referred to G-BXBU as a 'weather diversion' on several occasions, not as an aircraft that had declared an emergency. Although the controller stated she knew the aircraft had been in radio contact with the D&D Cell, and the emergency squawk of 7700 was visible on her screen, the status of G-BXBU's emergency was not interrogated and no handover from the D&D controller was sought. There was no verbal acknowledgement that its pilot might require additional assistance to that of a routine arrival to Exeter.

Exeter Airport follows a unit training plan which details the training and assessment requirements for controllers.

Footnote

[23] CAP 584 – '*Air Traffic Controllers – Training*'.

Section 3 of the unit training specifies the required training for ABES. It states:

> *'Staff must be able to establish some basic information as early as possible. When appropriate ascertain:*
>
> *Nature of the problem*
>
> *Intentions of personnel (e.g. aircraft crew or emergency services)*
>
> *Time available*
>
> *Additional information'*

It advises that ATC staff should be aware that aircraft emergencies are not always announced as such, and that staff should be prepared to act in response to events if it is thought an emergency is developing, even without a 'PAN PAN' or 'MAYDAY' call.

Controllers are periodically assessed on a variety of emergency scenarios described in the unit training plan. In one scenario described in the *'Aerodrome'*, *'Approach control'* and *'Approach control surveillance'* sections of the plan, '*a pilot makes a PAN or MAYDAY call, or other information indicates an emergency situation'*, indicating this is a scenario which controllers would be expected to manage effectively.

<u>Instrument approaches</u>

The controller initially told the pilot to expect an ILS approach, followed very shortly by a change of plan to an SRA approach, both of which are instrument approaches. To fly an instrument approach the aircraft must have appropriate instrumentation, and the pilot must be trained to fly in IMC and hold a valid instrument rating. The pilot of G-BXBU was not licenced to fly in IMC and the aircraft was not equipped to carry out an ILS approach.

An SRA is an instrument approach flown by the pilot according to ATC heading and rate of descent instructions. The controller assesses the aircraft position and height on radar and, when required, issues corrective headings and descent rates to regain the desired approach path. The minimum obstacle clearance height for a category A aircraft on an SRA approach to Runway 26 at Exeter is 788 ft.[24]

SRA approaches are not part of the PPL syllabus and are not commonly flown by pilots outside a training environment.

MATS Part 2 contains local operating procedures specific to each ATC unit. MATS Part 2 for Exeter Airport states:

> *'Unless otherwise stated inbounds receiving a radar service are to be offered vectors for an ILS approach. The pilot will request if an alternative type of approach is required, including positioning themselves to the ILS.'*

It is not clear how this applies to VFR traffic.

Footnote

[24] Doc 8168 (5TH Ed) – *'Procedures for Air Navigation Services - Aircraft Operations Volume I'*, Flight Procedures-Section 4 Chapter 1.

Visual Flight Rules

Flights conducted under VFR are permitted in VMC by day outside Class A airspace in the UK. The pilot of G-BXBU ordinarily flew in uncontrolled Class G airspace. He did not routinely file a flight plan with ATC and he had not done so for the accident flight. There is no requirement for VFR flights in Class G airspace to file a flight plan. Aircraft operating in uncontrolled airspace may request an air traffic service[25]. VFR flights in Class G airspace are entitled to request a Basic or Traffic Service. IFR flights in Class G airspace are entitled to request a Basic, Traffic, Deconfliction or Procedural Service. The pilot in G-BXBU retained responsibility for avoiding collisions and terrain.

The meteorological conditions in which aircraft are permitted to operate under VFR, are determined by the class of airspace, altitude and airspeed. The applicable VMC minima while operating outside controlled airspace are described in Table 2 (G-BXBU was flying at less than 140 kt).

Below FL 100	Below 3,000 ft
5 km visibility 1500 m horizontal separation from cloud 1000 ft vertical separation from cloud	As per below FL 100. ***or*** 5 km flight visibility, clear of cloud, insight of the surface ***or (if operating at less than 140 kt)*** 1500 m visibility, clear of cloud, in sight of the surface

Table 2

VFR Weather Minima outside controlled airspace

The airspace around Exeter Airport is an Air Traffic Zone (ATZ) with a radius of 2.5 nm centred on the airport, rising to an altitude of 2,102 ft. An ATZ conforms to the class of airspace in which it is situated, so the Exeter ATZ is considered Class G airspace. However, a pilot must obtain permission from the ATSU at the aerodrome to fly, take off or land within an ATZ[26].

Instrument flying

Training

The CAA PPL syllabus includes one flight exercise in which students are introduced to basic instrument flying. The PPL skills test includes simulated entry into IMC, following which the student must complete a 180° turn. The student must also demonstrate consideration of the relevant safety factors. The biennial SEP revalidation flight test does not require any additional training on inadvertent entry into IMC or for pilots to demonstrate recovery from a simulated entry to IMC.

Footnote

25 CAP 1434 – '*UK Flight Information Services'.*

26 ''*Guide to Visual Flight Rules (VFR) in the UK'*, Civil Aviation Authority, available at https://www.bfgc.co.uk/VFR_Guide.pdf [accessed April 2023].

Instruments

G-BXBU was not certified to fly in IMC or icing conditions. It did however have some instruments installed which would aid IMC flight, such as an attitude indicator (AI). The AI on G-BXBU was a Horizon Bendix J-8 model (Figure 16), featuring yellow markings on an entirely black background. In more modern AI's the symbolic sky and ground have representative colourings that are more instinctive in helping pilots to determine the attitude of the aircraft without outside visual reference (Figure 17).

Figure 16
Horizon Bendix J-8 Model

Figure 17
Example of modern AI design

Spatial disorientation

A pilot's spatial orientation, although supported by other senses, relies heavily on external visual references. An obscured visual horizon, false horizons from cloud tops or ground lights, or featureless terrain coupled with conflicting information from other senses such as vestibular and proprioceptive, can lead to spatial disorientation in flight.

There are five primary contributory factors which may lead to a pilot experiencing spatial disorientation:

Environment	–	cloud/ poor visibility resulting in little or no horizon
Manoeuvres	–	turns and spins which disturb the vestibular system
Pilot	–	training and practice in instrument flying, workload and distraction
Aircraft	–	AI size, colour and ease of interpretation
Health	–	congestion and other physiological factors affect proper function of the vestibular system

There are two classifications of disorientation – unrecognised (Type I) and recognised (Type II). Pilots recognising they have become disorientated should transfer to flying on instruments and believe them. In an unrecognised event, the pilot will feel normal until seeing the ground in the wrong place, understanding that the instruments look 'wrong', or until ground impact. In both cases, the pilot requires skill to maintain or recover the aircraft to a safe attitude until the required visual reference can be established.

Human performance

Decision making and workload management

The pilot of G-BXBU was making decisions under increasingly uncertain conditions as he ruled out his planned destination, home airfield and a chosen diversion airfield due to bad weather. This led to him seeking external assistance, in this case contacting the D&D Cell with the intention of finding a suitable diversion airfield.

A person's ability to make effective decisions is limited by, amongst other things, knowledge, skill and the ability to process information. Everyone will reach a point where there is too much information to process, or too many tasks to complete, for them to do so effectively – known as 'cognitive saturation'. An increase in workload to the point where mental capacity is reached, results in a degradation in the ability to process information. This weighs subsequent decision making towards using prior knowledge or experience rather than assessing the current circumstances and solving a novel problem with a novel solution. A pilot with reduced capacity may choose to land or divert to an airfield with which they are familiar, even if it has comparably poor weather conditions or with comparably complex approaches available. When there is limited cognitive space to analyse all options, this previous success and familiarity become important factors in the decision-making process.

Instrument flying is considered a more difficult cognitive task than flying visually. Research on pilot mental workload in flight showed that pilots who do not routinely fly on instruments reported higher levels of estimated mental workload when flying on instruments than when landing or taking off[27]. Inadvertent or unplanned flight into IMC will add further stress to a pilot who is not prepared to do so and is likely to consume the attention of the pilot to the point were making decisions beyond the immediate task of flying becomes more challenging. Anything that adds to the pilot's workload, such as communication from ATC or preparing for an unfamiliar approach, will increase the likelihood of the pilot reaching cognitive saturation.

Communication

Effective communication is necessary to achieve safe outcomes. Without normal bodylanguage cues ordinarily available to assist in the transfer of information, the standardisation of verbal communications has long been recognised as an effective way to avoid or mitigate potential ambiguity or misunderstandings in communications. This includes the phonetic alphabet and standard phraseology[28] which are well accepted norms within the industry. Although often considered in the context of pilot-to-controller or pilot-to-pilot

Footnote

[27] '*An Analysis of Mental Workload in Pilots During Flight Using Multiple Psychophysiological Measures*', Glenn F. Wilson in The International Journal of Aviation Psychology 12:1, pp 3-18, 2002.

[28] Doc 9432 – *'ICAO Manual of Radiotelephony'.*

interaction, the premise is relevant for all communication containing safety critical content – including between controllers and assistants.

CAP 584 – '*Air Traffic Controllers – Training'* states that effective communication in normal and emergency scenarios, and human factors training, shall be assessed as part of controller refresher training[29]. CAP 737 – *'Flight Crew Human Factors Handbook'* states that although UK ANSP's '*tend to have different views on HF training, but in the main the concept of CRM and human factors has transferred across to Air Traffic Control'*[30]. CAP 737 also suggests that exposure of pilots and controllers to each other's operational environment can be beneficial, although it is not a requirement for initial or refresher training for pilots or controller's. In the past, controllers in the UK received some flight training, but this is no longer the case.

The Exeter Airport human factors refresher training plan for the unit included team resource management, fatigue management and stress management. Eurocontrol[31] suggests that a breakdown in teamwork makes it more difficult for an individual or team to identify and correct weaknesses in monitoring pilot actions, communication between ATC personnel (including handovers) and between controllers and pilots[32] .

Further guidance for controllers can be found in CAP 745 *'Aircraft emergencies – Controller considerations'*, which provides guidance for controllers to understand the challenges which may be faced by flight crew during an emergency. It is primarily focused on commercial multicrew operations.

There is no training or guidance for controllers on stress responses that a general aviation single-pilot might experience during an emergency, how this may manifest and mitigation strategies which could be employed.

Checklists

Following checklists is a simple and well-established process, particularly when dealing with abnormal events. They provide an additional safety barrier where personnel are often operating outside their normal routines and with elevated levels of stress. Checklists can be used to ensure critical actions are completed, or that critical information required to inform the decision-making process is obtained. Their use can free mental capacity to create novel plans whilst ensuring those critical tasks are not missed. While the use of checklists is embedded in most aircraft operations, this concept has not transferred to ATC to the same degree.

Footnote

29 CAP 584 – *'Air Traffic Controllers – Training'* - Chapter 12 pp 52.
30 CAP 737 – '*Flight Crew Human Factors Handbook'.*
31 Eurocontrol is a pan-European organisation that provides technical and civil-military expertise in air traffic management.
32 Team Resource Management, Guidelines for the Implementation and Enhancement of TRM, Eurocontrol, 2021.

There is no reference to checklists in MATS Part 1 and ATSU's are not required to use them in emergency and abnormal events. Exeter Airport did have a list of procedures and aide-memoire's[33], including *'Emergencies: general'*. This aide-memoire was available at controller stations but not used routinely. The D&D Cell similarly stated they did not follow mandatory checklists in response to abnormal or emergency events.

Analysis

The accident

There was no evidence of any aircraft defects before impact that might have affected its controllability. It was not possible to determine the speed at impact with the large tree but the spread of wreckage and distance travelled by some of the larger pieces indicate it was probably greatly in excess of normal landing speed.

Decision to fly

When the pilot checked the weather information online at 0519 hrs, it indicated that at Exeter there would be light south-westly winds throughout the morning with less than 20% chance of rain. Weather forecasts for aerodromes along the planned route deteriorated throughout the morning and the extent of the poor weather was not reflected in the weather information available at 0600 hrs.

It was not possible to establish the extent of any additional weather planning the pilot carried out before departure. The forecasts available when he left home differed significantly from those that became available before G-BXBU took off.

In the absence of sufficient weather reports earlier in the day, the pilot could have delayed the flight until all relevant forecasts were available. There was an indication of poor weather enroute in the Newquay forecast available at 0600 hrs. There were no reports for the destination until the METAR at 0620 hrs and forecast at 0629 hrs, the latter showing that low cloud was expected at the time of arrival and, although the forecast conditions may have been sufficient to operate under VFR, it indicated the weather might deteriorate close to VFR limits. The conditions were sufficiently poor to merit reconsidering the flight or having a diversion plan to mitigate the risk posed by the low cloud base if the flight went ahead.

There were clear skies when the flight departed, which may have reinforced the pilot's belief the conditions were suitable for the intended flight. Nevertheless, there was sufficient ambiguity or indication of poor weather to suggest conditions might not be suitable for VFR flying.

In-flight decision making

It is likely the marked deterioration in the weather as the flight proceeded towards St Mary's prompted the pilot not to continue to his planned destination. His stated intention to divert to

Footnote

33 An aide memoire in this context has the same function and purpose as a checklist.

Bodmin demonstrates a degree of contingency planning, but it is not possible to know if he considered an enroute diversion, because he was not communicating with air traffic control.

It is difficult to create novel plans while under pressure and, in the absence of an obvious alternative option, it was logical the pilot attempted to return to his home airfield where he was familiar with the local flying environment and where skies were clear when he departed.

The investigation determined that at the time of the accident there were at least two aerodromes available with weather conditions suitable for G-BXBU to conduct a visual approach, offering the possibility of a safe outcome had the conditions been checked.

Instrument flying skills

The pilot had logged the minimum instrument flight training required by the PPL syllabus at the time of his initial training. It is unlikely this training enabled him to deal with this event as it was limited in scope and completed more than 20 years ago, and there is no requirement for pilots to revisit the basics of instrument flying in subsequent licence revalidation checks. It is possible the pilot had not even discussed the topic of inadvertent flight into cloud in a training setting since his initial skills test, where executing a level 180° turn is demonstrated.

Planning the response to an abnormal or emergency situation in advance increases the chance of success, saving time and mental capacity when dealing with the emergency in flight. Without a plan, experience or recent training to flying in IMC, there was a high risk that the pilot would become spatially disorientated when trying to conduct an instrument recovery to a diversion airfield. The simple AI display probably increased the challenge.

Pilots will be better prepared to deal with these factors if they are more aware of them. The following recommendation is therefore made:

Safety Recommendation 2023-011

It is recommended that the Civil Aviation Authority publish guidance for general aviation pilots on responding to unexpected weather deterioration, highlighting the factors affecting their performance and the benefits of planning before the flight how they will respond.

Transponder

The pilot did not comply with regulations requiring the use of transponders when fitted. Had the transponder been operating throughout the flight, it would probably have enhanced Exeter ATC's situational awareness when concern arose about a potential conflict between G-BXBU and the military jet which was holding in the vicinity. It is not possible to know what effect this would have had on the outcome of the accident flight. It is not known if the pilot monitored the relevant frequencies and if Exeter could have contacted him earlier. When the pilot did contact the D&D Cell, he turned on his transponder and both the D&D Cell and Exeter could then see his altitude on secondary radar.

Communication

The pilot's first contact with the Dunkeswell A/G operator was pivotal because the pilot, who rarely communicated with ATC, began to request, and accept external influence in the decision-making process for the flight.

On making first contact with the D&D Cell, the pilot immediately declared an emergency and requested assistance, explaining that he was stuck above cloud and needed to divert to somewhere nearby. In response to a request by the controller, he confirmed he was currently above cloud and had 1.5 hrs fuel endurance. This provided sufficient information to indicate there was no immediate pressure to provide the pilot with a solution. Despite the potentially very stressful situation, the pilot succeeded in asking for help when it is likely his ability to solve the problem himself had diminished.

It is not possible to know why the pilot made a 'PAN' call in preference to 'MAYDAY' when he declared an emergency on 121.5 MHz but, given his 90-minute fuel endurance, he may not have considered he was in immediate danger. Whether a PAN or MAYDAY call was made, it should not have affected the response by ATC to support G-BXBU. Guidance to controllers considers both states to be an emergency, the response to which (the application of the ATC emergency procedure) is the same. The CAA definitions distinguish between PAN and MAYDAY based on the immediacy of the emergency, not on the nature of support required. When the D&D controller advised that Exeter was willing to accept the aircraft, it is unlikely the pilot had the knowledge or mental capacity to question this plan, particularly as he had declared an emergency and shared relevant information about his problem with the D&D controller. In his transmission to Exeter ATC the pilot said, *"I've been diverted",* a passive phrase that suggests it was not something he chose to do himself.

The D&D controller does not appear to have considered what options were available to the pilot. In order to select viable diversion aerodromes, a controller would need to know at least the capabilities of the aircraft and pilot to fly in the conditions likely to be encountered.

To provide effective assistance controllers must provide practical guidance that can be understood by pilots in distress, and an intervention is more likely to be successful if the controller recognises when a pilot has a reduced capacity to respond.

Pilots might assume that agencies providing emergency assistance to aircraft will check the weather of potential diversion aerodromes. In this event, controllers do not appear to have considered whether the pilot and aircraft were capable of diverting to Exeter, and there was no obvious attempt to match the style of communication to the circumstances. (For example, whilst not incorrect, phrases such as "deconfliction service" and "ILS approach" may not have been useful or reassuring to a pilot with his experience or qualifications.) In part this may be because controllers are not sufficiently aware of the factors influencing human behaviour under stress, or how to address them.

CAP 745 aims to provide controllers with a flight crew's perspective on ATC communications in an emergency and is phrased in a manner that may make it more applicable to professional pilots. Pilots of light aircraft often operate in a less formal environment and with less frequency, and much of the information in CAP 745 may not transfer to the general aviation environment. MATS Part 1 states that 'calm and coordinated actions are essential' when dealing with emergencies but does not specifically address pilot stress reactions and the assistance which might be provided to account for it. Accordingly, the following Safety Recommendation is made:

Safety Recommendation 2023-012

It is recommended that the Civil Aviation Authority require air traffic controllers to receive training regarding the human performance characteristics and limitations associated with stress. This should include the verbal cues that may indicate that a pilot is operating under high stress, and mitigation strategies to help controllers deal with such events.

The D&D controller stated that he made assumptions based on the phone call received by the D&D support controller from the Exeter assistant. The Exeter assistant, who was not a controller qualified to make decisions about air traffic, did not identify herself as such on the phone, and the D&D support controller did not check her status when this information was omitted. The first assumption made by the D&D controller was that the Exeter assistant was a controller; the second, that the phone call had been instigated because an Exeter controller had heard G-BXBU make a 'PAN' call on the emergency frequency and intended to offer assistance. However, the practical application of D&D's executive control is that the D&D controller would take the lead in making an assessment, then contact an aerodrome which they deemed suitable, not the other way round.

The D&D controller advised the pilot that Exeter was willing to accept the aircraft, within seconds of the D&D support controller telling him this (Appendix 2), leaving no time to assess the suitability or practicality of this suggestion.

The D&D controller did not independently check the weather conditions at Exeter and a handover between controllers did not take place. The D&D controller stated he did not want to delay the transfer of G-BXBU to Exeter, based on the understanding that his support controller was speaking directly to a controller. However, as the aircraft had a stated fuel endurance of 1 hour and 30 minutes, there was no need to expedite the transfer at the expense of a full handover.

The phone call to the D&D Cell was made by the Exeter assistant regarding the military jet holding locally; it was not for the purpose of assisting an aircraft experiencing an emergency. Whereas the assistant's interaction with the D&D Cell ultimately resulted in the diversion of G-BXBU to Exeter, there was no active or informed decision to that effect. It is possible this was seen by the Exeter assistant as the most efficient way to remove a potential conflict with the military jet. However, it appears there was no attempt to resolve this potential conflict by moving the military jet away from G-BXBU, which was more readily achieved given the two-way radio contact between Exeter Radar (north) and the jet. The assistant did not receive or request information about G-BXBU or its pilot's capacity to carry out an approach in the prevailing conditions.

These misunderstandings appear to have misled the D&D controller to believe that Exeter had a more detailed awareness of the nature of the emergency and, significantly, that a controller there had determined that Exeter was an appropriate diversionary aerodrome.

The Exeter assistant described G-BXBU as a "weather diversion" and, in the absence of information normally included in a radar handover, the Exeter controller may not have known the seriousness of the situation its pilot faced. She commented that to her knowledge there were no other VFR flights operating in the area, which she believed was due to the weather conditions. She may therefore have expected that aircraft locally would have some IFR capability. These cues may have acted to confirm the controller's belief that the aircraft could make an approach in the prevailing weather conditions, and may explain why she did not consider she was dealing with an aircraft in difficulty. There were several contrary cues: G-BXBU had been in contact with the D&D Cell, the controller had heard a 'PAN PAN' call on 121.5 MHz earlier, and G-BXBU's emergency squawk of 7700 was visible on her radar screen. Whereas the D&D Cell has executive control in these circumstances, the normal responsibilities of a civil controller still apply. The Exeter controller was entitled to request a full radar handover from the D&D controller in order to understand the reason for the aircraft's diversion, and the ambiguity around the inbound aircraft was sufficient to indicate more information was required.

The Exeter controller advised the pilot of G-BXBU that he could expect vectors for the ILS approach for Runway 26. This indicates she did not appreciate the nature of the emergency the pilot was experiencing or his ability to carry out an approach in IMC. When the pilot said 'sorry I can't, can you say again?', she was prompted by a colleague to instead offer an SRA approach, which she did without further discussion. An SRA approach did not require onboard equipment but did require the pilot to be appropriately trained and qualified. The SRA decision point[34] was above the reported cloud base and therefore was unlikely to have been successful.

The ATC units involved do not appear to have considered what options were available to the pilot or to have communicated them effectively to each other. In order to select viable diversion aerodromes, a controller would need to know at least the aircraft type and the ability of the pilot to fly in the conditions likely to be encountered. The following Safety Recommendation is therefore made:

Safety Recommendation 2023-013

It is recommended that the Civil Aviation Authority specify the types of information that air traffic controllers will obtain and record when responding to aircraft in an emergency to ensure that pilots' needs are met and reported correctly if communicated to other air traffic control units.

Footnote

[34] The 'decision point' is the point at which an instrument approach must be discontinued and a go-around flown if the required visual contact is not obtained.

It is not possible to know why the pilot began his descent before being transferred to Exeter Radar. It is possible he was distracted by his interactions with the D&D Cell; and by trying to act on their requests to select an emergency squawk, maintain height and heading, and transfer radio frequency; and that he inadvertently descended into cloud. It is also possible that, given his proximity to Watchford Farm, he was attempting to establish visual contact with the ground in the hope of conducting an approach to his home base. Alternatively, he may have begun the descent intentionally: the aircraft had reached an altitude of 8,200 ft and was approximately 16 nm from Exeter Airport. Assuming a direct path from there to the runway flown at 90 kt, the aircraft would have needed to begin its descent and maintain a rate of descent of approximately 750 ft/min to land. If the pilot was attempting to divert to Exeter, he would have needed to begin a descent at this point.

It is likely, based on the D&D Cell's transmission to the pilot at 09:13:22, and the pilot's comment to Exeter that he had "been diverted", that the pilot thought there was a plan for him to divert to Exeter. If he had reached cognitive saturation, he may have felt his only option was to follow that plan. Controllers did not appear to understand that the pilot must descend into cloud to continue with the planned diversion to Exeter, or that he was not equipped to do so. Consequently, he had the undesirable options of complying with the apparent plan or questioning its suitability. Given the D&D Cell's publicised expertise and responsibilities for providing emergency assistance, and the absence of clear alternatives in a high stress situation, it is understandable that he would not question their plan.

It is also not possible to know what would have happened if the pilot had maintained altitude and followed the controller's instruction to follow a heading. Although there is no evidence of a considered plan to help the pilot, delaying the descent into cloud and additional communication between the pilot and Exeter ATC might have revealed Exeter's unsuitability as a diversion aerodrome. In the event, the worst of the weather had passed before the aircraft's fuel would have been exhausted, and remaining clear of cloud until then, might have enabled visual approaches to Watchford Farm, Dunkeswell or Exeter. There was no need for an immediate descent.

At the time the descent began, G-BXBU was in Class G airspace and, as a VFR flight, the aircraft did not require ATC clearance to descend. However, the D&D controller provided a deconfliction service to G-BXBU, which is only available to IFR traffic in Class G airspace. The confusion may have been compounded by the Exeter controller's initial intention to issue vectors initially for an ILS, followed by an SRA approach. These instructions suggest she believed she was controlling IFR traffic, which would ordinarily require descent clearance from ATC when carrying out an IFR approach. Although offering an ILS approach accords with local procedures, in this case doing so demonstrated a gap in understanding the pilot's circumstances.

Witness reports from pilots flying in the area at the time G-BXBU levelled off at 4,300 ft indicate the pilot may have been attempting to fly the aircraft in a gap between cloud layers. Shortly afterwards, at 09:16:49 hrs, G-BXBU was instructed to descend to 2,600 ft. Whilst this was intended to prevent the aircraft from descending below the minimum safe altitude in the area, it is likely to have introduced further confusion.

Checklists

The D&D Cell and Exeter ATC had checklists or procedures for dealing with emergencies, although neither controller used a checklist in this event. The use of an appropriate checklist in this event could have prompted an effective handover and ensured the transfer of critical information. The reported tendency to use procedures, checklists, and aide memoirs as guidance rather than formally, may have given rise to the impression that some or all of their contents could be disregarded.

Checklists make it easier to carry out routine or emergency procedures or create novel plans in foreseeable circumstances, and there is no evidence they are less effective in the air traffic control environment.

Therefore, the following Safety Recommendation is made:

Safety Recommendation 2023-014

It is recommended that the Civil Aviation Authority encourage the use of checklists in air traffic management operations when dealing with abnormal and emergency situations.

Emergency air traffic service provision

As a military unit, the operation of the D&D Cell differs from that of civilian ATSUs, which do not operate under a military structure. For example, the D&D Cell has a board providing an immediate visual guide for airfield data, including weather conditions, at all military aerodromes in the UK. There is no equivalent display for civil aerodromes. Exeter ATC was monitoring 121.5 MHz and was aware a 'PAN PAN' call had been made. However, its controllers were not familiar with the detail of the emergency and did not consider what assistance they could provide the aircraft. As MATS Part 1 restricts an ATSU from responding to a call on 121.5 MHz, except in limited circumstances, it is understandable that ATSU's do not actively monitor the emergency frequency for the purpose of responding to an emergency.

When declaring an emergency, if not already in receipt of a service from an ATSU, a pilot should do so on 121.5MHz. The transfer of operational control takes place when the aircraft in difficulty is handed over from D&D to the best-placed ATSU. It is unclear if the transfer of operational control took place during this event as there was no conversation between the D&D and Exeter controllers (as distinct from their assistants), but G-BXBU was transferred by D&D to the Exeter Radar frequency.

If an aircraft declares an emergency on a civil ATSU frequency, the ATSU will then contact D&D to give pertinent details of the emergency via landline. D&D will then give the ATSU operational control, although it is not clear who has the authority should the ATSU and D&D disagree on the best course of action to support the aircraft.

