AAIB
Air Accidents Investigation Branch

AAIB Bulletin 1/2023

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

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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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(ALL TIMES IN THIS BULLETIN ARE UTC)

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:	BAe ATP, SE-MAP
No & Type of Engines:	2 Pratt & Whitney Canada PW126A turboprop engines
Year of Manufacture:	1991 (Serial no: 2037)
Date & Time (UTC):	27 November 2021 at 0127 hrs
Location:	Belfast International Airport
Type of Flight:	Commercial Air Transport (Cargo)
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	60 years
Commander's Flying Experience:	10,800 hours (of which 1,305 were on type) Last 90 days - 62 hours Last 28 days - 27 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

Whilst flying in storm conditions the crew experienced difficulties in controlling the aircraft elevator but managed to land the aircraft safely. The cause could not be established but whilst investigating the problem, the Operator identified and implemented maintenance policy enhancements.

History of flight

The flight from London Stansted (STN) to Belfast International (BFS) took place during Storm Arwena, although forecast weather conditions were not sufficient to require de-icing/anti icing before departure. On climb out from London Stansted (STN) airport the aircraft encountered some very minor icing in the climb, but this did not warrant the use of the anti-icing boots. During cruise at FL200 the pilot noted the aircraft demonstrated a small level of hunting whilst trying to maintain altitude and the trim wheel was constantly twitching. However, as the air wasn't smooth he did not consider this abnormal for the ATP in light turbulent conditions.

In the descent to BFS the pilot noticed that the autopilot was struggling at times to maintain a set vertical speed. On final approach the pilot disconnected the autopilot to continue with manual flying. The crew then discovered that the elevator was stiff to move, requiring two hands and very jerky in operation, both when pushing and pulling. Despite the unusual response, the aircraft remained controllable and was landed successfully. During the taxi to the stand the pilot kept moving the elevator control and found it was freeing up gradually and after a few minutes it had returned to a more normal feel.

Operator's investigation

The crew confirmed that the autopilot had disconnected as they had received the audio warning and the autopilot engaged indications on the control panel and PFD had cleared. This was also confirmed by the data downloaded from the Flight Data Recorders. During the subsequent fault finding the engineers found the elevator primary servo and lever assembly sounded noisy and was not able to drive the elevator through the full range of motion. The elevator trim servo motor also did not drive through its full range. The primary elevator servo and lever assembly and elevator trim servo were all replaced and sent to the operator's component testing bay in Sweden for examination and testing. However, despite extensive testing the bay could not find any fault with the components.

The aircraft flew a further six cycles without incident. When on stand the flight crew discovered an elevator trim defect whilst depowering the aircraft. During testing, the electric trim switch was very slow to spring back to centre but when cleaned the spring action was restored. It was not possible to determine if this fault was related to the previous elevator control issue, but the cause was likely due to ingression of cleaning agents into the yoke switches. The operator has now ceased the disinfection of cockpit for ATP fleet due to the potential risk of inducing electrical problems and introduced a procedure for removing and residual cleaning agents from the yoke switches.

Safety Action

During these investigations the operator identified that inspection of the wiring in the steering columns was challenging due to access constraints. Consequently, a new procedure has been developed to enable a more extensive inspection. The operator is pursuing the completion of the steering column inspections across its ATP fleet as a priority.

INCIDENT

Aircraft Type and Registration:	Bell 206B, G-TOYZ
No & Type of Engines:	1 Allison 250-C20J turboshaft engine
Year of Manufacture:	1986 (Serial no: 3949)
Date & Time (UTC):	5 September 2022 at 1110 hrs
Location:	West Usk Lighthouse, Newport, Gwent
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 1 Passengers - 4
Injuries:	Crew - None Passengers - None Other - 1
Nature of Damage:	Ties securing a sign were broken
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	27 years
Commander's Flying Experience:	422 hours (of which 311 were on type) Last 90 days - 136 hours Last 28 days - 73 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and other enquiries by the AAIB

Synopsis

During a landing of a Bell 206B Jet Ranger, the combination of downwash and wind caused a sign to detach and strike a waiting passenger, who suffered minor injuries. The sign was not secured properly because the ground crew were distracted and under time pressure. The operator took action to improve the security of the sign, introduce site safety checks and increase the distance between the landing helicopter and waiting passengers.

History of the flight

On 4 September 2022, the operator's staff set up a temporary site in a field at West Usk Lighthouse for the operation of helicopter sightseeing flights (Figure 1). This consisted of a passenger parking, waiting and briefing area delineated by a rope cordon with a gate to 'airside'. A sign was displayed next to the gate and was used as part of passenger briefings before they were escorted to board the helicopter.

During the site set-up cows escaped on to the site from an adjacent field and needed to be removed and secured. The site set-up was then running late, and passengers were arriving and parking in incorrect locations. The sign was secured with two plastic cable ties on the top corners when normally it would be secured with plastic cable ties on all four corners. The sign measured 800 mm x 575 mm x 10 mm and weighed 2 kg (Figure 2).

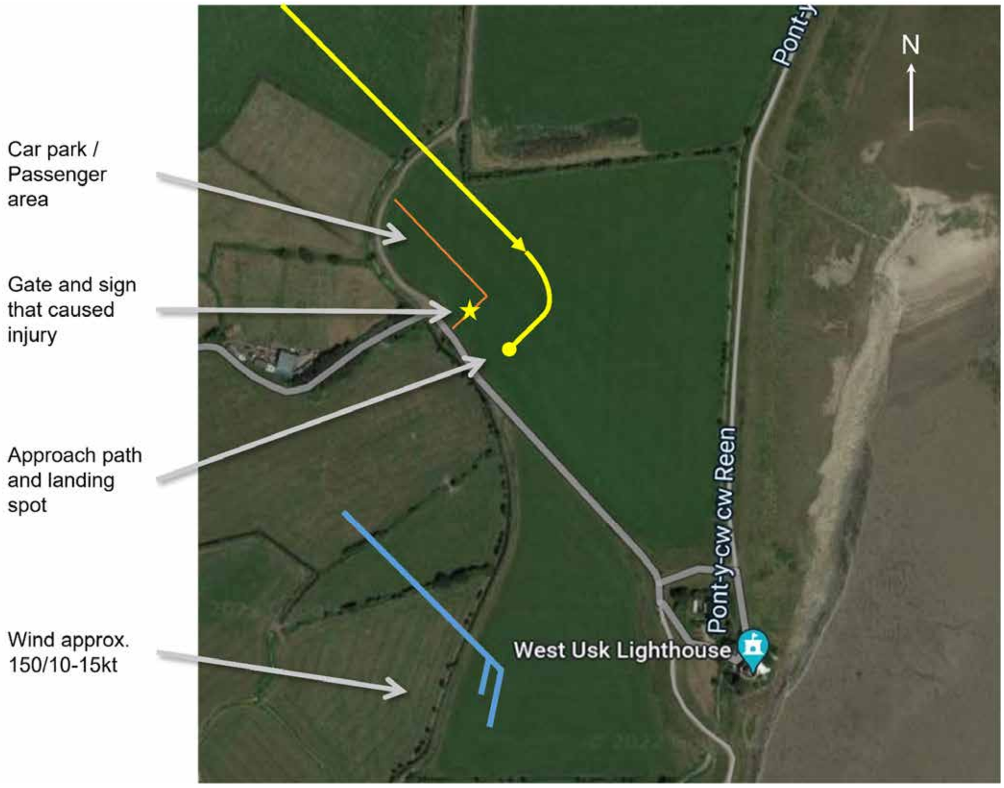


Figure 1

Site layout at West Usk Lighthouse (reproduced from pilot's sketch, not to scale and showing approximate approach path and landing position) © 2022 Google

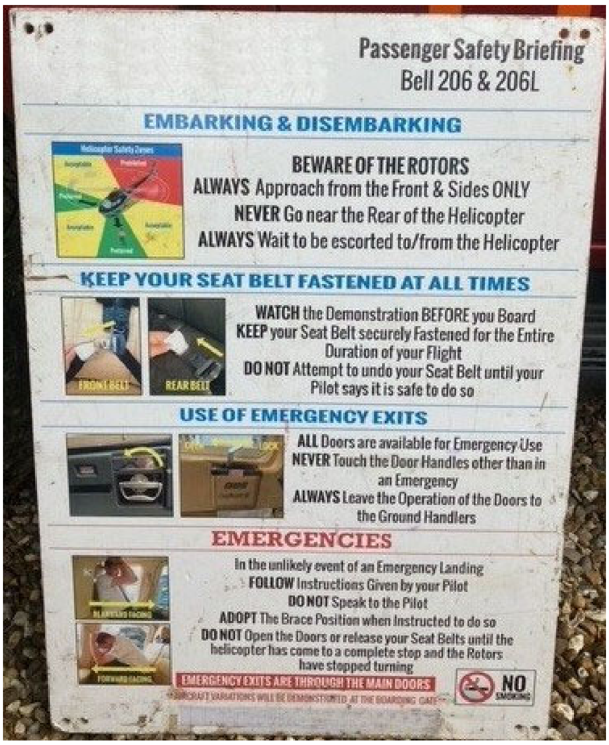


Figure 2

Sign that became detached (Image used with permission)

The cordon and sign were left set up overnight. The strongest wind recorded at Cardiff and Bristol Airports overnight was 15 kt. There was a strong wind warning in place for Cardiff Airport for winds of 15 – 20 kt with possible gusts of 25 – 30 kt.

The next day, on 5 September 2022, G-TOYZ (Figure 3) commenced flying with no check of the security of the sign. The TAFs for nearby Cardiff and Bristol Airports predicted winds of 150° at 9 kt and 160° at 10 kt respectively, and both predicted a 40% chance of occasional stronger wind of 15 kt from 1300 hrs. The pilot conducted eight uneventful flights in G-TOYZ. All landings were in the same place. The pilot reported that the wind speed had then increased to about 10 - 15 kt and, while landing on the ninth flight at approximately 1110 hrs, the cable ties broke and the sign became detached. The sign struck a passenger who was waiting to board, causing a cut to their lower leg that required stitches. No one had noticed the sign was not secured well or any movement in the sign before the accident.

Figure 3
G-TOYZ (Image used with permission)

Analysis

The operator's ground staff were distracted and under time pressure during the site set-up and did not secure the sign as well as usual. The helicopter downwash and prevailing wind acting on the sign were sufficient to break the plastic cable ties, and the sign became detached. It is possible that the sign was exposed to strong winds when left overnight and there was no process to check the safety of the site prior to each day's operation.

Safety actions

The operator took immediate action on the day to increase the distance between the landing helicopter and the passenger area.

The operator issued a flying staff instruction that required the sign to be secured with two cable ties on each corner and ordered metal lanyards to secure the sign in future (Figure 4).

The flying staff instruction also required the ground team leader to check the safety of the site before the first flight of the day and before each start of the helicopter engine.

Figure 4
New method of securing the sign (Image used with permission)

Conclusion

A sign was not secured properly because the ground crew were distracted and under time pressure. During a landing, the combination of downwash and wind caused the sign to detach and strike a waiting passenger who suffered minor injuries.

SERIOUS INCIDENT

Aircraft Type and Registration:	Boeing 737-8AS, EI-ENF
No & Type of Engines:	2 CFM 56-7B26 turbofan engines
Year of Manufacture:	2010 (Serial no: 35034)
Date & Time (UTC):	17 March 2022 at 0045 hrs
Location:	Manchester Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 6 Passengers - 167
Injuries:	Crew - None Passengers - None
Nature of Damage:	Fractured left main gear wheel hub
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	35 years
Commander's Flying Experience:	9,041 hours (of which 8,834 were on type) Last 90 days - 167 hours Last 28 days - 60 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and subsequent enquiries with the operator and wheel manufacturer

Synopsis

Whilst taxiing to the gate after landing, the outboard wheel on the left main gear failed because of a fatigue crack in the wheel hub. The wheel failure caused a hydraulic leak from the brake piston and the heat generated by the misaligned wheel, caused the hydraulic fluid to combust resulting in a fire.

The fatigue crack originated from a corrosion pit in the wheel hub. Following this occurrence, the wheel manufacturer developed an ultrasonic inspection technique to identify cracks in this location on the hub and the operator has incorporated the new inspection into their maintenance programme.

History of the flight

The aircraft made a normal approach and landed on Runway 23R at Manchester Airport, following which the crew were cleared to taxi to a stand at Terminal 3. Once on the taxiway, the crew found that to maintain the normal taxi speed a thrust of 40% N_1, which is higher than normal, was required. The crew considered that it was likely to be a flat tyre so continued to taxi to the terminal. With the increased thrust there was no noticeable difficulty in maintaining the aircraft in a straight line.

As the aircraft approached the stand the crew heard a radio transmission requesting the fire service attend an aircraft with "BRAKES ON FIRE" on stand. Realising that the call was about EI-ENF, the crew immediately completed the parking procedure and shut down the engines. A '*Standby*' call was made to the cabin crew and the situation was monitored. The fire service arrived and extinguished the fire, which had broken out around the left main landing gear wheels. As the fire was quickly extinguished, the flight crew considered that an emergency evacuation was unnecessary and, therefore, the passengers disembarked normally.

Recorded information

An assessment of the data on the quick access recorder identified that the approach and landing were normal, brake application was as expected and the manoeuvring speed around the taxiway corners was below 10 kt.

CCTV images showed that the fire started as the aircraft turned left from the apron towards the gate (Figure 1).

Figure 1

Still from CCTV showing a fire around the left main gear as the aircraft turned onto the stand (reproduced with permission)

Aircraft information

The Boeing 737-8AS is a single aisle commercial airline with a tricycle landing gear. Each main landing gear has two wheel assemblies attached to the landing gear axel. The wheels are made up of an inner and outer wheel half. Conical roller bearings located in the wheel half hubs carry the load from the wheel to the axel. Tie bolts hold the two halves together (Figure 2). The wheel brake pack is positioned within the inner wheel half.

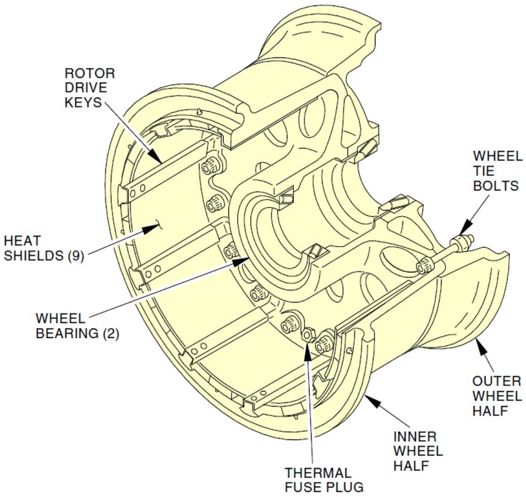


Figure 2

Boeing 737-800 wheel assembly (reproduced with permission)

Aircraft examination

After the event, the aircraft was examined by the operator's engineering personnel who discovered that the left main wheel inner hub had fractured. The resulting misalignment of the wheel had damaged the brake piston, causing a hydraulic fluid leak. They assessed that the heat generated by the misaligned wheel, whilst the aircraft taxied to the stand, was sufficient to ignite the hydraulic fluid.

