Air Accidents Investigation Branch

AAIB Bulletin 1/2024

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CONTENTS

SPECIAL BULLETINS / INTERIM REPORTS

SUMMARIES OF AIRCRAFT ACCIDENT ('FORMAL') REPORTS

AAIB FIELD INVESTIGATIONS

AAIB CORRESPONDENCE INVESTIGATIONS

CONTENTS Cont

AAIB CORRESPONDENCE INVESTIGATIONS Cont

(ALL TIMES IN THIS BULLETIN ARE UTC)

AAIB Field Investigation Reports

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

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

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

ACCIDENT

Aircraft Type and Registration:	Bombardier CL-600-2B16 Challenger 604, N999PX
No & Type of Engines:	2 GE CF34 turbofan engines
Year of Manufacture:	1998 (Serial no: 5387)
Date & Time (UTC):	31 January 2022 at 0018 hrs
Location:	London Stansted Airport
Type of Flight:	Private
Persons on Board:	Crew - 2 Passengers - 2
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damaged beyond economical repair
Commander's Licence:	Airline Transport Pilots Licence
Commander's Age:	48 years
Commander's Flying Experience:	4,235 hours (of which 1,320 were on type) Last 90 days - 48 hours Last 28 days - 36 hours
Information Source:	AAIB Field Investigation

Synopsis

Control was lost during an attempted landing in a strong crosswind, following an ILS approach. The left wingtip struck the runway several times and remained in contact with the ground as the aircraft departed the paved surface into the grass area at the side of the runway. The aircraft's stick pusher also activated, resulting in a hard landing that damaged the aircraft's nose landing gear assembly. The investigation determined that the approach was flown at an airspeed slower than appropriate for the conditions, and the aircraft floated during the landing, leading to an excessive angle of attack prior to the excursion.

The aircraft manufacturer stated that it intends to enhance the guidance it provides regarding crosswind landing technique.

History of the flight

The flight on the privately operated aircraft originated in El Gouna Airport, near Hurghada, Egypt, flying to London Stansted Airport via Cairo International Airport. The crew were notified of the flight two days beforehand but were not given a departure time. The day before the flight they were told the aircraft would depart at 1000 hrs, with the crew reporting for duty at 0900 hrs.

The operator telephoned the crew at 0835 hrs on the day of departure to advise that they required the flight to depart at 1130 hrs. The crew thus reported for duty at 1030 hrs on

30 January 2022, and departed for Cairo at 1130 hrs with three passengers, landing at 1230 hrs. Before departure the commander noted that the crew's duty was likely to be about 14 hours due to a long flight to Stansted caused by strong headwinds.

The departure from Cairo with two passengers, planned for about 1400 hrs, was delayed until 1853 hrs. The estimated flight time was 5 hours 15 mins, giving an ETA of 0008 hrs on 31 January 2022.

The departure from Cairo and the cruise to Stansted were uneventful. As the crew prepared for the approach, they noted from Stansted's 2350 hrs ATIS that the wind was from 290° at 13 kt. Based on estimated landing weight, they calculated a V_{REF} of 119 kt and a V_{REF} +X[1] of 125 kt[2].

The aircraft received radar vectors to establish on the ILS to Runway 22. During the approach the commander, who was PF, noted on the integrated electronic flight instrument system that wind at 1,500 ft aal was 54 kt and was primarily a crosswind. Once the aircraft had established on the glideslope it was configured for landing with FLAPS 45. Soon after, the crew contacted the Stansted Tower, which reported a surface wind from 300° at 13 kt gusting 25 kt. The co-pilot, who was PM, stated that after they received the surface wind he asked the commander if he was "OK" with the wind to which the commander replied he was comfortable with it. The co-pilot then said to the commander that if he was uncomfortable at any time they would perform a go-around (GA), which the commander acknowledged. ATC cleared the aircraft to land and passed the same surface wind, which the co-pilot acknowledged. This was about 90 seconds before the aircraft touched down.

After the commander disconnected the autopilot at approximately 150 ft aal the co-pilot made several calls of "excessive bank". The co-pilot considered the commander was "doing his best" in the gusty conditions.

The aircraft had no autothrottle. The commander recalled that he closed the thrust levers at about 50 ft aal and made a small nose-up elevator input. The aircraft did not have automated height callouts, so the co-pilot called 50 [ft], 40, 30, 20, 10 with reference to the radio altimeter display at the bottom of his attitude indicator. The aircraft began to float in the landing attitude about 10 ft above the runway. The commander recalled there was some windshear which led to the IAS suddenly reducing, and the left wing "snap rolled/dropped" followed by a temporary loss of directional control as the aircraft turned left by about 30°. The aircraft then landed on its nosewheel, followed by its left and then right landing gear, before departing the paved surface onto the grass. The commander believes the stick pusher activated at some stage.

The commander initiated a GA but he did not recall if either of the crew verbalised it. The co-pilot stated that after the bounce he called "go around" two or three times. The commander did not remember calling for FLAPS 20 according to the GA procedure, but believes the co-pilot made that selection when he realised a GA was initiated. As the commander

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1 The aircraft manufacturer stated that it uses the term V_{REF} +X. Others use V_{APP}

2 See *CL-604 operating manual* below regarding V_{REF} +X calculation.

advanced the throttles, he felt the co-pilot's hand assisting. Once the aircraft had started to accelerate through V_{REF} the commander pitched the aircraft up and the landing gear was selected UP. During the GA a NOSE DOOR OPEN warning[3] and a WOW INPUT caution[4] message illuminated. The co-pilot commented that during the GA the commander pitched the aircraft up "excessively" to about 20 to 25° and the airspeed started decreasing towards about 180 kt. As a result, he pushed on the flying controls, instructed the commander to "fly the aircraft" and to fly level at 4,000 ft amsl and 200 kt.

About 30 seconds after the GA had been executed, having seen "A LOT OF SPARKS COMING OUT OF THE AIRCRAFT AND ON THE RUNWAY", ATC asked the crew twice if everything was "OK", before they received a reply. The co-pilot responded that they were OK, advised ATC that they would be levelling off at 4,000 ft amsl, and requested vectors for another ILS approach. The aircraft was then instructed to call the ATC radar controller.

Being aware that the aircraft had bounced onto its nosewheel, and with the associated warning and caution, the crew discussed the implications of possible damage. As they had plenty of fuel, they decided to lower the landing gear and obtained down and locked indications. The NOSE DOOR OPEN warning then extinguished.

On initial contact with the ATC radar controller the co-pilot stated that once they had completed some checklists they would state their intentions, probably to land at Stansted. ATC reported surface wind from 290° at 16 kt, gusting 26 kt. The co-pilot asked the ATCO if she could find an airport nearby with "NORMAL WIND CONDITIONS", stating when asked that their crosswind limit was 15 kt. Soon afterwards the ATCO reported surface wind at London Gatwick Airport from 280° at 14 kt, gusting 18 kt, and advised the runway orientation of 260°/080°. The crew decided to divert to Gatwick, and received radar vectors to the ILS for Runway 26.

The aircraft landed at Gatwick without further incident. However, there was a grinding noise from the nosewheel as the aircraft slowed. Consequently, they elected to stop on the Rapid Exit Taxiway and, after an inspection by airport marshallers revealed damage to the nosewheel, they shut down the aircraft. After vacating the aircraft to inspect the nosewheel they discovered damage to the aircraft's left wingtip.

Pilots' comments

Commander

The commander stated that he had been working for the operator since 2019.

Due to the limited amount of flying he was required to do he observed a personal crosswind limit of 20 kt, as he was cautious about operating the Challenger 604 (CL-604) in strong crosswinds. He believed he had told the copilot this during the approach brief for the ILS into Stansted. He had completed recurrent training in a simulator every six months, despite the requirement being every 12 months. He completed his most recent Licence Proficiency

[3] Indicated that the aircraft's nose gear door had failed open.
[4] 'Weight-on-wheel input' indicated that the aircraft was unable to determine if it was airborne or on the ground.

Check two weeks before the accident. During this simulator detail he completed a crosswind landing, a rejected landing and had a demonstration of the aircraft's stall and stick pusher.

He commented that when they reviewed the TAF for Stansted, before departing El Gouna, he noticed the wind was from 260° at about 10 to 15 kt – less than his personal crosswind limit. When they reviewed the TAF again in Cairo the crosswind was still less than 20 kt. Due to the unexpected delay in Cairo, he updated his Flight Risk Assessment Tool[5] score for this sector and considered delaying the flight to the next day. His assessment of the fatigue risk was that "it was within the line but at the line" and decided to proceed with the flight.

The commander added that his workload was very high during the final approach but did not recall the co-pilot's monitoring calls of "excessive bank" at about 150 ft aal.

The commander considered that impairment due to fatigue was not a cause of the accident but that the length of the working day and the time of arrival, in combination with commercial pressure, was likely to have induced plan continuation bias[6].

He reflected later that he should have initiated a GA when the aircraft floated after the flare. He added that having elected to continue with the landing he should have added some power in the float to stop the speed reducing excessively, while holding an appropriate attitude as he waited for the aircraft to touch down.

Co-pilot

The co-pilot stated that he completed his type rating on the CL-604 in October 2021 and had about 150 hours on type. He was qualified to fly the CL-604 as the commander and copilot. He had previously operated scheduled flights for a major commercial air transport (CAT) operator.

The co-pilot said he was not aware of the commander's personal crosswind limit. He did not recognise the idea of a personal limit and commented that the aircraft limits should be observed.

The co-pilot stated that after the bounce and his GA call he noticed that the aircraft had left the paved surface and was on the grass verge of the runway. He added that after the aircraft had levelled at 4,000 ft, both pilots were "shaken". While the commander suggested that they should go back to Stansted, the copilot recommended that they look for a more favourable airport with a small crosswind component.

The co-pilot believed that the commander wanted to make a smooth landing as he knew this was "important for the owner". He considered there were no landing performance issues at Stansted given its long runway.

[5] A Flight Risk Assessment Tool enables proactive hazard identification and can visually depict risk. It can be an invaluable tool in helping pilots make better go/no-go decisions.
[6] An unconscious cognitive bias to continue with the original plan despite changing circumstances.

The co-pilot commented that while he had done crew resource management training with his previous CAT operators, he had not done any during his CL-604 type rating or with the operator of N999PX.

Personnel

Three pilots worked for the operator. There was no formal management or training structure for them, and each had a different agreed working pattern. The commander was informally considered to be the chief pilot and a line trainer but did not have any instructional qualifications. The co-pilot had completed type training for the CL-604, and the commander and other pilot, who worked for the operator, were providing informal line training to him.

The accident pilots reported that the relationship between them was strained. Difficulty arose from differences in their working patterns that were considered unfair, and from differences in their preferred style of giving and receiving instruction. They also differed in their reported approach to flying: the co-pilot favouring a highly standardised and procedural approach expected in a CAT operation and the commander favouring a more flexible approach found in general aviation operations. The co-pilot reported that he managed the relationship, while flying, by maximising his professionalism in the cockpit and strictly adhering to standard procedures and callouts.

When the accident occurred both pilots had been awake for 17 hours or longer and were in their window of circadian low. They had experienced delays during the previous flight, and delays at Cairo. They had also experienced higher than normal workload during the accident flight due to turbulence and a nervous passenger. The commander had a caffeine drink before the approach. There were no other reported fatigue risk factors for either pilot. The pilots were responsible for managing their own fatigue risk and no guidance or rules were provided by the operator.

Meteorology

An aftercast produced by the Met Office stated that during the period of the aircraft's approach and landing a cold front passed over the south-east of England moving in a southeasterly direction, producing scattered rainfall and low cloud across the area. The surface winds at Stansted between 2220 hrs and 0100 hrs were forecast as initially southwesterly, with mean speeds of 15 kt, gusting 25 kt, becoming north-westerly after midnight with mean speeds of 12 kt and no gusts. Observed winds through the period were initially south-westerly, later becoming north-westerly, in a range of 12 to 16 kt mean speed with one gust reported at 24 kt.

The forecasts at Heathrow and Gatwick Airports were similar, with forecasts of southwesterly winds becoming northwesterly at 12 to 15 kt and gusting 25 kt.

Stansted TAFs

In the briefing pack for the flight from Cairo to Stansted the TAF for Stansted, issued at 0502 hrs stated that the surface wind would become between 1200 hrs and 1500 hrs on 30 January, from 230° at 10 kt, before becoming, between 1900 hrs and 2100 hrs on 30 January, from 230° at 15 kt gusting 25 kt. The effective crosswind was 3 kt gusting 4 kt. It would then become, between 2100 hrs and 2400 hrs on 30 January, from 290° at 18 kt, gusting 30 kt. This equated to a crosswind component of about 16 kt, gusting 26 kt.

Stansted METARs

The METAR/ATIS published at 2350 hrs on 30 January stated that the surface wind was from 290° at 13 kt.

The METAR/ATIS published just after the accident at 0020 hrs on 31 January stated that the surface wind was from 300° at 13 kt gusting 24 kt, giving a crosswind component of 12 kt gusting 23 kt.

Anemometry data

London Stansted Airport provided the investigation with anemometry data that recorded the wind every second. The maximum wind speed recorded around the time of the accident was 20 kt from 300°. This was consistent with that forecasted and disseminated to the crew, either via METARs prior to the aircraft's arrival, or via the wind check given to the crew on short final of 300° at 13 kt gusting 25 kt. This equated to a crosswind component of 12 kt gusting 24 kt.

London Stansted Airport

The approach chart for the ILS approach to Runway 22 is at Figure 1. The missed approach procedure is '*Climb straight ahead not above 3000* [ft amsl].'

The Runway 22 LDA is 3,049 m.

The *Landing Performance* section of the CL-604's *Airplane Flight Manual* (AFM) indicates that in the prevailing conditions the actual landing distance would be approximately 760 m and the landing field length (landing distance required) approximately 1,290 m.

Weight and balance

The aircraft contained 16,000 lb of fuel on takeoff from Cairo, 2,000 lb more than required. The flight log and the pilots' accounts indicate the aircraft landed at Stansted with a total weight of between 32,243 lb and 32,803 lb. The takeoff and landing weights and CG were within the aircraft's flight envelope throughout.

Perf-06-01-25 of the AFM indicates that with FLAPS 45 and the landing gear down, the reference stall speed (V_{SR}) at 33,000 lb would be 99 KCAS.

Page 06-01-1 of the AFM states that V_{REF} is a minimum of 1.23 V_{SR}. Section Perf-06-1 of the CL-604's quick reference handbook indicates that at a landing weight of 33,000 lb a V_{REF} of 123 KIAS would be appropriate.

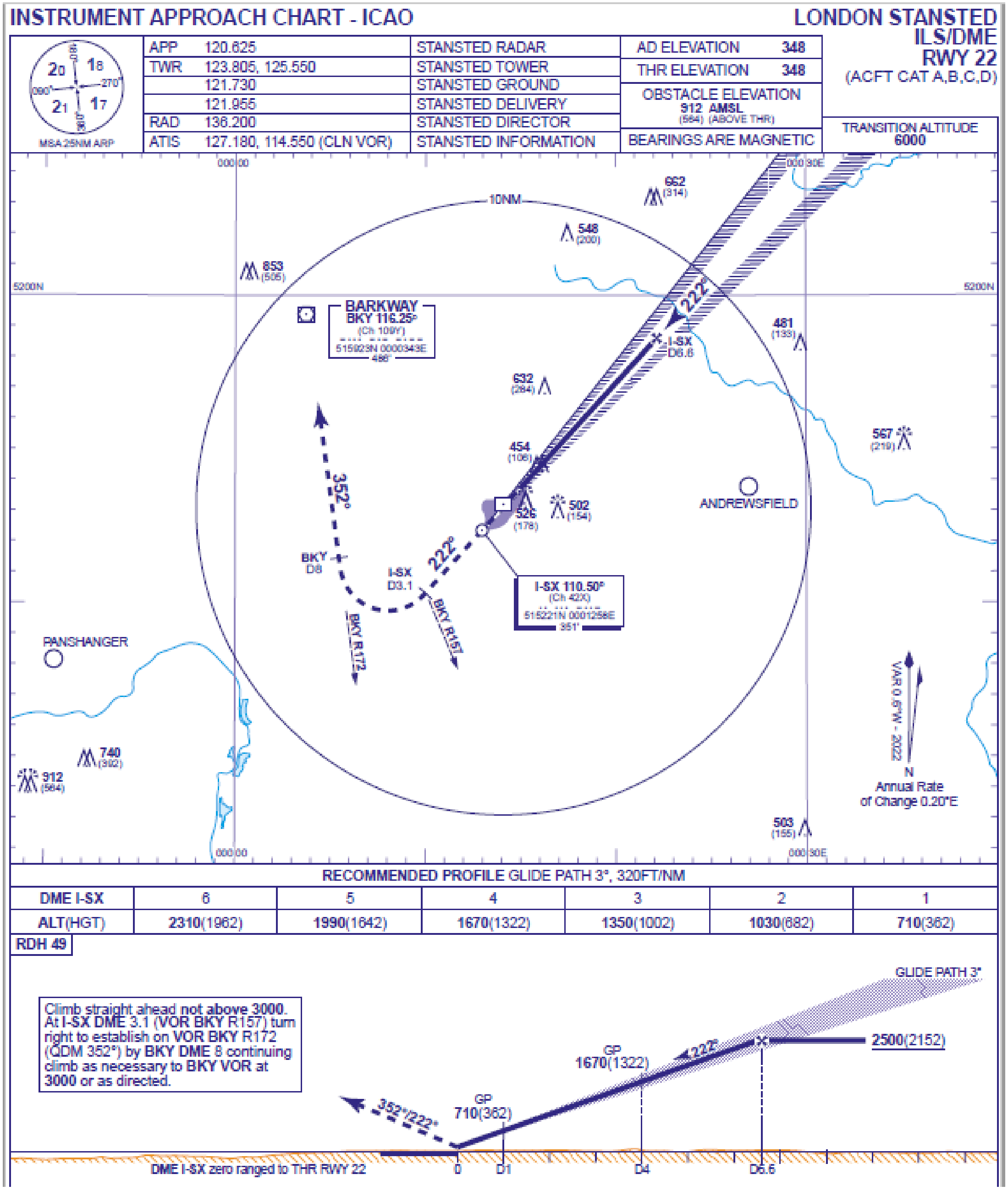

Figure 1

ILS approach chart for Runway 22
(UK AIP)

The AAIB calculated for a weight of 33,000 lb, using the charts on page 06-03-27 of the CL604's AFM, V_2 + 10 KIAS would have been 144 KIAS.

Manufacturer's documents

Airplane Flight Manual

The CL-604's AFM stated the following:–

'CHAPTER 6 – PERFORMANCE

5. PERFORMANCE CONDITIONS AND CONFIGURATIONS

…

D. Demonstrated Crosswind (Take-Off and Landing)

The maximum demonstrated crosswind component for take-off and landing [at 33 feet (10 meters) tower height] is 24 knots and is not considered limiting for take-off and landing. When using reverse thrust, this speed is limiting.'

The crew planned to use reverse thrust on the landing.

CL-604 Operating Manual

The manufacturer's Operating Manual (OM) stated in '*NORMAL PROCEDURES, Approach and Landing*' that V_{REF}+X is calculated by adding a wind correction of '*half steady state crosswind plus all gust (regardless of direction). Maximum correction is + 20 KIAS*' to the V_{REF}. For the reported wind of from 300° at 13 kt gusting 25 kt, and a V_{REF} of 123 kt, this equates to a V_{REF} +X of 142 kt.

It also stated the following:

'1. APPROACH AND LANDING

The following procedures are recommended in the event of a missed approach or any other situation which would necessitate making a go-around maneuver, with the airplane in the landing configuration…

An all engine go-around maneuver after touchdown during a normal landing is entirely the prerogative of the pilot to employ if conditions are not conducive for a full-stop landing.

…

Go-Around Procedure

(1) Thrust levers…...............................Advance to the pre-determined go-around N1 setting, while simultaneously pressing the Take-Off/Go-Around (TOGA) switch.

(2) FLIGHT SPOILER lever (if extended) ....Select to RETRACT.

(3) Airplane .... Rotate smoothly, at a speed of not less than V_{REF}

(4) Pitch attitude..Adjust to achieve a speed of not less than V2 + 10 KIAS as the flaps are retracted to 20°.

(5) FLAPS ....Select to 20°.

When a positive rate of climb is achieved:

(6) LDG GEAR lever ....Select to UP.

…

At a safe altitude (not below 400 feet AGL):

(7) FLAPS ....Select to 0°

…

L. Bounced Landing

If the pilot believes that thrust must be added and maintained until touchdown to salvage a landing, then a rejected landing should be executed.

Should the aircraft bounce on landing, a rejected landing should be executed. Go-around thrust should be set and the normal landing attitude or slightly higher should be maintained. Aircraft configuration should not be changed at this time. Once the aircraft is accelerating above V_{REF} and climbing through a safe height, the go-around maneuver should be continued.

Improper landing technique (thrust levers not at IDLE) may result in a shallow bounce. Should the pilot decide not to execute a rejected landing, then the normal landing attitude should be maintained and the thrust levers reduced to IDLE. Be aware that following the bounce, the ground spoilers may deploy as soon as the thrust levers are set to IDLE, even if the aircraft is still in the air.'

Crosswind guidance

The manufacturer provides guidance on crosswind landings for some of its aircraft, including the Challenger 300 series, in the respective *Recommended Operational Procedures and Techniques* (ROPT). However, the only guidance for the CL-604 is in the OM Supplementary Procedures, 06-13, '*Operation on Contaminated Runways*', '*Crosswind Landings*', where it states, '*In crosswind conditions, the crosswind crab should be maintained for as long as possible, until prior to touchdown…*' There is no guidance on crosswind landings in Normal Procedures, 04-08, '*Approach and Landing*' or its ROPT.

The manufacturer commented that its pilots' preferred technique for crosswind landings on the CL-604 was to fly wings level and de-crab in the flare, which is less likely to result in a wingtip strike than flying wing-down into wind.

Accident site

Examination of Runway 22 at London Stansted Airport showed three separate wing strike marks on the paved surface between the intersections of Taxiways Papa, Romeo and Uniform, each approximately 20 m long (Figure 2). Paint transfer from N999PX's wing was evident in the strike marks on the runway (Figure 3), becoming a furrow in the grass. As it continued to travel through the grass, the wingtip struck a concrete pad. Several pieces of debris were found in this area, including fragments of wingtip skin panel and wingtip light transparency.

Tracks corresponding to all three landing gear wheels were also evident in the grass.

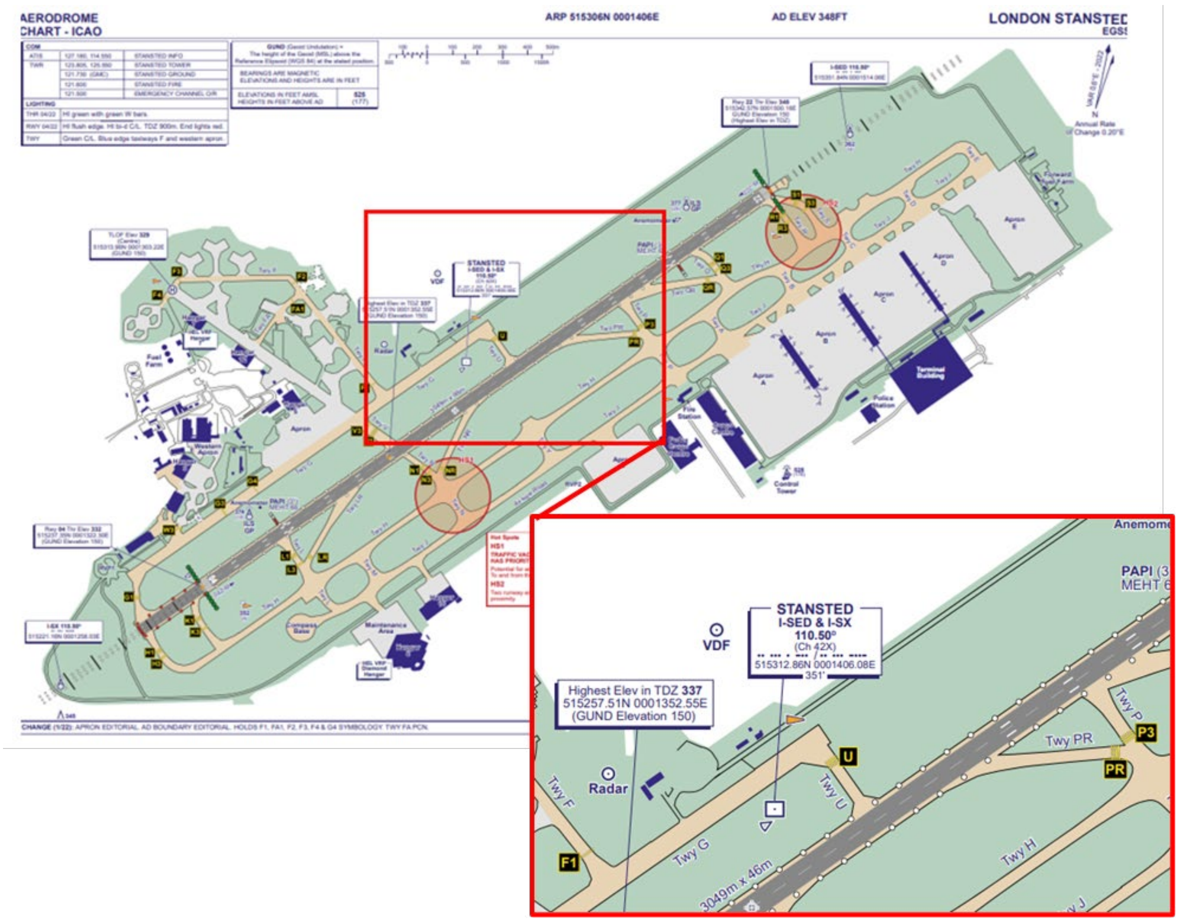

Figure 2

London Stansted Aerodrome Chart, inset showing area where N999PX left wing struck the ground

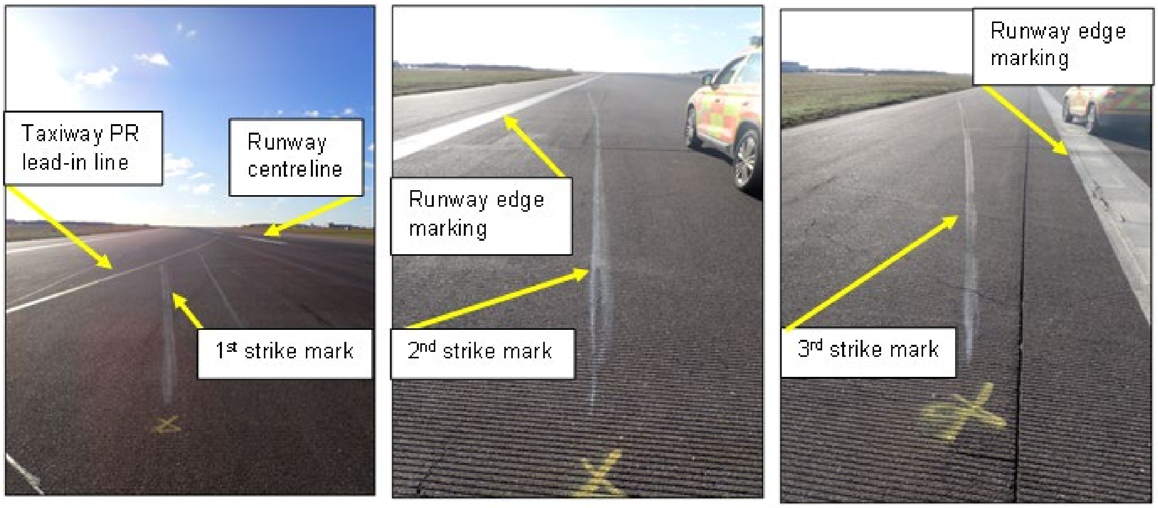

Figure 3

N999PX wing strike marks on Runway 22, viewed in direction of travel

Recorded information

Flight recorders

The aircraft was fitted with a CVR and FDR. The CVR, which was a solid-state device, had a nominal recording duration of 30 minutes but the aircraft remained powered for some time after landing at Gatwick and the recording of the event was overwritten.

CVR quality and operational test

The CVR's Cockpit Area Microphone channel, which records ambient sound in the cockpit, was unintelligible due to a high level of electrical noise on the recording. The balance of recording levels across the other channels was poor. The unit fitted to N999PX was last tested for correct operation in November 2011. The aircraft manufacturer recommends this check is carried out every 1,200 flight hours, having recently changed this interval from every 800 flight hours. N999PX was not operated commercially and, although these intervals were not mandated by regulation, N999PX's operator chose to use them for its maintenance programme. This change assumed that 500 flight hours would be flown each year but, as the annual utilisation of N999PX was much lower, this meant that the CVR on N999PX had not been tested for correct operation for over 10 years. In November 2022, following this event, the aircraft manufacturer introduced alternative calendar-based recommendations[7], for maintenance tasks on aircraft with low annual utilisation.

[7] The Low Utilization Maintenance Program was added to the CL-604 Maintenance Planning Document, Section 8.1.

FDR data for the approach and GA

Data from the FDR is shown in Figure 4, each square on the x-axis representing five seconds. This shows that N999PX's autopilot was disconnected at 150 ft agl at an IAS of 136 kt, the landing gear was down and FLAPS 45 selected. Both engines were set at approximately 50% N_1 (Point A on Figure 4). Before this there are mostly only minor modulations in control surface deflections, with slightly larger rudder deflections. The autopilot maintained the aircraft's flightpath without the application of large surface deflections. The angle of attack (AOA) vanes agreed and remained below +5°.

After the autopilot was disconnected, an increasing amount of left rudder was applied, the demand becoming more oscillatory over time, while the ailerons were positioned to give a right wing-down rolling moment. The power setting of the engines was increased to about 60% N_1 and the values recorded by the left and right AOA vanes diverged, indicating that N999PX was then in a sideslip.

Passing 50 ft agl and 130 kt, thrust was gradually reduced to idle over a period of eight seconds (from Point B). The aircraft, still in a sideslip, was then progressively flared for landing but did not touch down, instead remaining airborne for a further six seconds; and the AOA recorded by both vanes increased, reaching 18° for the left vane.

N999PX then suddenly rolled left and pitched sharply down (Point C)[8]. N999PX's pitch attitude changed from +8° to -2° and the roll attitude changed from 10° right wing-down to 13° left wing-down in under 2 seconds. Shortly afterwards, despite a substantial nose-up elevator input, and movement of the ailerons and rudder to recover the bank of the aircraft, the aircraft touched down on the nose and left landing gear, and then the right landing gear (Point D).

Engine N1 began to increase as a minimum airspeed of 101 kt was recorded but, because the elevators were still positioned to demand a nose-up attitude, the AOA and pitch attitude rose rapidly again and reached +24° and +14° respectively. The aircraft again rolled to the left, reaching 30° of bank and pitched down, this time making ground contact with the left and nose landing gear despite the further application of nose-up elevator (Point E). The FDR recorded a normal acceleration of nearly 2.5g at this point.

The aircraft went around and the flightpath stabilised in the climb, but the position of the individual landing gear disagreed and, subsequently, a master warning was triggered (Point F). At about 550 ft agl during the GA the aircraft's pitch reached a maximum of 21.6° nose-up.

[8] Aircraft manufactured from serial number 5463 onwards are equipped with an FDR that records at a higher data rate and record parameters for activation of the stick shaker and pusher. However, N999PX (serial number 5387) predated this change, and the FDR did not record parameters for either the stick shaker or pusher.