The AAIB investigation has received differing interpretations of D&D's executive control.

Although MATS Part 1 does provide guidance, there is no published equivalent interpretation from the D&D Cell, adding to the potential for misunderstanding between ATSUs. MATS Part 1 provides inconsistent guidance: one section stating that controllers should consider the most appropriate ATSU to manage an emergency and are empowered to transfer operational control to another ATSU; another that controllers should advise the D&D Cell of all emergencies, transferring executive control to D&D who then have the authority to delegate operational to control where they see fit. In informing the D&D Cell, this may remove the civil ATSU from the decision-making process. The D&D Cell is not necessarily the best placed unit to make decisions regarding an aircraft in difficulty, but having executive control creates an authority gradient in the decision-making process when working with civil ATSUs. This may cause inefficiencies, and distances controllers with local knowledge from the decision-making process without objective benefit. Whether the D&D Cell's executive control is solely 'administrative', or has the result that it holds 'responsibility for the overall management of the emergency' it is important the definition of these terms is clear to all ATCOs who are routinely interacting with the D&D Cell, to avoid any misunderstanding or misinterpretation. The positions expressed by the D&D Cell and the CAA are not consistent with the guidance in MATS Part 1, and currently the situation is not settled. Therefore, the following Safety Recommendation is made:

Safety Recommendation 2023-015

It is recommended that the Civil Aviation Authority determine the effect the D&D Cell's executive control has on civil ATCOs and inform civil ATCOs of any differences in their responsibilities whilst executive control is exercised.

In this event, Exeter controllers would have been aware that the weather at Exeter Airport was not suitable for a pilot and aircraft not equipped for flight in IMC, and could have acted accordingly had they received the initial 'PAN' call themselves. The complexity of communication between multiple personnel at both ATC units meant no controller or assistant had all the available information at any moment as the event unfolded.

The UK AIP states '*Distress and Urgency communications within the UK SRR are in accordance with standard international procedures*'[35]. ICAO Annex 10 states that the emergency frequency should only be used when normal channels are not available, and that it should only be used for genuine emergencies. It also states that ATSUs shall monitor 121.5 MHz and that an aircraft reporting a distress or urgent condition shall normally address the station already communicating with the aircraft, or in whose area of responsibility the aircraft is operating. Aircraft are required to monitor 121.5 MHz if possible.

The provision of a nationwide service on 121.5 MHz, including for aircraft practicing emergencies, is unique to the D&D Cell and can lead to volumes of communication on the frequency that discourage some pilots from monitoring it.

Footnote

35 'UK AIP' – GEN 3.6 Paragraph 6.3.1.

The involvement of the D&D Cell in this process increased the opportunity for misunderstanding and did not assist in achieving a safe outcome. Therefore, the following Safety Recommendation is made:

Safety Recommendation 2023-016

It is recommended that the Department for Transport review the current provision of emergency communications in the UK to determine if the involvement of a dedicated emergency air traffic service unit is the most effective way to assist civil aircraft in an emergency, and publish its findings.

There is no formal agreement between the Department for Transport and the Ministry of Defence defining the responsibilities of the D&D Cell. This may be a result of the D&D Cell continuing to provide a service to both the military and civilian aviation after the provision of civil SAR ceased to be a military operation in 2016. As the D&D Cell were associated with the military provision of SAR, it is possible their responsibilities were previously defined in this context. If the D&D Cell continues to provide emergency support to civil aircraft its responsibilities should be set out clearly. Therefore, the following Safety Recommendation is made:

Safety Recommendation 2023-017

It is recommended that the Department for Transport specify and publish details of the emergency air traffic service it requires the D&D Cell to provide.

Military-civil ATC interaction

Operations with a solely military purpose are outside the scope of this investigation. However, the AAIB has considered the service provided by the D&D Cell to the civil aviation community on behalf of the State, and four Safety Recommendations are made to the Civil Aviation Authority in areas that should also be addressed by the MAA. Accordingly, the MAA has stated that it intends to address the intent of Safety Recommendation 2023-012, 2023-013, 2023-014, and 2023-015 made to the CAA.

Conclusion

The aircraft collided with terrain because the weather conditions deteriorated beyond the capabilities of the pilot who was not trained or qualified to operate in poor weather. The forecasts available when the pilot assessed the weather did not accurately reflect the extent of the poor weather.

The pilot found himself stuck above cloud. When the pilot requested assistance in finding an appropriate aerodrome to land, the level of ATC support from the D&D Cell and Exeter ATC was not sufficient to provide the assistance required by the pilot, who was in a state of distress. A breakdown in communication and teamwork occurred between the D&D Cell, Exeter ATC and the pilot, which led to miscommunication, incorrect assumptions and omission of critical information.

Following published procedures would likely have allowed either the D&D Cell or Exeter Airport ATC to establish the unsuitability of Exeter Airport as a diversion aerodrome.

The investigation identified shortcomings in the system in place in the UK to provide emergency support to aircraft in distress.

Seven Safety Recommendations are made.

Safety Recommendations

Safety Recommendation 2023-011: It is recommended that the Civil Aviation Authority publish guidance for general aviation pilots on responding to unexpected weather deterioration, highlighting the factors affecting their performance and the benefits of planning before the flight how they will respond.

Safety Recommendation 2023-012: It is recommended that the Civil Aviation Authority require air traffic controllers to receive training regarding the human performance characteristics and limitations associated with stress. This should include the verbal cues that may indicate that a pilot is operating under high stress, and mitigation strategies to help controllers deal with such events.

Safety Recommendation 2023-013: It is recommended that the Civil Aviation Authority specify the types of information that air traffic controllers will obtain and record when responding to aircraft in an emergency to ensure that pilots' needs are met and reported correctly if communicated to other air traffic control units.

Safety Recommendation 2023-014: It is recommended that the Civil Aviation Authority encourage the use of checklists in air traffic management operations when dealing with abnormal and emergency situations.

Safety Recommendation 2023-015: It is recommended that the Civil Aviation Authority determine the effect the D&D Cell's executive control has on civil ATCOs and inform civil ATCOs of any differences in their responsibilities whilst executive control is exercised.

Safety Recommendation 2023-016: It is recommended that the Department for Transport review the current provision of emergency communications in the UK to determine if the involvement of a dedicated emergency air traffic service unit is the most effective way to assist civil aircraft in an emergency, and publish its findings.

Safety Recommendation 2023-017: It is recommended that the Department for Transport specify and publish details of the emergency air traffic service it requires the D&D Cell to provide.

Published: 27 April 2023.

Appendix 1 – Meteorological reports

Available airfield weather at 0600 hrs		
	METAR	TAF
Yeovilton	Not available	Not available
Exeter	Not available	Not available
Newquay	At 0550: light south-east **broken cloud at 1,200 ft**	Between 0600 and 1500: light south-easterly wind, good visibility, **scattered cloud at 4,000 ft** Temporarily between 0600 and 1200 (30% chance): 8,00 0 m visibility, **broken cloud 1,200 ft**
Culdrose	At 0550: light south-easterly wind, good visibility, scattered cloud at 300 ft	Not available
Land's End	Not available	Not available
St. Mary's	Not available	Not available

Table A1

Available METAR and TAF information at 0600 hrs

Available airfield weather at 0630 hrs		
	METAR	TAF
Yeovilton	Not available	Not available
Exeter	Not available	Not available
Newquay	At 0620: light southerly wind, 9000 m visibility, **broken cloud at 600 ft**	Between 0600 and 1500: light south-easterly wind, good visibility, **scattered cloud at 4,000 ft** Temporarily between 0600 and 1200: 8,000 m visibility, broken cloud 1,200 ft. Temporarily between 0600 and 1200 (30% chance): **broken cloud at 600 ft**
Culdrose	At 0550: light south-easterly wind, good visibility, **scattered cloud at 300 ft**	Not available
Land's End	Not available	Not available
St. Mary's	At 0620: light south-westerly wind, good visibility, **broken cloud at 1,100 ft**	Between 0600 and 1500: south-westerly wind, good visibility, **few cloud at 1,500 ft** Temporarily between 0600 and 0900: **broken cloud at 1,200 ft** Temporarily between 0600 and 0900 (30% chance): 7,000 m visibility, **broken cloud at 800 ft** Between 0900 and 1200: wind gusting to 25 kts

Table A2

Available METAR and TAF information at 0630 hrs

Appendix 1 – Meteorological reports cont

Available airfield weather at 0900 hrs		
	METAR	TAF
Yeovilton	Not available	Not available
Exeter	At 0850: - light southerly wind, 6000 m visibility, broken cloud at 500 ft	Between 0900 and 1700: light southerly wind, good visibility, scattered cloud at 1, 000 ft. Temporarily between 0900 and 1400: 6,000 m visibility, moderate rain and drizzle, broken cloud 700 ft. Between 0600 and 1200 (30% chance): temporarily 2,000 m visibility, mist, broken cloud 400 ft
Newquay	At 0850: light south-westerly wind, good visibility, **broken cloud at 300 ft**	Between 0900 and 1800: Wind becoming easterly Temporarily between 0900 and1200: visibility 800 m, **broken at 1,200 ft** Temporarily between 0900 and1200 (30% chance): 1,400 m visibility, mist, broken cloud at **200 ft**
Culdrose	At 0850: light south-westerly wind, 250 m visibility, fog, **scattered cloud at 0 ft, overcast cloud at 200 ft**	Between 0900 and 1800: light variable winds, good visibility, few clouds at 900 ft, scattered cloud at 2,000 ft Temporarily between 0900 and 1000 (30% chance): 500 m visibility, fog, scattered cloud at 100 ft
Land's End	At 0850: light south-westerly wind, good visibility, **few cloud at 500 ft, scattered cloud at 3,000 ft**	Between 0900 and 1800: south-westerly wind, good visibility, **scattered cloud at 1,500 ft** Temporarily between 0900 and 1200: **broken cloud at 1,200 ft** Temporarily between 0900 and 1200 (30% chance): 7000 m visibility, **broken cloud at 600 ft**
St. Mary's	At 0850: light south-westerly wind, good visibility, **few cloud at 800 ft, scattered cloud at 2,300 ft**	Between 0900 and 1800:south-easterly wind, good visibility, scattered cloud at 2,500 ft Temporarily between 0900 and 1100: broken cloud at 1,200 ft Temporarily between 0900 and 1100 (30% chance): 7,000 m visibility, broken cloud at 800 ft

Table A3

Available METAR and TAF information at 0900 hrs

Appendix 2 - Communication transcript

Colour key	
G-BXBU	
D&D Controller	D&D Support (DDS)
Exeter Controller	Exeter Assistant (ATCA)
Other aircraft on frequency	

Time	G-BXBU Radio communication with the D&D Cell 121.5 MHz and Exeter Radar 123.580 MHz	Mediator line – communication between Exeter assistant and D&D support
09:10:59	G-BXBU: Emergency frequency PAN PAN PAN this is Golf Bravo Xray Bravo Uniform	
09:11:17	D&D Controller (broken): Bravo Xray Bravo Uniform, London Centre, PAN acknowledged, pass your details when ready	
	Commercial aircraft 1: Golf Bravo Xray Bravo Uniform, it's [callsign] [unintelligible] ...go ahead	
09:11:21	G-BXBU: Er say again	
09:11:23	*Commercial aircraft 1: Golf Bravo Xray Bravo Uniform, this is [callsign] go ahead we heard the PAN PAN call*	
09:11:29	G-BXBU: Yeah, er I am er, I've got a, I've got in real trouble, I am a, it's a cap ten, two P O B, I am about eight miles, er east of Exeter, er and there is very thick cloud and I am above it and can't get below it, er according to Dunkeswell it is on the deck. I don't know what to do. I need to divert somewhere er close to me where I can land	
09:11:54	*Commercial aircraft 2: Golf Bravo Xray Bravo Uniform er this is [callsign] and we will contact London*	
09:12:00		DDS: D&D support
09:12:01	G-BXBU: Sorry can you please speak slower	
09:12:01		ATCA: Hello it's Exeter
09:12:02		DDS: Yep
09:12:03		ATCA: Hi, has anyone updated you firstly about the [military jet]?
09:12:04	*Commercial aircraft 2: Er Golf Bravo Xray Bravo Uniform this is [callsign], we copy what you are saying I'll call London for you*	
09:12:07		DDS: Er, no
09:12:08		ATCA: OK er, just to let you know that that [callsign] is still intending to land at Exeter, he's got a normal undercarriage indication now

Appendix 2 - Communication transcript cont

09:12:14	G-BXBU: Er thank you Bravo Uniform	
09:12:16		DDS: OK
09:12:16	D&D Controller: … Xray Uniform this is London Centre on one two one decimal five. Your PAN is acknowledged, your position is approximately four miles to the west of Chard. What is your altitude?	
09:12:17		ATCA: And also, has a light aircraft called you in the Dunkeswell area?
09:12:21		DDS: Yes, we are currently dealing with that situation
09:12:23		ATCA: Excellent, he's right in the way of er, of red five, would you, what's he, what's his intentions and his level?
09:12:27	G-BXBU: Altitude is currently seven thousand five hundred, and that is the cloud base	
09:12:29		DDS: Er, don't know his level but he is currently above cloud and er wanting to divert to the nearest aerodrome
09:12:35	D&D Controller: Golf Bravo Xray Bravo Uniform confirm you are above cloud	
09:12:37		ATCA: Well, that would be us
09:12:38		DDS: Er….
09:12:40		ATCA: Exeter
09:12:41	G-BXBU: I confirm I am above cloud at seven thousand five hundred. Er I've called Dunkeswell they say it is on the deck there. I am really quite anxious and don't know what to do	DDS: I think...
09:12:44		ATCA: He's basically flown all the way up the coast and then across our extended centre line twice in front of er, a [military jet]
09:12:49		DDS: Yes
09:12:50		ATCA: Er.. do you want to put him over to us?
09:12:50	D&D Controller: Golf Bravo Uniform roger. Golf Bravo Uniform what is your endurance?	
09:12:54		DDS (Offline discussion): Exeter are asking if er, maybe we want to, she asked to put it over to them…
09:12:55	G-BXBU: Er one and a half hours	
09:12:59	D&D Controller: Golf Bravo Uniform roger. Golf Bravo Uniform standby.	
09:13:03	G-BXBU: Standing by.	

Appendix 2 - Communication transcript cont

09:13:04		DDS (Offline discussion): They are wondering if er, they want to take over
09:13:05	D&D Controller: Golf Bravo Uniform	
09:13:06	*Commercial aircraft 2: Er London [callsign] are you happy if we come off frequency now.*	
09:13:11	D&D Controller: [callsign], affirm we have the aircraft position and [unintelligible] identified we will carry on and thank you for your help	
09:13:14		DDS: Standby we are just talking to the aircraft
09:13:15		ATCA: Oh OK, alright (offline: He's working D and D that aircraft)
09:13:18	*Commercial aircraft 2: OK copied, good luck*	
09:13:21		DDS offline: Exeter are willing to take the aircraft
09:13:22	D&D Controller: Golf Bravo Uniform roger. Exeter are willing to take you and standby your steer for Exeter is two three zero range sixteen nautical miles	
		ATCA: [unintelligible]
09:13:33	G-BXBU: What's the Exeter radio?	
09:13:35	D&D Controller: Golf Bravo Uniform, we will hand you over. Golf Bravo Uniform squawk seven seven zero zero	
09:13:41	G-BXBU: Squawking seven seven zero zero	
09:13:46	D&D Controller: Golf Bravo Uniform, make your heading two three zero report steady	
09:13:48		DDS: Exe.. er we are putting on emergency squawk, is there a frequency that we can put him on to?
09:13:52		ATCA: Er.. one.. one.. hang on
09:13:52	G-BXBU: Ah, can you hold the line	
09:13:55		ATCA (offline discussion): Which one of you wants to work this aircraft inbound, do you want to [name] or shall [name] take it? The inbound. For weather. The one that's been in the way for the last ten minutes. Yeah. Yeah?
09:14:06	G-BXBU: Er, squawking, er Golf Bravo Uniform, squawking seven seven zero zero. Can you say again next instruction?	
09:14:10		ATCA: Yeah, if you put it through one two three five eight zero
09:14:14		DDS: One two three five eight zero

Appendix 2 - Communication transcript cont

09:14:14	D&D Controller: Golf Bravo Uniform roger. Head, make your heading two three zero, maintain seven thousand five hundred feet	
09:14:17		ATCA: And what's his call sign?
09:14:18		DDS: Er call sign is…
09:14:21		ATCA: Oh we've got it, we've got it it's OK
09:14:22	G-BXBU: Two three zero, maintaining er seven thousand five hundred	
09:14:23		DDS: You've got
09:14:25		ATCA: Yep, alright then
09:14:26		DDS: alright then bye
09:14:26	D&D Controller: Golf Bravo Uniform identified on radar, deconfliction service	
09:14:27		ATCA: Thanks, cheers bye
09:14:35	G-BXBU: Sorry, say again	
09:14:36	D&D Controller: Golf Bravo Uniform you're identified on radar, in a deconfliction service, Exeter have you iden…, have you on their radar, contact Exeter frequency one two three decimal five eight zero	
09:14:52	G-BXBU: One two, one two three decimal five eight zero	
09:14:57	D&D Controller: Golf Bravo, Golf Bravo Xray Bravo Uniform, that is correct	
09:15:05	D&D Controller: Golf Bravo Uniform if no contact on that frequency return to this frequency one two one decimal five	
09:15:12		*Ringing*
	123.58	
09:15:27	G-BXBU: Er Exeter, er Golf Bravo Xray Bravo Uniform, have been PAN PAN PAN, have been diverted	
09:15:30		ATCA: Exeter
09:15:32		DDS: It's D&D support, we've just passed him over to you, has he come up?
09:15:34		ATCA: Yes I think he's called us now. Yes he has
09:15:36	Exeter: Golf Bravo Xray Bravo Uniform, Exeter Radar, roger the er PAN call, and we'll be vectoring you for the er ILS approach for runway two six for Exeter	

Appendix 2 - Communication transcript cont

09:15:37		DDS: Oh OK perfect.
09:15:40		ATCA: OK
09:15:41		DDS: Will you er let us know when he's landed?
09:15:42		ATCA: Yes will do
09:15:43		DDS: Thank you
09:15:44		ATCA: Cheers
09:15:44		DDS: Bye
09:15:54	G-BXBU: Sorry I can't, can you say again?	
09:15:57	Exeter: Golf Bravo Uniform I'll be vectoring you for the SRA Approach for runway two six at Exeter. Fly heading two two zero degrees	
09:16:21	Exeter: Golf Bravo Uniform fly heading two two zero degrees	
09:16:26	G-BXBU: Bravo Uniform, heading two three zero. What's your cloud base?	
09:16:32	Exeter: Golf Bravo Uniform the weather at Exeter we've got six kilometres visibility and the cloud is broken at five hundred feet	
09:16:49	Exeter: Golf Bravo Uniform, descend to altitude two thousand six hundred feet, QNH one zero one seven	
09:17:00	G-BXBU: One zero one seven, you er you require me to descend to what altitude?	
09:17:04	Exeter: Two thousand six hundred feet	
09:17:07	G-BXBU: Descending two thousand six hundred, you want me on two three zero?	
09:17:14	Exeter: Affirm, when you are able, fly heading two two zero degrees	
09:17:21	G-BXBU: Two two zero	
09:18:12	Exeter: Golf Bravo Uniform stop descent and maintain altitude two thousand six hundred feet	

ACCIDENT

Aircraft Type and Registration:	Pitts S-1S, G-BOXV
No & Type of Engines:	1 Superior XP-IO-360-A1HC3 piston engine
Year of Manufacture:	1984 (Serial no: 7-0433)
Date & Time (UTC):	26 August 2022 at 0904 hrs
Location:	Shobdon Airfield, Herefordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Fatal) Passengers - N/A
Nature of Damage:	Destroyed
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	1,978 hours (of which 530 were on type) Last 90 days - 26 hours Last 28 days - 8 hours
Information Source:	AAIB Field Investigation

Synopsis

During an aerobatic practice flight, G-BOXV was seen to enter a climbing vertical rolling manoeuvre from approximately 420 ft agl. The aircraft yawed right at the top of the manoeuvre which apexed at approximately 1,100 ft agl. During the right yaw, an uncommanded autorotative right roll developed and the aircraft entered a steep nose-down spiral dive. As the pilot attempted to pull out of the ensuing dive, the aircraft experienced an accelerated stall and a rolling departure to the right. At that point there was insufficient height remaining in which to effect a safe recovery and the aircraft struck the ground. The pilot was fatally injured in the accident.

No causal or contributory technical issues were identified during the post-accident examination of the aircraft.

The investigation found that the entry conditions to the initial climbing manoeuvre gave little or no safety margin when the aircraft began to dynamically diverge from the expected flight path at the apex. Entering the manoeuvre with more height and/or speed would likely have increased the pilot's chances of avoiding the loss of control and/or being able to recover from it safely.

Generic guidance for aerobatic pilots is contained in CAA Safety Sense Leaflet 19 – '*Aerobatics*'.[1]

Footnote

[1] https://publicapps.caa.co.uk/docs/33/20130121SSL19.pdf [accessed 7 February 2022].

History of the flight

The accident occurred on the first of two aerobatic practice flights the pilot had planned to undertake in the overhead of Shobdon Airfield (Shobdon) on 26 August 2022. While the second flight was to be a rehearsal of the display sequence the pilot intended to fly at a private event on 28 August, the investigation did not find evidence as to the pilot's detailed intentions for the accident flight.

G-BOXV took off from Runway 26 at approximately 0900 hrs. The pilot turned left on departure and climbed to position the aircraft south of the runway before commencing his aerobatic manoeuvring. Mobile phone video taken by an eyewitness showed the aircraft completing three distinct aerobatic manoeuvre combinations before, when approaching the eastern end of the airfield, it pulled up into a vertical climb from approximately 420 ±50 ft agl on a broadly easterly heading. While the aircraft did not stay in the video frame for all the subsequent manoeuvring, it could be seen that the aircraft was rolled left through approximately 450° as it climbed. The nature of the rolling motion indicated the pilot likely had some left rudder applied during the roll because G-BOXV's longitudinal axis was not closely aligned with the aircraft's upward flight path (Figure 1).

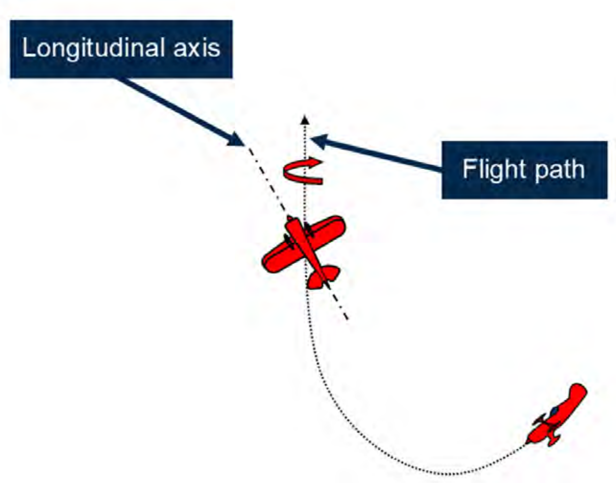


Figure 1

Pull up into vertical roll
(not to scale)

The aircraft continued climbing until reaching an estimated apex height of 1,100 ±200 ft agl. At the top of the manoeuvre G-BOXV was banked to approximately 90° right wing low with the nose 30°- 45° above the horizon. The nose of the aircraft then dropped progressively lower while the bank was maintained (Figure 2). During the transition from nose-up to nose-down, G-BOXV's nose appeared to fall more due to gravity than as the result of significant rudder application generating the right yaw.

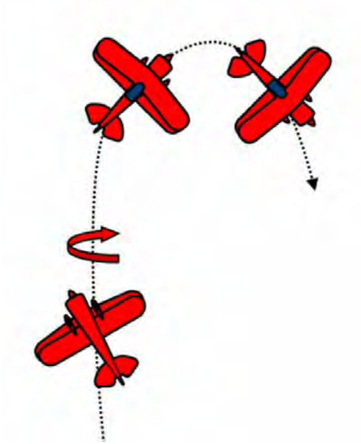


Figure 2
Apex of the climbing manoeuvre
(not to scale)

As the nose dropped through an estimated 45° nose-down, the aircraft began rolling right and the nose dropped further to approximately 80° nose-down (Figure 3). The aircraft continued rolling right, passing 360° of roll in approximately 2½ seconds. Audio recording from the mobile telephone footage corroborated eyewitness evidence that the engine rpm reduced, likely to idle, shortly after the aircraft began rolling during the descent.

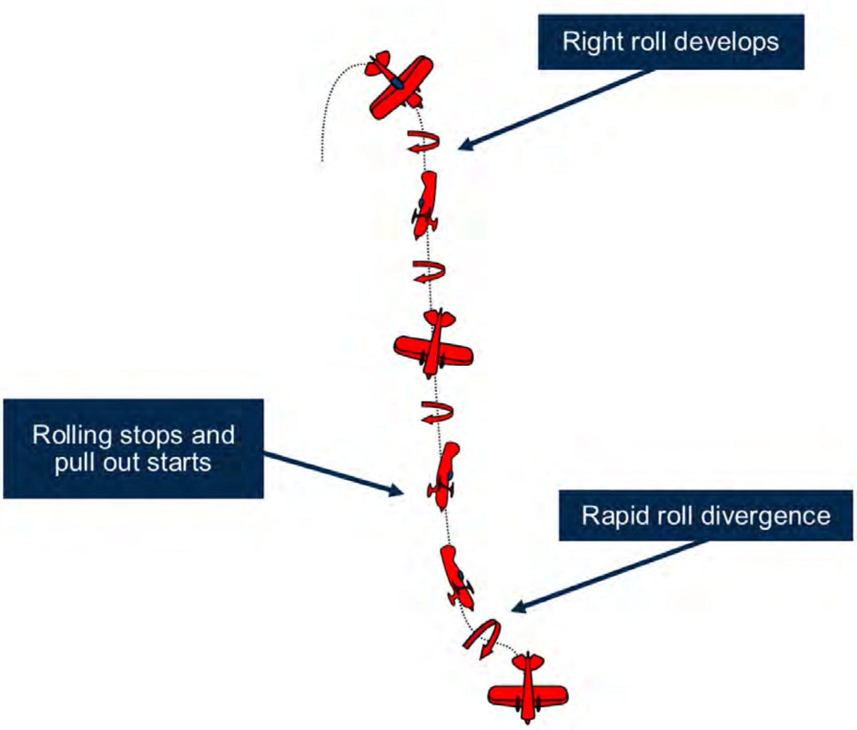


Figure 3
Downwards flight path
(not to scale)

Video footage showed the aircraft stopped rolling after approximately 1¼ turns, at which point it was pointing vertically down, if not slightly inverted. At this stage G-BOXV was approximately 400 ft agl. As the roll stopped, the aircraft's pitch attitude started to decrease, and the pilot appeared to be attempting to pull out of the dive. This pitching motion continued only briefly, stopping abruptly just before the aircraft diverged rapidly in roll to the right from about 200-250 ft agl (Figure 3). The divergent right roll continued until the aircraft struck the ground in an almost vertical attitude, just over two seconds later.

