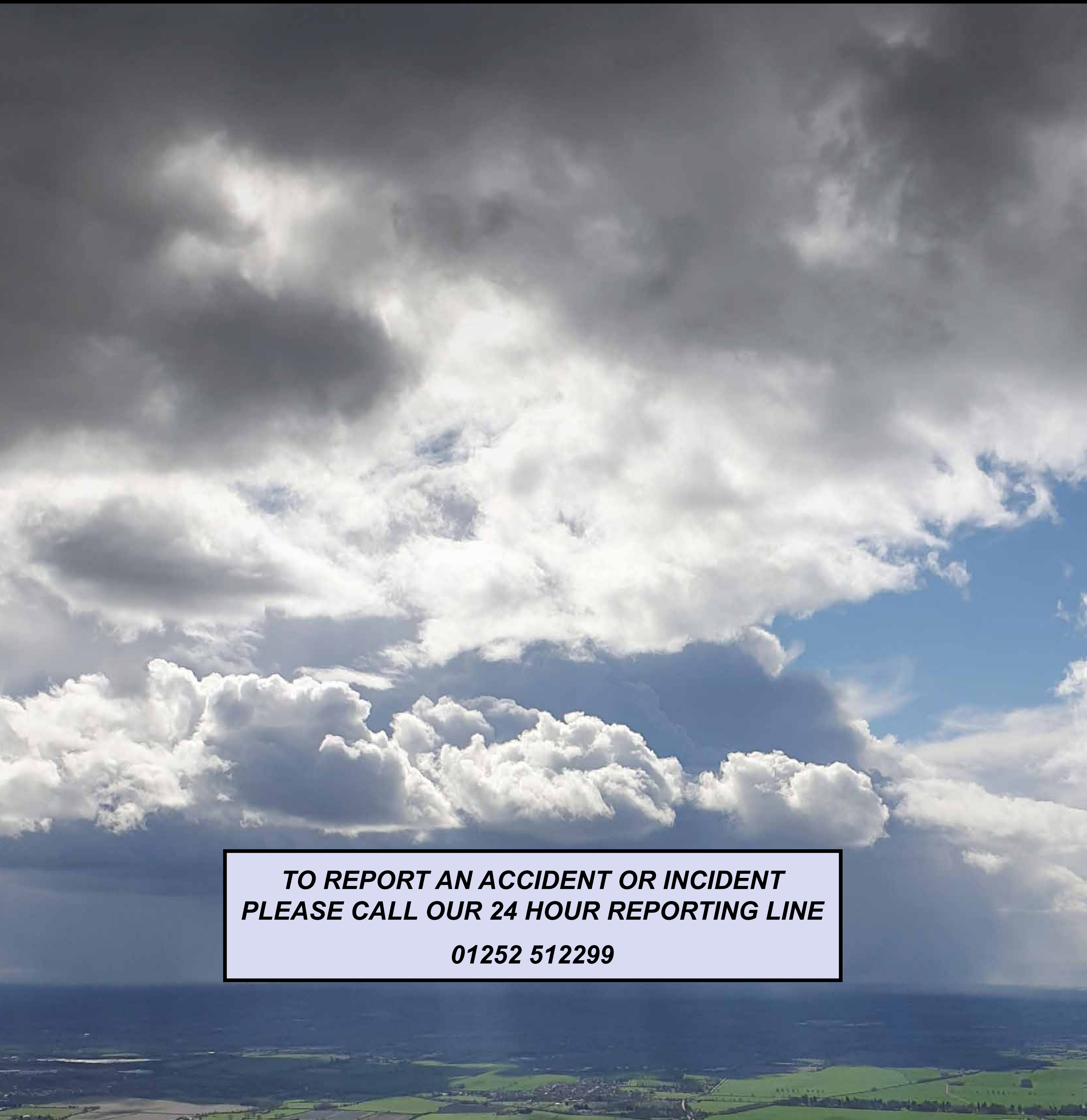
AAIB

Air Accidents Investigation Branch

AAIB Bulletin 4/2021



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01252 512299

Air Accidents Investigation Branch
Farnborough House
Berkshire Copse Road
Aldershot
Hants GU11 2HH

Tel: 01252 510300
Fax: 01252 376999
Press enquiries: 0207 944 3118/4292
http://www.aaib.gov.uk

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CONTENTS

SPECIAL BULLETINS / INTERIM REPORTS

None

SUMMARIES OF AIRCRAFT ACCIDENT ('FORMAL') REPORTS

None

AAIB FIELD INVESTIGATIONS

AAIB CORRESPONDENCE INVESTIGATIONS

CONTENTS Cont

AAIB CORRESPONDENCE INVESTIGATIONS Cont

SPORT AVIATION / BALLOONS

UNMANNED AIRCRAFT SYSTEMS

None

RECORD-ONLY INVESTIGATIONS

MISCELLANEOUS

ADDENDA and CORRECTIONS

None

(ALL TIMES IN THIS BULLETIN ARE UTC)

AAIB Field Investigation Reports

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

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

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

SERIOUS INCIDENT

Aircraft Type and Registration:	BAe ATP, SE-MAO
No & Type of Engines:	2 Pratt and Whitney Canada PW126 turboprop engines
Year of Manufacture:	1989 (Serial no: 2011)
Date & Time (UTC):	22 May 2020 at 1258 hrs
Location:	Birmingham Airport
Type of Flight:	Commercial Air Transport (Cargo)
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	None reported
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	57 years
Commander's Flying Experience:	4,984 hours (of which 211 were on type) Last 90 days - 56 hours Last 28 days - 30 hours
Information Source:	AAIB field investigation

Synopsis

In windy conditions the crew of SE-MAO performed a go-around from their first approach to Runway 33 at Birmingham Airport. On the second approach the aircraft departed the runway to the left after touching down. The crew had not applied or maintained into-wind aileron during the landing or landing roll and, despite the application of full rudder, could not keep the aircraft on the runway. The aircraft was off the paved surface for approximately 450 m. There was no damage to the aircraft or the airfield, and the crew were uninjured.

Following this incident, Safety Action was taken by the operator to introduce a crosswind limit for new co-pilots, and to include crosswind landing training in simulator sessions.

History of the flight

The crew of SE-MAO departed Guernsey Airport to fly to Birmingham International Airport at 1142 hrs. The weather in Birmingham for their arrival was forecast to be a strong wind from the southwest with good visibility and a high cloud base. The co-pilot was Pilot Flying (PF) for the sector. After being radar vectored for a Localiser (LLZ) DME approach to Runway 33 at Birmingham, the crew conducted a stable approach. At 1245 hrs during the flare to land the aircraft drifted to the right of the centreline with the nose about 20° left of the runway direction. A go-around was commenced, and the aircraft climbed away before being radar vectored for a further approach. At the request of the co-pilot, the commander became PF for the second approach which was again a stable LLZ DME for Runway 33. With 2 nm to go before touchdown, ATC announced the wind as from 230° at 14 kt gusting 27 kt. The aircraft touched down at 1258 hrs and, shortly afterwards, departed off the paved runway to the left. The distance from the aircraft first leaving the paved surface to when the last wheel returned to the paved surface was 450 m.

After stopping for an inspection by ground operations personnel, the crew taxied the aircraft to a stand. Subsequent engineering inspections revealed no damage to the aircraft although one main wheel tyre was replaced. There were no injuries to the crew who were the only occupants.

Recorded information

SE-MAO was equipped with an L3 FA2100 solid state cockpit voice recorder (SSCVR), which recorded 2 hours of audio, and a Plessey PV1584F1 tape flight data recorder (FDR), which recorded over 27 hours of data. A copy of the flight data was also recorded on a solid state L3 µQAR Quick Access Recorder (µQAR). The audio recordings included the commander's and co-pilot's communications, radio transmissions and audio from the cockpit area microphone. CCTV from the airport and video footage from a witness outside the airfield boundary were also reviewed to corroborate evidence and other data sources. Images from the witness's video are used in the report.

Due to the age of the aircraft and the extant flight recorder carriage requirements at the time the certificate of airworthiness was issued, the number of parameters recorded by the FDR was limited to less than thirty. As a result, parameters such as weight on wheels, rudder pedal position and power lever angle were not recorded. Also, the quality of the mandatory FDR recording was poor due to inherent issues of using magnetic tape as a recording medium. However, there were no such issues with the µQAR recording of the flight data.

First approach and go-around

Figure 1 plots the flight data for the first approach and go-around. It starts with the aircraft on the descent passing through 400 ft agl, crabbed to the left by over 20° to the runway heading, and shows that during the approach varying amount of aileron and rudder inputs were used to keep the aircraft on the extended runway centreline. Key points from the data are labelled [A] through [D] and detailed as follows:

1. The co-pilot (PF) called "GO-AROUND" just as the aircraft was about to touch down briefly on the left main gear [A] (and Figure 2). The aircraft heading was about 8° to the left of the runway heading and increasing. The rudder deflection varied around zero and just under half left aileron was being used.

2. During the next three seconds the aircraft veered away from the runway heading while the commander was heard to say "LAND IT LAND IT LAND IT". The engine torques increased from idle to about 80% and then back to about 25% just as the aircraft touched down [B]. At touch down, the aircraft's heading was 15° left of the runway.

3. Shortly after touchdown, the commander called "GO-AROUND" which the co-pilot acknowledged [C] whilst advancing the power levers.

4. The aircraft remained on the ground for about eight seconds during which a small amount of right rudder and left aileron was initially used. The aircraft's heading responded to the right rudder before veering away to the left. About 75% of full right rudder was then applied [D]. The aircraft's heading was 24° left of the runway as the aircraft became airborne (Figure 3).

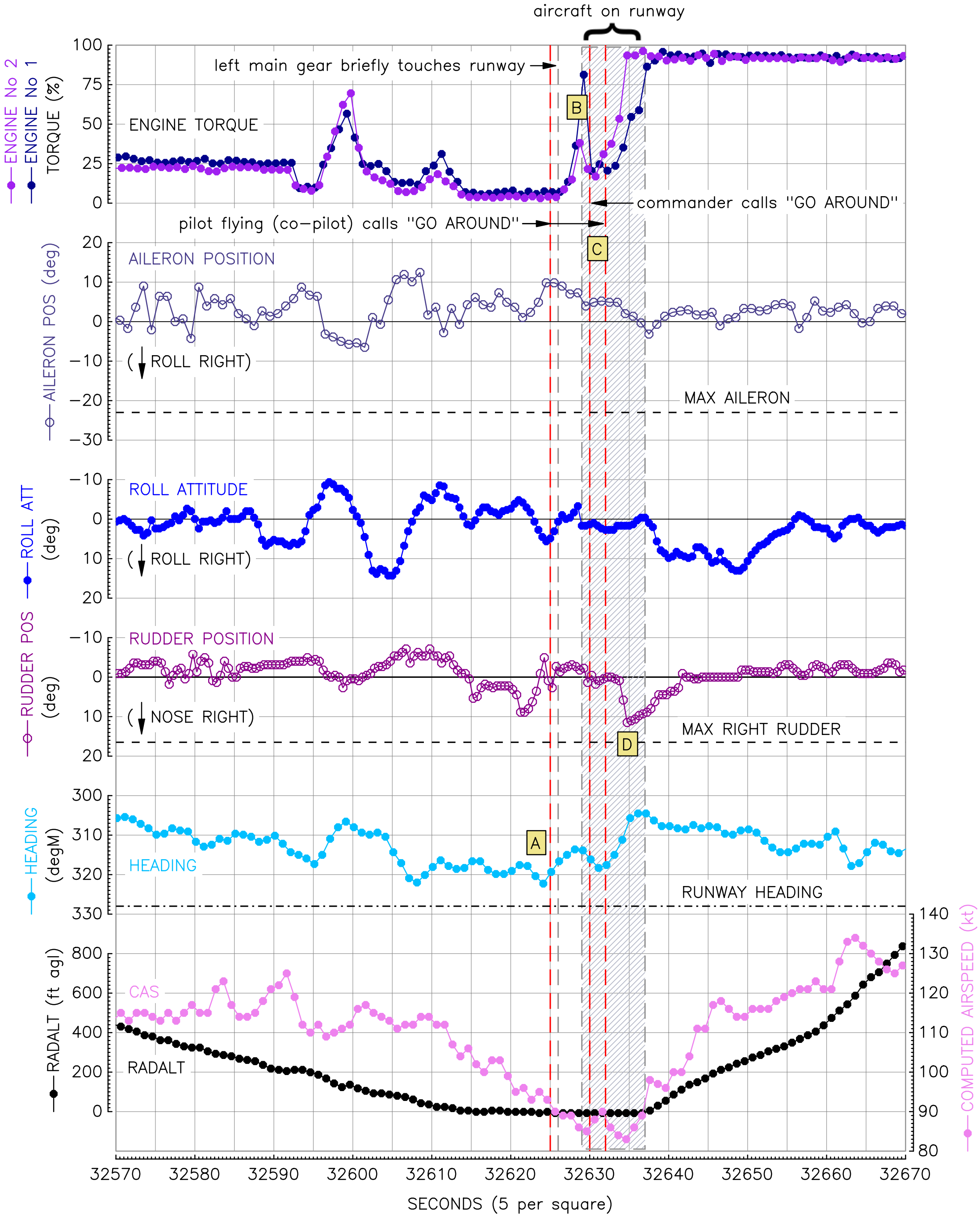


Figure 1

Flight data for the go-around

Figure 2

Image showing Point A from Figure 1 – touchdown on Runway 33

Figure 3

Image showing Point D from Figure 1 – power applied for the go-around

Second approach and landing

Figure 4 plots the flight data for the landing. It starts with the aircraft on the descent passing through 400 ft agl, crabbed to the left by about 20° to the runway heading. A small amount of left rudder was used throughout the approach, with similar roll control to that of the first approach. During the last 15 seconds of the approach, the rudder became more active and moved to the right, reducing the crab angle to about 10° left of the runway heading. Key points from the data for the landing are labelled [A] through [F] and detailed as follows:

1. At touchdown, the aircraft heading was about 10° left of, and veering away from, the runway heading [A] (and Figure 5).
2. Full right rudder was immediately applied [B] and slowed the veering to the left, which peaked at 24° nose left.

3. Full right aileron was applied [C] causing the aircraft to bank 8° left wing up [D] and lift the left main gear off the runway (Figure 6).

4. About five seconds after touching down, the aircraft left the paved surface to the left [E] (and Figure 7) but in a right turn on the nose and right main gear.

5. Seven seconds after leaving the paved surface, the aircraft turned onto the runway heading [F], but on a parallel track to the left of the runway, before veering a little to the left again then back right, re-joining the runway another seven seconds later (Figure 8).

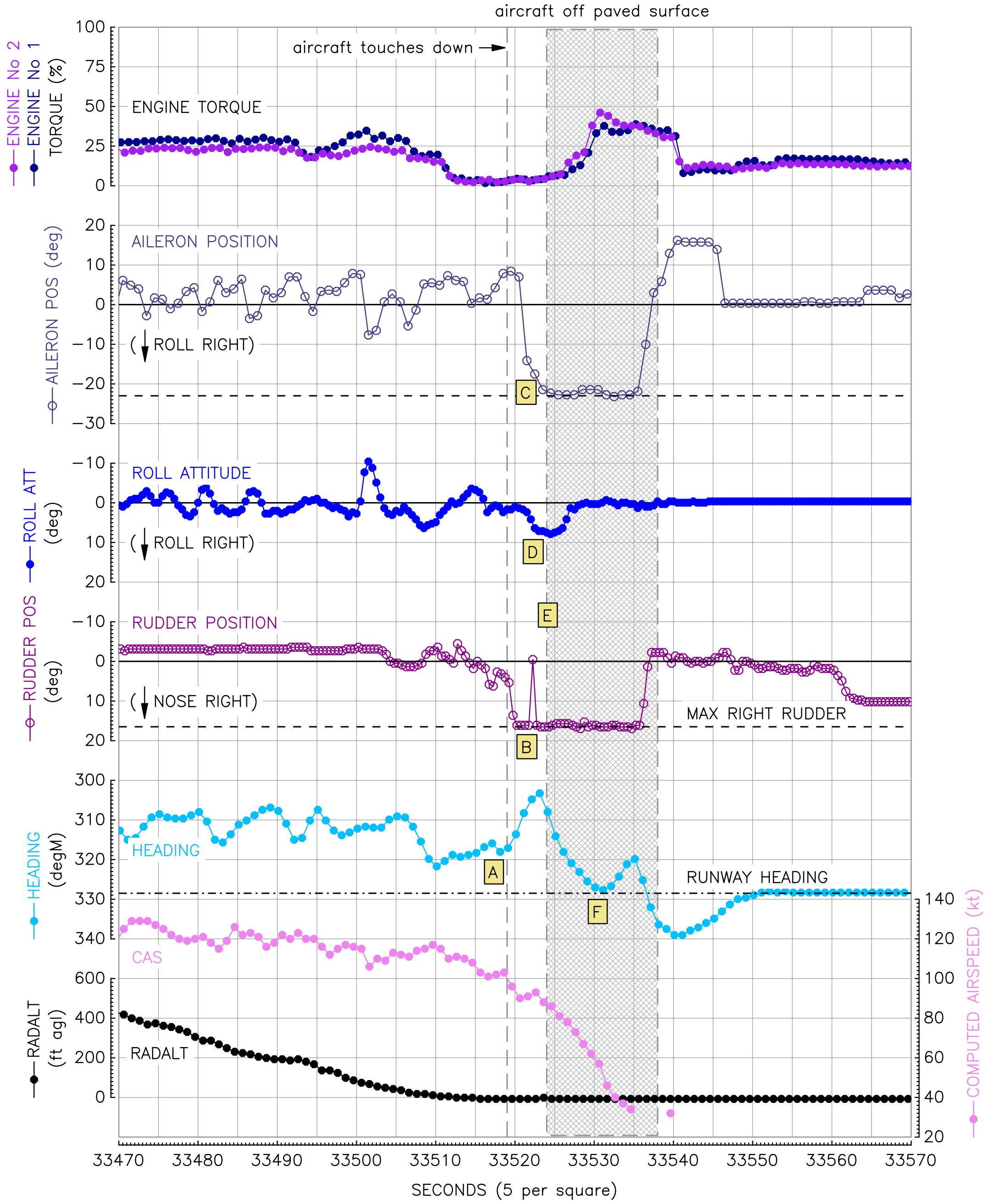


Figure 4

Flight data for the landing

Figure 5

Image showing Point A from Figure 2 – touchdown on Runway 33

Figure 6

Image showing Point C from Figure 4 – full right aileron applied

Figure 7

Image showing Point E from Figure 4 – SE-MAO leaves the paved surface

Figure 8

Image showing Point F from Figure 4 – SE-MAO returns to the paved surface

Aircraft information

The ATP is a twin turboprop aircraft with a wingspan of 30.632 m and a main landing gear span of 8.456 m. The propellers are 6-bladed with a diameter of 4.191 m and ground clearance of 0.54 m. The propeller tips are 9 m from the wing tips. The wings have a dihedral of 7°.

SE-MAO was built in 1989, entering service as a passenger aircraft the same year. The aircraft began operating in cargo configuration in 2007.

Aircraft examination

After the incident the aircraft was inspected by ground operations staff from the airport for any damage. As none was observed, the aircraft taxied under its own power to the stand. After shutdown the commander contacted the operator and engineers attended the aircraft to carry out a full inspection.

A full inspection of the wheels, tyres, brakes, propellers, and brake temperature sensors showed that there was no damage to the aircraft. One main wheel tyre was replaced as it showed some uneven wear. There were no leaks from or marks on the airframe. As a precaution the engineers also carried out a heavy landing check and found no damage.

The aircraft had a previous cosmetic defect with the nose landing gear leg, probably as a result of contact with a towbar during pushback operations. This defect had been noted in the month before the incident and a replacement scheduled. The nose gear was replaced as scheduled a few weeks after this incident. The cosmetic defect had no role in the incident.

Weight and balance

The weight of the aircraft on approach to Birmingham was around 30% less than the allowable maximum. The centre of gravity was within limits.

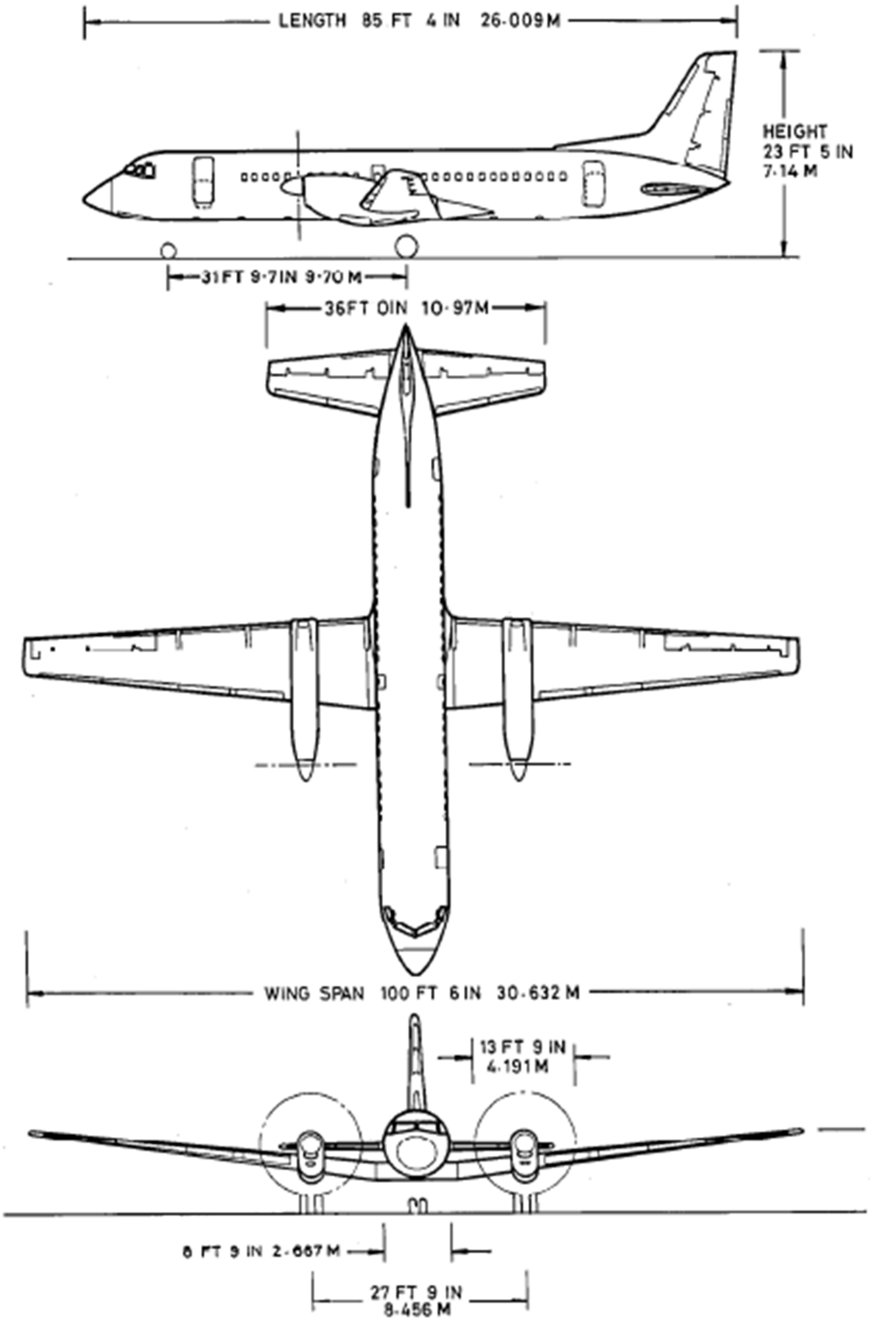


Figure 9

Dimensions of the ATP

Meteorology

The weather conditions on the day of the incident showed an area of low pressure to the west of the UK, extending a moderate to fresh, slightly unstable, south-westerly flow across the Birmingham area. This led to gusts of 25 kt in the morning, increasing to 31 kt by early afternoon, potentially giving moderate low-level turbulence. Visibility and cloud bases remained good throughout.

The latest TAF for Birmingham which was issued before the incident was at 1055 hrs. This forecast for the period of arrival for SE-MAO showed a south-westerly wind at 16 kt with gusts of 28 kt. The visibility was excellent with only scattered cloud at 4,000 ft aal. The previous TAF, which was issued at 0555 hrs, forecast very similar conditions with gusts up to 30 kt.

The observations at the airport for the times around the incident show the actual conditions were as forecast with the wind backing slightly from 250° at 1220 hrs to 230° at 1320 hrs. The wind was gusting throughout the period between 25 kt and 31 kt. The direction of the wind was varying from 190° to 280°. Both crew members reported that it was turbulent on the approach.

There had been little rain at the airport over the previous months and the ground was dry and hard.

Airfield information

Birmingham has a single runway, orientated north-west/south-east (Runway 15/33) (Figure 10). The landing distance available on Runway 33 is 2,449 m, and both ends of the runway are fitted with a Category 3 ILS DME. At the time of the incident there was an active NOTAM regarding the ILS glidepath on Runway 33. Due to ongoing work in the area of the glide path, it was not available for use.

To the west of the runway there are a number of buildings mainly clustered in the south-west corner of the airfield. This includes a large hangar which was completed in 2013. The airport terminals and passenger facilities are located to the east of the runway. There are two anemometers, one for each runway, located abeam the touchdown zones. The anemometers met all the required servicing and accuracy requirements set out by the CAA. ATC select the relevant anemometer for the runway in use for display in the tower. The wind given to the pilots is the two-minute mean for wind direction and speed.

The METAR wind is reported as the ten-minute average wind speed and wind direction. It is reported twice per hour. The METAR will also include a gust report (maximum three second gust in the ten-minute period) if the gust exceeds the mean wind speed by at least 10 kt.

The UK Aeronautical Information Publication[1] contains the following warning about Birmingham:

> *'Due to runway orientation relative to prevailing winds, pilots should anticipate crosswinds and may experience building induced turbulence and wind shear on aerodrome in strong winds.'*

In spring 2016 Birmingham fitted two temporary anemometers in addition to those already at the airport. These were located either side of the runway, near to the Runway 33 threshold.

Footnote

[1] https://www.aurora.nats.co.uk/htmlAIP/Publications/2020-07-16-AIRAC/html/index-en-GB.html [accessed November 2020].

The data from these temporary wind masts was provided to the Met Office by the AAIB who completed a study looking at the wind data against that in the METAR for the period the temporary masts were installed (7 April 2016 – 25 May 2016). The report makes the following conclusions:

- *'Analysis of the temporary mast wind data indicates a potential for the observed wind speeds in the vicinity of the Runway 33 threshold to be on the order of around 10% faster than those observed by the METAR anemometer when winds are from the west-southwest. There is evidence of potentially higher gustiness in the vicinity of the Runway 33 threshold when winds come from the west-southwest.'*

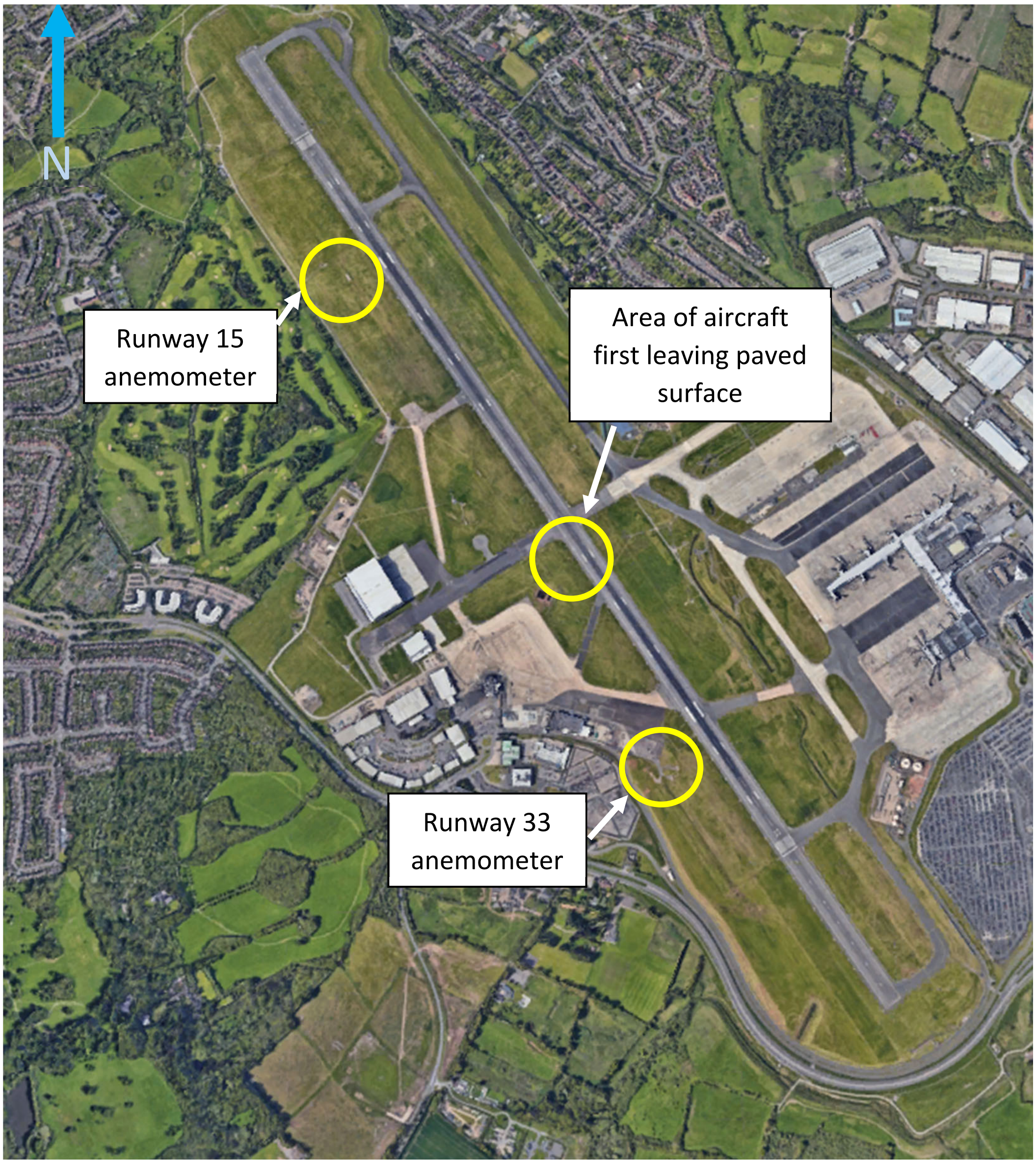


Figure 10

Image of Birmingham Airport
© 2020 Google, Image © Landsat / Copernicus

Incident site

A team was deployed to survey the incident site. The nature of the terrain over which the aircraft travelled during the runway excursion was even and firm. The aircraft tyre marks on the airfield and the tracks in the grass were very clear and allowed accurate measurement. To determine the path of the excursion from the runway, GPS markers were sited at key points on the aircraft tyre tracks and an unmanned air system (UAS) used to compile an aerial survey of the section of airfield.