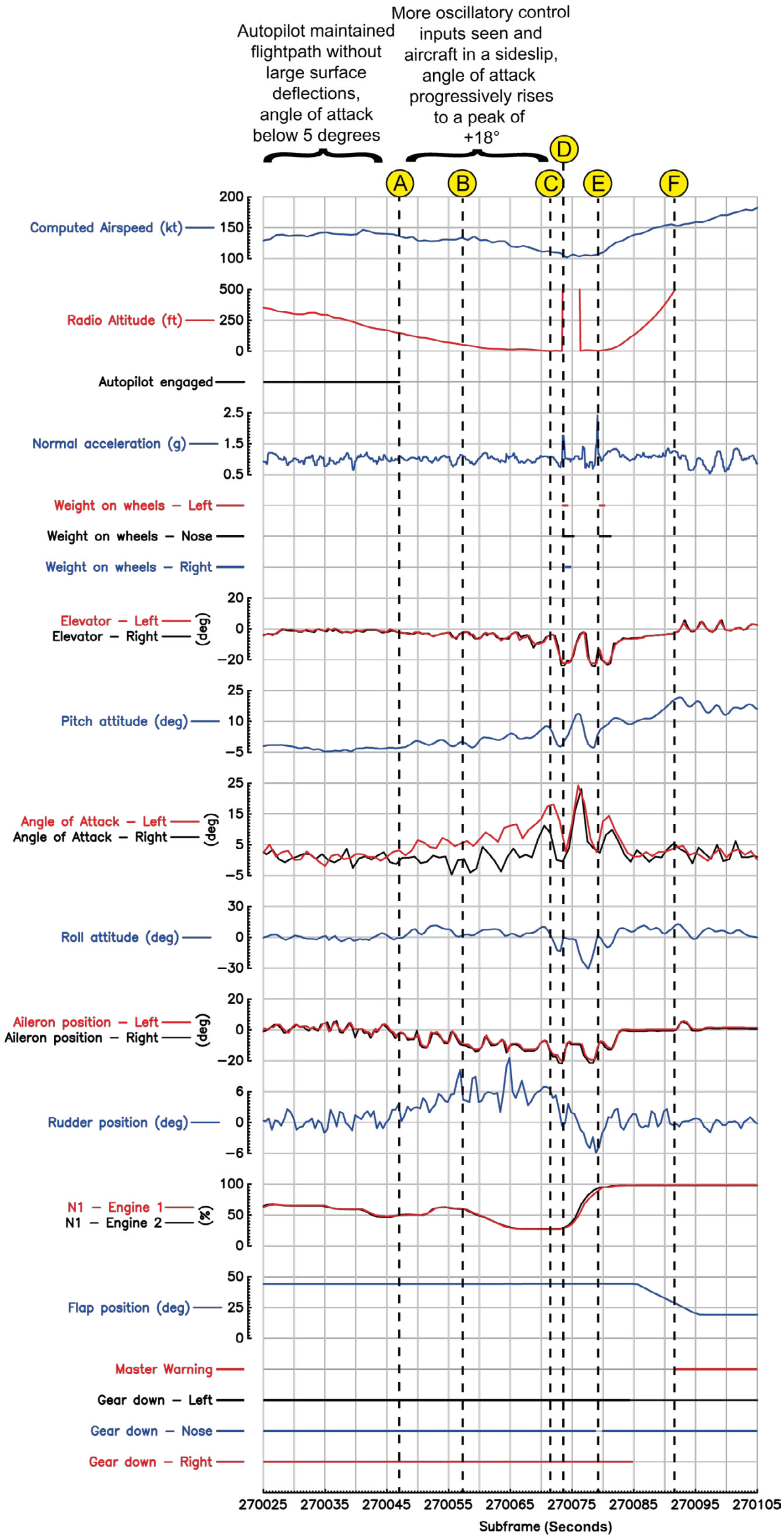

Figure 4

Data from the FDR showing N999PX's approach and GA at London Stansted

Closed-circuit television

Closed-circuit television (CCTV) recordings from London Stansted captured the aircraft's approach and GA, showing that N999PX struck the ground at least twice. An image from one of these recordings is shown below (Figure 5).

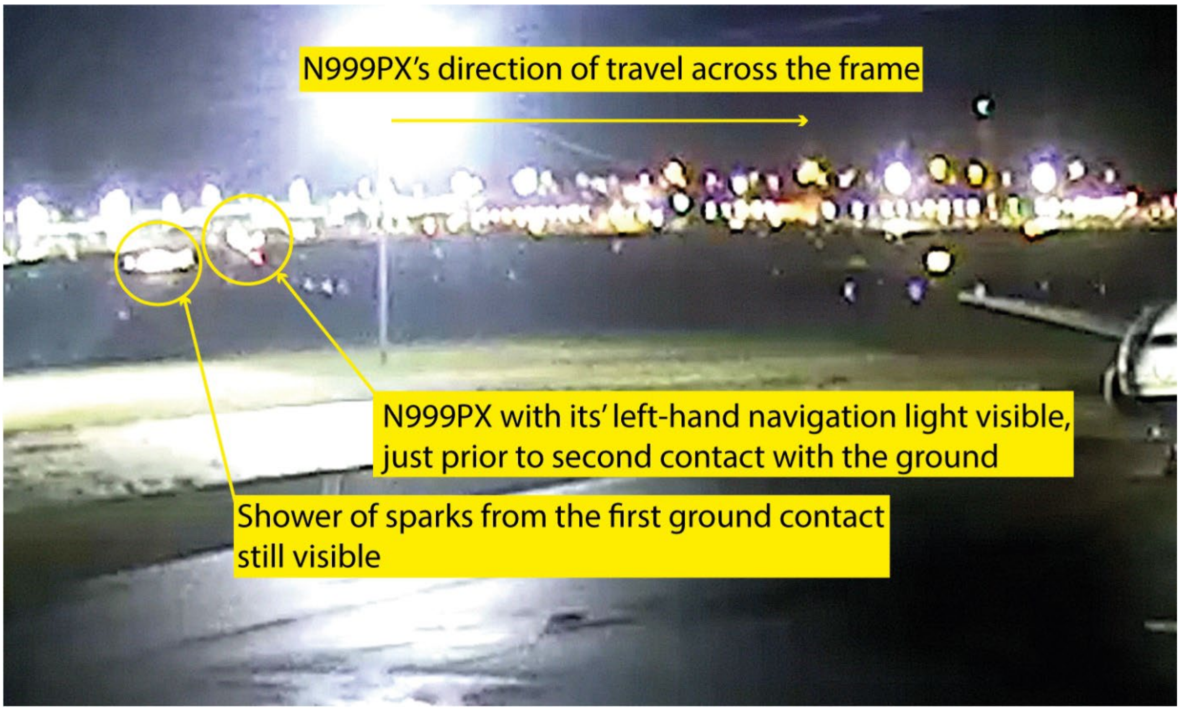

Figure 5

CCTV from London Stansted showing N999PX striking the ground

Aircraft information

General

The Bombardier CL-604, a variant in the Challenger 600 series of aircraft, is a low wing business jet powered by two fuselage-mounted GE CF34 turbofan engines. The wings of aircraft in the Challenger 600 series are thin high-speed aerofoils.

Stall protection system

The natural stall characteristics of the Challenger 600 series are a stall with no pre-stall warning (such as buffet), an abrupt load factor reduction at the instant of stall, and an uncontrolled and uncontrollable rolling motion. Any recovery action other than reducing the AOA is ineffective. In order to meet certification requirements, Challenger 600 series aircraft are equipped with an artificial stall protection system, incorporating stick shaker alert and stick pusher recovery functions.

The stall protection system (SPS) on the CL-604 provides the flight crew with aural, visual and tactile indications of an impending stall. It comprises a dual channel analogue stall protection computer (SPC), two AOA vanes, two dedicated lateral accelerometers for sideslip compensation, a stick shaker motor on each control column and a stick pusher motor connected to the right elevator control system.

The SPC includes algorithms which define the AOA thresholds[9] for engine auto-ignition, stick shaker and stick pusher activation. The stick pusher thresholds are set to lower AOAs than the AOA for natural aerodynamic stall, so that the stick pusher functions as prestall intervention. For each flap setting, the nominal engine auto-ignition, stick shaker and stick pusher thresholds are constant between the ground and 2,000 ft, reduce linearly between 2,000 ft and 15,000 ft and are constant above 15,000 ft.

The SPC monitors the AOA angle, lateral acceleration, flap position and pressure altitude from the air data computers and uses these inputs continuously in flight to calculate the AOA thresholds. If the signal from one AOA vane exceeds the calculated auto-ignition threshold, both engine's auto-ignition systems will activate. If the AOA continues to increase and the signal from one of the AOA vanes exceeds the programmed stick shaker threshold, the stick shaker motor on that side will activate and if the autopilot is selected it will be automatically disengaged. Both control sticks will shake as they are mechanically connected giving a tactile and aural alert. If both AOA vanes exceed the shaker threshold, both stick shaker motors will activate.

At even higher AOA, if the signal from one AOA vane exceeds the programmed pusher threshold, it will trigger the STALL aural warning and the red flashing STALL WARNING lights on the glareshield. If the signal from both AOA vanes exceeds the programmed pusher threshold, the stick pusher motor will be activated and will apply approximately 80 lb force to the control columns.

Other aircraft types incorporate logic to reduce the stick pusher input close to the ground. On the CL-604 there is no reduction or modulation in stick pusher force if an activation occurs close to the ground. The aircraft manufacturer advised that the stalling characteristics of the aircraft are such that a stall close to the ground could result in an unrecoverable loss of control. The SPS is therefore active throughout the entire flight. While the manufacturer acknowledges that a stick pusher activation close to the ground could result in the aircraft nose being driven into the ground, it stated that this is considered less hazardous than a stall.

The motor will cease to be active and the force on the control column removed once the AOA reduces below a calculated value below the pusher threshold. This hysteresis is to ensure that the push is of sufficient duration.

If the rate of increase of AOA is greater than one degree per second, the SPC lowers the AOA threshold to activate the aural, visual and tactile indicators at a lower AOA. This is to prevent the aircraft's pitching momentum from carrying it through the stall warning/stick pusher sequence into the stall.

In the case of a rapid increase in AOA, it is possible for the stick shaker and stick pusher to

[9] Bombardier publications also use the terms 'firing angle' and 'trip point'.

activate with little delay or even simultaneously, but this information is not included in the OM.

The stick pusher is armed when both STALL PROT PUSHER switches, located on the pilot and co-pilot side panels, are ON.

Operation of the stick pusher and associated warnings will cease in the following circumstances:

- The compensated AOA signal decreases from the pusher threshold by a predetermined degree
- G-switch activation at 0.5G
- Pilot or co-pilot AUTOPILOT/STICK PUSHER disconnect button is pushed and held
- Either STALL PROT PUSHER switch is selected off (although the stick shaker will remain armed in the case)

Stall protection system modifications, maintenance requirements and normal procedures

Two modifications are available on the CL-604 SPS: Service Bulletin (SB) 604-27-005 *'Dormant failures in the stall protection computer'* Revision 2[10], dated 30 September 2005 and SB 604-27-031 *'Introduction of a new angle of attack sensor'* Revision 2[11] dated 24 May 2011. Following embodiment of both SBs in 2011 at 4,109 flight hours, N999PX was equipped with the most up to date configuration of the SPS. SB 604-27-031 replaced the original contact-type AOA transducer, which was prone to mechanical wear, that could cause the transducer output to behave in a non-linear manner. It introduced a new design of non-contact transducer which was not susceptible to wear. Completion of SB 604-27-031 therefore eliminated the need for frequent repetitive functional checks on the AOA vanes. Completion of SB 604-27-005 substantially increased the interval for the functional checks of the SPC flap input and sideslip compensation from every 100 hours and 400 hours respectively, to every 4,800 hours. N999PX had not reached this interval at the time of the accident, having only completed 761 flight hours since installation of the new SPC.

Two separate operational tests of the SPC are required to be performed every 800 hours. One checks that each channel individually triggers the required warnings (single channel operational test) when it is supposed to and the other checks that STALL FAIL condition is correctly indicated if the difference between the left and right AOA values exceeds a predetermined amount (dual channel operational test). Both operational tests were most recently performed on N999PX in September 2021 as described below.

The CL-604 AFM Normal Procedures Consolidated Checklists describe a SPS daily check which tests the operation and sequencing of the stall protection system, including the engine

[10] Initial issue dated 30 June 2003.
[11] Initial issue dated 27 Jan 2010, Revision 1 dated 22 March 2010.

auto-ignition and the stick shaker and pusher activation. This must be completed by the crew prior to the first flight of the day. The crew could not recall completing the SPS daily check but had no reason to believe it was not completed.

N999PX recent maintenance history

N999PX was manufactured in 1998 and had been operated by the operator since 2007. It had a valid Airworthiness Certificate. The aircraft was maintained at a maintenance facility in the UK. A 12-month inspection was carried out in August 2021. The most recent maintenance check was carried out between 16 and 28 September 2021 at 8,402 flying hours and 4,842 cycles, when various items of line maintenance were performed. In accordance with the operator's normal practice, several defects had been recorded in the aircraft's technical log on the inbound flight to the maintenance facility. Due to this practice, it was not known how long each defect had been present for.

One of the documented defects related to a pilot report that the right AOA vane did not move or was intermittently inoperative. The maintenance engineers were unable to recreate the problem on the ground. The right AOA vane was replaced. Operational tests of the SPC (single and dual channel) were performed after replacement of the AOA vane and no anomalies were noted. No subsequent reports relating to the AOA vane were noted in the technical log.

At the time of the accident N999PX had accrued 8,451 flying hours and 4,870 flight cycles.

Manufacturer's stick shaker and pusher calculations

As stick shaker or pusher activation was not recorded on the FDR (N999PX predated the change to a higher rate recorder) the aircraft manufacturer performed retrospective calculations to determine the likely shaker/pusher status during the accident sequence. The calculations used the AOA values recorded on the FDR (corrected for recorded sideslip) to determine if the shaker or pusher thresholds were exceeded[12].

The calculations showed that the left AOA value exceeded the stick shaker threshold for approximately two seconds just prior to the first touchdown. Approximately four seconds later, both the left and right AOA values exceeded the stick shaker and pusher thresholds just prior to the second touchdown. The calculations showed that there would have been, at most, one second between the second stick shaker activation and the stick pusher activation.

Aircraft examination

Preliminary aircraft examination

The aircraft was examined on Taxiway Juliet at London Gatwick the morning after the accident. The outboard portion of the left wing and winglet had suffered considerable damage (Figure 6). There was a dent on the lower surface of the outboard leading edge.

[12] The parameters for the AOA vanes and sideslip are recorded asynchronously, at differing rates, and therefore are at best an approximation of the behaviour of the stall protection system, especially when the approach to stall is highly dynamic.

The landing light glazing at the wingtip and several fairings and skin panels were missing. The wingtip lower skin was abraded, in some locations through its entire thickness, and there was damage to the sub-structure. Grass and earth were lodged in the landing light housing and in the exposed structure at the base of the winglet. The winglet and wingtip trailing edge skin showed evidence of ground contact, including the mounting plate for the wingtip static discharge wick which was abraded flat. There was also evidence of ground contact on the outboard rear corner of the left aileron, a small section of which was missing, and on the aileron's outboard static discharge wick. The aileron upper skin was buckled. The trailing edge of the outboard flap fairing also showed evidence of ground contact.

Figure 6

Damage to N999PX left wing

Light scuffing was noted on the fuselage skin at the left wing root, which may have indicated relative movement between the wing and fuselage.

The nose landing gear left wheel axle had failed such that the top of the left wheel was angled towards the landing gear leg (Figure 7). Severe scoring and abrasion on the inboard sidewall of the left tyre had been caused by the tyre rotating against a grease nipple at the bottom of the oleo. Some localised buckling was evident on the lower fuselage skin immediately aft of the nosewheel bay.

Figure 7
Damage to N999PX nose landing gear (view looking aft)

The left tyre was deflated and the aircraft was towed to a remote stand at the airport and was parked for several weeks.

Detailed aircraft examination and damage assessment

The aircraft was subsequently moved to a hangar where a full hard landing inspection was performed by the maintenance organisation, under the direction of the aircraft manufacturer. This included general and detailed visual inspections of the aircraft structure and control surfaces, and operational tests of various systems. In addition to the visible external damage, the inspections identified some bulging and buckling of skin on the right side wall of the nose landing gear wheel bay in the vicinity of the nose landing gear trunnion fitting.

The main and nose landing gears were removed and sent to the landing gear manufacturer for stress testing; the results were unknown at the time of publication of this report.

An operational test of the aileron control system revealed several anomalies with the hydraulic actuation aspects of the system and identified that the ailerons did not return to neutral without moderate force being applied.

A wing symmetry/alignment check identified that the degree of twist to the left wing was out of allowable limits. The aircraft manufacturer considered that this indicated permanent plastic deformation of the wing attachment point, meaning that ultimate strength of the materials had been exceeded. In order to return to service, the aircraft would have required a complete wing set replacement. The aircraft insurers considered that the damage to the aircraft was beyond economical repair.

Neither the SPC nor the AOA vanes were removed from the aircraft for functional testing.

Other events

The AAIB is aware of two other events, occurring within five weeks of this accident, where the stick pusher on a CL-604 activated close to the ground. One event occurred on 27 January 2022 involving 2-SLOW, which experienced a left wingtip strike, stick pusher activation and nose landing gear collapse during landing at Heraklion Airport in Greece. The other event occurred on 28 December 2021 to G-XONE, on approach to Bern, Switzerland. In that case, the crew was able to recover the flightpath of the aircraft after the stick pusher had activated, but the aircraft had descended to 4 ft aal.

These events are under investigation by the Hellenic Air and Railway Safety Investigation Authority and Swiss Transportation Safety Investigation Board respectively, and Accredited Representatives from the AAIB are appointed to each investigation.

Analysis

Aircraft and site examination

Examination of the aircraft and ground marks revealed that the left wingtip and winglet, and the trailing edge of the aileron and outboard flap fairing, struck the runway during the landing sequence. This was consistent with the aircraft being in a left wing low and nose-high attitude. Wingtip contact with the ground continued as the aircraft departed the runway into the grass area to the left.

The damage to the nose landing gear axle probably occurred during the second touchdown on the nose and left landing gears, when the normal acceleration reached the maximum recorded value of almost 2.5g. It is likely that activation of the stick pusher contributed to the landing attitude and therefore the damage sustained by the nose landing gear axle.

Pre-flight decision making

The aircraft started the approach into Stansted nearly five hours later than planned and the forecast crosswind was stronger than forecast for the original arrival time. Having been delayed, had the crew considered the weather nearer the revised ETA they may have noted that a gusting 30 kt crosswind was forecast and given more consideration to alternate plans should the wind be out of limits on arrival.

Calculation of approach speeds

The AAIB calculated a V_{REF} 4 kt greater than that obtained by the crew, and a V_{REF} +X for the reported wind 17 kt greater. The lower speed used by the crew provided less margin for the effects of a gusting wind, with the potential for an excessive AOA to develop. Wind information was passed to the crew and commented on by the co-pilot, with sufficient notice to increase V_{REF} +X or discontinue the approach. However, the nature of the relationship between the two pilots may have influenced their communication. The co-pilot adhered to standard monitoring and callouts such as he used in CAT operations and no further discussion took place.

It would not have been necessary to recalculate an increased V_{REF} +X accurately, assuming it was not so great as to prevent the aircraft landing or stopping: any increase in airspeed in the given conditions would have reduced the AOA, and therefore the onset of any wing drop or stick shaker and pusher activation.

Handling during the approach

London Stansted Airport provided the investigation with anemometry data that recorded the wind every one second. This was consistent with information forecasted and disseminated to the crew. There was no evidence of any crosswind in excess of the aircraft's limit of 24 kt, the maximum recorded crosswind component occurring just before the landing was that reported by ATC. However, the effective crosswind component of the wind reported by ATC (13 gusting 25 kt) exceeded the commander's personal limit of 20 kt. When the relevant wind information was transmitted by ATC the commander's workload was high and he may not have heard it or, if he heard it, he may not have been able to analyse it promptly. The co-pilot reported that he was not aware of the commander's personal limit, so did not prompt the commander to observe it.

V_{REF} +X should be maintained until the aircraft crosses the threshold. The aircraft's IAS reduced below the crew's calculated V_{REF} +X of 125 kt about 5 seconds before idle was selected, with no recorded increase in engine thrust to compensate. As there was no autothrottle, this may indicate the commander's attention was focused on the aircraft's flight path. The co-pilot's callouts of excessive bank angle indicate he was monitoring the flightpath.

The premature deceleration below V_{REF} +X, without a correcting thrust increase, resulted in reduced energy as the aircraft entered the flare and subsequent float, and indicated the crew were not closely monitoring airspeed.

The AFM suggested that with FLAPS 45 and the landing gear down, the 1g stall speed at 33,000 lb would be 99 kt. The lowest speed recorded was 101 kt as the aircraft floated above the runway for several seconds.

The aircraft floated along the runway after the flare at about 10 ft for six seconds, probably because the commander wanted to make a smooth landing for the comfort of the passengers. Had the aircraft touched down soon after the flare was initiated it is less likely the stick pusher would have activated, and the aircraft may have stayed on the runway.

The commander commented that he should have added some power in the float to stop the speed reducing excessively. However, in the CL-604's OM it stated that '*If the pilot believes* *that thrust must be added and maintained until touchdown to salvage a landing, then a rejected landing should be executed.'* Had the commander recalled the OM guidance he might have discontinued the landing earlier. He had practised a crosswind landing and a rejected landing two weeks before the accident, and could probably have performed them competently.

Recorded elevator inputs during the final approach, after the autopilot was disconnected, appeared normal for the conditions until the flare. Aileron inputs were of greater magnitude, the aircraft flying the rest of the approach with the right wing down (into wind) and with significant left rudder deflection (flying with crossed controls). While there was no specific guidance in the CL-604's OM on how to handle a crosswind landing, the de-crab technique was recommended in the CL-604's Supplementary Procedures for contaminated runways. The co-pilot stated that he used this technique when flying, and it was appropriate for an aircraft with a relatively short landing gear and low wing.

The investigation did not determine the precise cause of the runway excursion.

Fatigue, decision making and communication

The pilots experienced a long working day that included delays, higher than normal workload and a tense relationship between them. The accident occurred during their window of circadian low. As there were no other fatigue risk factors, it is unlikely that reduced manual flying performance due to fatigue was severe enough to cause the accident. However, it is possible that the relationship issues and fatigue factors affected the pilots' decision making and communication prior to the flight and during the approach.

The go-around

During ATC exchanges after the GA the co-pilot did not respond promptly and his voice showed some indications of stress. This, and the crew's action to level off at 4,000 ft amsl (the published procedure being not above 3,000 ft amsl) indicate that the crew may have experienced startle, surprise or heightened stress. Their subsequent request to divert to an airport with a crosswind of no more than 15 kt, significantly less than the aircraft or commander's limits, indicates a desire to operate cautiously for the remainder of the flight.

Stall warning

The AAIB is aware of two other events involving low airspeed in CL-604 aircraft that occurred between December 2021 and January 2022.

Retrospective calculations by the aircraft manufacturer following the accident involving N999PX suggest that the stick shaker activated immediately prior to the first touchdown and that both the stick shaker and stick pusher activated prior to the second touchdown. Based on the FDR data, the conditions for activation of the stick pusher were achieved only briefly. Therefore, stick pusher activation was probably brief. However, the stick pusher activated with little delay after the stick shaker, giving the pilots little time to recognise and take the appropriate action after the shaker activated before the pusher applied a significant forward force on the control column.

The aircraft was equipped with the latest configuration of SPS, and operational checks of the SPC had been carried out four months before the accident. The manufacturer's calculations suggest that the SPS operated as intended and that the stick shaker and pusher activations were valid.

The lowest indicated speed achieved by the aircraft was 101 kt, 2 kt above the reference stall speed for the aircraft configuration. Stick pusher activation may have prevented a wing stall and more consequential outcome.

Crosswind landing guidance

Soon after the autopilot was disconnected the aircraft was in a sideslip until the flare before touchdown. However, a wings level attitude, followed by a de-crab in the flare, was the manufacturer's pilots preferred crosswind landing technique and that quoted for contaminated runways in the CL-604's OM.

The manufacturer provides guidance on crosswind landings for some of its aircraft, including the Challenger 300 series, in the respective ROPT. However, the only guidance for the CL-604 is in the OM Supplementary Procedures, 06-13, '*Operation on Contaminated Runways*', '*Crosswind Landings*', where it states, '*In crosswind conditions, the crosswind crab should be maintained for as long as possible, until prior to touchdown…*' There is no guidance on crosswind landings in Normal Procedures, 04-08, '*Approach and Landing*' or its ROPT.

The aircraft manufacturer indicated that it intended to update CL-604 manuals to include a similar level of information regarding crosswind landing technique as the other aircraft it manufactures but did not say when it would complete this action.

Conclusion

The aircraft yawed and rolled rapidly following a long float with insufficient airspeed in strong gusting wind conditions. Stick shaker activation was followed almost immediately by stick pusher activation, resulting in the aircraft landing on its nosewheel.

A crosswind exceeding the commander's personal limit was forecast before departure. It would have been possible to delay departure or select an alternative arrival aerodrome with more favourable conditions.

The commander reflected that although there was an opportunity to discontinue the approach earlier, he had felt compelled to continue with the landing by a degree of plan continuation bias. Fatigue, commercial pressure and the nature of their interactions may have made the pilots more susceptible to this bias.

Safety actions

The aircraft manufacturer stated it intends to update CL-604 manuals to include a similar level of information regarding crosswind landing technique as the other aircraft it manufactures.

Published: 30 November 2023.

ACCIDENT

Aircraft Type and Registration:	Cessna 210M, G-TOTN
No & Type of Engines:	1 Continental Motors Corp IO-520-L piston engine
Year of Manufacture:	1977 (Serial no: 210-61674)
Date & Time (UTC):	17 July 2023 at 1159 hrs
Location:	Bradda Head, near Port Erin, Isle of Man
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Fatal) Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	64 years
Commander's Flying Experience:	Approximately 2,500 hours (of which approximately 1,600 were on type) Last 90 days - 18 hours Last 28 days - 2 hours
Information Source:	AAIB Field Investigation

Synopsis

At 1131 hrs on 17 July 2023, the pilot took off in G-TOTN from Ronaldsway Airport, Isle of Man. The aircraft was later observed to enter a turn to the left before the wings levelled and the aircraft descended to strike the cliff at Bradda Head. The pilot did not survive. The investigation found no evidence of any technical faults that would have prevented the pilot from manoeuvring to avoid the cliff, and it is likely that the accident was a deliberate act. The pilot had been suffering from difficulties with sleep for a number of months and with anxiety in the weeks preceding the flight.

History of the flight

The pilot arrived at the airport around 0825 hrs and proceeded to the hangar where he pulled his aircraft out onto the ramp. There were numerous witnesses who saw the pilot either sitting in the plane or spoke to him around the hangar. At 1122 hrs the pilot called ATC to book out for a local flight, reporting that he was the only person on board. Having started the engine, and taxied out to the runway, the pilot took off at 1130 hrs. He flew a route to the southwest of the Isle of Man before flying up and down the coast several times. Witnesses reported the aircraft flying lower than they had seen with other aircraft but that it sounded normal. At 1155 hrs the pilot turned onto a southwest heading at Elby Point to fly parallel with the coast. He continued this heading, positioned over the sea around 1 nm from the coast until he was approximately abeam Bradda Head. At this point the aircraft turned to the east and the track flown took the aircraft into the cliff below the tower at Bradda Head. The impact with the cliff was not survivable.

During the flight the pilot had made several phone calls to a family member which indicated that he did not intend to return from the flight.

Accident site

Bradda Head is a rocky, steep headland, rising to some 115 m from the sea.

G-TOTN struck approximately halfway up the cliff face in a sheer section of the cliffs. The aircraft then fell to a smaller ledge below, coming to rest at a point approximately quarter of the way down the cliff on a steep slope. The engine detached from the aircraft and was retrieved from the sea at the base of the cliff along with some pieces of aircraft structure.

Recorded information

Radar and radiotelephony recordings were provided to the AAIB. CCTV footage from Port Erin captured the final moments of the flight. Both sources showed the aircraft making a left turn, followed by a relatively constant rate of descent with wings level before it struck the cliff face.

Aircraft examination

All major components of the aircraft including wings, engine, propeller, flying control surfaces and landing gear were present at the accident site. There was no evidence of pre-impact failure in the flying control cables. The engine contained oil, and a significant quantity of fuel was observed to have been present at the accident site.

Medical

The pilot had been suffering from difficulties first with sleeping and then with anxiety in the lead up to the flight. He had been seen by his GP who had prescribed drugs to try and alleviate the symptoms. He had not declared either his difficulties or his prescribed drugs to his Aeromedical Examiner (AME) who had last renewed his Class 2 flying medical in January 2023. As the AME was not the pilot's GP there was no entitlement to see the full medical records. Instead, pilots are required to disclose any injury, illness or prescription that might affect their fitness to fly to their AME, who can then decide on the continued validity of the medical certificate. Had the AME been informed of the diagnosis and prescriptions given to the pilot, the medical certificate would have been suspended.

Analysis

Having taken off from Ronaldsway Airport the pilot flew to southwest of the Isle of Man before flying up and down the coast several times. At 1155 hrs the pilot made a turn onto a heading that placed the aircraft on a collision course with the cliff at Bradda Head. The aircraft descended with the wings level until it struck the cliff. The impact with the cliff was not survivable.

The investigation did not find evidence of any technical failure that would have caused the aircraft to have been unable to deviate from its path before striking the cliff. The flight path captured by radar and CCTV also suggests that the aircraft was under control before it struck the cliff.

Conclusion

The pilot had been under the care of his GP who had diagnosed sleep issues and anxiety but had not informed his AME. Several phone calls were made during the flight that indicated that the pilot did not intend to return from the flight.

G-TOTN was flown directly towards Bradda Head below the level of the clifftop. The investigation found no evidence of any technical faults that would have prevented the pilot from manoeuvring to avoid the cliff, and it is likely that the accident was a deliberate act.

Published: 7 December 2023.

ACCIDENT

Aircraft Type and Registration:	Schleicher AS-K 13, G-DCMK
No & Type of Engines:	None
Year of Manufacture:	1975 (Serial no: 13305)
Date & Time (UTC):	12 August 2022 at 1054 hrs
Location:	Troed yr Harn, Talgarth, Powys
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - 2 (Serious) Passengers - N/A
Nature of Damage:	Destroyed
Commander's Licence:	BGA Instructor rating (Full)
Commander's Age:	71 years
Commander's Flying Experience:	7,099 hours (of which approximately 2,500 were on type) Last 90 days - 42 hours Last 28 days - 6 hours
Information Source:	AAIB Field Investigation

Synopsis

A student and his instructor were taking off under aerotow on an instructional flight when the tow rope detached from the glider. The instructor took over control and landed the glider in a nearby field. Both pilots sustained serious injuries but have since recovered.

The tow release had been modified, but not in a way that would have contributed to the occurrence, and the investigation was not able to determine with certainty any causal factors that would have resulted in a premature release from the tow.

History of the flight

The pilot of the glider was conducting an instructional flight from Talgarth airfield, with the aim of bringing the student to solo standard. They had flown together previously and the pilot reported the pre-flight preparation and briefing was all completed by the student to a satisfactory standard, with a particular focus paid to rigging and control connections. The weight and balance of the glider was assessed and within limits. The pilot and student discussed that it would be a crosswind takeoff under aerotow and agreed in the event of a launch failure that they would consider if a return to the airfield was a safe option; otherwise they would select a suitable field.