The wheel and brake manufacturer subsequently identified that the inboard wheel hub had fractured radially in four locations; they also identified a circumferential crack around the hub (Figure 3).

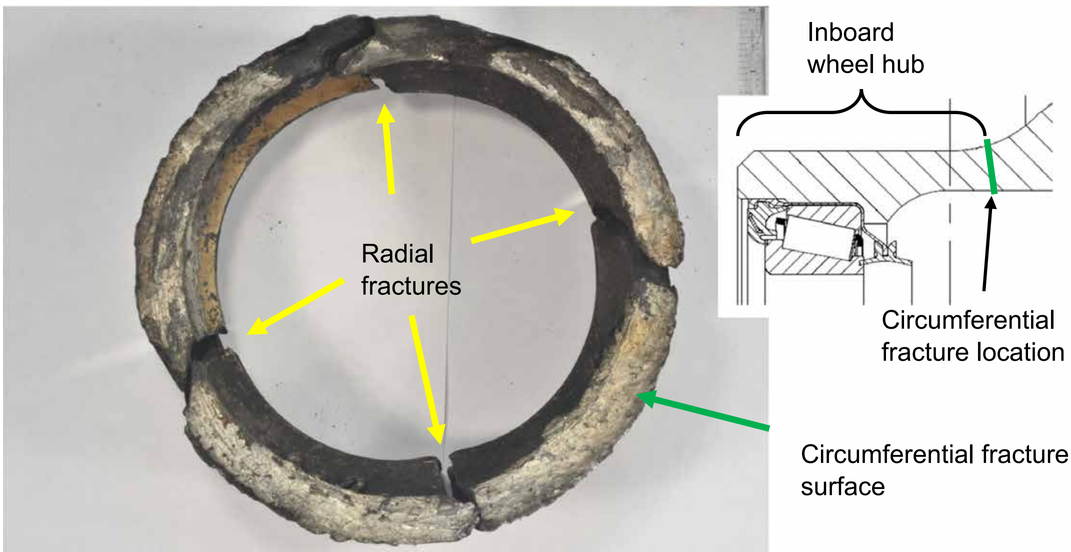


Figure 3

Inboard wheel half fragments showing the location of the circumferential and four radial fractures (reproduced with permission)

Three of the four radial fractures and the circumferential fracture were all consistent with overload. A fatigue crack was identified on one of the fracture surfaces, which originated at a corrosion pit located on the lead-in chamfer of the inner wheel half bearing bore (Figure 4). A number of other fatigue cracks, all originating from corrosion pits, were also found in the bore.

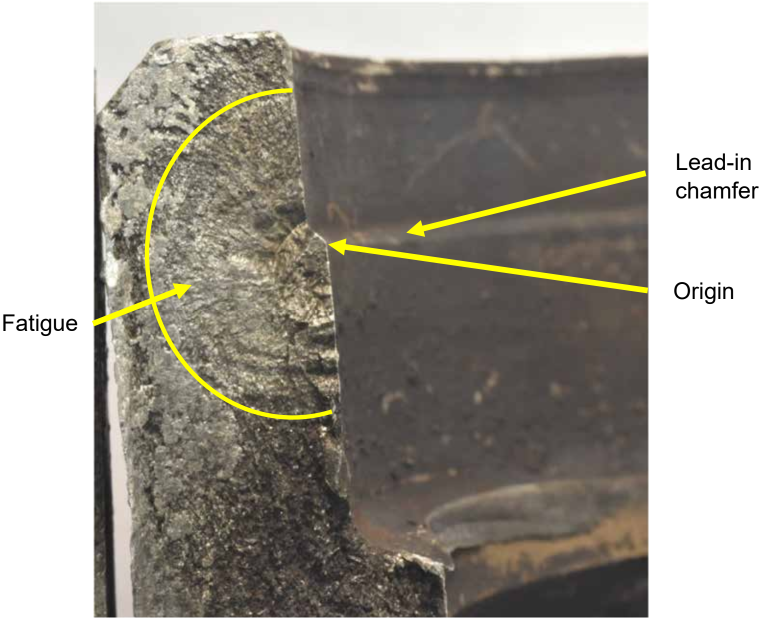


Figure 4

Radial fracture surface with area of fatigue highlighted (reproduced with permission)

Previous occurrence of similar hub failure

Following this occurrence, the operator experienced a similar event whilst operating in Spain, which is being investigated by the Spanish Comisión de Investigación de Accidentes e Incidentes de Aviación Civil (CIAIAC).

Safety actions

As a result of the wheel hub failures, the following Safety Action has been taken by the wheel manufacturer and the operator:

> The wheel manufacturer has developed an ultrasonic inspection to assess the condition of the internal bore of the wheel hub to identify the presence of cracks originating at the lead in chamfer of the bearing bore.
>
> The operator has introduced this optional ultrasonic inspection on their fleet of Boeing 737-8AS aircraft.

The wheel manufacturer stated that they would amend the component maintenance manual to introduce an ultrasonic inspection of the inner wheel half hub lead in chamfers.

ACCIDENT

Aircraft Type and Registration:	Bede BD-4, G-BOPD
No & Type of Engines:	1 Lycoming O-320-A2B piston engine
Year of Manufacture:	1974 (Serial no: 632)
Date & Time (UTC):	10 July 2022 at 0930 hrs
Location:	Fishburn Airfield, County Durham
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Left landing gear leg failed, propeller strike, and damage to left wing, left door, and engine cowls
Commander's Licence:	Private Pilot's Licence
Commander's Age:	68 years
Commander's Flying Experience:	1,597 hours (of which 1,444 were on type) Last 90 days - 10 hours Last 28 days - 6 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

After a normal landing the left landing gear leg detached. The leg fracture surface revealed beachmarks which were consistent with a failure due to metal fatigue. The pilot estimated that the aircraft landing gear had probably made over 2,000 landings, which the manufacturer said was probably the highest number of landings of this aircraft type.

History of the flight

The pilot had owned the BD-4 high-wing tailwheel aircraft since 1984 and had logged 1,444 hours with it. The aircraft was operated on a Permit to Fly and had accumulated 1,686 hours since manufacture in 1974. After a normal landing the pilot applied the brakes and the left landing gear leg detached. The propeller struck the ground and the aircraft veered to the left, coming to rest in a field of crops on the left side of the grass runway (Figure 1).

Aircraft examination

A photograph of the landing gear leg fracture surface revealed beachmarks which were consistent with a failure due to metal fatigue (Figure 2). The pilot contacted the aircraft manufacturer who informed him that they had not seen a fatigue failure in these landing gear legs before. The pilot estimated that he had probably made over 2,000 landings in it which the manufacturer said was probably the highest number of landings of this aircraft type.

The manufacturer no longer makes this landing gear leg type as it has been redesigned.

Figure 1
G-BOPD after the accident

Figure 2
Landing gear leg fracture surface

SERIOUS INCIDENT

Aircraft Type and Registration:	Cessna 182Q, G-BRRK
No & Type of Engines:	1 Continental Motors Corp O-470-U piston engine
Year of Manufacture:	1977 (Serial no: 182-66160)
Date & Time (UTC):	24 August 2022 at 1006 hrs
Location:	Finmere Microlight Site, Buckinghamshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Private Pilot's Licence
Commander's Age:	63 years
Commander's Flying Experience:	545 hours (of which 212 were on type) Last 90 days - 7 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Summary

The aircraft flew an approach to Runway 28 at Finmere aerodrome lower than required to keep a safe distance above road traffic passing the runway threshold. The right main landing gear contacted the top of an articulated vehicle and the pilot elected to go around. The aircraft made an emergency call on 121.5 MHz and continued to Elstree aerodrome without further incident. Although there are no regulatory requirements for unlicenced aerodromes, the owner of Finmere aerodrome has stated her intention to increase awareness of the large volume of vehicles on the road for pilots unfamiliar with the aerodrome.

History of the flight

The aircraft departed Elstree aerodrome with the intention of flying to Finmere aerodrome with one passenger on board. The departure and enroute segments of the flight were uneventful and the aircraft joined a left-hand circuit for Runway 28 at Finmere as planned. The pilot stated he was familiar with Finmere having flown there several times previously and he was aware of a road which passes perpendicular and close to the end of Runway 28.

As the aircraft turned on to final at approximately 1.5 miles from the threshold, the pilot recalled visually confirming there was no traffic on the road. As the aircraft approached, the pilot noticed a vehicle turning on to the road from the right in his peripheral vision. He stated that at this time he was focused on his landing point on the runway. He described hearing a 'bang' as the aircraft passed over the road and the passenger saw an articulated vehicle pass underneath them. The pilot and passenger both suspected the right main landing gear had contacted the vehicle, although the flying characteristics of the aircraft did not change.

The pilot opted to go around in order to assess if the aircraft had sustained any damage. The pilot and passenger were not able to visually identify any structural damage to the landing gear. As Finmere does not have an ATC service, the pilot call the Distress and Diversion Cell (D&D) on the emergency frequency 121.5 MHz. He declared an emergency and requested assistance from the D&D Cell to obtain a visual assessment of the right landing gear prior to landing.

The pilot was informed by the D&D controller that the aircraft could be inspected by ground personnel at Oxford Airport or Elstree aerodrome. He opted to return to Elstree aerodrome where he flew a low pass before ATC and a ground operations vehicle confirmed they could not see any damage to the aircraft's landing gear. The aircraft landed without further incident.

The driver of the articulated vehicle informed the AAIB of the event and provided photographs of tyre marks on the top of the articulated vehicle. A maintenance inspection after the event revealed no damage to the aircraft.

Aerodrome information

Finmere Aerodrome is an unlicenced aerodrome located 11 nm west of Milton Keynes. It has one asphalt runway, 10/28, which is 701 m long. The end of Runway 28 is 35 m from the road (Figure 1). Finmere requires pilots to request permission before visiting.

The owner of the aerodrome stated that pilots on a "normal approach path" to Runway 28 should have sufficient height to pass over any vehicles using the road and there have been no previous incidents or near misses reported. She stated that when granting permission in future, she intended to inform pilots unfamiliar with the aerodrome about the high volume of articulated vehicles on the road.

Unlicenced aerodromes

Unlicenced aerodromes are not subject to oversight from the CAA. CAP 793 – '*Safe Operating Practices at Unlicenced Aerodromes*' provides guidance on operating an unlicenced aerodrome, although its contents are not mandatory.

'[T]*he pilot-in-command shall be responsible for the safety of the aircraft**'*** as stated in the retained Regulation (EU) No 965/2012[1]. The pilot-in-command is also responsible for *'the initiation, continuation, termination or diversion of a flight in the interest of safety'.*

Footnote

[1] EU965/2012 NCO.GEN.105 https://www.legislation.gov.uk/eur/2012/965/annex/VII [accessed on 4 November 2022].

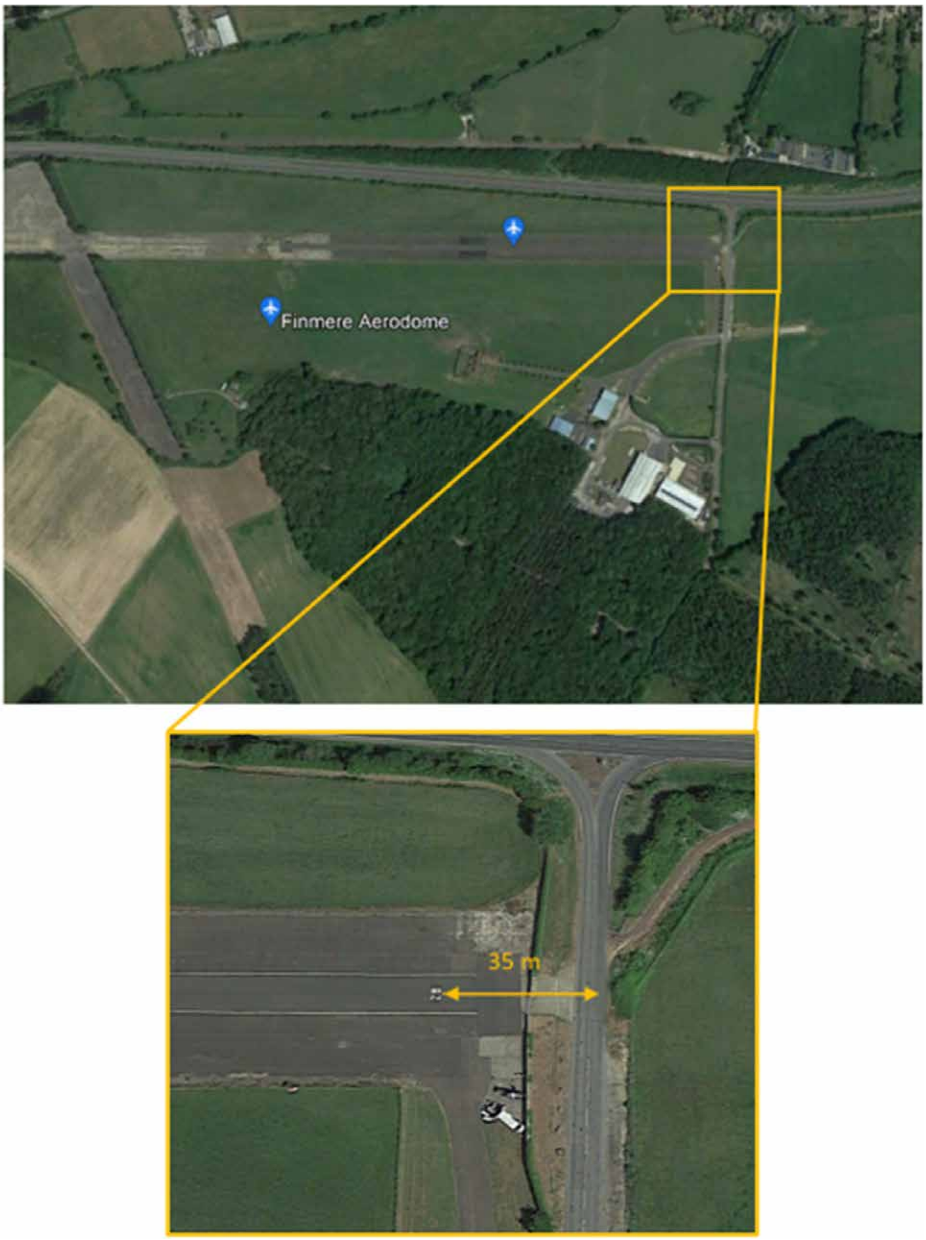


Figure 1
Distance from Runway 28 markings to public road

Conclusion

The aircraft approached the aerodrome over a road lower than necessary to maintain a safe distance from traffic using the road, resulting in the right aircraft wheel contacting the top of an articulated vehicle as it passed beneath the aircraft.