Using the images taken by the UAS it was possible to measure the distance from when the aircraft first left the paved runway surface until when the last wheel returned to the runway. The total distance was 450 m. Figure 11 shows the extent of the excursion, with the wheel tracks clearly visible in the grass.

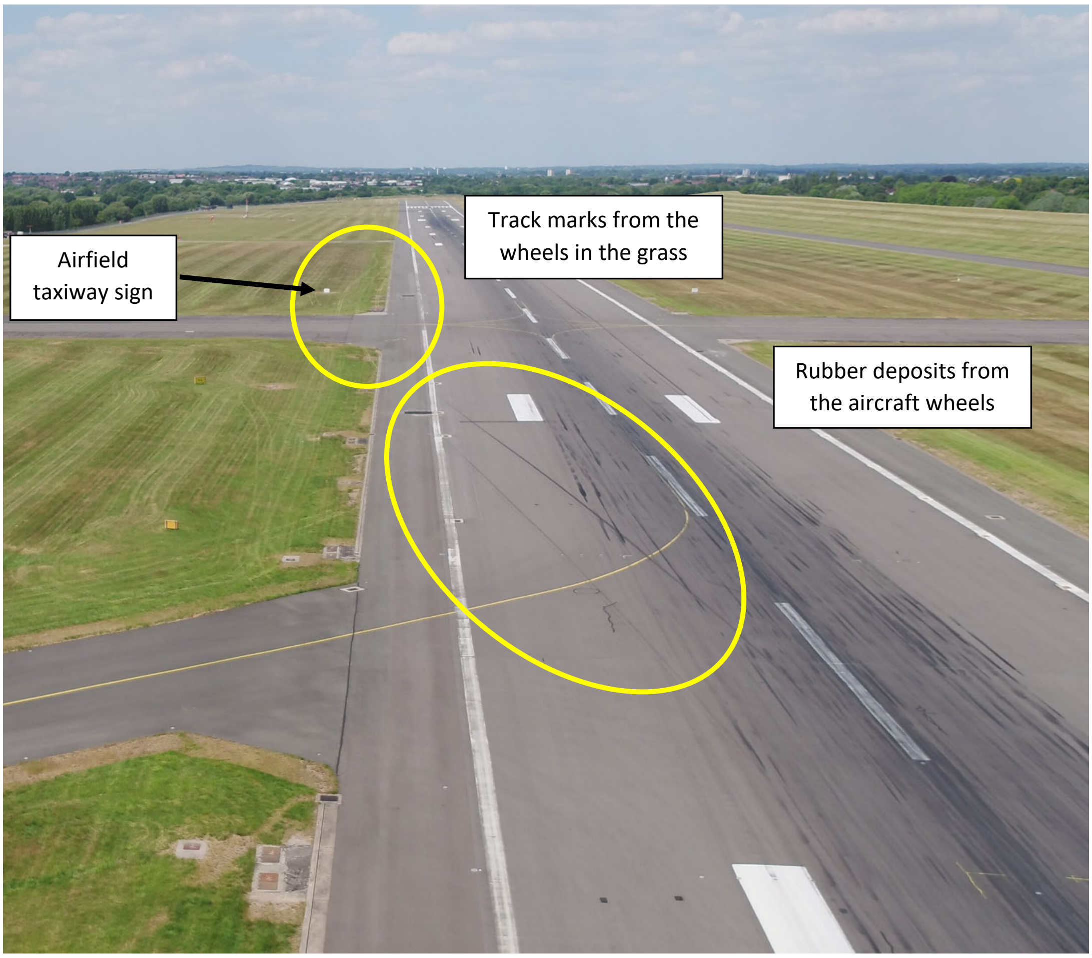


Figure 11

UAS image of the runway and grass markings

The airfield taxiway sign that passed under the left wing during the excursion was calculated to be just over 1 m below the lower surface of the wing. The sign was outside the diameter of the propeller, but it was above the lowest point of the rotational arc. Figure 12 shows the aircraft wing passing over the sign and Figure 13 shows an image of how close the sign was to the wing. Whilst all signs on the airport are designed to be frangible, it is likely that had the propeller hit the sign some damage would have occurred to the aircraft.

Figure 12

Image of the aircraft wing passing over the taxiway sign

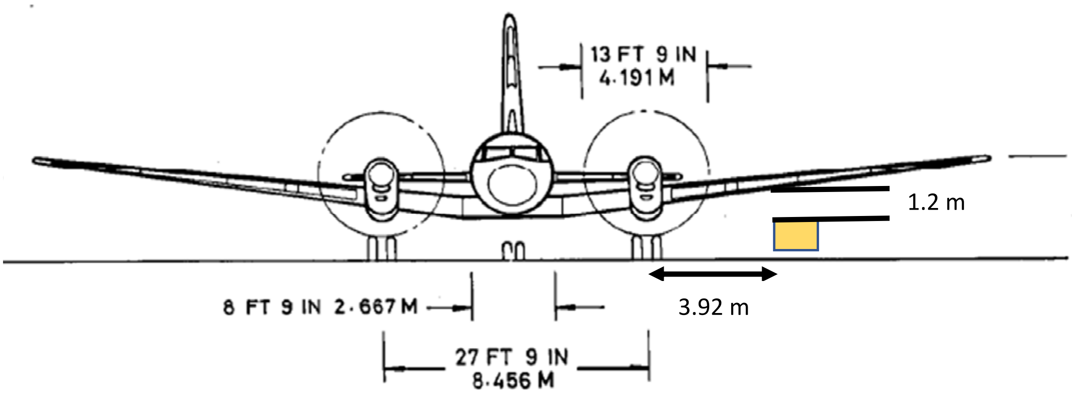


Figure 13

Distance of SE-MAO from taxiway sign represented by the yellow box

Flight crew

Both crew members were relatively new to the ATP. The commander had completed his type rating course in September 2019, completed line training in October 2019 and had approximately 211 hours on type at the time of the incident. The co-pilot had completed his type rating in May 2019, completed line training in August 2019 and had approximately 250 hours on type at the time of the incident. This was the co-pilot's first commercial air transport employment and he had approximately 730 hours total flying time at the time of the incident.

Both pilots completed an EASA type rating at a third-party organisation which was contracted by the operator. At the time that both completed their type rating there was no requirement to record crosswind landings as a discrete item in the training programme[2], although crosswinds did form a required element of the type rating. Both crew members were signed off for crosswind landings on the skills test form. Although both crew members recall completing one crosswind landing during the simulator phase of their type rating, neither recalls receiving any specific training in relevant handling techniques and the wind used was not at or near the aircraft limit.

After completing their type rating courses, both pilots proceeded to line training with the operator. Line training is a series of flights conducted with a training captain occupying the other seat. The line training syllabus included crosswind landings, but this requirement could be completed as a discussion item rather than as a practical exercise. Both pilots were signed off for crosswind landings as a discussion item. Having completed their training and a line check conducted by a senior training captain both pilots were released to fly the line as normal crew members.

In the winter of 2019/20 both pilots completed a recurrent simulator session. This session included a crosswind landing as part of the tri-annual recurrent rotation of events to be covered in the simulator.

Both pilots had flown some crosswind landings on the line before this incident, but neither could remember any landing where the crosswind exceeded 20 - 25 kt. They were in recent flying practice and had been flying throughout the previous three-month period.

Organisational information

The operator has no restrictions on the crosswind limit for either newly qualified flight crew members or inexperienced co-pilots. All pilots were restricted only by the flight manual maximum demonstrated limit of 34 kt (not including gusts).

Operational procedures

Crosswind landing technique

The manufacturer's aircraft operating manual provides the following guidance for a crosswind landing:

> *'The aircraft may be flown in crosswind conditions using the "Wing Down" technique, the "Kick-Off Drift" technique or a combination of the two. The approach should be made with the aircraft lined up with the extended centreline, using normal speeds plus any allowance for turbulence. Towards the end of the flare, with Power Levers at FLIGHT IDLE, apply the required aileron to prevent a wing lifting as the aircraft touches down. After the main wheels have touched the runway, lower the nosewheel to the ground as soon as possible and as*

Footnote

2 Since the crew of SE-MAO completed their training the EASA have updated their requirements to ensure that crosswind training is now a discrete item within the type rating training.

the speed decreases gradually centralise the ailerons, maintaining directional control and braking as for a normal landing.'

Nosewheel steering

The ATP is fitted with nosewheel steering which is controlled from a tiller on the left side of the flight deck. There is no tiller fitted for the right seat pilot. The nosewheel steering can be used when the aircraft is on the ground at any speed.

Landing technique and post-landing actions

Ideally the pilots should achieve a gentle round out, with the power levers at FLIGHT IDLE at the end of the flare. The aircraft should then be allowed to settle onto the runway, mainwheels first, before the nosewheel is gently lowered to the ground. When the aircraft is on the ground, GROUND IDLE should be selected, with REVERSE used as necessary. Directional control is with rudder initially, then with nosewheel steering as the speed decreases. As the aircraft slows below 60 kt, with GROUND IDLE selected, the control locks should be engaged.

As the aircraft has no right seat nosewheel steering tiller, the manual offers further guidance when the right seat pilot is flying:

> *"When the aircraft is firmly on the ground with the power levers in the GROUND IDLE position, the Left Hand Seat Pilot should take control of the aircraft whilst the rudder is still effective. As he does this, he should call "I Have Control", to which the other pilot will respond "You Have Control". In crosswind conditions it may be necessary for the Right Hand Seat Pilot to continue to apply some ailerons into wind after the change-over of control."*

The operator also published Standard Operating Procedures (SOPs) in the operations manual for landings. These SOPs stipulated that if the right seat pilot was landing, the left seat pilot would take control of the aircraft at 80 kt, although the right seat pilot would continue to hold the control column "*slightly forward and ailerons into the wind throughout the roll out". * If the left seat pilot was landing, then "*he/she will hand over the control column no later than eighty knots".*

Crew brief and actions

The crew did not discuss if, how or when hand over of the control column would occur for the second approach flown by the left seat pilot. They also did not discuss what inputs might need to be made on the control column given the strength of the crosswind for either approach.

Human factors

Human information processing

The concept of human information processing tries to explain how we make sense of the world around us. We are all subject to a continuous flow of stimuli from our surroundings which our brain must sift through and decide which should be processed before any possible response is generated. Figure 14 shows a simplified representation of the human information processing system taken from the CAA Flight crew human factors handbook[3].

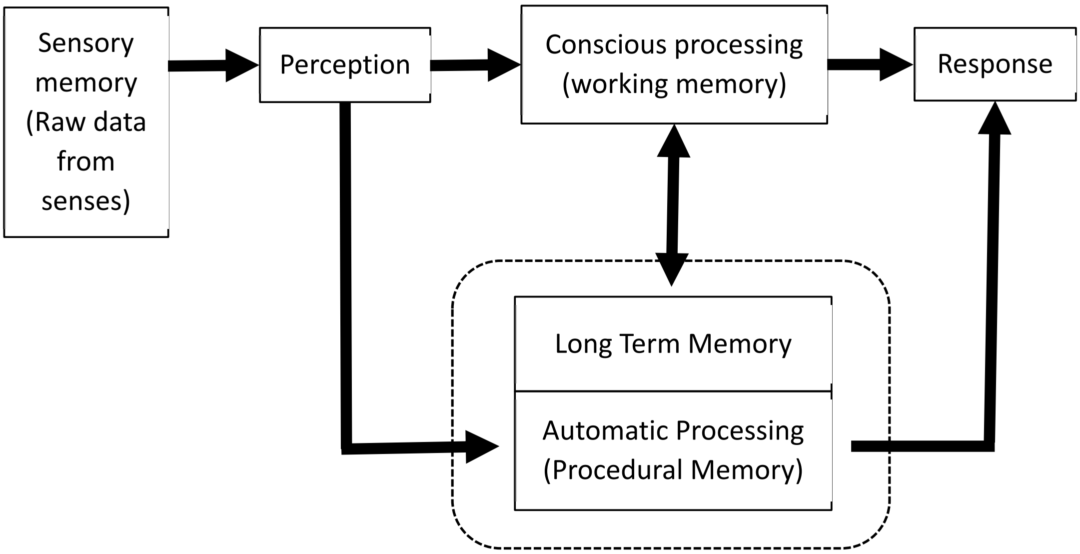


Figure 14

Simplified generic diagram of Information Processing

Figure 14 works from left to right. Using our senses, we detect data from our surroundings. This data cannot all be perceived and processed as we have limited cognitive resources to do so. There must be some filtering of the data so that we can focus on what is important at that moment. We have some very short-term capacity to store some of this data, although most of what we collect from our senses is lost as it is refreshed constantly. Sensory memory remembers stimuli just long enough to allow perception. Perception allows us to sort the sensory data into what needs our attention, and therefore needs further cognitive processing. Further processing takes place in the working memory.

We use our long term memory to store previous experiences which then provide a template for responding to data coming from the senses. Part of our long term memory also contains automatic processing, such as speech or motor programmes, which require little or no conscious cognitive effort. An example of such programmes could be changing gear in a manual car. These may be complex motor skills learned and practised over a period. Whilst automatic processes are very effective and efficient, there can be a risk that the wrong automatic process is triggered which can result in an incorrect response, especially when there are limited cognitive resources available.

When driving a car, to steer to the right requires the steering wheel to be turned to the right. This is an automatic response in most drivers once they have learnt the basics of driving. It is a re-enforced motor programme in anyone who drives regularly. When landing an

Footnote

[3] CAA CAP 737 *Flight crew human factors handbook* Page 19
https://publicapps.caa.co.uk/docs/33/CAP%20737%20DEC16.pdf [accessed November 2020]

aircraft, steering the nose of the aircraft to the right requires a right rudder input and, in a strong crosswind from the left, requires the use of full into-wind (left) aileron at the same time. This is not likely to be practised as often as most pilots drive a car and may occur only rarely for pilots operating in most areas. As a result, the 'steering the car' reaction may well be dominant in times of high cognitive workload when aligning the aircraft with the runway heading.

Analysis

Conditions at Birmingham

The weather conditions at Birmingham were a strong wind from the south-west with good visibility and little cloud. The strong wind gave a significant crosswind on the runway. The wind was also generating some turbulence on the approach. The ATP has a certified crosswind limit of 34 kt (not including gusts), and both the forecast and actual wind conditions were less than this maximum certified limit. The operator of SE-MAO had no limitations on the co-pilot flying the aircraft when there was a strong crosswind, and there was no additional limitation on the co-pilot below the certified limit of the aircraft type.

Whilst the Met Office study showed that it is possible the wind could have been stronger than that given on the METAR, the wind given to the pilots would have been from the threshold anemometer. This anemometer has been calibrated in accordance with the relevant CAA procedures. The AIP warns that in strong winds the crews may encounter building induced turbulence and windshear.

Crew training and experience

Both crew members were reasonably inexperienced on the aircraft type. Although crosswind landings were an element of their type rating courses, neither could remember having flown in conditions at or near the aircraft limit. Neither pilot used the full crosswind technique as outlined in the manufacturer's or operator's manuals.

First approach and go-around

The co-pilot flared the aircraft and it briefly touched down although insufficient rudder had been applied to line the aircraft up with the runway. As a result of not pointing down the runway, the co-pilot decided to perform a go-around and called "GO-AROUND". The commander either did not hear him or did not hear him correctly and instead called for the co-pilot to land the aircraft. As a result, the co-pilot closed the thrust levers that he had begun to open, and the aircraft again touched down about 20° nose left of the runway direction. The co-pilot did not have full right rudder applied and as a result the aircraft diverged from the centre of the runway in the strong crosswind. The commander called for a go-around which the co-pilot acknowledged. Go-around power was selected, and the go-around performed as per the SOPs.

Reversing a decision having started a go-around places an aircraft at significant risk. Applying power during the landing roll invalidates any landing performance calculation, and a breakdown of crew co-ordination can create significant confusion on the flight deck.

Whatever the reason for a go-around decision, once that decision is taken and the actions begun, it should be carried out with both crew members performing the tasks required. Should the other crew member have not heard the call or have misheard the call then it is necessary to restate the intentions immediately so that the crew have a joint and shared understanding of the actions underway.

Second approach

The second approach was flown by the commander at the request of the co-pilot. The aircraft was flared without being lined up with the runway and, after two short bounces, the aircraft touched down about 20° nose left of the runway heading. As the aircraft settled onto its landing gear and friction at the tyres increased, the aircraft began to head in the direction the wheels were pointing, which was to the left edge of the runway. This swing to the left was probably made worse by the weathercock effect of the crosswind, with insufficient right rudder applied at touchdown. The commander did not apply into-wind aileron although, as the aircraft swung left, he did apply full right rudder to steer the aircraft to the right. As the aircraft headed for the edge of the runway, the left main wheels lifted off the tarmac due to the application of full right aileron causing the aircraft to roll about the axis between nose and main tyres, and the commander could not stop the aircraft leaving the paved surface.

The application of full right aileron was almost certainly the result of an inappropriate automatic process (motor programme). Moving the steering wheel right when wanting to steer a car right and moving the control wheel to place the right aileron to full deflection are the same movements. It is likely therefore that as the commander reached his maximum ability to consciously process the inputs coming in from his senses, he subconsciously reverted to a more familiar automatic process and attempted to 'steer the car'.

The SOPs required the handover of the control column to the co-pilot at 80 kt but the aircraft had already left the paved surface by that stage.

Conclusion

Despite the challenging conditions, the crew did not discuss the conditions in any detail. They did not brief who would be holding the control column during either landing roll, or what actions they would take if they were required to abandon the approach or landing. The first approach resulted in confusion between the crew over going around which could have itself resulted in an incident or accident. The confusion was eventually overcome by the commander calling for a go-around.

The second approach resulted in a significant runway excursion due to the use of incorrect crosswind technique and the application of full right aileron. It is likely that the crew's inexperience of landing in strong crosswinds contributed to the misalignment at touchdown. It is likely this application of right aileron was as a result of an inappropriate motor programme to steer the aircraft right.

Neither attempt at landing used the crosswind technique as laid down in the manufacturer's and operator's manuals.

It was fortunate that the ground was hard due to a lack of recent rain. Except for the taxiway sign there were no other obstacles in the way of SE-MAO such as other aircraft or vehicles. As a result, despite a 450 m excursion off the runway, there was no damage to the aircraft or the airport facilities, and no injuries to the crew who were the only people on board.

Safety Action

As a result of this incident, the operator took the following safety action:

> Recurrent simulator sessions across all the operator's fleet were amended to include crosswind training.
>
> A crosswind limit would be introduced for new co-pilots during their first year of operation on type. This limit would be removed once the co-pilot had completed their first year of operations and successfully demonstrated the correct technique in their recurrent simulator.

Published: 4 March 2021.

ACCIDENT

Aircraft Type and Registration:	Rans S6-116 Coyote II, G-BUWK
No & Type of Engines:	1 Rotax 912-UL Piston engine
Year of Manufacture:	1993 (Serial no: PFA 204A-12448)
Date & Time (UTC):	4 August 2020 at 1000 hrs
Location:	Bradley's Lawn airstrip, Cross in Hand, Heathfield, East Sussex
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:	Private Pilot's Licence
Commander's Age:	65 years
Commander's Flying Experience:	6,070 hours (of which 5,800 were on type) Last 90 days - 79 hours Last 28 days - 37 hours
Information Source:	AAIB Field Investigation

Synopsis

G-BUWK, a Rans S6-116, took off from Bradley's Lawn airstrip, East Sussex. Witnesses then saw the aircraft make a spiral descent to the ground. There was a post-impact fire; the aircraft was destroyed and the pilot was found deceased. A post-mortem examination indicated that the pilot probably suffered a cardiac event resulting in incapacitation shortly after takeoff.

History of the flight

The pilot left his home at 0820 hrs on the morning of the flight, arriving at Bradley's Lawn airstrip, East Sussex at 0850 hrs. The landowner initially saw the pilot on his mobile telephone and again, at some point later, with the engine cowl of G-BUWK open (The landowner presumed this was for pre-flight checks). He chatted with the pilot for about 20 minutes during which the pilot commented that he intended to fly to Popham Airfield, Hampshire, where his partner had probably already landed. The pilot's partner had planned to fly her own aircraft to Popham from another departure airfield, meeting up airborne with the pilot prior to arrival. On the day of the accident, the pilot advised his partner by SMS that his departure was delayed, and he would fly direct to Popham and meet her there. The landowner commented that the pilot did not seem to be in a hurry.

The pilot indicated on the airstrip's 'Departures Log' that he would depart at 0950 hrs, listing Popham as his destination. About 10 minutes after the conversation, as the landowner was walking down a track behind the hangars, he heard the aircraft start up and, shortly afterwards, from a gateway abeam the windsock[1], saw the aircraft already airborne. He stated that the takeoff looked and sounded normal. Having turned away, he heard a loud bang a few moments later and looked up to see a column of black smoke and flames rising upwind of the airstrip.

Witnesses

A witness on the opposite side of the valley to the airstrip, south-east and under ½ nm away, had a clear view of the airstrip and the hangars. He saw the aircraft takeoff and stated that it was airborne by the time it passed the hangars. He considered that the takeoff looked normal and that the aircraft climbed steadily before disappearing behind trees. He then heard the engine stop and, about 15 seconds later, a large bang followed by a plume of smoke and two further bangs.

Another witness, about ¾ nm to the west, saw the aircraft come into view from the direction of the airfield and fly normally before suddenly "spinning" twice and disappearing behind some trees. A plume of smoke rose above the treeline. On seeing the smoke, the witness called the emergency services at 1001 hrs.

A third witness, at a car workshop about ¾ nm to the west of the airstrip recalled seeing an aircraft with markings and lettering similar to the accident aircraft whose engine sounded as if it was "running extremely rough". At the time he was at the entrance to the workshop looking to the west and was on a telephone call. Call logs showed the call began at 0959 hrs. He lost sight of the aircraft as he walked inside to the office, but about 30 seconds later, from the office window as he looked east, he stated that he saw the same aircraft above the treeline but that he could not hear any engine sound. The witness then described seeing the aircraft fly normally before "the tail pitch[ed] up and the right wing kick[ed] down and it seemed it was flipping over" as it disappeared below the treeline. At this point the witness hung up on the phone and shortly afterwards he saw black and heavy smoke rising.

Post-accident response

On seeing the plume of smoke, the landowner called the emergency services at 1003 hrs. He helped to direct emergency services to the scene and was joined by another pilot; both determined that they could not assist the pilot. The emergency services arrived within 10 minutes of the call.

Accident site

The accident site was in a grass field approximately 480 m south-west of the airstrip's Runway 22 threshold (Figure 1), and approximately in line with the extended runway centreline.

Footnote

[1] The windsock was between the threshold of Runway 22 and the hangars.

Figure 1
Partial ground track derived from ADS-B data

The aircraft had struck the ground in a near-vertical attitude with its wings level. The rear fuselage structure had separated from the front fuselage frame and had come to rest inverted adjacent to the right wing; the elevator and rudder control cables remained connected to the front fuselage. Deformation of the left and right wings indicated that the aircraft was rolling to the right about its longitudinal axis at the time of impact.

An intense post-impact fire destroyed most of the polyester fabric wing and fuselage coverings. All electronic equipment and instruments within the cockpit were also consumed in the fire. The fire had melted the inboard ends of the aluminium rear spars and strut braces. The steel frame of the forward fuselage was complete but severely disrupted.

Both fuel tanks, located between the inboard ends of the wing spars, had been destroyed during the accident. Deformation and flattening of the tubular leading edge spars forward of the tanks suggested that both tanks were close to being full at the time of impact. No fuel could be recovered from the aircraft after the accident.

The inboard sections of both aluminium aileron control rods had melted in the post-impact fire and the forward end of the elevator control rod had fractured as a result of the impact. Other than this damage, there was no evidence the flying controls had become disconnected before impact. It was not possible to determine the elevator trim or flap positions that were set at the time of the accident.

The carbon fibre propeller had been severely heat-damaged in the fire causing extensive delamination. One propeller blade had broken off the hub; the other had broken at the hub. There were no indications of leading edge damage on either of the blades and the location they were recovered from suggested they had little or no rotational energy[2] at impact.

The pilot was known to fly with a small gas camping stove aboard the aircraft. An exploded gas cylinder for such a stove was found in an adjacent field. The exploded casing of the aircraft's fire extinguisher was also found within the wreckage. Both probably exploded as a result of intense heating in the post-impact fire, and account for the two further bangs heard by witnesses after the accident.

Recorded information

Several avionic units were recovered from the accident site, including three tablet devices used for navigation, a Garmin GPS III Pilot, a Pilot Aware electronic conspicuity device and a Dynon Avionics D1 electronic flight instrument system. All were damaged in the post-impact fire and no data could be recovered from their internal memory.

The aircraft was fitted with a Mode S and ADS-B[3] Out transponder but was flying too low to be detected by radar. Some of the ADS-B Out broadcasts were nevertheless detected and recorded by ground stations of the Flightradar24[4] network that were in line of sight of the aircraft. The recordings covered a period of 17 seconds starting shortly after takeoff as the aircraft flew toward the south-west corner of the airstrip and ending about 200 m further on, 130 m north of the accident site. The last 12 seconds of recorded ADS-B Out broadcasts contained the aircraft's latitude and longitude, as shown in Figure 1.

Figure 2 plots the aircraft's GPS altitude (25-ft resolution), track and groundspeed from the ABS-B Out broadcasts. It shows that, shortly after takeoff, the aircraft turned right through about 25°, before turning left 9° on to a track of 237°, which was maintained at a groundspeed of 52 kt for the last seven seconds of recordings.

Footnote

2 The energy in this type of light propeller is low compared to similarly sized wooden or metal propellers, even when operating at high power.

3 Automatic dependent surveillance—broadcast (ADS–B) is a surveillance technology in which an aircraft determines its position via satellite navigation and periodically broadcasts it and other information, enabling it to be tracked. This capability is referred to as ABS-B Out. In contrast, ADS-B In refers to a suitably equipped aircraft being capable of receiving and interpreting the broadcasts from other aircraft.

4 Flightradar24 is a global flight tracking service comprising a network of over 20,000 ADS-B receivers.

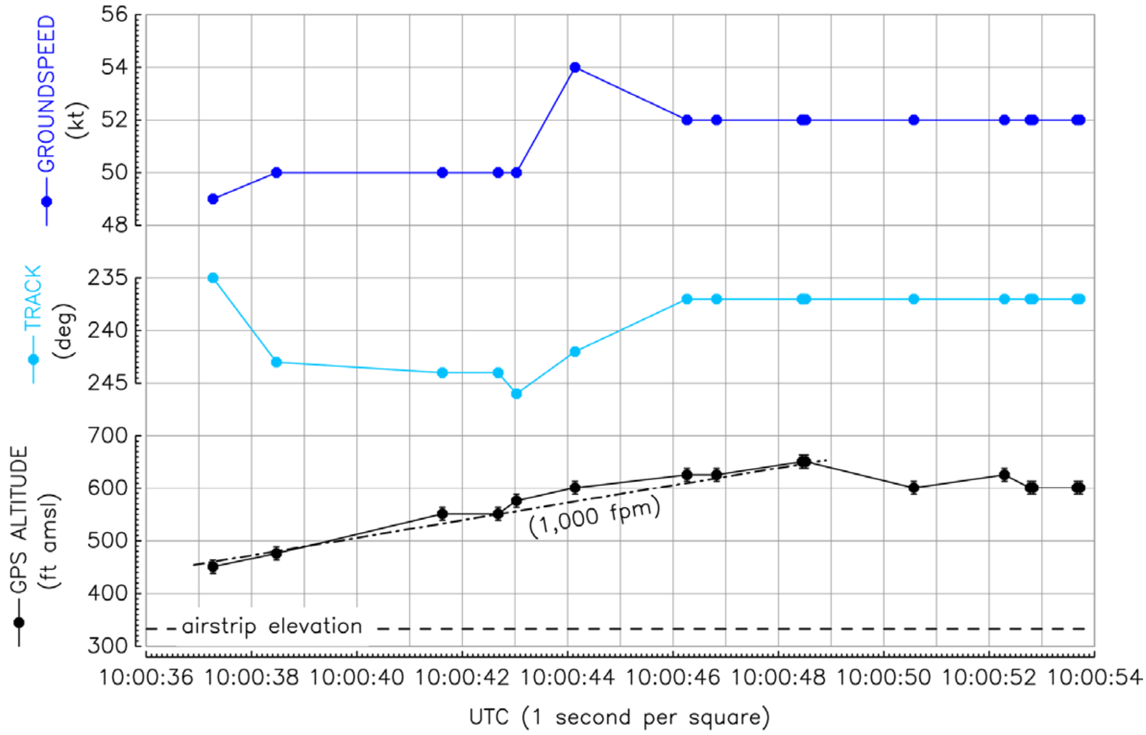


Figure 2

ADS-B Out flight data

As the aircraft passed over the south-west corner of the airstrip it was about 220 ft above the airstrip elevation and climbed a further 100 ft over the next six seconds. The climb rate of the aircraft was, on average, approximately 1,000 ft/min (consistent with normal climb performance information provided by the manufacturer for this aircraft type at a mass of 544 kg). It then descended at about 1,000 ft/min to 270 ft above the airstrip elevation before the recordings stopped. The last recorded point positioned the aircraft about 200 ft above and 130 m north of the accident site.