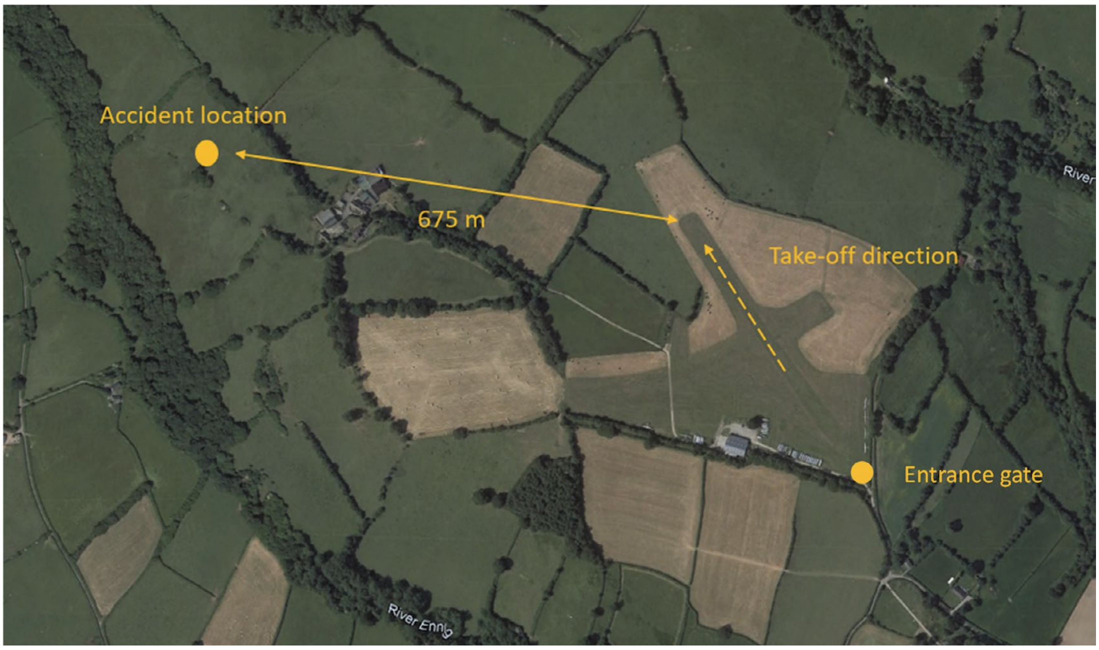

Figure 1
Takeoff run and accident location

The student was the handling pilot and the intention was to depart in a north-westerly direction (Figure 1), remain connected to the aerotow until 1,500 ft agl before tow release, then rejoin a left hand circuit to land in a north-easterly direction. The pilot intended to make minimal inputs and the student was expected to make all radio calls. The pilot noted the student was close to solo standard but needed to focus on his use of the airbrake during the approach.

Pre-takeoff checks were carried out as normal, and during the takeoff run the pilot recalled keeping his hand on the release knob until he was confident the student had aileron control. He then removed his hand from the release knob to avoid inadvertent inputs. The student recalled keeping his hand on the release knob throughout the takeoff roll, in line with BGA guidance[1].

The ground run was slightly longer than normal, likely due to a crosswind, high temperature and takeoff weight. The glider became airborne before the towing aircraft and began to climb. Moments later the student called out that the tow rope had detached from the glider. The pilot could see the rope trailing the towing aircraft. The student stated that although he could not be certain, he did not recall pulling the release knob and would have no reason to have done so.

The pilot took control and began to look for possible landing sites. He turned left towards lower ground, but he recalled the glider was quickly at tree height so his options were limited.

Footnote

1 BGA Safe aerotowing booklet states ‘*during the ground run, the glider pilot should have their left hand on the cable release*’.

He could not identify an area suitable for a safe landing and continued flying between trees before a field came into sight to the left of the glider that had a favourable slope and long grass. The pilot turned towards the field, during which both he and the student spotted electricity cables, and the glider hit the ground. The student exited the glider immediately, while the instructor remained in the cockpit.

The glider was damaged beyond repair. Both the pilot and student sustained spinal injuries.

Aircraft information

General

The Schleicher AS-K 13 is a two-seat glider, commonly used for training. G-DCMK was purchased in June 2017 by the gliding club and was maintained by its members. The K 13 was designed to have two tow releases fitted, the first in the nose for aerotowing and a second “belly hook” under the fuselage, primarily for winch launching. At some point in the glider’s history the belly hook was removed and replaced with a light spring to maintain the cable tension through the guides. This would not have affected the operation of the nose release.

Figure 2
G-DCMK

Nose tow release

The nose tow release fitted to G-DCMK at the time of the accident was a Tost E72, serial number 18058 (Figure 3 left). Figure 3 right shows a sectioned E85 tow release, which differs from an E72 in having a cast instead of welded housing. The tow release comprises the housing, adjustment screw, hook, link piece, release lever and a spring.

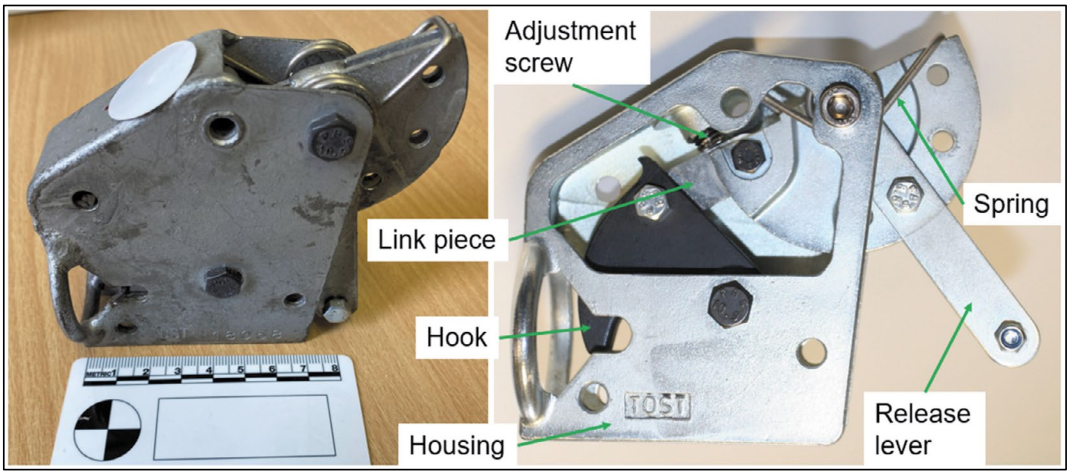

Figure 3

Left – Tost E72 tow release fitted to G-DCMK
Right – Example E85 tow release. Internal mechanism similar

It was operated by either pilot pulling on a plastic release knob attached to a steel cable in the cockpit (Figure 4 left and right). The steel cable passed through a series of guides and was attached to the release lever (Figure 4 centre), and another cable attached to the release lever continued under the cockpit area to the belly hook.

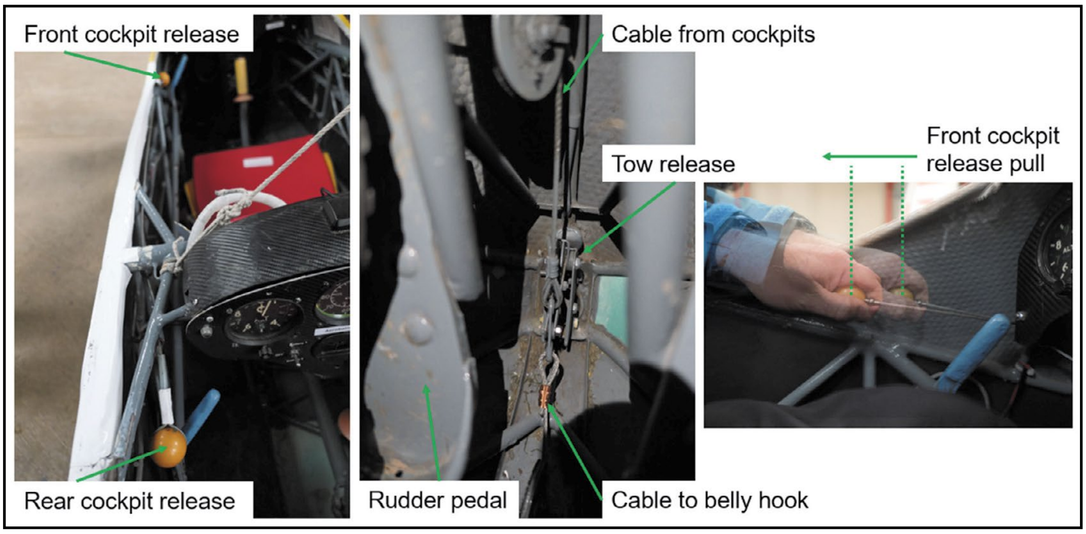

Figure 4[2]

Left – Cockpit releases
Centre – Cable attachments to the tow release
Right – Front cockpit showing the movement of the knob to release the tow cable

Footnote

[2] Note that all the images used in Figure 4 are from an exemplar aircraft and not from G-DCMK.

When the release cable is pulled the release lever rotates (counter-clockwise), against the spring tension, pulling the link piece and opening the hook, thereby releasing the tow ring.

The over-centre position of the mechanism is adjusted by the adjustment screw against the release lever. This adjustment screw is set at the factory and sealed with a security sticker. Incorrect setting of the screw may result in higher loads and a longer pull required to operate the hook mechanism and release the tow.

A previous report of an uncommanded nose tow release on this glider was investigated at the time by club members. No cause could be found for the uncommanded release and the E85 tow release was replaced as a precaution on 17 June 2022. The same replacement tow release was fitted to the aircraft at the time of the accident flight.

Aircraft examination

The AAIB inspected the glider and the tow rope at the gliding club and found no anomalies with the tow rope or rings. The front of the glider was disrupted and had been partially disassembled. It was found that one of the cockpit cable guides which was integral with the left mounting for the instrument panel, had detached from the fuselage. The tow release had been removed from the glider, so it was not possible to test the function of the tow release system.

The tow release was examined by the manufacturer, which noted that the white round sticker on the housing was not the security sticker applied by the factory (Figure 5 left). The sticker was removed and it was found that the over-centre adjustment screw had been removed (Figure 5 right).

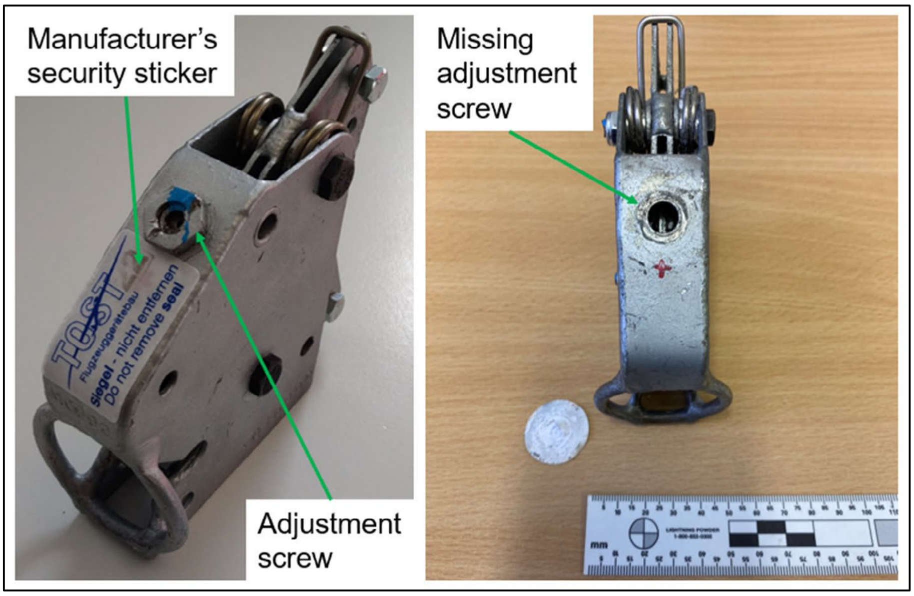

Figure 5

Left – Example of an E72 tow release as supplied from the manufacturer
Right – White round sticker removed showing missing adjustment screw

It was stated to the investigation that while installing it following the June 2022 incident, the replacement tow release would not fit because the adjustment screw fouled against the structure. To enable the release to be fitted the adjustment screw was removed. The tow release that was removed was an E85 which has a recessed adjustment screw as shown in Figure 3 right.

The AAIB was informed that the gliding club had performed its own investigation into possible causes for the premature release. It had considered several options and performed testing on another K 13 glider. These tests indicated that there was sufficient clearance to ensure that the front pilot's feet on the rudder pedals could not inadvertently pull the release cable and open the release hook.

Meteorology

At the time of the accident there were clear skies, a light north-easterly wind (less than 10 kt) and a temperature of 25°C.

Aerodrome information

The gliding club is located at Talgarth airfield, on the western edge of the Black Mountains in South Wales. The airfield has a number of grass runways, which provide three takeoff and five landing options. The airfield elevation is 970 ft amsl.

The takeoff run in the north-westerly direction is the longest available, sloping downhill from the entrance gate.

The airfield is surrounded by hilly terrain and there are limited options for forced landing sites in the event of low level disconnects from aerotows for gliders, or engine failures for powered aircraft.

Analysis

The examination of the tow release revealed that the over-centre adjustment screw had been removed from the housing. The adjustment screw is set by the manufacturer and sealed before delivery. The tow release is a certified, safety critical part and is supplied with an EASA Form 1. No modification or adjustment of this component is permitted except by qualified persons. No one at the gliding club was qualified to modify the tow release.

The adjustment screw on the E72 tow release was proud of the housing and prevented it from being fitted when the tow release was changed on 17 June 2022 following a previous uncommanded release. The adjustment screw of the E85 tow release which was removed from the glider during that change was recessed into the housing, so the problem only arose when the E72 was fitted. The removal of the adjustment screw would have increased the loads required to open the tow release hook and need a longer pull on the tow release cable, so would not have caused inadvertent release. The tow release manufacturer informed the AAIB that a special version of the E72 with a recessed adjustment screw is available.

It was not possible to determine whether detachment of the cable guide and panel mounting was a pre-existing defect or a result of the accident. If it were a pre-existing defect, it is unlikely to have caused an inadvertent release due to movement of the instrument panel because the panel is attached by an additional two bolts. It was found that if a tall pilot could push against the panel with their knees the resulting movement would not be sufficient to release the hook. Furthermore, any misalignment would cause additional friction, thereby increasing the load required to pull the release cable.

It was not possible for the investigation to establish if there was a technical issue with the complete tow release system (release knob to hook) that could have led to a premature release.

It is possible that the pilot or student inadvertently moved the tow release. Whatever the cause of the release, given the low level at which the glider disconnected from the aerotow, the pilot had to identify the safest landing site almost immediately.

Conclusion

The evidence available was not sufficient to determine conclusively why the tow rope disconnected from the glider. An inadvertent input on the release knob or an unidentified mechanical failure of the tow release system could not be ruled out.

Published: 30 November 2023.

ACCIDENT

Aircraft Type and Registration:	Pegasus Quik, G-CCPC	
No & Type of Engines:	1 Rotax 912ULS piston engine	
Year of Manufacture:	2003 (Serial no: 7994)	
Date & Time (UTC):	1 June 2022 at 0945 hrs	
Location:	East Fortune Airfield, East Lothian	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - 1 (Fatal)	Passengers - N/A
Nature of Damage:	Destroyed	
Commander's Licence:	National Private Pilot's Licence	
Commander's Age:	69 years	
Commander's Flying Experience:	155 hours (of which 6 were on type) Last 90 days - 6 hours Last 28 days - 3 hours	
Information Source:	AAIB Field Investigation	

Synopsis

During start up, the engine suddenly went to a high rpm. The aircraft accelerated over the ground and became airborne with the base bar attached to the front strut. It struck the ground in a field adjacent to the airfield and the pilot died from head injuries eight days later.

It is likely that the pilot started the engine with the hand throttle open and did not free the base bar, reduce the rpm or stop the engine before the aircraft became airborne. The pilot might have survived if he had been wearing his shoulder (diagonal) harness and his helmet had been designed to protect him from rotational head injuries.

Four Safety Recommendations are made in this report. Two to the CAA to mandate the embodiment of a starter inhibitor switch on the hand throttle, and to review the exception for a shoulder strap not to be worn. Two to the British Standards Institute regarding the design of helmets used for airborne sports. Safety Actions were also taken by the BMAA, Microlight Panel of Examiners and the pilot's flying club.

History of the flight

The accident pilot was a member of the flying club at East Fortune Airfield near North Berwick, where he kept his aircraft. On the day of the accident, he arrived at the airfield at approximately 0815 hrs and discussed with several members of staff his intended flight in the local area and cosmetic repairs he planned for his aircraft. There had been some lower cloud earlier in the morning, but the bases had lifted and the weather was suitable for the planned flight, with light winds from the north-east.

The flying club has multiple CCTV cameras from which recordings show the pilot putting on a helmet and entering the aircraft, which was parked on a grass area immediately in front of the club hangar. The recordings, one of which included audio, showed four engine start cycles and on the fifth cycle the engine started and immediately accelerated to a high rpm. This was at approximately 0940 hrs. Club staff, who were alerted by the sudden “abnormal” sound of the engine, ran out of the hangar and saw the aircraft accelerating rapidly over the grass and collide with a runway marker sign. The collision caused the aircraft to bounce as it crossed the taxiway and become airborne (Figure 1).

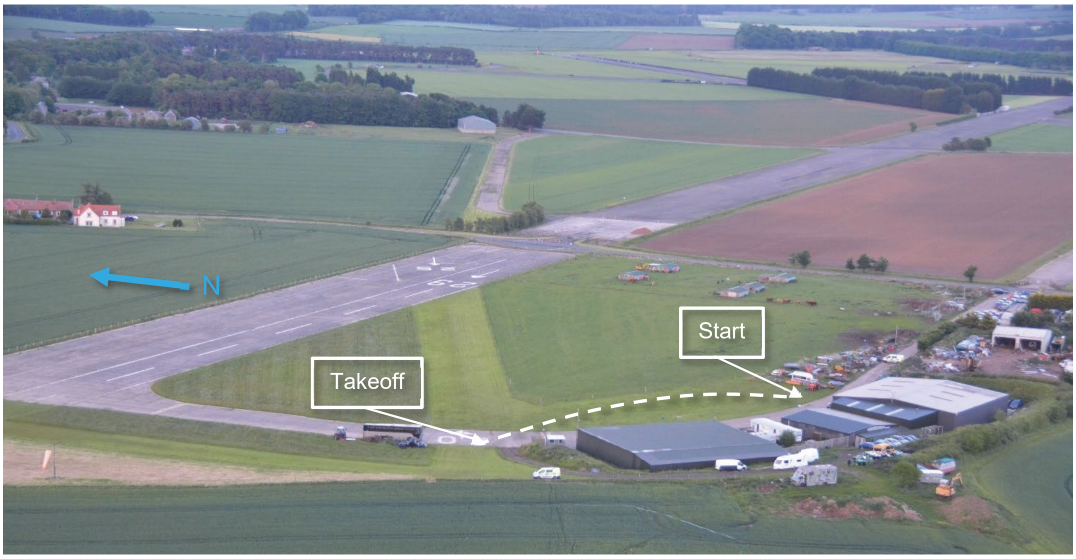

Figure 1

Approximate path of aircraft across the grass area (image used with permission)

The aircraft entered a wide left turn, climbing above the height of the hangars, before descending out of sight in a left-wing low attitude behind a hangar at the south-west corner of the airfield. Witnesses described hearing the engine “high revving” up to the point of impact with the ground and observed a “cartwheeling” wingtip just visible behind the hanger.

Flying club staff arrived quickly at the aircraft and found the pilot secured in his seat by the safety harness lap strap; he was not wearing the diagonal shoulder strap. The pilot’s helmet was still fitted, although the face visor had become detached. He was breathing but unresponsive and apparently unconscious.

An ambulance and the fire service attended the scene, followed by a doctor and paramedic. The pilot was released from his lap strap and the wreckage moved in order to provide medical assistance. The pilot was transferred to hospital by ambulance but died eight days later as a result of his injuries.

Accident site

Ground marks

Marks made by the aircraft's wheels as they travelled across the grass stretched from where the aircraft was parked on the grass in front of the hangar to the edge of the concrete taxiway. The marks indicate that the aircraft travelled in a left arc, missing a wire fence approximately 30 m in front and perpendicular to the direction the aircraft was parked. As the aircraft travelled towards the concrete taxiway, its right main landing gear struck a runway stop sign concreted into the ground at the edge of the taxiway (Figure 2) before becoming airborne.

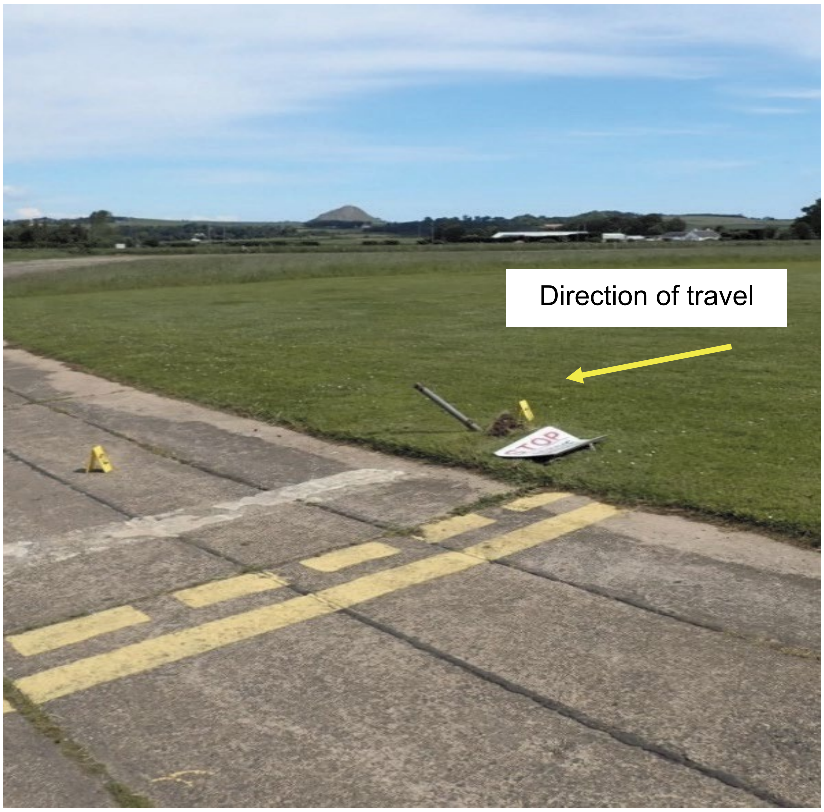

Figure 2
Runway stop sign struck by aircraft

Accident site

The aircraft came to rest in a field to the west of the airfield. Ground impact marks show that the aircraft's left wheel struck the ground first followed by the left-wing tip and the front of the trike. The aircraft cartwheeled and bounced before stopping approximately 28 m from the initial impact point. The trike came to rest on its right side with the pylon still attached to the wing (Figure 3).

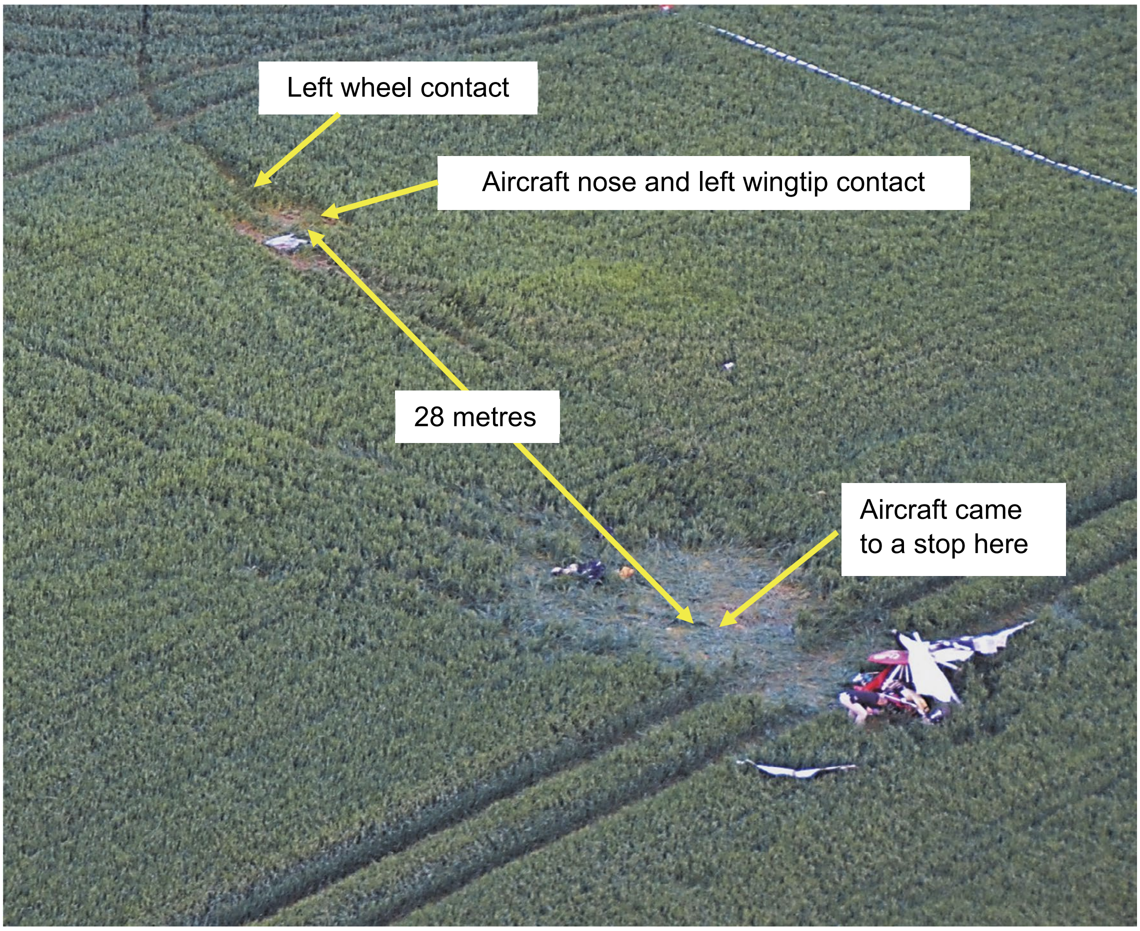

Figure 3
Accident site

Pilot information

The pilot held a UK National Private Pilot's Licence issued in 2018, and had flown 155 hours, of which 6 hours were in G-CCPC. His microlight rating was valid until the end of August 2022. He purchased G-CCPC in March 2022 and conducted differences training with an instructor on 20 March 2022.

Medical

Post-mortem report

The pathologist found that the pilot died from a severe rotational head injury sustained in the accident. There was no indication of medical impairment or incapacitation of the pilot before the aircraft struck the ground.

Pilot medical declaration

The pilot submitted a Pilot Medical Declaration on 1 August 2017, which was valid until May 2023.

Aircraft description

General

G-CCPC was a Pegasus[1] Quik flexwing microlight powered by a Rotax 912 ULS piston engine, which has a maximum rpm of 5,800. Significant features of the aircraft are shown in Figure 4.

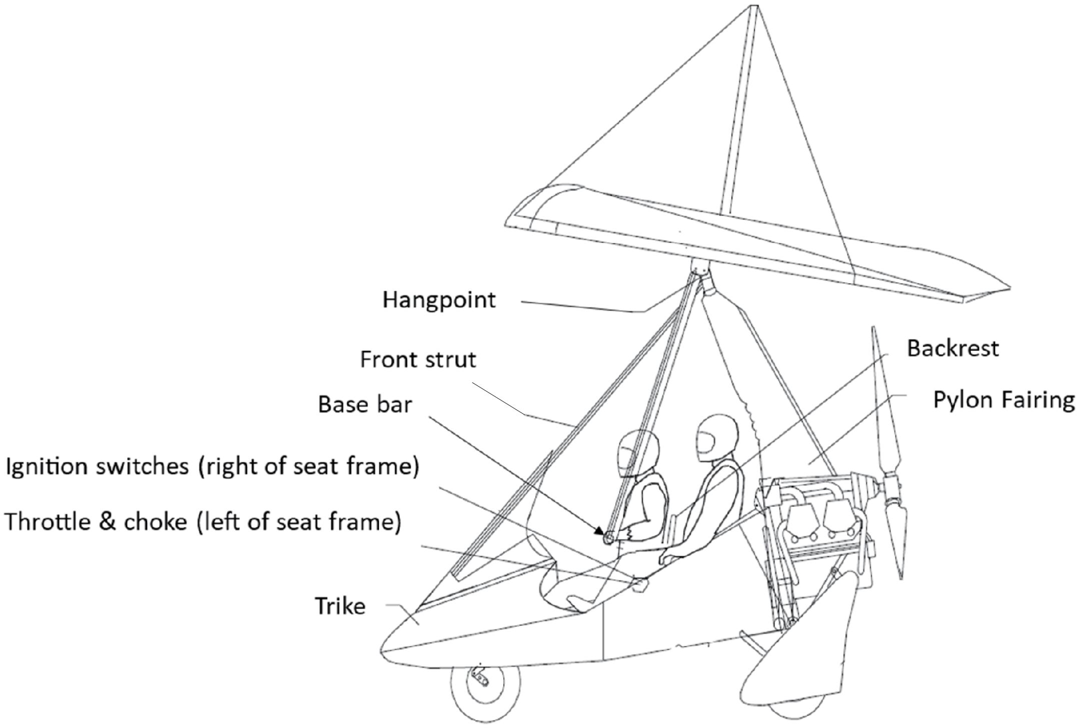

Figure 4

Significant features of the Pegasus Quik aircraft

Certification

The Pegasus Quik was certified by the CAA against British Civil Airworthiness Requirements (BCAR) Section S, Issue 3, '*Small Light Aeroplanes*', on 6 December 2002. The CAA Microlight Type Approval Data Sheet (TADS) Number BM66 applies.

Aircraft brakes

The aircraft is fitted with disc brakes on the two mainwheels, which can be operated by a hand lever located in the left footwell or a brake pedal located above the left footrest on the nosewheel steering bar (Figure 5). The aircraft does not have differential braking.

Footnote

1 The current manufacturer is P&M Aviation, formed from Pegasus Aviation and Mainair Sports in 2003.

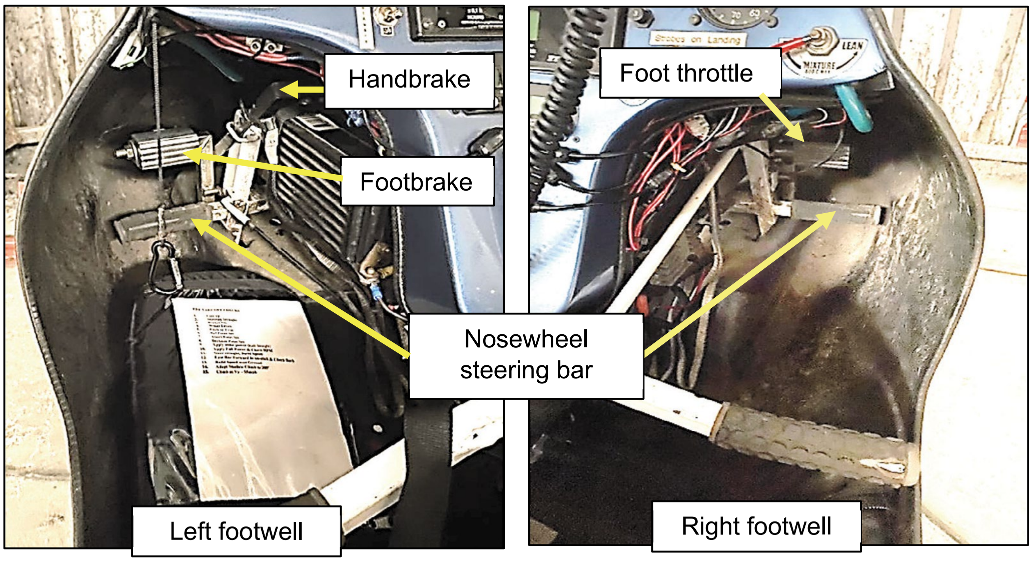

Figure 5

Location of footbrake, handbrake, foot throttle and nosewheel steering bar

Engine controls

The engine rpm is controlled by either a hand or foot throttle. The hand throttle is located on the left of the seat frame, and the foot throttle above the right nosewheel steering bar. Each of the controls are attached by Bowden cables, through a 'splitter box' to each of the two carburettor throttle linkages. The splitter box is designed to allow either the hand or foot throttle control to adjust the engine speed. If one of the controls is moved to fully open (maximum rpm), movement of the other control will have no effect as the engine is already operating at its maximum speed.