ACCIDENT

Aircraft Type and Registration:	Piper PA-34-200T, G-CAHA
No & Type of Engines:	2 Continental Motors Corp TSIO-360-EB piston engines
Year of Manufacture:	1977 (Serial no: 34-7770010)
Date & Time (UTC):	1 June 2022 at 1130 hrs
Location:	Dundee Airport
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to both propellors, engines and airframe
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	61 years
Commander's Flying Experience:	1,401 hours (of which 200 were on type) Last 90 days - 89 hours Last 28 days - 30 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft had completed a final training flight on a multi-engine pilot (MEP) course and was on final approach at Dundee Airport. The downwind checks had been carried out and the student pilot confirmed "three greens", indicating the landing gear was down and locked. Following what the instructor described as a normal landing, the aircraft began to wobble, listed to the right and the propeller on the right engine and the right wing struck the runway. The instructor took control and managed to keep the aircraft reasonably straight and brought the aircraft to a stop. The occupants escaped unhurt. On exiting the aircraft it was clear the right main landing had collapsed (Figure 1).

After the accident the engineers from the maintenance organisation responsible for the aircraft checked the entire hydraulic and electrical system and no fault could be found. Despite repeated selections of the landing gear there was no evidence of failure of the main and nose landing gear down lock safety mechanism and switches. The aircraft was subsequently not repaired as the aircraft has been written off by the insurers.

Figure 1
G-CAHA post landing (used with permission)

ACCIDENT

Aircraft Type and Registration:	Piper PA-46-350P, G-LAMI
No & Type of Engines:	1 Lycoming TIO-540-AE2A piston engine
Year of Manufacture:	2022 (Serial no: 4636798)
Date & Time (UTC):	9 July 2022 at 1000 hrs
Location:	Wycombe Airpark, Buckinghamshire
Type of Flight:	Private
Persons on Board:	Crew - 2 Passengers - 4
Injuries:	Crew - None Passengers - None
Nature of Damage:	Left wing, both landing gear and fuselage damaged
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	65 years
Commander's Flying Experience:	31,500 hours (of which 131 were on type) Last 90 days - 91 hours Last 28 days - 26 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

A syndicate of potential purchasers boarded G-LAMI for a sales demonstration flight. During the takeoff the commander realised there was insufficient runway remaining and rejected the takeoff. The aircraft skidded sideways and overran the end of the runway, stopping in the grass after the landing gear collapsed.

Several factors were identified which contributed to the unsuccessful takeoff including aircraft weight, pre-flight briefing and engine handling. The CAA is intending to publish an article in its *'Clued Up'* magazine about takeoff decision making and rejected takeoff (RTO) considerations in general aviation.

History of the flight

The accident flight was being conducted as a prospective buyer demonstration flight with the commander, the sales representative, one potential buyer as pilot flying (PF) and three passengers onboard. The intention was to depart from Wycombe Air Park heading towards Cardiff under IFR before returning to Wycombe.

The prospective buyers were already waiting in the airfield cafe when the commander arrived to prepare for the flight. Short introductions were made and there were issues with headset availability, which needed resolving. The commander felt he was under time pressure to depart as the passengers had other commitments later in the day. The commander used the Garmin G1000 Integrated Flight Deck (IFD) system to obtain the fuel quantity on board, which he recorded as being 15 US gallons, and requested a further 50 US gallons to be uplifted which he calculated would leave 20 US gallons remaining after the flight. The commander had previous experience of operating small charter operations and was comfortable in estimating the weight of the passengers. He performed his pre-flights checks, takeoff calculations and filed the flight plan as the aircraft was towed to the fuel pumps and 199.93 litres (52.8 US gallons) was uplifted. By his calculations they would be at the MTOW and would require 1,700 ft of ground roll using flaps 10° for the takeoff. He did not calculate the 50 ft obstacle clearance performance.

The passengers arrived at the aircraft with the sales representative and one of the passengers was identified to occupy the right cockpit seat. He advised the commander of his experience and said he would like to do "as much flying as possible". He asked the commander why he would take the right seat and was informed that the commander preferred to fly in the left seat for demonstration flights. Before taxiing, a short pre-flight safety briefing was given regarding the emergency exits. Control of the aircraft was passed to the PF for the taxi whilst the commander did the pre-flight checks from memory. Power checks were completed before entering Runway 24 from point A1 and then backtracking to line up for Runway 06. The commander demonstrated a 180° turn and by his estimation they were approximately 10-15 m (30-50 ft) from the end of the runway. Rotation (70-75 kt) and lift off (78 kt) speeds were briefed and the commander selected flaps 10°.

The PF fully advanced the throttle and shortly afterwards the commander heard a Master Warning and saw there was a red warning message on the Crew Alerting System (CAS) indicating that the Manifold Absolute Pressure (MAP) had exceeded 42 inches Hg reaching approximately 44 inches Hg. The commander placed his hand on the PF's hand and reduced the throttle so that the MAP stabilised at approximately 36-37 inches Hg and continued with the takeoff roll.

About halfway along the runway the commander became concerned that insufficient airspeed had been achieved to continue with the takeoff. The PF recalled being told to rotate at about 55 kt and then he heard the stall warner as the aircraft pitched up. One of the passengers stated they felt the aircraft "bounce" and a witness remembers seeing a "wing wobble" associated with a momentary lift off. The commander then shouted "Stop! I have control" and immediately closed the throttle and applied as much braking as he felt possible.

The aircraft deaccelerated and swung to the right as it ran off the end of the runway onto the taxiway. It continued off the paved surface into the grass and in doing so caused both main landing gears to collapse. The commander estimated they were travelling "not much more than walking pace" as they went onto the grass and came to a stop shortly afterwards (Figure 1).

Figure 1
G-LAMI shortly after the accident

The commander completed the emergency shutdown procedure, checked the passengers were ok and commanded an evacuation. The sales representative opened the upper cabin door, but the lower half was jammed and so all the occupants had to climb out over it. The AFRS was on the scene quickly and there was a strong smell of fuel coming from the left wing.

Accident site

Inspection of the end of Runway 06 revealed two lines of black skid marks starting from the painted Runway 24 numbers (Figure 2 left). The distance between the lines was 3.6 m and were to the left of the runway centreline. The skid marks continued in an arc to the right (Figure 2 centre) and converged at a point where they left the paved surface (Figure 2 right). The left skid mark was darker and there was evidence of the tyre scrubbing sideways, whereas the right skid mark was lighter, and the skid was in the direction of travel. At the point where the main gears left the paved surface there was another skid mark, 4.2 m to the right, from the nose landing gear (Figure 2 right).

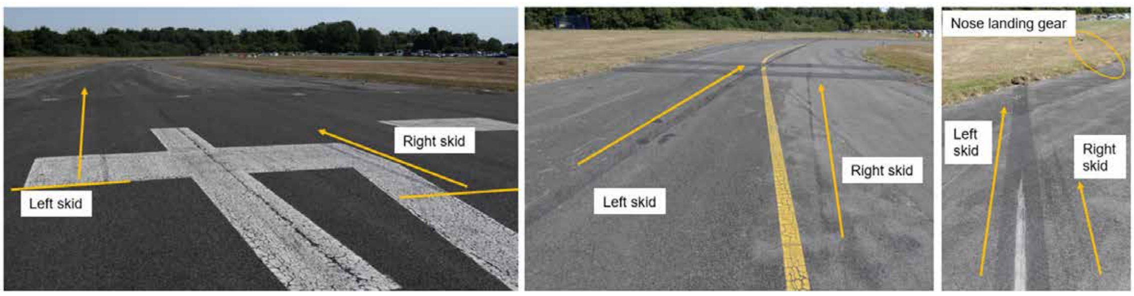


Figure 2
Skid marks on the runway

There was some evidence of the grass dying back and disrupted soil found approximately 260 ft from the end of the runway where the aircraft came to stop. To aid the recovery process the aircraft was partially defueled but no records were kept of the quantity of fuel removed from the aircraft.

Recorded information

The aircraft was fitted with a Garmin G1000 IFD system which stores multiple aircraft and engine parameters once a second on an SD memory card. The data was time stamped however the time did not correlate to the actual time, therefore it was re-labelled with T=0 at the last data point before the throttle was opened for the takeoff roll.

Using the positional data from IFD, it was possible to determine that after the 180° turn, the aircraft lined up to take off 31.7 m (104 ft) from the end of Runway 06 (Figure 3). It reached a peak ground speed of 71 kt (and KIAS of 71kt) after 30 seconds and had used 2,272 ft of the available runway. The positional track data overlaid with the skid marks seen with good correlation and the aircraft came to rest 259 feet from the end of the runway.

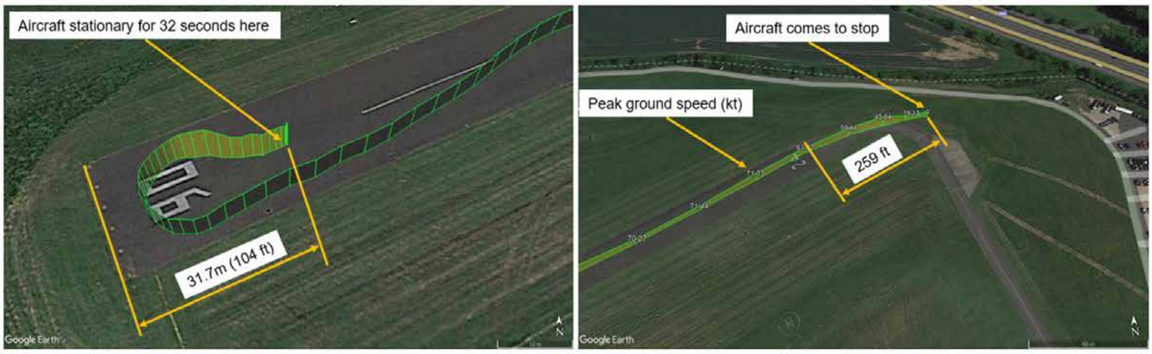


Figure 3

Take off roll start (left), Peak ground speed and stop point (right)

From the last time the IFD was powered on prior to the accident flight, the fuel quantity on board prior to refuelling was recorded as 37 US gallons. After refuelling, the IFD recorded the onboard fuel quantity as 94 US gallons which had reduced to 91 US gallons prior to starting the takeoff roll.

The ground speed, aircraft pitch, aircraft heading, MAP and engine rpm from the IFD was plotted against time in Figure 4 along with the calculated acceleration. At T=1 second the engine rpm starts to increase with a corresponding increase in MAP. The aircraft is moving at 2.4 kt at T=3 seconds when the MAP is 34.75 inches Hg, and the engine speed is 2,294 rpm. The MAP peaks 3 seconds later at 45.3 inches Hg and remains above the 42 inches Hg threshold for the CAS red warning for 4 seconds. It is then reduced and stabilised at 38 inches Hg for the remainder of the takeoff with the engine speed at 2,450 +/ 25 rpm.

The ground speed increases under constant acceleration between T=11 to T=29 seconds with a corresponding increase in IAS until the aircraft pitch increases to 13° nose up at T=31 seconds where the acceleration decreases. 1 second later the ground speed and IAS peak at 71 kt after which the throttle is closed, and the aircraft deaccelerates rapidly. As the aircraft pitched up, the heading veered slightly to the left, then swung 100° to the right after the brakes were applied and it came to a stop in 7 seconds.

The PF recorded the flight on the SkyDemon application on his mobile phone and it recorded the peak speed at 71 kt in the flight debrief report.

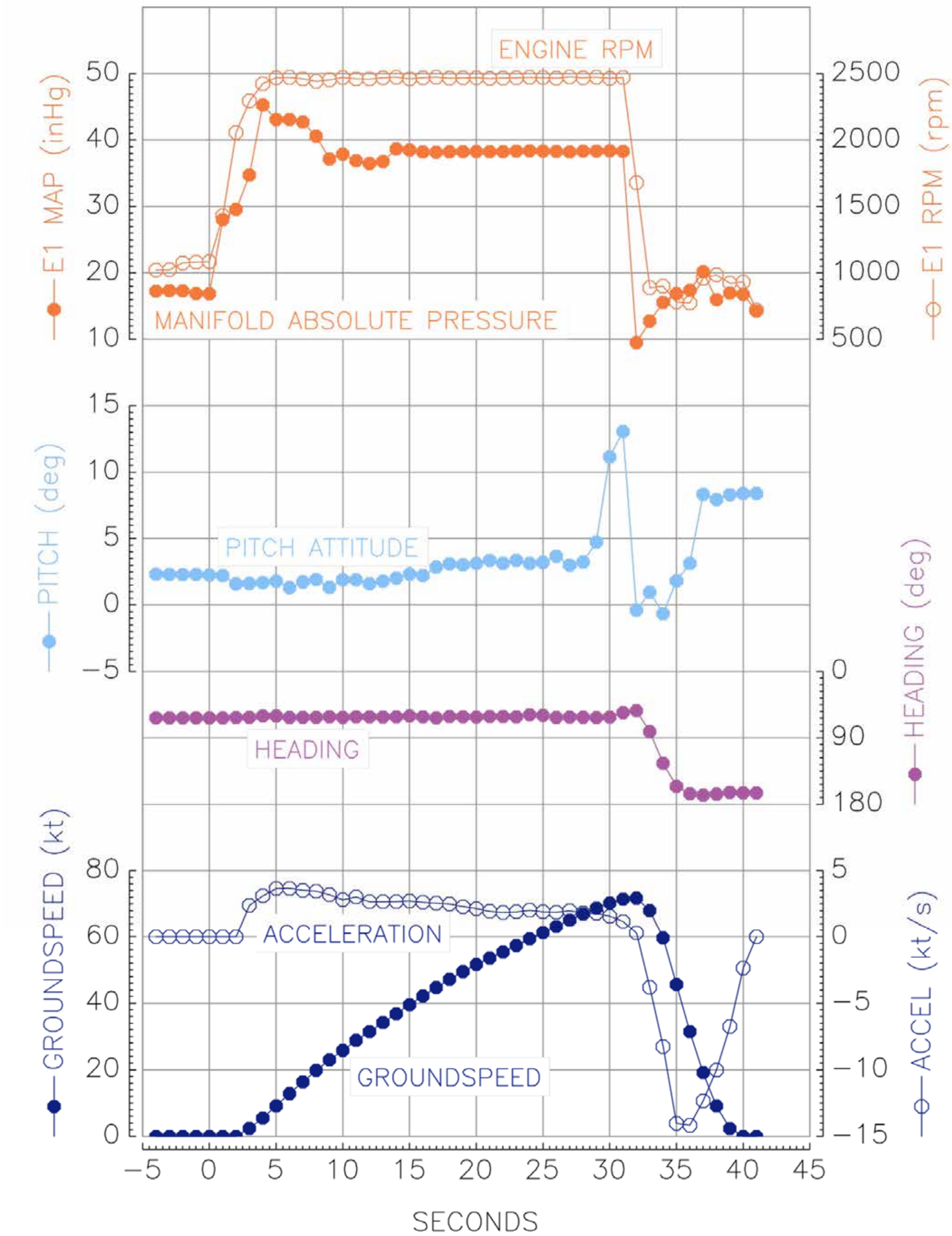


Figure 4
Garmin G1000 IFD data

Aircraft information

G-LAMI was a Piper Malibu Mirage PA-46-350P which had just been ferried across the Atlantic Ocean from the manufacturer in Florida. The aircraft logbook had 26 flying hours recorded at the time of the accident. The PA-46 is an all-metal single engine piston aircraft with a pressurized cabin with space for six people. The 350P version has a Lycoming TIO-540-AE2A engine with twin-turbo chargers and was fitted with a Hartzell three-bladed, composite, constant-speed propeller. The IFD system was shown on three large cockpit displays and aircraft access was via a two-part cabin door in the rear left side of the fuselage.