Aircraft information

The Rans S6-116 Coyote II is a high-wing, strut-braced aircraft with two side-by-side seats. The airframe is mainly of bolted and riveted aluminium tube construction, with the forward fuselage structure consisting of a welded tubular steel cage. The entire airframe is covered with pre-sewn polyester fabric envelopes.

G-BUWK was an ex-demonstrator aircraft, having been constructed from a kit in 1993 and bought by the pilot in October that year. The aircraft had completed 5,795 flight hours since it was built. Its Permit to Fly was valid until 3 June 2021.

It was fitted with a Rotax 912 UL four-stroke engine driving a two-bladed composite propeller via an overload clutch. The engine was installed in the aircraft in March 2012, having previously been fitted to another aircraft. Records indicated it had run for a total of 54 hours when it was installed and had achieved 2,531 operating hours at the time of the accident.

The engine logbook showed that the engine had been regularly serviced by the pilot, and was last overhauled in August 2011, before it was installed in the aircraft. The only other recorded engine removal was to complete a shock load assessment after the aircraft had been involved in an accident in October 2012.

The engine manufacturer's recommended overhaul life is 1,500 hours. This can be extended to 2,000 hours if Service Bulletin SB-912-570UL is applied. There was no record of this service bulletin in the engine logbook. As G-BUWK was operated on a Permit to Fly, the LAA did not mandate the manufacturer's service bulletin and, as detailed in LAA Technical Leaflet TL 2.23, there was no defined service life for this type of engine. Therefore, there was no requirement for the engine to have been overhauled during the 2,477 flying hours since it was installed.

The landowner and the other pilot reported that the pilot always re-fuelled the aircraft after each flight. He then re-filled the fuel containers with Mogas as he drove from or to the airfield and left them in the hangar ready to refuel the aircraft upon return. Full fuel containers were found in the aircraft hangar after the accident, indicating that the aircraft tanks were likely to have been full when the aircraft took off. However, the fuel within the containers was not representative of the fuel in the aircraft at the time of the accident, and samples were not taken.

Aircraft examination

The aircraft wreckage was recovered to the AAIB facility in Farnborough for further assessment.

The airframe structure was re-examined. No evidence of any pre-existing damage was found. All fuel lines, ducts and hoses had been consumed by the fire. The fuel selector valve was found in the *'LEFT'* position, which would have been the normal fuel tank for engine start[5].

Engine examination

Both carburettors were dislodged from the engine, but the throttle and choke cables were still attached. Both carburettor butterfly valves were in the open position. The casing around the left carburettor butterfly valve exhibited impact damage which prevented the valve from closing, suggesting the valve was in the open position at the time of impact.

All external engine accessories, including the alternator, electrical ignition system and fuel pump were damaged to the extent that their functionality could not be assessed. All spark plugs were in a good condition with no evidence of erosion or sooting.

Strip examination of the engine found no evidence of an engine malfunction.

Footnote

5 The fuel system on this engine returned fuel to the left tank whilst in operation, therefore the engine must be started on left tank to prevent over filling the tank.

Weight and balance

An assessment of the likely loading of the aircraft determined that the weight and balance would have been within the required limits.

Aircraft handling characteristics

The handling notes[6] highlight that the aircraft experiences greater speed decay rate owing to its *'lightweight nature where little kinetic energy is to be had.'* Stalls are preceded by easily distinguishable buffet. In a fully developed stall, '*the nose falls through very slightly and a high sink rate develops (approximately 1,000 to 1,500 fpm). The craft can be held wings level with the rudder.*' Flight tests[7] indicated that wing drop was no more than 15° and recovery was instantaneous on the release of back pressure.

The notes further state:

> *'If, during a deep stall (falling leaf) the pilot's feet are removed from the rudder pedals, the Coyote II will begin to dip each wing alternately until finally making a gentle spiral to the right or left. (NOTE: This is not a spin!). At this point it could be argued that it is spinning. However, rotation is not through the plane's center mass. Instead, it is as if it were riding down the sides of a vertical cylinder…. To further support this, the spin properties are very conventional. Entry requires full deflection of elevator and rudder and must be held in full deflection.'*
>
> *'The spin's rotation is approximately 80 degrees nose down with rotation through the center mass, almost through the aircraft centreline…. Rotation speed is 3 seconds per turn…. Sink rates average 1,500 to 2000 fpm, with 200 to 400 feet lost per turn depending on density altitude.'*
>
> *'This spiral and spin difference is easily recognized as well as controlled. Stall and spin testing in all configurations has been done with no unusual characteristics revealed.'*

Meteorology

The actual weather reports at Gatwick Airport recorded minimal cloud coverage at medium level, otherwise the sky was clear with good visibility and light south-westerly winds. Other airfields in the southeast of England reported very similar conditions. Witness statements suggest the wind may have been variable around the time of the accident.

Footnote

6 There is no generic Pilot's Operating Handbook for this aircraft type. The handling notes for each aircraft are included in the Technical Build manual.

7 These were flight tests conducted on two other Rans S6-116 by the Light Aircraft Association (LAA). The aircraft in their configuration including the same engine, and weight and balance, were representative.

Airfield information

Bradley's Lawn is a grass airstrip situated on fields surrounded by high trees (Figure 3). Its runway is aligned north-east / south-west; the flight path on departure from Runway 22 is over fields with gently rising ground. A TV aerial 489 ft in height (1,007 ft amsl) is situated just under 1 nm to the southwest from the airstrip.

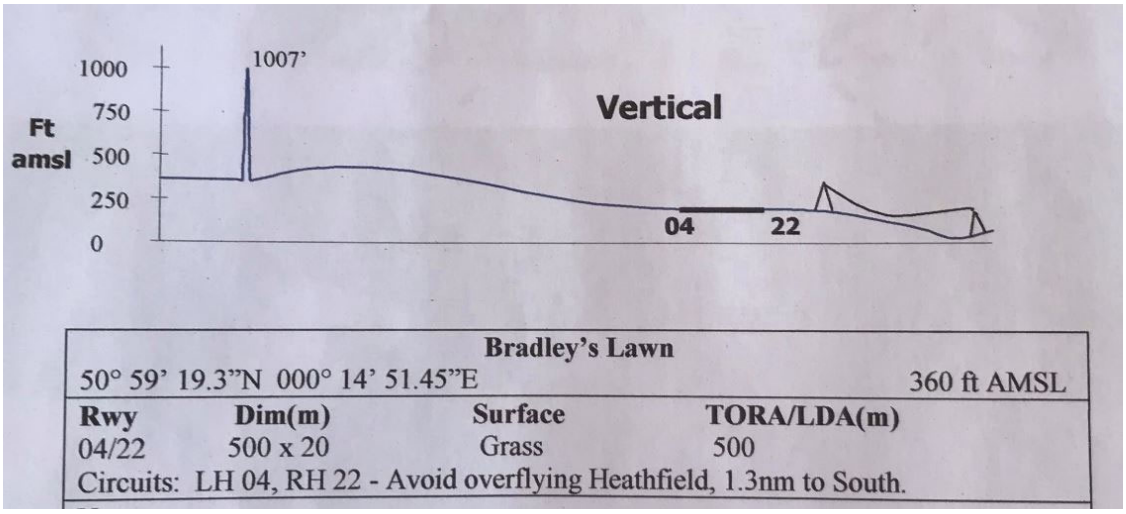


Figure 3
Bradley's Lawn airstrip

Personnel

The pilot held an EASA PPL (A) with a current Single Engine Piston (Land) rating and a Class Instructor rating with Part-FCL.945 privileges. He had owned G-BUWK since 1993, soon after he had gained his licence, and gained the most of his flying experience on it.

Medical information

The pilot held an EASA Class 2 medical valid until March 2021. He suffered from hypertension and had been diagnosed with a cardiac condition. The post-mortem examination found no soot in the airways or upper digestive tract and, despite extensive injuries, there was no adjacent haemorrhage. The post-mortem examination also found moderate three-vessel coronary artery atheroma.[8] The toxicology report was negative.

The pathologist concluded that the lack of soot indicated the pilot was not alive during the fire. This was corroborated by the lack of evidence of adjacent haemorrhage indicating that the pilot had no pulse or measurable blood pressure at the time that he sustained the injuries. The pathologist stated that atheroma in association with hypertension can be associated with sudden death. No acute myocardial infarctions were identified in the myocardium, a finding which is *'normal in cases of sudden death due to coronary heart disease.'*

Footnote

[8] Atheroma is the build-up of materials that can narrow an artery enough that it severely restricts blood flow.

The pathologist stated that the findings were:

> *'entirely consistent with a medical event, of likely cardiac origin occurring shortly after takeoff with unconsciousness and cardiorespiratory failure occurring prior to the crash. There is no evidence to suggest that the pilot was alive at the time of the impact or when the fire started.'*

Analysis

Witness evidence and recorded data indicate that the aircraft performance was normal during takeoff and climb. Witnesses described the loss of control in flight as sudden with a large drop of the nose followed by a rapid spiralling descent. The aircraft wreckage indicated that it struck the ground in a near-vertical nose-down attitude with right rotation.

Technical issues

The absence of leading edge strike marks on the propeller blades would normally be consistent with the engine at low power; however, as the engine was fitted with an overload clutch which protects the engine crankshaft in the event of a prop strike, the inertia of the engine would not have been transmitted through to the propeller when it struck the ground. Therefore, the lack of leading propeller damage may not indicate low engine speed on impact.

Examination of the two carburettors revealed that the butterfly valves were both open during the impact sequence, suggesting that the throttle lever was set for maximum engine power at the time. It was not possible to determine when the throttle was moved to this position.

Although the aircraft sustained extensive damage during the impact sequence and subsequent fire, there was no evidence of a pre-existing technical issue with the aircraft or engine.

Loss of control

Witnesses reported that the aircraft seemed to perform normally on departure with no indication of engine problems; this is corroborated by the recorded climb performance and aircraft speed, suggesting that the engine was producing sufficient power at least up until the point where a loss of control appears to have occurred.

Although one witness reported hearing the engine stop shortly after he lost sight of the nose-down attitude aircraft behind trees, this may have been as a result of the trees and wind masking the sound. While a separate witness reported seeing an aircraft with similar markings whose engine was running rough, it has not been possible to reconcile this sighting with the recorded data.

It was not possible to determine the exact cause for the loss of control in flight. The extent of the pilot's experience on the aircraft suggests that he should have been capable of recovering from a stall and any associated wing drop that might have resulted from a loss of performance. Therefore, an engine failure alone was not sufficient to result in such an outcome.

Witness evidence indicated that the loss of control in flight was sudden and unexpected. The phase of flight, the likely aircraft configuration and performance, and the finding of the flight test report that full control deflection was required to enter a spin, together suggest that inadvertent mishandling was unlikely to cause loss of control resulting in a spin.

The post-mortem report suggests incapacitation was likely of cardiac origin occurring shortly after takeoff, and the absence of other factors likely to have caused the loss of control indicate, it is the most probable cause of the accident.

Conclusion

G-BUWK experienced a loss of control in flight shortly after takeoff, which resulted in a steep spiral descent. The aircraft struck the ground and a post-impact fire started shortly afterwards.

Although engine failure could not be discounted, the loss of control was probably the result of the pilot suffering a cardiac event resulting in incapacitation shortly after takeoff.

Published: 4 March 2021.

Bulletin Correction

Following publication the Recorded information section of this report was amended.

The words 'capable of ADS-B In/Out,' were removed from line three of the first paragraph of this section. The paragraph now reads:

> Several avionic units were recovered from the accident site, including three tablet devices used for navigation, a Garmin GPS III Pilot, a Pilot Aware electronic conspicuity device and a Dynon Avionics D1 electronic flight instrument system. All were damaged in the post-impact fire and no data could be recovered from their internal memory.

The online version of the report was corrected on 10 March 2021.

ACCIDENT

Aircraft Type and Registration:	Scheibe Super Falke SF25E, G-KDEY	
No & Type of Engines:	1 Limbach SL 1700-EA1 piston engine	
Year of Manufacture:	1976 (Serial no: 4325)	
Date & Time (UTC):	23 March 2020 at 1651 hrs	
Location:	Aston Down Airfield, Gloucestershire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - 1 (Serious)	Passengers - N/A
Nature of Damage:	Destroyed	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	72 years	
Commander's Flying Experience:	3,446 hours (of which 344 were on type) Last 90 days - 1 hour Last 28 days - 1 hour	
Information Source:	AAIB Field Investigation	

Synopsis

The pilot of G-KDEY, was flying a series of circuits and was heading towards the airfield when the aircraft struck the ground in a field west of the airfield boundary.

The investigation found that carbon monoxide had been leaking from the exhaust and is likely to have impaired or rendered the pilot unconscious before the aircraft hit the ground.

The report highlights the EASA and CAA guidance on maintenance of piston engine exhaust systems to reduce the risk of carbon monoxide poisoning and the options available in selecting carbon monoxide detectors for General Aviation aircraft. A CAA safety leaflet and EASA report also highlights the issues associated with the use of Mogas and the increased risk of carburettor icing due to the ethanol content.

History of the flight

On the day of the accident the pilot decided to go flying in order to stay current as the weather was forecast to be good. He took 20 litres of Mogas[1], in a jerry can, which he had purchased from a local petrol station on 5 February 2020 to refuel the aircraft.

Upon arrival at Aston Down airfield he met, by chance, the other member of the aircraft's syndicate and told him that he planned to do a local flight and practice some visual circuits

Footnote

[1] Mogas (Motor Gasoline) is automotive fuel suitable for use in some piston-engine aircraft.

for about an hour. They prepared the aircraft together, which included putting the Mogas into the aircraft's fuel tank. While the pilot could not recall what the fuel quantity was before the Mogas was added, the syndicate member noted that the aircraft's electric fuel gauge indicated 5 litres before the 20 litres was added. The pilot commented that 20 litres of fuel would have given about 90 minutes endurance.

Prior to departure the pilot recalled checking NOTAMs on the flight navigation software on his portable electronic device (PED) and completing the external and internal pre-flight inspection, with the syndicate member assisting. Once onboard the pilot placed the PED on the passenger's seat and started the aircraft. He remembers taking off into wind but not what runway he used or whether he used a grass or concrete runway. The syndicate member watched the takeoff at about 1530 hrs from Runway 21, a hard runway, and recalls the pilot planned to land on Runway 09.

The pilot's only recollection of the flight was leaving the circuit in a northerly direction for a period of time, but did not go so far as to lose sight of the airfield, before returning to the airfield to fly some visual circuits. At about 1635 to 1640 hrs, a witness located about 1 nm north of the airfield saw the aircraft downwind in the visual circuit and commented that there appeared nothing untoward with the aircraft. The pilot's next recollection was regaining consciousness at a very low altitude but too late to recover the aircraft before it struck the ground; he then lost consciousness.

Just before the accident another witness, located about 500 m north-north-west of the accident site, observed the aircraft on approach to Runway 09 at Aston Down airfield before she lost sight of it behind some trees. She then heard a loud bang and, assuming the aircraft had crashed, dialled the emergency services who dispatched ambulances and police to the scene. Meanwhile the witness walked for about 20 minutes toward the location of the aircraft where she found the crashed aircraft in a field with the pilot seriously injured. She made him comfortable, provided some first aid and called the emergency services with an update.

The pilot's next recollection was him being tended to by the witness. Police, RFFS vehicles and ambulances started arriving at the scene 37 minutes after the accident. Due to the limited access to the scene and the pilot's injuries, an air ambulance also attended. The pilot was subsequently taken to hospital in the air ambulance.

Recorded information

The pilot used a flight planning and navigation application on his PED. He stated that for this flight, he only used it to check for NOTAMs prior to the flight and that it was not used for navigation in-flight. Consequently there was no track of the flight available to download.

The aircraft was fitted with a Mode C transponder which was unserviceable for the accident flight. A review of radar recordings in the vicinity did not reveal any useful data on the aircraft's flight path.

Accident site

Figure 1

Location of the accident site on the western boundary of Aston Down airfield

The wreckage of G-KDEY stretched across two fields to the west of Aston Down airfield (Figure 1).

From the ground marks it was evident the aircraft was heading east towards the airfield at the time of the accident. The first impact marks were made by the right wing tip, which touched the ground three times before the leading edge of the wing hit a small bus parked along the treeline of the west field (Figure 2).

Figure 2

Ground impact marks, detached right wing and impact angle on the bus

Figure 3

Damage to the cabin roof and the angle sliced through the tree line

On striking the bus, the wing detached and landed by the bus, while the remainder of the fuselage and left wing glanced off a flat roofed cabin located to the left of, but in line with, the vehicle.

The fuselage bounced off the top right side corner of the building's roof and continued into the treeline. The left wing and fuselage sliced through the trees (Figure 3) before hitting the east field at a shallow angle.

The remaining wing detached and landed to the left of the aircraft's path. The fuselage continued sliding along the ground before finally stopping in a slightly right nose down attitude pointing towards the airfield (Figure 4). One of the propeller blades broke away from the hub between hitting the trees and the ground in the east field and the remains were found under the left wing.

The other propeller blade bent backwards and, although some of the blade broke away, it was still attached to the hub.

The propeller's spinner had large impact dents but there were no radial score marks to indicate the propeller was rotating under power when it hit the ground (Figure 5). The tail and fuselage behind the cockpit were largely intact, with minor damage to the leading edges of the fin and left tailplane.

The engine was still attached to the aircraft, but the engine bay and mounting frame had twisted anticlockwise and bent downwards to the left of the aircraft's centreline.

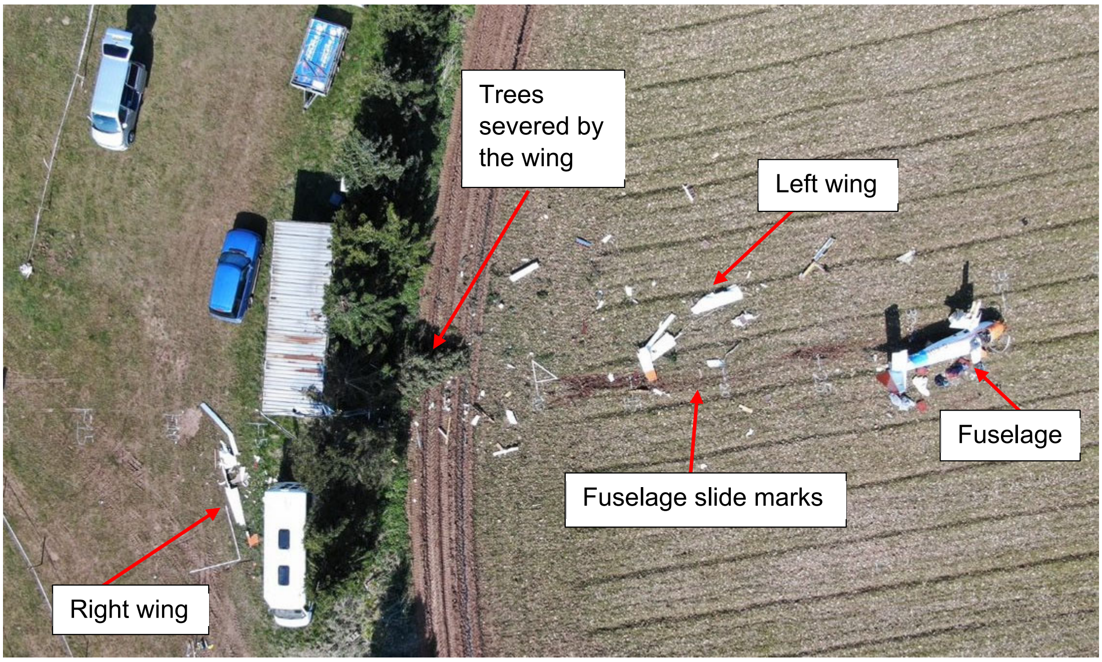


Figure 4
Overhead view of the final positions of the fuselage and wings

Figure 5
Remains of the propeller blades and the dented spinner

The fuel tank and fuel hoses behind the cockpit seats were untouched by the various impacts and the tank contained approximately 12 litres of fuel.

The wreckage was removed and transported to the AAIB's facilities for further examination.

Aircraft information

The Scheibe Super Falke SF25E is a touring motor glider designed to take off under its own power using an integrally mounted, non-retractable engine and propeller. It has a monowheel landing gear, tailwheel and fixed outriggers. The cockpit has two seats side by side and dual controls. The fuselage is constructed of tubular steel frames with a fabric covering whilst the wings are made from wooden box spars and plywood.

G-KDEY was built in 1976 and was powered by a Limbach SL 1700-EA1 four-cylinder, four-stroke, horizontally opposed, air-cooled engine. Equipped with a single magneto ignition system, single carburettor and wet sump lubrication system, the engine produced 50 kW (67 hp) at 3,600 rpm. The engine was replaced in 2009 and had operated for a total of 424 hours since installation.

The aircraft was fitted with a Hoffmann HO-V62R, twin bladed, lightweight propeller with a mechanical pitch change device. The pitch change device had three settings - takeoff, cruise and feathering.

A new BGA Airworthiness Review Certificate (ARC) was issued on 2 January 2020 following a combined annual maintenance and BGA inspection. During the annual maintenance, the propeller was removed for overhaul and the aircraft was flown twice, in February and March 2020, using a loaned propeller. The overhauled propeller was refitted on 7 March 2020 and the aircraft flew twice more without incident. The aircraft had flown a total of 1,768 hours since it was built.

Exhaust System

The exhaust consists of a silencer positioned directly under the engine and connected to each of the engine's four exhaust ports by down pipes. Exhaust gasses pass from the piston combustion chambers, through the down pipes to the silencer and are vented rearwards to atmosphere underneath the aircraft by a tail pipe. To make use of the heat from the exhaust, a heat exchanger is fitted around the silencer. Atmospheric air from the front of the engine cowling passes into the heat exchanger and is warmed by the silencer (Figure 6).

A flexible pipe from the heat exchanger is routed to the cockpit via a simple flap valve. To provide warm air, the pilot pulls the cabin heat handle in the cockpit which is attached to the valve by a Bowden cable. A second heat exchanger is fitted to the No 3 cylinder's down pipe to produce warm air for the carburettor. A flexible pipe is connected between the heat exchanger and valve attached to the carburettor to help prevent carburettor icing. The carburettor heat valve is also operated via a cockpit handle connected by a Bowden cable.

Aircraft examination

Airframe and flying controls

Continuity checks of the flying controls confirmed that they were connected and functioning correctly. Any damage found to the controls, connecting rods and cables was consistent with the various ground impacts and separation of the wings from the fuselage during the accident sequence.

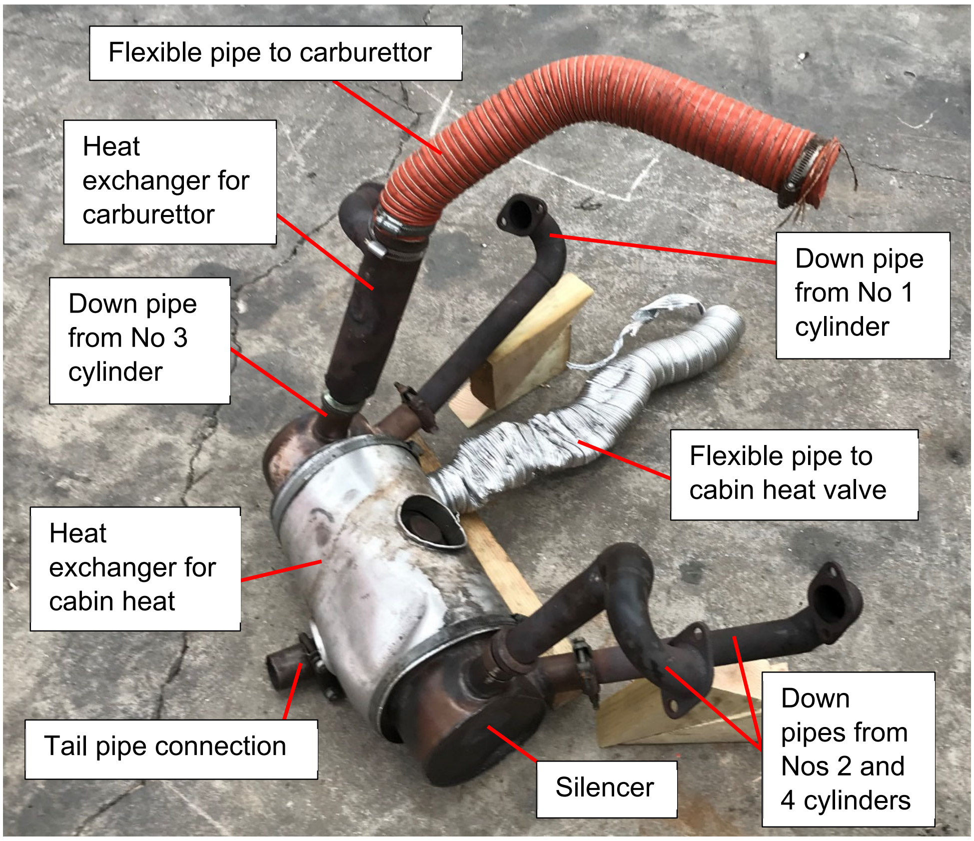


Figure 6
G-KDEY exhaust system

Aircraft examination

Airframe and flying controls

Continuity checks of the flying controls confirmed that they were connected and functioning correctly. Any damage found to the controls, connecting rods and cables was consistent with the various ground impacts and separation of the wings from the fuselage during the accident sequence.

Cockpit controls

The engine throttle handle was fully depressed and locked in place indicating full throttle was selected. The positions of the engine choke, cabin heater and carburettor heater handles showed that none of these functions were selected, although they may have been disturbed during the accident. The propeller feathering handle was pushed in and had jammed in place when the shaft bent during the accident. Whilst the fuel cock was OFF, the police accident report confirms the RFFS selected it OFF when they arrived at the scene. The magneto and battery switches were found selected ON.

Propeller

When the remainder of the propeller blades were rotated in the hub, one of the blades rotated by approximately 10° independently of the other and without engaging the pitch mechanism. Examination of the propeller by the manufacturer, Hoffmann GmbH & Co, found a number of anomalies but none of them were contributory to the accident. The examination report concluded that as far as could be ascertained from the evidence, the propeller had been fully functional. It is likely the excessive play in pitch rotation was caused by the impact with the trees or ground during the accident.

Engine

An external examination of the engine revealed the right rocker cover and securing clip had detached but were undamaged. The left rocker cover was still fitted and was also undamaged.

When the rocker valve clearances were checked against the manufacturer's recommended setting of 0.2 mm, they measured between 0.1 and 0.2 mm. Records show that they were set to 0.1 mm in December 2019.

After removing the spark plugs, visual examination revealed some build-up of carbon on their contacts. Helical coils had been fitted to the spark plug holes to prevent the steel plugs from damaging the alloy threads when inserted. On turning the propeller with the spark plugs removed, the engine crankshaft rotated without difficulty revealing that the engine had not seized.

When the cylinder heads were unbolted from the crankcase, thin layers of black combustion deposits were found covering the piston crowns, combustion chambers and valve heads. There were signs of staining between Nos 3 and 4 cylinder heads and their respective cylinders (Figure 7). Records show that cylinder pressures were only 10% below their maximum when they were tested in December 2019.

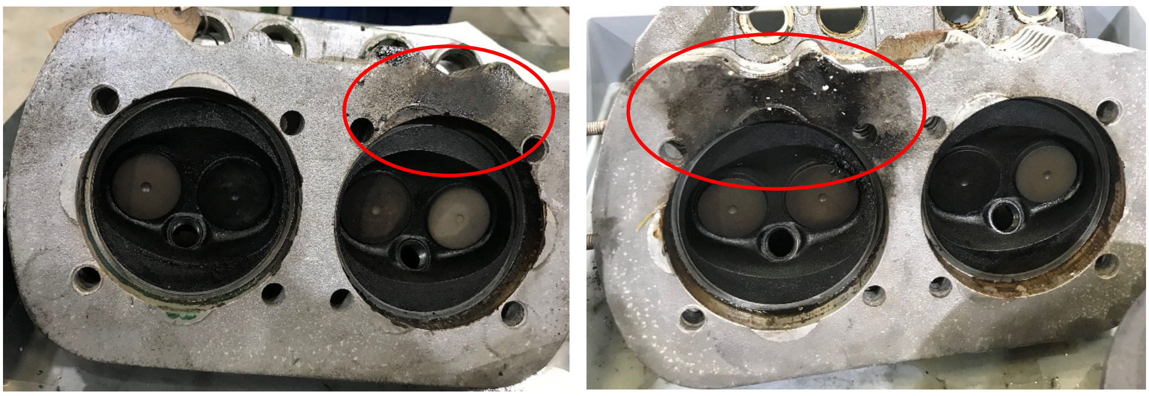


Figure 7

No 3 and 4 cylinder heads showing signs of staining

The engine manufacturer stated that the staining visible on the cylinder heads was condensation mixed with soot and may contain traces of fuel and oil. On engines that have been overheated, a slight deformation of the cylinders and cylinder heads occurs as operating time increases. For the Limbach 1700 engine, deformation only occurs at the cylinder head and the cylinders are made of grey cast iron. This means that during cold start, gases can be pushed through the seal between the cylinder and head. However, when these components are heated they become tightly sealed. The components of an air-cooled motor reach the operating temperature very quickly, so the sealing process is completed during engine warm-up.

If exhaust gases were able to flow through the seal during high loads, there would have been an immediate melting of the affected parts at the site of the leak. Under partial load, the exhaust gases reach a temperature of 900°C and aluminum alloys melt at approximately 650°C. A leaking exhaust gas stream would act like a cutting torch and quickly burn through the cylinder head at the sealing surface.

Some minor evidence of corrosion was found on the crankshaft, but the damage was localised and not widespread. The crankshaft bearings, piston connecting rods and bearings, although worn, were still in place and rotated freely. The oil pump was visually inspected and appeared to be undamaged. There was little debris in the sump filter screen and there was oil in the sump.