The foot throttle is the primary engine speed control and when foot pressure is removed the engine reverts to idle. The hand throttle, however, is a friction damped lever which allows the pilot to adjust the engine rpm. Unlike the foot throttle, once set the hand throttle will remain in this position until readjusted.

Manufacturer's hand throttle modification M112

There have been reported instances of the engine on the Pegasus Quik suddenly increasing to maximum rpm during engine start. At a high rpm, the aircraft brakes are not capable of holding the aircraft stationary and without the pilot taking immediate action the aircraft can quickly accelerate and reach flying speed. In 2003, the manufacturer issued optional modification M112[2] - '*Safety starter switch in hand throttle,*' that introduced a microswitch in the hand throttle housing to prevent the engine from starting if the throttle lever is not in the OFF (closed) position. The modification was installed as standard on all Quik aircraft manufactured from 2003 unless the owner chose not to have it installed.

Footnote

[2] CAA Microlight Type Approval Data Sheet (TADS) No: BM 66 Issue 9 Annex B '*Approved Optional Modifications*'.

Seat safety harnesses

The rear seat was equipped with a 4-point safety harness consisting of two shoulder straps and a lap strap. The front seat was fitted with a 3-point safety harness consisting of a lap strap and one manually adjustable diagonal shoulder strap.

Pilot's helmet

The pilot's helmet was marked with the British Standard Institute (BSI) Standard, BS EN 966:1996 '*Helmets for Airborne Sports.'*

The helmet had a hard outer shell of Glass Reinforced Plastic with an inner trauma lining[3] and a foam backed nylon comfort layer. It was equipped with integrated ear shells containing earphones and had a microphone boom attached to the left shell. Attached to the front of the helmet was a clear visor that could be locked in the up or down position. On the bottom edge of the visor was a neoprene draft-proof chin guard.

Last aircraft and engine maintenance

The aircraft had been extensively repaired following an accident on 31 July 2020, and both the aircraft and the engine had passed their post-repair Permit to Fly inspections on 28 February 2022. This was followed by a successful check flight on 1 March 2022. The owner had flown the aircraft five times between 20 March 2022 and the date of the accident without incident.

Recorded information

Engine monitoring device

The microlight was not fitted with any devices that recorded the flight path and there was no active transponder on board. It was fitted with an engine monitoring device which monitors the engine parameters, recording the maximums reached in successive six-minute periods. It also captures any parameter exceedances. The unit's data was downloaded and indicated that the engine had operated for a total of 756.5 hours. As the accident flight was under six minutes there was only one entry, which showed that the maximum engine speed reached was 4,880 rpm and no exceedances had been triggered during the short flight.

The unit also retains the last time an alarm level for each parameter was reached; the last alarm was more than 150 operating hours prior to the accident flight and not considered relevant to this investigation.

CCTV

There were a number of CCTV cameras installed at the airfield and one at a neighbouring business premises. Between them they recorded the flight from the initial attempted starts though to the final impact. The accident site was captured from a camera where a building obscured the ground contact of the aircraft. One of the on-airfield cameras included audio,

Footnote

3 The trauma liner was designed to absorb forces caused by direct blows to the helmet thereby providing protection from skull fracture injuries.

which corroborated the maximum engine speed recorded by the engine monitoring unit. The peak was reached on startup and dropped to approximately 4,630 rpm over the next few seconds.

The CCTV shows the base bar against the front strut when the aircraft was parked and it remained in this position in all the subsequent CCTV images as it travelled over the ground. After entering the cockpit, the pilot made various adjustments and then attempted to start the engine. The start was not successful on the first attempt. The quality of the recordings was not sufficient to accurately track the movement of the pilot's hands on the engine controls. However, when the engine started on the fifth attempt, it appears that the pilot moved his left hand from the instrument panel to the left side of the pod in the vicinity of the hand throttle and choke. The aircraft immediately started to move. The pilot then moved his left hand to the base bar within two seconds of the aircraft starting to move, followed about a second later by his right hand. The microlight accelerated in a curved path with the base bar against the front strut and the wing at a high angle of attack. The microlight struck a runway marker sign at the edge of the taxiway, bounced and became airborne with the wing displaced to the left.

Figure 6 shows cropped snapshots from the CCTV footage overlaid to show the aircraft position at one second intervals in each camera view. The time from the engine starting to the aircraft becoming airborne was approximately nine seconds

a) Start

b) Curved ground track

c) Takeoff

Figure 6

Cropped CCTV snapshots, overlaid to show the aircraft position at one second intervals in each camera view. There is overlap between the period covered by image b) and the other two sequences.

After taking off, the microlight flew in a low-level, tight, left turn (Figure 7). The images are not clear enough to determine whether the base bar was against the front strut after takeoff.

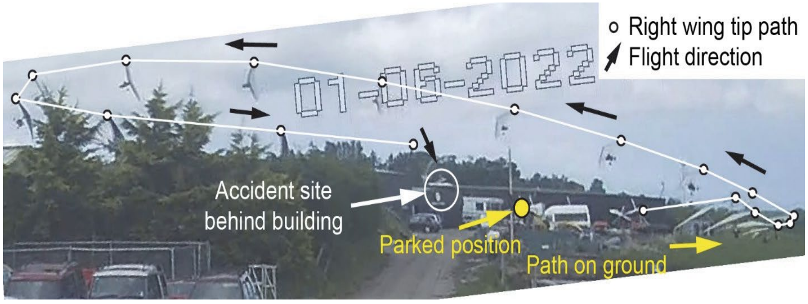

Figure 7

Cropped CCTV snapshots, rotated to horizontal,
and overlaid to show the aircraft position at one second intervals

The CCTV indicates that a few seconds prior to the final impact, the aircraft had a groundspeed of between 54 kt and 63 kt. The audio recording on the CCTV of the engine noise before impact was analysed. After taking into account the increased tone of the audio due to the aircraft travelling towards the microphone, the engine speed was slightly higher than during the ground run, which would be expected with a higher airspeed.

Prior to impact the microlight had a significant left bank angle.

Aircraft examination

On site examination of wreckage

Both ignition switches located on the right side of the seat frame were found in the ON position with the switch guard bent over the switches preventing them from being moved. The friction-damped hand throttle lever located on the left side of the seat frame was positioned slightly forward of OFF. Located directly below the hand throttle was the choke lever which was selected to OFF (Figure 8).

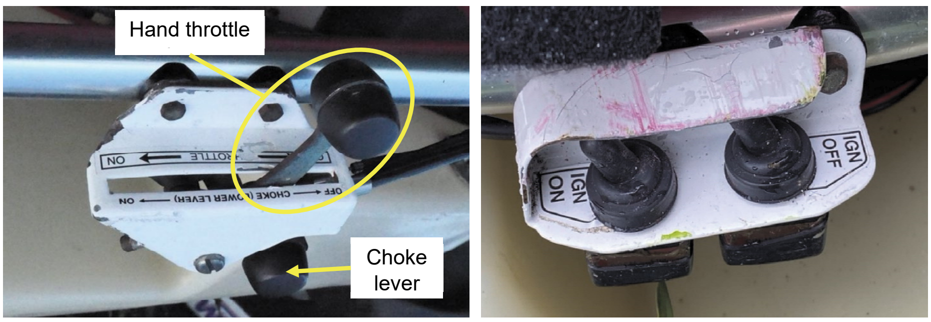

Figure 8

Hand throttle and choke levers (left), ignition switches (right)

The front of the trike's base tube had been disrupted at the rear steering bar attachment point. The nosewheel, front steering fork, foot throttle, and foot brake were intact and connected to the broken section of the base tube by pipes, wiring and cables.

The throttle and brake cables remained connected to their respective foot pedals and routed to their systems in the aft section of the trike. When pressure was applied to the footbrake, both main disk brakes operated and the footbrake returned to the OFF position when pressure was released.

A nylon strap was attached to the front strut which was used to tether the base bar when the aircraft was parked. The strap was found to be hanging loose from the strut and not tethered to the base bar.

Hand and foot throttle operation

When the hand throttle and the foot throttle were operated in turn, each one correctly and simultaneously operated both carburettors' throttle linkages. The manufacturer's optional modification M112 was not installed.

Seat harnesses

The rear seat shoulder straps were found disconnected from their lap strap and tied around the pylon. The rear seat lap strap had been adjusted so that it was tight against the rear seat cushion. The front seat diagonal shoulder strap had been tightened between the pylon and the base tube and routed under the seat cushion to prevent it from fouling the propeller during flight (Figure 9). In this configuration, the shoulder strap could not have been worn by the pilot during the flight.

Figure 9

Front seat diagonal shoulder strap positioned as found at the accident site

Requirements for the fitment and use of safety harnesses

British Civil Airworthiness Requirements Section S - Small Light Aeroplanes

BCAR Section S[4] contains the following requirements for the fitment of safety harnesses:

> ***'Emergency Landing Conditions***
>
> ***S 561 General***
>
> *a) The aeroplane, although it may be damaged in emergency landing conditions, must be designed as prescribed in this paragraph to protect each occupant under those conditions.*
>
> *b) The structure must be designed to give each occupant every reasonable chance of escaping serious injury in a crash landing when proper use is made of belts and harnesses provided for in the design, in the following conditions:*
>
> ***S 785 Seats and safety harnesses***
>
> *d) Each safety harness must be attached so that the pilot is safely retained in his initial sitting or reclining position under flight and emergency landing accelerations. (See AMC S 785 d).'*

Acceptable Means of Compliance and Interpretive Material (AMC) S 785 d) refers to Section S 1307, which contains what the CAA described as a 'configuration specific provision' for weight-shift controlled aircraft to be provided with only a lap strap for front seat occupants:

> ***'S 1307 Miscellaneous equipment***
>
> *a) All occupants must be provided with a lap strap and upper torso restraint, capable of restraining the wearer against the forces resulting from the accelerations prescribed for emergency landing conditions in S 561, and AMC S 1307 a), except that only a lap strap need be provided for front seat occupants of a weight-shift controlled aircraft.'*

The CAA informed the AAIB that the 'configuration specific provision' was first introduced in Issue 4 of BCAR Section S, dated 21 December 2007. The CAA could not positively determine why the configuration specific provision had been added but reported that it was:

> *'…highly likely that it was introduced to reflect the fact that in order to effectively control a weight-shift microlight, the pilot(s) need adequate upper body movement. There may also be consideration towards being able to operate the control bar from both seating positions if there was a student under instruction'.*

Footnote

[4] CAP 482: British Civil Airworthiness Requirements Section S – Small Light Aeroplanes, Issue 7, dated 19/12/2018 [accessed June 2023]

The CAA added that proposed amendments to Section S would have gone through the Section S Working Group comprised of industry experts and CAA specialists for approval. The CAA further stated that:

> *'We believe the key word in this requirement* [S 561] *is 'reasonable chance' and believe that when you consider the need for the pilot to effectively control the aircraft in normal operation, a properly worn lap belt is a logical solution in combination with guidance and advice for occupants to consider the use of safety helmets.'*

Previous AAIB Safety Recommendation on use of shoulder harnesses

In the report into the fatal accident involving the flexwing microlight G-STYX[5] in 2004, where neither the pilot nor the passenger were wearing the upper torso restraints fitted to the aircraft, the AAIB made the following Safety Recommendation on 15 November 2005:

> **Safety Recommendation 2005-082**
>
> It is recommended that the Civil Aviation Authority review its policy on the use of crash helmets and shoulder harnesses on microlight aircraft.

The CAA responded that:

> *'The CAA have reviewed the regulatory policies in both these areas as they apply to microlight aircraft. The requirements for seat belts and harnesses, and for briefings and instructions for passengers regarding their use, are contained in the Air Navigation Order and are believed to be sufficiently robust.'*

The G-STYX report also referenced a previous accident, G-MZCN in 2001[6], where the pilot was fatally injured because the passenger was not wearing an upper body restraint.

Air Navigation Order requirements

A Part 21 aircraft is defined by the CAA as an aircraft that was previously managed by EASA and considered as EASA Types. They are regulated under UK Regulation (EU) 2018/1139, also known as the UK Basic Regulation, and its implementing regulations cover airworthiness, operations and flight crew licensing. Aircraft operating on BMAA and LAA Permits to Fly are classified as non-Part 21 aircraft and are managed nationally under the Air Navigation Order[7] (ANO).

Schedule 5 of the ANO applies to equipment required to be fitted to non-Part 21 aircraft and pre-dates the configuration specific provision in BCAR S 1307. Schedule 5 provides

Footnote

[5] Aircraft Accident Report 2/2005 - Pegasus Quik, G-STYX 21 August 2004 - GOV.UK (www.gov.uk). [Accessed June 2023]

[6] Aircraft Accident Report 6/2001 - Mainair Blade 582, G-MZCN 13 January 2001 - GOV.UK (www.gov.uk). [Accessed June 2023]

[7] The Air Navigation Order. UK Statutory Instruments 2016 No 765.

the legislative basis for the incorporation of the 'configuration specific provision' into BCAR Section S, issue 4. With regards to safety harnesses, it states:

> *'… a flying machine must be equipped with a seat belt with an upper torso restraint system on each flight crew seat, having a single point of release.'*

However, Schedule 5 also states that '*the CAA may permit a flying machine not to be equipped'* with this item of equipment.

The CAA informed the AAIB that in addition to flexwing microlights, examples of aircraft where the flight crew seats were permitted to be provided with only a lap strap included two types of fixed wing aircraft that ceased being manufactured before 1980.

Operator's Manual

The manufacturer's Operator's Manual[8] contains the following notes and warnings regarding the use of safety harnesses and seat belts:

> ***'1.5. SAFETY HARNESSES***
>
> *P&M aircraft are equipped with a 3 point harness for the pilot, and a four point harness for the passenger. <u>These should be worn at all times</u>.*
>
> ***2.7. SECONDARY STRUCTURES AND SYSTEMS - SEAT BELTS***
>
> *Lap straps are provided for both occupants. In addition, a single diagonal shoulder restraint is provided for the front seat and twin shoulder restraints for the rear.*
>
> **WARNING**
>
> Both safety harnesses must be used in full with shoulder restraints. This must be checked before take off.
>
> ***7.2. STRAPPING IN***
>
> *Lap straps should be adjusted snugly across the hips to reduce tendency for either occupant to slide forwards under the strap. <u>Shoulder straps should be adjusted with a little slack to allow any necessary movement during flight</u> and to ensure that the lap straps remain in place without slipping upwards in the event of accident.'*
>
> **WARNING**
>
> Failure to put on safety harness and wear front seat or rear seat shoulder straps could be the cause of injury or death in the event of an accident.

Footnote

[8] Quik Range of Aircraft Operating Instructions Issue 3 dated 4 October 2012.

Use of the safety harness shoulder strap during training

Instructors did not actively encourage the pilot to wear the shoulder strap of the safety harness during his training for two reasons. Firstly, they believed that wearing the shoulder strap could restrict the movement of the pilot's body and prevent him from exercising full control of the base bar. It was believed that if the strap was adjusted to leave a little slack, in accordance with the manufacturer's guidance, it was prone to slip off the shoulder and could present a snagging hazard for the pilot's arms. Secondly, it could prevent the instructor in the rear seat from exercising full control of the base bar by restricting their reach during demonstrations or in the event of having to take control.

Use of the safety harness shoulder strap in the wider flexwing community

Interviews conducted with flexwing pilots, research and consultation with the BMAA revealed that not using the shoulder strap appeared to be a common operating culture in the flexwing community. This was based on a general belief that the perceived inconvenience of wearing the strap and the potential for restricting upper body movement presented a greater hazard than not wearing it. The fact that BCAR Section S contained a 'configuration specific provision' allowing flexwing microlights to be fitted with only a lap strap for front seat occupants was stated as contributory to this culture: if it was not mandated that shoulder straps should be fitted, pilots did not feel obliged to use them even when they were. Videos and images of flexwing microlights, freely available on the internet, showed some occupants not wearing the installed shoulder strap for the 3-point harness in the front seat and the 4-point harness in the rear seat. These images included flexwing aircraft equipped with inertia reel shoulder straps.

Guidance provided to flexwing instructors on the use of safety harnesses

At the time of the accident, there was no guidance provided to flexwing instructors on the recommended use of safety harnesses for the occupant of the front seat during training flights. To address this issue, the Microlight Panel of Examiners[9] published the following guidance in their Instructor and Examiner Bulletin (01/2022), dated December 2022. The full document is at Appendix A.

> ***'2. USE OF DIAGONAL RESTRAINTS IN FLEXWINGS***
>
> *There is a worrying trend developing of pilots not wearing diagonal restraints when fitted to flexwing aircraft.*
>
> *This may be because students see instructors not wearing them and therefore consider them not important.*
>
> *A reminder that any restraints fitted to an aircraft must be worn by a pilot in accordance with the requirements in the aircraft's POH and whatever restraints are fitted must be used.*

Footnote

[9] The Microlight Panel of Examiners are appointed and overseen by the CAA. The Panel, in turn, appoint flight examiners.

Instructors do not have to wear the diagonal harness if they assess it will interfere with their ability to remain safely and effectively in control.

Student's must be left in no doubt that this is an exception purely for instructors whilst conducting flying training, and examiners whilst conducting GST[10]s.

Whilst conducting GSTs the candidate must demonstrate to the examiner the correct use of these restraints, even if the examiner is not wearing them for safety considerations.'

Safety Actions taken by the BMAA

Following this accident, the BMAA took the following Safety Actions:

a) The guidance published in the Microlight Panel of Examiners' bulletin on the use of diagonal restraints in flexwings will be incorporated into the '*Instructor and Examiner Guide'* published by the BMAA at the next appropriate amendment.

b) A 'Belt-Up' safety campaign was launched in May 2023[11] promoting the safe use of safety harnesses in microlight aircraft, including a campaign poster, an article in the membership magazine. A video demonstrating correct inspection and fitting techniques is planned to be released in early 2024.

Royal Air Force Centre of Aviation Medicine analysis

The RAF Centre of Aviation Medicine (RAFCAM) assisted the investigation in understanding the relationship between the aircraft impact forces and the injuries sustained by the pilot. As part of this analysis, impact testing was carried out on the same type and model of helmet worn by the pilot. RAFCAM reported that:

'The evidence from the helmet damage coupled with the post-mortem findings indicated that the pilot had sustained a severe blow to the right side of his head which ultimately resulted in his demise.'

In describing the pilot's use of only the lap strap:

'The lack of upper torso restraint, provided by just the lap straps being connected, would have permitted the pilot's upper torso and head to flail forward excessively. This increased flailing would have resulted in the pilot more likely contacting the ground and cockpit structures during the impact, thereby increasing the severity of his head injuries. If the pilot had had his shoulder strap fitted it is likely that his forward and sideward flailing would have been lessened. It is then possible that this reduction in flailing could

Footnote

[10] General Skills Test.

[11] The British Microlight Aircraft Association/belt-up-safety-campaign [accessed June 2023]

have reduced the severity of the head injury as the impact velocity of his head with the ground and cockpit structures would have been reduced. As a consequence of a reduction in the head impact velocity the outcome of the accident may have been altered such that he may have survived. However, it is difficult to quantify the magnitude of the reduction in impact velocity achieved by limiting flailing of his upper torso.'

With regard to the helmet worn by the pilot:

'Although the pilot was wearing a helmet which was designed and conformed to the appropriate helmet standard: CSN EN 966 - Helmets for Airborne Sports, it is highly likely that the head impact energy and velocity were far in excess of those which the EN Standard dictates airborne sports helmets should attenuate.'

Survivability

Over the previous six years, the AAIB investigated seven flexwing accidents where the use of seat harnesses had been recorded in the accident reports. Where the full seat harness was worn, the occupants were more likely to sustain minor or no injuries. In three of the accidents where the front seat pilots were not wearing the shoulder strap, the pilots suffered serious or fatal injuries. The results of the level of injuries sustained in these seven accidents is summarised in Table 1.

Number of accidents	Harness worn by occupants	Injuries
1	All occupants wearing harness	None
2	All occupants wearing harness	Minor
1	All occupants wearing harness	Serious
2	No harness worn	Serious
1	**No harness worn**	**Fatal**

Table 1

Flexwing accidents over a six-year period where the use of seat harnesses had been recorded in AAIB reports

Comparison of head injuries sustained in two similar flexwing accidents

The AAIB investigated two similar accidents to Pegasus Quik aircraft that both occurred at Harringe Court Farm airstrip; one occurred on 6 August 2022 (G-CGRR) and the second on 14 May 2023 (G-CDPD)[12]. In both accidents the aircraft veered on landing and rolled onto their side (Figure 10).

Despite the similarities between the accidents, the injuries sustained by the pilots were substantially different. The pilot of G-CGRR, who was only wearing the lap strap and not

Footnote

[12] Pegasus Quik, G-CGRR 04-23 published 3 May 2023 and Pegasus Quik G-CDPD published 10 August 2023.

the shoulder strap, received serious facial injuries when his head contacted parts of the structure and the ground. Whereas the pilot of G-CDPD, who was wearing the full three-point harness, received only minor injuries.

Figure 10

Pictorial comparison of G-CGRR (left) and G-CDPD (right)

Safety Helmets

The CAA makes no requirement for sports aviation pilots to wear safety helmets, nor do they set standards for airborne sports helmets. Standards for airborne helmets are published by the BSI and the European Conformité Européenne (CE).

The pilot's helmet was marked with the BSI Standard BS EN 966:1996[13] '*Helmets for Airborne Sports.*' BS EN 996:1996 had two sub-categories: '*Helmets for paragliding and hang gliding (HPG)';* and '*Helmets for flying in ultra-light aeroplanes (UL)*.' The pilot's helmet was marked with UL. However, within the UK there is no defined ultra-light aeroplane category, instead sports aircraft such as G-CCPC are defined in Schedule 1 of the ANO as microlights, which are aircraft that can have a Maximum Takeoff Mass (MTOM) up to 600 kg with a stall speed, or minimum steady flight speed, not exceeding 35 kt CAS at MTOM.

Accidents that involve an oblique impact to the head can cause rotational motion of the head and brain. Existing research into brain injuries suffered during transport accidents, shows that rotational motion of the head produces a significantly greater risk of brain damage than the injuries sustained from direct frontal, vertical or lateral impacts. Currently the European

Footnote

13 This Standard has been superseded by BS EN 966: 2012 '*Helmets for Airborne Sports*' which still contains the HPG and UL categories and the same test criteria.

and British standards for airborne sports helmet testing does not include the helmet's response to oblique impacts. Rotation protection systems are available for helmets used for cycling, climbing, construction, horse riding, motorsports and winter sports[14]. RAFCAM's assessment of the pilot's helmet was that it did not incorporate protection from rotational head injuries.

Compass location

On G-CCPC, the compass had been relocated from the top of the cockpit coaming and mounted on the front strut directly in front of the pilot. This location made the compass easy to read and provided space to mount additional avionic units on the cockpit coaming. It was noted that on other similar flexwing aircraft at the flying club, the compass was also mounted on the front strut.

Where equipment is mounted on the front strut of flexwing aircraft, and the shoulder strap is not worn, there is an increased risk of the front seat occupant sustaining head injuries in an accident.

Microlight training

Obtaining a National Private Pilot Licence

To obtain a National Private Pilot Licence (NPPL) with a microlight class rating a pilot must complete a training course with a CAA certified flight instructor entitled to instruct on microlights. Training must follow the UK NPPL microlight syllabus published by the BMAA. Once qualified, pilots must undertake at least one hour of flying training in a 24-month period to revalidate their licence.

The pilot of G-CCPC completed his NPPL training in August 2018 and had flown with a CAA certified instructor in September 2020 and March 2022.

Starting the engine

To start a Pegasus Quik engine, instructors at the club taught the following technique:

- Maintain the right hand close to the ignition switches on the right side of the cockpit, ready to select them OFF to shut down the engine.

- The left hand operates the starter button on the left side of the instrument console and can be used to adjust the choke on the left side of the cockpit if required.

- The Quik wing is too short to rest on the ground and can be moved by the wind, potentially overturning the trike. To prevent this, the left arm can support the base bar while operating the starter. Alternatively, to free the left arm the base bar can be tethered to the front strut using a nylon strap.

Footnote

[14] Mips - Safety for helmets at https://mipsprotection.com [accessed 29 June 2023].

The pre-start checklist includes a step to check that the hand throttle is fully closed and that the right foot is clear of the foot throttle. When starting an engine from cold, students are taught to increase the engine oil pressure by turning the engine over twice, in five second bursts, with the ignition switches turned OFF and the choke closed. The choke is then opened as required for subsequent engine start cycles.

This start procedure and the guidance taught by the club was the same as provided in the manufacturer's Operator's Manual.

Starting with a flooded engine

If during the start cycle the engine has been fed with an excessively rich air-fuel mixture, the engine will not start and is considered to be 'flooded'. The BMAA advised that the following technique can be used to clear a 'flooded' engine prior to starting:

- Close the choke.
- Open the hand throttle to a high setting (or use the foot throttle in types where a safety starter microswitch is fitted in the throttle quadrant).
- Press the starter button.
- Be prepared to close the hand or foot throttle when the engine catches and turns over.

This technique to start a flooded engine was recognised, but not taught by the instructors at the club as they did not consider opening the hand throttle to a high setting to be a safe action. They taught that the engine should be cranked with the choke fully closed and some foot throttle applied until the engine cleared and started. This way the throttle setting could be easily reduced by lifting the foot off the foot throttle. It could not be determined if the pilot was aware of the technique described by the BMAA

Neither the engine manufacturer, nor the aircraft manufacturer's Operator's Manual contained specific advice on clearing a flooded engine.

Training for aircraft systems failures

The microlight training syllabus covers various system failures, including a stuck throttle and brake failure which is taught in lesson 16e[15], before a student is sent solo. Instructors at the club conducted these failure scenarios as a 'discussion' with students and did not simulate the malfunctions in an aircraft. The '*Microlight Instructor and Examiner Guide',* published by the BMAA, did not provide guidance on how instructors should conduct this lesson.

To assist microlight instructors and examiners in the conduct of training and testing for system failures, the Microlight Panel of Examiners published guidance on the following topics in their Instructor and Examiner Bulletin (01/2022), dated December 2022. This will

Footnote

15 '*Syllabus of Training for the National Private Pilot's Licence for Microlights',* approved by the CAA and published by the BMAA,

be incorporated into the '*Instructor and Examiner Guide*', Section 4, Lesson 16e – System Failures:

> Microlight instructors and examiners will include the following content in flying training and testing:
>
> - Preparation for unexpected situations and emergencies.
> - Conduct of aircraft checks.
> - Student response to unintentional mishaps and emergencies while on the ground and in flight.
> - Preventative actions which must be incorporated into daily checks and routines, including aircraft daily inspections, advice on the positioning of the base bar, and aircraft starting.

Safety actions taken by the flying club

To provide realistic training for pilots in the handling of system malfunctions, the flying club took the following Safety Actions:

> The flying club:
>
> - Published a 'Procedures Reminder' to club members, emphasising the following:
>   - The importance of the engine start checks to ensure the aircraft is configured correctly.
>   - Keeping fingers on the ignition switches during start to ensure the engine can be stopped immediately if it runs away.
>   - The importance of checking the hand and foot throttles during the daily inspection to ensure correct function.
> - Require, prior to first solo, students to complete the following training:
>   - Simulate an engine runaway during startup. To be conducted on the runway requiring the student to switch off the ignition switches to shut down the engine.
>   - Simulate a stuck throttle and a brake failure. Both scenarios to be conducted independently on either the runway or taxiway and require the student to steer the aircraft in a safe direction before switching off the ignition switches to shut down the engine.
> - Require the engine runaway, stuck throttle and brake failure, exercises to be included in biennial training flights for licence renewal.

Aircraft manufacturer's Service Bulletin Number 159

As a result of this accident the aircraft manufacturer issued Service Bulletin (SB) Number 159[16] that reclassified the starter inhibitor switch as a manufacturer's compulsory modification and provided instructions for it to be embodied on existing aircraft.

The SB recommended a start procedure which included the following step before the engine is turned over:

> *'Undo any parking strap, pull the control bar in.'*

With regard to the use of the harness, the SB stated:

> *'A pilot diagonal strap and passenger twin shoulder harness has been provided on all P&M aircraft since 1990. Correctly adjusted, the harness does not compromise full and free control inputs.'*

Analysis

Overview

The accident sequence began when the engine started and went immediately to a high rpm, causing the aircraft to accelerate across the ground and become airborne while the base bar was still tethered to the front strut. The pilot, who was not wearing the diagonal shoulder strap that formed part of his harness, died from a rotational head injury sustained when the aircraft struck the ground.

Medical

The post-mortem examination determined that there was no indication of medical impairment or incapacitation of the pilot before the aircraft struck the ground.

Base bar tethering

It is common practice on the Quik for the base bar to be tethered to the front strut when the aircraft is parked. CCTV evidence shows the base bar on G-CCPC located against the front strut as the aircraft accelerated over the ground and became airborne. The attitude and track of the aircraft during the short flight are also consistent with the base bar remaining in this position.

Whilst the nylon strap, that is fixed to the front strut, was not looped around the base bar when examined by the AAIB at the accident site, it was possible that the emergency services had unstrapped it while attending to the casualty.

The investigation concluded that the base bar was tethered to the front strut during the flight and was a factor in this accident.

Footnote

16 Pegasus Sport Aviation Ltd Service Bulletin Number 159, issued on 22 September 2023.

Engine starting

The first two engine turnovers were likely to have been carried out to increase the engine's oil pressure before attempting to start the engine from cold. The following two attempts were unsuccessful and may have convinced the pilot that the engine was flooded.

It is probable that in attempting to clear the flooded engine, on the fifth turnover the pilot set the hand throttle to a high rpm setting. Once the engine started and suddenly went to a high rpm, he did not reduce the throttle to idle nor switch off the ignition switches.

The engine start procedure in the manufacturer's Operating Manual advises pilots to keep their right hand close to the ignition switches to enable them to quickly cut the engine power if necessary. Had the pilot selected the switches to OFF he could have arrested the forward motion with the aircraft brakes. This was the procedure taught to the pilot by the club instructors as part of a stuck throttle scenario. However, the procedure was only discussed and not practised in the aircraft. There was no opportunity for him to experience the action of locating and switching off the ignition switches with the aircraft in forward motion. There was also no requirement for this skill to be demonstrated during biennial training, nor during instructor validation and revalidation training. This lack of practical experience in responding to a stuck throttle is considered to be a factor in this accident.

Since this accident, the Microlight Panel of Examiners has taken action to improve training and testing of pilot's response to system failures.

Hand throttle modification

As a result of reported instances of the engine on the Pegasus Quik suddenly increasing to maximum rpm during engine start, in 2003 the manufacturer introduced optional modification M112, which prevents the engine starting if the hand throttle is not in the OFF position. Had the modification been fitted to G-CCPC then this accident would not have happened.

Following this accident, the aircraft manufacturer prepared SB 159 to classify the starter inhibitor switch as a compulsory modification on their range of flexwing aircraft equipped with an electric starter. To prevent a reoccurrence of this type of accident, the following Safety Recommendation is made to the CAA to require the starter inhibitor switch to be fitted to all electric start, in-service Pegasus Sport Aviation Ltd flexwing aircraft:

Safety Recommendation 2023-037

It is recommended that the UK Civil Aviation Authority issue a Mandatory Permit Directive to mandate Pegasus Sport Aviation Ltd Service Bulletin 159, to embody a Starter Inhibitor Switch on all electric start, in-service Pegasus Sport Aviation Ltd flexwing aircraft.

Use of shoulder straps

The ‘configuration specific provision’ in BCAR Section S that allowed only a lap strap to be fitted on flexwing aircraft had resulted from representation from the flexwing community, who were concerned that the shoulder strap could limit the pilot’s ability to control the aircraft.