From the apex of the climb to impact with the ground took approximately 9 seconds, and only 7 seconds from the roll starting as the aircraft's attitude passed through 45° nose-down.

The airfield fire and rescue crew approached the accident site less than 3 minutes from the alarm being raised and, shortly thereafter, began fighting what remained of the intense post-crash fire. The pilot did not survive the initial impact.

Accident site

The aircraft struck the ground in a recently harvested and drilled crop field approximately 130 m south of the threshold of Runway 26 at Shobdon (Figure 4). An intense post-impact fire destroyed most of the aircraft.

Ground markings indicated that the aircraft struck the ground at a near vertical attitude, with the upper wing facing east. It then bounced and came to rest, upright, with the aircraft pointing in an east-south-east direction. The wings, which were of fabric covered wooden spar construction, were consumed by the post-impact fire and the fabric that covered the steel spaceframe fuselage was also consumed. One of the blades of the two-bladed fixed pitch propeller had cut into the ground and fractured at the hub. This portion of the propeller remained at the impact location; the other blade remained attached to the hub.

Continuity was confirmed for the aileron and elevator controls. The right rudder cable was also continuous, but the left rudder cable was found to have fractured close to the pilot's seat.

Recorded information

No sources of recorded data were recovered from the aircraft. The aircraft was not tracked by radar or other aircraft tracking networks.

The location of the cameras that recorded the three videos of the accident used in this investigation are shown in Figure 4.

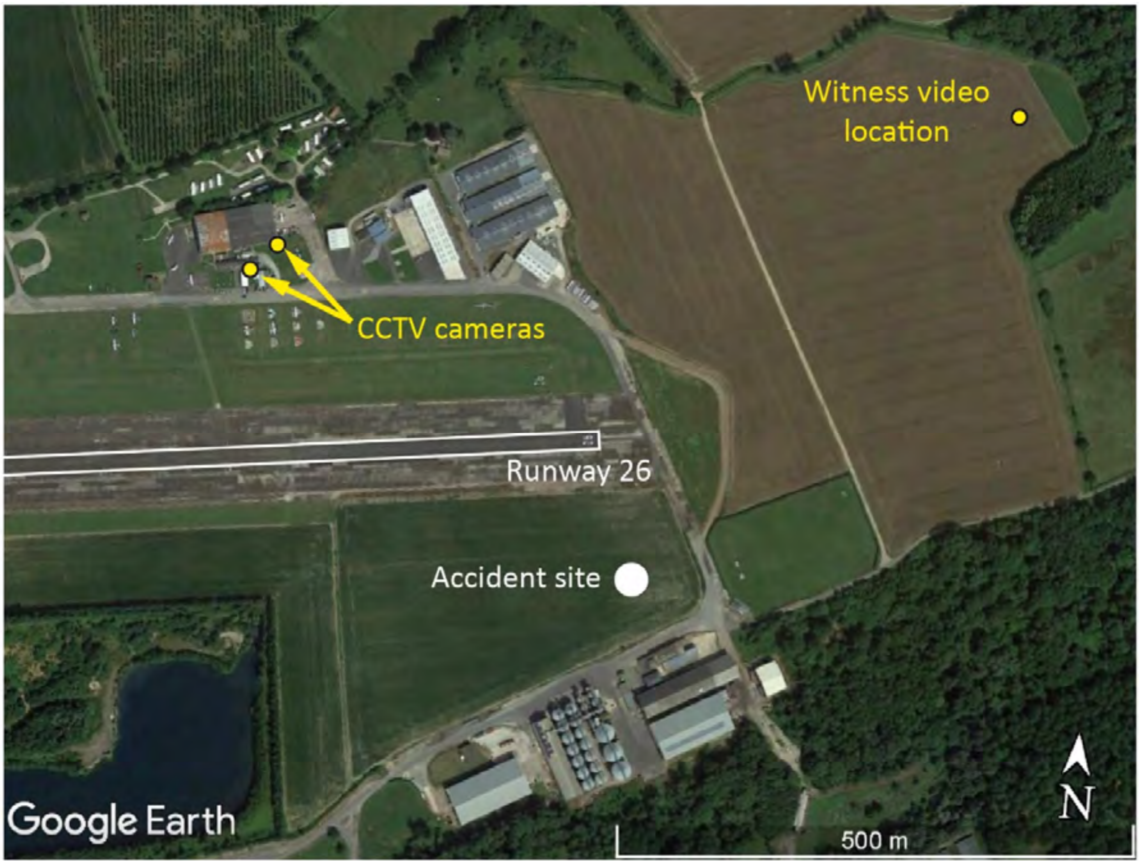


Figure 4
Sources of video recordings

CCTV cameras captured the lower parts of some of the manoeuvres and the impact with the ground. The field of view of the CCTV cameras did not extend up enough to capture higher parts of the manoeuvres flown, including the final accident manoeuvre. Figure 5 shows the final descent captured on CCTV.

A witness in a field to the north-east of the accident site recorded a video using their mobile phone. The aircraft was not always in frame as the phone was panned but it did capture most of the final manoeuvre. A difficulty with determining the flight path of the aircraft from this video is that, during a large part of the manoeuvre, the background was entirely made of cloud with few features to show how the camera was panning. Software tools were used to pattern match large areas of cloud to model the camera orientation when ground features were not in view. The limitations of this, and the assumptions required for estimating distance to the aircraft when it was in view of only one camera, have been accounted for in the error margins for the apex height stated earlier in this report.

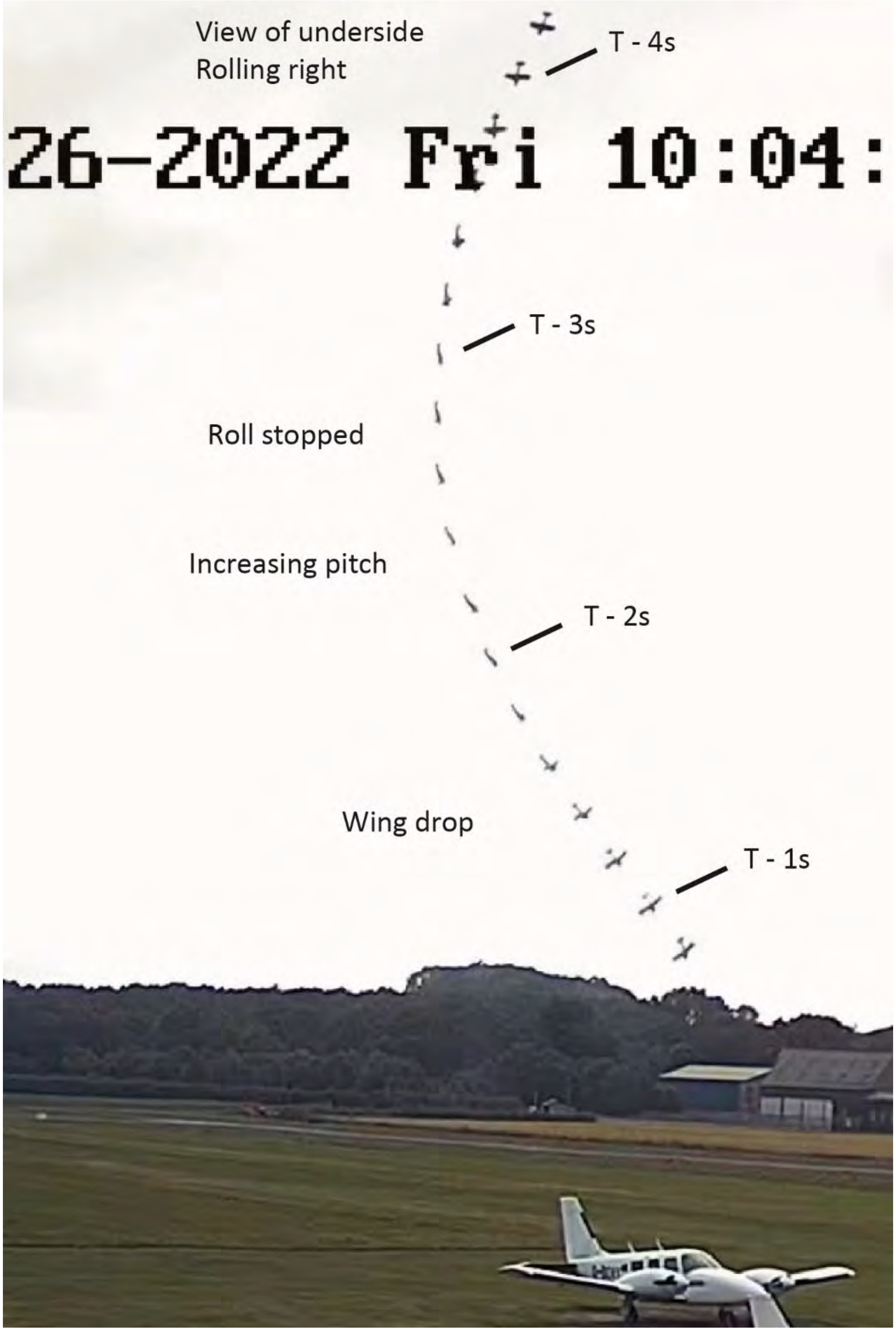


Figure 5

Compound image of cropped CCTV snapshots 0.2 seconds apart until 0.8 seconds before contact with the ground

The mobile phone video also captured the sound of the propeller (Figure 6). The frequency of the recorded tone is related to the speed of the propeller but is also affected by doppler shift due to the aircraft moving towards or away from the recording device. In this case the frequency shift was predominantly due to the initial speed of the aircraft at the start of the manoeuvre being largely towards the recording position. With fixed pitch propellers, such as the one in use, the speed of the propeller is affected by airspeed and the throttle position.

The audio recorded a sharp drop in propeller speed which, after factoring in the time taken for the sound to travel from the aircraft to the mobile phone, was about six seconds before impact. No sound of the impact was identified as the audio was swamped at this point by voices at the recording location.

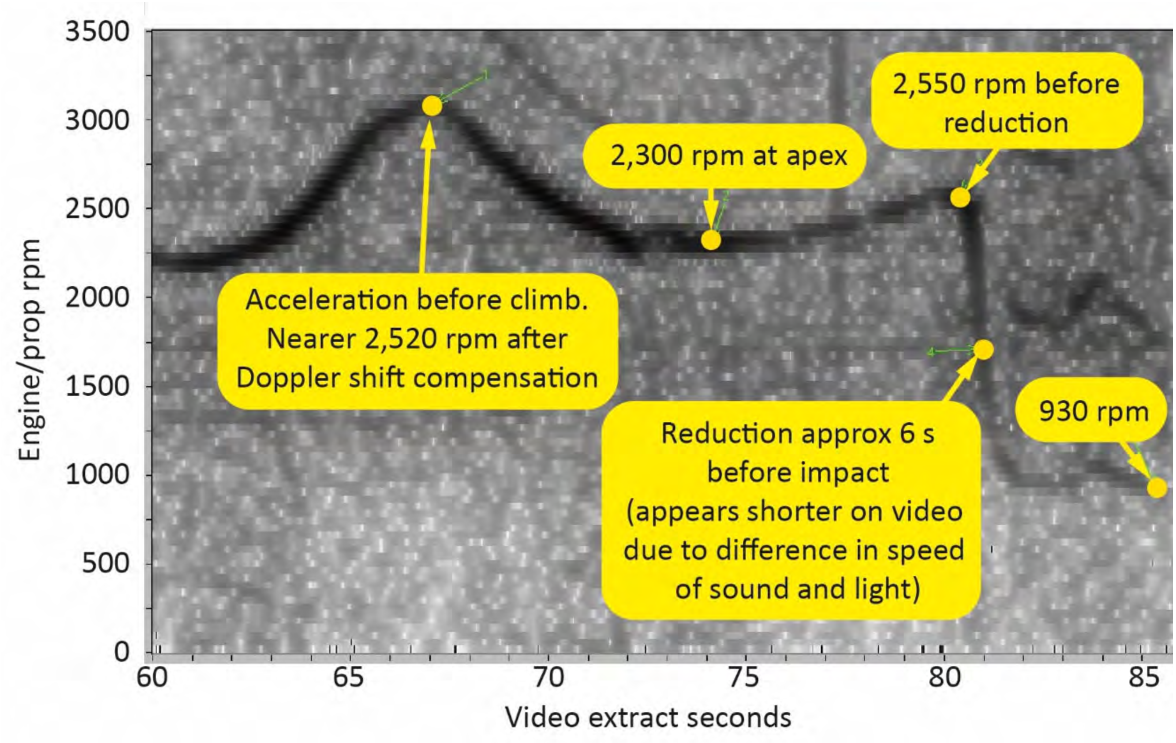


Figure 6

Spectrum analysis of the audio track of the mobile phone recording showing tone due to propeller blade noise. Scale halved to reflect propeller rpm rather than blade passes per minute

Aircraft information

The Pitts Special S-1S is a single seat, light aerobatic biplane built for competition aerobatics. Its wings are of wooden spar and ribs construction, with the fuselage made of a steel spaceframe. The wings and fuselage are covered in doped fabric. The aircraft has conventional flight controls with ailerons positioned on both upper and lower wings.

G-BOXV was built in the USA in 1984 and transferred to the UK register in 1990. The pilot purchased the aircraft in 2003, at which time it had accrued 230 flying hours. In January 2019, the original Lycoming engine was replaced with a new Superior XP-IO-360-A1HC3 engine. The fixed pitch MT-propeller which had been fitted in 2010 was retained. At the time of the accident the aircraft had flown 666 hours, with the engine accruing 54 hours. The aircraft had a valid Permit to Fly which had been revalidated in May 2022.

Aircraft examination

The aircraft wreckage was transported to the AAIB facility in Farnborough for further examination. The fractured rudder cable was removed from the aircraft and examined in a laboratory. This examination determined that the fracture had occurred because of loading associated with impact-related airframe distortion in combination with heating from the post-accident fire and did not pre-exist the accident sequence.

Examination of the remainder of the aircraft, including the engine, found no indication of damage that existed before the accident, but the extensive damage, caused by the intense post-accident fire, meant a complete assessment of the aircraft was not possible.

Survivability

The pilot was wearing a parachute but, with limited time and height available to him from the point at which the aircraft started rolling after the final manoeuvre apex, abandoning the aircraft would not have been an option. The forces exerted on the pilot during the impact resulted in injuries that were not survivable.

Weight and balance

The investigation was not able to ascertain the exact fuel load on board G-BOXV at the time of the accident. Weight and balance calculations confirmed that the aircraft would have been within its approved weight and CG envelope with the fuel tank full, empty or at any level in between.

Aircraft performance

Spinning, autorotation and spiral dives

Spins are preceded by a stall which can be from straight or accelerated flight. Once the wing has stalled, the phenomenon that develops and sustains a spin is autorotation. Autorotation can be defined as a self-sustaining rotational motion, initially in roll but may result in significant yaw depending on the nature of the spin, for example, in a flat spin the autorotation would be wholly yaw.

The main differences between a spin and a spiral dive are that spins can be erratic as they develop, and they are associated with a low indicated airspeed and significant yaw. Spiral dives tend to have higher and increasing airspeeds, low levels of yaw and, with the aircraft not being in a stalled condition, they are generally smoother than a spin.

Pitts Special spinning characteristics

The following information regarding height loss during spinning had been provided to a previous AAIB investigation into an accident involving a two-seat Pitts Special aircraft (G-ODDS[2]) in 2019.

Footnote

2 AAIB investigation to Pitts S-2A Pitts Special, G-ODDS - GOV.UK (www.gov.uk) [accessed 9 November 2022].

> '[assuming] *that a conventional technique to induce and maintain a spin was used, ie full rudder and control column held fully back with ailerons neutral… the manufacturer indicated that a 10-turn upright spin incurred a height loss of 3,400 ft in an elapsed time of 32 seconds. Therefore, each spin rotation takes approximately three seconds and incurs a loss of 340 ft with a rate of descent of approximately 6,800 fpm.*
>
> *The manufacturer advised that, with full opposite rudder deflection and neutral (or released) control column, it would take approximately 500 ft to stop the rotation and then another 500 ft to level flight with a 4 g acceleration.'*

The G-ODDS report also contained the following observation regarding spin recovery technique:

> *'…if in-spin aileron was maintained during the recovery the aircraft could potentially enter another spin, possibly inverted, in the opposite direction.'*

Pitts Special pilots who spoke to the G-BOXV investigation reported that, in an erect spin, the aircraft would adopt a "relatively flat" 30°-50° nose-down attitude while the airspeed would remain "low and stable." The manufacturer's information indicated that it would take 500 ft to stop the rotation from a fully developed spin at 6,800 fpm rate of descent. One pilot reported that, for a single turn spin before the rate of descent had built significantly, he found it possible to effect recovery to level flight in approximately 500 ft from initiating spin recovery action.

Meteorology

The weather at the time of the accident was benign. There was good visibility with a distinct horizon at low level, the wind was calm, and the cloud base was broken[3] at 2,500-3,000 ft.

Airfield accident response

Because aerobatic practices in the airfield overhead were not routinely permitted at Shobdon, the local procedures had not included any requirement for an enhanced level of standby posture for the on-site fire and rescue assets. While not included in the airfield procedures, shortly after G-BOXV took off, the Airfield Manager and on-duty Flight Information Service Officer (FISO) independently thought it prudent to put the fire crew on '*local standby*' as they would for a first solo flight. Consequently, the lead fire fighter had already donned protective clothing and was able to board the response vehicle, parked in front of the ATC building, within one minute of the alarm being raised. The second firefighter saw the impact while he was mowing the grass at the western end of the airfield and immediately drove back to join the rescue vehicle. The fire crew arrived on scene within three minutes of the accident occurring. In light of this accident, it was decided that the airfield fire and rescue service would, in future, be brought to immediate readiness for any aerobatic practices in the overhead as well as for first solo flights.

Footnote

[3] Five to seven eighths coverage.

The combined operations team had recently updated the airfield incident response plan. Their previous experience was that, in stressful situations, standard sequential checklists were not always easy to follow, and their unidirectional flow pattern meant that, if steps in the process were missed, the slip was less likely to be caught and rectified. As a counter to this, they had developed a three-phase matrix response aide-memoire with key action priorities for each phase forming a circular flow chart (Figure 7).

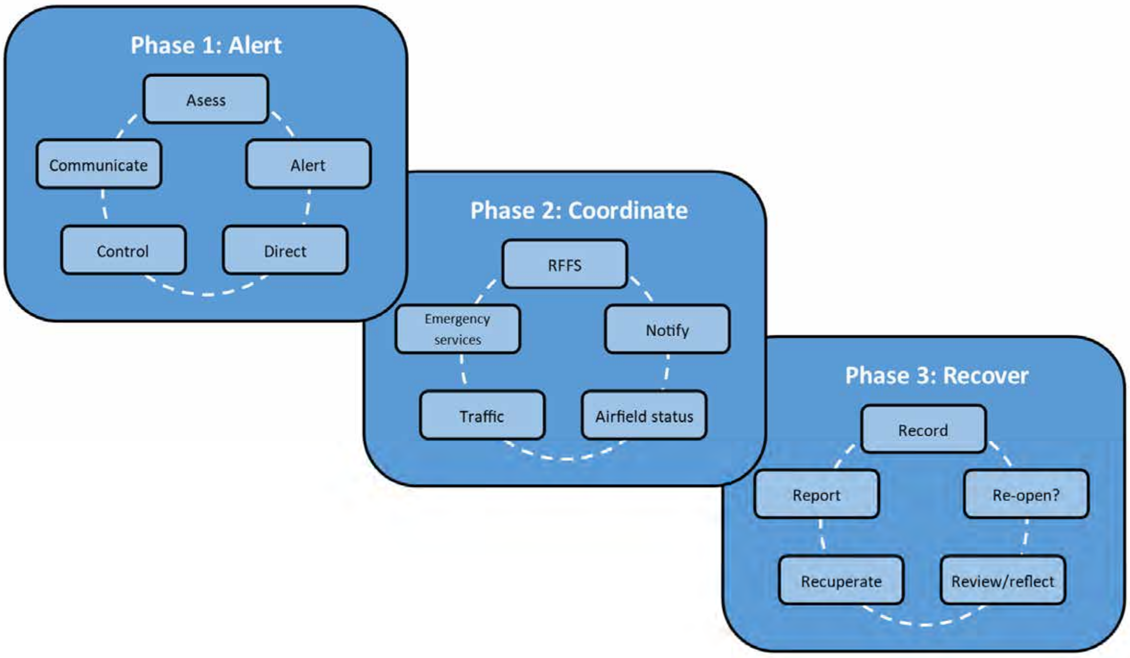


Figure 7

Overview of airfield incident response matrix (used with permission)

Within each action priority area, amplifying notes were provided as further prompts to the person coordinating the response. The matrix had been successfully trialled during a recent simulated emergency at Shobdon. Airfield personnel judged that the revised incident response matrix as well as their recent training had left them well prepared for the challenges posed by this accident.

Personnel

The pilot was a commercial pilot's licence holder with a Flying Instructor rating. He was an Intermediate Category competition aerobatics pilot and a qualified Upset Prevention and Recovery Training (UPRT) instructor. Before the accident flight, he last flew G-BOXV in an aerobatic competition on 21 May 2022 and had flown one further aerobatic practice in the aircraft on 9 July 2022. Between 9 July and 26 August, the pilot had undertaken 13 UPRT training flights as the instructor in a Slingsby T67M-200 Firefly aircraft.

The pilot's Class 1 aviation medical was valid, and the post-mortem could find no evidence of any chronic or acute medical condition that might have been causal or contributory to the accident.

Other information

Planned aerobatic manoeuvres/sequence

Documentation provided to the investigation indicated that, for his second planned flight, the pilot intended anchoring his display over a datum south of the runway (Figure 8). During the accident flight, the pilot began aerobatic manoeuvring south and west of this display area. The way the manoeuvres progressed suggested the pilot could have been using them to warm up while re-positioning the aircraft closer to his intended datum.

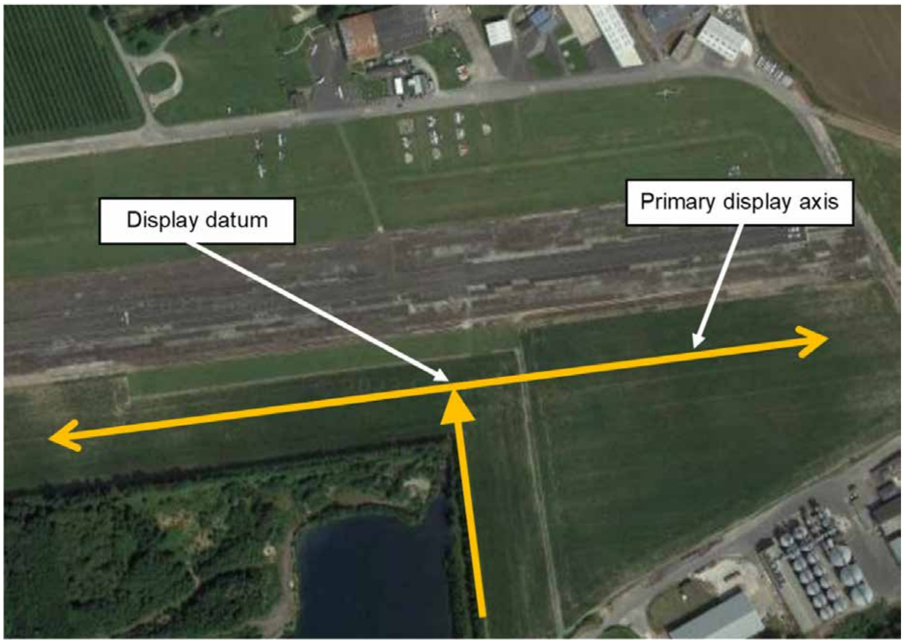


Figure 8

Primary display axis and datum for the pilot's second planned flight
(Imagery ©2023 Bluesky, Infoterra Ltd & COWI A/S, CNES / Airbus, Getmapping plc, Maxar Technologies)

The investigation consulted several pilots who had expert knowledge of the aircraft type and/or knowledge of the pilot's handling style and approach to flying to try and establish where the accident manoeuvre diverged from the pilot's intent.

The AAIB obtained evidence of two different aerobatic sequences the pilot was known to fly, one for aerobatic competitions and one for displays. Neither written sequence correlated to the sequence of manoeuvres captured on the mobile phone video of the accident flight.

The closest comparable manoeuvres to that immediately preceding the accident were the '*Avalanche'* and '*Reverse half Cuban*' from his display sequence and a 180° vertical roll followed by a 1½ turn spin from his competition sequence (Figure 9). Annotations on a copy of the pilot's competition sequence indicated he used 2,500 ft agl as a target entry height for the spin and that, in contrast to the accident manoeuvre, it was preceded by decelerating level and erect flight to generate the required stall conditions for entry. While all three manoeuvres began with climbing rolls ±45° from the vertical, none of them included a 450° upwards roll followed by a tight descending spiral.