The aircraft landing gear was a tricycle configuration with the single main wheels 3.7 m apart and the nosewheel 2.44 m forward of the main landing gear. A hydraulic actuator in each wheel well, attached to the main wing spar, retracted the main wheels.

The aircraft basic empty weight was 3,207.3 lb with an MTOW of 4,340 lb and the MLW was 4,123 lb.

Aircraft examination

The aircraft was inspected by the AAIB after it had been recovered following the accident. The left-wing top surface was creased outboard of the landing gear attachment with damage to the wing tip structure (Figure 5 top left). There was a puncture hole in the top surface (Figure 5 lower left) near the retraction jack actuator and the actuator had failed in compression and bending (Figure 5 top right). The actuator mounting lug on the wing spar had sheared (Figure 5 lower right) and the tyre had lateral abrasion marks (Figure 5 top right).

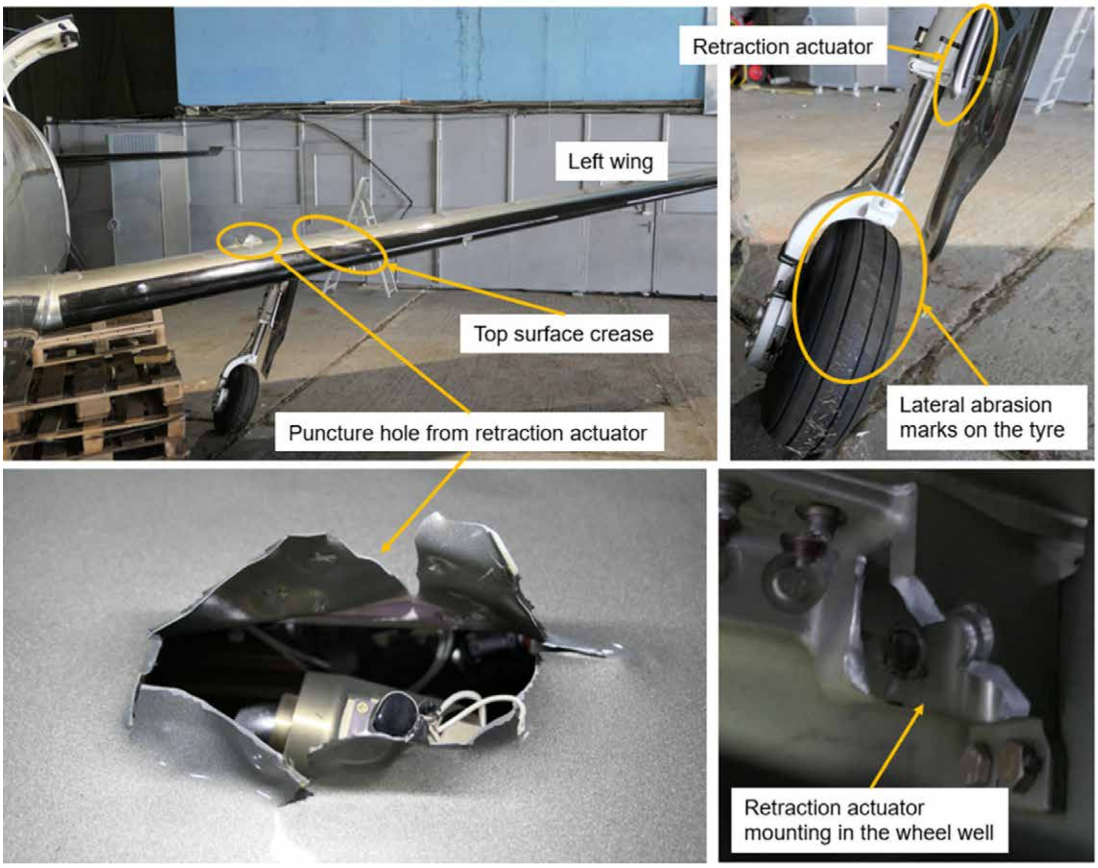


Figure 5

Left wing and landing gear damage

The right landing gear retraction actuator had failed in tension overload and the landing gear fairing had been damaged where it had contacted the weather radar pod (Figure 6 left). There were deep abrasion marks on the left side of the nosewheel rim with corresponding damage to the tyre (Figure 6 right).

Figure 6

Right landing gear damage (left), nose landing gear damage (right)

The fuselage to the aft of the cabin door was deformed with evidence of skin buckling. There was no evidence of the propeller striking the ground. The braking system showed no evidence of any defects that would have prevented normal operation.

Weight and balance[1]

The pilot stated that his pre-flight calculations showed the Take Off Weight (TOW) would be at the maximum permissible. However, after the event he recalculated the TOW as 1,996 kg (4,400 lb) and concluded they were overweight by 27 kg (60 lb).

He estimated the combined crew and passenger weight was 370 kg (815 lb) and calculated there was 62 US gallons of fuel onboard, weighing 169 kg (372 lb)[2] at the point of takeoff. The AAIB requested the weight of each of the passengers and crew, which totalled 435 kg (959 lb) and the IFD recorded 91.4 US gallons onboard weighing 549 lb at takeoff. This would have resulted in a TOW of 4,716 lb, which equates to 375 lb overweight.

The pilot stated he calculated the required fuel quantity to ensure that 20 US gallons would remain at landing and this resulted in the landing weight as 1,870 kg (4,122 lb) however, the AAIB calculated the landing weight would have been at 4,286 lb or 163 lb overweight using the increased passenger and crew weight.

Footnote

1 Weight and Balance calculations in the Piper POH are performed in ft and lb. Where values were reported in m and kg conversions are supplied in (ft) and (lb).
2 A density of 6.01 lb per US gal for AVGAS 100LL.

Aircraft performance

The takeoff ground roll and 50 ft obstacle clearance performance calculations were evaluated using the data obtained during the investigation (Appendix 1 and 2). The Pilots Operating Handbook (POH) graphs were extrapolated (under advice from the aircraft manufacturer) to include the higher TOW. The conditions used were:

OAT: 23°, Airfield pressure altitude: 27 ft, TOW: 4716 lb, Wind: Calm.

The takeoff performance graphs in the POH are all based upon flaps 0°, full throttle and 2,500 rpm before brake release on a paved, level and dry runway with a lift off speed of 78 KIAS. The pilot used flaps 10° as it was included in the normal takeoff procedure in the POH and he thought this would decrease the ground roll. The aircraft manufacturer did not have any data to quantify the difference in performance between flaps 0° and flaps 10° but confirmed that it would decrease the ground roll distance.

Applying the general safety factor of 1.33, as recommended in the CAA Skyway Code, resulted in a takeoff ground roll of 1,950 ft x 1.33 = 2,593 ft. The takeoff over 50 ft obstacle clearance distance was 3,150 ft.

The aircraft manufacturer had not published any performance graphs to calculate the braking distance required following a rejected takeoff. The landing ground roll distance calculations assume throttle closed, flaps 36°, braking heavy and a full stall on touchdown on a paved, level dry runway. G-LAMI was on the edge of stall with flaps 10° when the throttle was closed and heavy braking applied. To obtain the approximate braking distance required the calculations were performed but extrapolated for the increased TOW. The calculations showed a landing ground roll of nearly 1,200 ft would have been required (Appendix 3). This is equivalent to approximately half of the runway length.

Meteorology

The pilot reported the weather he had obtained was wind 5 kt from 350°, greater than 10 km visibility and 20°C. The actual weather reported was similar but with calm winds.

The weather was obtained from nearby RAF Benson for the time of the accident and was reported as winds of 6 kt from 320°, clear conditions, temperature of 23°C and a QNH pressure setting of 1031 hPa.

Aerodrome information

Wycombe Air Park has five runways; two asphalt 06/24 and three grass 06/24 & 35 (Figure 7). Runway 06 has a TORA of 730 m (2,395 ft) with a tall stand of trees (visible in Figure 2 left) 2,800 ft from the threshold and the M40 motorway beyond. Entry to Runway 06 is via the Alpha taxiway which joins to the Runway 24 threshold thereby necessitating a backtrack along Runway 24 or taxiing along the grass Taxiway Bravo which runs parallel.

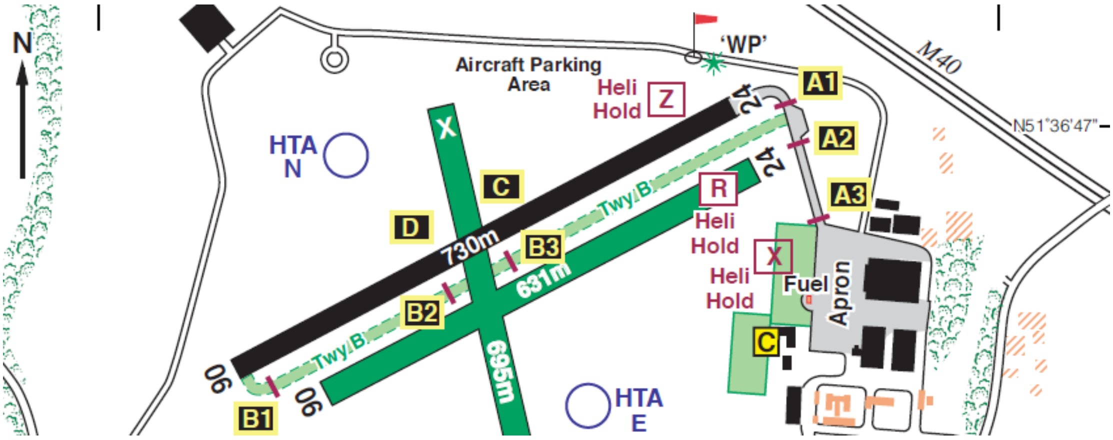


Figure 7
Wycombe Air Park runways and taxiways

Personnel

The commander had accumulated a total of 31,500 hours flying over 38 years on various aircraft types including large commercial air transport aircraft. He had 131 hours on all types of the PA-46 with 1.5 hours on the 350P. He had not flown the PA-46-350P in the last 28 days.

The PF had a total of 1,700 hours of which 900 hours were on the Piper PA-32 Saratoga. He also held a PPL(H) with 700 hours. He had not flown a PA-46-350P before nor was he familiar with the G1000 IFD.

Analysis

G-LAMI was being flown for a prospective purchaser demonstration flight, when the commander rejected the takeoff when he realised there was insufficient runway remaining to successfully takeoff. The aircraft skidded off the end of the runway and the landing gear collapsed. There were several factors identified which contributed to the takeoff being rejected.

Pre-flight preparation

The commander felt under time pressure to take off and he reflected this may have had an influence on the accuracy and effectiveness of his pre-flight preparations. He only had a limited understanding of the PF's flying experience and capabilities.

The commander had previous experience of operating small charter operations and so was familiar with estimating the weight of passengers. Whilst it was not possible to determine the commander's estimated individual weights for the passengers, the total was 65 kg less than the weight obtained during the investigation.

The commander used the IFD to check the fuel quantity onboard prior to refuelling, and noted it was 15 US gallons onboard. After refuelling and taxiing to the runway he calculated there was 62 US gallons onboard. The data subsequently recovered from the IFD memory card showed there was 37 US gallons onboard prior to refuelling and 94 US gallons at takeoff. The commander was not able to explain the difference.

The combined underestimation of the crew and passenger weight, with the increased fuel weight resulted in G-LAMI being 4,716 lb at takeoff, or 376 lb overweight. This additional weight would have had a negative impact on the takeoff performance by increasing the takeoff ground roll. The commander used the aircraft manufacturer's takeoff performance graphs to determine that he required 1,700 ft to takeoff with his calculated weight. But using the recalculated weight and applying the general safety factor of 1.33 the takeoff ground roll required was 2,593 ft. The takeoff ground roll was 200 ft longer than the TORA of 2,395 ft. The commander used flaps 10° which would have shortened the takeoff roll but the aircraft manufacturer was unable to provide any quantifiable improvement in takeoff distance. The 50 ft obstacle clearance performance was not calculated by the commander during his pre-flight planning, but it was noticed during the runway inspection that there were many trees at the end of the runway and the M40 motorway beyond them. It was not possible to determine their height, but the distance calculation showed G-LAMI needed 3,150 ft to clear a 50 ft obstacle and the trees were approximately 2,800 ft from the threshold of Runway 06/24.

The takeoff

There are two ways to enter and line up for Runway 06; the grass Taxiway Bravo or back-tracking Runway 24. The commander chose to backtrack Runway 24 to demonstrate the turning capability of the aircraft and performed a 180° turn at the Runway 06 threshold. As a result of the turn the aircraft was not able to use the full TORA but the commander estimated he had used only 30-50 ft. He deemed this acceptable based upon his takeoff performance calculation. But the aircraft was over 100 ft from the end of the runway by the time the aircraft was lined up, thereby making the ground roll 300 ft longer than the TORA.

The manufacturers takeoff performance graphs are based upon several criteria including that the takeoff roll is commenced by bringing the engine to full power before releasing the brakes and then maintaining the MAP at 42 inches Hg until the aircraft is airborne. From the IFD data it was possible to determine that the engine was at about 70% power when the takeoff roll commenced with the manifold pressure exceeding the maximum of 42 inches Hg after 3 seconds. The commander promptly reduced the MAP to 36 inches Hg before increasing it to 38 inches Hg which was then held for the remainder of the takeoff. The adjustment took approximately 10 seconds.

The aircraft accelerated constantly along the runway until it reached a speed of approximately 71 KIAS when the nose pitched up to 13°. A witness recalled hearing the stall warner sound at this moment and there was a notable reduction in the acceleration. Discussions with the aircraft manufacturer revealed that the aircraft should be rotated when the lift off speed of 78 KIAS is reached when trying to keep the ground roll to a minimum.

The combination of reduced power before brake release, followed by the need to manage the MAP during the roll and finally, the early rotation, resulted in further extending the takeoff ground roll. It was not possible to quantitively determine by how much these factors would have extended the roll but as already shown the TORA was insufficient before taking these into account.

The takeoff rejection

As the aircraft rotated, the commander judged that the takeoff would not be successful and he took control of the aircraft from the PF, closed the throttle and applied the maximum braking effort he could. There is no data available from the aircraft manufacturer to calculate the amount of runway required following a rejected takeoff at or near the lift off speed. Using the aircraft configuration and the landing ground roll performance calculations it was possible to approximate that nearly half of the runway would be needed to bring the aircraft to a stop. The aircraft was approximately 120 ft from the end of the runway when it started to decelerate. When the aircraft reached the end of the runway the main wheels went over the painted Runway 24 numbers and the tyres started to skid. The distance between the skid marks on the numbers was about the same as the width of the main landing gear indicating that the aircraft was travelling straight forward at this time. Furthermore, the IFD heading was still aligned to the runway orientation as it passed the end of the runway. The skid continued over the asphalt taxiway surface with more retardation coming from the right wheel and so the aircraft veered to the right which was reflected in the IFD data with a change in heading to 165°. When the aircraft reached the edge of the taxiway the aircraft was approximately sideways to the runway orientation and the distance between the skid marks made by the main and nose landing gear further support this.