As there was no regulatory requirement to fit or use a shoulder strap in flexwing aircraft, the BMAA did not provide guidance on the potential benefits of their use, despite a number of accident reports citing the lack of upper body restraints as a potential cause of injury or death. Similarly, the Microlight Panel of Examiners did not provide guidance to flexwing instructors on the recommended use of safety harnesses for the occupant of the front seat during training flights.

Over time this situation led to the emergence of a culture in the flexwing community that despite clear manufacturer’s warnings to always wear both parts of the seat harness assembly, there was a perception that wearing the shoulder strap presented a greater hazard than using the lap strap alone. A mark of the strength of this culture was that even where flexwing aircraft were fitted with inertia reel shoulder straps, which were designed to overcome the perceived restrictions in movement, shoulder straps were not always worn.

Instructors at the flying club where the pilot conducted his training for a NPPL, did not actively encourage the wearing of the shoulder strap as they believed it restricted their ability to fly from the rear seat and the pilot to operate the flying controls from the front seat. The pilot routinely saw instructors and other pilots not wearing the shoulder harness which likely reinforced his belief that it was safe to do the same. Once he completed his training and purchased his own aircraft, it was therefore probable that he would continue with this established practice.

Following this accident, the Microlight Panel of Examiners addressed this safety issue by issuing guidance to examiners and instructors on the wearing of shoulder harnesses.

Survivability

The RAFCAM described excessive flailing of the pilot’s upper torso and head during the accident sequence as a consequence of only using the lap strap as a restraint. It was likely that not using the diagonal shoulder strap resulted in the pilot’s head striking the ground and cockpit structure with significant force, thereby increasing the severity of his head injury. The RAFCAM assessment postulates that the potential reduction in the impact velocity of the pilot’s head when it struck the ground if he had been wearing his shoulder strap, may have made the outcome of the accident survivable.

The finding from RAFCAM and the experience of the AAIB that there is a greater risk of serious and fatal injury when a shoulder strap is not worn during an accident, is contrary to the CAA’s position that a properly worn lap strap, in combination with a safety helmet, provides adequate protection.

The aircraft manufacturer warns that the full harness should be worn and if correctly adjusted does not compromise full and free control inputs. However, pilots of the Pegasus Quik who expressed concern at wearing the shoulder harness quoted the exception in BCAR Section S 1307 as justification not to wear it. To ensure that the exception in BCAR Section S1307 is still appropriate, the following Safety Recommendation is made to the CAA:

Safety Recommendation 2023-038

It is recommended that the UK Civil Aviation Authority review the suitability of the Configuration Specific Provision in British Civil Airworthiness Requirements, Section S 1307 (a) Miscellaneous equipment which states, 'except that only a lap strap need be provided for front seat occupants of a weight-shift controlled aircraft'.

Airborne helmet safety standards

Whilst there was no regulatory requirement for microlight pilots to wear a safety helmet, the pilot wore a helmet designed to conform to BS EN 966: 2012 '*Helmets for airborne sports'.* However, this Standard does not protect wearers from the most likely cause of serious and fatal head injuries in aircraft accidents that result from rotational motion of the head when it is subject to an oblique impact. In this accident, the pilot died from a severe rotational head injury which his helmet was not designed to protect him from. Therefore, to ensure that BS EN 966: 2012 provides protection from oblique impacts that are likely to occur in aircraft accidents, the following Safety Recommendation is made to the BSI:

Safety Recommendation 2023-039

It is recommended that the British Standards Institute introduce a requirement in BS EN 966 'Helmets for Airborne Sports' to protect wearers from rotational head injuries

The helmet worn by the pilot was categorised for use in ultralight aircraft; however, this term has not been defined by either the BSI or the CAA. To ensure microlight pilots select helmets suitable for their airborne activity, the following Safety Recommendation is made to the BSI:

Safety Recommendation 2023-040

It is recommended that the British Standards Institute adopts the definition of a microlight from Schedule 1 of the Air Navigation Order (UK Statutory Instruments No. 765) in BS EN 966 'Helmets for Airborne Sports'.

Conclusion

The accident happened as a result of the aircraft becoming airborne with the base bar tethered to the front strut. The pilot might have survived had he worn a shoulder harness to restrain his upper torso and a helmet that offered protection from rotational head injuries.

During the start procedure, the engine went to a high rpm causing the aircraft to accelerate over the ground and become airborne. As a result of previous similar occurrences, the aircraft manufacturer had introduced an optional modification to prevent this from happening; however, this modification had not been embodied on G-CCPC.

The training in dealing with system failures, such as a stuck throttle, was conducted as a discussion and not as practical training in the aircraft. Consequently, the pilot had never practised locating and turning off the ignition switches while the aircraft was in forward motion.

While shoulder straps were fitted to the aircraft, there was a general concern within the microlight community that wearing them potentially restricted the pilot's ability to control the aircraft. Consequently, a culture had emerged of only wearing a lap strap; this practice significantly increased the risk of head injuries during an accident.

While protection from rotational head injuries is already available in safety helmets for other sports and transport users, the BSI standard for the airborne sports helmet worn by the pilot did not include this requirement.

Safety Actions

The Microlight Panel of Examiners published the following guidance in their Instructor and Examiner Bulletin (01/2022), dated December 2022.

2. USE OF DIAGONAL RESTRAINTS IN FLEXWINGS

There is a worrying trend developing of pilots not wearing diagonal restraints when fitted to flexwing aircraft.

This may be because students see instructors not wearing them and therefore consider them not important.

A reminder that any restraints fitted to an aircraft must be worn by a pilot in accordance with the requirements in the aircraft's POH and whatever restraints are fitted must be used.

Instructors do not have to wear the diagonal harness if they assess it will interfere with their ability to remain safely and effectively in control.

Student's must be left in no doubt that this is an exception purely for instructors whilst conducting flying training, and examiners whilst conducting GSTs.

Whilst conducting GSTs the candidate must demonstrate to the examiner the correct use of these restraints, even if the examiner is not wearing them for safety considerations.

Microlight instructors and examiners will include the following content in flying training and testing:

- Preparation for unexpected situations and emergencies.

- ○ Conduct of aircraft checks.
- ○ Student response to unintentional mishaps and emergencies while on the ground and in flight.
- ○ Preventative actions which must be incorporated into daily checks and routines, including aircraft daily inspections, advice on the positioning of the base bar, and aircraft starting.

The following Safety Actions were taken by the BMAA:

a) The guidance published in the Microlight Panel of Examiners' bulletin on the use of diagonal restraints in flexwing aircraft will be incorporated into the '*Instructor and Examiner Guide'* published by the BMAA at the next appropriate amendment.

b) A 'Belt-Up' safety campaign was launched in May 2023[17] promoting the safe use of safety harnesses in microlight aircraft, including a campaign poster, an article in the membership magazine. A video demonstrating correct inspection and fitting techniques is planned to be released in early 2024.

The pilot's flying club flying club took the following Safety Actions:

The flying club:

- Published a 'Procedures Reminder' to club members, emphasising the following:
  - ○ The importance of the engine start checks to ensure the aircraft is configured correctly.
  - ○ Keeping fingers on the ignition switches during start to ensure the engine can be stopped immediately if it runs away.
  - ○ The importance of checking the hand and foot throttles during the daily inspection to ensure correct function.
- Require, prior to first solo, students to complete the following training:
  - ○ Simulate an engine runaway during startup. To be conducted on the runway requiring the student to switch off the ignition switches to shut down the engine.
  - ○ Simulate a stuck throttle and a brake failure. Both scenarios to be conducted independently on either the runway or taxiway and require the student to steer the aircraft in a safe direction before switching off the ignition switches to shut down the engine.
- Require the engine runaway, stuck throttle and brake failure, exercises to be included in biennial training flights for licence renewal.

Footnote

[17] The British Microlight Aircraft Association/belt-up-safety-campaign [accessed June 2023]

Safety Recommendations

The following Safety Recommendation was made on 15 November 2005.

> **Safety Recommendation 2005-082**
>
> It is recommended that the Civil Aviation Authority review its policy on the use of crash helmets and shoulder harnesses on microlight aircraft.

The CAA responded that:

> *'The CAA have reviewed the regulatory policies in both these areas as they apply to microlight aircraft. The requirements for seat belts and harnesses, and for briefings and instructions for passengers regarding their use, are contained in the Air Navigation Order and are believed to be sufficiently robust.'*

The following Safety Recommendations are made in this report:

> **Safety Recommendation 2023-037**
>
> It is recommended that the UK Civil Aviation Authority issue a Mandatory Permit Directive to mandate Pegasus Sport Aviation Ltd Service Bulletin 159 to embody a Starter Inhibitor Switch on all in-service Pegasus Sport Aviation Ltd aircraft .
>
> **Safety Recommendation 2023-038**
>
> It is recommended that the UK Civil Aviation Authority *review the suitability of the Configuration Specific Provision* in British Civil Airworthiness Requirements, Section S 1307 (a) Miscellaneous equipment *which states, 'except that only a lap strap need be provided for front seat occupants of a weight-shift controlled aircraft'*.
>
> **Safety Recommendation 2023-039**
>
> It is recommended that the British Standards Institute introduce a requirement in BS EN 966 'Helmets for Airborne Sports' to protect wearers from rotational head injuries.
>
> **Safety Recommendation 2023-040**
>
> It is recommended that the British Standards Institute adopts the definition of a microlight from Schedule 1 of the Air Navigation Order (UK Statutory Instruments No. 765) in BS EN 966 'Helmets for Airborne Sports'.

Published: 7 December 2023.

APPENDIX A

INSTRUCTOR AND EXAMINER BULLETIN 01/2022

INSTRUCTOR AND EXAMINER BULLETIN 01/2022

How to use checks efficiently

Reinforce the understanding that checks are not just to be read from a list but to be part of a procedure that must incorporate both the check list and the actions together. Too often checks are just seen as a list to complete rather than a physical action.

Stress the need to practice **touch checks**, and the instinctive knowledge of position of the controls. This will help to prevent fumbling and losing time when things go wrong and actions need to be swift.

Remind students that touch checks mean physically touching, but **not** engaging/ activating systems such as ignition switches, fuel on/off, throttle, brake, parachute release mechanism for example.

Students should be taught to practice responses to various unintentional mishaps/ emergencies whilst on the ground, taxiing and in flight.

Examples include, but are not limited to the following:

1) Brake failure on start up
2) Starting unintentionally with full throttle
3) Failed or stuck throttle causing aircraft to go to full power on start-up and taxiing.
4) Throttle failure in flight for those aircraft with throttles that will fail 'safe,' i.e., go to full power. (What could happen? How will the engine perform with only one carb operating? What are the consequences? What to do?)

Preventative actions which must be incorporated into daily checks and routine:

- Aircraft should be stopped with the nose wheel straight. In any case, this should be checked before start up then, if the unexpected should happen the aircraft would go straight ahead to the pre-planned open area. There has been more than a one accident due to the aircraft not moving in the same direction as intended on start up!
- Wherever possible, have one hand on the throttle as the engine is started.
- Daily Inspection on aircraft to include throttle checks at carbs, on and off, and in the case of Flexwings, hand and foot throttle check.
- Additionally in the case of flexwings the control bar should be under armpits or at least untied at start up.
- Take note of and teach the aircraft manufacturer's instructions for dealing with emergencies in that aircraft, they may be specific and additional instructions.

The Instructor and Examiner Guide Section 4, Ex 16e - Systems Failures, will be updated for this.

I & E Bulletin 01-2022

INSTRUCTOR AND EXAMINER BULLETIN 01/2022

British Microlighting www.bmaa.org

20/12/2022

All Instructors and Examiners,

The Panel has decided there is a need for more guidance to be given to Instructors and Examiners on 1) Eventualities, checks and the POH and 2) Diagonal restraints in Flexwings.

Until the Guide is amended to incorporate the points covered in this Instructor Bulletin please make sure this content is included, where appropriate, in your flying training/testing.

1. **The following points are a list of reminders on the importance of teaching EVENTUALITIES, thorough CHECKS and referring to the aircraft's POH**

Eventualities

When confronted with an unexpected situation/emergency one will typically freeze momentarily. The first reaction is usually 'What happened?' followed by 'I can't believe this is happening.' This is the *'startle'* effect. Until this is under control you cannot function effectively to deal with the crisis.

See below the Yerkes Dodson Law with the bell shaped graph of *performance versus anxiety/ stress*. Note the need to remain on the upslope of the curve to be able to act effectively.

Discuss with students the importance of preparing beforehand by practising/ considering what can go wrong to be able to react with minimum delay to reduce the *'startle'* effect should the unexpected/emergency occur.

For example: prior to take-off, considering contingencies for an engine failure on take-off.

I & E Bulletin 01-2022

INSTRUCTOR AND EXAMINER BULLETIN 01/2022

2. USE OF DIAGONAL RESTRAINTS IN FLEXWINGS

There is a worrying trend developing of pilots not wearing diagonal restraints when fitted to flexwing aircraft.

This may be because students see instructors not wearing them and therefore consider them not important.

A reminder that any restraints fitted to an aircraft must be worn by a pilot in accordance with the requirements in the aircraft's POH and whatever restraints are fitted must be used.

Instructors do not have to wear the diagonal harness if they assess it will interfere with their ability to remain safely and effectively in control.

Student's must be left in no doubt that this is an exception purely for instructors whilst conducting flying training, and examiners whilst conducting GSTs.

Whilst conducting GSTs the candidate must demonstrate to the examiner the correct use of these restraints, even if the examiner is not wearing them for safety considerations.

This guidance will be added to the Instructor and Examiner Guide.

Should you need advice on any of the content of this Instructor Bulletin get in touch with one of the Panel members/ FIEs.

AAIB Correspondence Reports

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

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

The accuracy of the information provided cannot be assured.

SERIOUS INCIDENT

Aircraft Type and Registration:	ATR 72-212 A, G-CMFI
No & Type of Engines:	2 Pratt & Whitney Canada PW127M turboprop engines
Year of Manufacture:	2016 (Serial no: 1312)
Date & Time (UTC):	9 October 2022 at 1850 hrs
Location:	Leeds Bradford Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 4 Passengers - 41
Injuries:	Crew - None Passengers - None
Nature of Damage:	No damage
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	31 years
Commander's Flying Experience:	5,134 hours (of which 2,456 were on type) Last 90 days - 243 hours Last 28 days - 74 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

After landing, the crew smelled smoke on the flight deck. The aircraft was brought to a stop on the runway and the commander ordered a rapid disembarkation. The operator identified the source of the smell as a static inverter failure. The cause of the smoke emission was known by the aircraft manufacturer and its supplier. A corrective Vendor Service Bulletin had been developed and distributed to operators, but the operator was unaware of the issue.

The operator has updated maintenance and operational procedures in response to the event.

History of the flight

The flight was a charter from Biggin Hill to Leeds Bradford Airport. There were four crew members and 41 passengers on board. The flight was uneventful and the aircraft landed after flying a normal ILS approach to Runway 14. Whilst decelerating below 70 kt, the master caution sounded with an ELEC inverter (INV) 1 fault, followed by a master warning for ELEC smoke.

The co-pilot commented that he could smell smoke and the commander agreed. The aircraft was brought to a stop on the runway and the parking brake set. ATC were informed of the possibility of smoke being present on the flight deck and the crew requested the fire service to attend the aircraft.

The commander called the senior cabin crew member (senior) via the interphone and asked if he could smell smoke in the cabin, to which the senior cabin crew replied "no". The commander told the senior that the pilots could smell smoke on the flight deck. The senior left his seat at the back of the aircraft and walked through the cabin, after which he reported smelling smoke. There was no visible smoke on the flight deck or in the passenger cabin. The commander told the senior to wait for further instructions.

The commander then spoke on 121.6 MHz directly to the fire commander, who confirmed there was no visible external smoke and no hotspots were detected on the aircraft. The copilot commented that the smell of smoke was beginning to dissipate.

The crew discussed their options and the commander elected to initiate a rapid disembarkation on the runway, as he was not content to continue to taxi to the parking stand but wanted to avoid any panic which could be introduced by an evacuation. Both propellers were feathered and the propeller brake engaged, and the left engine was shutdown. The senior was informed of the decision to rapidly disembark the aircraft by a QNITS[1] brief via the interphone. The commander did not make a PA instructing the passengers to leave the aircraft and the evacuation checklist was not followed. The commander decided to keep the right engine running in 'Hotel mode' (see description below) to power the cabin lights as it was dark outside.

The passengers and cabin crew disembarked onto the runway and were subsequently transported to the airport. The pilots decided to remain on board to facilitate towing from the runway to a stand. There were no reported injuries.

Aircraft information

Electrical system

G-CMFI is an ATR 72-212 twin turboprop aircraft manufactured in 2016.

The ATR electrical system comprises two batteries (main and emergency), two engine-driven DC starter/generators, two AC wild frequency generators and two external power units. There are two static inverters (INV), supplied by the DC system, which provide constant frequency AC power (Figure 1).

INV 1 normally supplies AC BUS 1 and AC STBY BUS, while INV 2 normally supplies AC BUS 2. In the event of inverter failure or input power loss, the associated AC BUS is isolated from the affected inverter and AC BUS 1 and 2 are automatically connected by the Bus Tie Relay (BTR). In the event of INV 1 failure or input power loss, AC STBY BUS is automatically supplied from INV 2. An INV FAULT light will illuminate amber on the overhead panel in the event of an inverter failure or loss power supply.

Footnote

1 QNITS brief format: Questions, Nature of emergency or abnormal situation, Intention, Time, Special instructions.

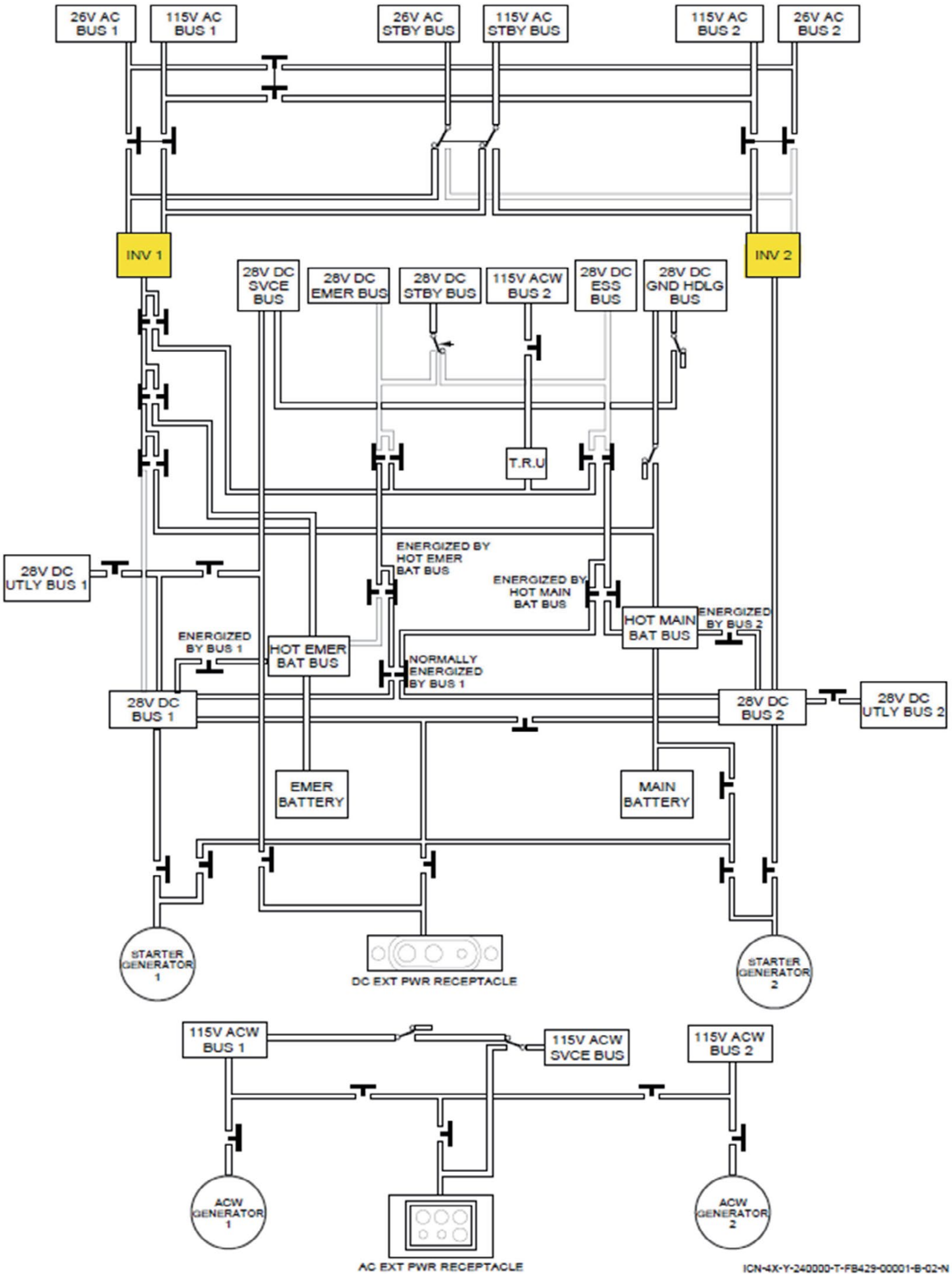

Figure 1

ATR 72-212 Electrical system

Hotel mode

In Hotel mode the propeller is held stationary by a hydraulically operated brake, allowing the right engine to operate as an auxiliary power unit. There are hazards associated with this operation such as noise and hot gases, and its use prohibited in tailwind speeds greater than 10 kt.

The flight crew operating manual gives the following operational procedures and limitations regarding right engine operation in hotel mode:

- 'Hotel mode may not be used when the aft service door is open.
- *Hotel mode may not be used when refuelling the aircraft.*
- *The tailwind component should not exceed 10kts except for transitory conditions.*
- *One flight crew member must remain in the flight deck at all times whilst Hotel mode is in use.*
- *Cabin crew [if on board] shall be informed when Hotel mode is in use, except during routine full engine start and shutdown.*
- *De-icing with Hotel Mode may only be accomplished when de-icing is to be conducted remotely and only after briefing the de-icing team.*
- *Both pilots must be aware that Hotel mode is in operation.*
- *The wing light must be turned on before the engine is started in Hotel Mode and must be turned off when the engine is shut down.'*

Source of fumes

The operator found the source of the fumes to be the static inverter number 1. It had recorded 6,617.22 flight hours in service, while the guaranteed mean time between unexpected removal (GMTBUR) is 15,000 flight hours.

Vendor Service bulletin

Following a consultation between the operator and manufacturer after this event, the manufacturer identified a Technical Progress Status (TPS) report which it highlighted that inverter 1-002-0102-2173 was known to have had several events of a similar nature[2], although the operator was not aware of this.

The report referred to Inverter Vendor Service Bulletin (VSB)[3], which identified that specific serial numbers of static inverters were affected by high failure rates and should be modified through replacement of capacitors. Both static inverters on G-CMFI were affected by this VSB. The VSB was transmitted by ATR in AOM 2017-08 and TPS 24-21-001. There was no associated airworthiness directive (AD).[4]

The manufacturer identified 42 previous events of smoke, or a smell of smoke where the cause was identified as the failure of a static inverter.

Footnote

2 ATR Technical Progress Status report (24-21-001).
3 Vendor Safety Bulletin 1-002-0102-2173- 24-41.
4 ATR 72-212 Airworthiness Operator Message 42/72/2017/08 issue 1.

In response to the event, the operator replaced INV 2 on G-CMFI with an inverter with a serial number not affected by the VSB. A bulletin was circulated within the maintenance department informing of a change to treat the manufacturer AOM's in the same way as a SB, to avoid a similar oversight of known issues in the future. A review of manufacturer AOM's was also carried out to ensure no other relevant messages were missed by the operator. None was identified.

Meteorology

The weather reported at Leeds Bradford Airport included clear skies and a light wind of approximately 8 kt from the south-east, and the temperature was 13°C.

Aerodrome information

Leeds Bradford Airport has one concrete runway 14/32 which is 2,250 m long. The landing distance available for Runway 14 is 1,801 m.

Personnel

Both crew members held valid licences and their medicals were in date.

Organisational information

Emergency procedures

Evacuation

Section 11 in the Operations Manual Part B (OMB) for the ATR 72 provides emergency evacuation procedures. It describes two types of evacuations as follows.

- *'The planned evacuation will usually be the result of an airborne event, and possible evacuation requirements will have been discussed with the crew via a QNITS brief. Examples of such planned evacuations may be perhaps after a gear unsafe warning in the air, or a fire.*
- *The unplanned evacuation will result from an unforeseen event, the crew not having had time to plan and discuss a strategy to deal with the situation.'*

Examples of unplanned evacuations include smoke in the cabin after landing, but the guidance document states *'Procedures are set out as a general guide, and at the* [commanders] *discretion, may be revised. For example, does the situation still require an evacuation, or would a rapid disembarkation be more prudent?'*

The *'Emergency evacuation checklist'* (Figure 2) and procedures in the Operations Manual Part B should be followed for any evacuation, but these are not memory items.

EMERGENCY EVACUATION (ON GROUND)

▶ AIRCRAFT	STOP
▶ BRAKE HANDLE	PARKING
▶ ATC (VHF1)	NOTIFY
▶ AUTO PRESS DUMP	ON
▶ MIN CAB LT	ON
▶ CABIN CREW (PA)	NOTIFY
▶ CL 1+2	FTR THEN FUEL S.O.
▶ FIRE HANDLES 1+2	PULL
▶ AGENTS	DISCH AS RQRD
▶ ENG START selector	OFF & START ABORT
▶ FUEL PUMPS 1+2	OFF
▶ EMER EXIT LT	ON
▶ EVACUATION (PA)	INITIATE
• Before leaving aircraft	
▶ BAT	OFF

Figure 2

QRH '*Emergency evacuation (on ground)*' Checklist

Post-evacuation guidance in OMB states that the commander must take charge and provide any relevant information to the rescue team. The crew should direct passengers to a secure and protected area upwind away from the aircraft, keeping passengers grouped together. It further states that '*passengers will rely on leadership*'.

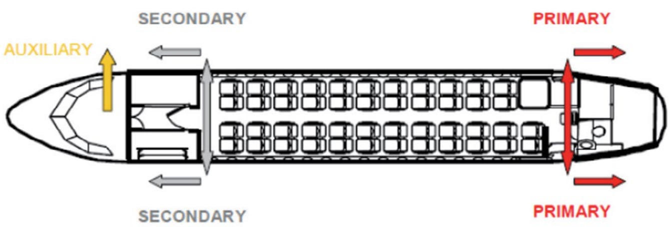

Figure 3

Recommended exit routes on land

During an evacuation, all five emergency exits should be used (Figure 3).

Precautionary rapid disembarkation

Operations Part B for the ATR 72 describes a rapid disembarkation as:

> *'A situation may arise where there is a need to disembark the aircraft promptly using normal exits only, e.g. during passenger boarding, push/power back or prior to arrival… Although serious, the situation may not warrant a full evacuation but crews must remain vigilant in the event that the situation may turn into a full emergency...* [the commander] *should then inform passengers of the situation via the PA.'*

There was no procedure for crew to follow when initiating a rapid disembarkation with engines running.

The operator issued the flight crew instruction (FCI) '*Evacuate or Deplane*' in 2018, which was intended to prepare pilots to consider the most appropriate response following an emergency.

The operator stated that the main difference between an evacuation and rapid disembarkation is that the emergency exits are not used in a rapid disembarkation. The forward exits and aft exit on the right side differ from the aft left exit (which is used to board and disembark the aircraft during normal operations) as they have no access steps. The operator considered there was an increased risk of injuries to passengers in using these emergency exits.

Updated operator guidance

In response to this event, the operator indicated it intends to update its procedures and guidance to flight and cabin crew regarding rapid disembarkations, to provide greater clarity on the distinction between an evacuation and a precautionary rapid disembarkation, and the appropriate application of both procedures. It proposed the following:

- Emergency Rapid Disembarkation checklist
- Evacuation/ Rapid disembarkation training material for CRM and refresher training
- Flight Crew Instruction – Rapid Disembarkation
- Cabin Crew Instruction – Precautionary Rapid Disembarkation

These are in draft form and are intended to be published in line with the operator's normal publication processes.

Analysis

Source of fumes

The static inverter failure mode involved in this occurrence was identified by ATR and its supplier in 2017. The topic was communicated to the operator through a TPS report, VSB, and an AOM. These do not require mandatory operator action and the topic was addressed through an AD. The operator was not aware of the incidence of failures. The new procedure introduced by the operator, requiring AOM's to be read and assessed for relevance to their fleet, is intended to avoid information of this nature being overlooked in future.

Rapid disembarkation

There was no procedure for rapid disembarkation with engines running, and the guidance on when it might be appropriate to do so was incomplete. The OMB suggested it may be prudent in some circumstances to implement a rapid disembarkation instead of an evacuation but did not provide detail. In the absence of a clear procedure the crew elected to keep the number 2 engine in Hotel mode, where the risks of doing so were not explicitly considered.

The cabin crew and passengers were not made aware of the operating engine on the right side of the aircraft as they disembarked. The commander did not make a PA to the passengers, as required by the guidance which was available in the Operations Manual Part B, and the risk of losing control of the passengers once they had deplaned was not considered in this context. By not disembarking themselves, the pilots were not present to manage the post-disembarkation phase of the occurrence. This may have created additional ambiguity around who held responsibility for the passenger's safety in a high-risk environment. As it was not considered an evacuation, the *'Post Evacuation'* section of OMB was not expressly applicable, although this guidance may be as relevant in this scenario as if a full evacuation had taken place.

Conclusion

The source of the fumes was confirmed to be the failure of static inverter 1. There was a Technical Progress Status report published by the manufacturer and an associated Airworthiness Operator Message indicating previous failures of static inverters which were not seen by the operator before the event. The operator introduced new procedures to ensure future AOM's will be treated as safety bulletins.

A rapid disembarkation was carried out in the absence of a specific procedure. The operator intends to introduce additional checklists and guidance for crews choosing to conduct a rapid disembarkation in future.

SERIOUS INCIDENT

Aircraft Type and Registration:	Boeing 737-8K5, G-FDZX
No & Type of Engines:	2 CFM56-7B27/3 turbofan engines
Year of Manufacture:	2011 (Serial no: 37258)
Date & Time (UTC):	12 June 2023 at 1630 hrs
Location:	Manchester Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 6 Passengers - 181
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	37 years
Commander's Flying Experience:	7,500 hours (of which 6,000 were on type) Last 90 days - 175 hours Last 28 days - 55 hours
Information Source:	Aircraft Accident Report Form submitted by the commander and further enquiries by the AAIB

Synopsis

As the Boeing 737 was making an approach to Runway 05R at Manchester Airport a thunderstorm was approaching the airport. At decision height, visual reference with the runway was lost and the flight crew initiated a manually flown, manual thrust go-around. During the initial actions of the go-around the aircraft experienced a sudden loss of headwind which caused a loss of airspeed. The commander reacted to the loss of airspeed by reducing the pitch attitude which resulted in a slight descent, which triggered an EGPWS caution. The commander reacted appropriately to the caution and the aircraft climbed away without further incident.

The operator is taking action to raise awareness of the threat of thunderstorms in the UK and promote appropriate briefing to mitigate the threat, and is reviewing its guidance for manual thrust go-arounds.

History of the flight

The aircraft was flying back to Manchester Airport from Zakynthos in Greece. Thunderstorms had been forecast across most of the UK and the crew had taken extra fuel to account for possible extended routings or delays. The commander was the pilot flying.

As the aircraft approached Manchester the flight crew negotiated a routing to the north of the airport to avoid cumulonimbus clouds visible to the south. They were vectored onto the

  All times are UTC

ILS approach for Runway 05R. Their weather radar showed a thunderstorm cell moving left to right across the airport but they were below the base of the cloud and could see the runway. As the aircraft was handed from the approach controller to the tower controller they were advised that the previous aircraft had gone around. The tower controller cleared the aircraft to land, stating "05R, CLEARED TO LAND, WIND 160 19 KNOTS, RECENT GUST 27 KNOTS, HEAVY SHOWER ON THE THRESHOLD". The pilots could still see the runway so decided to continue the approach. They reviewed their missed approach actions.