Consultation with a Limbach engine specialist indicated that although the engine had been running with a rich fuel mixture, it was in good condition for its age.

Ignition System

While the ignition system was being removed from the engine, the castellated nut and washer holding the magneto's impulse coupling onto the drive shaft was found to be held on only by the last few threads of the shaft. The split-pin that should have prevented the nut and washer from unwinding was found in the engine's magneto housing with one leg bent and the other leg broken in half (Figure 8). The magneto had been overhauled in 2017.

The ignition harness, magneto and spark plugs were removed and rebuilt on a bench and their operation checked; no anomalies were found.

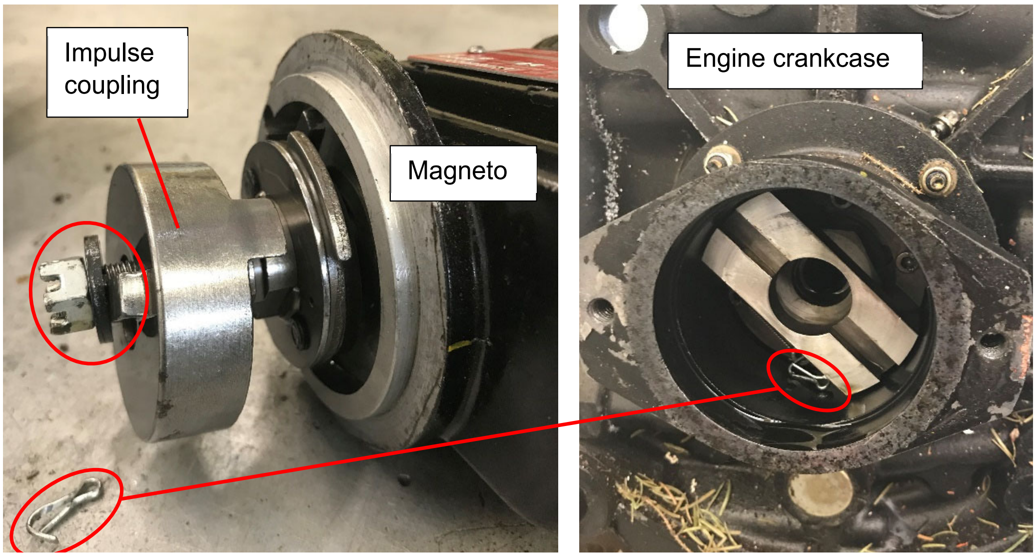


Figure 8

Magneto impulse coupling, nut, washer, split-pin and engine magneto housing

Fuel System

The fuel supply was intact between the fuel tank, fuel pump and carburettor. When inspected, the fuel lines, gascolator, fuel pump and carburettor all contained fuel.

A fuel sample was taken from the fuel tank and checked for the presence of debris, water contamination, fungal growth and clarity. No anomalies were found. Using a water extraction method[2] the sample's ethanol content was measured at approximately 3.8%, within the 5% allowable for UK E5 graded fuels.

The fuel pump was removed and its operation confirmed. The pump was dismantled for visual inspection of the filter screen, diaphragm and internal chambers and no anomalies were found.

The carburettor was also removed, dismantled and all parts visually inspected. No faults were found with any of the internal components or chambers and the fuel jets were clear of any debris.

Fuel octane rating

The Limbach L1700 engine series operating and maintenance manual[3] specifies that only Super Plus 98 fuel (according to DIN EN 228), unleaded fuels with a minimum octane rating of 98 Research Octane Number (RON) or Avgas 100LL are approved for use in this engine type. The manual cautions against the use of other fuels not approved by the manufacturer.

The use of lower octane rated fuel, such as 95 RON, in older piston engines can cause early ignition where one or more pockets of air/fuel mixture detonate outside the normal combustion front created by the spark plug and cause 'knocking.' Severe knocking can lead to catastrophic engine failure where holes are melted through the piston or cylinder head. Modern vehicle engine management systems (EMS) compensate for octane differences to avoid knocking, but older engines do not have an EMS. There was no evidence of knocking present in the pistons or combustion chambers.

Ethanol in Mogas

Mogas has a higher vapour pressure when compared to AVGAS and the addition of ethanol only increases this vapour pressure. The relatively slow fuel rate supplied to the carburettors via various pipes and pumps, which can add heat to the fuel, increases the risk of spontanous generation of vapour bubbles. High ambient temperatures and low ambient pressures further increases the risk of vapour lock. The weather conditions at the time of the accident were unlikely to have caused this problem.

Footnote

2 LAA TL2.26 '*Procedures for use of E5 unleaded Mogas to EN228*'. Available at http://www.lightaircraftassociation.co.uk/engineering/TechnicalLeaflets/Operating%20An%20Aircraft/TL%202.26%20Procedure%20for%20using%20E5%20Unleaded%20Mogas.pdf [accessed October 2020].

3 Limbach Flugmotoren '*L1700 engine for Powered Gliders and Very Light Aircraft Operating and Maintenance Manual*', edition 1 March 2016. Available at http://www.limflug.de/en/support/downloads.php?type=operatingAndMaintenanceManuals&id=L1700-all-operatingAndMaintenanceManual-en.pdf&action=download [accessed October 2020].

Ethanol has a strong affinity for water causing the fuel-ethanol-water mixture to slowly degrade rubber and plastic parts of carburettors and composite fuel tanks. Particles in the carburettor bowl can clog the jets resulting in poor engine performance. There was no evidence of particles in the carburettor, fuel tank or fuel system and the carburettor jets were clear of blockages.

Ambient temperature and humidity in combination with an ethanol fuel mixture can cause a higher enthalpy of vapourisation leading to an increased risk of carburettor icing. The combination of fuel vaporisation and pressure drop can cause a reduction in temperature of over 30°C. As the temperature falls below freezing, water vapour will form ice on the throttle valve and the internal surfaces of the venturi chamber, restricting air and fuel flow to the engine. With the aircraft engine throttle closed, during descent for example, there is a large pressure drop in the carburettor which can cause a rapid build up of ice. Because the throttle is closed, the restriction of fuel and air flow can go unnoticed. In addition, when power is removed, the exhaust temperature decreases and reduces the temperature of the warm air available from the exhaust heat exchanger for carburettor heating.

Exhaust System

Large dents were evident in the exhaust's silencer box caused by the ground impact. As the silencer is fitted below the engine, it bore some of the weight of the engine and the fuselage when it slid along the ground. The tail pipe partially fractured along a weld around the diameter of the pipe where corrosion had thinned the material. The remainder of the pipe bent around the lower structure of the engine bay and had to be cut off to allow the engine to be removed.

On dismantling the remaining exhaust system, the down pipes from No 1 and 2 cylinders were easily removed by hand from the silencer despite their securing clamps and sealing rings remaining in place. Visual examination revealed the ends of both pipes had corroded and fractured completely around their diameter. The detached ends of the pipes were still fitted in the silencer. The jagged edge of No 1 cylinder's down pipe had bent inwards as the pipe was pushed further into the silencer during the accident (Figure 9). The two exhaust down pipes from No 3 and 4 cylinders were removed and visually inspected but only minor surface corrosion was evident.

Forensic analysis found that although the exhaust down pipe from No 2 cylinder was corroded and the wall thickness had reduced, it had fractured during ground impact. The down pipe from No 1 cylinder was severely corroded and forensic analysis found that it had already failed some time before the accident. Both the pipe and its sealing ring showed traces of exhaust gas leakage. The evidence was very difficult to detect visually with the exhaust still fitted to the engine and in the engine bay. The signs of leakage were not easily descernable even with the system dismantled and required forensic examination to confirm that leaks had occured.

Figure 9

No 1 and 2 cylinders' exhaust down pipes and silencer pipes showing failures

Whilst the partial failure of the exhaust tail pipe at the weld was due to ground impact, there was evidence that gas leakage had also occurred at the connection of the tail pipe to the silencer. The tail pipe had three, 3 cm cuts along the length of the pipe from the end to enable it to expand to fit over the silencer connection. A clamp was placed over the cut end of the pipe to secure it in place. As the pipe had not been fully pushed over the connection, the cuts were not completely blanked by the silencer pipe, which allowed gas to escape when the engine was running (Figure 10). The aircraft manufacturer stated that the tail pipe fitted was not an approved design.

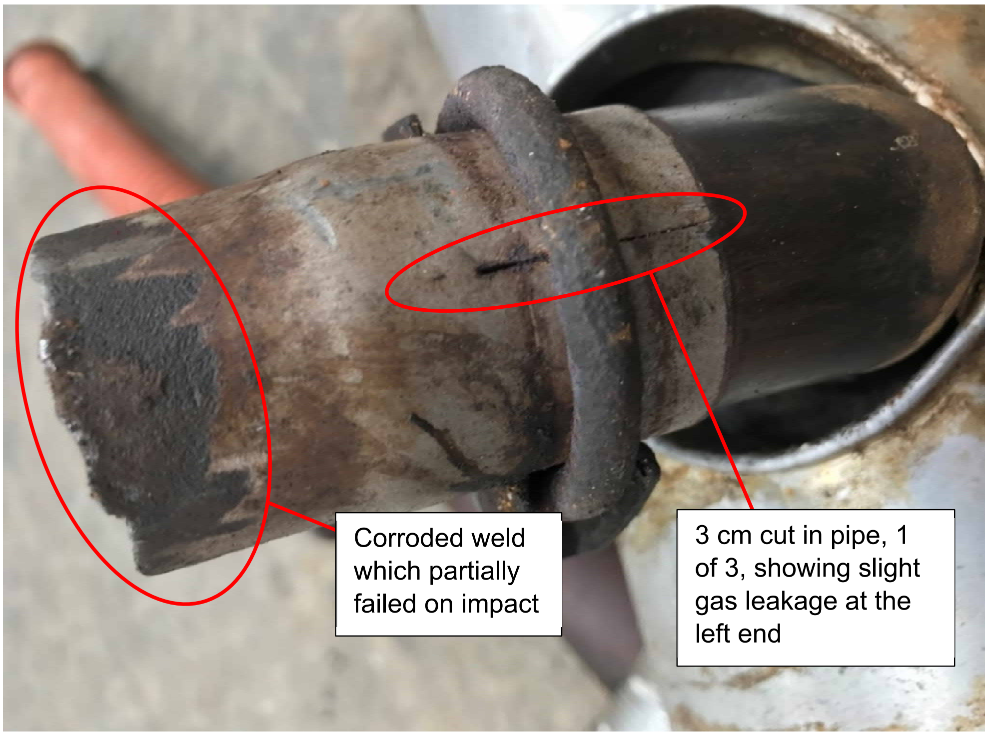


Figure 10

Partially fractured tail pipe attached to the silencer

EASA Safety Information Bulletin 2010-19[4] (EASA SIB 2010-19) was issued following reports of numerous events resulting from failed exhaust system components on piston engine aircraft and helicopters. In most cases, the causes of the events were CO poisoning, partial or complete loss of engine power, fire or a combination of these. Standard maintenance manuals or procedures do not always contain adequate inspection procedures for exhaust systems. The bulletin stresses the importance of properly inspecting and maintaining exhaust system components to reduce the hazards associated with their failure.

Engine bay firewall

During engine removal, it was evident that the seals and grommets used in the engine firewall to protect the cockpit from engine bay gasses had deteriorated and perished. It was likely that gasses in the engine compartment could flow into the cockpit through the firewall (Figure 11).

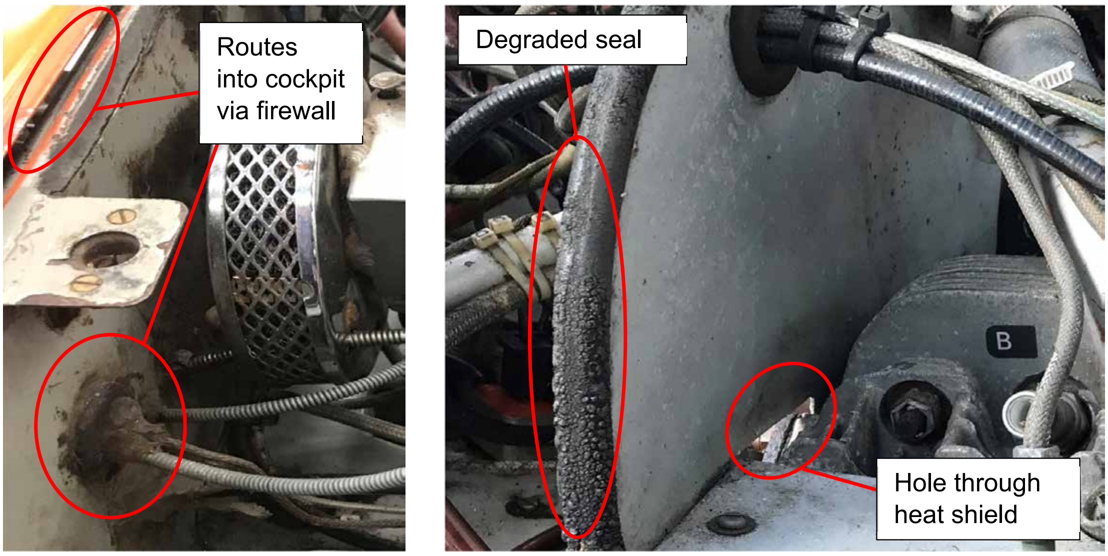


Figure 11

Exhaust gas routes into the cockpit through bulkheads and firewalls

Survivability

The pilot used a four-point harness which was found to be in good condition with no cuts or degradation of the fabric. The seat buckle was undamaged. The four parts of the harness remained in place with no disruption or bending of the anchor points.

The tubular frame structure of the fuselage intruded into the cockpit space on the right side where it had been damaged when the right wing detached or the fuselage hit the ground. The right seat was displaced to the left, partly over the edge of the right seat.

Footnote

4 https://ad.easa.europa.eu/blob/SIB_201019_Exhaust_Muffler_Inspection.pdf/SIB_2010-19_1 [accessed 2 October 2020]

Meteorology

The Met Office provided an aftercast for the period of the flight. It stated that there was high pressure over the area leading to fine settled conditions. Visibilities remained above 10 km with no cloud reported below 5,000 ft amsl with light south-easterly winds throughout the period. The syndicate member estimated that the wind was from 120° at 20 kt gusting to 30 kt.

Observations at Gloucestershire Airport, approximately 11 nm north of the accident site, at the time of the accident indicated that the wind was from 140° at 5 kt. The visibility was in excess of 10 km, the temperature was 13°C and the dew point -1°C. The atmospheric pressure was 1024 hPa. When plotted on the CAA's carburettor icing chart they indicate that there was a likelihood of serious icing with descent power (Figure 12).

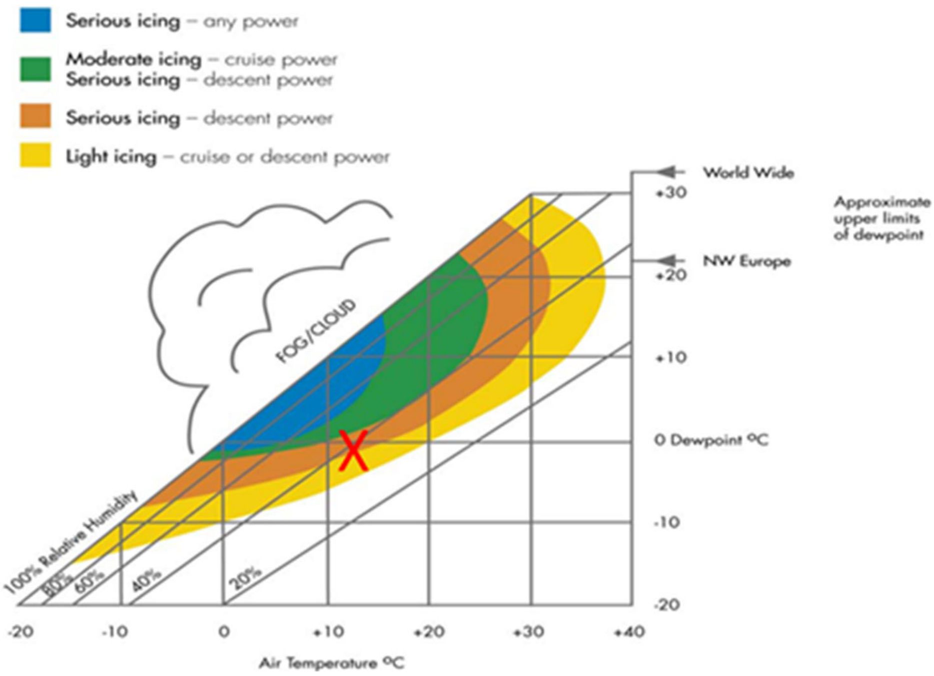


Figure 12

Carburettor Icing Chart

Symptoms of CO poisoning

The symptoms of CO poisoning are not always obvious, particularly during exposure to low-level concentrations. A tension-type headache is the most common symptom of mild CO poisoning. Other symptoms include, dizziness, feeling and being sick, tiredness and confusion, stomach pain, shortness of breath and difficulty breathing.

The symptoms of exposure to low levels of CO can be similar to those of food poisoning and flu but, unlike flu, CO poisoning does not cause a high temperature.

The longer CO is inhaled, the worse the symptoms will be, including loss of balance, vision, memory and, eventually, loss of consciousness.

Medical

The pilot suffered serious injuries in the accident including a trauma to his head. While in hospital he was not tested for carbon monoxide (CO) poisoning.

He had no underlying medical issues that would have contributed to a possible incapacitation.

CO detection

A CO spot detector was fitted to the centre of G-KDEY's instrument panel to warn the pilot if CO entered the cockpit. The detector's tan coloured spot turns black in the presence of CO. It was purchased from a non-aviation specific store in February 2020. The detector was removed and placed in front of a petrol mower exhaust to check its operation. The spot had to be held directly in the exhaust flow for 4 to 5 minutes before it started to discolour and approximately 7 minutes to turn it black (Figure 13). After an hour in fresh air, the spot reverted to its original colour.

Figure 13

Spot detector colour change when exposed to CO

Research into exhaust system failures and analysis of different CO detectors was commissioned by the FAA and a report, DOT/FAA/AR-09/49[5], was published in 2009. It expands the information contained in the EASA SIB 2010-19 and contains an evaluation of the three most common commercially available CO detector types: biometric, semiconductor and electrochemical. It concluded that electrochemical sensors appeared to be the most suitable for a General Aviation (GA) environment as they were relatively accurate with a quick response time, were inherently immune to false alarms and had low power consumption.

The AAIB investigation of the accident involving Piper PA-46-310P Malibu, N264DB, on 21 January 2019 found that the pilot was probably affected by CO poisoning[6]. As a result, the AAIB made Safety Recommendations to the EASA, FAA and CAA recommending that they require piston engine aircraft to have an active CO detector fitted. In response to

Footnote

[5] US Department of Transportation *Detection and Prevention of Carbon Monoxide Exposure in General Aviation Aircraft,* October 2009. Available at http://www.tc.faa.gov/its/worldpac/techrpt/ar0949.pdf [accessed October 2020].

[6] AAIB Aircraft Accident Report AAR1/2020, Piper PA-46-310P Malibu, N264DB, 21 January 2019, 13 March 2020. Available at https://www.gov.uk/aaib-reports/aircraft-accident-report-aar-1-2020-piper-pa-46-310p-malibu-n264db-21-january-2019 [accessed November 2020].

these recommendations, CAA Safety Notice SN-2020/003[7], published on 2 March 2020, considered measures to minimise the likelihood of CO contamination and the hazards of CO exposure, and provided guidance on the use of CO detectors in GA aircraft. The safety notice highlighted spot detectors' '*lack of attention-getting capability'*. Active detectors have the advantage of '*actively engaging the occupant's attention'* and can be set to detect low CO saturation levels of 35 parts per million (ppm) or above. The EASA, the FAA and the CAA are currently reviewing the regulatory requirements for the carriage of CO detectors.

Additionally, the Australian Transport Safety Bureau (ATSB) investigation of the accident involving a de Havilland Canada DHC-2 Beaver floatplane, VH-NOO, on 31 December 2017, also found that the pilot and some passengers were also probably affected by CO poisoning[8]. As a result The ATSB have recommended that the Civil Aviation Safety Authority of Australia takes further safety action to enable it to consider mandating the carriage of CO detectors in piston-engine aircraft, particularly passenger-carrying operations.

Pilot's comments

The pilot was interviewed by the AAIB six weeks after the accident, but did not recal detail of the accident flight.

He stated that he was aware of the possibility of carburettor icing and added that he used carburettor heat habitually throughout a flight, including during the final approach.

The pilot added that, given the conditions on the day, he was unlikely to have used the cabin heater. Also, as he mainly flew gliders, he probably would not have checked the aircraft's CO detector in flight. The syndicate member commented that he had not noticed the CO spot detector change colour before.

The pilot was also aware of the increased possibility of fuel vapour lock when using Mogas, but had never experienced it. He was not aware of any flight manual limitations on types of fuel that may make the engine susceptible to vapour lock. He has always used Mogas, sourced from a local automotive fuel garage, in the aircraft. There was no Avgas 100LL available at Aston Down airfield.

Analysis

The flight

The aircraft was observed by a witness while downwind in the visual circuit, about 10-15 minutes before the accident, and appeared to be operating normally. This was likely to have been a circuit prior to the one in which the accident happened.

Footnote

7 Safety Notice SN-2020/003 – '*Carbon Monoxide Contamination & Detection in General Aviation Aircraft'*, published by the CAA. Available at https://publicapps.caa.co.uk/modalapplication.aspx?catid=1&pagetype=65&appid=11&mode=detail&id=9442 [Accessed December 2020].

8 ATSB Investigation number AO-2017-118, de Havilland Canada DHC-2 Beaver aircraft, VH-NOO, 31 December 2017. Available at https://www.atsb.gov.au/publications/investigation_reports/2017/aair/ao-2017-118/ [accessed February 2021].

The pilot stated that he remembered regaining consciousness just before impact. While it is not known if or when he became incapacitated it was probably only for a short time. Had he become incapacitated on the downwind leg the aircraft would have continued downwind before either he regained consciousness, or it descended and struck. Had he become incapacitated during the turn onto the final approach the aircraft is likely to have continued turning and descending before either he regained consciousness or it struck the ground.

Engine power

Examination of the engine, the propeller and the spinner indicated that the engine was not producing power when the aircraft struck the ground. However, the remains of branches were lodged in the engine bay and propeller from the trees that were damaged in the tree line between the east and west fields. It is likely the engine stopped when the propeller sliced through the trees, causing one blade to separate near the root and land in the east field, while the other was bent backwards but remained attached to the hub.

Magneto coupling

The magneto impulse coupling securing-nut and washer were found partially unwound but still on the shaft, and the split pin not fitted. It is likely the nut and washer would have unwound completely in time, although the magneto's impulse coupling would not have disconnected from the magneto. This did not contribute to the accident.

Engine condition

Despite the anomalies found with the engine, there was no evidence of a mechanical failure of the engine immediately before the accident.

Avgas, Mogas and carburettor icing

Avgas 100LL, the most commonly used aviation fuel for piston engines, has an octane rating of 100 and contains no added ethanol, making it suitable for the Limbach L1700 engine. However, Avgas costs more and its lead additive has an adverse environmental impact, and the aviation industry is working to phase it out. There are unleaded versions of Avgas 100LL, such as UL94, but they are not direct replacements. Some have a lower octane rating making them suitable only for lower octane-rated engines. To date, a direct replacement has not been approved for all aviation piston engines and Avgas 100LL continues to be used.

As Mogas is a popular choice for GA users due to its lower cost and wide availability, several engines have been designed to use this fuel and some older engines have been successfully converted. For some of those approved and converted to use Mogas, manufacturers such as Limbach will state the grade of fuel that should be used – for example 98 RON – in order to maintain the engine's performance and prevent damage.

The use of Mogas can cause a number of issues including increased risk of vapour lock and clogging of fuel filters with particles. One of the main issues highlighted by EASA report EASA.2008.C51, '*Safety implication of Biofuels in aviation',* published by EASA[9] is '*carburettor icing due to raised enthalpy of evaporation for ethanol-admixed gasolines if there is no additional heat input into the intake air'*. Safety Sense Leaflet 14 – '*Piston engine icing'* published by the CAA[10] also discusses the problem of carburettor icing, explains how to recognise the symptoms and provides procedural advice to pilots on how to avoid the problem.

There are plans to increase the ethanol content of UK Mogas up to 10% (E10) for environmental reasons in 2021. The EASA.2008.C51 report highlights that fuel related problems in aviation piston engines are likely to increase with the planned introduction of E10 fuels, particularly for older engine types.

The pilot stated that he was aware of carburettor icing. He added that he used carburettor heat habitually throughout a flight, including during the final approach. The carburettor heat control handle was found in the off position during the aircraft examination, although it is possible it moved during the accident sequence.

Increased levels of ethanol in Mogas increases the risk of carburettor icing. Given the weather conditions on the day, partial or complete engine failure due to carburettor icing could not be ruled out.

Carbon monoxide

There were no reported underlying medical issues that may have caused the pilot to become incapacitated and he has no memory of the flight until moments before the accident. The results of forensic examination showed that it is highly likely CO was present in the engine bay during the flight. CO could have leaked into the cockpit via the degraded firewall seals and grommets. Although leakage may have been minimal, the effects of CO are cumulative and would have built up over the duration of the flight. The pilot and the BGA inspector commented that the canopy was not sealed and leaked fresh air into the cockpit from around it's structure reducing the risk of CO poisoning.

The pressure test results from the annual maintenance in December 2019 were well within the 33% pressure reduction limit in the Limbach L1700 engine operating and maintenance manual and would not have given cause for concern.

Even if the colour of the CO detector spot attached to the instrument panel had changed, the pilot may not have noticed unless he specifically looked at the spot. By that time, he would already be suffering the effects of CO poisoning. At the low saturation levels (<50 ppm) stated in DOT/FAA/AR-09/49, the spot may not have changed colour at all or changed so slowly that it would be barely noticeable. Concentrations would have to rise significantly above low levels before a colour change would be noticed and it is likely the

Footnote

9 https://www.easa.europa.eu/sites/default/files/dfu/Final_Report_EASA.2008-6-light.pdf [accessed November 2020].

10 http://publicapps.caa.co.uk/docs/33/20130121SSL14.pdf [accessed December 2020].

pilot would already be impaired. Once the activated spot detector was exposed to fresh air, it returned to its original colour and erased any record of the presence of CO in the cockpit.

CAA SN-2020/003 provides an overview of both passive and active CO detectors. The notice highlights the advantages of carrying an active detector which is designed to provide visible and audible warnings at specific CO thresholds (often 50 ppm) giving the pilot time to respond.

The inspecting BGA engineer observed that following this accident he did not consider "dark spot" detectors to be an adequate means of alerting pilots to the presence of hazardous CO levels.

Survivability

The rigid structure of the fuselage, the integrity of the pilot's four-point seat harness and the shallow angle the aircraft struck the ground probably enabled the pilot to survive this accident.

Conclusion

The investigation found evidence of exhaust system gas leakage in the engine bay and pathways by which the gas could have reached the cockpit. EASA SIB 2010-19 emphasises the need to carry out detailed inspections and maintenance of the exhaust system of piston engine powered aeroplanes.

The available evidence is consistent with the pilot having suffered CO poisoning and being incapacitated before the accident occurred. Although he reported regaining consciousness, it was not in time to prevent the accident.

The issues associated with the use of Mogas and the impact of ethanol content in fuel on carburettor icing are highlighted in CAA Safety Sense Leaflet 14 and EASA report EASA.2008.C51. The increasing popularity of Mogas, it's low price, reduced environmental impact and the future increase in ethanol content makes incidents of carburettor icing more likely. Partial or complete engine failure due to carburettor icing could not be ruled out as a contributary factor in the accident.

Published: 18 March 2021.

ACCIDENT

Aircraft Type and Registration:	SB-5E glider, G-DEJH
No & Type of Engines:	None
Year of Manufacture:	1970 (Serial no: 5041A)
Date & Time (UTC):	7 August 2019 at 1303 hrs
Location:	Summit of Cross Fell, Pennines, Cumbria
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Serious) Passengers - N/A
Nature of Damage:	Destroyed
Commander's Licence:	BGA Glider Certificate with Bronze endorsement
Commander's Age:	15 years
Commander's Flying Experience:	69 hours (of which 2 hours were on type) Last 90 days - 21 hours Last 28 days - 9 hours
Information Source:	AAIB Field Investigation

Synopsis

The 15 year old pilot, who was part of a private group visiting a gliding club near Penrith, was flying low behind the ridge at Cross Fell in the Pennines when the tail section of the glider began to oscillate rapidly before breaking away from the glider. The glider pitched nose down and was heavily disrupted when it struck the surface. The pilot was seriously injured. The cause of the failure was flutter, which was driven by the ruddervators and likely occurred when the glider was flying between the Rough Air speed limit and V_{NE}.

A number of safety actions have been taken to improve the supervision of young glider pilots, maintenance of training records and the introduction of a national syllabus for hill soaring (ridge flying).

History of the flight

The 15 year old pilot was part of a private group, who were all members of the same gliding club, visiting a gliding club located near Skelling in Cumbria. They arrived on Friday 2 August 2019, five days before the day of the accident, and during the intervening period undertook a number of check flights and were briefed on flying in the local area and along the ridges[1].

Footnote

[1] Ridge flying, which can also be referred to as hill-soaring, will be used throughout this report except where the term hill-soaring is specifically used in the documentation referred too.

On Wednesday morning (7 August 2019), the Chief Flying Instructor (CFI) briefed the pilot on the relevant NOTAMs and weather. He explained how the wind speed and direction would affect the conditions on the ridge, which would be different to what the pilot experienced on previous days. The CFI marked a copy of an Ordnance Survey Map (Figure 1) highlighting the area on the south-westerly ridges that were likely to give the best lift (solid green), and the areas the pilot should avoid (dotted green).