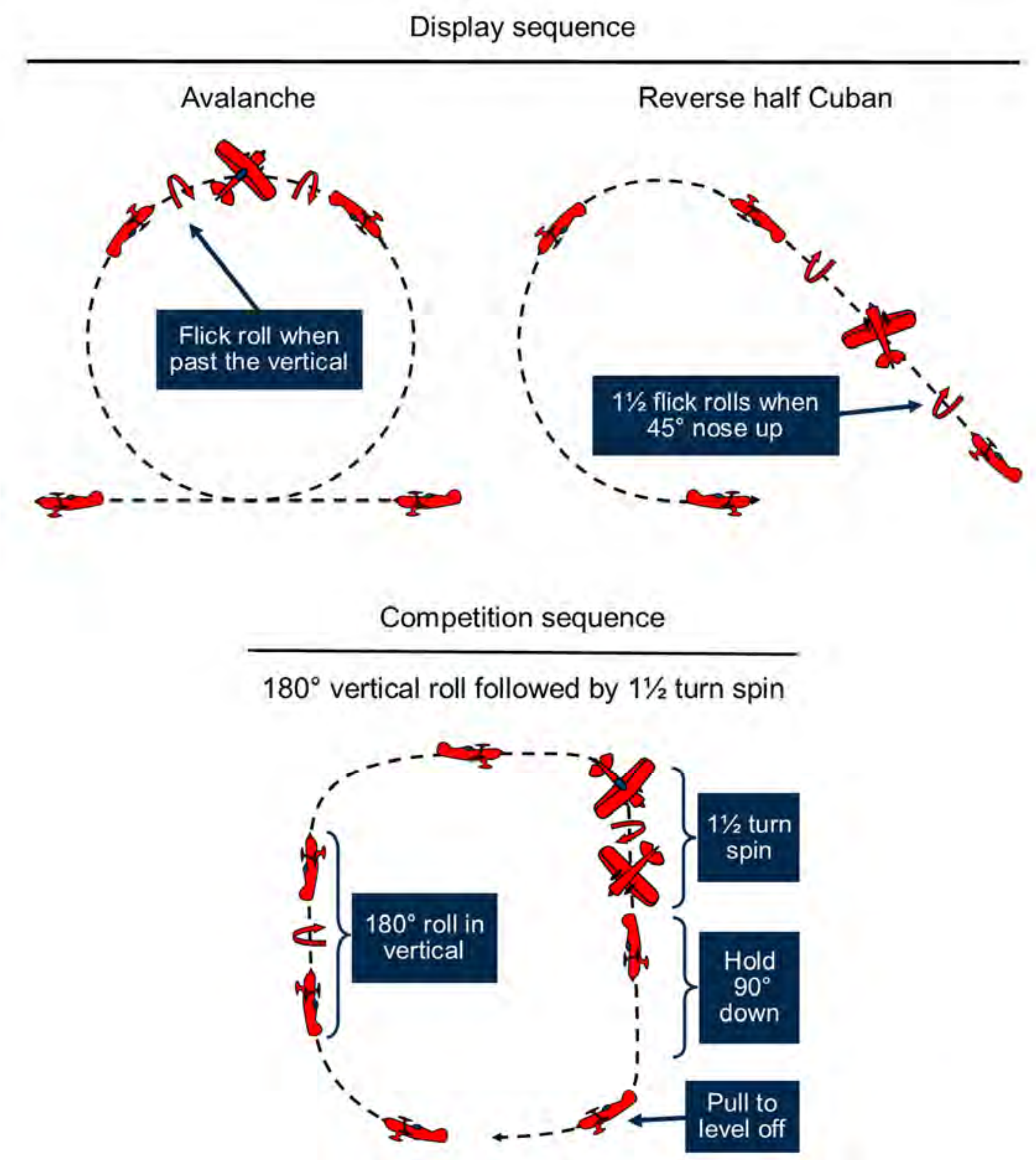


Figure 9

Closest comparable manoeuvres from the pilot's known aerobatic sequences (not to scale)

While no supporting documentation could be found, the investigation was provided with video footage taken on 1 August 2020 of the pilot flying a climbing manoeuvre like that which preceded the accident. This video showed the aircraft pulling up into the vertical before rolling left through 450°. This roll, like the one in the accident manoeuvre, was off-axis to the left and finished with a steeply banked 'knife-edge' over the top. As the aircraft's nose dropped below the horizon, the pilot held the pitch attitude at approximately 45° nose-down with the aircraft inverted for about one second before rolling erect and continuing the 45° descent. In the August 2020 video, the transition from nose-up to nose-down was more dynamic than on the accident flight; visually, the aircraft appeared to have more airspeed approaching the apex and the right yaw looked more positively controlled. Additionally, on the accident flight the aircraft remained close to 90° angle of bank as the nose dropped, while for the August 2020 manoeuvre, the bank angle was closer to 120°, thus requiring less yaw but more pitch to bring the nose down to the desired angle. A simplistic comparison of the accident manoeuvre with the one from 1 August 2020 is shown at Figure 10.

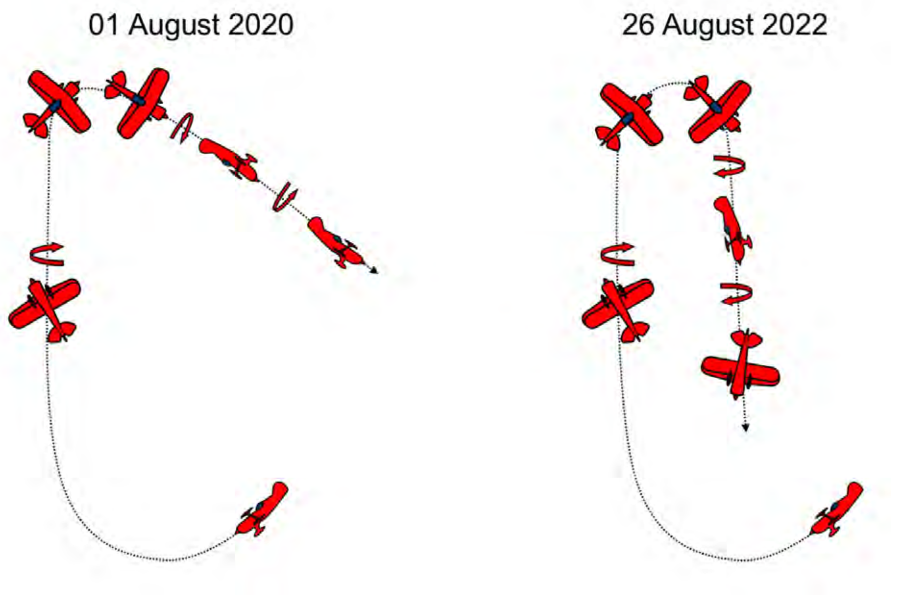


Figure 10

Comparison of 1 August 2020 manoeuvre and accident manoeuvre (not to scale)

Background noise from another aircraft on the August 2020 video interfered with G-BOXV's engine note, thus making any spectral audio analysis inconclusive. It was not possible to determine if the August 2020 manoeuvre was flown with a higher power setting than on the accident flight.

The accident pilot normally flew to a minimum 1,000 ft agl base height during competition flying and would use 500 ft agl as his minimum height for displays.

UPRT syllabus

Multiple individual manoeuvres would be demonstrated and practised on each of the three flights comprising the UPRT airborne syllabus that the pilot regularly delivered. A consolidated list of the individual exercises for each flight is reproduced at Table 1 from a copy of the pilot's kneeboard aide-memoire that he used when teaching the course. Elements with direct read across to the accident manoeuvre are shown in bold.

UPRT Exercise 1	UPRT Exercise 2	UPRT Exercise 3
▪ Steep turns ▪ Unaccelerated stall ▪ Slow flight **▪ Spiral dive** **▪ Recovery from nose low upset** ▪ Stalls: nose high/low, secondary ▪ Maximum rate turn ▪ Stall in maximum rate turn	▪ Energy trading demonstration ▪ Zero G flight to demonstrate flight below VS with no stall symptoms ▪ Jammed controls: ▪ Ailerons ▪ Elevator ▪ Recovery from nose high upset **▪ Roll/yaw to lower nose and recover from nose high upset** ▪ Demo UPRT3 aerobatic manoeuvres ▪ Recovery from inverted flight **▪ Recovery from incipient spin**	▪ Recovery from nose high upsets by centring controls ▪ Stalling in balanced turn ▪ Stalling in skidding turn ▪ Demo ineffectiveness of ailerons to counter wing drop ▪ Vertical accelerated stall **▪ Practice recovery from upsets various attitudes: surprise & startle** ▪ Nose high ▪ Nose low **▪ Stalls (1G and accelerated)**

Table 1

Consolidated reproduction from the pilot's kneeboard aide-memoire for the UPRT syllabus

Analysis

At the time of the accident G-BOXV had a valid Permit to Fly and was operating within the manufacturer's defined weight and balance envelope. Although extensive fire damage prevented a detailed reconstruction of the aircraft, examination of the wreckage identified that, prior to the accident, the primary flying controls were correctly connected and free from restriction. The engine was in good condition with no indications of low or poor performance. It is therefore likely that there were no technical issues with the aircraft which affected its ability to fly normally during the accident flight.

The accident pilot was correctly licenced and qualified for the intended flight. In his role as an UPRT instructor, albeit in pre-planned training scenarios, he regularly demonstrated how to recover an aircraft from unusual attitudes, incipient spins, spiral dives, and accelerated stalls. He was an experienced aerobatic pilot who had successfully flown G-BOXV in competitions and public displays for many years.

The investigation did not find evidence of the pilot suffering from any chronic or acute medical issue that might have been causal or contributory to the accident.

Accident manoeuvre

From analysing the video evidence taken in August 2020 and August 2022, and in the absence of the pilot's known aerobatic sequences containing any comparable manoeuvres, the investigation deemed it likely the pilot was attempting a similar manoeuvre to that seen in the 2020 video. If that was the case, the aircraft departed from the pilot's intended flight path as the nose dropped below the horizon at the top of the final climb.

Based on witness testimony, if the pilot had intended to spin the aircraft after the climb, it is likely he would have planned on doing so higher and from level flight, using a more controlled and conventional technique. Given the Pitts Special's spinning characteristics as explained to the investigation, of low sustained airspeed and comparatively shallow nose-down attitude, the investigation determined that G-BOXV entered an autorotative spiral dive after the final apex, rather than a spin.

Visually, the apex of the accident manoeuvre was less dynamic than that seen on the August 2020 video. This suggests that the aircraft was slower as it transitioned from climb to descent. The reasons for this could be one or a combination of the following (when compared with the August 2020 manoeuvre):

- A larger rudder pedal input during the upward roll leading to greater off-axis yaw angle and therefore higher resultant drag and faster speed decay.
- A lower power setting leading to faster speed decay in the climb.
- A lower entry speed leading to lower airspeed at the apex.
- A slower rate of roll meaning it took longer to complete 450° roll, thereby resulting in a higher than intended climb and slower apex airspeed.

The low apex airspeed would have reduced the pilot's aerodynamic control over the aircraft's flight path leaving him less able to positively position the aircraft as it transitioned from nose-up to nose-down. With little or no observed pitch rate, the aircraft would have had a low angle of attack and did not appear to be stalled over the top of the manoeuvre. Being close to 90° angle of bank, the aircraft was yawing right as the nose dropped so the left (outer) wing would have been moving faster and producing more lift than the right wing. This resulting aerodynamic asymmetry appears to have developed into an autorotative right roll.

With the right wing producing less lift, its ailerons would have been unable to generate enough counterbalancing rolling force, even assuming the pilot had applied full left aileron to oppose the roll. The autorotative roll developed rapidly and the aircraft's nose dropped steeply as it did so. In an un-stalled condition and subject to autorotation, G-BOXV quickly became established in a steep nose-down spiral dive with the aircraft accelerating despite the pilot's apparent selection of idle power.

As the aircraft's speed increased in the descent, its ailerons would have become more effective, and the pilot managed to stop the roll after approximately 1¼ turns. However, by the time the roll stopped, the aircraft was very low and in a steep nose-down attitude. That the aircraft started to pitch out of the steep dive led the investigation to conclude the pilot was active on the controls throughout the attempted recovery. With limited height remaining and a high rate of descent, it is likely that the rapidly approaching ground prompted the pilot to pull as hard as possible to recover from the dive. The observed sudden reduction in pitch rate was indicative of an accelerated stall as the g-loading increased. The rapid roll divergence could have resulted from a residual rudder or aileron input at the point of the stall. Based on the video evidence, even if the initial pitch rate acceleration had been maintained, it is unlikely recovery could have been completed successfully in the remaining height available.

Height considerations

The investigation was not able to determine why the aircraft appears to have been committed to the vertical climb from below the pilot's reported minimum base height for aerobatic manoeuvring.

Based on the manufacturer's flight trials and pilot reports, the minimum height loss in a single turn spin followed by an expeditious recovery to level flight would be somewhere between 500 and 1,000 ft agl. Even from 1,300 ft agl, the upper tolerance of the photogrammetry-derived apex, there would have been little or no contingency height for a single turn spin and recovery if working to an assumed 500 ft base height. The pilot's notes on his competition sequence indicated he used 1,500 ft above base height as the target entry height for a 1½ turn spin. The investigation concluded that the pilot had not intended to spin after the vertical rolling manoeuvre.

A spin is a stalled manoeuvre with a relatively low nose-down attitude and low airspeed when compared with the spiral dive experienced by G-BOXV. The steeper attitude and increasing airspeed, despite the engine being at low power, would have resulted in a higher rate of descent than if spinning. Based on the time between apex and impact, the estimated average rate of descent would have been 8,700 fpm from a maximum height of 1,300 ft agl and 6,000 fpm from 900 ft agl[4]. Taken from the start of the autorotative roll these figures would be 1,000-1,500 fpm higher. The investigation thought it unlikely the pilot intended entering a steep spiral dive after the manoeuvre apex.

Without supporting evidence, the investigation was unable to determine if any of the aerobatic manoeuvres seen on the accident flight were flown with specific entry and safety parameters in mind. One expert witness observed that the manoeuvres appeared to follow a less structured flow than he would have expected from a planned sequence.

Conclusion

The accident occurred after control was lost when an autorotative roll developed as the aircraft yawed at the top of a vertical climb. Low airspeed during the yaw would have reduced the aerodynamic control available to the pilot such that he could not prevent the aircraft entering the subsequent spiral dive. The entry conditions to the manoeuvre gave little or no safety margin when the aircraft began to dynamically diverge from the expected flight path. While the pilot was able to regain control of the aircraft, by the time he did so there was insufficient height remaining in which to effect a safe recovery.

While the investigation could not determine why the pilot was unable to prevent the aircraft from entering the spiral dive, starting the climb with more height and/or speed would likely

Footnote

4 Based on the photogrammetry-derived apex height of 1,100 ±200 ft agl.

have increased the pilot's chances of avoiding the loss of control and/or being able to recover from it safely. The investigation was not able to determine what the pilot's contingency criteria were, but this accident serves as a reminder that conducting low level aerobatics comes with inherent risks when manoeuvres, planned or unplanned, do not proceed as expected.

Generic guidance for aerobatic pilots is contained in CAA Safety Sense Leaflet 19 – '*Aerobatics*.'

Published: 3 May 2023.

ACCIDENT

Aircraft Type and Registration:	Flight Design CT2K, G-CBDJ
No & Type of Engines:	1 Rotax 912ULS piston engine
Year of Manufacture:	2001 (Serial no: 7850)
Date & Time (UTC):	24 March 2022 at 1400 hrs
Location:	Beccles Aerodrome, Suffolk
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Fatal) Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	87 years
Commander's Flying Experience:	2,677 hours (of which 1,621 were on type) Last 90 days - 20 hours Last 28 days - 9 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft was on a flight from Temple Bruer airstrip, Lincolnshire to Beccles Aerodrome, Suffolk. The approach was described as "unstable". The aircraft bounced on landing and probably stalled. The pilot was fatally injured when the aircraft subsequently struck the ground.

The pilot was familiar with his aircraft and in recent practice, but the landing diverged from his intended plan. Given that he was 87 years old and recognised that he would likely have to stop flying in the near future, it is possible that some age-related deterioration in human performance was a factor in this accident. The investigation highlighted a lack of medical guidance for both pilots and medical professionals, as well as a cohort of private pilots who are not subject to an independent professional assessment of age-related deterioration in piloting ability. Four Safety Recommendations have been made to the CAA, three about the Pilot Medical Declaration and one about the revalidation of ratings.

History of the flight

The pilot was a member of a small aviation group that flew from Temple Bruer airstrip, Lincolnshire, which is located just outside the northern Aerodrome Traffic Zone (ATZ) boundary of RAF Cranwell. On the day of the accident, he planned to fly from Temple Bruer to Beccles Aerodrome, Suffolk, which he had visited on two previous occasions.

The weather for the route was clear with light winds from the east. The pilot booked out at Temple Bruer and took off at 1246 hrs, climbing on a south-easterly heading. Three minutes later the pilot informed Cranwell ATC that he was returning to Temple Bruer with a "SLIGHT PROBLEM". Approximately one minute later he informed ATC that the problem had been solved and that he was continuing towards Beccles.

The pilot continued on a south-easterly course, operating at altitudes up to 3,500 ft amsl. At 1350 hrs he contacted Beccles Radio requesting the airfield details; the radio operator responded that Runway 09 was in use and that the wind was from the east at less than five knots. The pilot positioned to join downwind then established on a final approach, reporting both positions on the radio. The radio operator replied to the final call, passing the wind direction and speed.

Eyewitness accounts described the final approach of G-CBDJ as "unstable" in roll and pitch initially, then becoming stable before touching down on its main wheels approximately 50 m in from the threshold. The aircraft was observed to bounce to around 10 ft into the air before touching down again on the nosewheel. It bounced a second time and pitched markedly nose up, described as being to 45° as it appeared to climb away. On reaching around 100 ft above the runway, witnesses described the aircraft veering to the left and rolling to approximately 90° angle of bank before the nose "dropped" and the aircraft fell to the ground in a field adjacent to the runway. No witnesses interviewed by the AAIB could recall hearing sounds of the aircraft's engine increasing power after either landing attempt. There were no reports of turbulence on final approach on the day of the accident.

The aerodrome Rescue and Fire Fighting Service (RFFS) vehicle arrived quickly at the aircraft and found the pilot in the left seat with the safety harness in place, breathing but unresponsive. Recognising that they would not be able to release him safely from the wreckage, the RFFS crew continued to provide reassurance to the pilot and monitored the aircraft for signs of fire until further assistance arrived. They established that the aircraft was fitted with a Ballistic Parachute Recovery System (BPRS). An ambulance arrived at 1404 hrs followed by the Fire Service at 1412 hrs. The Helicopter Emergency Medical Service (HEMS) then arrived at 1420 hrs. The HEMS doctor determined that the pilot had succumbed to his injuries and died at the scene.

Accident site

The aircraft came to rest approximately 100 m to the north of Runway 09 and 240 m from the threshold. Both wings had detached from the fuselage, with the lower surfaces upper most. The fuselage was on its right side, on top of the wings with severe disruption to the nose section (Figure 1). The field to the north of the runway was planted with a rapeseed crop which was approximately 1 m in height. The crop was heavily damaged in the immediate area of the aircraft and there was a short visible swath cut into the crop (highlighted in Figure 1 right) that was consistent with the left wingtip being the first part of the aircraft to make contact with the field.

Figure 1
Aerial view of the accident site

Aircraft information

G-CBDJ was a Flight Design CT2K microlight which was built in 2001. It had an all-composite construction with a high wing, conventional control surfaces and a tricycle landing gear. A three-bladed propeller was driven by a Rotax 912ULS engine. The aircraft was fitted with a BPRS. Prior to recovering the aircraft to the AAIB, the BPRS was deployed at the accident site with the necessary safety precautions in place.

A Brauniger Alpha Multi-Function Display (MFD) was fitted to the centre of the instrument panel in the cockpit of G-CBDJ. The MFD used a monochrome Liquid Crystal Display (LCD) to provide the pilot with the following information: fuel quantity, the aircraft's indicated airspeed, altitude, vertical speed, engine rpm, engine oil temperature, water coolant temperature, exhaust gas temperatures and oil pressure.

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

The MFD provided a visual alert to the pilot if the airspeed or engine parameters exceed set limits. For example, the alert thresholds for aircraft indicated airspeed for G-CBDJ was 38 kt. If an engine exceedance was detected, or the airspeed was below the set limit, the associated display readout on the LCD would flash on and off.

If external electrical power to the MFD was lost in flight, a back-up battery installed within the MFD automatically provided electrical power that enabled the unit to continue to operate for several hours. The voltage of the integral battery was tested by the MFD each time external electrical power was applied to the unit. If the voltage was detected as being low, a warning was presented on the MFD.

Aircraft handling

Pilots experienced on the CT2K informed the AAIB that in common with many types, it had characteristics that required vigilance from the pilot. For example, if a pilot lands on the nosewheel, the nose of the CT2K tends to "kick up" markedly, requiring the immediate application of power to go around. One pilot stated that, "it is a difficult aircraft to land, especially if it bounces...you have to apply power to catch it...you have to be on your game".

The maximum speed to extend the flaps on the CT2K is 62 KIAS and the recommended approach speed is 55 KIAS.

Recorded information

Recorded information for the accident flight included the aircraft's position and altitude, which had been recorded by ground-based radar and equipment that had received transmissions from an electronic conspicuity device[1] fitted in the aircraft. RTF recordings of communications between the pilot and ATC, that commenced as the aircraft departed Temple Bruer airstrip, were also available.

When electrical power was applied to the MFD on G-CBDJ after the accident, the integral battery passed the unit's built-in test. The MFD had an internal recording function which monitored engine rpm, altitude and airspeed to determine the start and end of a recording period. Each recording started once the engine had been running for one minute and the MFD detected an increase in altitude of about 75 ft, indicating that the aircraft had taken off. The recording ended once the engine had stopped with an airspeed less than about 27 kt and with no change in altitude detected for a subsequent period of approximately 30 seconds. The MFD recorded flight duration reflected the time that the aircraft had climbed above 75 ft and the airspeed remained above 27 kt.

Recorded information was recovered from the MFD for the accident flight and the 23 previous flights dating back to 14 November 2021. This data provided a peak value of airspeed, altitude, vertical speed, and engine parameters (except oil pressure). It was not possible to determine at what point peak values occurred during a flight.

A portable tablet computer was also found in the aircraft. This was damaged and no data was recovered. A member of the pilot's family confirmed that the device was operating a navigation application. This provided a moving map with the aircraft GPS derived position, and a route could be entered between points, such as when flying between airfields.

Summary of recorded data

The pilot of G-CBDJ made initial radio contact at 1244 hrs with Cranwell Zone ATC to request permission to depart from Temple Bruer into the Military Air Traffic Zone (MATZ), for a flight to Beccles (Figure 2). The pilot was cleared for departure, with the aircraft subsequently taking off from Runway 08 at 1246 hrs before then turning onto a south-easterly heading. However, at 1249 hrs, the pilot reported to ATC that he had a "SLIGHT PROBLEM" and was returning to Temple Bruer, with the aircraft making a left turn back towards the airstrip. ATC inquired if they could further assist the pilot, who responded by advising "NO, NO I'M, I'M FINE THANK YOU, IT'S JUST SOMETHING HASN'T FIRED UP AS IT SHOULD HAVE DONE". About one minute later, at 1250:54 hrs, the pilot

Footnote

1 PilotAware Rosetta.

contacted ATC and advised them "PROBLEM SOLVED" and that he was turning back on course towards Beccles. A family member of the pilot informed the AAIB that the pilot used this phrase when his navigation application did not activate the planed route, or did not connect correctly to the PilotAware Rosetta conspicuity device.

At 1258 hrs, G-CBDJ exited the Cranwell MATZ and the pilot advised ATC that he was changing to "safetycom"[2] frequency enroute. This was the last recorded communication from the pilot; there were no reports of the pilot communicating whilst enroute and the air/ground radio communications at Beccles was not recorded.

As G-CBDJ approached the town of Spalding, the pilot altered course to fly an almost direct track to Beccles, during which the aircraft was operated at altitudes of up to about 3,500 ft amsl.

At 1352 hrs, G-CBDJ had descended to an altitude of about 1,000 ft amsl and was joining crosswind for a right-hand circuit to land on Runway 09 at Beccles. The final recording of the aircraft was at 1354:58 hrs when it on the final approach and positioned 800 m from the runway threshold at an altitude of about 430 ft amsl (a height of 350 ft aal), which equated to a flight path angle of 7° to the runway threshold. The aircraft's descent rate at this time was about 450 ft/min and its calculated airspeed, based on a windspeed of 5 kt, was between 60 and 70 KIAS.

The MFD data for the accident flight indicated that the engine had been running for one hour and eighteen minutes, and that the recorded flight time was one hour and ten minutes. The engine was started at 1236 hrs and it had stopped between 1355 and 1356 hrs; this was consistent with the time for the aircraft to have reached the airfield from the final radar position based on its groundspeed. Table 1 provides the peak values recorded by the MFD during the accident flight. None of these values exceeded a threshold for an alert.

Engine rpm	KIAS kt	Altitude ft	Rate of climb ft/min	Rate of descent ft/min	Water temperature °C	Oil temperature °C	EGT Sensor 1 / 2 °C
4,900	110	3,466	1,100	1,200	113	103	814 / 773

Table 1

Peak MFD parameter values recorded during the accident flight

Footnote

[2] SafetyCom is a common traffic advisory frequency (135.480 MHz) for use at, or near to, aerodromes that do not have an assigned frequency.

Figure 2

Aircraft track from Temple Bruer to Beccles Aerodrome
© 2022 Google, Image © Landsat / Copernicus

Aircraft examination

The wreckage was recovered to the AAIB for detailed examination. Continuity of the flying controls was confirmed, along with the engine controls. Witness marks on the fuselage correlated to the flaps being deployed to their full (landing) configuration at the time of the accident. There was evidence of over compression on the left side of the nose landing gear tyre and there was slight deformation of the wheel hub (Figure 3). A detailed engine teardown revealed that the engine was probably performing normally prior to the accident. from performing normally.

Figure 3

Damage to the nose landing wheel

With the exception of the MFD, the disruption to the wreckage precluded detailed testing of the aircraft systems.

Pilot information

The pilot held a UK Private Pilot's Licence, first issued in 1989, and had flown 2,677 hours of which 1,621 hours were in G-CBDJ. He gained a microlight endorsement in 1991 and revalidated the privileges of his microlight class rating on 6 April 2021 by providing evidence of his experience. His aviation skills were well regarded by his peers at Temple Bruer. They commended his skills in dealing with turbulent conditions at their flying strip, and his awareness of how his aircraft handled in such conditions.

A member of the pilot's family informed the AAIB that the pilot was getting to the stage where he was "slowing down" and that the pilot was "coming to the conclusion that he would have to stop flying in the near future".

Post-mortem report

In his post-mortem report, the pathologist found that the pilot died from multiple traumatic injuries sustained in the aircraft accident. There was no indication of medical impairment or incapacitation of the pilot before the aircraft struck the ground, but this could not be ruled out.

Licence revalidation

There are two methods of revalidating a microlight class rating issued before 1 February 2008 for a UK PPL holder; the first is by experience[3]. The requirement is that within the preceding 13 months and during the validity of an existing Certificate of Experience, the holder must have completed at least five hours of flying as a pilot of a microlight, including at least three hours as Pilot in Command[4]. This method of revalidation does not require a training flight or assessment with an instructor. The pilot of G-CBDJ had flown approximately 62 hours in the preceding 13 months.

The second method, which applies to all microlight class ratings issued after 1 February 2008 and for pilots with a National Private Pilot's Licence, is that within the 24-month period of validity of a Certificate of Revalidation, the holder must have completed:

- A minimum total of 12 hours flight time[5].
- At least one hour of flight training in a microlight aircraft conducted by an instructor entitled to give flight training in a microlight aircraft.

Pilots holding a UK PPL with a microlight class rating issued before 1 February 2008 may choose to adopt the NPPL revalidation scheme but there is no requirement for them to do

Footnote

3 This revalidation route also applies to class ratings for Self-Launching Motor Gliders.

4 Up to two hours can be conducted as dual flying instruction as Pilot Under Training with a qualified flying instructor who has certified that he/she was fit to act as pilot in command.

5 It also requires the following:
- Eight hours flown as PIC.
- Twelve take offs & landings.
- At least six hours flown within the 12 months preceding the expiry date of the current certificate.

so. The BMAA informed the AAIB that it was not possible to quantify either the number of pilots who renewed their microlight class rating by experience, or the number who could exercise that renewal method but had opted to comply with the NPPL scheme.