As the aircraft reached the decision height of 390 ft amsl it entered heavy rain and the pilots lost visual reference. They described "hitting a wall of rain" and "it all going black outside". Both pilots called 'go-around' simultaneously. The commander pressed TOGA and manually advanced the thrust levers with the autopilot and autothrottle disconnected. Both pilots confirmed thrust was increasing. The co-pilot selected Flap 15 and with a positive rate of climb selected the landing gear UP. However, as the commander increased the pitch through 10°, he noticed the airspeed rapidly reducing. Concerned the aircraft may stall he applied a nose-down pitch input to prevent further speed loss. Initially he could not work out why the aircraft was not accelerating and climbing as he would expect during a go-around. He recalled that 'the airspeed was close to V_{REF}, the trend vector was touching the top of the red and black band and the aircraft felt slow to react'[1]. After a few seconds he realised the acceleration and climb had stagnated so he started to add additional thrust. The EGPWS system then announced 'DON'T SINK DON'T SINK', and 'PULL UP' was displayed on the PFD. The commander immediately applied full thrust and, as the speed increased, he increased the pitch attitude. Once safely climbing away they started to accelerate, retracted the flaps and reduced the thrust.

Once level at the missed approach altitude the pilots reviewed their options. They considered another approach to Manchester but ATC advised that subsequent aircraft had broken off the approach and the crew realised there would be a delay whilst the weather cleared. They decided to divert to Newcastle where the weather was clear. The remainder of the flight was uneventful.

Both pilots commented that they were startled by the sudden loss of visual reference.

Recorded information

The cockpit voice recorder was downloaded and used to assist in constructing the history of flight. Table 1 and 2 show the data obtained from the FDR and the operator's analysis of its FDM data.

Footnote

[1] The red and black band on the PFD speed tape indicates the speed at which the stick shaker (stall warning) will activate. The trend arrow indicates the predicted airspeed in ten seconds.

Altitude (above runway threshold elevation)	Aircraft recorded wind	Comment
1,000 ft	225° at 6 kt	Aircraft met the operator's stabilised approach criteria. The autopilot and autothrottle were engaged. Gear down and Flap 30. V_{APP} 156 kt. V_{REF} 143 kt.
800 ft	215° at 5 kt	Autopilot and Autothrottle disconnected. N_1 was 55%.
700 ft	175° at 10 kt	Wind begins to vary in direction and strength, becoming mostly a right crosswind. IAS increases to 165 kt (V_{APP} +9), thrust reduces to 30% N_1 and several right aileron inputs were made to maintain the localiser (localiser maintained within 0.5 dot deviation).
500 ft	115° at 21 kt	IAS 157 kt, thrust 33% N_1 and increasing. Rate of descent begins to increase (averaging 800-900 fpm) and the aircraft descends slightly low on the glideslope.
320 ft	105° at 23 kt	IAS 158 kt, thrust 49% N_1. Tracking the localiser but almost 1 dot low on the glideslope.
200 ft	090° at 23 kt	IAS 160 kt, thrust 40% N_1. Aircraft 0.5 dot low on the glideslope. Over the next 4 s, thrust is increased to 57% N_1, IAS reduces to a minimum of 148 kt (V_{APP}–8 & V_{REF}+5), rate of descent increases from 700 fpm to a peak of 1,000 fpm during this short period. There was little pitch change during this time.
140 ft	080° at 26 kt	Go-around is initiated and the TOGA switch is pressed. IAS 150 kt.

Table 1

Data from the approach

Altitude *(above runway threshold elevation)*	Aircraft recorded wind	Comment
140 ft	080° at 26 kt	N_1 increases to 86%, pitch increases to 10° and Flap 15 was selected (max go-around thrust was 98.7% N_1). LNAV engages automatically and the target speed bug aligns to the flap limit speed. Minimum IAS recorded is 141 kt (V_{REF}-2) as the aircraft reaches a maximum pitch attitude of 10° and a calculated rate of climb of less than 1,000 fpm.
200 ft	120° at 13 kt	N_1 86%, the landing gear is retracted and the pitch decreases to 7.5°, then 5°, followed by 4°. During the pitch change the flaps complete retraction to Flap 15 and the speed bug automatically changes to 174 kt and the thrust is manually increased to approximately 90% N_1. The aircraft flies level then begins a shallow descent over a period of 6 s, the minimum height reached is 150 ft ARTE, a total height loss of 50 ft. This is followed by an EGPWS caution "DON'T SINK, DON'T SINK". Full thrust is applied immediately.
Climb to 3,500 ft		The aircraft climbs away with N1 99%, rate of climb greater than 2000 fpm, increasing to greater than 3,000 fpm. HDG SEL is engaged passing 400 ft aal. Passing 1,000 ft aal, thrust is reduced to 88% N1. Passing 3,200 ft amsl the pitch is reduced and flap retraction commences and is completed by 3,500 ft amsl. The autopilot and autothrottle are re-engaged in HDG SEL and ALT HOLD.

Table 2

Data from the go-around

Meteorology

The forecast issued for Manchester Airport before G-FDZX took off and valid at the time of arrival was:

- Surface wind from 070° at 7 kt, visibility greater than 10 km and cloud scattered at 4,500 ft.
- Temporarily from 1200 hrs until midnight visibility 7 km in rain showers,
- 40% chance that temporarily between 1200 hrs and 2100 hrs, surface wind variable at 15 kt gusting 25 knots, visibility 3 km in heavy rain shower, thunderstorms and hail,
- 30% chance from midnight until 0600 hrs visibility 7 km.

The following actual weather reports were issued around the time of the incident.

At 1720 hrs:

- Surface wind from 210° at 5 kt varying from 180° to 240°, visibility greater than 10 km and cumulonimbus cloud, temperature 26°C, dew point 18°C and sea level pressure 1013 hPa.
- Temporarily rain showers.

At 1750 hrs:

- Surface wind from 200° at 5 kt varying from 130° to 240°, visibility greater than 10 km, light thunderstorm and rain, cumulonimbus cloud, temperature 21°C, dew point 17°C and sea level pressure 1014 hPa.
- Recent thunderstorm, hail and rain.
- Temporarily visibility 4 km, thunderstorm and rain.

When ATC cleared the aircraft to land, the controller reported the wind was from 160° at 19 kt with a recent gust to 27 kt. He gave a further wind check as the aircraft approached 50 ft above their decision height of 190° at 15 kt (decision altitude was 386 ft amsl / 200 ft aal). As the pilots were initiating the go-around the controller reported another wind check with a direction of 180°. The wind strength was not audible on the CVR.

Operator procedures

The operator's Operations Manual (OM) Part A contains the following recommendations concerning thunderstorms during takeoff and landing:

'The following recommendations shall be observed:

- *Do not land or take off in the face of an approaching thunderstorm. A sudden wind shift or low-level turbulence could cause a loss of control.*
- *On arrival hold clear if a thunderstorm is overhead or in the approach path. Divert if necessary.*
- *Avoid severe thunderstorms even at the cost of diversion or an intermediate landing.'*

The Boeing 737 QRH provides guidance on the recognition of windshear in the absence of an alert. It states that '*unacceptable flight path deviations*' are an indication the aircraft is in windshear. It states:

'Unacceptable flight path deviations are recognised as uncontrolled changes from normal steady state flight conditions below 1000 feet AGL, in excess of any of the following:

- *15 knots indicated airspeed*
- *500 fpm vertical speed*
- *5° pitch attitude*
- *1 dot displacement from the glideslope*
- *Unusual thrust lever position for a significant period of time.'*

The operator's OM Part B Volume 1 describes the go-around procedure. An extract is shown in Figure 1.

Aircraft manufacturers findings

The aircraft manufacturer reviewed the FDR data and commented:

'Lowering the nose is not consistent with published guidance in this scenario. A windshear escape manoeuvre[2] *is expected when unacceptable flight path deviations occur, which includes applying maximum thrust and rotating towards an initial pitch attitude of 15 degrees.'*

Startle and surprise

Startle is a '*brief, fast and highly physiological reaction to a sudden, intense or threatening stimulus*'[3]. A startle response occurs immediately in response to a startling stimulus and can impair pilot responses for a short period of time, usually between 0.3 and 1.5 s[4].

Footnote

[2] Windshear is a change of wind speed and/or direction over a short distance along the flight path. The windshear escape manoeuvre is published in the aircraft's Quick Reference Handbook. It is design to achieve maximum climb performance to escape from windshear conditions.

[3] Landman, A., Groen, E.L., van Passen, M.M. Bronkhorst, A. & Mulder, M. (2017) 'Dealing with unexpected events on the flight deck: A conceptual model of startle and surprise' in Human Factors, Vol 59 pp 1161-1172.

[4] Martin, W., Murray, P. & Bates, P. (2012) 'The effects of startle of pilots during critical events: a case study analysis' Proceedings of 30th EAPP Conference: Aviation Psychology & Applied Human Factors – working towards zero accidents.

2.2.20 Go-around and Missed Approach Procedure

Table 2.2.20(1)

Pilot Flying	Pilot Monitoring
Push the TO/GA switch	
Verify that thrust increases.	
Call "FLAPS 15" or "FLAPS___" as needed.	
	Set the flap lever as directed and monitor flap retraction.
Verify the rotation to go-around attitude	
	Verify that the thrust is sufficient for the go-around or adjust as needed.
	Verify a positive rate of climb on the altimeter and call "POSITIVE RATE."
Verify a positive rate of climb on the altimeter and call "GEAR UP."	
	Set the landing gear lever to UP.
	Verify that the missed approach altitude is set.
If the airspeed is within the amber band, limit bank angle to 15°.	
Above 400 feet radio altitude, verify LNAV or select HDG SEL as appropriate.	Observe mode annunciation.
Verify that the missed approach route is tracked.	
At acceleration height, call "FLAPS___" according to the flap retraction schedule.	Set the flap lever as directed. Monitor flap and slats retraction.
After flaps are set to the planned flap setting and at or above the flap maneuvering speed, select LVL CHG or VNAV.	
Verify that climb thrust is set.	

Figure 1

Extract from the Operator's OM-B showing the go-around procedure

Surprise is: '*an emotional and cognitive response to unexpected events that are (momentarily) difficult to explain, forcing a person to change his or her understanding of the problem.*' Surprise often follows a startle response if the cause of the stimulus that triggered the startle is not understood. Experimental studies looking at the effects of surprise on the flight deck have shown for example, delayed initiation of responses[5] and incorrect or incomplete application of procedures[6].

Footnote

5 Martin, W.L., Murray, P.S., Bates, P.R., & Lee, P.S. (2016) 'A flight simulator study of the impairment effects of startle on pilots during unexpected critical events.' Aviation Psychology and Applied Human Factors, Vol 6, pp 24-32.

6 Casner, S.M., Geven, R.W. & Williams, K.T. (2013) 'the effectiveness of airline pilot training for abnormal events.' Human Factors, Vol 55, pp 477-485.

Analysis

As the pilots made the approach to Runway 05R there was a thunderstorm moving towards the airfield, but they maintained visual contact with the runway until decision height. The company's OM recommends that an approach should not be attempted in these conditions. However, as the pilots could clearly see the runway they considered it safe to continue.

After passing 1,000 ft the wind shifted from a tailwind to a headwind and a right crosswind, the airspeed was variable, the aircraft descended to almost 1 dot low on the glideslope and there were large changes in thrust. These changes did not exceed the parameters specified in the aircraft's QRH but may have provided a clue to the presence of windshear. However, there was no automatic windshear alert at any point.

When the pilots lost visual reference, they initiated a manual thrust go-around, setting approximately 86% N_1 During the initial go-around actions the wind shifted 40° in direction which resulted in an 18 kt loss of headwind, causing a loss of airspeed. The commander reacted to the loss of airspeed and negative airspeed trend by reducing the pitch attitude. The reduction in pitch attitude with less than full go-around thrust caused the aircraft to descend, triggering the EGPWS 'DON'T SINK' caution. He reacted appropriately to the caution and the aircraft climbed away. The go-around procedure requires the pilot monitoring to '*verify the thrust is sufficient for the go-around or adjust as needed'*. During this go-around additional thrust was required. Both pilots reported being startled by the sudden loss of visual reference on the approach. The commander reported that he was surprised that the aircraft was not performing as he expected on a go-around and he became focused on the airspeed loss; it took him a few moments to understand what was happening. The co-pilot reported his ability to monitor was reduced and this limited his ability to assist the commander during the first few moments of the go-around.

The aircraft manufacturer considered that the correct response to the situation was to use maximum available thrust or to fly the windshear escape manoeuvre (WEM). To address these issues the operator has proposed to:

- Raise awareness amongst their flight crew that thunderstorms in the UK can pose a similar threat to other well-known thunderstorm areas elsewhere on their network.
- Emphasise the possibility of unalerted windshear and signpost the guidance contained within the company manuals.
- Use the details of this event to encourage flight crew to build operational resilience via relevant threat-based briefings, to increase situational awareness and mitigate against the effects of 'surprise'.
- Review the guidance regarding manual thrust go-arounds and how flight crew determine if 'sufficient thrust' is set.

Conclusion

The slight descent and EGPWS caution during the go-around were caused by the commander reducing the pitch attitude in response to a loss of airspeed. The loss of airspeed was due to a change in wind direction caused by the approaching thunderstorm with insufficient thrust applied. The go-around procedure requires the flight crew to verify sufficient thrust is set to achieve the climb performance during a go-around. The aircraft manufacturer considers a windshear escape manoeuvre to be an appropriate response in these circumstances.

ACCIDENT

Aircraft Type and Registration:	Boeing 777-336ER, G-STBL
No & Type of Engines:	2 General Electric Co GE90-115B turbofan engines
Year of Manufacture:	2014 (Serial no: 42124)
Date & Time (UTC):	15 June 2023 at 1740 hrs
Location:	Entering Bay of Bengal
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 17 Passengers - 244
Injuries:	Crew - 2 (Serious) 3 (Minor) Passengers - None
Nature of Damage:	None reported
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	49 years
Commander's Flying Experience:	17,678 hours (of which 1,662 were on type) Last 90 days - 156 hours Last 28 days - 47 hours

Aircraft Type and Registration:	Boeing 777-236, G-YMML
No & Type of Engines:	2 Rolls-Royce RB211 Trent 895-17 turbofan engines
Year of Manufacture:	2001 (Serial no: 30313)
Date & Time (UTC):	28 June 2023 at 1240 hrs
Location:	Beijing Daxing International Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	19,682 hours (of which 9,902 were on type) Last 90 days – 302 hours Last 28 days – 77 hours
Information Source:	Aircraft Accident Report Form submitted by the commander

Synopsis

Approximately 1 hour 50 minutes after departing Singapore en route London, G-STBL encountered severe turbulence over the Bay of Bengal and unsecured cabin crew were thrown around in the cabin. Two crew members were seriously injured and three sustained minor injuries. The aircraft returned to Singapore.

In a similar event, G-YMML encountered what the commander described as "moderate chop" around 15 minutes before landing at Beijing Daxing Airport and while manoeuvring to avoid convective weather seen on radar. The commander was informed after landing of a serious injury to one of the crew that had been sustained during the turbulence.

In both cases, the pilots took action to avoid areas of poor weather and turbulence but, nevertheless, their aircraft encountered turbulence of sufficient severity to injure unsecured crew. When route weather forecasts cover large areas and contain general predictions of the likelihood of encountering turbulence, pilots may not be able to identify specific areas in flight where it will actually be encountered.

History of the flight

G-STBL

The flight crew had access to a draft version of the flight briefing approximately four hours before they were due to be collected from their hotel in Singapore. The commander stated this allowed all of the pilots to examine the weather forecast at leisure. The crew noted warnings of cumulonimbus cloud (CB) and thunderstorms for the Bay of Bengal.

On the crew transport to the airport the operating co-pilot briefed the crew on the flight and included the weather warnings for the Bay of Bengal. The commander reiterated the forecast of thunderstorms for the first three hours of the flight and said he would turn the seatbelt signs on if necessary. He also stated that if at any time the cabin crew were uncomfortable with the situation in the cabin they should call the flight deck to ask for the seatbelt signs to be illuminated.

The crew arrived at the airport 1 hour and 20 minutes before departure and the pre-flight process was conducted without incident. After departure, the aircraft climbed to a cruise altitude of FL300.

As the aircraft approached the Bay of Bengal, the crew were cognisant of the threat of CB, as forecast in their weather briefing, and were aware that track deviations would probably be required to avoid hazardous weather. Soon after the aircraft entered Chennai airspace the crew heard a company aircraft ahead ask for a deviation of 20 nm left of track. ATC cleared that aircraft to manoeuvre up to 20 nm either side of track. At this point, although the incident aircraft was experiencing only "light chop" (turbulence) and only low intensity returns were visible on the weather radar, the commander switched on the cabin seatbelt signs as a precaution.

It was night and the crew could see flashes of lightning to the left of the aircraft's track. The aircraft weather radar has the facility to check returns at selected flight levels and the crew did this to assess the risk posed by the weather. Nothing significant was seen. When the crew heard another aircraft ahead request a deviation off track they decided it would be prudent to do the same and requested permission to deviate 20 nm right of track, which was approved by ATC.

The intensity and frequency of the turbulence increased slightly so the commander decided to contact the senior cabin crew member (SCCM). The commander called Door 2L but was told the SCCM was further aft. He stated that he told the cabin crew that it "could be worth sitting down in a few minutes as it could get bumpy." He then called Door 5L, at the rear of the aircraft, where he found the second most senior cabin crew member. He asked them to pass the message of the bumpy conditions to the SCCM.

Less than two minutes later, at approximately 1730 hrs and with nothing significant visible on the weather radar, the aircraft experienced a severe turbulence episode lasting around 12 seconds. The commander described the situation by saying "There was just too much noise and vibration to take anything in. All I could do for a few seconds was check that the nose was at a safe attitude just above the horizon with wings level and that the engine power was reasonable". There was a significant display of St Elmos Fire[1] around the cockpit windshields and the stall warning stick shaker was briefly triggered.

At the time of the event the SCCM was in the aircraft's business class galley and recalled that perhaps only one minute elapsed between the seat belt signs illuminating and the severe turbulence beginning. He saw a crew member across the galley leave the floor and hit the cabin ceiling. The SCCM went across to protect the other crew member from galley carts, which were insecure. The turbulence quickly subsided but the SCCM soon received phone calls from Door 5 to say that there were injuries among the crew. The SCCM informed the pilots of the situation and then went aft to Door 5 and found two crew injured on the galley floor. The crew enacted their medical action plan and were assisted by two doctors from among the passengers who volunteered their support. The doctors were able to use the comprehensive (professional use only) medical kit carried on board the aircraft and administer intravenous pain relief.

The SCCM went to the flight deck and took part in a conference call with the pilots, the contracted medical provider, and the operator's maintenance control and operations department. The medical provider recommended a diversion on medical grounds and, following discussion, it was decided to return to Singapore. The return to Singapore would be through the same airspace as the outbound flight and so the commander made a public address (PA) to reassure the passengers, but only light turbulence was encountered during the return.

After this decision to return to Singapore was made, the SCCM returned to the cabin. One cabin crew member was seriously injured with an evident fracture of a leg and three others had less significant injuries. The able crew members were redistributed to look after the

Footnote

[1] St Elmo's Fire is a visible luminous electrical discharge observed around parts of an aircraft when the electrical charge on the aircraft becomes sufficiently intense.

injured crew and the passengers. At 1920 hrs the crew member who had hit the cabin ceiling began to exhibit symptoms described as a possible concussion by the SCCM. They were given oxygen and another crew member was assigned to look after them. As the planned sector was long there were relief pilots on board and one assisted the cabin crew by manning an exit door for landing. The most seriously injured crew member remained on the floor near the rear of the cabin to avoid moving them to a seat and aggravating their injuries. The aircraft landed in Singapore at 2003 hrs and was met by paramedics and police. The injured crew were taken off the aircraft and transferred to hospital. One crew member was detained in hospital with a fracture to their lower leg. The others were released from hospital but on return to the UK a crew member still suffering issues with a leg injury attended hospital and was also diagnosed with a fracture. Both of the crew members that sustained fractures had been in the vicinity of Door 5 at the rear of the aircraft during the turbulence event.

G-YMML

The aircraft was approaching Beijing Daxing Airport. The commander stated that the aircraft weather radar showed areas of convective cloud along the arrival route. Around 25 minutes before landing and due to the convective weather the commander decided to switch on the FASTEN SEAT BELT signs, and at 20 minutes to landing a PA was made. The commander reported that the aircraft then encountered occasional light turbulence. As the aircraft descended the weather radar showed increasing amounts of cloud and CB build ups. The turbulence became continuous and the aircraft was given radar vectors to avoid the weather, resulting in a longer arrival route. The commander described the turbulence during the arrival as "occasional moderate chop". From the pilots' standpoint the approach and landing were uneventful, but after landing the SCCM informed the commander that one of the crew had sustained an injury to their ankle during the turbulence.

The SCCM reported that the FASTEN SEAT BELT signs were illuminated earlier than expected but it was assumed that the intent was for the cabin crew to secure the cabin for landing. Shortly after the signs illuminated, she recalled a PA from the pilots saying that there was 20 minutes to landing. The SCCM described the turbulence as initially "not too bad", but described a brief episode of violent turbulence which left them struggling to remain standing. The SCCM sat down in her allocated crew seat and called the rear galley to ask if the cabin crew there were secure. The SCCM then received a call from Door 3 saying that one of the crew had fallen in the right passenger aisle near the rear galley during the turbulence and sustained an injury to their ankle. The injured crew member was now in a crew seat at the rear of the aircraft. As the injured crew would be unable to operate their door in the event of a further emergency, the SCCM sent a crew member from the front to the rear of the aircraft to fulfil the door duty and the injured crew member was relocated to a passenger seat. As the SCCM was aware the aircraft would shortly land in Beijing and that there was little the pilots could do to aid the injured crew, the SCCM decided to wait till after landing before informing the pilots of the event. During the approach a large number of the passengers were sick due to the turbulent conditions. After landing the SCCM told the commander that medical assistance for the cabin crew member would be required at the gate. There was a 35-minute delay before the aircraft was allocated a stand, but paramedics met the aircraft at the gate to attend to the injured crew member.

The paramedics immobilised the injured ankle, gave the crew member some pain relief and took them to the crew bus on a wheelchair. The crew member had to hop onto the bus and while doing so fell in the wet conditions aggravating their injury. From the crew hotel the injured crew member was transferred to hospital with the assistance of the SCCM who liaised with the operator's medical provider. The injured crew member required surgery on the injured ankle, which was expected to prevent her from operating for several months.

Recorded information

Flight data for the events to both aircraft are presented in Figures 1 and 2.

For G-STBL (Figure 1), the aircraft was cruising at FL300 and 315 kt CAS at the start of the event. The minimum and maximum recorded normal acceleration for the duration of the event (about five minutes) was 0.2 g and 2.3 g. These occurred within the first 10 seconds where the normal acceleration initially dipped to 0.7g and then spiked at 2.3 g in less than one second. A stick shaker activation was recorded during the 2.3 g spike. The recorded normal acceleration was between 0.5 g and 1.5 g for the remaining time during the event.

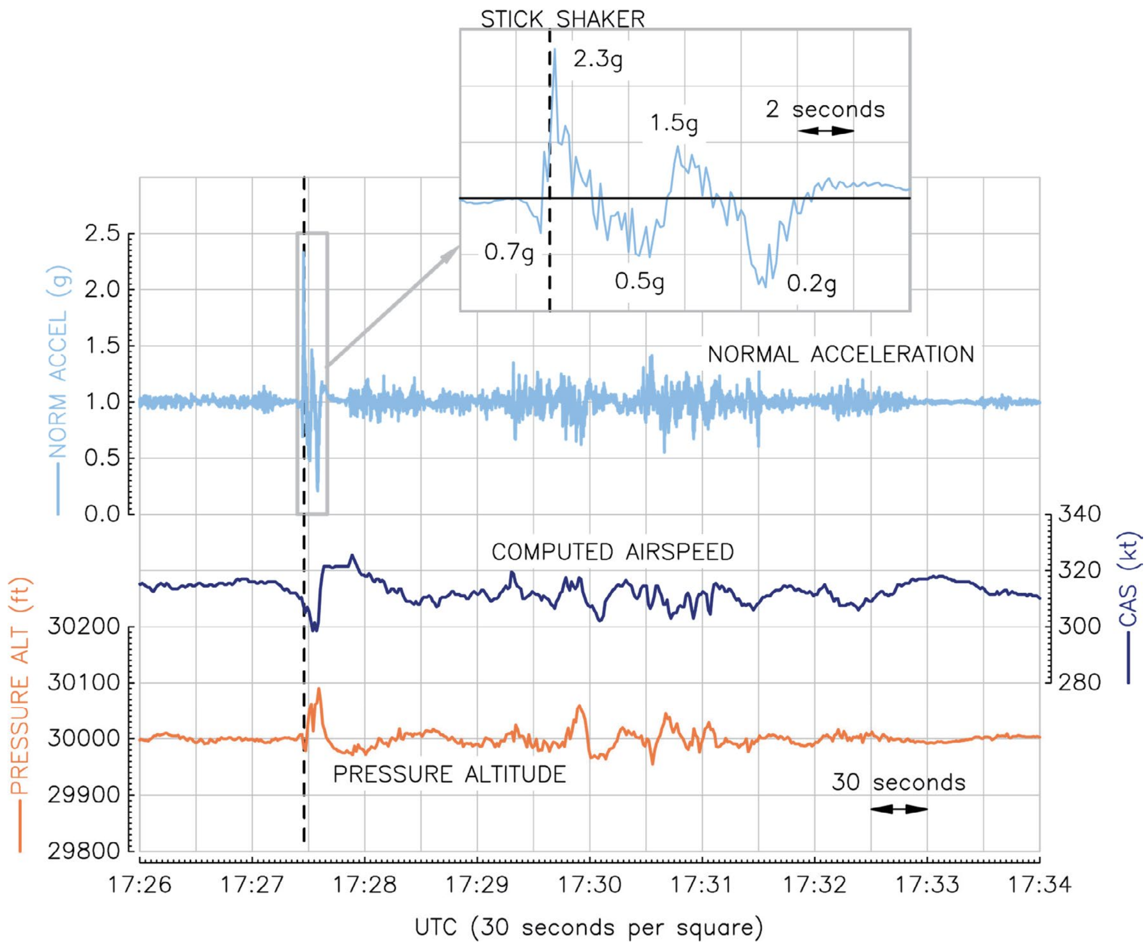

Figure 1
G-STBL flight data for turbulence event

For G-YMML (Figure 2), the aircraft was level at FL128 and at about 300 kt CAS at the start of the event. The minimum and maximum recorded normal acceleration for the duration of the event (about three minutes) was 0.5 g and 1.5g.

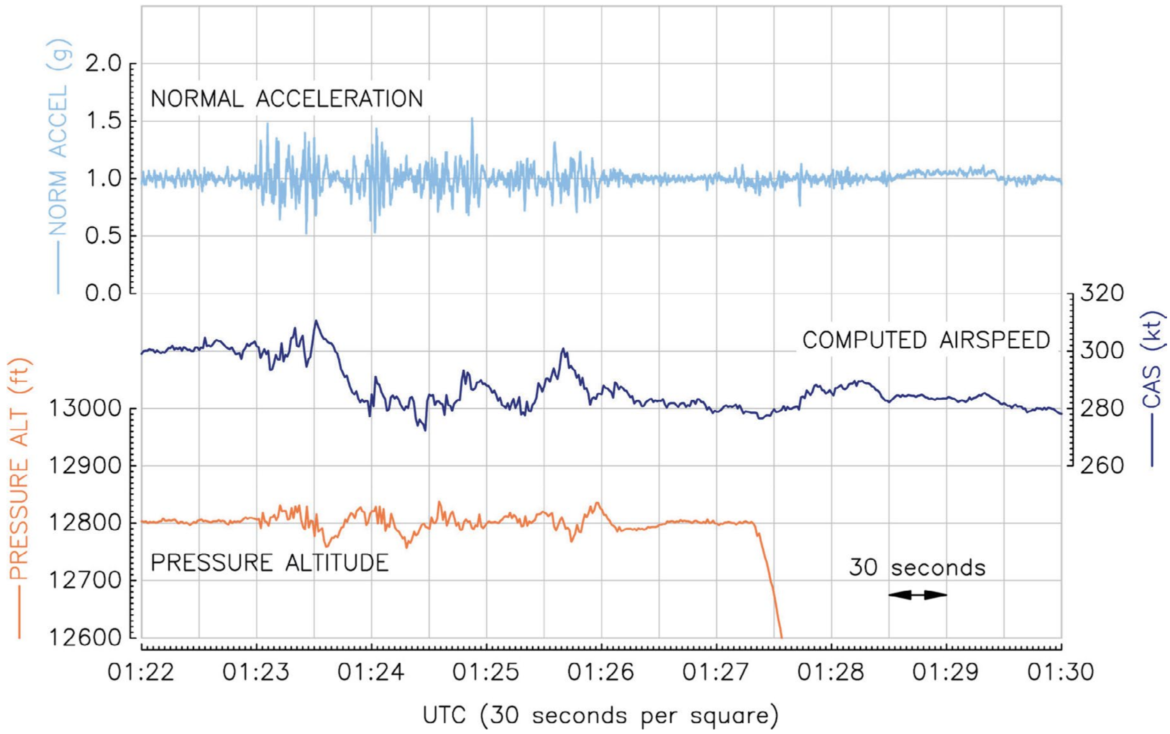

Figure 2
G-YMML flight data for turbulence event

Meteorology

G-STBL

A SIGMET had been issued and was valid until 1745 hrs on 15 June 2023. It, along with the significant weather chart (Figure 3), forecast isolated embedded thunderstorms on the aircraft's route. The chart indicated CB tops reaching FL480 and the SIGMET indicated CB tops to FL520. The explanatory note on the significant weather chart stated that the forecast of CB implies the presence of thunderstorms, hail, ice and moderate to severe turbulence.

The Met Office provided additional turbulence information to the AAIB which, while used to construct the forecast, was not available to the pilots on the flight. The additional information was based on Eddy Dissipation Rate, which is the ICAO standard for turbulence forecasting and is based on Graphical Turbulence Guidance developed by the National Centre for Atmospheric Research in the USA. The Eddy Dissipation Rate forecast for FL300, valid at 1800 hrs on 15 June 2023, (Figure 4), indicated that there would be light to moderate turbulence in the vicinity of the incident. The black dot shows the position of the incident and is near the eastern edge of any turbulence.