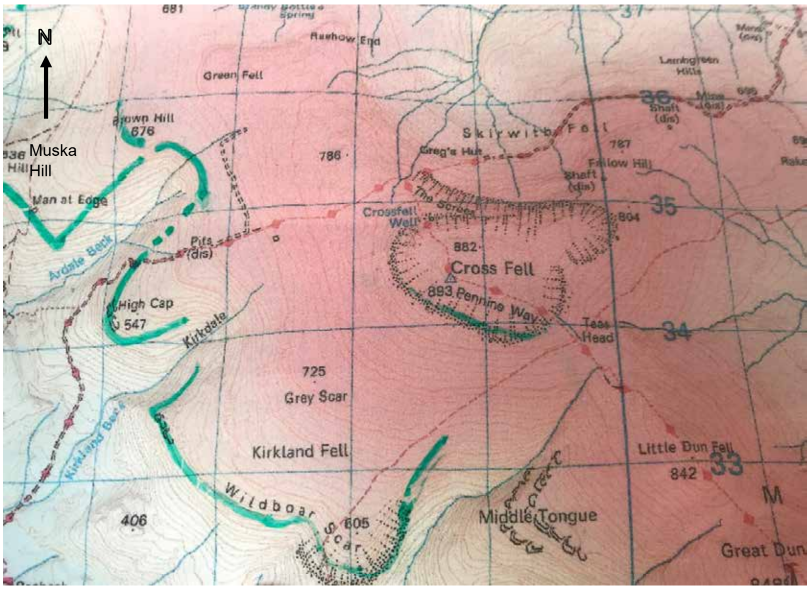


Figure 1

Ordnance Survey Map used for the briefing on the day of the accident

The pilot first launched at 1154 hrs but did not achieve sufficient height to transit to the ridge. On the second launch, at 1230 hrs, he achieved sufficient height and on the way to the ridge encountered a strong thermal which allowed him to reach a height of approximately 3,000 ft. Witnesses at the launch site reported that the glider was initially sighted along the lower ridge near Wildboar Scar. Pilots in a glider airborne at the same time reported seeing the glider between Muska Hill and Kirkland Fell.

Two walkers, who were beside the stone shelter near the trig point at the summit of Cross Fell, (Figure 3) reported that there was a "really strong wind" across the valley from the west. They saw a glider climbing to the west of the ridge before later seeing the same glider fly low in a straight line behind the windward[2] edge of the ridge in a north-westerly direction. The pilot gave a wave as he passed the walkers, who could see a clear silhouette of the pilot and waved back. The walkers reported seeing the glider being "bounced up and down" during the later stages of the first pass, with one exclaiming how close the glider was as it passed. On seeing the glider turn back along the ridge and line up for a second pass, one of the walkers started a video recording of the flight; they stated that this time the glider flew slightly higher and further away at a distance of about 60 m (200 ft) (Image from video at Figure 2.) After the glider passed, the walkers saw the tail oscillate,

Footnote

[2] The walkers annotated an ordnance survey map with the gliders track which was later analysed by the AAIB.

heard a crack and the tail then separated from the glider. The glider pitched nose-down with the right wing hitting the ground first. One of the hill walkers ran to attend to the pilot, who was severely injured and unconscious, while the other walker called the emergency services.

Figure 2

Still taken from video of the second pass (Image used with permission)

Previous flights

When the group arrived on 2 August 2019, the CFI briefed them on operating from the airfield and gave an overview on the techniques to adopt when flying the ridge. He reviewed the knowledge and experience of the accident pilot, who had not flown from the airfield before, by examining his logbook and training record card, and made his initial assessment following a discussion with him.

The CFI conducted two check flights with the pilot, the first of which lasted 26 minutes and covered general handling, stalling and wing drop recovery technique. The CFI stated that he showed the pilot the ridge, while airborne, and as the ridge was "not working" explained the challenges and techniques, and the best areas to fly on the ridge; however, they did not fly along any part of the ridge. On the second winch launch, the CFI initiated a practice cable break which the pilot handled correctly. The CFI assessed the pilot as Check Level 2[3], that allowed him to fly G-DEJH which is a single seat, SB-5E glider.

On 3 August 2019, the wind conditions were still not suitable to fly the ridge. In the morning, the pilot flew a third check flight with a different instructor which lasted 4 minutes and, in the afternoon, flew G-DEJH for the first time for 29 minutes during which he soared in thermals. Later in the day he flew with another 15 year old from the same group on two short flights each lasting 5 minutes. The pilot was the commander for one of these flights.

On the morning of 4 August 2019, the conditions for flying the ridge were marginal; therefore, the pilot flew a short 17 minute flight with one of the older members of the group. In the afternoon, the weather conditions had improved, and so the pilot flew for a second time with

Footnote

[3] The club system of Check Levels is explained later in this report.

the other 15 year old who acted as commander for the flight. This 15 year old had earlier flown along the ridge with the CFI and passed on the information about the ridge that he had received from the CFI to the pilot. They mainly flew around Muska Hill, but as the wind was not strong enough they did not attempt to fly further south along the ridge towards Cross Fell.

On 5 August 2019, the pilot flew G-DEJH for 93 minutes along the whole of the ridge, including the area of Cross Fell. However, he did not fly along the summit as he only gained enough height to cross over to the north-west. Weather conditions prevented any flying from taking place on 6 August 2019.

The pilot flew the dual flights in a twin seat ASK13 glider and the solo flights in G-DEJH.

Accident site

The summit of Cross Fell (Figure 3) marks the highest point in the Pennines. The lower slope below the summit rises gently upwards towards the plateau whose western and south-western sides form a curved ridge. The ridge is a steep escarpment with a gradient at times in excess of 30%; at its steepest point the escarpment has a gradient of 40% rising approximately 40 m in height.

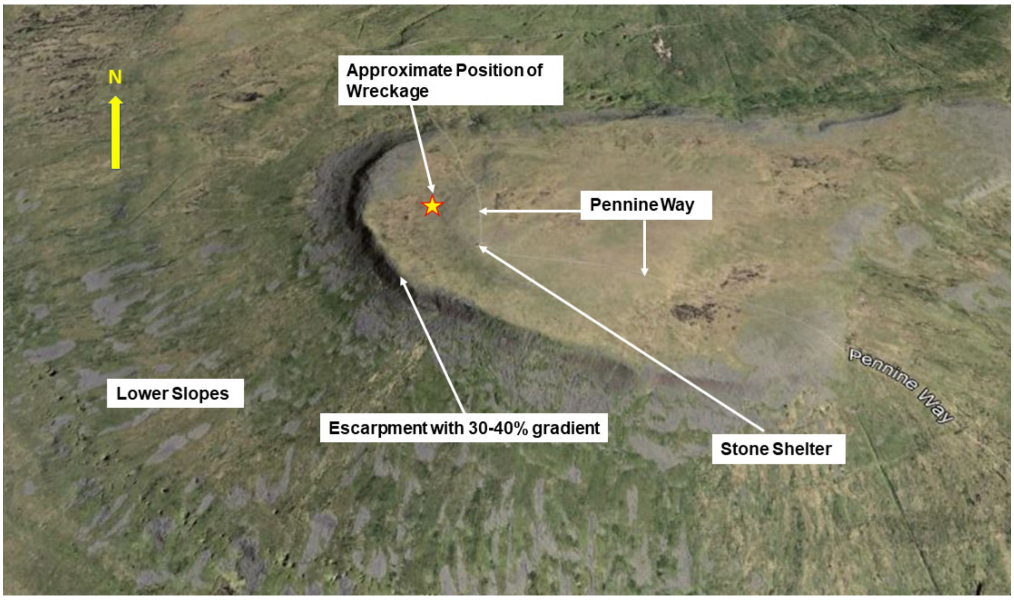


Figure 3

The plateau of Cross Fell Summit, with approximate position of wreckage (Google Earth)

The main wreckage was on an area of relatively flat ground approximately 170 m north-west of the trig point on the summit plateau of Cross Fell. This was approximately 80 m west of the Pennine Way path. The accident site was compact with the main sections of the aircraft located together. Deep impact marks were present in the ground from the nose, right wingtip and wing leading edge. However, the fuselage of the glider had largely disintegrated in the impact, and lightweight sections of plywood skin had been blown by the wind across a large area.

The nose of the glider was destroyed in the impact and sections of the plywood skin were found buried almost vertically in the ground. Little of the cockpit fuselage structure remained intact. The mid-fuselage wing box area was largely intact and lay inverted, as did the wings which were heavily disrupted, particularly the right wing. The tail boom had largely disintegrated, but the V-tail remained relatively intact and connected to the control mixing unit by the control rods, although these were significantly twisted and distorted.

The instrument panel had detached from the aircraft but remained at the point of impact. Control continuity was observed from the V-tail to the mixing unit, but the control rods from the wing and forward of the mixing unit were heavily damaged and no longer connected.

Recorded information

Mobile phone video

The Pennine Way is a popular hiking route that crosses the summit of Cross Fell, where the trig point and stone shelter are used as scenic viewpoints by walkers using the path. On the day of the accident two walkers had stopped at the stone shelter. They became aware of the glider manoeuvring at relatively low level around the hill and started to take pictures. They then used a mobile phone to film the glider as the pilot commenced the second low level pass across the summit plateau, which ended in the accident sequence. The video was a panning shot of the aircraft initially at low level to the left of the walkers' position, passing directly abeam and then continuing to their right.

Analysis using specialist video software showed that shortly after the glider passed the camera position, both surfaces of the V-tail began to oscillate laterally. When viewed frame by frame the ruddervators on each side of the V-tail were seen to lag the motion of the fixed tail structure. The oscillation continued to increase in amplitude until approximately three seconds later when the whole tail section broke away from the fuselage and continued to rotate clockwise (viewed from behind) attached only by the control rods. Immediately after the structural failure, the aircraft nose and right wingtip dropped to point at the ground and the glider fell vertically until it passed below the level of the summit and hit the ground.

The glider was not fitted with a data logging device, nor a transponder. So, no other recorded data of the flight path was available to the investigation.

Analysis of the video footage gave an estimated ground speed during the low-level pass of between 85 and 95 kt with the glider flying on a north-westerly heading. The glider was estimated to be flying at less than 100 ft over part of the ridge that the CFI had not highlighted as green on his briefing map as an area that was likely to be good for soaring.

Aircraft information

General

G-DEJH is a SB-5E single-seat, wooden glider with a distinctive V-tail (Figure 4). It was manufactured in 1970, imported to the UK in 1981 and the last logbook entry in April 2019 showed it had flown 2,261 flying hours. Following this accident only one other model of this type, an SB-5B, remained operational in the UK.

Figure 4

SB-5E glider, registration G-DEJH (Image used with permission)

Design and certification

The original model, the SB-5A, was designed by an academic flying group at a German university and the prototype first flown in 1959. The German Luftfahrt-Bundesamt (LBA)[4] certified the type in May 1964. Later models were manufactured under licence by a German manufacturer who continues to provide airworthiness support.

The design was certified to the German national regulations issued in 1939 *'Airworthiness requirements for sailplanes (BVS), books 1 to 3'* and flight tested in accordance with UK regulations *'BCAR, Section E "Gliders", Subsection E2[5]'*. The glider was not checked against other elements of BCAR Section E. When the EASA took responsibility for European Type Certificates, the SB-5E was transferred to an EASA Type Certificate; however, the technical documentation remained in the original German language format.

The SB-5E glider was available in kit form or completely assembled by the German manufacturer who is the current EASA Type Certificate holder. The BFU advised that the original academic flying group no longer held any documentation relating to the design and the manufacturer had no record of G-DEJH (serial number 5041A). It is, therefore, possible that G-DEJH was assembled from a kit.

Construction

The main fuselage, wings and V-tail structures are constructed from plywood with a plywood skin covered in a glass fibre coating. The ailerons and ruddervators (combined rudder and elevators) are plywood framed with a fabric skin. There is a small non-retractable centre wheel and metal skids on the tail and wingtips. The wings are fitted with retractable airbrakes.

Footnote

4 The Luftfahrt-Bundesamt is the national civil aviation authority in Germany.
5 BCAR Sub-section E3 covers structures and flutter prevention.

Aircraft examination

Structure

Following a review of the video of the accident, given the extent of the disruption to the airframe, the empennage structure became the focus for a detailed inspection. The recovered tail section showed evidence of tearing of the plywood fuselage skin and shear failures of the skin from the underlying frames, stringers and longerons. The control rods linking the V-tail ruddervators to the cockpit controls were twisted and distorted in a spiral manner. It was not possible to check the amount of play in the control linkages due to the extent of the damage. It was also not possible from the wreckage to assess how the aeroelastic[6] properties of the wooden structure may have changed with time, or to eliminate the possibility that there had been some pre-existing damage.

Kaurite glue

In 2006, the BGA issued a mandatory inspection (047/02/2006) relating to the use of Kaurite glue in the construction of predominantly post-war, German, wooden gliders. This required an inspection for loss of structural integrity as a result of degradation of the glue over time. Records for the 2006 annual maintenance check on G-DEJH showed that this mandatory inspection had been carried out and confirmed that Kaurite glue had not been used in the construction of the aircraft. An inspection of the wreckage did not identify any issues with the pre-impact integrity of the bonded joints on the aircraft.

Ruddervators

It was observed that the ruddervators were not mass balanced and it was found that the centre of gravity (CG) was aft of the hinge line; this was later confirmed by the manufacturer to be by design.

Air speed limitations

The ASI had been annotated with a green band around the outside of the dial, transitioning to amber at 85 kt and with a broad red line between approximately 108 kt and 110 kt (Figure 5).[7]

The limitations placard in the cockpit had a section entitled *'Speed Limitations (Knots)'* and indicated that the maximum operating speed (V_{NE}) was 108 kt and the Rough Air speed limit was 85 kt (Figure 6). The placard was dated 03/09/2016 and had been issued by a BGA Inspector.

Footnote

6 Aeroelastic analysis is concerned with the aerodynamic forces and the deformation of the structure.

7 The red line indicates the Never Exceed Speed (V_{NE}) for the glider and should not be exceeded in any circumstances. The amber section starts at the Rough Air limit and indicates the speed range which should only be flown in calm air and with caution. The green section indicates the normal operating speed range for the glider.

Figure 5

ASI from G-DEJH showing speed range markings

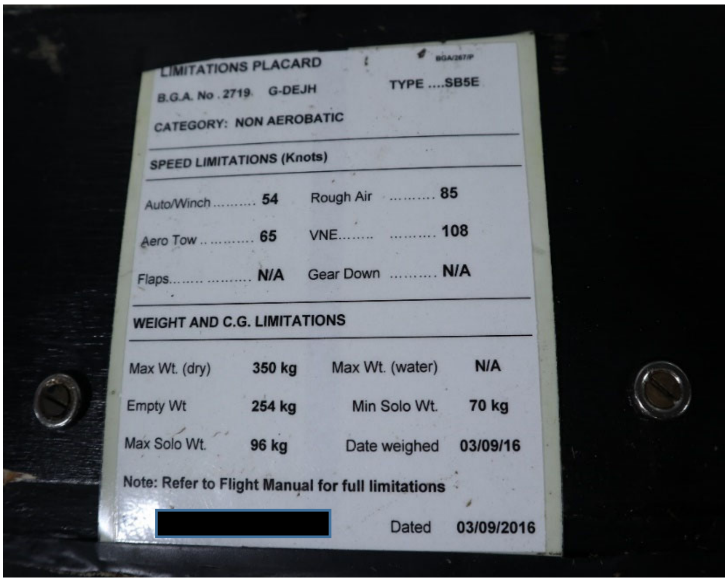


Figure 6

Cockpit placard from G-DEJH

Placarding and ASI maintenance tasks

The BGA Inspector who conducted the annual maintenance check on G-DEJH in 2016 confirmed that he reissued the limitations placard in the cockpit and had applied the green, amber and red markings on the ASI.

G-DEJH's maintenance records contained old placards dating back to 1992, which had previously been removed and these also quoted the Rough Air speed limit as 85 kt. This speed was also quoted on the Certificate of Airworthiness that was issued by the BGA when the glider was imported into the UK in 1981. This suggested that the glider had probably operated with a placard and ASI stating the Rough Air speed limit as 85 kt for most of its time in the UK. The original airworthiness documents issued for the glider included the Type Certificate Data Sheet (TCDS) and the Flight Manual. Both these documents were only available in German. The TCDS provided the operating limitations for the glider, including the maximum operating speed (V_{NE})[8] of 200 km/h and the maximum speed in strong turbulence (V_{RA})[9] of 140 km/h. Conversion of these speeds into knots gives a V_{NE} of 108 kt and V_{RA} of 75 kt. Hence the placard and ASI markings correctly reflected the certified V_{NE} limit, but indicated an incorrect V_{RA} that was 10 kt higher than the certified limit. The Flight Manual referred to the *'maximum speed in gusty weather'* rather than V_{RA} and gave a speed limit of 140 km/h.

The BGA datasheet for the glider is in English and quotes a V_{NE} of 108 kt and a Rough Air Maximum speed of 75 kt / 140 Kph. The datasheet did not use the term V_{RA}.

The incorrect placard and ASI markings were not identified when the glider was checked during the annual Airworthiness Review Certificate (ARC) renewal, which only requires the inspector to check that the '*placards are properly installed*'.

The BGA advised that they would use this accident to highlight to their inspectors in the September 2020 edition of their Technical News Sheet, the importance of always referring to source documents when reissuing limitation placards or annotating ASIs.

Airworthiness documents

Airworthiness Directives

The manufacturer's website[10] contains links to documents relating to the operation and maintenance of the glider, including the Flight Manual and Technical Notes. Two of these Technical Notes related to issues with the structure of the tail section (where the ruddervators are attached) and compliance with the requirements of the notes was mandated by LBA Airworthiness Directives (ADs).

The first AD[11] was issued in 1986 and detailed a one-off check of frame 25 for cracking prior to the next flight; if a crack was found, the frame was to be replaced before the glider flew again. The second AD[12] was issued in 1993 and required the re-enforcement of frame 26 before the end of the year. While the AAIB found no reference to the ADs in the glider maintenance records or logbook, examination of the wreckage showed no cracks in the affected areas of frame 25, and frame 26 had been re-enforced. A Technical News Sheet on the BGA website[13] issued in 2010 stated that:

Footnote

[8] EASA CS-22 Book 2 defines V_{NE} as the Never exceed speed: *(Do not exceed this speed in any operation and do not use more than 1/3 of control deflection.)*
[9] EASA CS-22 Book 2 defines V_{RA} as the Rough-air speed: *(Do not exceed this speed except in smooth air, and then only with caution. Examples of rough air are lee-waves rotor, thunder clouds etc.)*
[10] Service page of the Eichelsdorfer GmbH website, https://www.flugzeug-eichelsdoerfer.de/service.html (Accessed 9 June 2020)
[11] LBA Airworthiness Directive LTA 1986-023, https://www2.lba.de/ltadocs/1986-023.pdf (Accessed 9 June 2020)
[12] LBA Airworthiness Directive LTA 1993-133, https://www2.lba.de/ltadocs/1991-133.pdf (Accessed 9 June 2020)
[13] British Gliding Association Technical News Sheet Issue 5-2010, https://members.gliding.co.uk/wp-content/uploads/sites/3/2015/04/1430312314_tns-5-2010.pdf (Accessed 27 May 2020)

'There has always been a requirement to record compliance with Airworthiness Directives, however it has been observed during BGA and CAA audits that compliance with this requirement is poor in some areas.'

The news sheet also stated that:

'Owners using the old style BGA Glider logbook must also maintain a BGA AD status report (BGA 280).'

This requirement was applicable to G-DEJH, but the investigation could not find a BGA Form 280 in the glider records. EASA type certified gliders issued with a non-expiring Certificate of Airworthiness are checked annually and an ARC is issued accordingly. BGA approved inspectors check the glider against the requirements of an Airworthiness Review Checklist (BGA 276). The investigation identified that although this checklist has an item to confirm that all relevant Airworthiness Directive's (AD) have been complied with, it does not reference a check that the logbook or BGA Form 280 is present and complete as a record of that compliance.

The BGA have reviewed the BGA 276 checklist and advised that they intend to amend it so that the section relating to ADs specifically refers to a check of the glider logbook and the BGA Form 280. Any amendments have to be agreed with the CAA, and the BGA indicated that the proposed change would be submitted in November 2020.

The online EASA Safety Publications Tool[14] contains a list of mandatory continuing airworthiness information for all aircraft that hold an EASA Type Certificate. However, the LBA ADs pre-dated the formation of EASA and there were no publications on the EASA website specifically applicable to the SB-5 series of gliders.

Crashworthiness

The glider was not designed with any specific crashworthiness features, other than a seat harness. However, the level of disruption to the airframe during the impact rendered the seat harness ineffective.

Airfield information

The gliding club operated from an unlicensed field (Figure 7), approximately 4 nm west-north-west from the summit of Cross Fell. The ridges used by the club lie beneath the summit of Cross Fell and are recognised as ideal, but challenging, due to the complex ridge structure[15] and its gullies. After entering the area at Muska Hill, pilots are advised to be above 1,500 ft aal before either crossing in front of Man at Edge to the south, or into Ousby Dale to the north.

Footnote

14 EASA Safety Publications Tool, https://ad.easa.europa.eu/ (Accessed 9 June 2020)
15 The ridge structure consists of: Melmerby Ball, Cuns Fell, Ousby Dale, Sharp Sheafs, Muska Hill, Man at Edge, High Cap and Wildboar Scar.

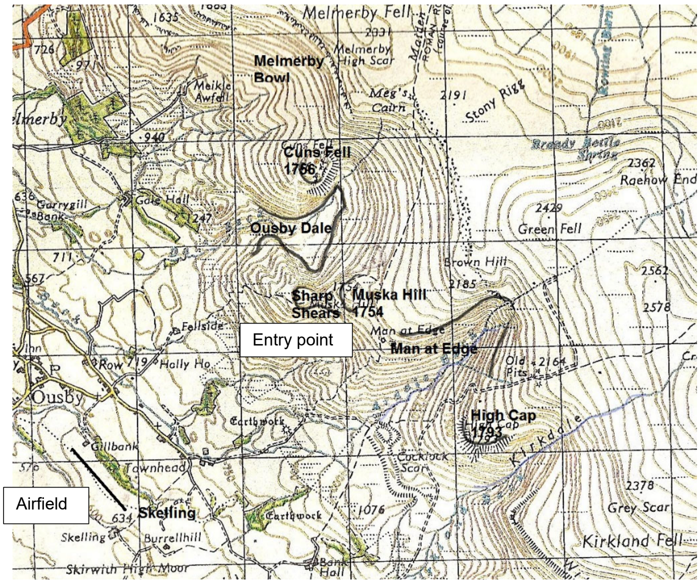


Figure 7

The ridge structure below Cross Fell

Meteorology

CFI's assessment of the weather

The CFI gave the daily briefing at about 0800 hrs on the day of the accident, during which he briefed a wind direction of 260° with an estimated strength of 20 kt and the possibility of showers and cumulus cloud. This was an estimate of the highest wind strength likely to be encountered throughout the day. The CFI considered the day to be an "easy ridge day" on the basis that the wind, which was steady and perpendicular to the ridge, would provide clean uplifting air and assessed it as suitable for pilots with Check Level 2 and above.

The wind strength and direction were based on the judgement of the Duty Instructor (DI) drawing upon the Met Office data, briefings for the area and actual readings from the Warcop military training area.

Aftercast provided by the Met Office

An aftercast provided by the Met Office reported that the area would have been dry with good visibility and convective clouds, likely to be cumulus. This correlated well with evidence from the video of the accident, which indicated a cloud base a few hundred feet above the summit of Cross Fell.

The area would also have experienced a moderate to strong westerly to south-westerly flow, with winds of around 15 kt at the surface and 25 kt at the summit of Cross Fell. The aftercast highlighted that there would have been local wind effects around the Fells with lee waves[16], which may have caused unexpectedly higher gusts and variability in wind direction.

Footnote

[16] Lee waves are also known as mountain waves. These occur in the lee of hills or mountains and consists of a turbulent vortex that is parallel to the ridgeline. Often this is accompanied by clouds which are referred to as rotor clouds.

Effects of wind on a ridge

Wind follows the contours of a hill on the windward side and, due to the venturi effect, its strength will increase as it passes over the summit. As a result, the wind strength on the summit of a hill is greater than the ambient wind speed away from the summit at the same height. The strength of the ambient wind governs the degree of turbulence created. The airflow curls over and around features creating mechanical turbulence[17] behind the demarcation line[18]; this line moves forward to the leading edge of the ridge and becomes progressively steeper as the wind strengthens. Slight changes in wind direction can significantly alter the lift characteristics of a ridge.

A view of the plateau (Figure 8) in the approximate direction that the glider was flying immediately prior to the accident, shows the wind effects that the glider likely encountered. It illustrates the area of best lift in the smoother uplifting air on the windward side of the ridge (left of the demarcation line) and the more turbulent air behind (right of the demarcation line). On the north-western edge, where the ridge curved round to the east, the turbulence would have been greater as the wind direction became less perpendicular to the ridge. The direction of the wind is also likely to have been affected as it flowed around the plateau, possibly resulting in a slightly more south-westerly flow. The plateau at the summit of Cross Fell, sitting above the main ridge, would likely have experienced stronger winds than the ambient wind at the same level.

The pilot from the air ambulance, who landed 75 m downwind of the accident site on the summit of Cross Fell about 45 minutes after the accident, reported that he experienced light turbulence.

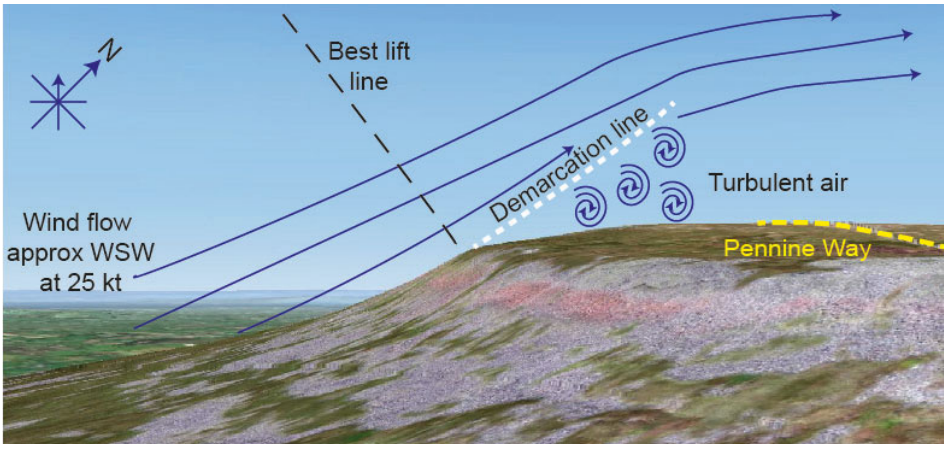


Figure 8

Likely effect of the wind on the summit of Cross Fell where the accident occurred

Footnote

17 Mechanical turbulence is the result of the friction between the airflow and the ground, especially irregular terrain and obstacles, which causes eddies and therefore turbulence in the lower levels.

18 The demarcation line is a term used by helicopter pilots in mountain flying. It is a line which separates the clean up-draughting airflow and the turbulent down-draughting airflow.

Estimation of headwind

Based on the estimated heading of the glider, and taking into account the wind conditions in the aftercast, the glider is likely to have encountered a headwind of between 5 and 10 kt. However, the variations in wind direction and speed, arising from the effects of the ridge on the airflow, might have resulted in a range between as little as no headwind to greater than 15 kt.

Pilot's qualifications and experience

Pilot's gliding clubs

The pilot's home gliding club operated from Lee-on-Solent until May 2018 when the club became dormant; the pilot then flew from other clubs, mainly at Lasham and Upavon, where he continued his flying training.

Gliding qualifications

The relevant Gilding Certificate, endorsements and badges awarded by the Fédération Aeronautique Internationale (FAI) and issued by the BGA are at Appendix A.

The pilot gained his Solo endorsement in December 2017 when he was 14 years old and the Bronze endorsement in June 2019. He had achieved the requirements for both the Duration and Height legs for the Silver and Gold badges, but these attainments had not been endorsed due to his age. He had also completed the soaring elements of the Cross-country endorsement; these consisted of one thermalling and one wave flying flight. The pilot was not able to complete the other requirements due to age restrictions. All these flights had been completed either at Lasham or Aboyne.

Logbook and BGA training progress card

The pilot's logbook detailed 69 hours of flying over 200 flights. However, the entries only provided the basic information of each flight such as date, location, length of flight and name of instructor (if dual). The entries lacked additional details in the remarks column which, if entered, could have provided information on the gliding activity undertaken (eg training exercise, thermal or ridge flying). No entries had been counter-signed by an instructor, except for the check flights the pilot had flown at the gliding club at Skelling, which had been endorsed by the CFI. Other documentation showed that the pilot had met the requirements for the Height and Duration legs for both the Silver and Gold badges.

The BGA training progress card is used to track the progress of unqualified pilots. The pilot held training cards issued by Lee-on-Solent and Lasham which recorded three attempts at hill soaring, but these had not been endorsed by an instructor. The pilot confirmed that he had made these entries in his training card and showed the AAIB the supporting entries in his logbook. The training cards only recorded that he had passed the theoretical knowledge and oral test for the Bronze endorsement but not the relevant skills test. The CFI of the pilot's home gliding club confirmed that he had completed all the elements, including the skills test, for his Bronze endorsement in June 2019.

Knowledge and experience

Prior to the expedition, the pilot had flown from other sites where he would have experienced thermal, wave and ridge flying. Examination of his logbook showed two dual flights from Denbigh[19] Airfield, only one of which involved around 30 minutes of ridge flying. There was no evidence that the pilot had received any other practical training or theoretical knowledge covering ridge flying.

Relevant airspeed limits

The pilot understood the speeds to be flown in differing conditions in the SB-5E glider and quoted 108 kt for V_{NE} and 85 kt for the Rough Air speed limit. Although he could not recall the speed he had been flying just prior to the accident, he believed that it would have been about 80 to 85 kt.