Ageing pilots

In April 2021 the AAIB published a report into a fatal glider accident, G-CFST, involving a 91-year-old pilot[6]. The report considered data from the CAA that showed the average age of non-commercial pilots in the UK was increasing. In 2000 it was 43.7 years; by 2018 it had increased to 52.2 years. After a review of available literature, the G-CFST investigation found that:

> *'Older pilots are not necessarily less-safe pilots and poor decision making can affect pilots of all age and experience levels. Nonetheless, age-related deterioration in eyesight, hearing, mobility, memory, cognition and decision making are recognised as having an impact on piloting ability.'*

And that:

> *'Although the broad effects of ageing are well known, there is great variability on how any specific decline will affect an individual pilot and chronological age is not a reliable metric to predict age-related impairment…while experience, knowledge, aptitude and wellbeing can offset or delay the effects of ageing, there will inevitably come a point where the most sensible option for an individual is to retire from flying as PIC.'*

The investigation concluded that:

> *'Unless precipitated by an accident or incident, without an objective metric for making the decision, it relies on individual pilots to be honest with themselves and for supervisors to be candid enough to reach a shared acknowledgement that their days as PIC are over. Family, friends and peers can play a part in encouraging and supporting pilots when that decision has to be made. This is especially important for pilots not affiliated to clubs or sporting associations.'*

Medical requirements for General Aviation pilots

All pilot licences require a medical certificate or declaration of some description. Holders of a UK PPL or NPPL wishing to fly a UK (G) registered aircraft in UK airspace can apply for a Pilot Medical Declaration (PMD) using the CAA's medical online system. The online PMD was introduced in October 2016 following a public consultation[7] in which the CAA sought the General Aviation (GA) community's opinion on adopting the Driver and Vehicle Licensing Agency (DVLA) standard for Group 1 (car) Ordinary Driving Licences (ODL) as the medical standard for their sector, expanding on a scheme previously available to

Footnote

[6] AAIB investigation to Schleicher ASH 25 E, G-CFST - GOV.UK (www.gov.uk) [accessed February 2023]

[7] See CAP 1284, *UK Private Pilot Licence and National Private Pilot Licence Medical Requirements*, CAA, June 2015.

NPPL holders[8]. This was part of the CAA's wider aspiration to make regulation *'more proportionate and less burdensome, while still seeking to protect third parties*', and focused the risk analysis on the probability of serious incapacitation in flight.

The current PMD is an affirmation of a pilot's medical fitness to fly based on a '*reasonable belief*' that they meet the medical requirements for a Group 1 ODL and are not subject to any disqualifying medical conditions. There is no requirement to consult a General Practitioner (GP) or an Aeromedical Examiner (AME), and the pilot does not have to hold a driving licence. Essentially, if you believe you are fit enough to drive to an aerodrome, you may consider yourself to be fit to fly your aircraft. In addition, the applicant must comply with the following requirements:

- Only fly an aircraft no greater than 2,000 kg MTOW.
- Must not be taking medication for any psychiatric illness.

Additional medical restrictions apply if the applicant wishes to fly aircraft greater than 2,000 kg but below 5,700 kg MTOW, and an AME must be consulted if the pilot is unsure about the applicability of a condition, treatment or medication[9].

PMD validity

After completing the online process, the PMD is valid until the age of 70 years, with no upper age limit, unless voluntarily withdrawn for medical reasons. After this, a new declaration must be submitted every three years. The accident pilot renewed his PMD on 21 December 2021, hence valid until 21 December 2024.

Assessment of ongoing medical fitness

The CAA's website provides the following guidance for the assessment of ongoing fitness for PMDs:

> *'If you have reason to believe you no longer meet the DVLA Group 1 ODL* [medical] *standard, or suffer from any of the specified medical conditions, you must not fly and must withdraw the declaration…'*

The CAA does not provide further guidance on the DVLA's medical standard for Group 1 driving licences, nor does it provide a link to the DVLA's website[10] which contains comprehensive advice to drivers. A pilot who intends to make a PMD must actively seek out information relevant to his personal medical history from DVLA sources.

Footnote

8 The NPPL was established using a declaration of medical fitness by the pilot, which was then countersigned by their General Practitioner, who had access to the pilot's medical records.
9 Further information is available at https://www.caa.co.uk/general-aviation/pilot-licences/applications/medical/medical-requirements-for-private-pilots [accessed May 2022].
10 https://www.gov.uk/driving-medical-conditions [accessed May 2022].

Collating evidence following the implementation of PMDs

As part of the implementation phase of the introduction of PMDs the CAA published CAP 1397 - *Comment response document: UK Private Pilot Licence and National Private Pilot Licence medical requirements,* in April 2016, in which it stated:

> *'It will be important to collect evidence post-implementation to confirm the safety analysis assumptions.*
>
> *A record keeping system will have to be established to monitor the effects of implementing the new proposal. This will request private pilots submit information on an annual basis to the CAA documenting such items as: age, type of flying, hours flown in last year, total hours.'*

The CAA informed the AAIB that following the introduction of PMDs, no record keeping system had been established to collect the annual data necessary to enable the validation of the system.

In October 2020 the CAA conducted a post-implementation review of the PMD process and looked at a sample of 800 PMD holders out of a total of 14,400. This sample comprised 400 pilots who had previously had a medical status of 'unfit' or had a medical referred, and 400 who had no previous unfit or referred status. It found that 4% of the 800 pilots reviewed should not be self-declaring their medical status for various reasons. The CAA concluded that:

> *'If this percentage represents the whole number of PMD holders, the number made in error is of concern to the CAA. These errors included disqualifying heart conditions, neurological conditions and drug/alcohol misuse. It is not clear to us whether this is due to unclear guidance material or a misunderstanding on the pilot's part.'*

In parallel with this review, anticipating the UK's departure from EASA at the end of 2020, the CAA launched a consultation on opportunities for change for the UK's GA sector[11]. One of the initiatives identified was a review of the PMD process in order to '*enhance the end user experience and identify opportunities in the context of the simplification and rationalisation of GA flight crew licensing*'.

Consequently, the CAA launched a further public consultation in October 2022[12] to revisit the questions originally asked, prior to the launch of PMDs, to provide guidance for future development of the scheme and to establish whether any changes needed to be made.

Footnote

[11] Published as CAP 1985: *UK General Aviation opportunities after leaving EASA – a consultation,* CAA, November 2020.

[12] CAP 2408, *Consultation: Pilot Medical Declaration (PMD) review*, CAA, October 2022.

The DVLA

Guidance for medical professionals

The drivers' medical section within the DVLA deals with aspects of driver licensing when there are medical conditions that affect, or potentially affect, the safe control of motor vehicles. It provides a summary of medical guidelines in the publication, '*Assessing fitness to drive – a guide for medical professionals*'[13]. This is intended to assist doctors and other healthcare professionals in advising their patients whether the DVLA requires notification of a medical condition, and the potential licensing outcome from the notification.

In the publications section, *'Age-related fitness to drive',* the DVLA provides the following guidance:

> ***'Older age is not necessarily a barrier to driving.***
>
> - *Functional ability, not chronological age is important in assessments.*
> - *Multiple comorbidity should be recognised as becoming more likely with advancing age and considered when advising older drivers.*
> - *Discontinuation of driving should be given consideration when an older person – or people around them – become aware of any combination of these potential age-related examples:*
>   - *Progressive loss of memory, impaired concentration and reaction time, or loss of confidence that may not be possible to regain.*
>   - *Physical frailty in itself would not necessarily restrict licensing, but assessment needs careful consideration of any potential impact on road safety.*
> - *Age-related physical and mental changes vary greatly between individuals, though most will eventually affect driving.*
> - *Professional judgement must determine what is acceptable decline and what is irreversible and/or a hazardous deterioration in health that may affect driving. Such decisions may require specialist opinion'.*

When medical professionals are assessing a patient's fitness to drive, the DVLA advises that they should:

- *'advise the individual on the impact of their medical condition for safe driving ability.*
- *advise the individual on their legal requirement to notify DVLA of any relevant condition.*
- *notify DVLA directly of an individual's medical condition or fitness to drive, where they cannot or will not notify DVLA themselves.'*

Footnote

[13] Assessing fitness to drive: a guide for medical professionals - GOV.UK (www.gov.uk) [accessed February 2023].

This process provides the DVLA with a mechanism of enforcement should a patient choose not to notify the DVLA of a relevant condition that medical professionals have assessed will preclude them from driving.

The CAA does not produce similar guidance to assist medical professionals (other than AMEs) in understanding the effects of age or medical conditions on the ability to fly. Pilots are expected to interpret advice they receive from medical professionals in relation to driving and apply it to their private flying. The CAA informed the AAIB that '*pilots are responsible for ensuring they are up to date with any current requirements*', and that any changes to regulations or guidance are promulgated through SkyWise[14] alerts.

The DVLA reported to the AAIB that it had not been informed by the CAA that the CAA had adopted the medical standards for Group 1 driving licences and applied them to aviation. Consequently, there is no process for the DVLA to inform the CAA if it refuses or revokes a driving licence for medical reasons[15], or if a driver voluntarily surrenders their licence.

Driving licences and medical conditions

To understand how medical issues affect driver licensing, the AAIB consulted the DVLA to obtain data for the number of Group 1 licences that are refused, revoked or voluntarily surrendered for medical reasons each year. Data from 2020 to 2022 has been excluded since they are skewed due to the influence of Covid-19. The results are contained in Figures 4 to 6 and are grouped into two cohorts: drivers under 70 years of age and drivers of 70 years of age and older.

The total numbers of licences surrendered in each cohort indicates a measure of compliance with the medical standards for driving (Figure 4).

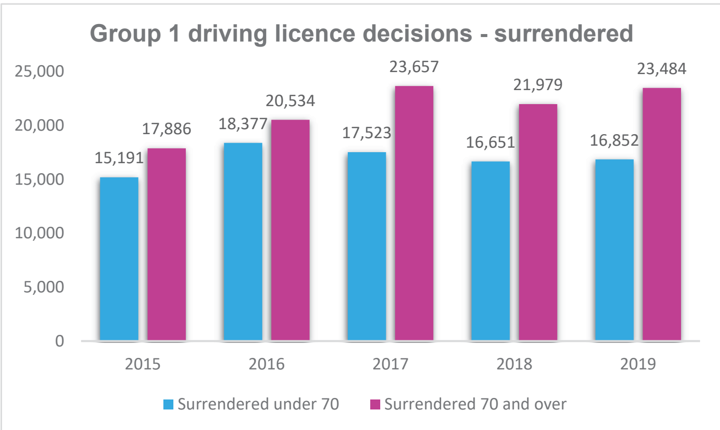


Figure 4

Driving licences surrendered

Footnote

14 SkyWise is a CAA website and application that provides news, notifications and alerts to the aviation sector.

15 An application for a driving licence can be refused where the applicant does not have a current driving entitlement, eg. first applications, renewals after expiry or application after revocation. A revocation occurs when a driver has a current driving entitlement removed by the DVLA.

The total numbers of licences refused and revoked (Figures 5 and 6) indicate a measure of intervention made by the DVLA to withhold or withdraw a driving entitlement from individuals who do not meet the medical standard to hold a Group 1 licence.

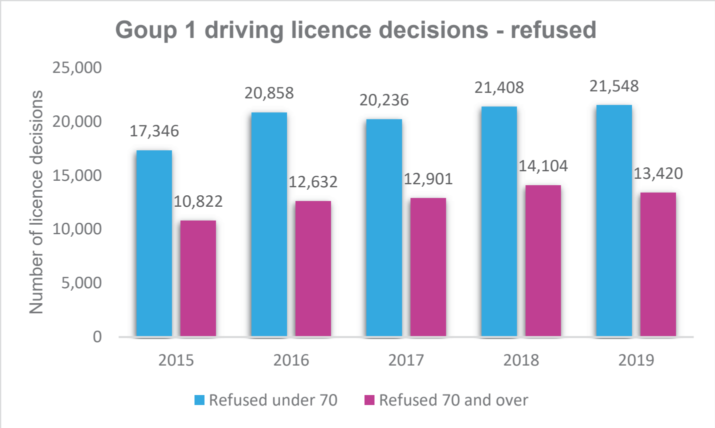


Figure 5
Driving licences refused

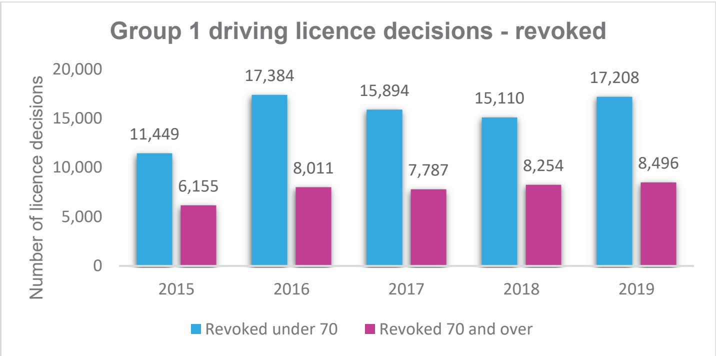


Figure 6
Drivers licences revoked

For the five years of data, the trend is for an increasing number of licenses to be refused, revoked, and surrendered in both age cohorts. Also of note is that the number of surrendered licences is broadly similar to the number of licences subject to enforcement action (revoked + refused).

Unlike the DVLA, the CAA does not revoke pilot licences for medical reasons. If an AME-assessed medical is revoked, or PMD voluntarily withdrawn, the flying licence remains in place, but its privileges should not be used until a valid medical certificate or PMD is regained.

Analysis

The accident flight

The investigation could not determine the nature of the "SLIGHT PROBLEM" the pilot initially reported to Cranwell ATC that caused him to decide to return to Temple Bruer. The pilot's response to an offer of assistance from ATC that "SOMETHING HASN'T FIRED UP AS IT SHOULD HAVE DONE" followed by "PROBLEM SOLVED", suggests that the issue was transitory and likely related to the pilot's portable computer that he may have been using to assist in navigating to Beccles. A member of the pilot's family informed the AAIB that the pilot had previously used the phrase when the navigation application he used had not worked as expected. There was no further reference to a technical issue in subsequent radio communications.

The route from Temple Bruer to Beccles was familiar to the pilot and the weather was fair. Evidence from recorded data and communications with the ground radio operator at Beccles showed that the pilot joined the circuit from the north-west, establishing himself downwind in a right-hand circuit for Runway 09, and then onto the final approach. Witnesses reported that G-CBDJ's approach at first appeared to be "unstable" in roll and pitch before settling to a more stable approach profile. The cause of this instability could not be determined, and no local turbulence was reported. It is possible that the pilot was trying to reduce the airspeed below 62 kt, which is the maximum speed for selecting flaps. The pilot had flown a total of 1,621 hours in G-CBDJ, 62 hours of which had been in the preceding 13 months. Of those, seven hours had been flown over six flights in March 2022. As such, he was in recent practice.

An aircraft can bounce on landing for many reasons; a hard landing or landing with excessive speed are two of the more common causes. In either scenario, the most effective response is to go around. Following the second touchdown on the nosewheel, witnesses reported seeing G-CBDJ apparently climbing away in an increasingly nose-up attitude, described as being up to 45°. However, no witness could recall the sound of the engine increasing rpm. Without the application of sufficient power to climb away, combined with a significant nose-up attitude and full flap, a stall was the likely outcome. The aircraft was not fitted with a stall warner and the MFD provided only a visual indication of airspeed. The witness marks on the left side of the nosewheel were indicative of the tyre being compressed against a hard surface, most probably during a bounce on landing. Post-accident examination of the wreckage did not reveal any pre-accident defects which would have affected either the landing phase, or a go-around by the pilot.

Pilots who had flown the aircraft informed the AAIB that the CT2K could be "tricky to land", and that pilots needed to be "on their game" if things did not go as planned. The accident pilot was familiar with his aircraft and in recent practice, but the landing diverged from his intended plan. Given that he was 87 years old and recognised that he would likely have to stop flying in the near future, it is possible that some age-related deterioration in human performance was a factor in this accident.

Medical

The pilot had a current medical declaration that was valid until 21 December 2024. The post mortem found no indication of medical impairment or incapacitation of the pilot before the aircraft struck the ground.

Pilot Medical Declaration scheme

The online PMD introduced in October 2016 adopted the DVLA medical standard for Group 1 driving licences as the standard for pilots of GA aircraft less than 2,000 kg MTOW. Under the scheme, there is no requirement to consult a GP or an AME, and the pilot does not have to hold a driving licence, only have a '*reasonable belief*' that they could. The CAA does not provide guidance on the DVLA's medical standard for Group 1 licences, nor does it provide a link to the DVLA's website which contains comprehensive advice to drivers. Pilots who intend to make a PMD must actively seek out information relevant to their personal medical history from DVLA sources and translate any guidance found to their private flying.

During a post-implementation review of the PMD process in October 2020, the CAA looked at a sample of 800 PMD holders out of a total of 14,400. It found that 4% of the 800 pilots reviewed should not be self-declaring their medical status for various reasons. The CAA concluded that if this percentage was applied to all PMD holders, the potential of 576 declarations being made in error would be '*of concern*'. Additionally, the CAA reported that it was not clear whether this was '*due to unclear guidance material or a misunderstanding on the pilot's part'.*

The CAA informed the AAIB that a review of the PMD scheme is underway. However, to clarify the medical standards required for pilots to make an online medical declaration, the following Safety Recommendation is made:

Safety Recommendation 2023-007

It is recommended that the UK Civil Aviation Authority provides comprehensive guidance for pilots on the medical factors that must be considered when making an online Pilot Medical Declaration.

The DVLA publishes a summary of medical guidelines intended to assist medical professionals in advising their patients whether the DVLA requires notification of a medical condition, and the potential licensing outcome from the notification. However, medical professionals may not be aware if their patients engage in private aviation and there is no requirement for pilots to declare this. The obligation to take medical advice received on fitness to drive and translate this to flying activity is placed solely on the pilot. Therefore, the following Safety Recommendation is made:

Safety Recommendation 2023-008

It is recommended that the UK Civil Aviation Authority provides guidance for medical professionals to promote awareness of the medical standards required by the Pilot Medical Declaration scheme.

The DVLA has established a process by which drivers, doctors and other healthcare professionals are provided with comprehensive guidance on the medical requirements to hold a driving licence. The DVLA also has a mechanism by which driving licences can be refused or revoked based on the medical history of the licence holder. The CAA does not revoke flying licences for medical reasons, but places an obligation on GA pilots to withdraw their PMD and cease flying if they have reason to believe they no longer meet the medical standard for a Group 1 driving licence. However, should a GA pilot misunderstand this requirement, or choose not to comply, there is no means by which these individuals are visible to the CAA and they might continue to fly.

Figure 7 shows the total number of driving licences that were subject to enforcement action (refused and revoked) for medical reasons by the DVLA for the years 2015 to 2019.

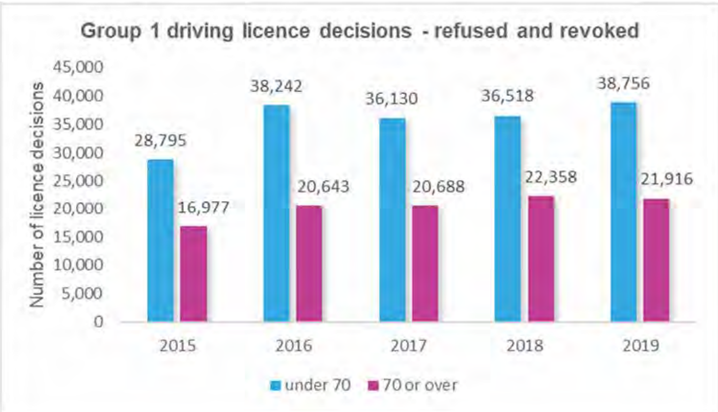


Figure 7

Driving licences refused plus revoked

The CAA informed the AAIB that it had not consulted with the DVLA prior to adopting driver medical standards for the PMD scheme. Nor had it established a formal record keeping system to collect annual data on pilots making PMDs to confirm the safety analysis assumptions. Collaboration with the DVLA prior to the publication of the original public consultation document in 2015 would likely have revealed to the CAA the scale of the DVLA medical-related licensing decisions and the benefits of a feedback process from healthcare professionals to assist the oversight of licences. Therefore, to augment the CAA's ongoing review of the PMD scheme, the following Safety Recommendation is made:

Safety Recommendation 2023-009

It is recommended that the UK Civil Aviation Authority engages with the UK Driver and Vehicle Licensing Agency to understand their process for managing medical related driving licence decisions, and ensure that the UK Civil Aviation Authority's process for managing the Pilot Medical Declaration scheme is as effective.

Pilot licence revalidation

The pilot held a UK PPL and revalidated his microlight class rating on 6 April 2021 by providing evidence of his flying experience gained in the previous 13 months. This method of revalidation is only available to pilots issued with the microlight rating prior to 1 February 2008. The AAIB was unable obtain details of the number of pilots who are eligible for this category of licence revalidation. However, whilst its size is unclear, this group certainly represents an ageing demographic that is potentially not being actively monitored. Most notably, this method of revalidation does not require a training flight to be conducted with an instructor.

Studies and literature reviewed during previous AAIB investigations suggest that there is no single reliable metric to predict age-related impairment in GA pilots. Guidance provided by the DVLA to medical professionals broadly reflects this finding in relation to driving and concludes that *'Professional judgement must determine what is acceptable decline and what is irreversible and/or a hazardous deterioration in health that may affect driving'.*

The parallel processes of flying licensing and medical certification should be expected to provide appropriate oversight of pilots. However, in this case, a self-declared medical that does not require input from a GP, combined with a method of licence revalidation that does not require a training flight with an instructor, exposes a missed opportunity for at least one independent professional assessment of age-related deterioration in piloting ability. Therefore, the following Safety Recommendation is made:

Safety Recommendation 2023-010

It is recommended that the UK Civil Aviation Authority assesses the continued appropriateness for holders of UK PPLs with microlight class ratings issued before 1 February 2008 to revalidate that rating solely by providing evidence of experience.

Conclusion

The aircraft bounced on landing and probably stalled. The pilot was fatally injured when the aircraft subsequently struck the ground.

The accident pilot was familiar with his aircraft and in recent practice, but the landing diverged from his intended plan. Although the post mortem found no indication of medical impairment or incapacitation, the pilot was 87 years old and had prior to the flight recognised that he would likely have to stop flying in the near future, it is possible that some age-related deterioration in human performance was a factor in this accident.

The investigation highlighted a lack of medical guidance for both pilots and medical professionals who use the Pilot Medical Declaration which is based on the DVLA medical standard for Group 1 driving licences. It also identified that pilots that have a UK PPL with a microlight rating issued prior to 1 February 2008 are not required to fly with an instructor for licence revalidation; such a flight would provide an opportunity for independent assessment of agerelated deterioration in piloting ability.

Four Safety Recommendations have been made to the CAA, three about the Pilot Medical Declaration and one about the revalidation of ratings for holders of licences with microlight ratings issued prior to 1 February 2008.

Published: 20 April 2023.

ACCIDENT

Aircraft Type and Registration:	Pegasus Quik, G-CGRR
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	2010 (Serial no: 8541)
Date & Time (UTC):	6 August 2022 at 1355 hrs
Location:	Harringe Court Farm, Ashford, Kent
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Serious) Passengers - N/A
Nature of Damage:	Minor damage to trike, wing damaged beyond repair
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	62 years
Commander's Flying Experience:	306 hours (of which 90 were on type) Last 90 days - 2 hours Last 28 days - 1 hour
Information Source:	AAIB Field Investigation

Synopsis

During the landing, the aircraft veered to the right and bounced before tipping over onto its right side. The cause of the accident could not be determined.

Although the pilot was wearing a lap strap, he was not wearing the shoulder strap provided. Consequently, he sustained serious facial injuries when his head made contact with the front strut.

History of the flight

The pilot arrived at Harringe Court Farm airstrip, where the aircraft was based, at about 1000 hrs on the day of the accident. He prepared the aircraft for a planned solo flight to two local airstrips, both of which he had flown to before. The weather in the morning was described as generally good, although there were reports of some thermal air currents coming off the hill on which the airstrip was positioned. The pilot reported he was used to such conditions and, whilst uncomfortable at low level, the thermal effects soon dissipated during the climb after takeoff.

The pilot had no recollection of the accident flight due to the injuries he received. It was, however, possible to get a record of his flying activities from information recovered from the aircraft's navigation unit and the pilot's mobile phone.

The pilot took off from Harringe Farm to the north at 1234 hrs. Data recovered from the aircraft and the pilot's phone, recorded that he conducted a local flight, landing at two other airstrips, before returning to Harringe Farm at 1345 hrs. A witness at Harringe Farm saw the aircraft carry out an apparently normal final approach to land in a northerly direction. The weather at the time was described as good, with just a light breeze. The witness reported that after touching down, the aircraft bounced to a height of about a metre before touching down again. On doing so, they described seeing the left rear wheel of the tricycle undercarriage slowly lift into the air. They expected to see it settle onto the ground again, but it continued to rise until the aircraft's right-wing tip caught the ground, bringing the aircraft abruptly to a halt on its right side.

Members of the public seeing the accident came quickly to assist the pilot, who had been seriously injured. The emergency services were called and the pilot was transferred to hospital by air ambulance.

Accident site

The airstrip, orientated 010° / 190°, was on farmland at the top of a small hill. The accident occurred approximately halfway along the landing strip and a few metres beyond the western edge. Although there was only minor damage to the trike, the wing had suffered significant damage to the keel, cross spar and front section of the leading-edge structure which had folded under the wing. The nose of the wing had also swivelled clockwise and was pointing to the right of the aircraft.

The pilot's helmet and damaged headset were located next to the trike; the visor was located 20 m away from the right side of the aircraft. The compass was found next to the cockpit and had detached from its mounted position on the front strut. Although the front seat lap strap buckle had been released, there were no anomalies found with the operation of the buckle or the strap. The front seat shoulder strap had been rolled up and secured with a plastic tie-wrap close to the pylon behind the rear seat. Two avionic units were mounted on the top of the cockpit coaming directly in front of the pilot (Figure 1).

Aircraft examination

Examination of the engine controls and brake systems did not show any faults or anomalies. The front strut was intact with most of the aircraft damage occurring to the wing and the A-frame, with the right upright and its top knuckle having failed in overload. All the damage to the aircraft was consistent with it rolling onto its side.

There was evidence of blood inside the nylon sleeve that covered the front strut and on the lower section of the right upright.

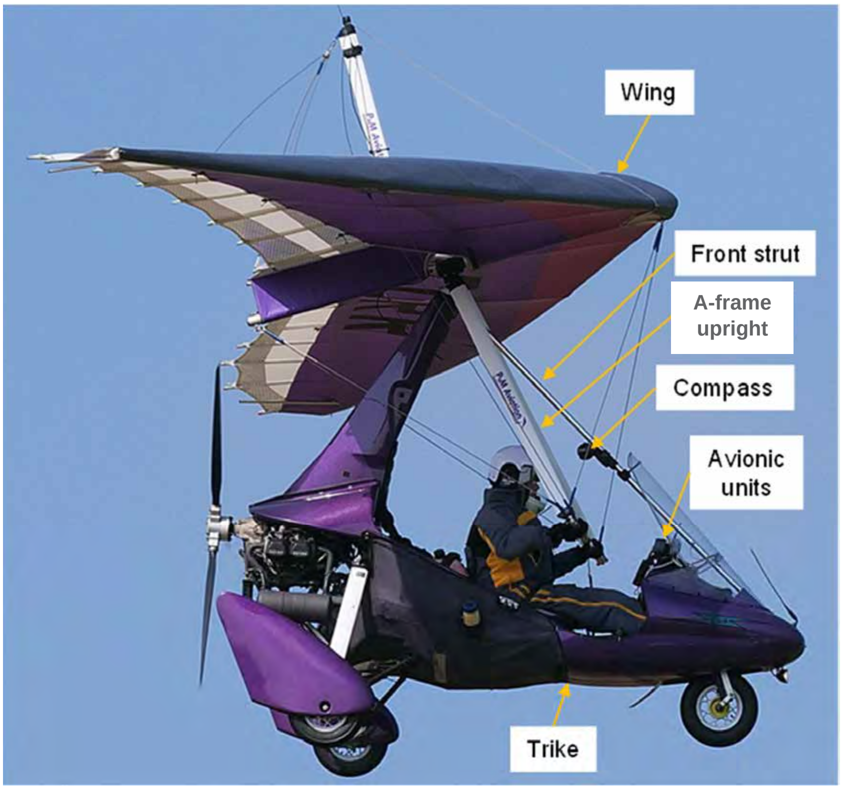


Figure 1

G-CGRR pictured in flight showing significant features
(Image used with permission)

Survivability

Seat harnesses

The rear seat was fitted with a four-point harness and the front seat with a three-point harness. The front seat harness consisted of a lap strap and a shoulder strap, although the pilot stated that he had never used the shoulder strap on this, or any of the other three microlight types he had flown. The pilot reported that when he bought G-CGRR the front seat shoulder strap was rolled up and secured with a plastic tie wrap; he had not changed this arrangement. He commented that the shoulder strap was not particularly long which normally resulted in a relatively tight fit, making it difficult to use.