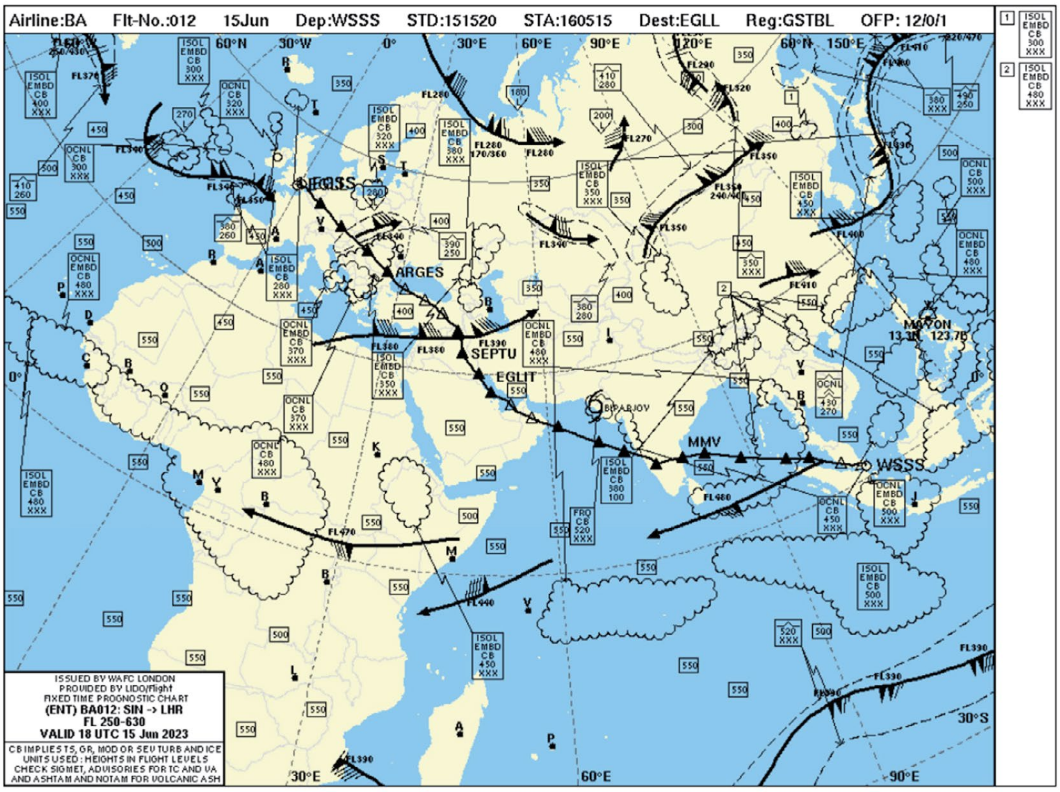

Figure 3

Significant weather chart from the crew briefing pack

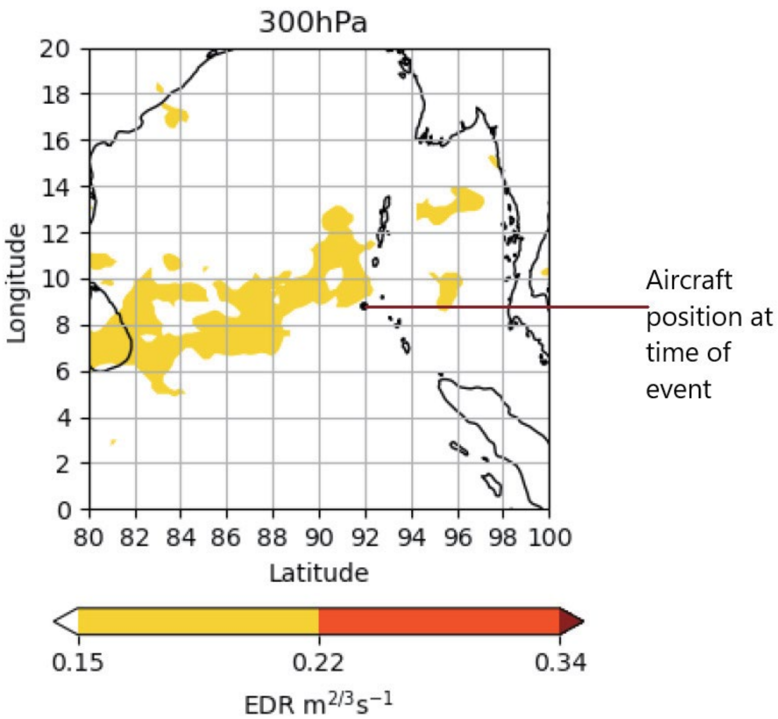

Figure 4

Eddy Dissipation Rate for 300 hPa (approximately FL300) valid at 1800 hrs on 15 June 2023

The forecast of the extent of CB is shown on the image in Figure 5. This indicated a large area of CB across the Bay of Bengal with over 60% of the sky affected by CB. The information supplied to the crew was based on a forecast model run at 1800 hrs on 14 June 2023. The CB extent shown in Figure 5 was drawn from a model run at 1200 hrs on 15 June 2023. Later forecast charts than those supplied to the crew showed greater amounts of CB over the Bay of Bengal.

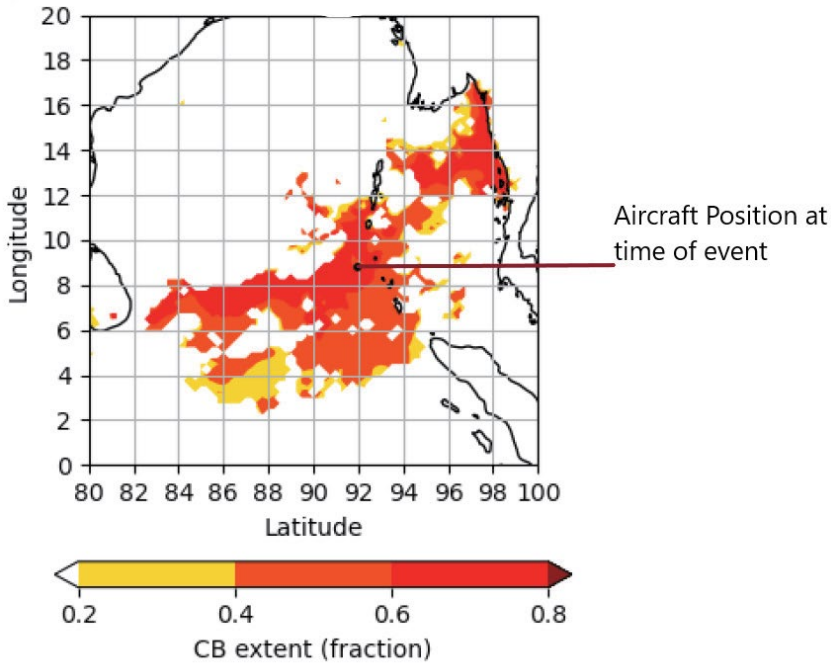

Figure 5

Forecast extent of cumulonimbus clouds

Overshooting tops are areas of a CB where the cloud top is higher than would normally be expected through thermal equilibrium. Normally, the rising warm air within a CB will stop rising when its temperature equals the temperature of the surrounding air. However, rapidly rising air will have built up a momentum that allows it to rise further above the normal anvil top of the cloud. The evidence of an overshooting top is indicative of strong updraughts within the cloud structure. The satellite imagery in Figure 6 is indicating in yellow, areas where there is evidence of overshooting tops. This area is in the vicinity of the incident.

The Met Office summarised the situation as follows:

'There was an extremely active system in the vicinity of the incident location. Evidence from Figure 6 suggests that there were significant updraughts within the cloud, with cloud tops extending up to FL480. In addition, there would also be significant downdraughts in the region immediately ahead of the system. There was no Clear Air Turbulence forecast in the area.'

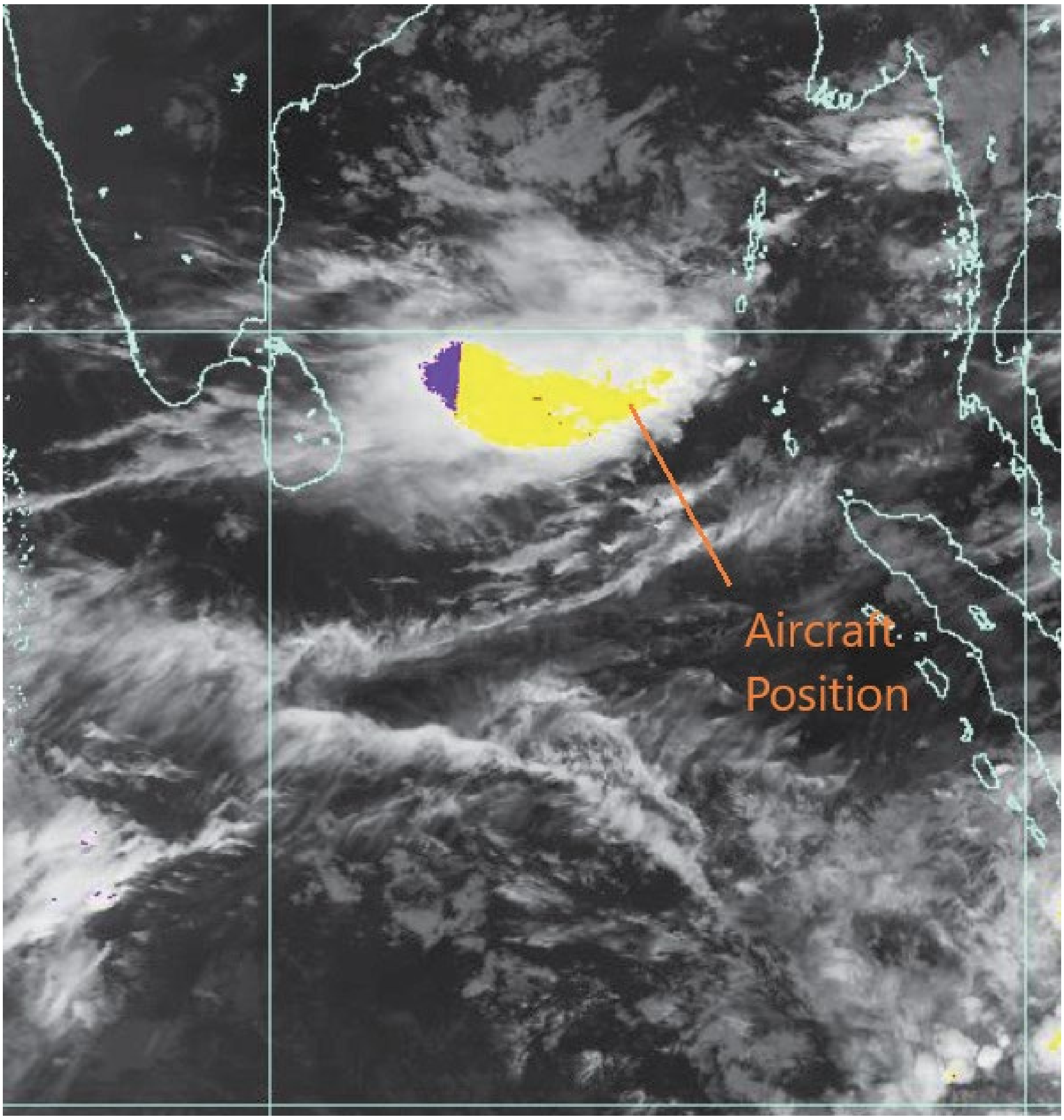

Figure 6

Satellite imagery indicating areas of overshooting cloud tops

G-YMML

G-YMML was approximately 20 minutes from landing at Beijing Daxing Airport when it encountered turbulence. The crew's forecast weather chart for the arrival section of the route is at Figure 7. The route crossed a forecast area of CB with tops up to FL420 just before Beijing. The crew recalled weather consistent with the forecast being visible on weather radar during the aircraft's descent toward Beijing. After discussion with ATC, they changed course to avoid the weather shown on radar.

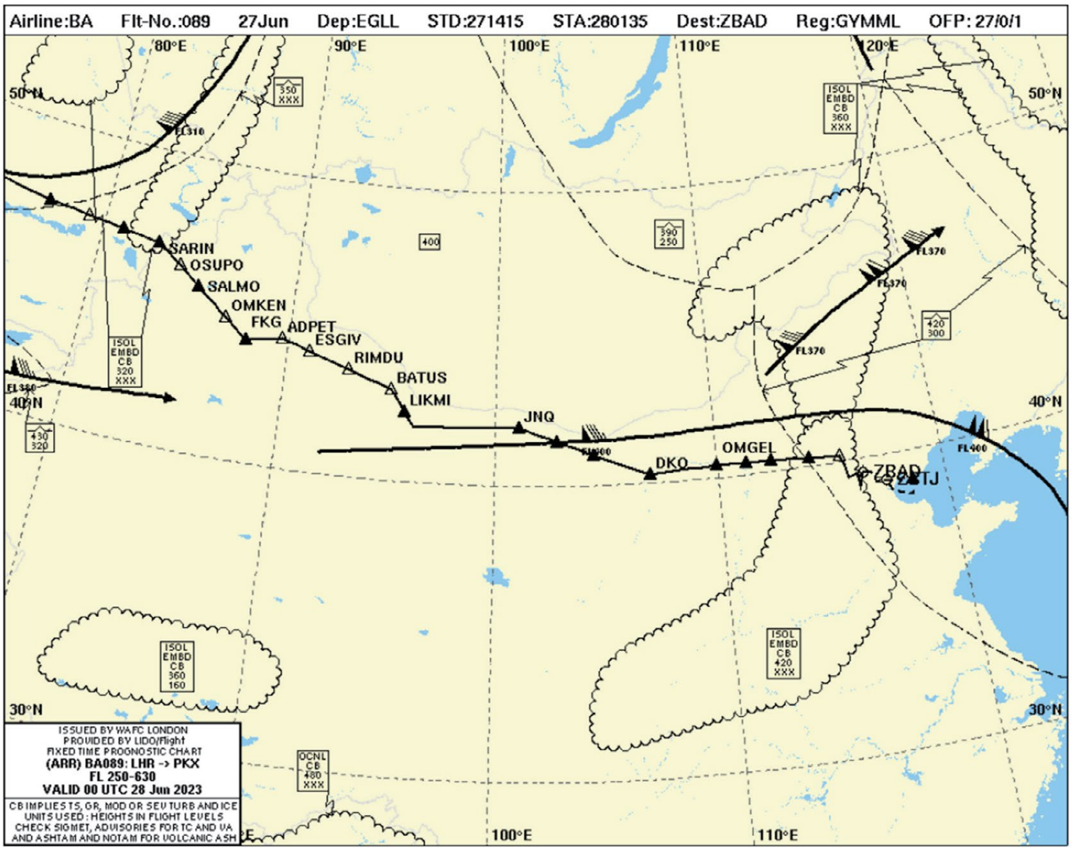

Figure 7

Beijing Daxing Airport arrival weather chart

However, despite manoeuvring clear of weather returns on radar the aircraft encountered a significant turbulence event which, though described as moderate by the pilots, had a serious impact in the cabin.

Description of levels of turbulence

The various levels of turbulence can be described as follows:

- Light turbulence is the least severe, with slight, erratic changes in attitude and/or altitude.
- Moderate turbulence is similar to light turbulence, but of greater intensity - variations in speed as well as altitude and attitude may occur, but the aircraft remains in control all the time.
- Severe turbulence is characterised by large, abrupt changes in attitude and altitude with large variations in airspeed. There may be brief periods where effective control of the aircraft is impossible. Loose objects may move around the cabin and damage to aircraft structures may occur.
- Extreme turbulence is capable of causing structural damage and resulting directly in prolonged, possibly terminal, loss of control of the aircraft.

Organisational information

The operator has guidance for crew in responding to turbulence events in the '*General Procedures'* section of its operations manual. The manual considers turbulence in two main cases, either Anticipated or Unanticipated and the guidance is as follows:

> *'Anticipated: Turbulence can sometimes be anticipated. In such situations the flight crew will advise the SCCM with regard to timing of cabin service, securing of galleys and cabin equipment and whether the level of turbulence is expected to require the crew to sit down and fasten their harnesses. Instructions must be clear and unambiguous. Unless otherwise instructed, the service should continue normally but must not include the serving of hot beverages or use of hot water equipment while the seat belt sign is on.*
>
> *If turbulence is imminent, use of the PA will ensure a clear, undiluted message reaches all cabin crew members in the shortest possible time. The flight crew will switch on the seat belt sign prior to entering the area of turbulence.*
>
> *Unanticipated: Often turbulence is not forecast or anticipated. In such instances, flight crew will attempt to alert crew by switching on the seat belt signs as soon as practicable. Cabin crew must react proactively to turbulence when encountered and take steps to secure their immediate safety.'*

Analysis

G-STBL

The weather forecast provided to the crew indicated the presence of CB in the area of the event and hence, implicitly, the likelihood of moderate to severe turbulence. The aircraft weather radar did not display to the pilots any significant weather returns. However, the pilots could see lighting flashes to the left of the aircraft's track and heard another aircraft ahead divert to the right of track. At this point, although the turbulence was light the commander switched on the FASTEN SEAT BELT signs. The commander also decided to divert to the right of track as a pre-emptive measure to avoid the visible weather.

As the intensity of the turbulence increased, the commander called the cabin to tell the cabin crew it "could be worth sitting down in a few minutes as it could get bumpy". Shortly after this call and with no weather in the vicinity visible on radar, the aircraft experienced a severe turbulence event lasting approximately 10 seconds during which the normal acceleration dipped to 0.7 g and increased to 2.3 g in less than one second. The aircraft stall warner was triggered. The commander described levels of noise and vibration that overwhelmed his senses and left him with limited capacity to control the aircraft. His focus was on maintaining the wings level, keeping the aircraft nose just above the horizon and maintaining a reasonable power setting. The commander's description of the event is consistent with the descriptor for severe turbulence. The cabin crew were not secure when the event occurred and a number of them were thrown from their feet by the violent motion. The most serious injuries occurred near the rear of the aircraft. The B777 is a long aircraft and motion is more pronounced toward the rear.

The weather information supplied to the crew did indicate an area of CB with the concomitant warning of moderate to severe turbulence. However, the forecast covered a vast area and only forecast isolated thunderstorms.

After the event and with the severity of the injuries evident, the crew consulted with the operator and the operator's medical provider on options for a diversion and it was decided to return to Singapore.

G-YMML

As the aircraft made its descent toward Beijing Daxing Airport, the pilots were aware of convective weather indicated on radar. The chart in their weather briefing forecast a large area of isolated embedded CB with cloud tops to FL420 just to the west of the airport. As before, CB implies moderate or severe turbulence.

Approximately 25 minutes from landing the commander switched on the FASTEN SEAT BELT sign and made the landing PA. This is normally made 20 minutes before landing and directs the crew to secure the cabin for landing. As a result, the cabin crew did not interpret the illumination of the FASTEN SEAT BELT as a warning of turbulence and carried on with their normal duties. The commander described the turbulence as "occasional moderate chop" and did not report that it presented any significant difficulties during the arrival. The range of normal acceleration values during the turbulence was 0.5 to 1.5 g, less than with G-STBL. However, shortly after the PA was made the cabin crew reported that the turbulence in the cabin was so pronounced that it became difficult to stand, and one of the cabin crew fell and injured their ankle. While it was swollen and painful the extent of the injury was not apparent until the crew member received medical treatment later.

The SCCM was made aware of the injured crew member and redeployed other crew to ensure all emergency exits were attended for landing. In order not to disturb the pilots during a critical phase of flight and aware that there was nothing they could do to assist the situation, the SCCM elected to inform the commander of the incident after landing.

Conclusion

Although the pilots of both aircraft were taking action to avoid weather, each aircraft suffered a turbulence event of sufficient severity to cause injuries amongst the unsecured cabin crew. Route weather forecasts give a general prediction that turbulence is likely but often cannot reflect actual conditions in sufficient detail to enable pilots to avoid specific instances of turbulence. G-YMML was approaching its planned destination and so landed there. G-STBL returned to its airfield of departure on receipt of medical advice. The safety of the aircraft was not jeopardised.

ACCIDENT

Aircraft Type and Registration:	Cessna 402, VP-AAK
No & Type of Engines:	2 Continental TSIO-520-EB engines
Year of Manufacture:	1974 (Serial no: C402B)
Date & Time (UTC):	7 August 2023 at 1757 hrs
Location:	Anguilla Airport, Anguilla
Type of Flight:	Commercial Air Transport
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to right propeller and right wing
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	52 years
Commander's Flying Experience:	5,747 hours (of which 1,911 were on type) Last 90 days - 110 hours Last 28 days - 34 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot reported that, after departure, he heard a "high pitched whistling sound" coming from the crew door. He diagnosed that it came from the external handle not sitting flush, although the door was securely closed. The pilot elected to return to the airfield to restow the handle. As the aircraft approached the flare it experienced what the pilot described as a "strong windshear/downdraft" which resulted in a heavy landing on the nosewheel and right main landing gear. The heavy landing caused the right propeller to strike the ground and the right wing failed adjacent to the engine cowling (Figure 1).

Figure 1

VP-AAK at the side of Runway 11

The pilot was able to steer the aircraft to the edge of the runway and vacate the cockpit without assistance. The reported weather at 1800 hrs, three minutes after the accident, gave a recorded wind velocity of 110°/14 kt, with visibility greater than 10 km and there were towering cumulus and cumulonimbus clouds in the vicinity of the airfield. While the pilot was aware of the cumuliform clouds in the vicinity of the airport, he had not expected them to cause windshear and was unable to prevent the heavy landing that ensued.

ACCIDENT

Aircraft Type and Registration:	Czaw Sportcruiser, G-DVOY
No & Type of Engines:	1 Rotax 912ULS piston engine
Year of Manufacture:	2010 (Serial no: LAA 338-14976)
Date & Time (UTC):	20 May 2023 at 1330 hrs
Location:	Bute Airfield, Isle of Bute, Scotland
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Left wing leading edge ruptured, nose leg detached, main undercarriage structurally compromised, and propeller and spinner destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	61 years
Commander's Flying Experience:	400 hours (of which 240 were on type) Last 90 days - 12 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further AAIB enquiries

Synopsis

The aircraft touched down long and fast onto a grass strip familiar to the pilot. The grass was long and also wet following a rain shower some minutes earlier. The pilot was unable to slow the aircraft with sufficient control to prevent the aircraft from colliding with the airfield boundary fence at the end of the grass strip.

History of the flight

As the aircraft approached the Isle of Bute, the pilot could see a localised rain shower over the destination unlicensed airfield. The pilot decided to continue the approach for an overhead join, having established that Runway 27 was favourable. On base, the pilot was "unable to visualise the airfield" for a few seconds and in particular the grass strip, which he could not distinguish from the rest of the airfield. The pilot turned onto final, using a mental image of the approach, based on previous flights to the airfield, to align the aircraft for where he knew the runway should be. The aircraft, in full flap landing configuration, was high as it passed over the threshold, but similar to the approaches the pilot previously made when giving himself additional clearance above trees that used to be on the approach to Runway 27.

The aircraft touched down with about 250 m of the 480 m runway remaining, at an airspeed of about 56 kt, approximately 10 kt more than the normal touchdown speed. The pilot usually stopped the aircraft within 100 m of touchdown without having to brake so was not too concerned with landing long and fast; however, he quickly realised the aircraft was not slowing down as expected. He tried to brake but the aircraft skidded slightly to the right which he corrected back to the left. Further braking attempts were not enough to prevent the aircraft from colliding, at about 20 kt, with the airfield boundary fence on rough ground at the end of the grass strip. The pilot, realising he wasn't going to stop the aircraft in time, tightened his seat harness and loosened the canopy, and at the last moment, turned off the master and magneto switches. The nose leg detached as the aircraft went over the rough ground, before the left wing struck the fence as the aircraft came to a stop. Uninjured, the pilot turned off the remaining electrics and fuel, before exiting the aircraft.

Figure 1
Accident site (used with permission)

Once out of the aircraft, the pilot noticed that the runway grass was long, and "soaking wet" following the rain shower minutes earlier.

Pilot's comments

The pilot stated that his inability to distinguish the runway from the surrounding grass should have provided an indication of the length of the grass. He felt that "confirmation bias allowed him to make a poor decision to land with only 250 m of the runway left" instead of choosing to go around on the approach, realising "the clues were there to make a better decision".

CAA guidance

A series of Safety Sense (SS) Leaflets published by the CAA can be found on the CAA's website.[1] SS12 provides guidance on Strip Flying and includes assessing the site, and the challenges to be considered on the approach, advising to 'always go around early if in any doubt about the approach'. The Aerodrome Planning section of the Skyway Code[2] also contains useful guidance on these topics.

Footnote

1 Safety Sense Leaflets | Civil Aviation Authority (caa.co.uk) [accessed 16 October 2023].
2 CAP1535P Skyway Code V3.pdf (caa.co.uk) [accessed 16 November 2023].

SERIOUS INCIDENT

Aircraft Type and Registration:	Piper PA-28-161, G-RAAM
No & Type of Engines:	1 Lycoming O-320-D3G piston engine
Year of Manufacture:	1980 (Serial no: 28-8016276)
Date & Time (UTC):	16 April 2023 at 1245 hrs
Location:	Blackbushe Airport, Hampshire
Type of Flight:	Training
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:	71 years
Commander's Flying Experience:	6,500 hours (of which 5,000 were on type) Last 90 days - 33 hours Last 28 days - 11 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

G-RAAM was on final approach to Runway 25 at Blackbushe Airport when it clipped a tree that may have been above the maximum height for obstacles on the approach path.

Hampshire County Council (HCC) will start the planned works in autumn 2023 to remove the obstacles. The airport has published information to pilots to increase awareness and to exercise caution until the work has been carried out.

History of the flight

The pilot, a qualified flying instructor, was on final approach to Blackbushe Airport Runway 25, when he became aware he might have clipped an obstacle and elected to go-around. The go-around and subsequent landing were successful. After landing it was discovered that there was a twig attached to the left landing gear wheel.

The weather at the time was clear with good visibility, wind from 290° at 7 kt and the pilot described as "gusty".

Aerodrome information

Civil Aviation Publication (CAP) 168 - '*Licensing of Aerodromes*[1]' defines an approach and landing Obstacle Limitation Surface (OLS) to ensure the flight path of aircraft taking off and landing remains free of fixed ground obstacles. The dimensions for the OLS are dependent on the provision of navigation aids for landing and the runway dimensions. Blackbushe Airport has two non-instrument approach runways: 07 and 25, both less than 1,200 m long and 46 m wide. Figure 1 shows the OLS for the Runway 25 approach with a typical light aircraft approach path highlighted. Light aircraft are at approximately 150 m (500 ft) agl and 2,000 m from the runway threshold when they turn onto final, which equates to approximately 70 m (230 ft) above the OLS.

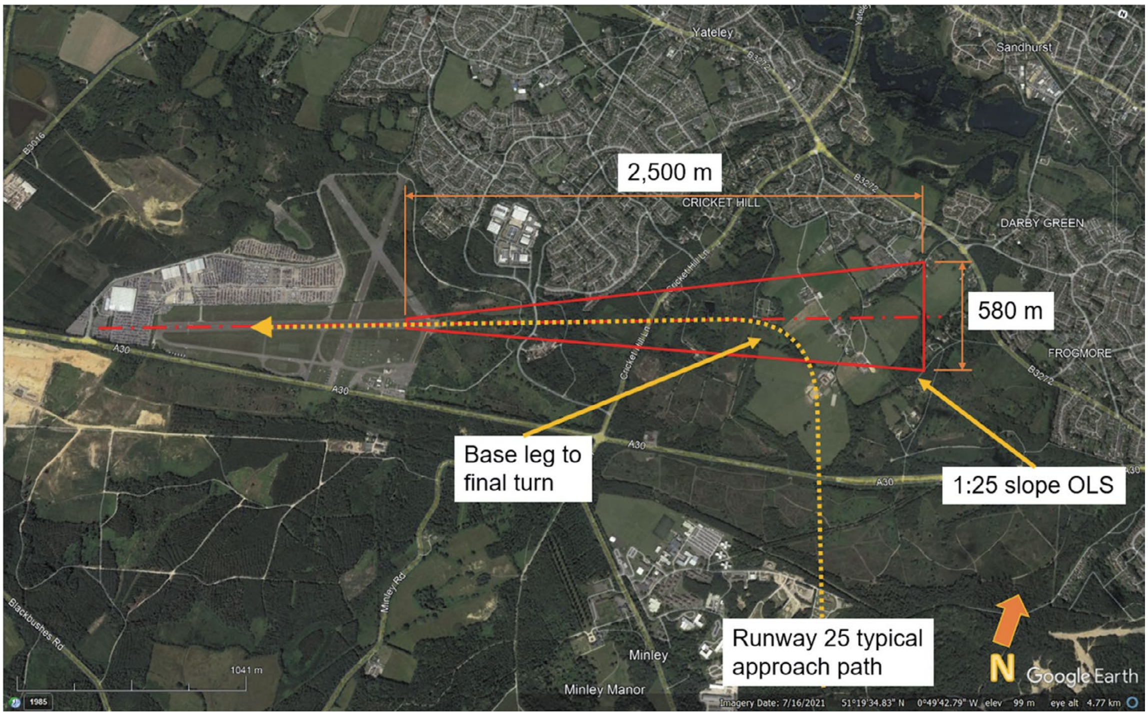

Figure 1

OLS and typical light aircraft approach path to Runway 25

The Runway 25 approach path is over Yateley Common (Figure 2), which is described by the Hampshire Countryside Service as an '*extensive heathland complex with areas of open heather, gorse, birch and oak woodland*'[2].

Footnote

1 CAP 168 Licensing of Aerodromes (caa.co.uk) Edition 12 (accessed June 2023).
2 Yateley Common | Hampshire County Council (hants.gov.uk) (accessed June 2023).

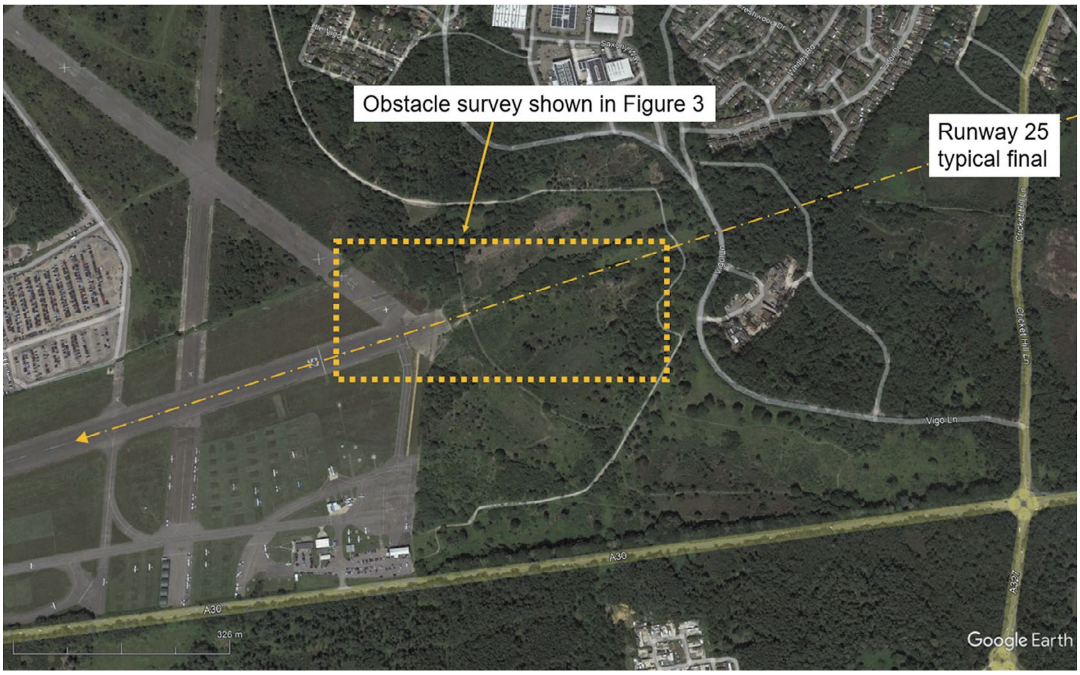

Figure 2
Yateley Common

The airport undertook a tree survey every two to three years, the last of which in 2021 identified many trees penetrating the Runway 25 approach OLS. Following the 2017 survey, a discussion between the airport and HCC identified those trees as a hazard to the approach and arranged for their removal. Although HCC undertook extensive works on the common during the winter of 2017-2018, the airport did not follow up with HCC and verify their removal. Furthermore, they did not formally engage with HCC again, apart from some incidental verbal conversations after the 2021 survey. A further survey was completed in March 2023, and the results for the Runway 25 approach OLS are shown in Figure 3.

From the survey it was found that a total of 19 trees penetrated the Runway 25 approach OLS with three of those penetrating more than 2 m. Two penetrated more than 3 m, with the tallest tree 3.74 m above the OLS, 200 m from the runway threshold. For a light aircraft touching down at the runway threshold on a typical glide slope, there would be approximately 1 m vertical clearance between the top of this tree and the aircraft.