The BGA advised the investigation that the required speed to fly a ridge is commensurate with the conditions at the time. When flying along a ridge, particularly at a low height, handling is an important factor alongside a minimum airspeed of 50 kt which would give a reasonable stall margin for a glider such as the SB-5. The Rough Air speed limit would only be relevant if the pilot expected to encounter rough air.

The gliding club at Skelling

Check level

The gliding club at Skelling is a member of the BGA and operates in accordance with their policies and guidance. The Club's Flying Orders include a grading system of four levels based on experience, known as a Check Level, which is applied to all pilots operating from the airfield. A pilot's Check Level is set by the Duty Instructor (DI) following completion of a satisfactory check flight. When the weather conditions for the day are assessed, a Check Level is assigned by the DI thereby determining who is permitted to fly. This check level can be reviewed at any time during the day and promulgated by radio to any gliders airborne at the time.

Check Level 2 is defined as:

1. 'Qualifying Criteria: 15 hours and 25 launches P1 plus satisfactory check flight with an approved, rated instructor.
2. Currency allowance: 21 days.
3. Privileges: May convert to SB-5E.
4. Must receive a daily briefing from approved instructor to fly solo and read the posted daily briefing notes.
5. *X/C*[20] [cross-country flying]: *Not allowed'.*

Footnote

[19] Also known as Lleweni Parc Airfield.
[20] The ridge is within gliding range of the airfield and therefore a Check Level 2 pilot would not need the X/C endorsement.

The section in the Flying Orders entitled '*DI Guidelines for setting the days Check Level*' stated:

> *'An easy ridge day may be check 2. A strong crosswind of 15 knots plus would probably be check 3 or possibly check 4. This will depend upon the actual wind direction and runway selected.'*

Requirement for a ridge check

In the section for visiting pilots, the Flying Orders state:

> *'The check system will be operated at the launch point for all visiting pilots (non-instructors) after a review of their logbook and subject to normal checks (Winch currency, Launch failures, site and ridge checks).'*

There was no other mention in the Flying Orders for a flight check on the ridge to be carried out.

Following this accident, the gliding club amended the section on Supervision in the Flying Orders as follows:

> *'Junior pilots under the age of 18 yrs may only[21] fly on the ridge when the conditions for the day have been deemed suitable. A check flight may or may not be required at the discretion of the DI. A specific pre-flight briefing by the DI must be obtained prior to launching.'*

Airfield briefing

The Flying Orders stated that visiting pilots must be given an airfield briefing and receive a copy of Appendix A to the Flying Orders, which outlined the details of the airfield. In addition, pilots should have received a copy of *'Flying the Fell',* a locally produced guidance document containing guidance for flying along the ridge, which included a map of the area. However, this document did not cover the threats or hazards, such as the wind effects, when flying the ridge. Both documents were accessible through the club's website.

British Gliding Association

Governance

The BGA is the national governing body for gliding and is self-regulated by its membership of 80 independent clubs which are primarily run by volunteers. Governance is delivered through BGA Laws and rules that endeavour to foster an environment that provides the freedom for clubs to operate independently. The BGA is the national governing body of gliding. In addition to governing the sport in the UK, the BGA highlights applicable law, provides self-regulation through 'Operational Regulations', and provides guidance on acceptable means of compliance and safety. The 80 gliding clubs in the UK are members of the BGA. Complying with BGA operational regulations is a membership requirement.

Footnote

21 The entry in the Flying Order book was in normal font with *'may only'* in italics and not underlined.

Laws and rules

The BGA publishes its '*Laws and Rules'* under a number of documents such as its Operational Regulations (ORs)[22]. It also publishes other documents which includes the '*Instructor's Manual'* (IM)[23] and '*Managing Flying Risk – Guidance for Pilots and Clubs'* (MFR)[24].

Definition of a qualified glider pilot

The BGA Gliding Certificate is issued when a pilot achieves the Solo endorsement.

A student pilot becomes a qualified glider pilot when they have achieved both the Bronze and Cross-country endorsements, or an equivalent licence. Pilots who do not hold these endorsements are still under training. This requirement was stated in the IM and MFR, but was not stated in the ORs, nor the document that outlines the requirements to qualify for the Gliding Certificate and endorsements[25].

Flying with other pilots

The BGA considers that two pilots flying together, when neither is an instructor, is the same as flying with a passenger. The commander must be a fully qualified glider pilot holding both the Bronze and Cross-country endorsements. However, at the time of the accident, BGA ORs only stated that pilots must hold a Bronze endorsement to fly together.

The MFR included a section entitled *'Flying with other Pilots'* which highlighted the threats that could be present with this type of flying and provided guidance on how pilots could manage these effectively. It did not state the level of qualification required to fly with other pilots.

Supervision

The BGA provided guidance in the MFR on supervision and the factors that should be considered by a supervising instructor. It stated:

> *'An unqualified pilot should be supervised by an instructor approved to do so by the CFI and that young pilots under 18 should be individually supervised as they have a different attitude to risk and little experience taking important decisions.'*

The IM provided more detailed guidance to instructors on supervision, particularly of unqualified pilots in the transition stage from post solo to achieving Bronze and Cross-country endorsements.

Visiting Pilots

While the MFR contained a section on supervision, there was no recognition of the supervisory challenges for CFIs concerning visiting pilots. However, the MFR did cover the need for a briefing document for visiting pilots.

Footnote

22 BGA Laws and Rules *Operational Regulations,* Version 1 effective date 8 Mar 2015.
23 BGA (2017) *Instructors' Manual*, 4th edition.
24 BGA *Managing Flying Risks – Guidance for Pilots and Clubs,* Version 10 effective date 26 Apr 2019.
25 BGA Laws and Rules *Gliding Certificate and endorsements requirements*, Version 1.2 effective date 1 Oct 2017.

Training records

The ORs covered the logging of personal flying and stated:

> *'…glider pilots are required to keep an adequate record of their flying to prove they meet, as appropriate, BGA requirements for training and solo flying...'*

The IM also contained a chapter on '*How to read a logbook*' and other sections on the management of student training records and pilot's logbooks.

Training material

The BGA recommended a study guide titled *'Bronze and Beyond – A Glider Pilot's Guide'*, which covered the theoretical knowledge required for the Bronze endorsement. This guide covered air law, operational procedures, principles of flight and weather, and was used by the pilot for his theoretical studies. Neither the study guide, the syllabus published by the BGA for the attainment of the Bronze and Cross-country endorsement nor the IM provide guidance on ridge flying. However, the BGA website did provided links to a number of documents and books that covered ridge flying.

Following this accident, the BGA included references in the MFR to a chapter in the FAA Glider handbook[26] on soaring techniques, and a publication by the Fédération Française de Voile called '*Safety in Mountain Flying*'[27].

Standardised European Rules of the Air

Standardised European Rules of the Air (SERA) stipulates a number of rules for the protection of persons and property[28], which includes:

> SERA.3101 which specifies that no aircraft shall be operated in a negligent or reckless manner so as to endanger life or property of others.
>
> SERA.3105 which specifies that the minimum height for VFR flights shall be those specified in SERA 5005(f), except when necessary for take-off or landing.
>
> SERA. 5005(f) which specifies that the minimum height as 500 ft agl for flights operating under VFR when not operating over congested cities towns or settlements, or over an open-air assembly of persons.

Under ORS 4 No 1174[29] the CAA permits a glider to fly below 500 ft above the ground or water, or closer than 500 ft to any person, vehicle, or structure when hill soaring. Neither the CAA nor the BGA had published guidance on how this permission should be safely applied.

Footnote

26 FAA (2013) Chapter 10 '*Soaring Techniques*', *Glider Flying Handbook*, 2013. Available at https://www.faa.gov/regulations_policies/handbooks_manuals/aircraft/glider_handbook/ [accessed Aug 2020].

27 FFVP, *Safety in Mountain Flying*, 1st edition, December 2011. Available at https://members.gliding.co.uk/wp-content/uploads/sites/3/2015/04/1430312053_mountainflyingsafety.pdf

28 Chapter 1 '*Protection of Persons and Property*' under Section 3 '*General Rules and Collision avoidance*' of the Annex '*Rules of the Air*'.

29 Paragraph 4 of Official Record Series (ORS) 4, No 1174 *'Standardised European Rules of the Air – Exceptions to minimum height requirements*' published by the UK Civil Aviation Authority (CAA) on 6 June 2016

Flutter

Causes of flutter in aircraft structures and control systems

Flutter is defined as an oscillation of a structure under the interaction of aerodynamic and aeroelastic forces. It occurs when aerodynamic loads cause the deflection of a structure in bending and/or twist and is typically seen in cantilevered aerofoil structures such as wings and vertical and horizontal stabilisers on the tail. The frequency of oscillation can become very rapid and, in some cases, divergent where the amplitude (maximum deflection) of the oscillation increases with each cycle. Divergent flutter can very rapidly result in structural failure due to overload.

Several factors can contribute to the susceptibility of an aircraft structure to flutter, the most significant being structural stiffness with susceptibility reducing as stiffness increases. Flutter can also be induced by the combination of an aerodynamic structure and a control surface, such as a wing and aileron, or vertical stabiliser and rudder. Turbulent airflow can induce deflection of the fixed structure which is not immediately matched by the control surface. If the CG of the control surface is behind the hinge line when the structure deflects, for example due to an aerodynamic disturbance or turbulent airflow, the control surface will lag behind in its response due to inertia. To counteract this effect, control surfaces can be mass balanced with weights to bring the CG of the control surface in-line with or forward of the hinge line.

EASA certification requirements

The EASA sets out its current certification specifications for Sailplanes and Powered Sailplanes in CS-22. CS 22.629 states that the sailplane must be free from flutter up to at least the maximum design speed (V_D). CS 22.1505 states that V_{NE} should not exceed 0.9 times the maximum speed demonstrated in flight tests (V_{DF}), which in turn must not be less than 0.9 x V_D. Therefore, sailplanes should be free of flutter up to V_{NE}.

CS 22.1517 states that V_{RA} may not exceed the design gust speed in free flight (V_B). CS 22.335 (c) states that V_B must not be less than the manoeuvring speed (V_A[30]).

SB-5 certification requirements

The regulations (BVS Books 1 to 3) to which the SB-5 was certified did not specify a speed below which the glider should be flutter free.

The regulations contained four certification groups (BGR) numbered 1 to 4. BGR 1 is categorised as low stress, which the regulations define as beginner / training gliders which should not be used for towing or aerobatics or operated above an altitude of 300 m (980 ft)[31]. The remaining three groups are defined by increasing load levels and have fewer operational restrictions allowing them to be used for activities such as aerobatics.

Footnote

30 EASA CS-22 Book 2 defines V_A as the Manoeuvring Speed: (*Do not make full or abrupt control movement above this speed, because under certain conditions the sailplane may be overstressed by full control movement.*)

31 Translated from the original German.

Certification Requirement 3302, in Book 3 of the regulations, states:

> *'All gliders except BGR 1 require mass balancing for all rudders around their axes of rotation.'*

Neither the EASA TCDS, the Flight Manual, nor the BGA datasheet documented a height restriction for operation of the SB-5.

Previous structural failures of SB-5 gliders

The BFU advised that they had investigated several serious incidents and accidents involving SB-5 gliders, and stated that '*often the problem was that pilots did not observe the speed and became too fast.'* One fatal accident which occurred on 9 August 1976 involved a SB-5 glider, registration D-0087, where the tail broke off during '*cruise*'. Another fatal accident in 1992 involved the structural failure of the right wing, which detached when the glider was in a spin. The BFU were unable to provide detailed information on the cause of these accidents as, owing to their age, the relevant investigation files had been destroyed. The BFU had no other records of structural failures involving the SB-5.

In 1993, as a result of in-service reports that had not resulted in an accident, the BFU published a flight safety information notice the title of which translated as '*Glider Pilots on SB-5 Watch Out!*': an English translation of the notice provided by the BFU is at Appendix B. The notice referred to a fatal accident where an SB-5 glider suffered a structural failure after the student pilot entered a spin shortly after a winch launch. It also cited two other accidents where similar gliders had broken-up due to structural overload and stated that exceeding the limitations in the Flight Manual '*could be deadly*.'

The notice highlighted that the maximum permissible speed of the SB-5 is low when compared with modern high-performance gliders and can easily be achieved in routine manoeuvres. The notice recommended that:

> *'The flight operating limitations should be known and adhered to.'*
> *'Overload of any kind should be avoided.'*

The investigation consulted the EASA, BFU and the EASA Type Certificate holder and was unable to identify any other occurrences of flutter leading to the structural failure of the tail section of the SB-5 glider.

Analysis

G-DEJH suffered a structural failure of its tail while being flown across the plateau at the summit of Cross Fell.

Flight path

Analysis of the video indicates that the flight path of the glider was most likely behind the escarpment and the demarcation line, at a low height where turbulent airflow was likely to be encountered. The walkers reported seeing the glider "bouncing up and down" during the first pass, which was not seen on the video during the second pass. However, the video did show the sudden excitation of the tail section and onset of divergent flutter, which led to the detachment of the tail approximately three seconds later. The air ambulance pilot stated that he experienced light turbulence when he landed on the summit of Cross Fell, downwind of the accident site. It was not possible to establish the degree of turbulence encountered during the two passes that the glider made.

Airspeed

The pilot believed that just prior to the structural failure he would have been flying at approximately 85 kt. This was the placarded Rough Air speed limit for G-DEJH and where the marker around the ASI changed from green to amber. The glider is only certified to be flown above the Rough Air speed limit in calm air and then with caution.

Analysis of the glider's flight path, based on the video, derived a groundspeed of between 85 and 95 kt. The low level wind conditions around the ridge are complicated and it is difficult to accurately determine the wind speed in order to calculate the airspeed of the glider, though the walkers did report that there was a really strong wind from the west. While it was not possible to determine the actual airspeed that the glider was being flown, it is likely to have been between the incorrectly marked Rough Air speed limit of 85 kt and V_{NE}, which was correctly placarded at 108 kt.

The ASI and cockpit placard had been incorrectly annotated with a Rough Air speed limit of 85 kt since at least 1992, and possibly since the glider was imported to the UK in 1981. This discrepancy had not been detected when the limitations placard in the cockpit and ASI markers were replaced at the 2016 annual maintenance check. It is, therefore, likely that the glider had operated above the actual certified Rough Air speed limit of 75 kt on previous occasions in rough air.

Structural failure of the tail section

Examination of the wreckage determined that the tail section failed as a result of overload and that there was no visual evidence of pre-existing damage or weakening of the glue that bonded the skin to the structure. However, it was not possible from the wreckage to determine if there had been any change to the aeroelastic properties of the wooden structure resulting from the glider's age, or to eliminate the possibility that there had been pre-existing damage. Such damage might have occurred since the last annual maintenance, the last daily check, or during the accident flight; however, the annual and pre-flight inspections did not identify any damage. It was also not possible to assess the amount of play in the control linkages due to the extent of the damage, but this was an inspection item that had been signed as '*acceptable for continued operation'* during the last annual maintenance check.

The walkers reported that during the latter stages of the first pass the glider was seen to bounce up and down, which was consistent with the glider flying in an area of turbulent air. At a similar position on the second pass, the tail started to oscillate laterally before it structurally detached from the glider, though it remained attached by its control rods. From analysis of the movement of the structure and control surfaces, using specialist video software, it was concluded that this was flutter.

It is possible that the flutter was initiated by the deflection of the V-tail structure as the glider encountered turbulence as it flew across the plateau at low level. As the V-tail surfaces oscillated laterally, the video showed the ruddervator control surfaces, likely due to a lack of mass balancing, lagging the movement of the main tail structure and driving an increase in amplitude. The flutter became divergent and led to a rapid overload and detachment of the tail structure.

Certification

The SB-5A was Type Certified by the LBA in 1964 to German airworthiness regulations dating from 1939. The lack of mass balancing would have made the ruddervators more susceptible to flutter suggesting that G-DEJH had originally been classified as BGR1, which was intended as a limited flight envelope, low stress trainer. However, unlike current EASA regulations, the investigation could find no requirement for the glider to remain flutter free up to a specified airspeed.

The investigation was unable to determine when or on what basis the glider was allowed to operate beyond the restricted envelope of BGR1.

Advisory information

The flight safety information notice issued by the BFU in 1993 advised that the glider type had a history of structural failure in overload following relatively small speed excursions above the approved limits. They advised that the flight limitations should be adhered to and overload of the structure avoided.

The circumstances leading to the structural failure on G-DEJH were consistent with the findings from previous investigations conducted by the BFU where failure occurred after speed limits were exceeded.

Pilot's training and attainment

The pilot had achieved a relatively high level of attainment very quickly and had only been constrained by the age restrictions in gaining additional endorsements. However, he had only recently achieved his Bronze qualification and was not a qualified glider pilot.

While the pilot believed he had a reasonable level of ridge flying experience, examination of his logbook and training cards, and discussions with an instructor, revealed that prior to the visit his experience was limited to about 30 minutes during a single flight with an instructor. Therefore, he would not have acquired the skills, knowledge or experience necessary to identify the hazards of flying the ridge at Cross Fell or to assess the risk to himself and third parties from his chosen flight path: the glider was flown at a very low level behind the escarpment and close to walkers on the Pennine Way.

BGA training syllabus for ridge flying

There was no BGA approved training syllabus for ridge flying. Ridge flying can expose glider pilots to hazards which are not encountered during thermalling and wave soaring; specifically, the localised effects of the wind on the ridge and the challenges of low-flying in close proximity to the terrain and other obstacles. The completion of a training syllabus by the pilot would have provided assurance that he had gained the necessary level of knowledge and skills to fly the ridge solo.

Following this accident, the BGA amended the MFR to include guidance on the knowledge and training required to conduct ridge flying safely. The guidance addressed the CAA permission to fly closer than 500 ft, but did not include guidance on how to ensure that third parties on the ground are not put at risk. The BGA is also revising its training syllabus to align with EASA Part-SFCL, which includes the theoretical knowledge and practical techniques to be taught for ridge flying.

Pilot's logbook and BGA training progress card

The pilot's logbook and training card had not been completed in accordance with the BGA guidance and therefore did not present a clear record of his actual experience of ridge flying. The ORs require all glider pilots to keep an *'adequate'* record of their flying as evidence of the level of experience attained. The IM encourages instructors to make comments in the student's logbook on the content of the flight.

Following this accident, the pilot's home gliding club reviewed its requirements for completion of the logbook and training card to ensure robust records of a pilot's training are kept. The BGA is also reviewing the requirement for training record-keeping in preparation of the implementation of EASA sailplane regulations.

CFI's assessment of the pilot's experience

The CFI's assessment of the pilot based on his training card, logbook and discussion with him, was that the pilot had achieved a high level of attainment for his age with a breadth of experience that included ridge flying. This perception was supported by the quality of flying demonstrated during the check flights and by observation of the pilot over the following days. On this basis the CFI believed that he had satisfactorily assessed the pilot's ability to fly the ridge safely and classified him as Check Level 2.

Since this accident, the BGA has updated the MFR to include a requirement for home clubs to provide information on their pilots to the CFI of clubs that they intend to visit. The BGA advised that while the number of club visits to other airfields has reduced, there is an increasing number of visits by individual pilots or informal groups. To address this change, they have published a *'Site Hazards and Mitigations Template'* in the MFR to assist clubs in assessing the hazards and risks when hosting visiting pilots.

Check flights

The pilot flew the check flights required, which could include a flight on the ridge if the wind conditions were suitable; if not the instructor would show the ridge from the air and discuss the techniques to be used. The conditions on the first day were not suitable to fly the ridge and so while the CFI briefed the pilot while airborne, the pilot had no opportunity to demonstrate the techniques on the ridge with an instructor. Instead, his practical understanding of flying the ridge was gained during the mutual flight with another 15 year old pilot.

Check Level

The Check Level system used by the club is an important mechanism for managing the risks associated with the challenges of flying the ridge and considers the pilot's experience and the weather conditions. However, the guidance to DIs in the Club's Flying Orders on how to set the Check Level for the day was generic. It did not provide guidance for the differing wind conditions that may be experienced between the airfield, the lower ridge line and the summit of Cross Fell.

On the day of the accident the CFI assessed the conditions to be Check Level 2 based on his assessment that the conditions made it an easy ridge day. However, the increasing strength of wind towards the summit, with its associated increase in turbulence, meant that a higher Check Level could have been more appropriate.

Following this accident, the gliding club reviewed their Check Level requirements and amended the guidance in the Flying Orders for the DI when setting the day's Check Level to *'Take into account what the upper wind is forecast to be as this can affect the turbulence one can encounter in the various gulleys.'*

Flying with other pilots

On two occasions the CFI authorised the pilot to fly with another 15 year old who also only held a Bronze endorsement without a cross-country endorsement, which meant they were both unqualified. The situation at the time of the accident was unclear as to whether two unqualified pilots flying together was permissible with the ORs stating that a pilot was only required to hold a Bronze endorsement to fly with passengers.

The BGA has since reviewed their ORs to clarify that passenger flying is only to be undertaken by qualified glider pilots over 16 years of age who have been authorised by the CFI.

Supervision

The BGA state in the MFR that '*Pilots under the age of 18 may have exemplary handling skill but a different attitude to risk and little experience of taking important decisions. Clubs should provide their young pilots with individual supervision'.* However, on this occasion the level of supervision may not have been adequate. This is evident by: the incomplete logbook and training card entries; two young unqualified pilots flying together; the choice of flight path which placed the glider in an area where the pilot was likely to encounter turbulent air; flying in close proximity to persons on the ground.

The issues that are likely to have influenced the level of supervision are:

- The absence of a syllabus covering the theoretical knowledge and practical training required for ridge flying meant there was no evidence that the pilot had received the necessary knowledge and experience.
- The logbook and training cards did not provide a clear picture of the level of experience that the pilot had gained.

- The BGA regulations surrounding the level of qualifications required to fly with another pilot were inconsistent.
- The club's guidance to DIs on the criteria for setting the Check Level for the day was unclear.

As a result of these findings, the additional following actions were taken:

> The BGA sent an e-mail to all BGA Club CFIs and Chairmen emphasising the guidance in place for the supervision of young solo pilots and pilots under training. It re-stated that pilots remain unqualified, requiring close supervision, until they have been awarded both the Bronze and Cross-country endorsements.
>
> Clarification was provided in the BGA ORs on the need for a qualified instructor to exercise appropriate supervision during training, including solo flying of unqualified pilots and paid passenger flying.

UK CAA general permission under ORS 4 No 1174 minimum heights

The CAA has issued a permission for glider pilots to fly below 500 ft agl or closer than 500 ft to a person when hill soaring; however, pilots must still comply with their responsibilities under SERA.3101 not to endanger third parties.

The pilot twice flew in close proximity to walkers on the Pennine Way. He was aware of the walkers during the first pass when he waved to them and could have chosen to fly on a different part of the ridge to maintain greater separation. However, his briefings on ridge flying had focused on where to fly to obtain lift rather than how to use the permission.

Following this accident, the BGA issued a new section to the MFR titled '*Hill, Ridge and Mountain Soaring'* which addressed the CAA permission under ORS 4 No 1174 . The amendment drew attention to the requirement that '*an aircraft shall not be operated in a negligent or reckless manner so as to endanger life or property of others'*. It also states that '*Public/third-party safety is the absolute priority*' and gave a number of protocols for hill soaring which included: '*Do not fly lower than necessary to utilise the soaring conditions*' and '*NEVER fly close to, towards or directly over any person on the ground*'.

Conclusion

This accident occurred as a result of a structural failure of the tail section of the glider due to flutter, which likely occurred when the glider was flying between the Maximum Rough Air speed limit and V_{NE}.

Divergent flutter of the V-tail developed when the glider flew low into an area where turbulence might be encountered. The investigation was unable to discount the possibility that there was pre-existing damage or that the aeroelastic properties of the structure had changed over time. It was also not possible to eliminate the possibility that there had been free play in the control system or structural damage having occurred prior to, or during the accident flight. The glider also had design features which made it more susceptible to flutter than gliders certified to current regulations.

The pilot reported that he had flown to the Rough Air speed limit displayed on the cockpit placard and marked on the ASI; however, he would not have known that this limit was incorrect, and the permitted limit was 10 kt lower. Given that the BGA Certificate of Airworthiness quoted the same, incorrect, speed limit when the glider was imported to the UK in 1981, it is likely that the placard and ASI had been incorrectly annotated since this time. This suggested that individuals who replaced the placards and ASI markings had copied the limits across, rather than referring to a source document.

The pilot had received limited training and practical experience of ridge flying. His practical understanding of flying the ridges near Cross Fell was provided by another 15 year old pilot while flying together in the same glider. The BGA is addressing the absence of formal training on ridge flying by introducing a training syllabus which will bring it in-line with the requirements of EASA Part-SFCL.

The pilot's logbook and training cards were not complete, leaving the CFI to partially base his assessment of the pilot's abilities on the check flights and discussion with the pilot, which led the CFI to believe that his experience was greater than it actually was. The BGA has advised that the increasing trend is for small groups of pilots to visit and fly from other sites, which reinforces the need for pilots' records to be complete and for host clubs to have robust processes in place to accurately assess the ability of visiting pilots.

The investigation also found that while the airframe was compliant with two relevant ADs, there was no record of these having been carried out as there was no AD Status Form (BGA 280) available for G-DEJH. Maintaining an accurate record of the status of ADs is an essential part of ensuring the airworthiness of an aircraft.

Safety actions

The following safety actions have been carried out:

The gliding club near Skelling has:

- Amended their Flying Orders such that for junior pilots under the age of 18 years wishing to fly on the ridge:
  - They may only fly on the ridge when the conditions for the day have been deemed suitable.
  - A check flight may be required at the discretion of the Duty Instructor.
  - A specific pre-flight briefing by the Duty Instructor must be obtained prior to launching.
- Reviewed the Check Level requirements and the guidance to Duty Instructors for setting the day's Check Level

The pilot's home club has reviewed its requirements for completion of pilot logbooks and training cards to ensure robust records of a pilot's training are kept.

The BGA has:

- Initiated a review of their Form 276 Airworthiness Review Checklist to ensure the section relating to Airworthiness Directives specifically refers to a check of the glider logbook and the BGA Form 280. The BGA is expected to submit their proposed amendment to the CAA, for approval in November 2020.

- Highlighted in the September 2020 edition of their Technical News Sheet, the importance of always referring to source documents when reissuing limitation placards or annotating ASIs.

- Reminded all BGA Club chairmen and Chief Flying Instructors on the guidance in place for the supervision of young solo pilots and pilots under training.

- Reviewed their Operations Regulations to clarify:

    – That passenger flying is only to be undertaken by qualified glider pilots aged 16 years or over and who have been authorised by the Chief Flying Instructor.

    – The need for a qualified instructor to exercise appropriate supervision during training, including solo flying of unqualified pilots and paid passenger flying.

- Updated their document Managing Flying Risk – Guidance for Pilots and Clubs to include:

    – The requirement for home clubs to provide information on their pilots to the CFI of the club that they intend to visit.

    – References on soaring techniques and Safety in Mountain Flying.

    – Guidance on the knowledge and training required to safely conduct ridge flying.

    – Guidance on the permission for gliders to fly lower than 500 ft when hill soaring.

    – A template for clubs to use when assessing the hazards and risks when hosting visiting pilots.

- Initiated a review of the requirement for training record-keeping in preparation for the implementation of EASA Part-DTO.

- Revised the BGA training syllabus to comply with EASA Part-SFCL, which includes the theoretical knowledge and practical techniques to be taught for ridge flying.

Published: 25 March 2021.

APPENDIX A

RELEVANT GLIDING CERTIFICATES, ENDORSEMENTS AND BADGES

BGA Endorsements		
Endorsement	**Minimum Age to award**	**Remarks**
Solo	14 years	BGA Glider Certificate is issued on completion of first solo flight.
Bronze	14 years	Issued on completion of the training syllabus, theoretical knowledge test and general flying skills test.
Cross-country	16 years for the completion of the field landing and navigation tests. Other elements can be completed earlier.	
FAI Silver	16 years. Only awarded to a qualified glider pilot; the Duration and Height gain flight can be completed before that age.	Consists of three qualifying flights: duration, distance and height gain.
FAI Gold	16 years. Only awarded to a pilot holding a Silver Badge. The Duration and Height gain elements can be completed before the age of 16.	Consists of three qualifying flights: duration, distance and height gain.
FAI Diamond	16 years. Only awarded to a pilot holding a Gold badge. The height gain can be completed before the age of 16.	Consists of three qualifying flights: goal, distance and height gain.

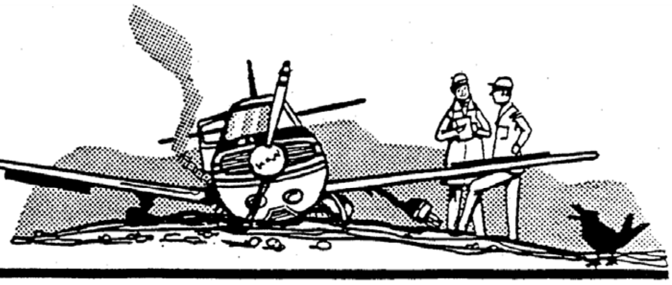
Table 1

Relevant BGA endorsements and FAI sporting badges

APPENDIX B

FLUGUNFALLUNTERSUCHUNGSSTELLE BEIM LUFTFAHRT-BUNDESAMT
Postfach 30 54, D-38020 Braunschweig, Tel. 05 31/23 55 - 0

FLUGUNFALL-INFORMATION



V 112
Braunschweig, May 1993

Glider Pilots on SB-5 Watch Out!

Shortly after winch launching with the glider type SB-5E; a student pilot entered spinning.

After the spinning movement stopped the lower spar cap of the right wing spar fractured at the mounting during the flare phase. The entire wing section was torn out of the fuselage mid-air and crashed to the ground 50 m next to the fuselage. The student pilot was fatally injured by the impact.

Two other accidents with SB-5 are known where the glider fragmented mid-air after overload.

The operations manual of the SB-5 indicates adherence to the operating limitations of the glider. This basically also applies to other types. To count on a "secret reserve" beyond these limitations could be deadly.

Test flights with the SB-5, the results of which were published in the Aerokurier 3/1964, showed two additional points which should be heeded during training flights.