Issue 6 of the Quik Pilot's Operating Manual states that the seat harnesses should be worn at all times and warns that *'Failure to put on safety harness and wear front seat or rear seat shoulder straps could be the cause of injury or death in the event of an accident'.*

Safety helmet

The pilot wore an open-faced airborne sports helmet[1] fitted with a transparent visor. The helmet which had been removed during the pilot's rescue had some minor scratches and dirt

Footnote

[1] British Standards Institute BS EN 966:1996 categorises this helmet as a *'Helmet for airborne sports'.*

on its right side. The visor had been badly damaged with multiple scrape marks and a wide vertical line scored from top to bottom to the left of the visor's centre line. The distortion of the visor along the vertical line matched the profile of the front strut. The horizontal curved profile of the visor had bent inwards along this vertical line (Figure 2). A large piece of the visor had broken away from the upper left quarter.

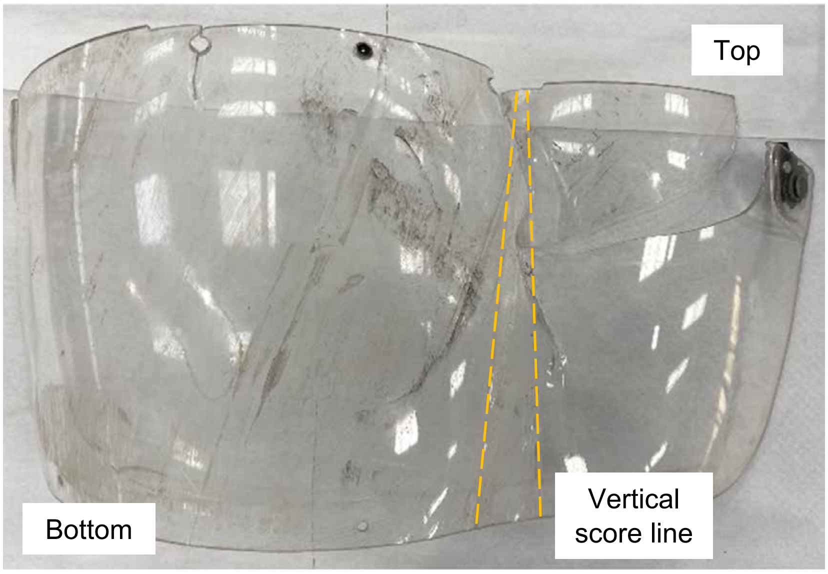


Figure 2
Damaged helmet visor

Analysis

The cause of the accident could not be determined.

No faults with the aircraft were found during the examination. The damage to the propeller blades indicated that the engine was running at a low speed. The minor damage to the trike showed that most of the impact forces were absorbed by the wing.

Although the possibility of the visor being damaged as a result of contact with the right A-frame upright was considered, the curved profile of the vertical line could only have been formed by impact between the visor and the front strut. As the pilot had not worn the shoulder strap, his upper torso would not have been restrained during the impact and the visor on his helmet would only have provided limited protection to his face. It is probable that both these facts resulted in the pilot sustaining serious facial injuries during the impact.

Conclusion

During the landing the aircraft tipped over onto its side. The pilot, who was not wearing the shoulder strap provided, sustained serious facial injuries when his head struck the front strut and the right upright during the accident sequence.

Published: 3 May 2023.

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.

SERIOUS INCIDENT

Aircraft Type and Registration:	ATR 72-211, G-CLNK
No & Type of Engines:	2 Pratt & Whitney Canada PW121 turboprop engines
Year of Manufacture:	1989 (Serial no: 147)
Date & Time (UTC):	25 October 2022 at 2030 hrs
Location:	East Midlands Airport
Type of Flight:	Cargo
Persons on Board:	Crew - 3 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to nosewheel tyre
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	61 years
Commander's Flying Experience:	11,011 hours (of which 63 hours were on type) Last 90 days - 63 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

After landing in a light crosswind, as the aircraft decelerated through 80 kt, it swerved right and hit a runway edge light, damaging the nosewheel tyre. The operator has taken action to address aircraft handling during the ground roll in crosswinds.

History of the flight

G-CLNK was operating from Jersey Airport to East Midlands Airport and made a radar vectored autopilot coupled approach to Runway 09. During the approach, the reported wind at the airport obtained by the pilots was from 150° at 10 kt. The commander was PF. He stabilised the approach by 1,000 ft and then established the aircraft with a slight crab into wind and power set at 25% torque. In the latter stages of the approach the commander disconnected the autopilot, removed the small amount of crab in the flare and touched down aligned with the runway. Once all wheels were on the runway, he selected ground idle and, as the aircraft continued to decelerate along the runway, it began to swerve to the right. He handed control to the co-pilot and applied left nosewheel tiller to straighten the aircraft. The commander noticed that the right wing lifted, which he ascribed to the turn to the right in combination with the crosswind from the right. The commander then applied more tiller input to the left, aided by the application of left pedal and differential left brake input by the co-pilot, to which the aircraft slowly began to respond.

During the landing roll the commander reported seeing an object on the runway ahead and to the left. Review of the CCTV subsequently showed a 'spark' under the aircraft during the landing roll.

The METAR for the airport valid at the time of landing reported wind from 140° at 12 kt.

The commander reported the excursion to ATC, and a runway inspection was carried out which reported a broken edge light. An engineering inspection found damage to the tyre of the nosewheel, which was replaced.

Personnel

The commander was experienced and who had recently completed his type conversion on to the ATR 72 after previously flying the BAe ATP. The co-pilot had also recently converted to the ATR 72.

The commander reported that, during his line training, he experienced little exposure to crosswinds greater than 10 kt but, since then, had experienced significant crosswinds with no control issues during landing. He also stated that he would routinely use the tiller on the BAe ATP during the landing roll at 80 kt and below to maintain aircraft direction, in part owing to his experience of asymmetrical braking action on the aircraft.

Manufacturer information

In 2014, the manufacturer published a safety note[1], which outlined the crosswind landing technique. In 2016, it issued a Flight Operations Information Notice[2] for the ATR 42 and 72. Both these publications provided guidance and recommendations on '*aircraft handling during the landing roll and deceleration'*, noting that *'insufficient aileron input, crosswind will lift the upwind wing and make the aircraft turn'.* In 2018, the manufacturer presented their analysis of 18 events over a 5-year period between 2013 and 2017 which shared a number of common characteristics.

The ATR Flight Safety website[3] summarises the guidance and recommendations for aircraft handling during the landing roll and deceleration as follows:

- *'Review and brief crosswind landing technique for the decrab, flare and landing roll, prior to the approach (TEM);*
- *After touchdown, hold the control column nose down to increase directional efficiency;*
- *Maintain aileron input into the wind. Gradually increase it as airspeed decreases;*

Footnote

1 ATR, 2014, Safety Note #1 *'Be Prepared for Crosswind landing'.*
2 ATR, FOIM 2016/06 Issue 1 *'Crosswind landing', dated June 7, 2016.*
3 https://safety.atr-aircraft.com/my-product/prevent-runway-excursion-in-crosswind/#1574785943767-6e2e8ed0-5ba6 [accessed January 2023].

- *Correct heading deviation smoothly, using the rudder above 70 kt and progressively the tiller below 70 kt;*
- *Rudder correction upwind shall be very smooth and progressive. Most of the time, gently reducing/adjusting the rudder input downwind is enough to correct heading deviation downwind;*
- *Use brake to minimize landing roll.'*

It provides further guidance on the use of rudder stating:

> *'…correction in upwind direction requires less effort than in* [the] *downwind direction. An equal effort will have a stronger effect upwind. Just releasing the downwind input without applying a force in upwind direction will lead to a rudder deflection in upwind side – allowing heading corrections only through downwind pedal movements.'*

Operator information

Operator's investigation

Flight data showed that the aircraft swerved abruptly to the right through 10º as it decelerated through 80 kt. There was '*little to no aileron input into wind…during the ground roll*' and no application of rudder during the turn right. However, *'as the aircraft reaches the 100º track, there is a sharp input of both rudder and brake which sharply changes the aircraft direction back to the runway centreline'.*

The operator concluded that a *'lack of in-to-wind aileron was the most likely cause of the divergent path of the aircraft'* and that the crosswind '*induced a weather-vane effect that induced roll and also initiated the uncommanded turn on the landing roll-out'.* It also concluded that recovery occurred as a result of the co-pilot's application of left pedal and brake, and not through the use of nosewheel steering. It further considered that the lack of application of in-to-wind aileron may have been because the PF did not perceive the need for its application in the light crosswind, where he would have in stronger crosswinds.

Operator training and guidance

The operator identified aircraft handling during the landing roll with a crosswind as a key threat. Since it used a third-party training organisation for the type rating training of its pilots on the ATR 72, it arranged that its own instructors would deliver the final simulator session of the type rating course and additional simulator training would be conducted by its own instructors on completion of the type rating course. In addition, it arranged that its own instructors would deliver the final simulator session of the type rating course, as well as the proficiency checks and skills tests in the simulator. This enabled the operator to deliver its own instruction on the areas of aircraft handling, which included crosswind landings.

The operator's documentation advised that the '*Weathercock effect makes the aircraft turn into the wind direction*'. It recommended to use of rudder to maintain directional control, holding '*the control column in nose down position to increase directional efficiency*.' It also cautioned '*In case of insufficient aileron input, crosswind gusts could lift the upwind wing, reduce the aircraft ground contact and could make the aircraft turn into the wind (weathercock effect).*' The guidance advised the use of nosewheel steering below 70 kt for directional control.

The part B of the operator's Operations Manual stated:

> *'During the landing rollout, maintain wings level using aileron into wind, and rudder steering; at a suitable speed below 70 kts Captain resumes control (if he had been PM) of tiller and PLs* [prop levers]*, or passes yoke control to co-pilot.'*

Analysis

There was probably insufficient in-to-wind aileron applied during the landing roll both before and after the handover of control, which resulted in the upwind wing lifting and the aircraft turning into wind. The initial attempt to correct the turn by nosewheel steering through the use of the tiller, rather than by use of rudder to maintain directional control also likely contributed to the runway excursion.

The PF applied insufficient in-to-wind aileron and may not have recognised the need in the light crosswind, having 63 hours on type and limited experience flying it in similar conditions. The use of the tiller was probably a reversion to the technique that the commander had used on the previous type that he had flown. The manufacturer's guidance indicates that the use of rudder above 70 kt, instead of the tiller, would have resulted in better directional control.

Conclusion

After landing in a light crosswind, as the aircraft decelerated through 80 kt, it swerved right and hit a runway edge light. The loss of directional control probably occurred because of insufficient in-to-wind aileron. The recovery of directional control was delayed by the use of nosewheel steering through the tiller, rather than the use of rudder.

Safety actions

The operator took the following actions:

- The crew underwent further training in the simulator on the aircraft handling technique in crosswinds during landing.
- The syllabus for the operator conversion course is being rewritten to maximise crew exposure to crosswinds.
- The operator advised all involved in training on the ATR 72 to be alert to and monitor for incorrect crosswind techniques or inappropriate use of nosewheel steering through the tiller.

ACCIDENT

Aircraft Type and Registration:	1) Boeing 777-300(ER), HL-7782 2) Boeing 757-256, TF-FIK
No & Type of Engines:	1) 2 GE Aviation GE90 turbofan engines 2) 2 Rolls Royce RB211 turbofan engines
Year of Manufacture:	1) 2009 (Serial no: 37643) 2) 1999 (Serial no: 26254)
Date & Time (UTC):	28 September 2022 at 1850 hrs
Location:	London Heathrow Airport
Type of Flight:	1) Commercial Air Transport (Passenger) 2) Commercial Air Transport (Passenger)
Persons on Board:	1) Crew - 18 Passengers - 199 2) Crew - 6 Passengers - Unknown
Injuries:	1) Crew - None Passengers - None 2) Crew - None Passengers - None
Nature of Damage:	1) Left wingtip damage 2) Damage to the rudder
Commander's Licence:	1) Airline Transport Pilot's Licence 2) Airline Transport Pilot's Licence
Commander's Age:	1) 52 years 2) 55 years
Commander's Flying Experience:	1) 10,561 hours (of which 3,384 were on type) Last 90 days – 249 hours Last 28 days – 73 hours 2) 15,500 hours (of which 12,500 were on type) Last 90 days – 160 hours Last 28 days – 50 hours
Information Source:	Aircraft Accident Report Forms submitted by both commanders and further enquiries by the AAIB

Synopsis

Whilst taxing for takeoff the wingtip of a Boeing 777-300 collided with the rudder of a Boeing 757 which was not fully parked on its stand. The commander of the B757 turned onto the stand centreline without stand guidance and did not inform the ATC ground controller that they were not fully parked, contrary to Heathrow Aeronautical Information Publication (AIP) instructions. The commander of the B777 taxied past the protruding B757 believing it to be fully parked and that the ATC clearance and green taxiway lights implied the route was clear. Previous similar incidents have occurred at Heathrow.

History of the flight

A Boeing 757 landed at 1843 hrs on Runway 27L at London Heathrow and taxied to parking Stand 241 at Terminal 2B. It was dark but visibility was good. As the commander turned the aircraft onto the stand centreline he saw that the stand visual docking guidance system (VDGS) was not on and, at 1848:05 hrs, stopped the aircraft approximately 20 m from the final parking position. The co-pilot called the ground handling agent on the radio and asked when the VDGS would be activated. The handling agent replied that marshallers were aware of their arrival and would be there "very shortly". Several ground staff were waiting on the stand but they were not qualified to activate the guidance system. As the flight crew expected the guidance to be activated imminently and had informed the handling agent, they did not inform the ATC ground controller that they were not fully parked.

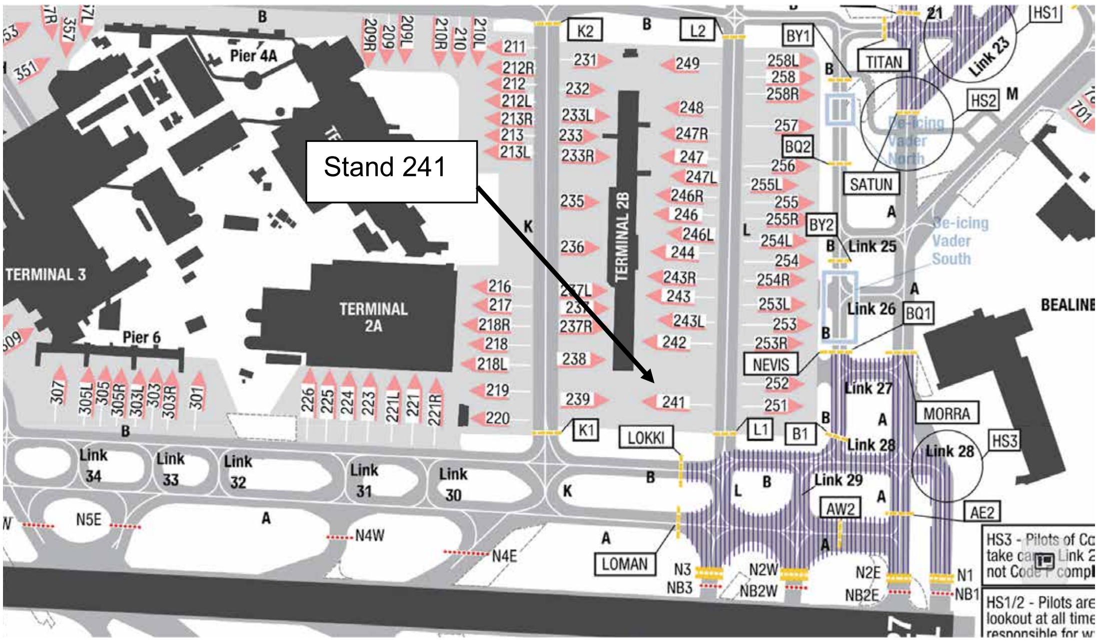


Figure 1

Heathrow Airport Ground Map

Concurrently a Boeing 777-300 was taxiing from Terminal 4 for takeoff on Runway 27R. It crossed Runway 27L and was cleared to "FOLLOW THE GREEN LIGHTS AND HOLD AT TITAN" which routed the aircraft along Taxiway Alpha then north on Taxiway Lima. As it made the left turn from Alpha to Lima the co-pilot saw the B757 on Stand 241 and told the commander it looked like it was protruding from the stand. The commander looked at the B757 but could not see an anti-collision light, so thought it was fully parked. He thought it was "quite close" but as ATC had not mentioned a conflict, he felt it was safe to taxi past. He reduced speed slightly and moved slightly right of the taxiway centreline, and continued to taxi north on Lima.

At 1853:56 hrs, as the B777 taxied past, the B757 crew felt a sudden jolt. They had been stationary for nearly six minutes. The B757 co-pilot looked out of his window and saw the B777 taxiing past, and the B757 pilots realised there had been a collision. The commander called the cabin crew at the back of the aircraft to check if they were okay. The crew confirmed they had felt the jolt but they were fine and no one had been injured. The commander then informed ATC that they thought there had been a collision.

The B777 crew had not felt the collision and continued north on Lima. As they approached the northern end of Taxiway Lima, ATC instructed them to hold position and informed them of the potential collision. At the same time a passenger on the B777 told the cabin crew that they had seen the wingtip hit the other aircraft. The cabin crew passed the message to the flight crew at about the same time as ATC instructed them to stop.

Just prior to the collision, an airport operator leader vehicle had arrived on Stand 241 to marshal the aircraft. The driver saw the B777 pass behind but did not realise there had been a collision. He switched on the guidance system at about the same time as the collision occurred. After the B757 commander confirmed the crew were okay he taxied the aircraft forward to the final parking position.

ATC initiated the ground incident procedure and both aircraft were inspected. The inspection confirmed there was damage to the left wingtip of the B777 and to the rudder of the B757. The B777 was shut down on the taxiway and passengers were disembarked to busses and into the terminal. The B757 passengers disembarked normally.

Figures 2 and 3 show the damage to the B777 left wingtip. Figure 4 shows the damage to the B757 rudder.

Heathrow ground handling

On the day of the accident one of the tunnels used to access the central area at Heathrow was closed for several hours. During the closure a contraflow was in operation within the other tunnel. The ground handling agent reported that this caused several of their staff to be delayed getting to work. As the B757 approached Heathrow, due to these staff shortages the ground handling agent realised they would not have a dispatcher available to meet the aircraft and activate the stand guidance. The handling agent reported that it had a prior agreement with the airport operator that, in these circumstances, they would ask the airport operator to send a marshaller to the stand. The handling agent made the request to the airport operator when the B757 entered the Heathrow Terminal Manoeuvring Area, and the airport operator agreed to send a marshaller when able. The airport operator assigned the task to one of its leader vehicle drivers, and he proceeded to the stand as soon as he had finished his previous task, arriving just prior to the collision.

The airport operator reported that it did not have an agreement with any handling agent to provide marshallers in the event of staff shortages. It would only expect to provide a marshaller in the event of a failure of the guidance system as specified in the UK AIP entry for Heathrow. The airport operator also confirmed that other access points were available to staff so the tunnel closure should not have caused any staff to be delayed.

Figure 2
Boeing 777 left wing tip

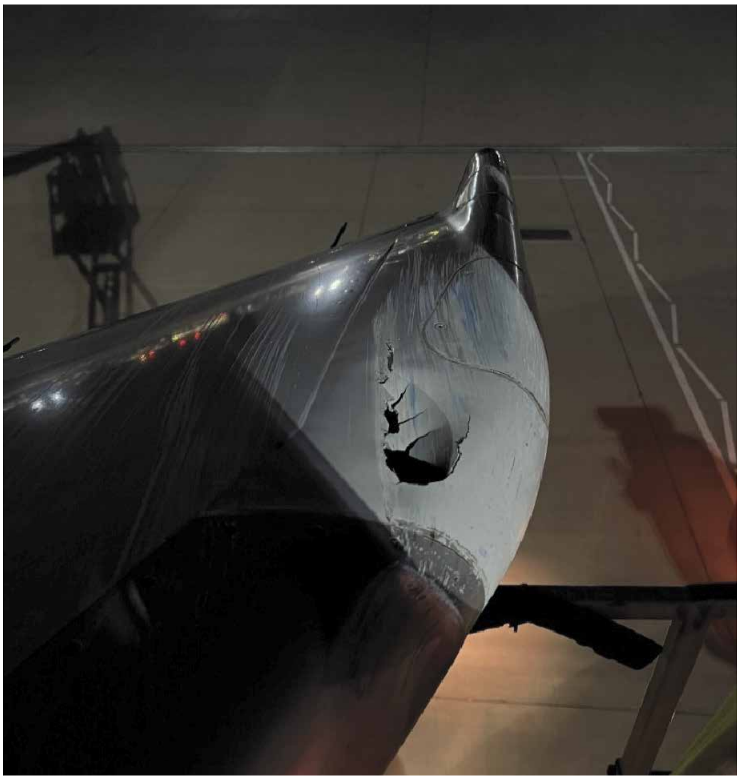


Figure 3
Boeing 777 left wing tip from above

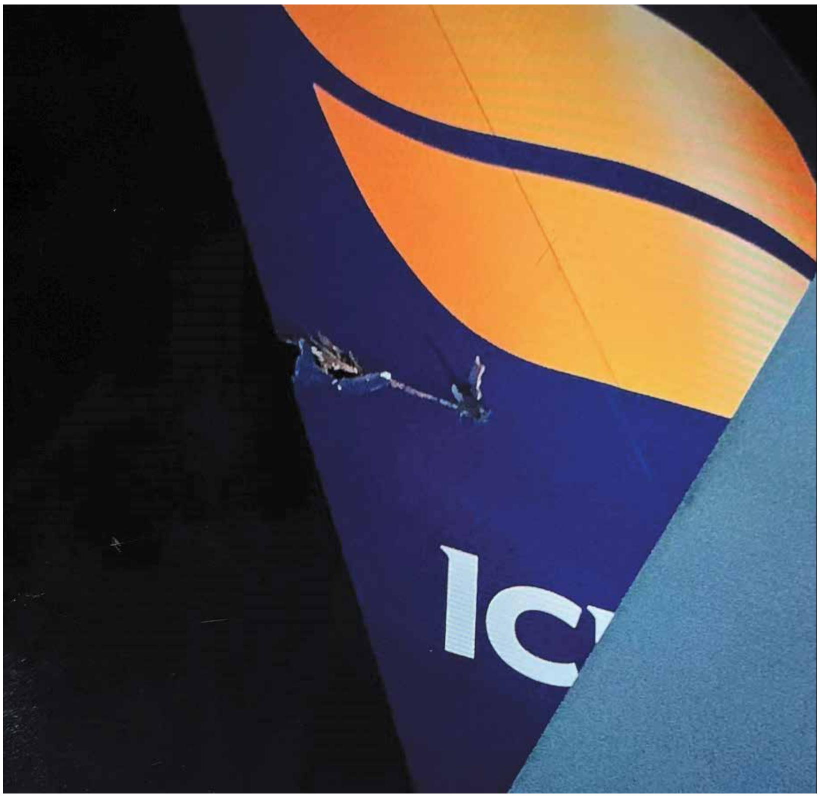


Figure 4
Boeing 757 rudder

Recorded information

The CVR and FDR were recovered from both aircraft. The FDR from both aircraft had data from the accident and the CVR from the B757 had a recording of the accident, but by the time the power was isolated from the CVR of the B777 the incident had been overwritten. The available recordings were used to confirm the history of flight.

Aerodrome CCTV and footage was obtained from the leader vehicle dashcams. This confirmed the B757 anti-collision light was on and working normally when the accident occurred. Figure 5 was created by the airport operator and shows the approximate position of each aircraft when the collision occurred.

Figure 6 shows radio transmission on the ATC ground frequency from the time the B757 stopped short of the stand to the time of the collision. Shortly after they stopped there were several periods of between 5 – 7 seconds when there was no transmission. The longest gap during the 6 minutes was 18 seconds.

A review of the CVR from the B757 during the time the aircraft was stationary on stand did not reveal any attempt to contact the ATC ground frequency or any discussion about contacting them until after the collision.