As the left main landing gear reached the curb the lateral forces exerted on it caused the retraction actuator to buckle, snap and puncture the wing top skin. The landing gear collapsed causing the left wing to be damaged as it travelled across the grass. The nose landing gear remained intact which resulted in the rear fuselage contacting the ground behind the cabin door. The right landing gear retraction actuator was overloaded in tension as it crossed the curb and when it failed, the landing gear over extended and was damaged by contact with the weather radar pod.

Summary

Given the pre-flight time pressures it is possible that the commander misread the fuel quantity onboard and underestimated the weight of crew and passengers which rendered his takeoff calculations inaccurate.

Added to this, the takeoff was further compromised by the start position on the runway, not achieving maximum power before brake release or during the takeoff roll and the early rotation. The MAP CAS warning was a result of the PF not fully understanding the operation of the throttle which could have been mitigated by a more detailed pre-flight briefing. The need to correct the MAP during the early part of the ground roll also contributed to the takeoff being rejected.

The decision to reject the takeoff should be considered in conjunction with the 50 ft obstacle clearance calculations and the possible consequence had they continued with the takeoff. It is probable that the aircraft would not have cleared the trees and could have ended up on the M40 motorway.

The AAIB has worked with the CAA on a previous investigation where decision making with respect to rejecting a takeoff was considered. The report into G-REJP[3] considered that pilots should have a structured self-briefing before takeoff to assist clear decision making and prompt action in the event the takeoff does not proceed normally. In addition, the CAA intends to produce an article in its *'Clued Up'* magazine about takeoff decision making and RTO considerations in general aviation; to include, for example, encouraging pilots to specify, before each takeoff, a runway decision point, and to consider the actions required to stop the aircraft.

Conclusion

The commander made the decision to reject the takeoff when he realised there was insufficient runway remaining to takeoff. Due to the change in braking surface when the aircraft ran over the painted runway numbers, it started to skid and veered to the right. This resulted in the aircraft skidding off the taxiway and coming to rest in the grass with the aircraft pointing approximately 100° to the runway heading. The landing gear collapsed, and the fuselage was damaged.

Several factors were identified which contributed to the takeoff being rejected. The aircraft was 376 lb above the MTOW due to misidentification of the fuel onboard prior to refuelling and an underestimation of the total weight of passengers. Both of these factors may have been a consequence of the commander feeling under time pressure during the pre-flight preparations. The takeoff was started over 100 ft into the runway after the backtrack and 180° turn. The PFs lack of understanding on how to handle the MAP at the start of the takeoff resulted in a CAS warning and the subsequent reduction in MAP setting lengthened the takeoff roll. This may have been due to the lack of a pre-flight briefing of the PF and an assumption on his skill level by the commander, both of which potentially occurred due to the perceived time pressure.

The CAA is intending to publish an article in its *'Clued Up'* magazine about takeoff decision making and RTO considerations in general aviation.

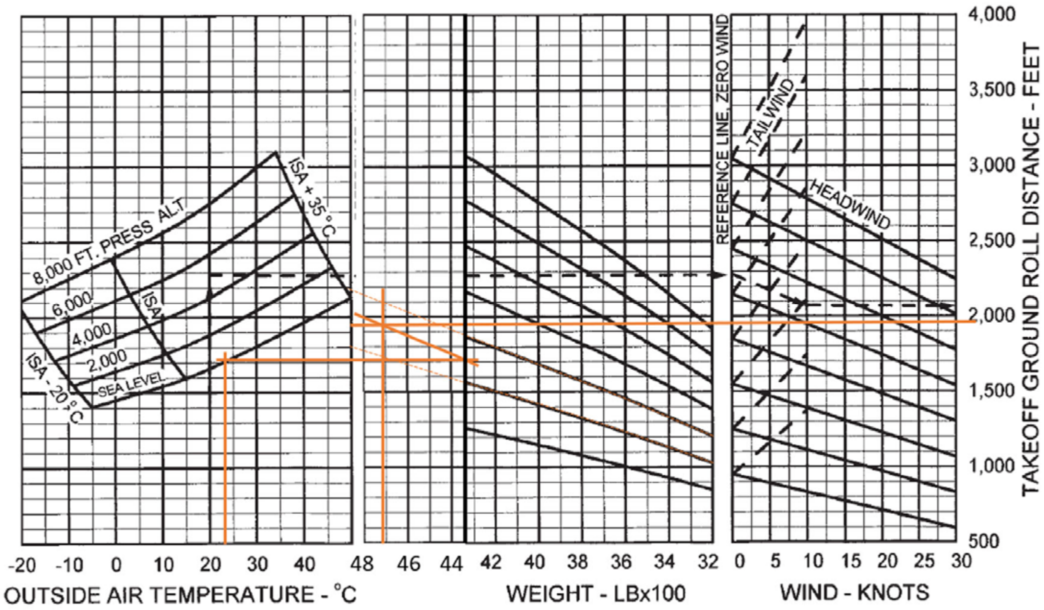
Appendices 1 to 3 - see next page.

Footnote

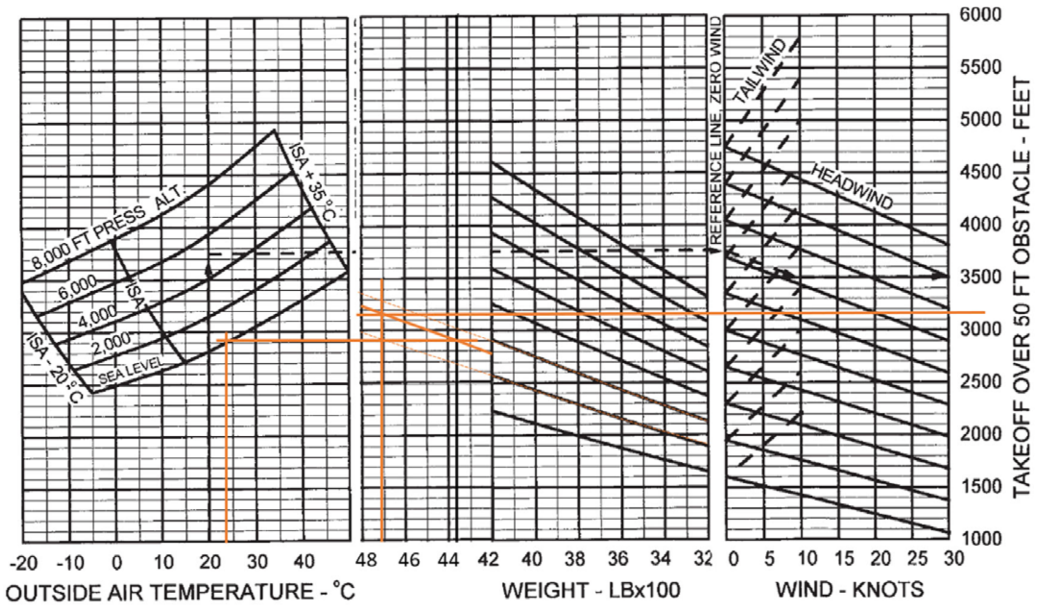
[3] Report published in the October 2022 Bulletin (https://www.gov.uk/aaib-reports/aaib-investigation-to-europa-xs-g-rejp) [accessed November 2022].

Appendices

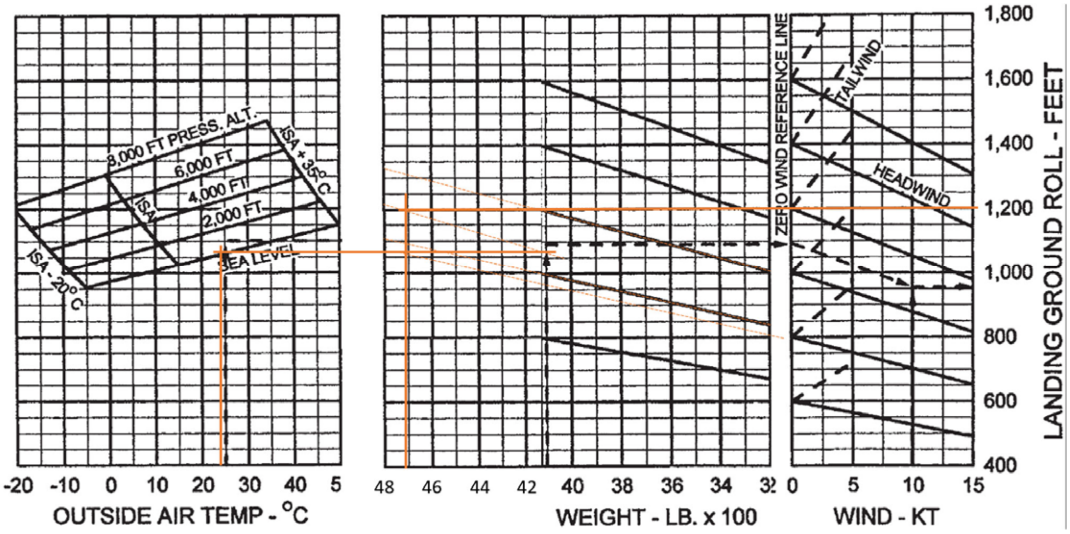
Appendix 1 - Takeoff ground roll calculation:



Appendix 2 - 50 ft obstacle clearance calculation:



Appendix 3 – Estimated braking distance calculation:



ACCIDENT

Aircraft Type and Registration:	Cameron O-90, G-BYTW
No & Type of Engines:	No Engines
Year of Manufacture:	2000 (Serial no: 4747)
Date & Time (UTC):	14 August 2022 at 0600 hrs
Location:	Snetterton Racetrack east car park, London Road, Norwich
Type of Flight:	Private
Persons on Board:	Crew - 2 Passengers - 1
Injuries:	Crew - 1 (Serious) 1 (None) Passengers - None
Nature of Damage:	Damage to a fence
Commander's Licence:	Private Pilot's Licence
Commander's Age:	65 years
Commander's Flying Experience:	242 hours (of which 242 were on type) Last 90 days - 3 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

As the balloon landed, its basket hit a wire fence. This resulted in a jolt in the basket during which the student pilot caught and twisted his foot in a restrainer mounting within the basket floor breaking his leg. The instructor and passenger were uninjured.

History of the flight

After a short flight with a student pilot and a passenger on board, at the point where there was 25% of the balloon gas supply left, the instructor selected a suitable landing site. During the descent the student noticed two obstacles at the chosen site, and so a landing site slightly further on was selected. This area was the car park of the Snetterton Racetrack complex and consisted of a grassed area with a low wire fence. The student fitted his pilot restraint and moved to the back of the basket and controlled the descent. He briefed the passenger and instructor to attain landing positions and stowed loose items. At about 10 ft agl, he noticed the balloon was gaining speed whilst descending but by this point he was committed to landing, so decided to use the fence to slow and stop the balloon. He then took up his landing position 90° to the direction of travel. The student used the rip line[1] for a count of two and moments later the basket contacted the fence. This jolted him

Footnote

1 The rip line is used to open the circular fabric vent valve to release hot air and deflate the balloon.

forward in the basket and he felt his left foot move, catch and twist, stopping against the pilot restraint anchor point on the floor of the basket. He immediately realised that he had broken his leg. The instructor and passenger were uninjured. The balloon and basket were undamaged.

Instructor's comments

The instructor stated that during the approach he observed another balloon flying low over Snetterton about five minutes in front with an estimated speed of about 4 kt. He assumed his balloon was experiencing the same conditions and was travelling at roughly the same speed but has since realised that he was probably travelling slightly faster than he had anticipated.

The course of action taken by the student seemed sensible to the instructor. However, with hindsight, he believed that the use of the rip line as they crossed the fence, rather than before, would have brought the balloon to a stop to land safely just beyond the fence. He also considered that using a wire fence to arrest the balloon was likely to cause damage to property, the balloon and basket with increased risk of injury to the occupants.

He observed that the student could have positioned his foot away from the anchor point fitting in the basket. As a result, in future he will advise occupants in the balloon to ensure their feet are clear of fixtures and fittings on the basket floor when bracing for landing.

ACCIDENT

Aircraft Type and Registration:	Pegasus Quik, G-EEWZ
No & Type of Engines:	1 Rotax 912ULS piston engine
Year of Manufacture:	2005 (Serial no: 8101)
Date & Time (UTC):	27 July 2022 at 0930 hrs
Location:	Stoke Airfield, Kent
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Serious) Passengers - None
Nature of Damage:	Substantial; beyond economic repair
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	58 years
Commander's Flying Experience:	546 hours (of which 382 were on type) Last 90 days - 16 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot was intending to conduct a local flight. At the takeoff time, grass Runway 06 was in use, the weather was good and the wind was north-easterly at about 10 kt.

During the takeoff roll the aircraft accelerated to about 55 mph, at which point the pilot pushed the basebar to rotate the aircraft. The aircraft lifted slightly before the left wing dropped and the aircraft rapidly veered left. The pilot was unable to control the aircraft's direction, and it struck one of several hangars that were located along the left edge of the airstrip (Figure 1).

The pilot was seriously injured and was transferred to hospital by ambulance, while the passenger was unharmed. The aircraft was severely damaged.

The pilot believed the accident was a combination of a reduction in the headwind and a possible early rotation.

Figure 1
G-EEWZ after the accident

ACCIDENT

Aircraft Type and Registration:	Thruster T600N 450, G-CBIR
No & Type of Engines:	1 Jabiru 2200A piston engine
Year of Manufacture:	2002 (Serial no: 0022-T600N-061)
Date & Time (UTC):	10 August 2022 at 1620 hrs
Location:	Causeway Airfield, County Londonderry
Type of Flight:	Private
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - 1 (Minor) 1 (None) Passengers - N/A
Nature of Damage:	Landing gear bent, pod damaged, propeller blade damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	53 years
Commander's Flying Experience:	3,510 hours (of which 120 were on type) Last 90 days - 26 hours Last 28 days - 12 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft landed heavily when the student and instructor both made a nose-down pitch input on the single control stick following a simulated engine failure.

History of the flight

When the instructor closed the throttle while simulating an engine failure at about 200 ft after takeoff, the student pulled back on the single shared control stick, causing the aircraft to pitch up. The instructor declared, "I have control", took control, and advised the student that pulling back on the stick was not the correct response. The student, whose hand remained on the control stick, followed its movements while the instructor applied power and pitched nose down.

The instructor carried out a touch-and-go and climbed the aircraft to a height he considered sufficient to demonstrate the correct procedure of lowering the nose following a loss of engine power. As he reduced the power and started moving the stick forward, the student pulled back firmly, overriding the instructor's control input and causing the aircraft to pitch up. The instructor shouted "I have" [control] and when he pushed the stick forward, the student did likewise, causing a steep nose-down attitude.

Despite the resulting high rate of descent, it was necessary to maintain a nose down attitude to gain sufficient speed for the elevator authority required to flare. The aircraft landed heavily, causing failure of the main landing gear, and the aircraft became inverted when the nose wheel dug in. Fuel leaked from the tank vent. The instructor vacated the aircraft and assisted the student, and members of the flying club attended shortly afterwards.