1. Even with a slight increase of pitch angle speeds of more than 150 km/h are reached.

2. While exiting spinning after one turn, speeds of 200 km/h can be reached, i.e. maximum speed is exceeded.

Even if the weather conditions are very good for thermal flight and invites flying with high downhill speeds the SB-5 pilot should be aware that the permissible speeds are comparatively low compared with modern high performance aircraft.

We do not intend to dampen the spirits of SB-5 pilots, but we urgently recommend the following to prevent accidents of the kind described:

- **The flight operating limitations should not only be known but adhered to**
- **The flight characteristics especially during entry and exit of uncontrolled flight attitudes should be known**
- **Overload of any kind should be avoided**
- **The SB-5 which is a good and reliable glider for skilled pilots should not be used during training of less experienced student pilots.**

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:	Airbus A319-111, G-EZDD
No & Type of Engines:	2 CFM56-5B5/P turbofan engines
Year of Manufacture:	2008 (Serial no: 3442)
Date & Time (UTC):	25 August 2020 at 1529 hrs
Location:	On descent towards Gatwick Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 6 Passengers - 64
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	30 years
Commander's Flying Experience:	6,250 hours (of which 1,055 were on type) 3,155 hours as PIC (of which 1,055 were on type) Last 90 days - 27 hours Last 28 days - 27 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

On approach to Gatwick Airport the crew noticed a "wet sock" smell coming from the air conditioning vents in the cockpit and an "acrid smell" in the cabin. As a precaution both pilots donned oxygen masks and continued the approach to Gatwick. After landing the crew went to a local hospital for precautionary medical checks.

The cause of the smell was traced to oil contamination of the environmental air conditioning system.

History of the flight

Passing 6,000 ft in the descent to Gatwick Airport, the flight crew became aware of a strong "wet sock" smell coming from the cockpit air conditioning ducts. At the same time the cabin crew contacted the flight deck to alert them to "an acrid smell" in the cabin.

The flight crew donned their oxygen masks as a precaution and continued their approach for an otherwise uneventful landing. As a safeguard, the crew went to a local hospital for medical checks after the flight.

Aircraft examination

The aircraft had been the subject of three different '*Smell in Aircraft Reports*' (SIAR) in the previous three weeks:

- On 5 August engineers found evidence of a leak from the aircraft's Auxiliary Power Unit's (APU) drain mast and its oil cooler. These units were replaced and, after a '*pack burn off procedure*' to remove any remaining traces of oil, the aircraft was returned to service.
- On 12 August a further report was raised by flight crew but no fault was found during the Operator's standard SIAR fault finding procedure.
- On 13 August fault finding following a third SIAR found evidence of an oil leak from an APU gearbox plug. After the plug's O-ring had been replaced the aircraft was returned to service.

During the diagnosis for the incident event, the engineers found further evidence of oil leaks associated with other Line Replaceable Units (LRU) on the APU. After additional functional tests, it was decided to replace the APU, but the "oil smell" was still present. Suspecting downstream contamination of the environmental air conditioning system (ECS), nine components within the No 2 ECS were replaced. There were no further reports of SIC events between the aircraft returning to service and the conclusion of the investigation.

Medical

Two of the crew experienced "tight chests" and "tingling" fingertips during the fumes event but suffered no long-lasting effects. The commander reported that, on arrival at the local hospital, medical staff were not expecting them and did not have a specific fumes-related investigation protocol.

The Operator's policy for post-flight medical support following smell events is described in their '*Cabin Smell Event Care Pathway'* document. The Operator's expectation is that '*local medical procedures*' would be applied if immediate medical support is required, and they do not provide specific instructions to supporting facilities. If symptoms persist crews are referred to local occupational health services for ongoing support.

The UK CAA publish fumes event care pathway guidance documents on their website[1].

Other information

The Bureau d'Enquetes at d'Analyses report[2] into a fumes event aboard an Airbus A320 which diverted into Marseille-Provence airport concluded that implementing '*prior local arrangements*' between aircraft operators, airports and medical facilities could benefit the investigation of future cabin air quality events.

Footnote

1 https://www.caa.co.uk/Passengers/Before-you-fly/Am-I-fit-to-fly/Guidance-for-health-professionals/Aircraft-Fume-Events [Accessed February 2021].

2 https://www.bea.aero/les-enquetes/evenements-notifies/detail/incident-grave-de-lairbus-a320-immatricule-ec-hqj-et-exploite-par-vueling-survenu-le-17-11-2017-en-croisiere [Accessed January 2021].

Discussion

The cause of the “wet sock” smell was traced to oil contamination of the aircraft’s No 2 ECS system. The source of the contamination is likely to have been oil leaking from at least one of the APU’s LRUs.

While not a significant factor in the analysis of this incident, standardised medical protocols for assessing personnel experiencing cabin air quality events could help immediate treatment and provide supporting evidence to future investigations.

SERIOUS INCIDENT

Aircraft Type and Registration:	Boeing 737-8K5, G-TAWG
No & Type of Engines:	2 CFM56-7B27E turbofan engines
Year of Manufacture:	2012 (Serial no: 37266)
Date & Time (UTC):	21 July 2020 at 0500 hrs
Location:	Birmingham Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 6 Passengers - 187
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	41 years
Commander's Flying Experience:	10,262 hours (of which 2,615 were on type) Last 90 days - 16 hours Last 28 days - 13 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and information from the operator

Synopsis

The operator had suspended operations for several months due to Covid-19 restrictions, and prior to the incident flight the reservation system from which the load sheet was produced had been upgraded. There was a fault in the system which, when a female passenger checked in for the flight and used or was given the title 'Miss', caused the system checked her in as a child. The system allocated them a child's standard weight of 35 kg as opposed to the correct female standard weight of 69 kg. Consequently, with 38 females checked in incorrectly and misidentified as children, the G-TAWG takeoff mass from the load sheet was 1,244 kg below the actual mass of the aircraft.

Following this serious incident, the operator introduced a daily check to ensure adult females were referred to as Ms on the relevant documentation, with a secondary check by Operations staff against passenger loads. A more formal system of checks was introduced on 24 July 2020.

History of the flight

General

The operator was the UK associated regional arm of a large European company, with a number of operating bases at major and regional airports within the UK. On 10 July 2020, three adult females were checked in for a flight as children. The reason was identified as the use of the title 'Miss', which the system interpreted as a child and not as an adult, equivalent to a weight difference of 34 kg. Action was taken to correct the problem, and the situation was monitored. On 21 July 2020, three flights by three different aircraft from the same operator departed from the UK with inaccurate load sheets caused by the same issue. G-TAWG was the first of the three to take off, at 0500 hrs from Birmingham International Airport.

The flight crew had two documents available to them: the flight plan showing the route and planning information with predicted takeoff weight; and a load sheet providing the actual weight and distribution of the passengers, including additional weight such as cargo, from which aircraft performance was calculated. Procedures for how these documents were used were set out in the airline's Operations Manual.

The incident flight

The aircraft was to depart on a scheduled flight from Birmingham International Airport to Palma de Mallorca airport (PMI), Spain. The weather at 0450 hrs, 10 minutes before departure, was wind calm, CAVOK, OAT 8°C, dew point 6°C and QNH 1026 hPa. As part of the prestart procedure, the flight crew reviewed the flight plan, which gave an expected takeoff weight (TOW) of 66,495 kg (Figure 1), and the load sheet, which gave a TOW of 64,889 kg (Figure 2). They noticed that there was a discrepancy, with the load sheet showing 1,606 kg less than the flight plan. They noted that the number of children shown on the load sheet was higher than expected, at 65, compared to the 29 which were expected on the flight plan. The commander recalled thinking that the number was high but plausible; he had experienced changing loads on the run-up to the temporary grounding[1] as passengers cancelled and altered trips at short notice.

```
PLD    : PAX 072/086/029 CGO 0KG

          EST        MAX    ACTUAL
DOW  042650    ------    .....
PLD  015918    ------    .....
ZFW  058568    061688    .....
TOF  007927    020895    .....
TOW  066495    078999    .....
TF   005281    ------    .....
LDW  061214    065317    .....
REM  002646    ------    .....
```

Figure 1

Flight plan weights and passengers

Footnote

[1] As a result of the imposition of Covid-19 restrictions.

PASSENGER/CABIN BAG	11328	70/	47/	65/	5/	TTL 187
		PAX Y	182			
TOTAL TRAFFIC LOAD	14066					
DRY OPERATING WEIGHT	42650					
ZERO FUEL WEIGHT ACTUAL	56716	MAX	61688	L	ADJ	
TAKE OFF FUEL	8173					
TAKE OFF WEIGHT ACTUAL	64889	MAX	78999		ADJ	
TRIP FUEL	5400					
LANDING WEIGHT ACTUAL	59489	MAX	65317		ADJ	

Figure 2

Load sheet weights and passengers

He remarked that variances between actual and expected Zero Fuel Weight (ZFW)[2] were not uncommon. A further issue with the load sheet on the flight was the baggage load, which had been calculated as 35 bags at a standard mass of 16 kg, and 150 bags whose actual masses averaged 14.5 kg per bag. This was an unusual occurrence, but the use of actual masses was permitted by the Operations Manual. The commander also took care to check the load sheet taxi fuel was correct, as he had noticed a discrepancy with the flight plan statistical taxi fuel[3]. After a brief discussion, the flight crew decided that they were content with the load sheet, the actual bag weights being very close to standard and the new ZFW being understood as a function of the differing passenger load.

The flight crew followed the normal procedure to calculate takeoff performance independently using the Boeing Onboard Performance Tool (OPT). With a light and variable wind, they elected to use a 5 kt tailwind with the load sheet data to compute takeoff performance. Nothing unusual was noticed by the crew on departure and the flight continued normally to the destination.

Subsequent use of the actual takeoff weight for performance calculations showed that all departure airspeeds should have been one knot greater than those used on the incident flight, and the thrust required should have been 88.9% N_1 compared to the 88.3% N_1 set on the incident flight. The screen displays from the Boeing OPT are shown in Figure 3, with the incorrect load sheet takeoff weight on the left and the correct takeoff weight on the right. The resulting one knot difference in takeoff speeds (V_1, V_2 and V_R) can be seen in the bottom right of each screenshot, and the different takeoff thrusts on the bottom left.

A calculation was carried out for the actual TOW and environmental conditions, using a calm wind rather than assuming a 5 knot tailwind. The result showed that a thrust of 88.2% N_1 would have been required to meet regulatory requirements.

The crew procedure for performance planning is set out at Figure 4.

Footnote

[2] The Zero Fuel Weight is the weight of the aircraft fully loaded with crew, passengers, bags and freight with only the weight of the fuel to be added.

[3] Statistical taxi fuel is a statistical prediction of the fuel expected to be used for taxiing based on previous departures.

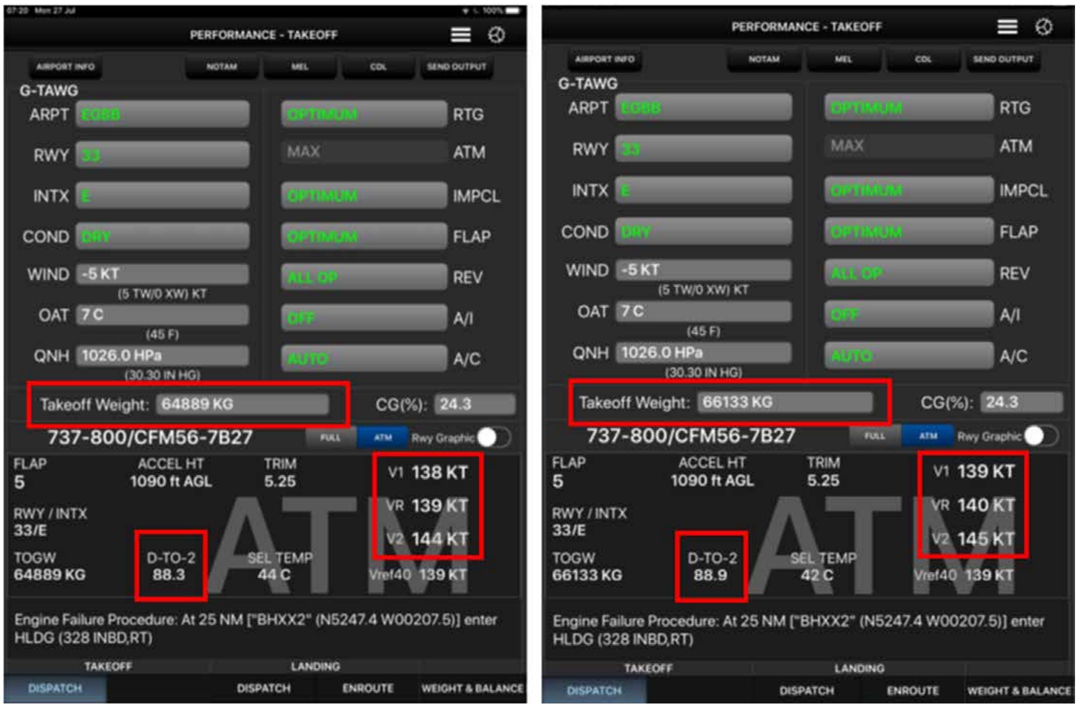


Figure 3

Boeing Onboard Planning Tool performance data

Table 2.2.6(1)

Captain	First Officer
Both pilots shall verify the loadsheet independently.	
Callout:	
• Actual ZFW	Verify against planned ZFW on OFP. Enter actual ZFW in CDU PERF INIT page. Call out PERF INIT GW minus taxi fuel as gross error check against loadsheet TOW.
• Actual TOW (check for gross error)	Verify against planned TOW on OFP.
• CRZ CG (use MACTOW or MACZFW whichever is lower). Verify CDU entries.	Enter CRZ CG on CDU PERF INIT page. Execute entries.
• MACTOW. Verify MACTOW entry	Enter MACTOW on TAKEOFF REF page 1/2.
All weights should be called out rounded up to the next higher 0.1T.	
For OPT calculation, agree airport, runway, takeoff weight, thrust, configuration and other assumptions. Complete takeoff calculation independently using the latest airport information.	

Figure 4

Performance planning procedure

The Ground Operations Manual sets out the actions to be taken should any last-minute changes (LMC) above a certain value be made to the payload (Figure 5).

3.4 Last Minute Changes

If any last minute change occurs after the completion of the loadsheet, (mass and balance documentation), this must be brought to the attention of the commander and the last minute change must be entered on the loadsheet (mass and balance documentation).

If the total LMC exceeds the values shown in this table below, a new mass and balance document must be prepared.

Aircraft Type	LMC Exceeds
B737	500 kg (Including fuel)

Figure 5

Last-minute change weight limit

Airline IT system

Part of the operator's IT system was an integrated check-in system, which was undergoing an upgrade as part of a wider system upgrade for the airline industry.

Prior to the upgrade being implemented, users were involved in considering any risks that might occur as part of the upgrade and, during User Acceptance Testing (UAT), the system functioned as expected. In some of the training meetings held in London in February 2020, the different titles for passengers, such as Mr, Mrs and Dr, used by the various markets, had been discussed in relation to standard IATA usage. The relationship between a passenger's title and the standard weight allocated was not discussed. No specific test scenarios looking at passenger titles were examined in the UAT.

On the first flight after the upgraded system was implemented, an adult female passenger was checked in for a flight as a child and was also shown on the load sheet as a child. This was spotted by the flight dispatcher and the operator's systems delivery manager. A check of the flight revealed two other cases where the same error had occurred. No safety or ground operations reports were submitted about this occurrence.

The system programming was not carried out in the UK, and in the country where it was performed the title Miss was used for a child, and Ms for an adult female, hence the error. A manual solution for correcting the problem was quickly identified that involved a team identifying upcoming flights, checking each booking, and changing all adult females with the title 'Miss' to 'Ms', which overcame the problem. Subsequently, this work was shared between two teams, and the process was completed every afternoon and evening for the next day's flights. It was checked again every morning, where possible, before flights departed.

As a further mitigation measure, Ground Operations had requested that the check-in-staff pay particular attention to female passengers and double check that they showed in the system as females and not as children when they presented themselves at the check-in desk or at the gate. This request was sent out electronically to all ground stations. This was initially a recommendation, as it was not prescribed in the Ground Operations Manual.

The upgrade programmers adapted a piece of software, which changed the title of any adult female from Miss to Ms automatically, and this was implemented on 17 July 2020. This adaptation was only capable of changing bookings before check-in. Any passenger bookings with the title Miss already checked in, including online up to 24 hours before departure, would not be amended. On 20 July 2020, the programmer was making enhancements to the program to improve its performance. This should not have stopped the program from working, but as this was a 'fix', it could not be known for sure.

A combination of the teams not working over the weekend and the 'online' check-in being open early on Monday 20 July, 24 hours ahead of the flight, meant the incorrectly allocated passenger weights were not corrected.

Analysis

The incident occurred due to a simple flaw in the programming of the IT system, which was due to the meaning of the title 'Miss' being interpreted by the system as a child and not an adult female. This was because in the country where the system was programmed, Miss is a child and Ms is an adult female. This issue had not been identified as part of the initial risk analysis and did not manifest itself during the trial simulations. For the incident flight, the weight of passengers on the load sheet was below the actual weight of the passengers by 1,244 kg, which was more than the 500 kg LMC weight difference above which a new load sheet should have been produced, had the weight discrepancy been identified.

When the issue was first identified, the operator had instigated Safety Action to prevent an incorrect load sheet being produced and used for aircraft performance planning. However, the work of correcting the adult females wrongly listed as children was handled by teams that were not working over the weekend. Passengers were able to check in online 24 hours before departure, on 20 July 2020. On this day, a software 'fix' was being applied to the system, possibly preventing it from identifying incorrect passenger status before the incident flight on 21 July.

Whilst an incorrect takeoff weight was used for aircraft performance planning, the thrust required for the actual TOW and environmental conditions (88.2% N_1) was marginally less than the thrust used for the takeoff (88.3% N_1). This meant the safe operation of the aircraft was not compromised.

Conclusion

A flaw in the IT system used by the operator to produce the load sheet, meant that an incorrect takeoff weight was passed to the flight crew. As a result, the aircraft departed with a takeoff weight 1,244 kg more than stated on the load sheet. An upgrade of the system producing load sheets was carried out to prevent reoccurrence.

Safety action

Following this serious incident, the operator took action to prevent re-occurrence:

- A member of the Systems team manually checked the flights daily to ensure that the title 'Miss' was amended to 'Ms'.
- A secondary check was instigated with the Operations department against the booked passenger loads.
- A reminder briefing was given to Ground Handling Agents to ask them to be alert at check-in or during boarding for any adult female passengers showing as Miss or a child.
- A formalised procedure for a Customer Care Executive to check bookings was instituted on 24 July 2020.

ACCIDENT

Aircraft Type and Registration:	Europa, G-BXTD
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	2000 (Serial no: PFA 247-12772)
Date & Time (UTC):	28 July 2020 at 1226 hrs
Location:	Enstone Airfield, Oxfordshire
Type of Flight:	Private
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to right wing, undercarriage strut, flaps and fuselage aft of the wing
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	65 years
Commander's Flying Experience:	20,076 hours (of which 91 were on type) Last 90 days - 37 hours Last 28 days - 21 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further inquiries made by the AAIB.

Synopsis

During a right turn and climb shortly after takeoff, the engine rapidly reduced speed and stopped. Unable to restart the engine, the instructor carried out a forced landing in a field. The aircraft was badly damaged but both occupants were uninjured.

The cause of the engine stoppage could not be positively determined. It was found that the bend radius of the oil pipe connected to the oil pump had narrowed the cross-section of the pipe, restricting oil flow into the engine. However, there were also possible causal factors of corrosion, due to an extended period in which the aircraft was not flown, and fatigue damage related to a previous incident.

History of the flight

On the morning of the accident, the weather at Enstone airfield was dry, clear and bright with over 10 km visibility. There was a light westerly wind with scattered clouds and the airfield runway surfaces were dry.

The intended flight was to be the first of a series of flights to enable an instructor to familiarise the owner with operating his Europa aircraft. The instructor was an experienced pilot holding an ATPL and Class Rating Instructor (Single Engine). The owner was also an experienced general aviation pilot.

The owner and instructor removed the aircraft from its trailer to prepare it for reassembly. Once satisfied it was rigged and assembled correctly, they prepared the aircraft for flight. Concerned that the engine had only been run for 44 minutes since the Permit to Fly check flight in December 2019, the instructor gave a detailed brief to the owner on the actions to take in the event of an emergency.

With the start-up checks complete, the engine was started and the aircraft taxied by the owner to grass strip Runway 26S. After completing engine power checks, the owner selected full power and commenced the takeoff roll. Both pilots reported that engine rpm, temperatures and pressures all remained normal during the takeoff. Both pilots also reported that it took slightly longer to achieve rotational speed than expected. They later attributed this to rolling resistance from the grass strip, the strip's upwards slope and the aircraft's weight, which had been calculated at just 2.1 kg below its maximum of 589.8 kg.

Once airborne and climbing, the rate of climb was 800 ft/min at 200 ft agl, which the owner and the instructor considered normal. The owner started a right turn to comply with local noise abatement measures when, at 520 ft agl, the engine rpm decreased over a period of approximately 5 seconds and then stopped. There were no indications of engine problems prior to the loss of rpm.

The instructor immediately took control of the aircraft and turned right, away from a large house near a wooded area and towards open fields. Estimating that they could not reach Enstone airfield safely, he promptly selected the most suitable field available for a forced landing. He pitched the nose of the aircraft down aggressively to maintain enough airspeed to reach the field while the owner attempted to restart the engine, but to no avail. The propeller did not move. The instructor called for the owner to switch the master and fuel switches off and touched down in the field of crops. As the landing speed was higher than normal, he realised they were going to run into a nearby hedgerow. He pulled hard on the brake lever, causing the aircraft to turn to face the opposite direction and the aircraft stopped before it reached the hedgerow.

Police, fire and ambulance services attended the scene but both pilots were uninjured and had climbed out of the aircraft before their arrival.

Accident site

Measuring the length of the path through the crops revealed that the aircraft had travelled approximately 50 metres along the ground before stopping. The landing and subsequent turn damaged the aircraft's right undercarriage outrigger, wing, flap and aileron. Cracks were evident in the rear fuselage between the cockpit and tail (Figure 1) and the tail section below the left elevator was also cracked and the skin distorted. There was no damage to the cockpit area.

Aircraft history

Built in January 2000, the previous owner had reported that the aircraft had suffered a propeller strike and the propeller had been replaced. The engine was shock-load tested but no further repairs or replacement parts were considered necessary. The aircraft had flown less than 580 hours when it was placed in storage in 2013. He reported that he had run the engine monthly to keep it in working condition.

Figure 1

Aircraft final resting position and cracks evident in the rear fuselage section

The new owner purchased the aircraft in March 2019 and started work to restore the aircraft to flight capability. He consulted with the aircraft manufacturer and an experienced Europa aircraft engineer to produce a detailed aircraft restoration and maintenance programme. He also completed a number of type conversion flights between March 2019 and February 2020 in a similar Europa aircraft.

The aircraft's LAA inspection and Permit to Fly check flight were completed on 2 December 2019 without incident and with the owner as passenger. Two more flights followed in February 2020 but no further flights were made in the aircraft before the day of the accident.

Engine examination

The exterior surfaces of the aircraft around the engine bay were clean although there was a small trail of oil under the aircraft from the oil breather 'catch-pot' overflow pipe. The oil tank and coolant levels were full.

When the propeller was turned, it rotated by 15° but would not turn any further. Rotax 912 UL engines are fitted with a torsional load absorption mechanism to reduce the effect of instantaneous loads during engine start, shut down and rapid power changes. This mechanism allows the propeller shaft to be rotated 15° before further rotation turns the engine crankshaft.

Before removing the engine, the owner noticed the cross-sectional shape of the pipe from the oil cooler had narrowed where it had been bent by 90° in order to connect it to the oil pump (Figure 2). On checking the Europa engine installation manual, the owner realised that an oil pipe with a pre-formed 90° bend was available, to avoid bending the pipe when connecting it to the pump. However, the owner also commented that later testing on a bench showed that this geometry only created an 'oval' cross-section in the pipe and did not 'kink' it. Further, the aircraft had flown with the pipe in this geometry for its Permit test flight and for a further flight as part of the owner's type conversion, with no indication of oil pressure problems at any stage.

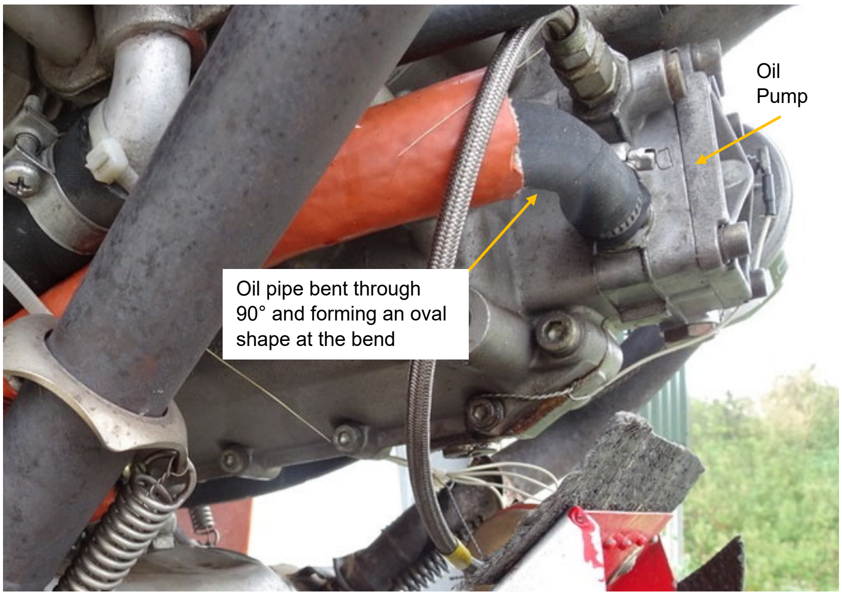


Figure 2

Oil pipe showing narrowing at the bend connecting it to the pump

After removing the pistons from the engine, dents were found on the top surfaces (crown). The shape of the dents matched the edges of the cylinder inlet valves. None of the inlet valve stems were bent and the edges of the valves showed no signs of impact damage. The dents in the piston crowns were also coated with carbon deposits (Figure 3).

Figure 3

Piston crowns showing dents from impact with inlet valves

The No 4 piston had also been in contact with the cylinder head, creating cylinder head shaped dents in the crown (Figure 4).

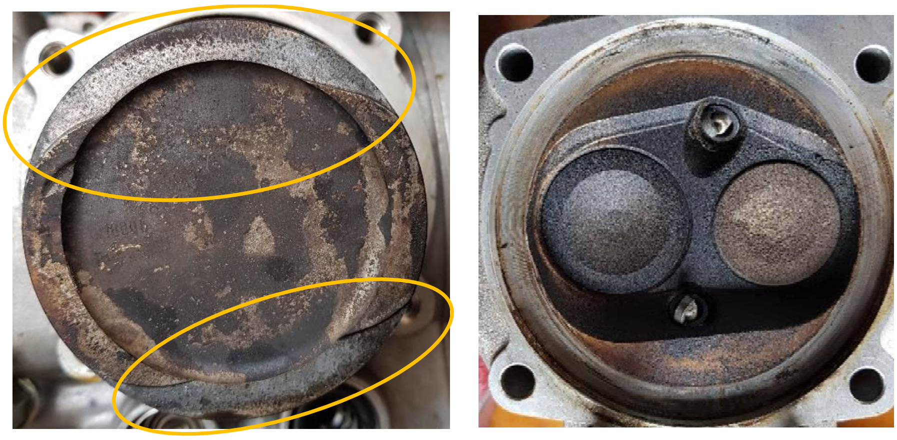


Figure 4

Piston crown (left) showing dents made by the cylinder head (right)

When the engine crankcase was opened, it was evident the No 4 piston connecting rod and bearing had failed at the attachment to the crankshaft (Figure 5). There were impact marks along the lower edges of the adjacent No 3 piston and cylinder.

Figure 5

Failed No 4 piston connecting rod

Surface pitting caused by corrosion was found around the sides of each piston below the piston rings.

Analysis

The inability to rotate the propeller beyond 15° indicated that the engine crankshaft was jammed and unable to rotate following the accident.

The sharp bend radius and distortion of the oil pipe at the connection to the oil pump would have caused oil flow to be restricted to the engine to some degree. However, the presence of oil in the crankcase, and over the working parts, shows that oil was reaching the working parts and the aircraft had flown a number of times in this condition, without adverse indications.

The inlet valve impact marks on the piston crowns indicate that an abnormal event, such as an engine overspeed after a propeller strike, had caused the valves and the pistons to collide at some point before the aircraft's purchase in 2019. The presence of carbon deposits in the dents also showed that the damage had occurred prior to the accident flight. Once the valves were removed and inspected, the owner determined that the valve stems were straight and there were no impact witness marks on the edge of the valve heads; the valves may have been replaced during a previous engine repair. The owner commented that he should have given more weight to the propeller strike information when deciding the depth of inspections necessary to restore the aircraft after the purchase in 2019.

Evidence of surface pitting around the sides of the pistons showed that a corrosive environment had existed within the crankcase and 'regular running' of the engine had probably not been enough to avoid corrosion damage during the extended period in which the aircraft was not flown. Corrosion-initiated fatigue may have weakened the engine's working parts, resulting in failure of the No 4 connecting rod.

Conclusion

The cause of the engine stoppage could not be positively determined. It was found that the bend radius of the oil pipe, connected to the oil pump, narrowed its cross section, restricting oil flow into the engine to some extent. However, bench tests of this geometry, and the fact that the aircraft had flown like this a number of times, indicated that it is unlikely to have been the major factor in the engine failure.

There were also indications of corrosion within the engine, probably due to an extended period in which the aircraft was not flown. There was further evidence of mechanical damage within the engine related to a previous incident, probably of a propeller strike and likely engine overspeed. The combination of these factors, the corrosion and mechanical damage, is more likely to have brought about the engine failure, through a fatigue mechanism in the No 4 connecting rod.