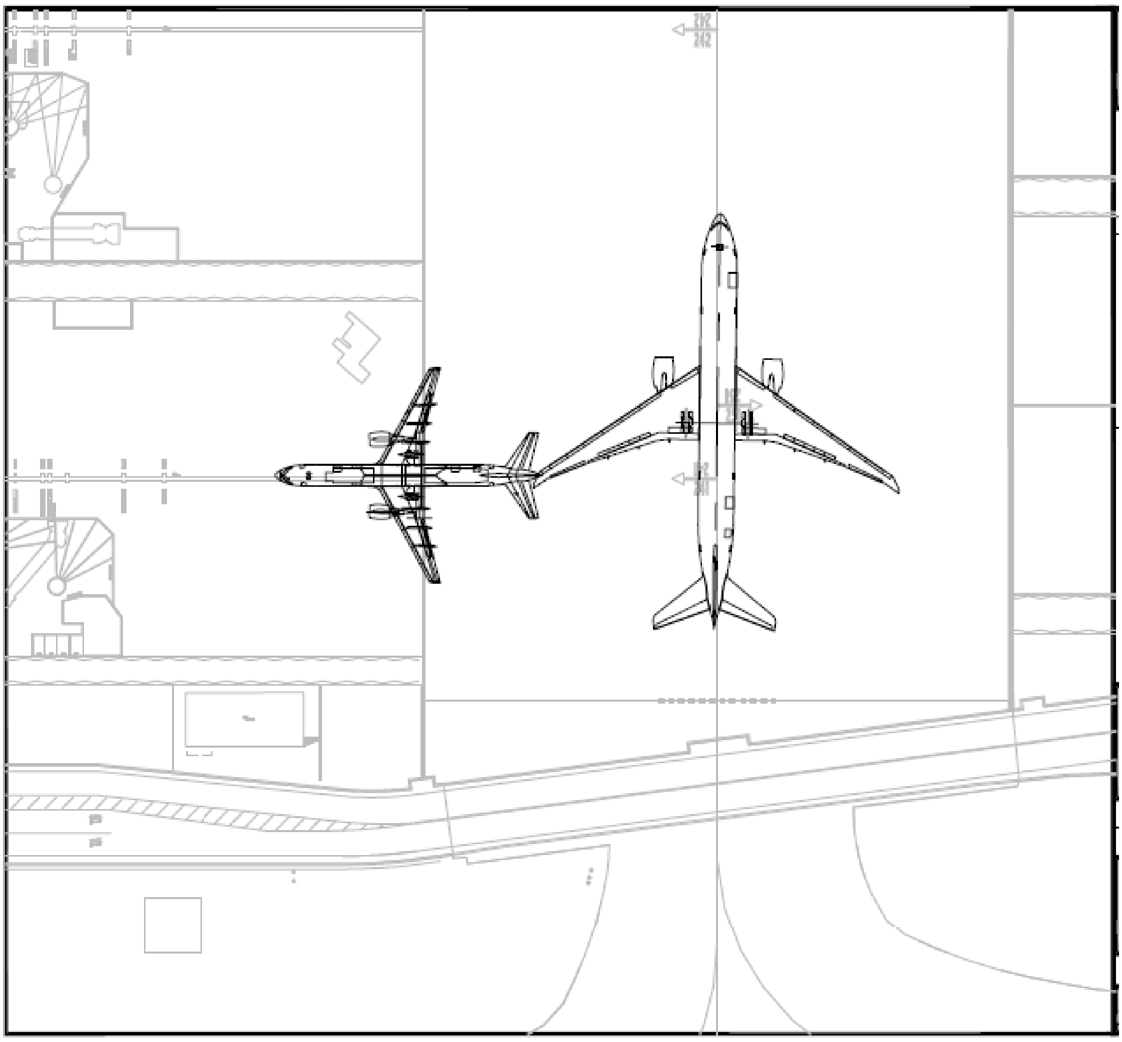


Figure 5

Approximate positions of the B777 and B757 when the collision occurred
(image used with permission)

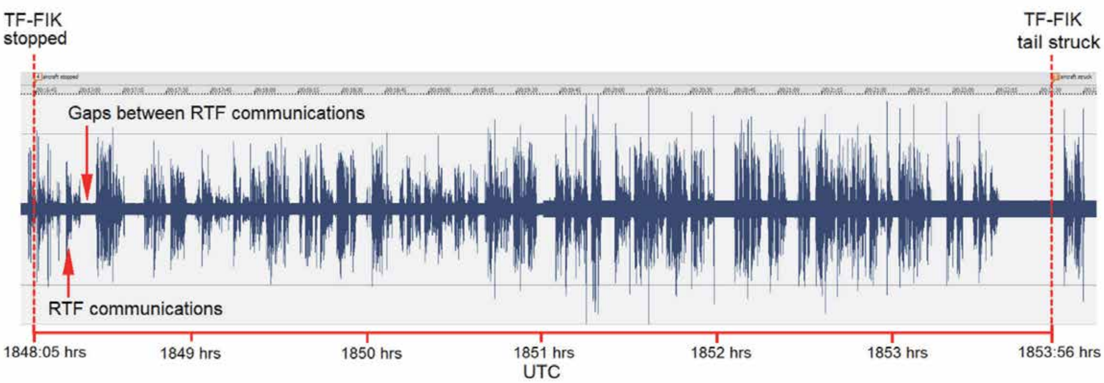


Figure 6

Analysis of the ground frequency whilst the B757 was stationary on Stand 241

Aerodrome information

Taxiway Lima is a 'code F' taxiway, suitable for a Boeing 777-300. Parking stands are delineated by a double white line. If parked aircraft are positioned within the white lines, an aircraft taxing on the centreline will have sufficient wingtip clearance.

The UK AIP entry for Heathrow contains the guidance shown in Figure 7. The AIP entry is several pages long and describes many procedures for Heathrow, of which this is a small part. It describes the procedure flight crew should follow if the stand guidance is not active when approaching the stand or if it fails whilst parking. Holding position on the centreline has the advantage that the aircraft overtly blocks the taxiway, reducing the chance of a collision, and permitting the aircraft to continue to taxi if required and with permission.

Flight crew must not attempt to self-park if the VDGS is not activated or calibrated for their aircraft type.
In the event of there being no activated VDGS displayed upon approach to the stand flight crew should:

- *Hold position on the taxiway centre-line.*
- *Inform Ground Movement Control (GMC) they are awaiting stand entry guidance.*
- *Contact company to arrange activation.*

Note, GMC may request aircraft to 'report parked' – this is not an instruction to self-park.

In the event of a failure of the VDGS during parking, flight crew should

- *Inform Ground Movement Control (GMC) of a stand guidance failure.*
- *Contact company to arrange a marshaller.*

Figure 7
Text from the UK AIP entry for Heathrow Airport

Stand 241 cannot be seen from the ATC visual control tower as it is obscured by a hotel and the terminal buildings. The view from the ground controller's position in use at the time is shown in Figure 8. Figure 9 shows an image from the ATC ground movement radar as the B777 taxied past Stand 241. A small primary radar return can be seen at the back of the stand and is likely to be the B757 protruding from the stand. Primary radar returns are masked once the aircraft is on stand. An aircraft normally shows a secondary radar return until its transponder is switched off. Whilst taxiing, a label giving the aircraft's callsign (and parking stand for inbound aircraft) is displayed alongside the secondary return. These labels are suppressed when the aircraft is on stand. With the B757 not fully parked it would normally show as a hollow diamond until the transponder is switched off. However, as shown in Figure 9, no diamond was displayed for this aircraft. It was not determined why the diamond was not displayed. ATC reported that the controller would not normally respond to the small primary returns as they are common across the airport. Similarly, even if the hollow diamond had been displayed, it is unlikely to have suggested anything abnormal to the controllers as these are often displayed on stands (as can be seen on several other stands in Figure 9).

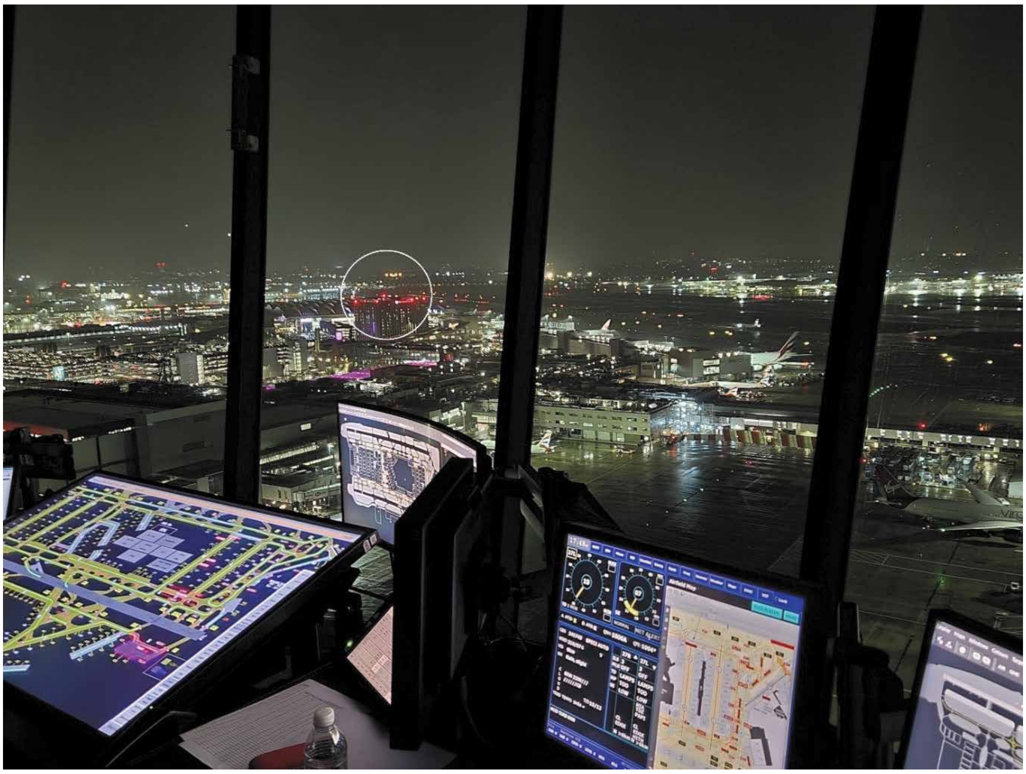


Figure 8

View from the ATC ground controller position (location of Stand 241 circled)

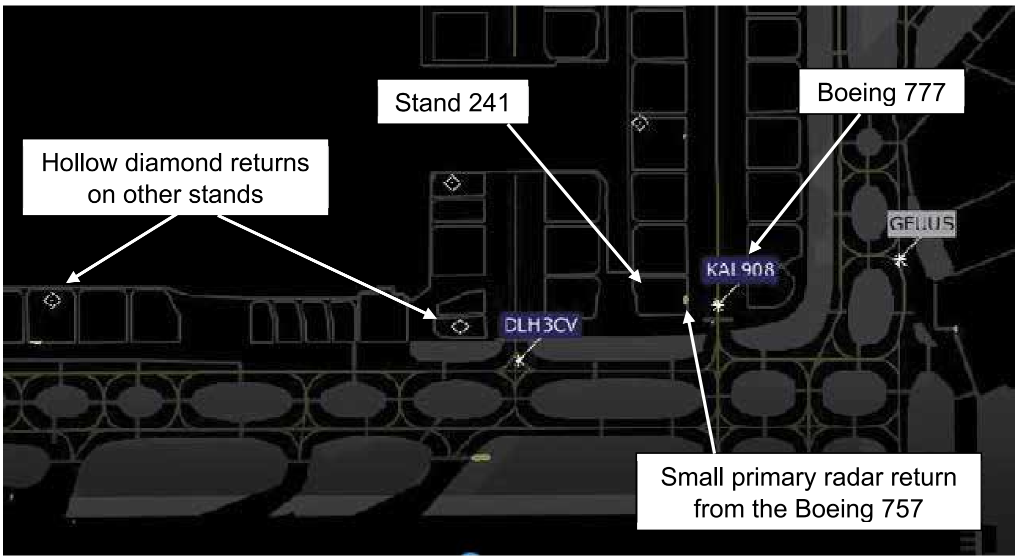


Figure 9

Extract for the ground movement radar as the B777 passed Stand 241

Flight crew

Flight crew experience and recency is shown below.

	Boeing 777-300		Boeing 757-256	
	Commander	Co-pilot	Commander	Co-pilot
Total time (hours)	10,561	3,478	15,500	2,907
Time on type (hours)	3,384	2,735	12,500	2,321
Last 90 days (hours)	248	176	116	194
Last 28 days (hours)	73	56	50	59
Start of duty	1835 hrs		1430 hrs	

Table 1

Flight crew hours and recency

The B777 crew reported that they were well rested and did not consider fatigue was a factor in the accident. They reported they departed stand on time and were not under any abnormal time pressure.

The commander of the B757 reported that he had read the AIP entry regarding stand guidance in the past. However, his normal practice was to initiate the turn onto the stand before looking to see if the guidance was activated rather than looking sideways for guidance whilst still on the centreline. He stated that, in his experience, the guidance was often switched on as the aircraft turns onto the stand and that starting the turn had never been a problem; nor had he heard of it being a problem for other pilots. He reported that he did consider informing ATC that they were not fully parked, but the ground frequency was too congested and it was not possible for them to make a radio call.

Previous incident

A similar event occurred six weeks before this event, on 16 August 2022. A Boeing 787-900 was parking on Stand 244 when the stand guidance system failed. The aircraft stopped short of the final position to await a marshaller. As the marshaller arrived and starting to marshal the aircraft, a Boeing 787-800 was taxing south along Taxiway Lima. The right wingtip of the Boeing 787-800 collided with the tail of the Boeing 787-900. Initially no one realised a collision had occurred and the Boeing 787-800 took off without the flight crew knowing the aircraft was damaged. Figure 10 shows the damage to the Boeing 787-800, discovered after landing.

The Boeing 787-900 crew did not report to ATC that they were not fully parked. That incident was not investigated by the AAIB.

Following this event, the Heathrow Air Navigation Service Provider (ANSP) issued a Safety Alert to remind operators about the AIP entry regarding VDGS. The Safety Alert was highlighted at the Heathrow Flight Operations Safety Committee and in several other forums.

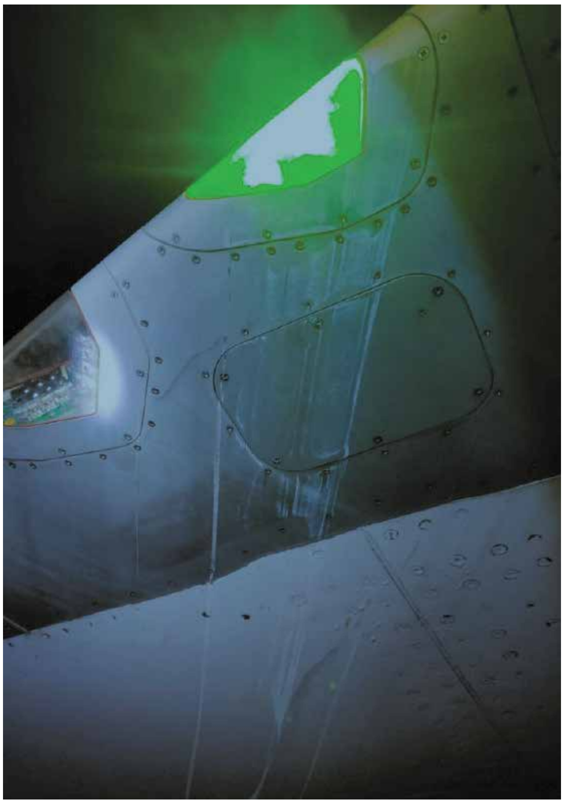


Figure 10
Damage to a Boeing 787-800 after a similar collision

The AAIB has investigated previous ground collisions at Heathrow. On 15 October 2007 a collision occurred between and Airbus A340 (4R-ADC) and a Boeing 747 (G-BNLL) and on 23 March 2004 a collision occurred between an Airbus A321 (EI-CPE) and a Boeing 747 (G-BNLK). Both events occurred near the runway holding points. The reports highlighted that pilots and tug drivers often perceive an ATC taxi clearance to imply the route is clear of obstructions. Controllers will alert crews if they know of a conflict but cannot do so if they don't. AAIB Safety Recommendations were made to enhance the guidance available to ensure pilots and tug drivers are aware that conflicts may exist whilst taxiing, and that pilots and tug drivers remain responsible for ensuring safe separation. The Safety Recommendations were accepted.

Organisational information

The sequence of events that led to this accident began with the VDGS not being switched on when the aircraft arrived at the stand. During the period between 1842 hrs and 1858 hrs reviewed as part of this investigation five other aircraft reported being unable to park because there was no stand guidance. However, as these were reported to ATC, in accordance with the AIP, no other incidents occurred. Heathrow ATC and the airport operator reported that lack of stand guidance is currently a persistent problem.

Analysis

The collision occurred when a Boeing 757 was waiting to park on stand and a Boeing 777 attempted to taxi behind it. The B777 pilots saw the B757 protruding from the stand but considered it was safe to continue taxiing because ATC had cleared them to do so, and because they had green taxiway lights ahead. They also reported that the anti-collision light on the B757 appeared to them to be off, suggesting it was fully parked. CCTV evidence showed the anti-collision light was on.

Heathrow ATC cannot see this parking stand from the visual control tower, and ground radar did not show the B757 once it had turned onto stand, so ATC had no way to know the aircraft was not fully parked. The AAIB has previously reported on ground collisions where pilots thought they had safe separation because they had an ATC clearance. ATC try to inform pilots if they become aware of a hazard, but they can only do this if they know about the hazard. Whilst it remains the pilot's responsibility to ensure sufficient wing tip clearance exists, it is not possible to see the wingtips of a B777-300 from the flight deck, as they are 32.4 m outbound and approximately 47 m behind the flight deck. Parking stands are delineated with a double white line, and if anything is protruding beyond these lines wing tip clearance cannot be assured. A significant proportion of the B757 was over the lines and protruding into the taxiway as illustrated in Figure 5.

When the B757 approached the parking stand the guidance system was not switched on. In these circumstances the LHR AIP entry instructs pilots to remain on the taxiway centreline and inform ATC. However, the B757 commander reported he normally initiated the turn before checking for guidance and was not aware that this could cause a problem. He reported that they did not inform the ATC ground controller due to congestion on the ground frequency but there was no discussion between the pilots on the CVR about contacting the ATC ground controller until after the collision and analysis of the ground frequency recordings suggested sufficient gaps existed to make a call. The rule to stop on the centreline and inform ATC is the primary barrier to prevent this type of accident. However, there are different rules and procedures in airports around the world and it can be challenging for pilots to read all the guidance and remember all the rules at each airport. The stand guidance rule at Heathrow is a few lines within many pages of text so is not especially prominent.

A similar incident occurred a few weeks before this accident but, in the previous incident, one of the aircraft took off without the pilots knowing their aircraft was damaged and continued its flight to its destination. It was luck that the damage was minor and a more serious accident did not occur. Following this incident, the ANSP issued a Safety Alert to remind the major operators at Heathrow about the AIP rule and this was highlighted in several airport operator forums. After this more recent accident an Aeronautical Information Circular and a NOTAM have been published highlighting the rule.

Lack of stand guidance when arriving on stand is reported to be a regular problem at Heathrow. On the day of this accident, it was reported that the problem was exacerbated by staff shortage caused by the closure of one of the tunnels used to access the central area. A lack of resources in one part of a system can have a safety consequence in another part of the system, with the potential to contribute to an accident. In this case, pilots and ATCOs inherited a problem initially caused by ground staff shortages.

Conclusion

The collision occurred because the commander of the B777 continued to taxi past the protruding B757, believing it was fully parked and that the ATC clearance and green taxiway lights implied the route was clear. The commander of the B757 did not follow the Heathrow AIP instruction to remain on the centreline if no stand guidance is available, because his normal practice was to look for guidance after he had turned onto the stand.

The initiating event was a lack of stand guidance when the B757 arrived on stand, caused by ground staff shortages. Lack of stand guidance is a common occurrence at Heathrow that all parties should continue to work together to address.

Bulletin Correction

Prior to publication two amendments were made to the report.

> On page 115 under the section 'Heathrow ground handling', the second sentence of the second paragraph 'It would only expect to provide a marshaller in the event of a failure of the guidance system.' was changed to:
>
> > 'It would only expect to provide a marshaller in the event of a failure of the guidance system as specified in the UK AIP entry for Heathrow.'
>
> On page 124 the final sentence of the conclusion 'This is a common problem at Heathrow.' was changed to:
>
> > 'Lack of stand guidance is a common occurrence at Heathrow that all parties should continue to work together to address.'

The online version of the report was corrected before the report was published on 8 June 2023.

ACCIDENT

Aircraft Type and Registration:	Cessna Citation 560XL, EC-KPB
No & Type of Engines:	2 Pratt and Whitney PW545C turbofan engines
Year of Manufacture:	2008
Date & Time (UTC):	1 June 2022 at 1420 hrs
Location:	RAF Northolt, South Ruislip, Middlesex
Type of Flight:	Commercial Air Transport
Persons on Board:	Crew - 2 Passengers - 3
Injuries:	Crew - None Passengers - None
Nature of Damage:	Detached nosewheel and fractured nose gear forks
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	48 years
Commander's Flying Experience:	3,800 hours (of which 850 were on type) Last 90 days - 243 hours Last 28 days - 78 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and additional enquiries with the operator

Synopsis

Whilst taxiing, after landing, the nose landing gear wheel detached from the aircraft. Assessment of the wheel assembly identified that one of the conical bearings within the axle assembly had failed, most likely as a result of corrosion. The cause of the onset of corrosion could not be determined.

History of the flight

Whilst taxiing after a normal landing the crew heard an unusual noise from the aircraft and then felt the front of the aircraft drop.

The nosewheel had detached from the nose landing gear (NLG) leg and came to rest in the grass adjacent to the taxiway, leaving the forks on the NLG resting on the taxiway (Figure 1).

Figure 1

EC-KPB broken NLG fork assembly
(reproduced with permission)

Aircraft information

The Cessna Citation 560XL has a traditional tricycle landing gear. The NLG has a single strut arrangement with a single wheel attached to the fork (Figure 2). The NLG is steerable via the pilot's rudder pedals and is not braked.

The nosewheel assembly on EC-KPB was last replaced in September 2021 and had been fitted for 337 flying hours and 230 cycles. Prior to being fitted, the wheel assembly had been reconditioned in accordance with the manufacturer's component maintenance manual. Grease was applied at the time it was fitted. According to the Aircraft Maintenance Manual (AMM) no maintenance was required to be carried out on the wheel since it was fitted, and none was carried out.

It was not possible to establish whether the bearings were new or re-used when they were fitted during the wheel reconditioning, but they would have been inspected at the time. It is likely that they were of similar usage; however, this could not be confirmed.

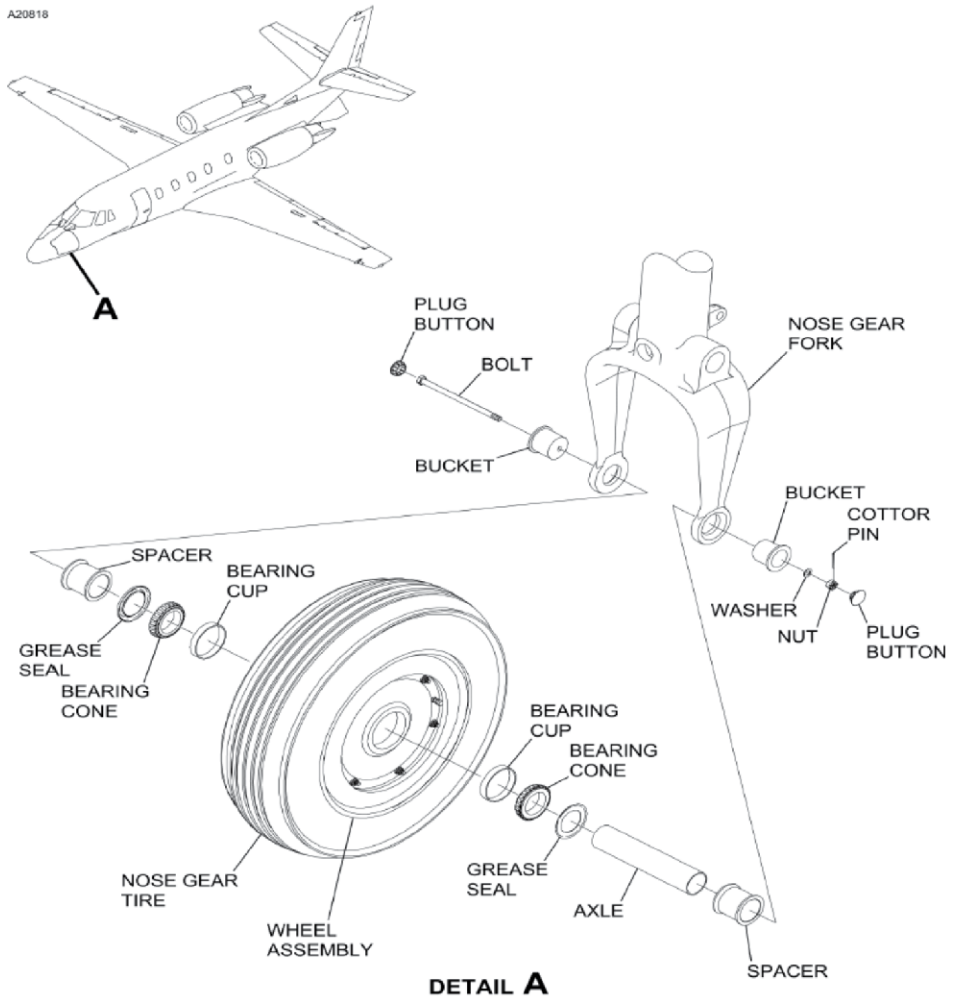


Figure 2

Cessna Citation 560XL NLG arrangement
(reproduced with permission)

Examination of the wheel assembly

One of the conical bearings in the wheel assembly had failed. Due to the extensive damage to the bearing, laboratory examination could not determine the cause of the failure; however, examination of the non-failed bearing identified evidence of multiple lines of material pitting along the length of the rollers and a band of corrosion pitting around the shoulder (Figure 3). Similar indications on the cone (Figure 4) and cup were noted. This was indicative of corrosion pickup between the rollers and races, the linear pitting was particularly indictive of corrosion whilst the bearing was stationary. As both bearings operated in the same environment, it is likely the failed bearing would also have been corroded.

Although only a small amount of grease remained on the failed bearing components, as it had burnt off due to the heat generated during the bearing failure, grease was found within the wheel cavity. This grease type was consistent with the grease approved in the AMM. The grease seal, which protects the bearing from ingress of moisture and dirt from the outside environment, and is located outboard of the bearing, was damaged during failure of the bearing. It, therefore, could not be determined if the seal was functioning correctly before the bearing failed.

Figure 3

Roller bearings from the non-failed bearing, exhibiting linear and circumferential pitting

Figure 4

Roller bearing cone from the non-failed bearing, exhibiting linear pitting and corrosion around the track shoulder indicating the onset of corrosion

Failure sequence

Examination of the wheel components determined a possible failure sequence as follows:

1. Corrosion pitting in the bearing races caused spalling and then disintegration of the bearing cage.
2. This caused the rollers to skid and due to a combination of frictional heating and loose material the bearing seized, causing the axle to spin on the buckets that support it at each end. This generated more heat.
3. A combination of the heating and sideways loading caused the spacer on the side of the failed bearing to disintegrate.
4. As the spacer failed, the side load caused the axle to migrate towards it, hot working the end of the axle, which was splayed by the bucket, forming a flange.
5. The axle then continued to migrate until it disengaged from the bucket on the non-failed side, snapping the through bolt.
6. The wheel then twisted out of the forks and separated from the aircraft.

Conclusion

The detachment of the NLG wheel resulted from a failure of the conical wheel bearing within the hub. The cause of the bearing failure could not be directly established; however, the non-failed bearing in the wheel assembly exhibited evidence of corrosion. As the bearings operated in the same environment it is possible that the failed bearing was also corroded which is likely to have played a part in its failure sequence. The cause of the onset of corrosion could not be determined.

ACCIDENT

Aircraft Type and Registration:	DJI Mavic 2 Enterprise
No & Type of Engines:	Four electric motors
Year of Manufacture:	Unknown
Date & Time (UTC):	7 August 2022 at 1648 hrs
Location:	Bangor Train Station Car Park, Gwynedd
Type of Flight:	Emergency Services Operations
Persons on Board:	Crew - None Passengers - None
Injuries:	Crew - N/A Passengers - N/A
Nature of Damage:	Damaged beyond economic repair
Commander's Licence:	Other
Commander's Age:	37 years
Commander's Flying Experience:	7 hours (of which 4 were on type) Last 90 days - 1 hour Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

The UAS was being used in a police operation over an abandoned building near a public car park and train station. During hover over the building the aircraft's motors stopped and the aircraft fell vertically with no prior warning to the remote pilot. The aircraft struck the roof of the building and the battery separated. Recorded data indicated that the battery probably disconnected in flight. This could have been caused by the battery not having been fully latched prior to takeoff, or the latching mechanism or battery being worn from repeated use resulting in an in-flight disconnection. The operator has taken safety action to remind their pilots of the importance of pre-flight checks and checking airframe and battery condition at their base.