Figure 1

Cockpit of G-CBIR (upright after recovery) showing single control stick

Instructor's comment

The instructor commented that he should have demonstrated the second recovery at a greater height or in circumstances where he could be sure the student would not intervene. He observed that regular practice handing over control would be useful, especially after a period of student solo flying, and to ensure that when an instructor advises "I have control", the student responds with "you have control".

ACCIDENT

Aircraft Type and Registration:	Evolve Dynamics Sky Mantis
No & Type of Engines:	4 electric motors
Year of Manufacture:	2020 (Serial no: ED-SKM-2020-08-030)
Date & Time (UTC):	25 July 2022 at 1300 hrs
Location:	St Albans, Hertfordshire
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:	Aircraft destroyed
Commander's Licence:	Other
Commander's Age:	52 years
Commander's Flying Experience:	20 hours (of which 8 were on type) Last 90 days - 3 hours Last 28 days - 0 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The unmanned aircraft fell to the ground from a height of 20 m due to a loss of electrical power. This was caused by separation of electrical connections due to thermal damage of the UA and battery connectors. Damage was also found to the batteries fitted during the three previous flights.

The manufacturer has updated the Sky Mantis Operating Manual to highlight the need to check the aircraft and battery connectors during pre-flight checks.

History of the flight

The Evolve Dynamics Sky Mantis UAS was being operated in support of emergency services that were tackling a building fire in St Albans. The UA had successfully completed two flights at the site and was about 13 minutes into its third flight when, from a height of about 20 m, it suddenly fell to the ground. The aircraft was destroyed (Figure 1). The operator had a 200 m cordon in place and was operating the aircraft overhead waste land. No persons were injured.

The UAS operator had purchased the aircraft in 2020, which was supplied with five batteries. The operator's procedures required that a weekly check flight was performed, which took place on the morning of the day of the accident. The aircraft's battery was replaced prior to each flight on the day. These are referred to as 'check flight', 'flight 1', 'flight 2' and 'accident flight' batteries in this report. The pilot stated that he did not notice anything unusual during his checks of the aircraft between flights.

Figure 1
Sky Mantis after the accident

Aircraft information

The Evolve Dynamics Sky Mantis is an electrically powered, 7.5 kg quadcopter UAS designed for use by the emergency services sector. Lift and propulsion are provided by four electric motors mounted at the end of fuselage arms which drive two-bladed propellers.

Aircraft electrical power is provided by a 34Ah Lithium-ion battery (Figure 2). This is fitted into the rear of the aircraft and secured in place using a locking mechanism, which provides a visual indication when it is correctly latched. The battery charge level is displayed using four LED's that are fitted adjacent to the latches on the rear of the battery (Figure 3).

At the front of the battery is an electrical connector that mates with contacts inside the aircraft. This provides multiple paths for electrical power to be provided so that the loads can be evenly distributed. The connections on the battery are provided by pads that are held in place by thermoplastic composite material, and the corresponding mating pins inside the aircraft are spring loaded.

The aircraft may be stored with a battery fitted or removed. When removed, the battery compartment is open.

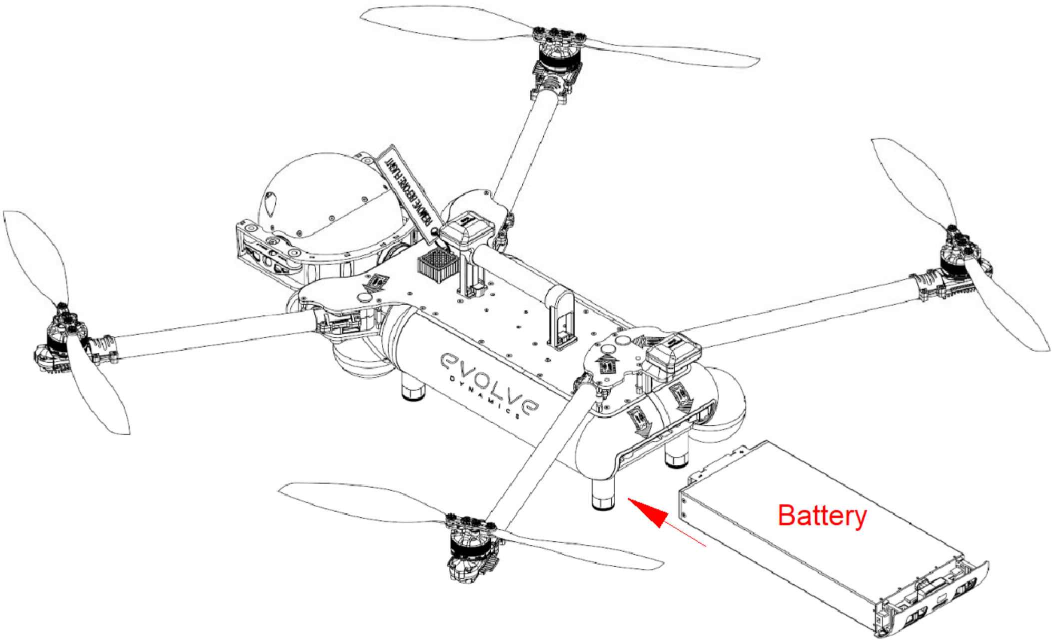


Figure 2
Sky Mantis battery insertion

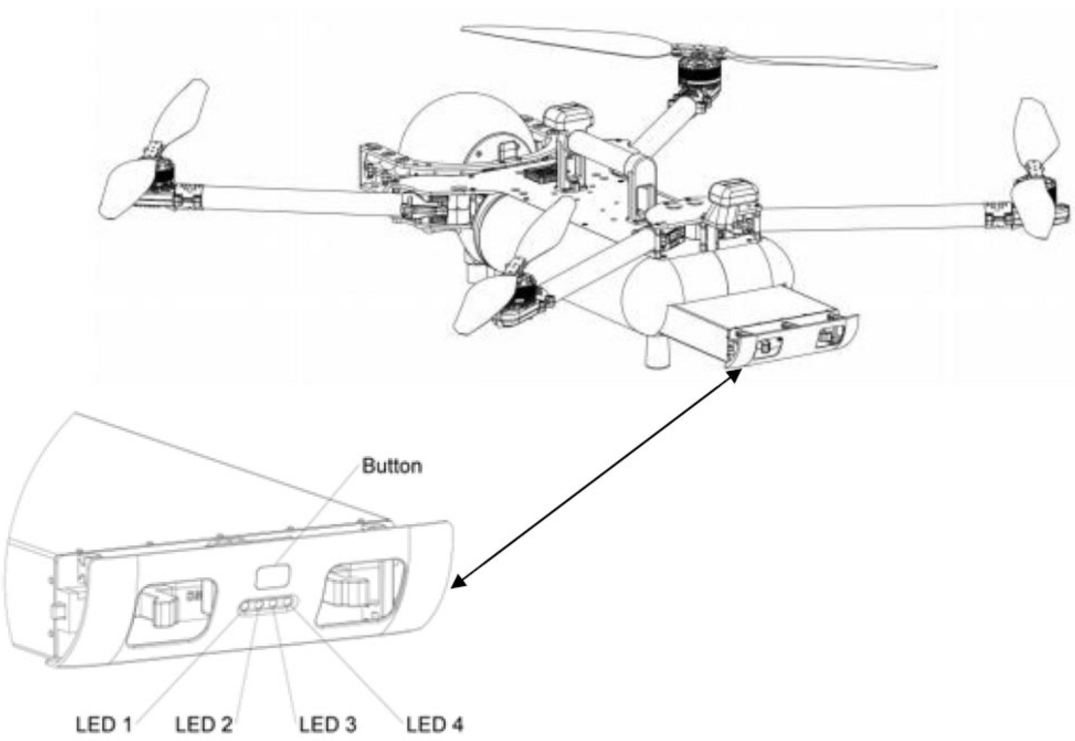


Figure 3
Sky Mantis battery charge indicator

Aircraft examination

The aircraft and its five batteries were examined by the manufacturer. This showed that the aircraft's battery connector had been extensively damaged by heat, which had caused 12 of its pins to collapse within the connector. The corresponding electrical connector pads on the flight 2 and accident flight batteries also showed varying levels of thermal damage (Figure 4). The flight 2 battery connector pads had receded slightly into the battery, and there were adjacent scorch marks. The accident flight battery was much more significantly damaged, with the pads having collapsed within the battery.

The contacts on the check flight and the unused fifth battery appeared undamaged, but the flight 1 battery showed evidence of scorching near one of its contacts.

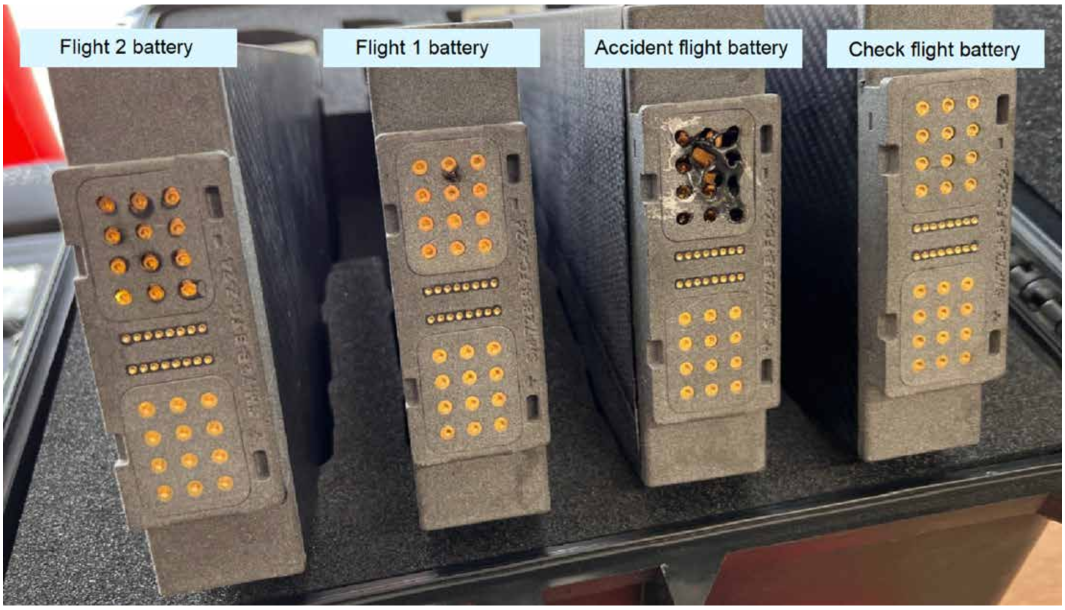


Figure 4

Damage to battery connectors

The manufacturer stated that that the damage to the connectors was a result of the number of pins in contact within the connector having been progressively reduced, which led to the electrical current through the remaining connections causing sufficient heat to distort the plastic of the connector. This led to the further loss of electrical load sharing between connections and additional heat, until the point where a complete loss of electrical power occurred. The recorded flight logs were also consistent with this, showing that at 13 minutes 27 seconds into the accident flight, there was a complete loss of electrical power. In the final minute of the flight preceding the loss of power, there were also several rapid fluctuations in the battery supply voltage and current flow to the aircraft. These were considered to be related to the connector starting to fail. A check of the battery charge indicator after the accident showed that it was at 75% charge remaining.

Due to the extent of the damage to the aircraft connector, it could not be established why its pin contacts had not been mating correctly with the battery connections. The manufacturer's experience of the aircraft and battery connectors was that they had been reliable in-service, with only one other similar failure of the connector. However, this other occurrence had been due to a battery that had overheated whilst the aircraft was being operating at very high temperatures in a desert environment, and for a prolonged period at high loads. Possible wearing of the contacts was also considered but the manufacturer stated that they had a number of aircraft in service with much higher operating hours with no evidence of connector related issues. As part of its iterative development process, the manufacturer has now enhanced the design of the aircraft connector and the batteries to improve the electrical contacts, and so reduce the potential for heat damage.

Battery latching

In 2019 the AAIB investigated an accident[1] involving an Evolve Dynamics Sky Mantis UAS that had dropped to the ground from a height of 50 m when its electric motors stopped, despite the battery being fully charged. It was concluded that this was caused by the battery not being fully locked in place. The manufacturer subsequently changed the battery latch mechanism to provide visual confirmation that the battery was locked in place. This change had been applied to the batteries used by the operator of the accident aircraft.

Operational information

The manufacturer provides Operational Information to pilots/operators using an online system. At the time of the accident, this information included the requirement that pilots/operators were to '*Ensure before each flight that all parts are in good condition. DO NOT fly with damaged or worn parts*'. The manufacturer advised that this was intended to cover checks of the battery and aircraft connectors. Following the accident, the manufacturer amended the pre-flight checklist, by adding the following item: '*Aircraft and battery contacts clean and undamaged*'. The operator of the UAS has incorporated this into information and training it provides to its pilots.

Analysis

The aircraft lost electrical power in flight and fell to the ground because of separation of electrical contacts between the aircraft and battery connections. The separation was a result of a loss of structural integrity due to thermal damage to the connectors.

The small scorch mark on the flight 1 battery indicates that the battery connector on the aircraft had been damaged at some point prior to, or during, flight 1. It was not determined as to how this occurred, but it is possible that foreign object debris could have entered the open battery compartment prior to fitting the battery, or that the battery was not fully locked into place during this flight. Either possibility could have resulted in an increase in inter-contact resistances, causing temperature increases of the connector material that allowed pins to recede or be damaged. This damage eventually culminated in an electrical thermal run-away during the accident flight until pin separation occurred.

Footnote

1 AAIB Bulletin 7/2019 https://www.gov.uk/aaib-reports/aaib-investigation-to-evolve-dynamics-sky-mantis-uas-registration-n-a [accessed November 2022].

The scorch mark on the flight 1 battery, and more extensive thermal damage evident on the flight 2 battery went unnoticed by the pilot during his checks between each flight.

Safety action taken

The manufacturer has updated the Sky Mantis Operations Manual to include an instruction during pre-flight to check that the aircraft and battery connections are clean and undamaged.

ACCIDENT

Aircraft Type and Registration:	Freefly Systems Inc. Alta X
No & Type of Engines:	4 electric motors
Year of Manufacture:	2021 (Serial no: Q848350)
Date & Time (UTC):	29 June 2022 at 1124 hrs
Location:	Henley-on-Thames, Oxfordshire
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:	Aircraft not recovered
Commander's Licence:	Other
Commander's Age:	53 years
Commander's Flying Experience:	831 hours (of which 18 were on type) Last 90 days - 73 hours Last 28 days - 28 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further AAIB enquiries

Synopsis

The UAS, an Alta X, was being operated commercially to provide video footage at the Henley Royal Regatta when a low voltage battery warning occurred in flight at a height of 50 m. As the aircraft was being flown back to the landing site, the aircraft battery voltage reduced to the point where controlled flight was lost. It fell, in near free fall, and impacted a boat on the river, causing damage. No persons were injured. The pilot could not recall checking the aircraft's battery voltage prior to takeoff, and the low voltage battery warning had been changed to trigger at a lower level than that recommended by the manufacturer.