The tree survey also identified trees penetrating the Runway 07 approach and takeoff OLS, and the Runway 25 takeoff OLS. The survey was conducted from the runway thresholds using optical instruments and so it is possible that other trees may be penetrating the OLS but were hidden by taller trees in the foreground. The current survey may therefore not include all penetrations of the OLS and so a further survey would be required to ensure all the trees are identified.

Following this incident, the airport will survey the trees which have been identified as penetrating the OLS with works starting in autumn 2023 after the ground bird nesting season has finished.

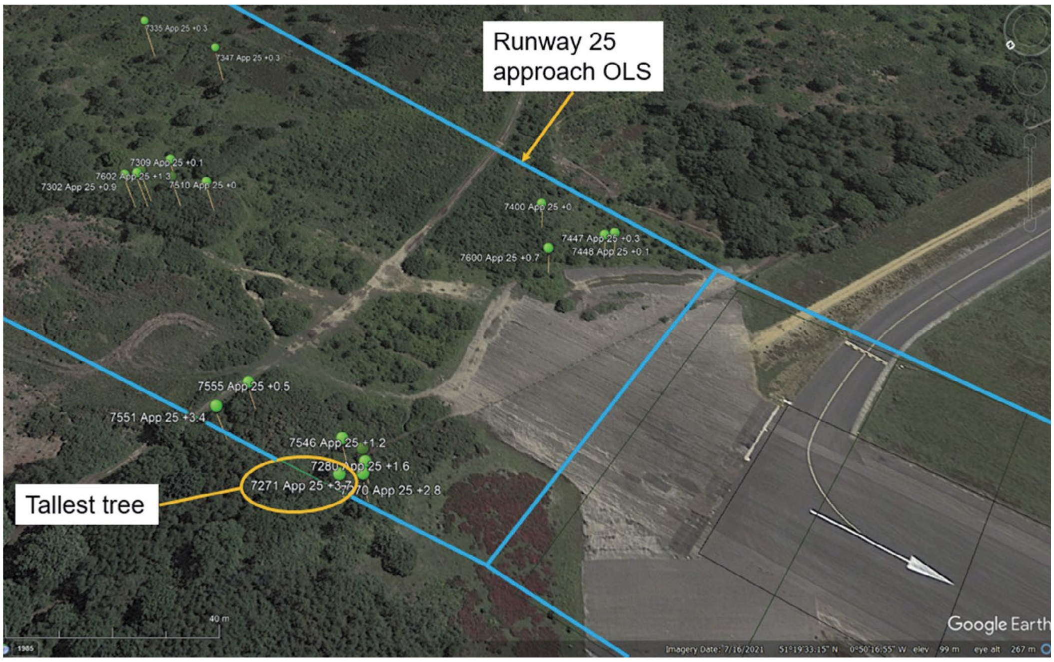

Figure 3

2023 Obstacle survey results for the Runway 25 approach

To mitigate the risk to pilots during the interim period, Blackbushe Airport Safety Action Group has published the following information:

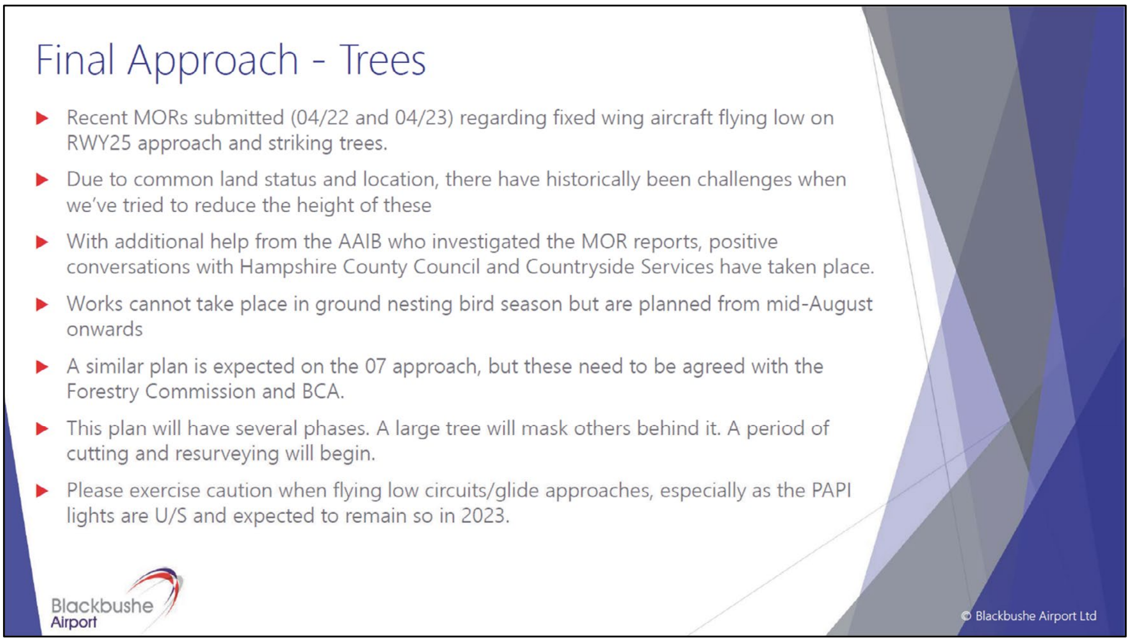

Figure 4

Safety information to Blackbushe pilots

ACCIDENT

Aircraft Type and Registration:	Robinson R22 BETA, G-BXOA
No & Type of Engines:	1 Lycoming O-320-B2C piston engine
Year of Manufacture:	1997 (Serial no: 1614)
Date & Time (UTC):	1 September 2023 at 1325 hrs
Location:	Welshpool Airport, Powys
Type of Flight:	Experience flight
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - 1 (Minor)
Nature of Damage:	Damaged beyond economical repair
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	41 years
Commander's Flying Experience:	842 hours (of which 300 were on type) Last 90 days - 152 hours Last 28 days - 47 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further AAIB enquiries

Synopsis

The helicopter, in a low hover, suffered from a dynamic rollover during a flight with a passenger on a helicopter experience day. The accounts of the pilot and passenger differed as to who was controlling the cyclic during the moments before the helicopter struck the ground; the AAIB investigation was unable to resolve these differences.

History of the flight

The passenger, who had no previous experience of flying a helicopter, was participating in a full day's helicopter experience with an instructor. The passenger advised that this was not in preparation to commence formal training towards a PPL(H). The accident occurred at the end of the second flight.

The pilot and passenger met at the airfield at about 0930 hrs. Shortly afterwards, the pilot, who was an instructor, showed the passenger around the helicopter. This included an explanation of the operation of the tail and main rotor systems and the controls in the cockpit. The pilot stated that a safety brief was then provided, which included the procedure they would use when transferring command of the flight controls between each other. This used the phraseology "you have control" and "I have control". The pilot advised that he would perform the takeoff but, when they were straight and level in the cruise, control of the cyclic would be passed to the passenger. The pilot explained to the passenger that the controls were very sensitive and that he would have his hand near the cyclic control whilst the passenger had control of it.

During the cruise, the pilot stated that the passenger had on occasion applied cyclic inputs in the opposite direction to that required. The pilot had taken control back almost immediately before explaining what the correct inputs should have been. The pilot also reported that on one occasion the passenger had not released his grasp on the cyclic when instructed and had needed to repeat the instruction.

After some further practice, the pilot considered that the passenger's performance was sufficient to allow him to spend a few minutes in the hover whilst controlling the cyclic. The passenger maintained the helicopter in a static hover for a few seconds before the helicopter started to drift and the instructor intervened. During one occasion, the pilot described that "heavy" forward cyclic had been applied in response to the helicopter moving forward. The pilot subsequently landed the helicopter to provide a break for the passenger, debrief him and refuel the helicopter in advance of the second part of the lesson. This would include refining the use of the cyclic as well as control of the yaw pedals and collective.

As the helicopter departed the apron the air/ground radio operator radioed the pilot to advise him that he may have seen some "spray" from the engine. The pilot checked the engine instruments, whose indications were normal, before hover taxiing back to the apron where he checked the ground where the helicopter had been parked. Nothing unusual was observed and the pilot proceeded with the flight.

Having completed the training exercise on the use of the tail rotor pedals and collective, the pilot flew the helicopter back to the airfield where the passenger was to further practise control of the cyclic whilst in the hover. The pilot advised that he considered that the passenger's control of the cyclic had improved but it was still occasionally abrupt, and that he had needed to repeat a few times the command to release the controls back to him.

Having brought the helicopter into a stable hover at a height of approximately 10 to 15 ft above the ground, control of the cyclic was passed to the passenger. Control of the yaw pedals and collective remained with the pilot. The pilot stated that the helicopter started to drift backwards, to which the passenger applied a "heavy" forward cyclic input. The helicopter then drifted left at which point the pilot advised the passenger that he was taking control before trying to apply right cyclic. However, the pilot stated that the passenger did not release his grasp and had applied left cyclic. The helicopter moved left whilst also dropping, which the pilot tried to counter with collective and cyclic inputs but was unable to prevent the front of the left skid of the helicopter from contacting the ground. The helicopter subsequently fell onto its left side due to dynamic rollover.

As the helicopter struck the ground, the windscreen broke and detached from the helicopter. The passenger, who was sitting in the right seat, was momentarily suspended in his seat by the multipoint harness before releasing himself. Both occupants then vacated the helicopter through the windscreen aperture and moved away from the helicopter. The pilot and passenger had no external injuries evident. However, the passenger reported that the next day he had visited a hospital due to pain in his upper body.

The passenger's account of the accident sequence differed from that of the pilot. He stated that he had immediately released his grip of the cyclic control when commanded by the pilot, and that the helicopter "accelerated forward" before it "swerved to the right" and then "to the left and hit the ground".

Figure 1
Accident site

Conclusion

The pilot considered that the accident had occurred due to the passenger not releasing the controls when commanded, and applying left cyclic which was counter to the direction required and which opposed the input the pilot was trying to apply.

The passenger stated that he did apply forward cyclic but, upon being told that the pilot was taking control, he immediately released his grip on the cyclic as instructed. The passenger also advised that he "was not in control of the yaw pedals or collective at that time".

The AAIB investigation was unable to resolve the differences between these two statements, but this accident highlights the importance of clear communication and setting out responsibilities as part of the pre-flight brief and, should it be deemed appropriate, the ability of the pilot to stop the flight at any time.

SERIOUS INCIDENT

Aircraft Type and Registration:	Rotorway Executive 162F Modified, G-ZHWH
No & Type of Engines:	1 Rotorway RI 600N piston engine
Year of Manufacture:	2001 (Serial no: 6596)
Date & Time (UTC):	10 September 2023 at 1730 hrs
Location:	In flight over Hampshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	No damage reported
Commander's Licence:	Private Pilot's Licence
Commander's Age:	67 years
Commander's Flying Experience:	580 hours (of which 39 were on type) Last 90 days - 17 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

The helicopter took off with its ground handling wheels attached. This was discovered after landing as one was still attached and one was missing, having fallen off in flight. There were no known injuries or damage.

Safety action was taken by the UK maintenance organisation to amend the helicopter's checklist, in its Pilot Operating Handbook, to add a check that the ground handling wheels have been removed prior to departure.

History of the flight

The pilot stated that he was on a local flight from a private site where the helicopter was kept. Prior to moving the helicopter out of its hangar, he completed the pre-flight inspection. He then self-manoeuvred it out of the hangar on its ground handling wheels. Each wheel weighs about 12 lb (5.4 kg). Figure 1 shows the helicopter with a wheel fitted. However, once the helicopter was in a position for startup and takeoff he became distracted by his dogs, which he had to take into his house. Upon returning to the helicopter the pilot forgot to remove the wheels and subsequently took off with them on. He only realised this after landing when he found one wheel attached and one missing. Realising the missing wheel had fallen off inflight, he immediately notified the local ATC unit and police but there had been no notification of any damage or injuries caused by the wheel falling off in flight.

Figure 1
G-ZHWH with ground handling wheel fitted

Pilot's comments

The pilot commented that he should not have completed the pre-flight inspection in the hangar with the wheels on. The pilot subsequently attached a bungee to the wheels, which extends to the cockpit, with a 'Remove before flight' flag. He also added an item to his '*START UP, RUN UP AND TAKE OFF'* checklist, to check that the wheels are removed.

Helicopter information

The kit-built helicopter was designed in the USA. There is a UK distributor of the kits, which is also a maintenance organisation for those helicopters registered in the UK. It also provides type rating conversions.

At the time of publication of this report, the design company had ceased trading and could not be contacted.

The ground handling wheels are attached to the rear of the helicopter's skids, with the handle to the rear. The handle is then pulled forward over centre which raises the rear of the helicopter onto the wheel and locks the wheel in position (Figure 1). The rear of the tail of the helicopter is then pulled down until the helicopter is on the wheels, and it can then be manoeuvred as required. The wheels are to be removed before flight.

Helicopter's Pilot Operating Handbook (POH)

The helicopter's POH was produced by the design company in the USA, and a copy is required to be kept in the helicopter. There was no item in any checklist to ensure that ground handling wheels are removed before flight. This was also the case for all other variants with ground handling wheels from this design company.

The UK distributor/maintenance organisation commented that it has been informing its students and new owners not to leave the wheels on, including when putting the aircraft in the hangar. That way owners should always take the wheels off when the helicopter is put on the ground after moving. The organisation also tells owners to do a final walk around before flight.

As a result of this incident, and the inability of the design company to consider amending the POH, the UK maintenance organisation amended the helicopter's '*START UP, RUN UP AND TAKE OFF*' checklist by adding '*VERIFY THAT BOTH GROUND HANDLING WHEELS HAVE BEEN REMOVED BEFORE FLIGHT*'. The organisation planned to make this amendment to other helicopters' POH at their annual check. This would also be done on all the other variants maintained by the maintenance organisation. The CAA supported this safety action.

Discussion

This event highlights the danger of distractions during a critical phase of a flight. This incident is unlikely to have happened had the pilot removed the wheels after he had moved the helicopter out of the hangar, and then completed the pre-flight inspection. Nonetheless, having noticed the distraction at the time, he could have returned to the beginning of a previous phase in his pre-flight preparations to ensure nothing untoward had been missed. A final walk around before engine start, as the maintenance organisation recommends, would also have probably prevented this incident. It is fortunate no known damage or injury resulted from the wheel falling off.

Conclusion

The pilot became distracted during his pre-flight preparations. As a result, the helicopter took off with its ground handling wheels attached and one subsequently fell off in flight. While it was not known when or where the wheel fell off, it had the potential to cause damage and/or serious injury.

Safety action

As a result of this incident the helicopter's maintenance organisation in the UK amended the '*START UP, RUN UP AND TAKE OFF*' checklist by adding '*VERIFY THAT BOTH GROUND HANDLING WHEELS HAVE BEEN REMOVED BEFORE FLIGHT*'. Other helicopters' POH would be amended when undergoing an annual check. This would also be done on all other variants maintained by the Maintenance organisation.

ACCIDENT

Aircraft Type and Registration:	Sukhoi SU-29, G-SUUK
No & Type of Engines:	1 Vedeneyev M14P piston engine
Year of Manufacture:	1998 (Serial no: 001-01)
Date & Time (UTC):	16 September 2023 at 1310 hrs
Location:	Andrewsfield Aerodrome, Essex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Minor) Passengers - 1 (Minor)
Nature of Damage:	Extensive damage
Commander's Licence:	Private Pilot's Licence
Commander's Age:	81 years
Commander's Flying Experience:	1,950 hours (of which 600 were on type) Last 90 days - 5 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

Whilst the aircraft was making an approach, it is likely that its airspeed reduced such that the left wing stalled, causing a loss of control and impact with the ground.

History of the flight

The aircraft was making an approach to Runway 09 at Andrewsfield Aerodrome. The pilot sat in the rear seat and the passenger, who was a recently qualified pilot, sat in the front. Airfield CCTV showed that as the aircraft approached the runway the left wing dropped. The wingtip struck the ground causing the aircraft to cartwheel and it came to rest inverted in a ploughed field to the side of the runway (Figure 1). The passenger was able to free herself from the aircraft but the pilot required assistance. Both escaped with only minor injuries.

The pilot reported that he did not know what happened and believed there was nothing wrong with the aircraft. He thought he must have let the airspeed reduce on short final. He reported he had been flying the aircraft for 15 years so could not understand why he would have allowed this to happen.

The passenger reported that the approach had seemed normal until the wing dropped. She recalled that when the wing dropped the aircraft was so low it immediately flipped over.

Figure 1
G-SUUK after the accident

Conclusion

It is likely the airspeed reduced on short final causing the left wing to stall and the aircraft to roll to the left. The aircraft was low enough that the wingtip struck the ground.

Accident

Aircraft Type and Registration:	Skyranger Swift 912(1), G-CJXF	
No & Type of Engines:	1 Rotax 912UL piston engine	
Year of Manufacture:	2017 (Serial no: BMAA/HB/696)	
Date & Time (UTC):	25 September 2023 at 1012 hrs	
Location:	1 nm south of Dunstable, Bedfordshire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Propeller damage and minor damage to fabric skin	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	56 years	
Commander's Flying Experience:	535 hours (of which 460 were on type) Last 90 days - 18 hours Last 28 days - 6 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB	

Synopsis

The aircraft struck a bird shortly after takeoff which resulted in a loss of engine power. The pilot realised he was not going to clear the treeline ahead but maintained controlled flight until impact with hedges.

History of the flight

The pilot was taking off from a large field approximately 1 nm south of Dunstable. Shortly after becoming airborne he saw a heron flying on an intercepting course. He was expecting the bird to change course but when it became obvious they were about to collide, the pilot banked the aircraft to the left to avoid it. He estimated that the heron missed the aircraft's windscreen by 100 mm, but as the heron passed over the windscreen he heard another bird hit the propeller. The engine coughed for a few seconds but continued to run. However, he realised the loss of power meant he was not going to clear the trees ahead. He turned slightly to the right to avoid the tallest trees and focused on maintaining airspeed. Just prior to contact with bushes he switched off the engine. The aircraft settled into the hedgerow. The pilot was not injured and was able to exit the aircraft via a ladder.

Figure 1
G-CJXF after the accident

Other information

After the accident the pilot found the remains of a pigeon in the field and blood on the propeller.

The pilot reported that he had been trained to brief himself on his actions in the event of an engine failure before every takeoff and he had done so on this occasion, planning to turn to the right if necessary, knowing there was a large field in that direction.

Several days after the accident the pilot discovered that a fountain in an adjacent pond was on a timer and it had switched on at approximately the same time he had been taking off. He believed the noise from the fountain had scared the birds and caused them to take flight just as he was taking off.

He reported that he was investigating installing a bird scarer which he could operate remotely before taking off or landing at the field.

Bird avoidance

The CAA has published a safety sense leaflet titled '*Bird Avoidance*'[1] which contains advice for pilots to avoid bird strikes.

Conclusion

The aircraft collided with a bird shortly after takeoff, resulting in a loss of power. When the pilot realised he was not going to clear the tree line ahead, he maintained airspeed, steered the aircraft away from the tallest trees, switched off the engine and flew the aircraft in controlled flight into the hedges.

It is likely that pre-planning and rehearsing his actions in the event of an engine failure helped the pilot to resolve the emergency with minimal damage and no injuries.

Footnote

[1] Accessed November 2023.

ACCIDENT

Aircraft Type and Registration:	TL-3000 Sirius 600, G-SBOI
No & Type of Engines:	1 Rotax 912ULS piston engine
Year of Manufacture:	2022 (Serial no: 22 SI 215)
Date & Time (UTC):	10 August 2023 at 0800 hrs
Location:	Fishburn Airfield, County Durham
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Minor) Passengers - 1 (Minor)
Nature of Damage:	Extensive damage to the aircraft
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	66 years
Commander's Flying Experience:	252 hours (of which 49 were on type) Last 90 days - 24 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and additional enquiries by the AAIB

Synopsis

The aircraft performance was not as expected during the takeoff and it failed to climb, despite the engine appearing to be developing full power. The aircraft suffered extensive damage during the subsequent impact with the ground. The cause of the poor performance was not established.

History of the flight

The pilot intended to fly to Blackpool Airport with a passenger. He elected to take off using the slightly uphill Runway 26, as the wind was calm and the runway was aligned with his intended direction of travel. The temperature was 21°C, the dewpoint 16°C and the aircraft's weight and centre of gravity were within limits.

On application of full power, the pilot reported that the engine rpm indicator and engine sound were consistent with the engine delivering full power, but he noticed that the acceleration along the runway was "somewhat impaired". Despite the poor acceleration, the takeoff was continued and G-SBOI briefly left the ground but re-settled twice, before becoming airborne much further down the runway than anticipated. However, once airborne G-SBOI would not accelerate and the stall warning horn sounded continuously. Having only attained a height of 10 to 15 ft, the aircraft rolled to the left and struck the ground.

Figure 1

Damage sustained to G-SBOI (used with permission)

Damage to the aircraft was extensive and hindered the pilot's egress from the wreckage, but only minor injuries were sustained by the pilot and passenger, who were both wearing full harnesses.

Conclusion

No definitive cause was established for G-SBOI's poor acceleration, but the use of a 'stop-go' point and takeoff decision making is covered in the UK CAA's GA update of January 2023[1].

Footnote

1 UK Civil Aviation Authority, Clued up GA Update, January 2023. Available at Rejected Take Offs (caa.co.uk) [accessed October 2023]

ACCIDENT

Aircraft Type and Registration:	Uvify Ifo
No & Type of Engines:	4 x electric engines
Year of Manufacture:	Several (it was a swarm of vehicles)
Date & Time (UTC):	16 May 2023 at 1510 hrs
Location:	Norton St Phillip, Bath
Type of Flight:	Training
Persons on Board:	Crew - None Passengers - None
Injuries:	Crew - N/A Passengers - N/A
Nature of Damage:	Significant damage to two UAs
Commander's Licence:	Permission for Commercial Operations (PfCO)
Commander's Age:	36 years
Commander's Flying Experience:	34 hours (of which 32 were on type) Last 90 days – 3 hours Last 28 days – 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

A swarm of 638 UAs took off as part of a planned test of a light display. The preprogramed launch and animation flight were completed without incident. As the UAs switched to 'RETURN TO HOME' mode they returned to their grid positions. Several UAs then flew out of formation, before the pilot sent an emergency hold command to which the fleet responded, and all UAs held their position. A manual 'RETURN TO HOME' command was sent and the UAs returned to their grid formation. When the swarm began to descend the same UAs again flew out of formation. The swarm was then landed in altitude order, due to concerns about battery endurance. All UAs stayed within the planned geofence. Three UAs sustained broken arms and there were several chipped propellers.

An investigation by the operator determined that deviations from the planned flight route were caused by flat batteries in the controller unit, which had been left switched on when stored. The operator has introduced a new procedure to remove all controller batteries when not in use.

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 2023

7 Jun 2022 **DJI Mavic Air 2** Near Falmouth Harbour, Cornwall

The remote pilot was operating the 570 g UA, taking video of a ship under tow approximately 300 m from the nearest land. The ship's crew were not aware that the flight was to take place or who was operating the UAS. The video footage shows the UA passing to the side of the ship and bridge several times, during which someone on the bridge is seen to wave. The UA flew nearer to the ship with each pass before it collided with the ship's superstructure and fell onto the deck below.

4 Jul 2023 **DJI Matrice M600 Pro** Near Constantine Bay, Cornwall

The Matrice M600 and Mavic 2 Pro were operating on the coast in a commercial operation with visual line of sight. On completion the remote pilot of the Matrice believed the Mavic was at the takeoff and landing position and did not see that it was in the approach/departure lane. The UAs collided over the sea and the Mavic dropped vertically into the water. The M600 returned normally for an uneventful landing. The Mavic was found in a rock pool several days later.

20 Jul 2023 **DJI Matrice 300** Near Morpeth, Northumberland

The remote pilot had planned a series of automated mapping missions. On the third day of conducting this mission, the UA lost real time kinematic signal which caused the UA to pause during a turn away from a wind turbine. The remote pilot resumed the flight and the UA initially reversed along its previous flight path, flying into the wind turbine. The remote pilot was not aware the turbine had the ability to rotate 360° around its vertical axis. This required a larger area to avoid for the UA to maintain 50 m clear of the turbine in all positions, which was not taken into account when planning. The UA sustained significant damage and was replaced. There was no visible damage to the wind turbine.

18 Sep 2023 **DJI Inspire 3** Near Northwich, Cheshire

The aim of the flight was to film a target car travelling south along a closed private road. When the UA was approximately 300 m north of the pilot it was turned left to position behind the car, but drifted further east than intended and struck a lone tree next to the road. The UA sustained irreparable damage. There were no uninvolved persons nearby and nobody was injured. The remote pilot considered that a fresh westerly breeze had contributed to the unintended easterly drift and that, with hindsight, adopting a piloting position more closely aligned with the road and reducing the speed of both aircraft and target car could have "potentially avoided the accident.

Record-only UAS investigations reviewed: October - November 2023 cont

6 Oct 2023 **DJI Phantom 4 Pro V2** Near Frome, Somerset

Having completed a local surveying mission, the pilot was manually flying the UA to the launch point. When coming in to land, the pilot noticed that the controls were not as responsive as they should be and, following a motor error displayed on the controller, the UA fell to the ground.

9 Oct 2023 **DJI Matrice 300** Ripley, Derbyshire

A couple of minutes into a test flight, a noise was heard coming from one of the UA's motors. A motor error displayed on the controller and, shortly afterwards, the UA descended rapidly from a height of about 45 m. A subsequent inspection found that one of the motors was stiff.

22 Oct 2023 **Model aircraft** Near Macclesfield, Cheshire

The pilot lost the orientation of the model aircraft. He cut the throttle but the aircraft flew away over open land and was not recovered.

23 Oct 2023 **DJI M30T** Colwyn Bay, Conwy

A few seconds after takeoff at night the UA struck some overhead cables and fell to the ground. The remote pilot was under time pressure to take off and omitted the visual check for obstacles using a torch as per the operator's procedures.

26 Oct 2023 **PW.One** Near Long Lawford, Warwickshire

During a test flight in an area controlled by the operator, the UA appeared to enter Flight Termination mode and it spiralled, out of control, to the ground.

29 Oct 2023 **MA Scale G91** Abingdon-on-Thames, Oxfordshire

Shortly after takeoff the remote pilot lost radio link with the model aircraft. The failsafe activated the retractable undercarriage putting the retractable gear legs down, and shutting down the gas turbine engine. The model continued to fly and, being well trimmed, covered some distance before landing on a garage roof just outside the perimeter of the airfield.

17 Nov 2023 **DJI M300** Carlisle, Cumbria

The UA moved un-commanded into a power line, either because it was hit by a bird or because the UAS detected the bird and moved autonomously.

Record-only UAS investigations reviewed: October - November 2023 cont

27 Nov 2023 **DJI Matrice 300 RTK** Near Ripon, North Yorkshire

The UA was flying over some trees as part of an automated mapping mission. The remote pilot looked down at the controller, and when he looked up he could no longer locate the UA. Subsequently there was a loud whirring noise observed from the woodland area, which was presumed to be the UA striking trees. The UA was found at the base of a tree close to the last GPS location.

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

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.

1/2023 Leonardo AW169, G-VSKP
King Power Stadium, Leicester
on 27 October 2018.

Published September 2023.

2/2023 Sikorsky S-92A, G-MCGY
Derriford Hospital, Plymouth, Devon
on 4 March 2022.

Published November 2023.

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

http://www.aaib.gov.uk

GLOSSARY OF ABBREVIATIONS

aal	above airfield level
ACAS	Airborne Collision Avoidance System
ACARS	Automatic Communications And Reporting System
ADF	Automatic Direction Finding equipment
AFIS(O)	Aerodrome Flight Information Service (Officer)
agl	above ground level
AIC	Aeronautical Information Circular
amsl	above mean sea level
AOM	Aerodrome Operating Minima
APU	Auxiliary Power Unit
ASI	airspeed indicator
ATC(C)(O)	Air Traffic Control (Centre)(Officer)
ATIS	Automatic Terminal Information Service
ATPL	Airline Transport Pilot's Licence
BMAA	British Microlight Aircraft Association
BGA	British Gliding Association
BBAC	British Balloon and Airship Club
BHPA	British Hang Gliding & Paragliding Association
CAA	Civil Aviation Authority
CAVOK	Ceiling And Visibility OK (for VFR flight)
CAS	calibrated airspeed
cc	cubic centimetres
CG	Centre of Gravity
cm	centimetre(s)
CPL	Commercial Pilot's Licence
°C,F,M,T	Celsius, Fahrenheit, magnetic, true
CVR	Cockpit Voice Recorder
DME	Distance Measuring Equipment
EAS	equivalent airspeed
EASA	European Union Aviation Safety Agency
ECAM	Electronic Centralised Aircraft Monitoring
EGPWS	Enhanced GPWS
EGT	Exhaust Gas Temperature
EICAS	Engine Indication and Crew Alerting System
EPR	Engine Pressure Ratio
ETA	Estimated Time of Arrival
ETD	Estimated Time of Departure
FAA	Federal Aviation Administration (USA)
FDR	Flight Data Recorder
FIR	Flight Information Region
FL	Flight Level
ft	feet
ft/min	feet per minute
g	acceleration due to Earth's gravity
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GPWS	Ground Proximity Warning System
hrs	hours (clock time as in 1200 hrs)
HP	high pressure
hPa	hectopascal (equivalent unit to mb)
IAS	indicated airspeed
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
IP	Intermediate Pressure
IR	Instrument Rating
ISA	International Standard Atmosphere
kg	kilogram(s)
KCAS	knots calibrated airspeed
KIAS	knots indicated airspeed
KTAS	knots true airspeed
km	kilometre(s)
kt	knot(s)
lb	pound(s)
LP	low pressure
LAA	Light Aircraft Association
LDA	Landing Distance Available
LPC	Licence Proficiency Check
m	metre(s)
mb	millibar(s)
MDA	Minimum Descent Altitude
METAR	a timed aerodrome meteorological report
min	minutes
mm	millimetre(s)
mph	miles per hour
MTWA	Maximum Total Weight Authorised
N	Newtons
N_R	Main rotor rotation speed (rotorcraft)
N_g	Gas generator rotation speed (rotorcraft)
N_1	engine fan or LP compressor speed
NDB	Non-Directional radio Beacon
nm	nautical mile(s)
NOTAM	Notice to Airmen
OAT	Outside Air Temperature
OPC	Operator Proficiency Check
PAPI	Precision Approach Path Indicator
PF	Pilot Flying
PIC	Pilot in Command
PM	Pilot Monitoring
POH	Pilot's Operating Handbook
PPL	Private Pilot's Licence
psi	pounds per square inch
QFE	altimeter pressure setting to indicate height above aerodrome
QNH	altimeter pressure setting to indicate elevation amsl
RA	Resolution Advisory
RFFS	Rescue and Fire Fighting Service
rpm	revolutions per minute
RTF	radiotelephony
RVR	Runway Visual Range
SAR	Search and Rescue
SB	Service Bulletin
SSR	Secondary Surveillance Radar
TA	Traffic Advisory
TAF	Terminal Aerodrome Forecast
TAS	true airspeed
TAWS	Terrain Awareness and Warning System
TCAS	Traffic Collision Avoidance System
TODA	Takeoff Distance Available
UA	Unmanned Aircraft
UAS	Unmanned Aircraft System
USG	US gallons
UTC	Co-ordinated Universal Time (GMT)
V	Volt(s)
V_1	Takeoff decision speed
V_2	Takeoff safety speed
V_R	Rotation speed
V_{REF}	Reference airspeed (approach)
V_{NE}	Never Exceed airspeed
VASI	Visual Approach Slope Indicator
VFR	Visual Flight Rules
VHF	Very High Frequency
VMC	Visual Meteorological Conditions
VOR	VHF Omnidirectional radio Range

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