History of the flight

The 1.1 kg Mavic 2 Enterprise UAS was being used to locate suspects during a police operation. The wind was light, the air temperature was 18°C and there was no precipitation. The Mavic needed to be deployed quickly but the remote pilot reported checking the battery and the aircraft prior to takeoff. He decided to take off from near the corner of a car park (Figure 1) next to an old industrial site to the south-east that had been fenced off. The pilot was contacted by another officer and asked to fly to and hover over the middle of an abandoned building on the industrial site.

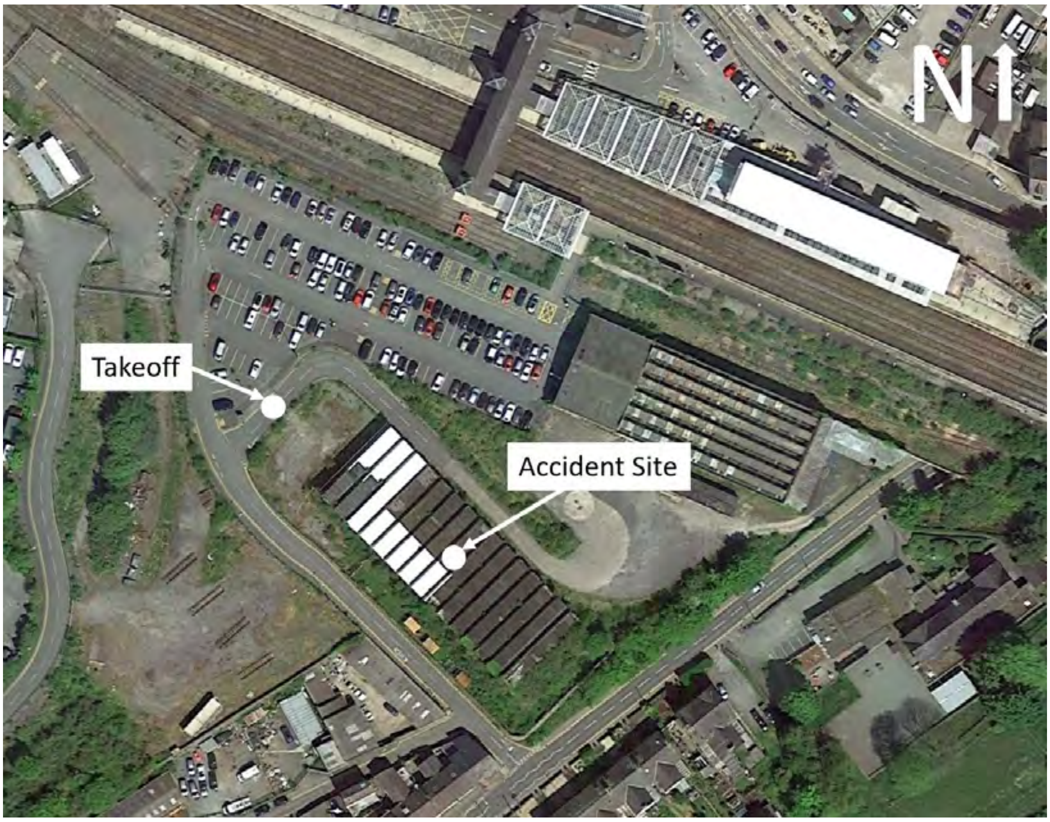


Figure 1

Takeoff and accident site location

(Imagery ©2023 Bluesky, Infoterra Ltd & COWI A/S, CNES / Airbus, Maxar Technologies, Map data ©2023)

About 4 minutes after takeoff another officer joined him who he asked to act as his observer. The aircraft was hovering over the centre of the building in Figure 1 when, about 6 minutes after takeoff, the pilot lost signal and video feed on his controller screen. The observer told him that they had seen the aircraft drop and the noise had stopped. The pilot looked up and could not see the aircraft.

It was located shortly afterwards on the roof of the building. The battery had separated from the airframe and they were about 1.3 metre apart from each other.

Recorded information

The recorded data file was downloaded from the controller. No faults were recorded and it showed the battery state of charge reducing linearly from 98% to 77% when the recording ended while the aircraft was in a hover at a height of 39 m above the takeoff point. Battery voltage fluctuations began 4 seconds before the end of recording. The last data point was recorded 5 minutes and 42 seconds after takeoff.

The data was sent to the aircraft manufacturer for analysis. They stated that there was an '*abrupt change in battery voltage before the flight record ended*' and that '*it could be possible that it was because of the battery disconnection (or loose connection) from the aircraft due to improper installation of the battery or the battery being swollen (*The battery has been* *used for about 3 years according to the log file and high temperature during Summer may have an impact on the battery)'.*

They stated that another possible reason for a loose connection was the battery having been used for three years and '*probably reaching its end of lifecycle'*.

The remote pilot was wearing a video camera (bodycam) which showed him setting the aircraft on the ground prior to takeoff (Figure 2). The operator and remote pilot reported that this image shows that the gap between the battery and airframe is larger than it should be when the battery is correctly installed. This picture was sent to the aircraft manufacturer and they stated that it was not possible to judge from this image if the battery was partially attached or not, or whether it was swollen or not.

Figure 2

Image from the pilot's bodycam prior to takeoff

The video camera also showed the aircraft, as a very small dot, falling from the sky. Another small dot was sometimes apparent directly above it, which the operator thought was the separated battery, but it was likely an artefact of the video. When a bird flew across the camera's field of view a small dot also appeared behind it. There was no indication that the aircraft had struck a bird.

Aircraft examination

The aircraft had suffered damage to its underside, with damage to the motor arms and the camera/gimbal assembly. The battery had black scuff marks (Figure 3). The operator re-installed the battery into the aircraft which showed that the scuff marks did not form a line with any marks on the aircraft's upper surface (Figure 4). This showed that the marks were made on the battery after it had separated from the airframe. However, the damage to the battery was not consistent with it falling from a height of more than 20 m on to a solid roof; there were no dents. It was also only about 1.3 m away from the airframe, so it is probable that the battery separated when the airframe struck the roof.

Figure 3
Battery from the accident Mavic

Figure 4
Accident battery re-installed in accident Mavic

The operator tested the battery locking mechanism after the accident with the accident battery, and it functioned normally. The battery was powered on and it provided power to the aircraft.

The operator also carried out a test with a partially latched battery and were able to power up the aircraft with no warnings provided to the pilot.

The operator reported that the battery did not exhibit any signs of swelling, and they reported that the data from the battery showed that its highest recorded temperature was 42.3°C, which is below the temperature limit of 50°C. The battery had had 46 charge cycles.

Aircraft manufacturer information

The aircraft manufacturer has published safety guidelines[1] for the Mavic 2 Enterprise which contains a Pre-flight Checklist which states:

> *'Ensure the Intelligent Flight Battery is mounted firmly in place'*

In the section 'Maintenance and Upkeep' it states:

> *'The battery is rated for 200 cycles. It is not recommended to continue use afterward.'*

They have also published battery safety guidelines for the Mavic 2 Enterprise[2] which state:

> *'Never use or charge swollen, leaky, or damaged batteries.*
>
> *The batteries should be used at temperatures between -20° and 40°C. Use of batteries in environments above 50°C can lead to fire or explosion.'*

The aircraft manufacturer stated that '*if the battery was properly handled according to the guideline, the possibility of abnormal performance of the battery is very low'.*

Operator information

The operator concluded that the most likely cause of the accident was that the pilot had not properly installed the battery and fully engaged the locking mechanism. They considered that the pilot had likely rushed to set up the aircraft, due to the nature of the urgent deployment, and not realised the battery was not properly installed.

The operator also noted that the pilot had not placed the aircraft on a takeoff mat to prevent dirt ingress into the motors and did not wait until joined by an observer before taking off. He also did not brief the observer on what their role was.

Analysis

The aircraft's motors stopped and the aircraft fell vertically with no prior warning to the remote pilot. The recorded data indicates that the most likely cause was a loss of battery power to the aircraft which instantly cut off the motors and the link to the controller. The battery state of charge was 77% at the time and there had been no warnings related to the battery. Both the operator and the aircraft manufacturer concluded that the most likely cause was the battery becoming disconnected. The damage to the battery was consistent with it having separated when the aircraft struck the roof of the building, and this detachment was more likely if it was already loose.

Footnote

1 https://dl.djicdn.com/downloads/Mavic_2_Enterprise_Advanced/Mavic_2_Enterprise_Series_Disclaimer_and_Safety_Guidelines.pdf. Accessed 17 January 2023.

2 https://dl.djicdn.com/downloads/Mavic_2_Enterprise_Advanced/Mavic_2_Enterprise_Intelligent_Flight_Battery_Safety_Guidelines.pdf. Accessed 17 January 2023.

The operator believed that the pre-flight checks were probably rushed and that the body worn camera image showed the battery not fully engaged. The aircraft manufacturer could not confirm whether it was fully engaged, but it is possible that it was not. It is also possible that the battery was engaged at that time, but that the latching mechanism or battery were slightly worn from use which led to an in-flight disconnection. There was no indication that the battery was swollen or had exceeded the temperature limit.

There are no sensors on the battery locking mechanism to detect and warn the pilot that a battery is not fully latched. For this type of UAS it is important that it is flown in a manner to reduce the risk to uninvolved third parties if it were to fall vertically, and in this case the aircraft was being flown over a large abandoned building which reduced that risk.

Conclusion

The aircraft's motors stopped and the aircraft fell vertically with no prior warning to the remote pilot. Recorded data indicated that the battery probably disconnected in flight. This could have been caused by the battery not having been fully latched prior to takeoff, or the latching mechanism or battery being worn from repeated use leading to an in-flight disconnection. The operator has taken safety action to remind their UAS pilots of the importance of pre-flight checks and checking airframe and battery condition at their base.

Safety Action

The operator has shared the learning from this accident with all its UAS pilots and reminded them of their responsibility to turn on their body worn camera before they carry out the UAS pre-flight checks so that the checks are captured, and of their responsibility to take time on the UAS checks that are completed at a local air base to ensure the aircraft is fit for use.

They also planned to reinforce the briefing of observers, and to carry out routine checks of the batteries.

ACCIDENT

Aircraft Type and Registration:	DJI Mavic 2 Enterprise Zoom
No & Type of Engines:	4 DJI electric engines
Year of Manufacture:	Unknown (Serial no: 276DFB5001QU7B)
Date & Time (UTC):	5 December 2022 at 1430 hrs
Location:	Garstang, Lancashire
Type of Flight:	Commercial Operations (UAS)
Persons on Board:	Crew - N/A Passengers - N/A
Injuries:	Crew - N/A Passengers - N/A
Nature of Damage:	Damage to propellers and body
Commander's Licence:	Other
Commander's Age:	50 years
Commander's Flying Experience:	257 hours (of which 35 were on type) Last 90 days - 26 hours Last 28 days - 9 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During an aerial survey flight, the UAS detected a rapid loss of battery power and initiated an immediate automatic landing. Whilst descending, its flight behaviour became erratic, control was lost to the remote pilot, and the UA struck an uninvolved person before hitting the ground. It was not possible to determine a cause for the loss of battery power or the flight behaviour. There may have been an opportunity during flight control checks to consider unexpected battery discharge rate as a reason to abort the flight.

History of the flight

The UAS was planned to fly as part of a survey to monitor progress on a construction site, to take images along the front and across the site within the property boundaries agreed with the client. Weather conditions on the day were good visibility, low winds and moderate temperature.

The flight started from a location towards the rear of the construction site, approximately 300 m from the site frontage. The remote pilot then flew the UA to approximately head-height and completed flight control checks, where the battery indicator showed 95% but rapidly dropped to 88%. The pilot continued, manually flying the aircraft at a height of 50 - 60 m over the construction site towards a point approximately 50 m from the site frontage to record the imagery.

The pilot received a CRITICALLY LOW – LANDING battery notification and the UA initiated automatic landing[1].

The UA was observed to fly in an erratic manner, and the pilot stated he had limited lateral control available to enable him to fly it into a clear area. It came close to houses under construction and stopped responding to control inputs. The pilot described it as then "appearing to descend too fast, despite the propellers spinning", before going out of sight behind some construction materials. The UA struck a site worker on their arm, dropped into some cement, and fell to the ground. The site worker was not injured.

Figure 1
UA after falling to the ground

Aircraft information

The DJI Mavic 2 Enterprise Zoom is a commercially available UAS. It comprises a UA with maximum take-off weight of 1100g, and a handheld control unit. The UA is fitted with a battery unit which has an integral charge level indicator.

Battery management

The UA was fitted with a battery that had been fully charged for the flight. It can be set up to notify the pilot with an alert at pre-set battery charge levels. This UA was configured to provide alerts for LOW BATTERY at 30%, and CRITICALLY LOW BATTERY at 20% power remaining. A battery level of 30% is intended to have enough power left for the aircraft to Return to Home (RTH) to the last recorded Home Point. However, the aircraft also self-determines whether the battery level is sufficient to RTH based upon position information, meaning that a RTH notification and action can occur independently from pre-set battery level warnings.

Footnote

1 The aircraft will land automatically if the current battery level can only support the aircraft long enough to descend from its current altitude. The user cannot cancel the auto landing but can use the remote controller to alter the aircraft's orientation during the landing process. (Mavic 2 Enterprise Series User Manual v1.8)

When a CRITICALLY LOW BATTERY level alert is triggered, the UA will land after 10 seconds, or immediately if deemed to be an extremely critically low[2] battery level. Both actions cannot be cancelled by the pilot, but limited directional control should remain available for hazard avoidance.

The aircraft did not notify the pilot of low battery at 30% remaining, only CRITICALLY LOW – LANDING immediately before descending. Control of the aircraft was lost to the pilot and he was unable to avoid hazards despite applying control inputs.

Batteries for this aircraft have a manufacturer's rating of 200 cycles[3]; this battery had 43 recorded cycles. The operator normally replaces batteries at 100 recorded cycles.

Aircraft examination

The UA was sent to an authorised repair facility for assessment. No discrepancies could be found with the battery condition, and the battery's integral charge level indicator showed 50-75% charge. The battery appeared to have been seated correctly and no physical defects were found with the UA that could have caused the loss of control.

The flight log was analysed post-flight but there was no data that showed a loss of power or flight control.

UAS Operation Regulations

UAS operations within UK airspace are legislated by three main pieces of regulation[4] alongside UK CAA policy and guidance *UK CAA CAP722 Unmanned Aircraft System Operations in UK*. Flight operations are further categorised using a risk-based approach and the incident flight was being operated within the 'Specific' category where the UAS operator is subject to additional oversight by the CAA due to a higher level of risk associated with the operations. To comply with the additional oversight, the operator of this UA had an operations manual[5] and was issued with a CAA operational authorisation for Pre-Defined Risk Assessment (PDRA) UKPDRA01 which enables Visual Line of Sight (VLOS) operations within 150 m of any residential, commercial, industrial or recreational areas for UAS with a Maximum Take-Off Mass of less than 25 kg. The operator was also the remote pilot, and he held a valid Operation Authorisation - Permission for Commercial Operations (PfCO).

Regarding operational conditions and limitations of safe distances between the UA and people, structures, and objects, UKPDRA01 states:

> *'No flight within 50 metres of any uninvolved person[6], except that during take-off and landing this distance may be reduced to 30 metres. Any overflight of uninvolved people must be kept to a minimum.'*

Footnote

[2] Less than 6% battery charge (Mavic 2 Enterprise Series User Manual v1.8).
[3] Mavic 2 Enterprise Series Disclaimer and Safety Guidelines v1.6, dated 01/2021.
[4] Regulation (EU) 2019/947, Regulation (EU) 2019/945, The Air Navigation Order (ANO) 2016.
[5] Operations Manual, Version 4.6, dated 31/01/2022.
[6] An uninvolved person is someone not directly under control of the UA pilot, as defined within CAP722 and ANO 2016.

The operator's operations manual sets out flight parameters and safe operating distances from people, property and hazards in accordance with CAA CAP722 and UKPDRA01. The flight was planned to operate within these restrictions and a pre-flight plan and risk assessment were carried out by the pilot. The construction worker who was struck by the UA was not under the control of the remote pilot and was classed as an 'uninvolved person'.

Analysis

The flight was planned in accordance with applicable regulation and guidance for safe distances between the UA and uninvolved people and structures. Due to the erratic flight behaviour of the UA during its automatic landing, coupled with loss of flight control, the UA subsequently breached the required safe distances and then struck the construction worker.

The battery was fully charged prior to the flight, was within the manufacturer's recommended number of cycles, and no defects were found to have affected its charge. During flight the battery percentage detected by the UAS dropped at an unexpectedly high rate that resulted in an automatic landing without notifying the pilot at the pre-set charge thresholds.

The first indication of an abnormal battery discharge rate was during flight control checks. The pilot chose to continue with the planned flight as it would have been achievable using the indicated 88% battery level. Subsequently, the UAS continued to detect a high discharge rate which triggered the automatic landing.

After the flight the battery integral charge level indicator showed 50-75% charge. It was not possible to determine the difference between this charge level and the battery power displayed on the handheld controller during the flight. Flight log data did not explain the discrepancy in battery level.

Discussion

The UAS measured a high loss of battery power in a short space of time, leading to an uncontrolled landing where the distance between the UA and uninvolved people and structures was compromised. This sequence of events resulted in the UA striking an uninvolved person. It was not possible to determine a cause of the UA's detecting a loss of battery power or its flight behaviour.

Whilst the displayed level of power remaining was sufficient for the planned flight, there may have been an opportunity during flight control checks for the pilot to consider the abnormal battery discharge rate was likely to continue, and to abort the flight.

AAIB Record-Only Investigations

This section provides details of accidents and incidents which were not subject to a Field or full Correspondence Investigation.

They are wholly, or largely, based on information provided by the aircraft commander at the time of reporting and in some cases additional information from other sources.

The accuracy of the information provided cannot be assured.

Record-only investigations reviewed: March - April 2023

10 Mar 2020 **Squarecraft Cavalier SA.102-5** **G-AZHH** Rufforth East Airfield, North Yorkshire

The aircraft overshot the runway during landing, damaging the engine, cowling and propeller. The owner has since modified the brakes on the aircraft.

9 Dec 2022 **Grob G115A** **G-GPSX** Wolverhampton Halfpenny Green Airport

The aircraft bounced twice during landing before the student pilot, who was performing her second solo flight, initiated a go-around. She pulled back on the control column more than intended, causing the aircraft to stall. The student pilot sustained minor injuries and the aircraft was damaged beyond economic repair.

1 Mar 2023 **Rockwell Commander 114** **N6081F** Gloucestershire Airport

Following a bounced landing, the nose gear collapsed and the aircraft veered off the runway onto the grass.

2 Mar 2023 **Thruster T600N 450** **G-CBGV** Freshwater Farm, Isle of Wight

In the final stages of the approach the engine stopped and could not be restarted. The pilot carried out an emergency landing in a nearby field. During the landing, the nose of the microlight dug in and the aircraft became inverted, damaging the forward fuselage.

3 Mar 2023 **Zenair CH 750** **G-CLYN** Goodleigh, Devon

During the roll-out and at low speed the aircraft began to drift sideways in long grass. The wingtip dropped and touched the ground causing the aircraft to become inverted.

11 Mar 2023 **Avid Hauler Mk 4** **G-BWRC** East Winch Airfield, Norfolk

During a forced landing following an engine failure, the nose landing gear and main landing gear collapsed.

27 Mar 2023 **Avid Aerobat (Modified)** **G-BUON** Near White Fen Farm Airfield, Cambridgeshire

Shortly after takeoff the engine stopped. The pilot managed to carry out an emergency landing in a field but, during the landing, the aircraft struck a depression, breaking the nose landing gear and flipping the aircraft onto its back. The pilot attributed the engine failure to the fuel cock not being fully open which had been overlooked during pre-takeoff checks.

Record-only investigations reviewed: March - April 2023 cont

1 Apr 2023 **Cessna F152** **G-CIUU** North Weald Airport, Essex

The instructional circuit took place in crosswind conditions. During the landing flare the aircraft yawed to the left then veered right on touchdown, departing the runway onto soft ground. The aircraft sustained damage to the right wingtip fairing. The instructor reflected that he should have intervened earlier to correct the yaw before touchdown.

2 Apr 2023 **DHC-1 Chipmunk 22 (Lycoming)** **G-BBNA** Husbands Bosworth Airfield, Leicestershire

After touchdown, control of the aircraft was lost and it left the runway and ran into a hedge. The pilot received only minor injuries but the aircraft suffered substantial damage to the wings and engine.

2 Apr 2023 **Quik GT450** **G-CFGD** Watnall Airfield, Notthinghamshire

The aircraft encountered a gust before touchdown causing it to bounce. The pilot began a go-around but the aircraft veered left and struck a hedge.

3 Apr 2023 **Ikarus C42 FB UK** **G-CBVY** Wingland Airfield, Spalding, Lincolnshire

The pilot considered that after touchdown he was too fast to stop within the remaining runway length and so initiated a go around. The aircraft was left of the runway centreline and as power was applied the left wingtip struck a vehicle parked just off the runway in a marked parking area. The aircraft spun through 180° and came to a halt.

13 Apr 2023 **X'air Hawk** **G-CHIW** Perranporth Airfield, Cornwall

The nose landing gear collapsed on landing and the aircraft came to a halt.

16 Apr 2023 **Ikarus C42 FB80** **G-CDMS** Popham Airfield, Hampshire

On the approach to land, the student pilot rounded out too high and then immediately corrected by lowering the aircraft nose. The aircraft touched down on the nosewheel, which broke free from its leg and the propeller struck the ground.

27 Apr 2023 **Bolkow BO 208C Junior** **G-AVLO** Brighton City (Shoreham) Airport, West Sussex

Following an approach that the pilot thought was normal, the aircraft bounced on touchdown. The pilot elected to continue with the landing, but the aircraft bounced two more times and, on the final touchdown, the nose landing gear collapsed and the propeller struck the ground. The pilot had been concerned after the first bounce that the high nose attitude might have led to a stall if he went around, so he decided to continue with the landing.

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).

BULLETIN CORRECTION

Aircraft Type and Registration:	BB85Z hot air balloon, G-ELMR
Date & Time (UTC):	13 September 2022 at 1730 hrs
Location:	Deighton, North Yorkshire
Information Source:	Aircraft Accident Report Form submitted by the pilot and subsequent information submitted by passengers

AAIB Bulletin No 2/2023 refers

After publication the AAIB became aware of further details of the injuries to passengers on the flight. As a result the report has been updated to take account of this further information.

Bulletin header, Injuries

Corrected text:

Injuries:	Crew - None	Passengers - 1 (Serious) 3 (Minor)

Original text:

Injuries:	Crew - None	Passengers - 1 (Serious); 1 (Minor)

Page 104, final sentence of Synopsis

Corrected text:

During the landing sequence four of the passengers were injured.

Original text:

During the landing sequence two of the passengers were injured.

Page 105, final sentence of History of the flight

Corrected text:

One of the passengers sustained a serious head injury with others reporting neck and limb injuries.

Original text:

One of the passengers sustained an injury to their neck and another reported similar injuries later.

Page 105, Analysis

Corrected text:

Having realised that ground contact short of his planned field was unavoidable, the pilot gave the landing instructions to the passengers. The lateness of the instructions and the background noise of the burners may have meant the passengers did not hear the instructions clearly or in time. The balloon touched down heavily, before bouncing and coming to rest in a ditch. Four of the passengers were injured.

Original text:

Having realised that ground contact short of his planned field was unavoidable, the pilot gave the landing instructions to the passengers. The balloon touched down heavily, before bouncing and coming to rest in a ditch. Two of the passengers were injured, possibly due to not being in the correct landing position throughout the sequence.

Page 105, Conclusion

Corrected text:

Four passengers on the flight were injured during the landing sequence, possibly due to being unable to adopt the correct landing position in time.

Original text:

Two passengers on the flight were injured during the landing sequence, possibly because they did not maintain their briefed and demonstrated landing position.

The online version of this report was corrected on 8 June 2023.

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

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

Published July 2015.

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

Published August 2015.

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

Published October 2015.

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

Published March 2016.

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

Published September 2016.

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

Published March 2017.

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

Published March 2018.

2/2018 Boeing 737-86J, C-FWGH
Belfast International Airport
on 21 July 2017.

Published November 2018.

1/2020 Piper PA-46-310P Malibu, N264DB
22 nm north-north-west of Guernsey
on 21 January 2019.

Published March 2020.

1/2021 Airbus A321-211, G-POWN
London Gatwick Airport
on 26 February 2020.

Published May 2021.

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

http://www.aaib.gov.uk

GLOSSARY OF ABBREVIATIONS

aal	above airfield level
ACAS	Airborne Collision Avoidance System
ACARS	Automatic Communications And Reporting System
ADF	Automatic Direction Finding equipment
AFIS(O)	Aerodrome Flight Information Service (Officer)
agl	above ground level
AIC	Aeronautical Information Circular
amsl	above mean sea level
AOM	Aerodrome Operating Minima
APU	Auxiliary Power Unit
ASI	airspeed indicator
ATC(C)(O)	Air Traffic Control (Centre)(Officer)
ATIS	Automatic Terminal Information Service
ATPL	Airline Transport Pilot’s Licence
BMAA	British Microlight Aircraft Association
BGA	British Gliding Association
BBAC	British Balloon and Airship Club
BHPA	British Hang Gliding & Paragliding Association
CAA	Civil Aviation Authority
CAVOK	Ceiling And Visibility OK (for VFR flight)
CAS	calibrated airspeed
cc	cubic centimetres
CG	Centre of Gravity
cm	centimetre(s)
CPL	Commercial Pilot’s Licence
°C,F,M,T	Celsius, Fahrenheit, magnetic, true
CVR	Cockpit Voice Recorder
DME	Distance Measuring Equipment
EAS	equivalent airspeed
EASA	European Union 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
GNSS	Global Navigation Satellite System
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
PM	Pilot Monitoring
POH	Pilot’s Operating Handbook
PPL	Private Pilot’s Licence
psi	pounds per square inch
QFE	altimeter pressure setting to indicate height above aerodrome
QNH	altimeter pressure setting to indicate elevation amsl
RA	Resolution Advisory
RFFS	Rescue and Fire Fighting Service
rpm	revolutions per minute
RTF	radiotelephony
RVR	Runway Visual Range
SAR	Search and Rescue
SB	Service Bulletin
SSR	Secondary Surveillance Radar
TA	Traffic Advisory
TAF	Terminal Aerodrome Forecast
TAS	true airspeed
TAWS	Terrain Awareness and Warning System
TCAS	Traffic Collision Avoidance System
TODA	Takeoff Distance Available
UA	Unmanned Aircraft
UAS	Unmanned Aircraft System
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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