History of the flight

The Alta X unmanned aircraft (UA) was being operated commercially to provide video footage of boat racing at the Henley Royal Regatta[1], Henley-on-Thames, which took place between 28 June 2022 and 3 July 2022. The aircraft was being operated from a pontoon on the River Thames, from where it was to be flown whilst filming the boats from approximately 150 m down-river from the pontoon's position to 250 m up-river (towards to race finish line).

The river was segregated by booms, which provided an area on the east side of the river for competition and support boats to operate, and on the west side, privately operated and commercial boats. The area on the east side of the river was considered by the pilot to be

Footnote

1 https://www.hrr.co.uk/ [accessed September 2022].

a controlled area, within which he would operate the aircraft. He did not intend to operate the aircraft over the uncontrolled area.

The pilot was accompanied on the pontoon by a camera operator and an observer. They had filmed before at the regatta, in 2019 and 2021, with the Alta X being used in 2021. The pilot advised that the number of races scheduled during the first few days of the regatta had increased from previous years, with about 80 races per day starting at about 0830 hrs and finishing about 1830 hrs (UTC). The races were scheduled in blocks of five with each race starting five minutes apart, and a ten-minute gap between each block. It was the intention of the pilot to be able to film at least every second race, which meant that the aircraft would be flown about every ten minutes, with the aircraft landed back onto the pontoon between each flight.

The pilot had intended to replace the aircraft's two batteries after every third flight with a fully charged set. This was based on his experience that the dynamic nature of the flying could more quickly deplete the aircraft's batteries. The battery voltage level was displayed to the pilot on his flight controller. When fully charged, the batteries were at 50.4 V and the pilot had configured the aircraft and hand-held controller to provide a warning when the voltage reached 42 V.

The first day's flying on the 28 June 2022 passed without incident and the pilot, camera operator and observer arrived on the pontoon to prepare to film the second day of racing scheduled to start at 0830 hrs. The weather was dry, 19°C with good visibility and a wind from the south-east of about 10 kt.

At 1120 hrs, the aircraft took off on its 21st flight of the day, which was to film race 35. The flight initially proceeded as normal, with the pilot flying the aircraft overhead two competing boats (Figure 1) at a height of about 50 m (164 ft agl). Operating on the uncontrolled side of the river were several privately operated boats. This included The Celtic Queen (Figure 2), which was travelling down-river. Onboard this boat were six people, of which two were seated near the bow of the boat.

When the aircraft was about 250 m up-river from the pontoon, the aircraft's low voltage battery warning activated. The pilot responded by flying the aircraft back towards the pontoon to expedite its landing. However, when the aircraft was almost overhead the pontoon at a height of about 50 m, it stopped responding to the pilot's commands and started to rotate whilst also descending rapidly. The aircraft struck The Celtic Queen, which was now almost abeam the pontoon, before falling into the river. No persons were injured. One of the aircraft's batteries came to rest between the two passengers seated near the bow, which was about 2 m away from where the aircraft had struck the boat. The aircraft was not recovered from the river.

The pilot stated after the accident that he did not recall checking the aircraft's battery voltage prior to taking off, and that his records indicated that it was making its sixth consecutive flight since the batteries had last been changed.

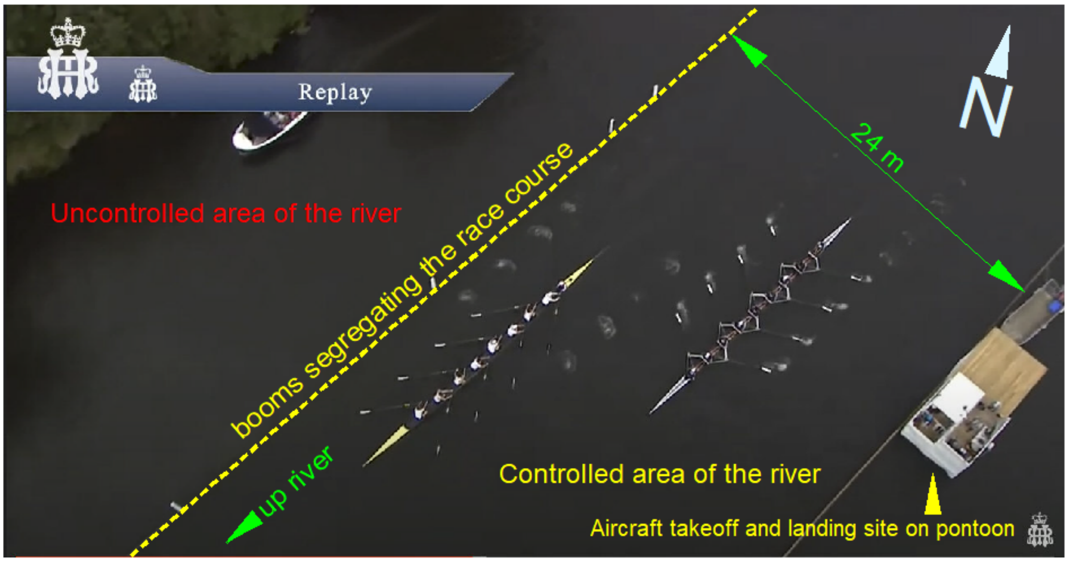


Figure 1

Image taken from the aircraft's camera showing the takeoff and landing pontoon and the adjacent controlled/uncontrolled sides of the river

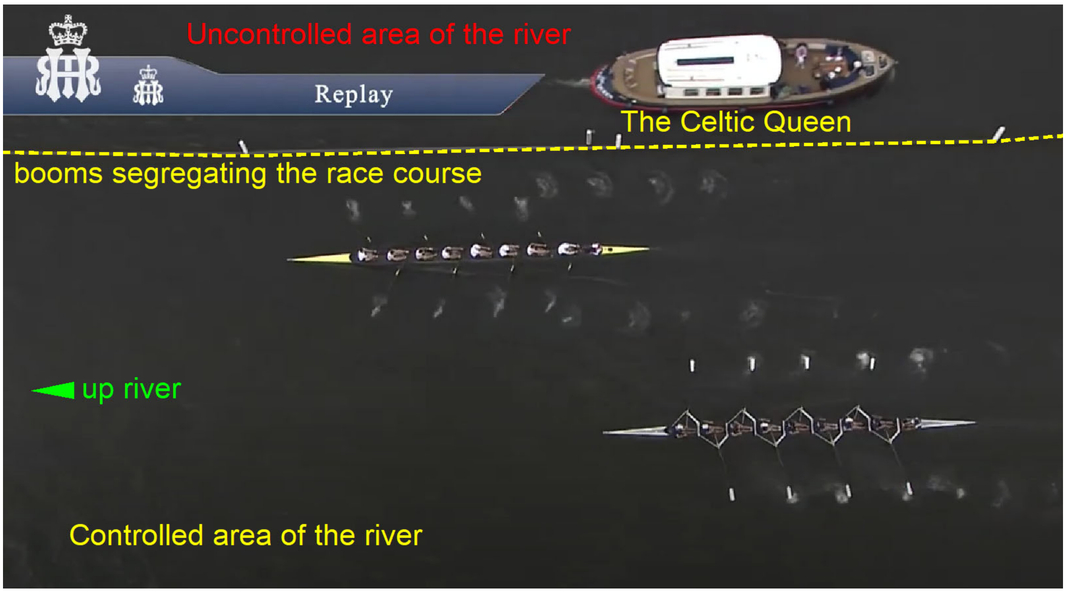


Figure 2

Image from the aircraft, with The Celtic Queen travelling down-river.

Figure 3

Image from the aircraft taken shortly before its loss of control

Damage to The Celtic Queen

The Celtic Queen is a boat of approximately 20 m in length and 3 m wide (Figure 4), with a cabin of metal construction. At the bow and stern are seating areas for passengers.

The aircraft had initially collided with the forward left side cabin roof causing deformation in a section of the stainless-steel handrail and damage to the surface of the roof (Figure 5). The aircraft then struck the left side of the cabin and adjacent gunwale, prior to it falling into the river and sinking. Composite material from the aircraft had been embedded into the wooden surface on the gunwale (Figure 6) and one of its batteries had detached from the aircraft and come to rest on the forward deck (Figure 7).

Figure 4

The Celtic Queen (Photograph used with permission)

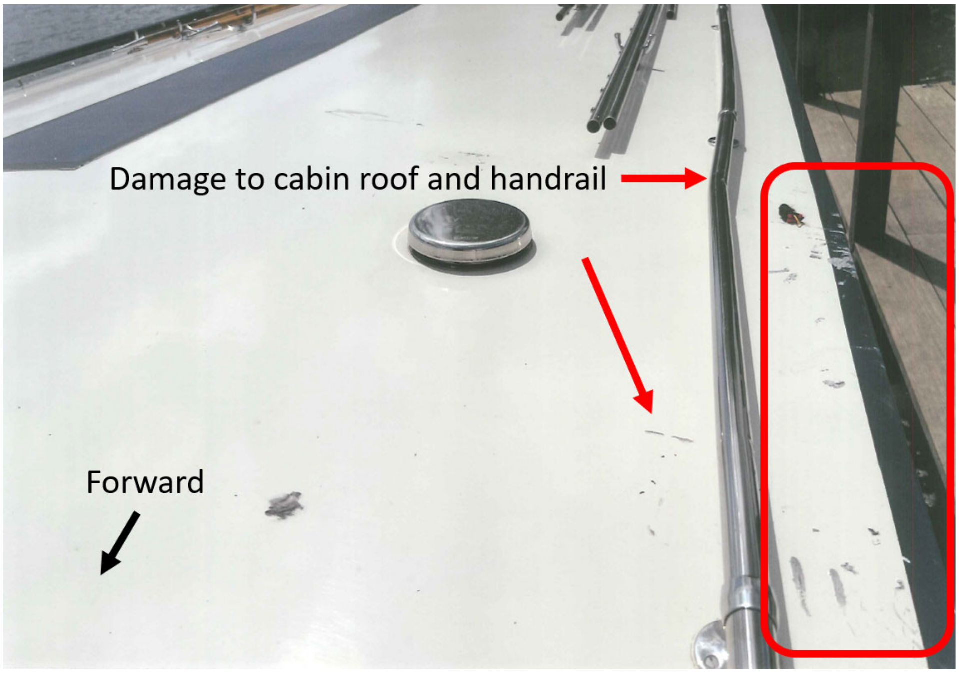


Figure 5
Damage to cabin roof and left side handrail

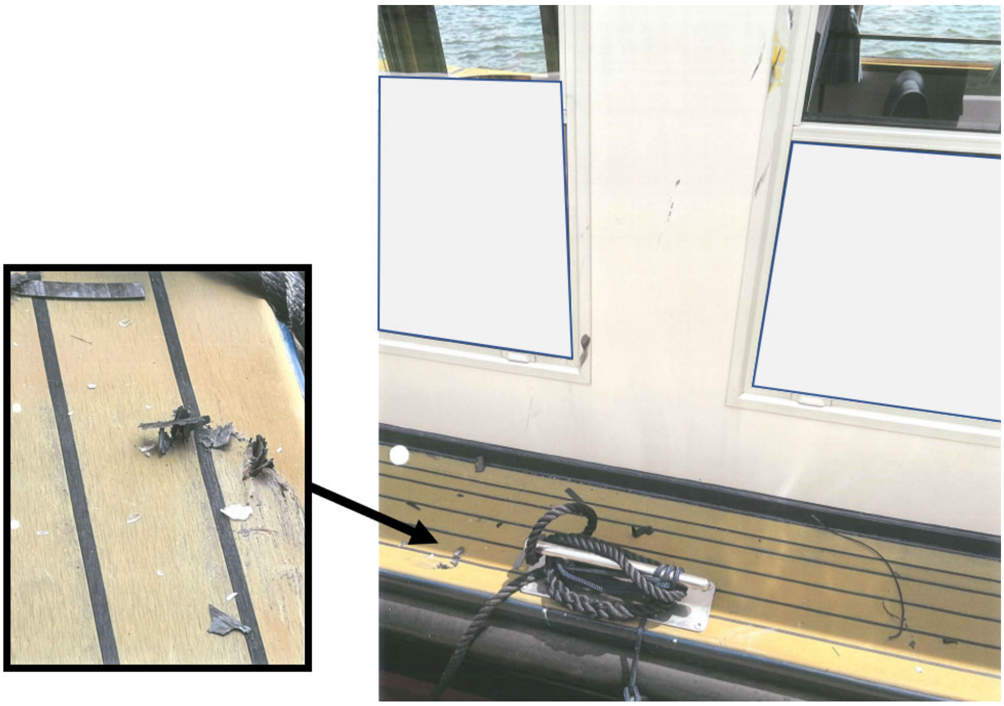


Figure 6
Damage to the cabin and gunwale

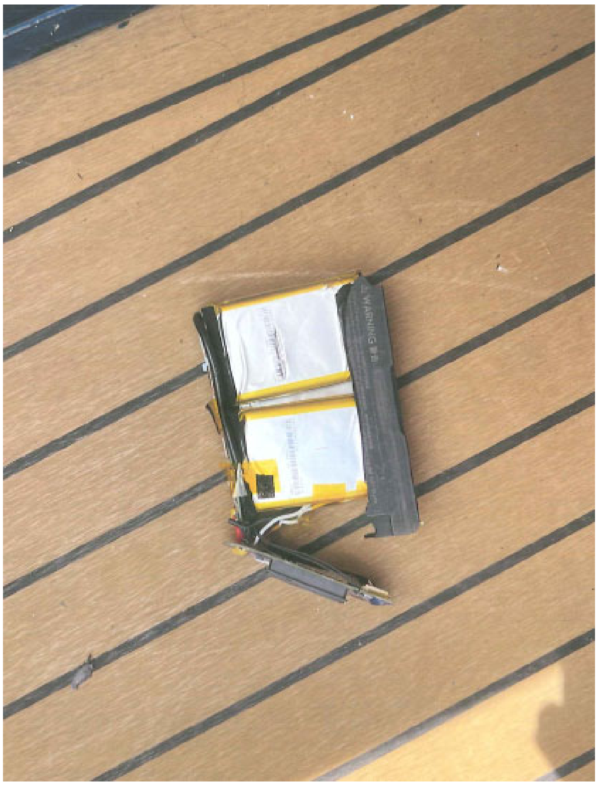


Figure 7
Aircraft battery on forward deck

Recorded information

Video footage transmitted from the aircraft to the ground during the accident flight was available. This commenced when the aircraft was overhead the pontoon, as it was flying up-river, and ended three seconds after it had started to descend out of control.

If the last images from the footage coincided with the aircraft colliding with the boat, this would be consistent with the aircraft having descended from a height of 50 m in near free fall. This would have equated to a speed at impact of about 30 m/s (~60 kt) and a kinetic energy of about 13,700 Joules.

Flight logs stored in the aircraft were not available as the aircraft has not been recovered.

Aircraft information

The Alta X (Figure 8) is an unmanned, electrically powered quadcopter with a maximum takeoff weight of 34.9 kg[2]. This type of aircraft relies upon its propulsion system for lift. The aircraft's rotors are 84 cm in length and, when the motor arms are extended for flight, the aircraft measures 2.28 m from rotor tip to rotor tip. During the accident flight the aircraft's takeoff weight was 28 kg, which included an underslung camera mounted on a gimbal.

Footnote

[2] Based on operating at a pressure altitude of between sea-level and 1,000 ft, and at temperatures of between 0°C and 20°C.

Figure 8

Alta X (not the accident aircraft)

Operational information for the aircraft is provided online[3] by its manufacturer. This showed that at a takeoff weight of 28 kg the flight time available would be about 25 minutes. This was based on the aircraft taking off with its two 12S lithium polymer batteries fully charged to 50.4 V, and subsequently landed when the voltage had reduced to 44 V. The manufacturer had configured the aircraft to provide a warning when the voltage was at, or less than, 44 V. The warning caused lights at the end of the aircraft's motor arms to flash on-and-off and a battery symbol to be displayed on the manufacturer's Ground Control Application (GCA)[4].

The manufacturer's operational procedure *'Before Starting',* stated that the battery voltage was to be *'ABOVE 48V'*. The manufacturer advised that this was the minimum voltage that it recommended prior to flight. Its online information also stated that if the low battery voltage warning occurred, to *'LAND as soon as possible'* and included the following:

> ⚠ Recommended landing voltage is 44V.

The manufacturer stated that the landing voltage of 44 V was based on an aircraft operating at close to its maximum weight, but at lower operating weights with a reduced load on the batteries, the 44 V provided a conservative limit. Performance data on operating the aircraft at battery voltages of less than 44 V was not published. However, the manufacturer advised that it was aware that some operators flying the aircraft at 10.4 kg (no payload),

Footnote

3 https://freefly.gitbook.io/freefly-public/products/alta-x [accessed August 2022].

4 Software that could be operated on a PC and through which the pilot could also control the aircraft.

were continuing to fly the aircraft for approximately 15 minutes after the battery voltage had reduced to 44 V.

Various aircraft settings could be adjusted by their owners, which included the trigger level for the low voltage battery warning. The accident pilot had changed this from 44 V to 42 V, which he stated was based on his experience of operating the aircraft.

Accident aircraft control and display systems

The Alta X can be operated using remote control modules from different manufacturers. The accident aircraft was being operated using a JETI DS24 handheld remote-control module. This displayed the aircraft's battery voltage level on an integral LCD and was set by the pilot to provide an aural alert when the battery voltage reached 42 V. The pilot was not using the manufacturer's GCA software. Total flight time between each battery change was not displayed, but an individual flight timer was available. This was automatically reset after landing.

The underslung camera was controlled by the camera operator using a separate controller. This did not display aircraft status information, such as its battery voltage.

The aircraft was being operated in manual mode at the time of the accident, which provided attitude stabilization, but the aircraft would drift with the wind unless manual corrections were made.

Regulations for UA operations

UK guidance for Unmanned Aircraft System operations

Detailed guidance for operating Unmanned Aircraft Systems (UASs) in UK airspace is contained within the CAP 722 document series which references the basic regulations and is published by the CAA. CAP 722 is the lead document and CAPs 722A-E cover wider topics such as risk assessment methodology, training policy and a glossary of terms relating to UAS operations.

CAP 722D definitions relevant to this accident were:

- UAS operator: '*any legal or natural person operating or intending to operate one or more UAS*.' The UAS operator is responsible for the overall operation of the UAS, and most specifically the safety of that operation. This includes the conduct of any safety risk analysis of the intended operations.
    - Provided they hold the correct CAA-issued IDs, an individual can act as both remote pilot and operator for the UA they are flying.
- Uninvolved persons: '*persons who are not participating in the UAS operation or who are not aware of the instructions and safety precautions given by the UAS operator'.*

UAS operational categories

UAS operations in the UK are regulated according to the perceived level of risk that the intended operation presents. Operations are deemed to fall within one of the following three broad categories:

- Open: operations presenting a low risk to third parties.
- Specific: operations requiring a CAA-issued operational authorisation because they present a greater risk than those in the Open category.
- Certified: operations that present an equivalent risk to that of manned aviation.

The accident aircraft was being operated in the Specific category at the time of the accident.

Specific category

The operational authorisation document sets out the privileges and limits of the operation. Each operational authorisation is specific to the named UAS operator and is dependent on the risk assessment and evidence supplied to the CAA by that operator.

The operational authorisation issued to the pilot of the accident aircraft specified that he could overfly uninvolved persons with the aircraft, as long as it was no closer than 50 m to them (ie a 'bubble'), except that during takeoff and landing this distance could be reduced to 30 m.

Risk assessment

The operator of the aircraft had produced a risk assessment and method statement for fights scheduled to take place at the regatta. This covered the use of three UAS, which included the Alta X, an Alta 8 and a DJI Inspire 2. The following statement regarding monitoring of the aircraft batteries was included within the *'Safety - Technical'* section: '*Battery levels are constantly monitored by both pilot and ground crew, in the event of a sudden loss of power the UAS will descend in a controlled manner*'.

The documentation also included a 5 x 5 risk matrix and the following risks and mitigations concerning loss of aircraft battery power, and risk of injury to person or damage to property:

			Severity of injury / fatality				
0-6=Low risk 6-10=Moderate risk 11-15=High risk 16-25=Unacceptable risk			Negligible	Minor	Major	Hazardous	Catastrophic
		Score	1	2	3	4	5
Likelihood of Safety Risk Occurring	Frequent	5	5	10	15	20	25
	Occasional	4	4	8	12	16	20
	Remote	3	3	6	9	12	15
	Improbable	2	2	4	6	8	10
	Extremely Improbable	1	1	2	3	4	5

Risk	Probability of hazard	Severity of injury / fatality	Risk Score	Mitigations	Residual probability	Residual Severity	Residual risk score	ALARP (Y/N)	Remarks
Loss of power due to flight batteries running low resulting in an unplanned descent onto property or people.	4	5	20	• Flight batteries checked for state of charge immediately prior to taking off • Aircraft is fitted with a sensor that measures the capacity used with audible warnings on the pilot's TX when pre-defined levels are reached. • Flight times are monitored with a warning to the pilot when pre-defined times are reached. • Flight pack voltage is monitored with audible warnings set at pre-defined levels. • Motor cut-offs set to 'soft' meaning that power is gradually reduced as batteries reach critical levels. This results in a more controlled descent.	1	3	3	Y	
Aircraft failure. Damage is caused to property, people are injured or killed.	4	4	16	• Specific, preventative maintenance schedules. • Single points of failure minimised. • Pre-flight checks. • Site survey to identify alternative landing areas/ areas to avoid. • Flight planning. • Cordoned off main take-off / landing area. Where possible • Spotter employed to forewarn of encroachments into flying area. • Minimum distances applied to maintain from people and property • Maximum speed reduced as distances close	1	4	4	Y	

The assessment also included the following (redacted) text concerning operational pressures.

Pressure on pilot by client leading to flying errors resulting in injury or death or damage to property	4	5	20	• [redacted] Pilots are experienced with handling clients and resulting production pressure. • [redacted] Pilots are experienced at operating under pressure • aims to send its most experienced pilots to jobs where pressure is expected.	3	5	15	Y	
ALTA X @34.86Kg				• Pilots will only conduct flights if they are safe • [redacted] operates a 'Just culture' • fully supports the decision by the pilot not to fly if the pilot is concerned about safety • In Live Outside Broadcast environments where it is necessary for the flights to be "directed" from the Outside Broadcast Vehicle, communications whilst the aircraft is in flight such as shot requirements will be filtered through the Aerial Camera Operator. • At all times the pilot's decision is final. • In Pre-record situations the pilot will not deviate from pre-briefed shots. • Production attention is drawn to the final 2 paragraphs of the Crew Safety Briefing - *Appendix G* [redacted] *Operating Safety Case or* [redacted] *Risk Assessment and method Statement.*					

Risk of injury to persons

A research paper[5] from the Australian Civil Aviation Safety Authority (CASA) states that the highest risk of injury to persons being struck by an UA, is an impact to the head, with energies of between 40 and 120 Joules being '*dangerous*' and more than 120 Joules as '*causing severe damage to humans*'.

Personnel

The accident pilot was an experienced UAS operator and was aware that there was a risk associated with operational pressures from the client. However, he advised that there was also a desire to "keep the client happy and not miss filming races". The pilot also considered that fatigue may have been a factor, advising that the flights were complex in their nature, often operated in variable wind conditions and from a small landing site surrounded by water. The previous working day had also been long, whilst covering an increased number of races compared to those in 2019 and 2021.

During pre-flight checks, the pilot stated that his normal practice was to verbally call out the aircraft's battery voltage. This, he explained, was intended to provide self-confirmation that he had completed the check, and so that the camera operator and observer nearby were informed. However, the pilot advised that neither the camera operator nor observer had been briefed as to what level of voltage was acceptable. The pilot stated that he would takeoff at battery voltages of less than 48 V, which he considered acceptable when performing shorter duration flights.

Analysis

The risk assessment performed by the operator had identified that a loss of battery power in flight could result in a '*catastrophic'* outcome and was classified as an '*unacceptable risk'*. However, the operator's classification reduced this to *'Low Risk'* when mitigations were applied. These mitigations included checking the battery voltage level prior to takeoff. However, the pilot, could not recall performing this check. The aircraft was operating its sixth flight since the batteries had been changed, which was twice that intended by the pilot. He suggested that he may have been fatigued and perhaps the desire to film as many races as possible provided further pressure which may have also distracted him. This may provide possible explanations as to why the aircraft's batteries were not changed prior to the accident flight as intended by the pilot.

The pilot stated that he would takeoff when the battery voltage was less than 48 V, which he considered was acceptable when making short flights. This differed from the manufacturer's guidance of '*above 48 V'*, although this value was based on the aircraft being operated at its maximum weight.

Although, the operator's risk assessment stated that the pilot and ground crew would monitor battery voltage, neither the camera operator nor observer had been briefed prior to takeoff

Footnote

5 https://www.casa.gov.au/human-injury-model-small-unmanned-aircraft-impacts [accessed September 2022].

as to what voltage was acceptable. Therefore, neither would have been able to assist the pilot in identifying that the battery voltage was getting low.

The manufacturer's default trigger threshold for the low voltage battery warning was 44 V, and this was also the level at which it recommended that the aircraft should be landed as soon as possible. This warning threshold had been changed by the operator to trigger at 42 V. Shortly after the low voltage warning had occurred in flight, the battery reached a critical voltage level at which point controlled flight was lost and the aircraft then descended in near free fall.

The aircraft's kinetic energy when it collided with the boat was estimated to have been about 13,700 Joules. The CASA research paper indicates that fatal injuries would have occurred if the 28 kg aircraft falling at 30 m/s had struck a person on the boat.

Conclusion

Whilst returning to land following a trigger of the low battery voltage warning, the aircraft's battery voltage depleted to the extent that controlled flight was no longer possible. The aircraft descended, in near free fall, and impacted an occupied private boat on the river. If the aircraft had struck a person on the boat, it is likely that fatal injuries would have occurred.

The pilot did not replace the aircraft batteries when he had intended to, and a pre-flight check of their voltage before the accident flight was most likely not performed. In addition, the low voltage battery warning had been set to a level below that recommended by the manufacturer.

Had the battery warning been set to the manufacturer's recommended setting, the aircraft may have been landed safely under the pilot's control.

Bulletin Correction

Prior to publication it was noted that the aircraft manufacturer was incorrectly stated to be 'Free Fly', whereas the correct description is 'Freefly Systems Inc.'.

The online version of the report was corrected before the report was published on 12 January 2023.

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 UAS investigations reviewed: October - November 2022

26 Aug 2022 **Parrot Anafi** Swanwick, Hampshire

During a survey flight of a motorway bridge, one of the two rotors on the rear left arm of the UA separated in flight. The remote pilot managed to land the aircraft safely which suffered only minor damage.

12 Sep 2022 **DJI Mavic 2 Enterprise Dual** Horden, County Durham

The UA was being flown in a residential street in support of a live operation. It was being flown by a remote pilot who was supported by an observer; however, the observer became distracted due to operational events. At this time, the pilot lost visual line of sight with the UA and it collided with a house in the street.

14 Sep 2022 **DJI M300 RTK** Biggleswade, Bedfordshire

Just after a manually controlled takeoff, and without prior warning, the remote pilot heard a 'branch snap' sound and control of the UA was lost. It fell to the ground from a height of about 4 m and suffered significant damage. The pilot was unsure of the cause and had completed four uneventful flights earlier that day.

15 Sep 2022 **DJI Phantom 4** Whitwick, Leicestershire

Whilst videoing a blast in a quarry, the UA, with 80% battery capacity remaining, dropped into a lake. The remote pilot reported that he had seen no warning lights or messages.

27 Sep 2022 **DJI Mavic Pro Mark 1** River Mersey near Bromborough, Wirral

The UA operating over water and being used to film and take images of a boat trial. The UA was returning to the landing site when it suddenly dropped from about 10 m into the water and was not recovered.

3 Oct 2022 **Parrot Disco** Lewannick, Cornwall

The remote pilot reported flying the UA at 50 m agl when it suddenly failed to respond to his control inputs. It did not enter its failsafe mode but began diving steeply toward the ground at full power. The UA struck the ground broke apart. The pilot explained that, in failsafe mode, the UA would loiter at 50 m agl before executing an automated landing at its memorised "home point" if communication was not restored within five minutes. He thought the nature of the incident indicated a major onboard electronic control system failure but, "due to the UAS's obsolescence," no detailed technical analysis of the cause was undertaken.

Record-only UAS investigations reviewed: October - November 2022 cont

6 Oct 2022 **Parrot Anafi** Stechford, Birmingham
Whilst in hover, the remote pilot's screen went blank. The UA entered an uncontrollable spin and dropped into a garden.

13 Oct 2022 **MA HobbyZone AeroScout S** Fareham, Hampshire
The model aircraft flew beyond line of sight into a field. Several days later it was found badly damaged.

14 Oct 2022 **DJI Matrice 300 RTK** Lutterworth, Leicestershire
The remote pilot was conducting a low-level survey. Once the survey was complete, the remote pilot positioned himself close to the landing point. As the UA approached, the pilot looked at the controller and camera view from the UA, and unconsciously moved into the path of the aircraft. The UA struck him before falling to the ground, causing minor damage to the UA. The pilot, who was wearing body armour, was uninjured.

21 Oct 2022 **DJI Phantom 4** Coventry, West Midlands
Whilst in transit to a survey start point, the UA dropped to the ground from 100 m and was destroyed.

27 Oct 2022 **DJI M300 RTK** Carlisle, East Sussex
During night flying training, the UA suddenly dropped to the ground and suffered substantial damage. Afterwards it was found that the two rear motor arms had not been extended correctly.

28 Oct 2022 **DJI Mavic 2 Enterprise Advanced** Near Wantage, Oxfordshire
During flight the UA began to run out of battery power. The UA automatically landed itself onto a tree canopy.

25 Nov 2022 **DJI M30** Maidenhead, Berkshire
During landing at night, the UA struck some branches of a tree and fell to the ground.

26 Nov 2022 **MA SebArt Wind S50** Earley, Berkshire
The signal to the model aircraft was lost during aerobatic manoeuvres. The model aircraft flew behind some trees and was not recovered

Miscellaneous

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

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

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

1/2015 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

AAIB

Air Accidents Investigation Branch