In considering these factors, the owner noted (as above) that after his purchase he should have given more weight to the reported propeller strike when deciding the depth of maintenance necessary to restore the aircraft. He also commented that his 'take-home' is that engines that have not been flown for many years should be treated with great caution.

Bulletin Correction

Prior to publication it was noted that the incorrect version of this report had been sent to the printers, therefore the version that appears in the hard copy of the April Bulletin is incorrect. The version that appears online and above is the corrected version.

ACCIDENT

Aircraft Type and Registration:	Rockwell Commander 112, G-LITE
No & Type of Engines:	1 Lycoming IO-360-C1D6 piston engine
Year of Manufacture:	1975 (Serial no: 291)
Date & Time (UTC):	23 September 2020 at 1410 hrs
Location:	Perranporth Airfield, Cornwall
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 2
Injuries:	Crew - None Passengers - None
Nature of Damage:	Extensive damage to landing gear and left wing
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	67 years
Commander's Flying Experience:	6,632 hours (of which 45 were on type) Last 90 days - 149 hours Last 28 days - 59 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries

Synopsis

The aircraft stalled onto the runway during takeoff and overran the end. The aircraft was probably over its maximum takeoff weight and may have been affected by windshear due to the proximity of cliffs at the end of the runway.

History of the flight

The pilot, a qualified flying instructor, left his home base at Sleap Airfield in Shropshire on the morning of the accident to pick up a passenger from Perranporth Airfield in Cornwall. He took a member of the flying club with him who was learning to fly, but who did not operate the aircraft. On arrival at Perranporth he landed on Runway 27 without incident.

After a short time on the ground the pilot prepared for the return flight to Sleap Airfield. For the departure, the passenger boarding the flight at Perranporth occupied the front right seat of the aircraft with the other passenger now sat in the rear of the aircraft. Newquay Airport, 5 nm to the north, was reporting a wind of 14 kt from 300°, which the pilot considered favoured a takeoff from Runway 27. After start he taxied for Runway 27 and made a power check, which did not reveal any problems. He then entered Runway 27, carrying out a rolling takeoff with 10° of flap set.

The pilot reported that the aircraft appeared to accelerate normally and became airborne at about 60 kt, before it was halfway down the runway, but that it failed to climb. The stall warner then "squeaked" and the aircraft settled back onto the runway briefly before becoming airborne again. He reported the aircraft then stalled, hitting the runway hard. There was then insufficient runway remaining in which to stop the aircraft and it overran the end, causing extensive damage. Once the aircraft came to rest the three occupants, who were uninjured, were able to vacate unaided using the cabin door.

Aerodrome information

Perranporth Airfield is an unlicenced aerodrome located on the north Cornish coast at an elevation of 330 ft amsl. It has two operational asphalt runways: Runway 05/23 (799m) and Runway 09/27 (741m). At the time of the flight, both runways were available for use. Due to the proximity of sea cliffs at the end of Runway 27 two popular VFR flight guides carried a warning that aircraft using this runway should expect windshear and severe turbulence in strong winds.

Since the accident, one of these guides has been updated to advise that Runway 09/27 is not now generally available due to these wind effects. The guide also now provides more detailed information in the related warning advising of 'Rotor/Curl-over' affecting approximately the last quarter of Runway 27 during onshore winds over 10 kt. It warns that this results in changes to head and tail wind components in excess of 10 kt and more than 1,000 ft/min sink rates with severe turbulence, stall and loss of control.

Both the airfield and the flying club based there had their own websites, although neither of these provided information on the wind effects possible on Runway 27. The airfield website stated that Runway 27 was only available by approval, either over the radio or when booking prior to flight, but suggested that this was due to other users of the runway rather than because of the possible wind effects. The flying club website provided users with links to two other published information providers: one included the warning about Runway 27, but the other provided only basic information, with no warnings included.

Pilots phoning to book into the airfield were asked to provide some basic information about the aircraft, departure point and any fuel required on landing. Operational information regarding the airfield, including the warnings associated with Runway 27 was not routinely passed on as it was considered the person normally taking the call was not suitably qualified to do so.

Flight planning

The pilot reported he had flown to Perranporth Airfield twice before during the year, the last time only about a week earlier. On both flights the pilot reported he used Runway 05/23. For the flight on the day of the accident he used a flight planning app to carry out his pre-flight planning. The software provided basic aerodrome information but did not include any aerodrome warnings. The pilot reported he did not refer to a flight guide or other sources of information to get additional information prior to the flight. He was not aware of the warning related to Runway 27 and had not been advised of it when contacting the airfield to book his flight or when at the airfield itself.

Weight and balance

The pilot had planned to take sufficient fuel for the return flight with an additional 45 minute reserve. He estimated each of the two flights would take 90 minutes and, as the aircraft used 9 USG per hour, this gave a total fuel requirement of 33.75 USG. He stated he had refuelled the aircraft prior to departure from Sleap, dipping the tanks to check he had the correct quantity on board. He had then calculated his fuel onboard when at Perranporth for his departure as weighing 158 lbs, but had not re-dipped the tanks.

The pilot reported he had asked the passengers their weights, which had each been given as 14.5 stone, equivalent to 203 lbs. The pilot stated his own weight was 11 stone, equivalent to 154 lbs. He also reported there was a single bag weighing 10 lbs.

Other evidence suggests that some of these weights may have been underestimated.

The pilot used these figures to calculate a takeoff weight of 2,635 lbs, 15 lbs under the maximum takeoff weight of 2,650 lbs. The same weights were also used to calculate the aircraft's Centre of Gravity (C of G), although the pilot used different lever arms to those quoted in the aircraft's C of G schedule. Despite this the aircraft was, using the weights provided, within the permitted C of G range.

Previous accident

A previous accident occurred at the airfield on 11 August 2016 and was investigated by the AAIB[1]. The aircraft involved also sunk back onto Runway 27 on takeoff and overran the end in virtually identical wind conditions. Both occupants received minor injuries and managed to vacate the aircraft, but the aircraft had then been destroyed by fire.

Analysis

Based on the information provided, at takeoff the aircraft was probably above its maximum permitted takeoff weight. This may well have accounted for the difficulties described by the pilot in trying to get airborne at the normal takeoff speeds described, resulting in the aircraft settling back onto the runway. When the aircraft became airborne for the second time it was then probably far enough down the runway to encounter the negative wind effects associated with the prevailing wind. This, combined with the aircraft's weight, are consistent with the stall described.

The accident emphasises the importance of using properly derived weights and figures, especially when an aircraft's weight is known to be close to any limits.

In addition, the accident highlights the variety of information sources available to pilots and the potential difficulty in ensuring they have secured the appropriate information required. Whilst the provision of reliable information for licenced aerodromes is formalised through Aeronautical Information Publications there is no equivalent system for unlicenced

Footnote

[1] Reference: AAIB Bulletin 11/2016, Piper PA-28-161 Cherokee Warrior II, G-CGDJ (EW/G2016/08/06).

aerodromes. These aerodromes generally rely on information they provide themselves directly or through others, such as the publishers of flight guides. Other sources of information, such as planning software, may intentionally only publish basic information in the expectation that pilots will refer to other sources.

It is important therefore that pilots understand the limitations of any sources of information they may use. Of equal importance therefore is the need for those providing information to ensure it is not only fit for the purpose for which it is intended but that those using it may understand the extent of what is being provided.

Safety action

Runway 09/27 has now been removed from normal operations. Whilst the runway may still be used, pilots can only do so after having received specific information on the associated limitations.

Both the airfield owner and resident flying club will also be reviewing their websites to incorporate this new information.

ACCIDENT

Aircraft Type and Registration:	Aviad Zigolo MG12, G-CIUF
No & Type of Engines:	1 Monster 185 piston engine
Year of Manufacture:	2015 (Serial no: 4/2015/27)
Date & Time (UTC):	4 November 2020 at 1140 hrs
Location:	Near West Heath Common Quarry, West Sussex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to right mainwheel strut and fuselage tubes
Commander's Licence:	Private Pilot's Licence
Commander's Age:	64 years
Commander's Flying Experience:	1,376 hours (of which 24 were on type) Last 90 days - 17 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft's propeller drive belt failed shortly after takeoff, resulting in a forced landing in which the aircraft was damaged, but the pilot was not injured. An improved quality drive belt is now available from the aircraft kit importer.

History of the flight

The pilot took off from a farm airstrip near Rogate, West Sussex, for a local flight and reported that the initial climb performance and engine rpm were normal. On reaching 900 ft agl the engine speed fluctuated, and the pilot heard a flapping sound as the propeller drive belt started to fail. The pilot reduced the throttle setting and the drive belt snapped. He then closed the throttle and the engine stopped abruptly.

The pilot set up an approach to a grass field but as he descended the glide deteriorated and the aircraft undershot into a very narrow field, coming to rest against a willow bush (Figure 1). The willow bush absorbed some of the impact energy and the pilot, who was uninjured, was able to vacate the aircraft without assistance. The aircraft's right mainwheel strut and some of the fuselage tubes were damaged in the impact.

Figure 1
G-CIUF following the forced landing

An inspection of the aircraft by the pilot after the accident found that the engine had seized, which he considered to have been caused by the engine over-speeding after the propeller drive belt had failed. The engine-driven belt pulley showed signs of overheating, due to the belt slipping.

The Aviad Zigolo MG12 is classified by the CAA as a single seat deregulated (SSDR) type, and is therefore unregulated with respect to its airworthiness. The aircraft maintenance manual requires that the drive belt is changed at 100 hour intervals. The failed belt had accumulated 44 hours in service since installation. The pilot stated that drive belts of improved quality were now available from the aircraft kit importer.

Conclusion

The forced landing occurred due to the failure of the propeller drive belt. The drive belt had not exceeded its suggested service life, but new drive belts of improved quality are now available from the aircraft kit distributer.

ACCIDENT

Aircraft Type and Registration:	Ikarus C42 FB100 Bravo, G-OSPH
No & Type of Engines:	1 Rotax 912ULS piston engine
Year of Manufacture:	2012 (Serial no: 1205-7202)
Date & Time (UTC):	1 December 2020 at 1330 hrs
Location:	Chilbolton Airfield, Stockbridge, Hampshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Landing gear collapsed
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	42 years
Commander's Flying Experience:	127 hours (of which 60 were on type) Last 90 days - 23 hours Last 28 days - 7 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries made by the AAIB

Synopsis

The pilot normally flew this aircraft from the left seat; however, on this occasion he was flying a short cross-country flight from Blackbushe to Chilbolton whilst occupying the right seat. This meant that his hands were transposed on the control column and throttle lever from their usual position. During the landing, at approximately 5 ft to 10 ft agl, the pilot felt the aircraft descending more rapidly than he had intended. To correct the rate of descent, he instinctively pushed the control column forward rather than the throttle, which resulted in a hard landing during which the landing gear collapsed.

Aircraft description

The Ikarus C42 primary flight control consists of a control column mounted on a centre console between the pilot seats. There are two throttle levers pivoted on the cockpit floor directly in front of the seats between the pilot's legs.

Pilot and passenger position in the cockpit

The pilot normally flew the aircraft from the left seat. However, as he was flying with an experienced passenger, who had also been his instructor, he reported that he "elected to fly" as the aircraft commander from the right seat.

The pilot's operating handbook does not specify which seat the aircraft commander should occupy. In conventional GA flying, the aircraft commander normally occupies the left seat unless they are a pilot under training with an instructor.

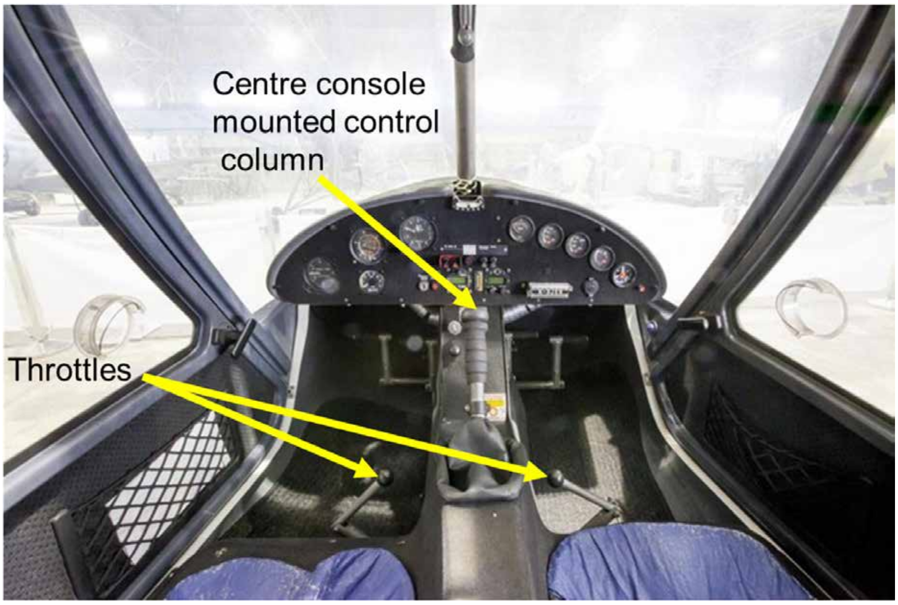


Figure 1

Example Ikarus C42 cockpit layout (Image © National Museums Scotland)

Pilot's comments

The pilot was very clear as to the cause of this accident and identified the following causal factors:

- With a more experienced pilot, who had previously been his instructor, sitting next to him, his familiarity with the aircraft and destination caused him to feel that it was a routine flight. However, he had not identified the risks that the subtle differences in flying from the right seat might introduce.
- He normally flew from the left seat which meant that he operated the control column with his right hand and the throttle with his left hand. His hand positioning, when operating the aircraft from the right seat, was transposed. As he was landing, he instinctively corrected what he felt was a too rapid a descent; however, his automatic sub-conscious response moved his left hand forward on the control column rather than the throttle.
- The proximity of the aircraft to the ground left no time for the pilot to apply the correct control inputs and rectify the situation.

AAIB comment

This accident illustrates what a seemingly minor change or difference can make to a routine flight. All types of flying require complex sets of processes and procedures. Training and practice introduce automatic corrective response reactions as dynamic conditions arise during flight. If a change is introduced which alters the validity of the automatic responses, care should be taken to assess the risk that change will bring, and how that risk might be mitigated.

ACCIDENT

Aircraft Type and Registration:	Mainair Blade, G-CBJT
No & Type of Engines:	1 Rotax 582-2V piston engine
Year of Manufacture:	2001 (Serial no: 1302-1101-7-W1097)
Date & Time (UTC):	24 August 2020 at 1800 hrs
Location:	Otherton Airstrip, Staffordshire
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - 2 (1 Minor) (1 Serious) Passengers - N/A
Nature of Damage:	Damaged beyond economic repair
Commander's Licence:	Private Pilot's Licence
Commander's Age:	60 years
Commander's Flying Experience:	1,137 hours (of which 1,098 were on type) Last 90 days - 39 hours Last 28 days - 18 hours
Information Source:	Aircraft Accident Report Forms submitted by both pilots

Synopsis

Shortly after takeoff the aircraft suffered a loss of power. The instructor took control and turned the aircraft to the right with the intention of carrying out a forced landing. A steeply-banked turn was required to avoid a tree and the aircraft descended rapidly. The aircraft struck the ground in a ploughed field and stopped after approximately six metres. The student in the front seat suffered serious injuries and the aircraft was damaged beyond economic repair.

History of the flight

The aircraft was taking off from Otherton Airstrip for a dual cross-country navigation exercise to Pound Green Airfield. The crew consisted of a student, who was also the aircraft owner, in the front seat and the instructor, as commander, in the rear seat.

The sortie plan was to depart Runway 25 at Otherton, with the student as PF, and climb in the overhead before commencing the cross-country route. The meteorological conditions were benign with good visibility, no cloud below 3,600 ft amsl and the wind was from 200º at 3 kt. During the takeoff roll and initial climb, engine temperatures were normal and there were no abnormal symptoms. After takeoff, the student made a left turn to a crosswind leg, avoiding overflying some ponds to reduce disturbance to people fishing. The instructor stated that "The student made an early to port turn and the aircraft was flown to the left of the track[1] which I normally encourage my students to follow in order to comfortably make the fields on the right of the crosswind leg in the event of an engine failure." However, the instructor did not correct the flightpath. The student believed he followed the line of the track as taught. Between approximately 90 and 150 ft agl, the aircraft suffered a marked power loss, and the instructor took control. In his view there was no option to land ahead and so he initiated a turn to the right, intending to land along the furrows of a potato crop in an adjacent field (Figure 1).

Figure 1
Approximate flight path of aircraft.

As the aircraft turned right, the intended approach path crossed a line of trees. The instructor stated: "I commenced a turn between two trees with the intention of landing between them, but the skidding of the aircraft was drawing us nearer to the tree to port. I had to increase the rate of turn to avoid the tree and we lost height rapidly." In doing so, he applied an angle of bank (AOB) of between 45° and 60º, with a consequent significant increase in the rate of descent.

The recollection of the impact sequence differed between the occupants. The student recalled the aircraft striking the ground while still banked to the right. The instructor recalled that, when he believed the aircraft would clear the tree, he levelled the wings at approximately 20 ft agl and then began to flare for landing. As the aircraft struck the ground the landing gear dug in, decelerating the aircraft rapidly. Looking at the accident site later, the instructor believed the left wing struck the tree and caused the aircraft to yaw left. The instructor estimated that the aircraft only covered six metres during the impact sequence, and the time elapsed from engine failure to impact was approximately 15 seconds.

The aircraft came to rest pointing back towards the airfield, and the forward fuselage was badly damaged (Figure 2). The student suffered serious injuries, but the instructor suffered minor injuries and was able to extract himself from the aircraft. He asked some passers-by to call an ambulance and he remained with the student until the emergency services arrived to effect a rescue.

Footnote

[1] The track referred to is the access track shown by the white line in Figure 1.

Figure 2

Aircraft after the forced landing

Aircraft information

The Mainair Blade is a two-seat flex-wing microlight powered by a two-stroke Rotax 582 engine (Figure 3).

Personnel

The instructor had conducted all bar two lessons of the student's training. This had consisted of 52 hours 45 minutes dual instruction and 10 hours 45 minutes of supervised solo flight. Of this time, 24 hours 5 minutes had been flown in the accident aircraft.

Analysis

The engine failed shortly after takeoff, so the aircraft was at low altitude and low speed and there was very little time to consider options. The student had been taught forced landing techniques and his instinct was to land ahead when the engine failed. The instructor, as commander, took control immediately the engine failed. In his view there was insufficient clear distance to land safely ahead or to the left, so he initiated a turn to the right intending to land in a crop field. The intended approach path to that field crossed a line of trees but to avoid the closest tree the instructor used up to 60º AOB. The high AOB increased the rate of descent and the instructor's workload significantly.

As a result of the increased rate of descent, the aircraft could not reach the intended touchdown point and was extensively damaged during the impact sequence. As a result of the fuselage disruption, the student suffered serious injuries and had to be rescued by the emergency services.

The cause of the engine failure was not determined.

Figure 3
Mainair Blade microlight

Conclusion

The engine failed, for an unknown reason, at very low altitude. The instructor flew a right turn to attempt a forced landing in an adjacent crop field. The aircraft struck the ground and decelerated rapidly causing extensive damage. The student in the front seat was seriously injured.

ACCIDENT

Aircraft Type and Registration:	X'Air Falcon 582(2), G-CGOV	
No & Type of Engines:	1 Rotax 582/48-2V piston engine	
Year of Manufacture:	2010 (Serial no: BMAA/HB/599)	
Date & Time (UTC):	13 September 2020 at 1730 hrs	
Location:	Old Park Farm Airfield, Port Talbot	
Type of Flight:	Private	
Persons on Board:	Crew - 2	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Damage to landing gear	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	41 years	
Commander's Flying Experience:	361 hours (of which 146 were on type) Last 90 days - 1 hour 30 minutes Last 28 days - 1 hour 30 minutes	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

Synopsis

The aircraft landed heavily in a field beside the departure runway following a total loss of engine power shortly after takeoff. The cause of the engine failure was not determined.

History of the flight

The pilot was flying from Old Park Farm Airfield, a grass airstrip with a 300 m runway aligned north-south and a shorter runway aligned approximately 12/30. In light winds, departure on Runway 18 is the preferred option owing to its slight downward gradient. High-tension power lines cross the departure paths to the south and west, and there is a large area of rough open ground about 1 nm to the south-west between the airfield and Swansea Bay. The pilot was familiar with the airstrip and had considered the options if faced with an engine failure when departing from the southerly runway.

The wind was light and variable, and the temperature was 21ºC with a dew point of 13ºC.

The pilot started the aircraft and carried out the engine warm-up checks before taxiing from the hangar to the takeoff point where the power checks were carried out. She reported that all indications during the engine warm up and power checks were normal. The pilot then shut down to allow a second pilot to embark the aircraft, before starting it once more and repeating the engine power checks without issue.

After waiting for 5 minutes while other aircraft landed, the pilot took off from the southerly runway, setting full power before releasing the brakes to achieve a short takeoff. The pilot reported that the engine power, acceleration and climb performance were all normal. The aircraft departed to the south-west and was turning more westerly during the climb, passing 600 ft aal, when the pilot described experiencing a "coughing" of the engine followed a few seconds later by total power loss.

The pilot turned the aircraft away from the high-tension power lines and rough open ground ahead, back towards the airstrip, and identified a field short of the airstrip in which to land. Subsequently, she realised the aircraft would overshoot the intended landing point and turned left into the field containing the airstrip. She stated that a "loss of lift" occurred late on the approach which she attributed to localised wind effects owing to trees. The aircraft landed in a part of the field containing crops and a steeper gradient than the runway. The occupants were uninjured, but the landing gear was extensively damaged.

Previous flight

The aircraft's previous flight, conducted to renew its permit to fly, was on 11 August 2020. The aircraft had been re-filled with Mogas from a nearby petrol station for the flight, which took place without incident.

Imagery

A video of the accident flight showed a loss of engine power with a smooth rundown, followed by several 'surges' before it stopped completely. The propeller appeared to be free to turn in the airflow following the loss of power. The video showed that the pilot maintained an initial speed of 60 mph which reduced to 50 mph in the latter stages of the approach. It also showed that the late turn into the field in which the aircraft landed was made at less than 200 ft aal.

Aircraft information

The X'Air Falcon is a fixed wing microlight. The wing is mounted above the fuselage and the engine is mounted centrally above and in front of the wing leading edge. Fuel is fed from the fuel tanks, located in the fuselage behind the seats, by a fuel pump fitted close to the engine. The fuel pump is actuated pneumatically using pressure impulses from the engine crankcase.

The engine manufacturer recommended:

> *'If possible, the* [fuel] *pump should be located below the fuel tank level…. If the fuel tank is considerably lower than the engine, an electric pump should be used.'*

The aircraft did not have an electrical fuel pump.

The ASI is calibrated in mph. An aide-memoire in the cockpit stated the best glide speed as 60 mph IAS and the stall speed as 32 mph IAS. The flight test schedule for the renewal of the Permit to Fly recorded that the clean stall was demonstrated at 31 mph.

The pilot observed that, during practice forced landings, the high-mounted engine could disrupt the airflow over the elevator resulting in less control authority.

Figure 1

G-CGOV, X'Air Falcon (with permission of the owner)

Post-accident inspection

A preliminary inspection by a BMAA Inspector found that the engine turned freely by hand with apparent compression and the engine-driven fuel pump was working. Fuel was found in the tank and the carburettor float bowls, with no dirt or particulates in the fuel filter. However, the fuel appeared "*yellowed*" in colour. The reason for this was not determined.

Mogas

The LAA published a Technical Leaflet (TL)[1] on the use of Unleaded Mogas, stating:

> *'Unleaded Mogas… has a much higher vapour pressure than 100LL or UL91 Avgas. The initial boiling point of the fuel is only slightly above ambient temperature, so it takes only a slight rise in temperature or drop in pressure to make it start to vapourise.'*

Accordingly, it also states:

> *'...unleaded Mogas fuel is restricted to operation with a fuel tank temperature not exceeding 20° C and an altitude not exceeding 6,000 ft.'*

Footnote

[1] LAA, TL2.26 *'Procedures for the use of unleaded MOGAS to EN228'*, Issue 2, Dec 2017, available at http://www.lightaircraftassociation.co.uk/engineering/TechnicalLeaflets/Operating%20An%20Aircraft/TL%202.26%20Procedure%20for%20using%20E5%20Unleaded%20Mogas.pdf [accessed January 2021].

The TL states that vapour problems are most likely to occur *'… in aircraft fitted with engine-driven mechanical fuel pumps….'*, and:

> *'In the typical aircraft system the fuel pump is located above the fuel tank, so the fuel pressure on the upstream side of the fuel pump is reduced below atmospheric by the action of the pump sucking up the fuel, making it very vulnerable to fuel vapour formation on the inlet side of the pump….'*

In a properly designed fuel system any vapour that forms should not become trapped, but it is possible that the vapour could form in low pressure areas, such as the suction side of a fuel pump, and this can cause a stream of vapour bubbles to enter the carburettor resulting in a loss of power and, if not addressed, a total loss of power.

Although the BMAA has not published similar limitations, it stated that it viewed the LAA TL and the limitations it applies as:

> '…*a helpful guide or rule of thumb. Owners should be mindful that these factors increase the likelihood of vapour locking as well as Ethanol content, general fuel quality, fuel system layout and method of aircraft operation.'*

Carburettor icing

Safety Sense Leaflet 14, '*Piston Engine Icing*'[2], published by the CAA describes the types of icing that may be encountered, and the engine factors and atmospheric conditions that contribute to icing with piston engines. The leaflet presents a chart which provides a graphical representation of the temperature and humidity conditions where engine icing may occur. The temperature and dewpoint on the day of the accident would have resulted in a relative humidity in the region of 60%, where the chart presents that moderate icing may be encountered when cruise power is set, or serious icing when descent power is set.

The LAA TL states that tests have shown that:

> *'when using Mogas, carburettor icing will commence under an even wider range of temperature and humidity conditions than with Avgas.'*

Analysis

Causes for the loss of power

A preliminary inspection of the engine did not reveal a cause for the loss of power. The discoloration of the fuel may indicate the poor quality of the fuel, but the short period that had passed since the aircraft had been refuelled would suggest that there had not been sufficient time for it to degrade. The BMAA Inspector who carried out the inspection suggested that the nature of loss of power seen in the video may indicate electrical failure, as opposed to fuel starvation or quality, as the cause.

Footnote

2 CAA, January 2013, available at http://publicapps.caa.co.uk/docs/33/20130121SSL14.pdf [accessed January 2021].

Another possibility for the loss of power is vapour forming in the fuel. The design of the fuel system is such that the fuel pump draws fuel from the tank some distance below it. For this design of fuel system where the fuel tank is much lower than the engine, the engine manufacturer recommends an additional electric fuel pump installed below the fuel tank level.

The low pressure from the suction required to raise the fuel from the tank to the engine fuel pump made the formation of vapour more likely. The low fuel flow during the 5 minutes holding before takeoff may have allowed these vapour bubbles to accumulate and cause the power loss after takeoff.

Carburettor icing was possible with the conditions experienced that day and the use of Mogas would also have increased the likelihood. However, the loss of power occurred while full power was set during the climb, and not a lower power setting when the risk of carburettor icing is more likely. The nature of the power loss also suggests that carburettor icing was not the likely cause.

The turnback

Prior to the flight the pilot had considered the threats and appropriate options in the event of an engine failure. This meant she was mentally prepared for such an event and able to make the decisions necessary for a safe turnback from the wires and the open rough ground ahead. Aware of the need to mitigate the risk of stalling in the turn, while also ensuring sufficient control authority, the pilot maintained 60 mph throughout the turn.

The reduction of airspeed below the best glide speed in the latter stages of the approach would have increased the rate of descent of the aircraft. The left turn into the field containing the airstrip in the final stages of the approach would not only have further increased the rate of descent but also given the pilot limited opportunity to assess the touchdown among crops on the steeper gradient.

Conclusion

The aircraft suffered a hard landing following the total loss of engine power. The cause of the engine failure was not determined, but fuel vapour locking or carburettor icing were both possibilities given the configuration of the fuel system and the use of Mogas.

Although the aircraft was damaged in the subsequent forced landing, the pilot was able to achieve a safe turn away from obstacles because she had considered beforehand what she would do following an engine failure during departure from this runway. However, the loss of performance during the late turn into the landing field in the final stages of the approach probably contributed to the hard landing.

AAIB Record-Only Investigations

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

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

The accuracy of the information provided cannot be assured.

Record-only investigations reviewed January - February 2021

10-May-17 **DH87B Hornet Moth** **G-ADKM** Weybread Farm Strip, Suffolk

The pilot described the touchdown on the grass airstrip as "hard and not well controlled", and reported damage to the landing gear, the propeller tips and lower wing tips. A subsequent maintenance inspection revealed damage to the lower wing spars. The pilot considered his lack of experience on type was a contributory factor, and commented that the LAA scheme for type conversion may have been beneficial.

08-Aug-20 **Thruster T600N 450** **G-RAFH** Ballyclare, Co Antrim

The aircraft's engine failed during flight, resulting in a forced landing. The aircraft struck the boundary hedge at the far end of the field, damaging the aircraft.

15-Aug-20 **Vans RV-9A** **G-CGXR** Kirkbride Airfield, Cumbria

During the rollout after a normal landing, the nose of the aircraft began to oscillate up and down and the nose landing gear collapsed. There were no injuries.

23-Oct-20 **Extra EA 300/L** **G-BZII** Little Gransden Airfield, Bedfordshire

On approach, at approximately 20 ft agl, the aircraft developed a high rate of decent. This resulted in a heavy landing and the main landing gear collapsed on touchdown. The engine, wing and propeller were also damaged.

09-Dec-20 **Piper PA-28-151 (Modified)** **G-BOTI** Dunkeswell Aerodrome, Devon

After refuelling the aircraft, the commander taxied across the displaced threshold of Runway 22 towards a link taxiway. The right-wing struck a metal post on the boundary fence.

21-Dec-20 **Eurofox 912(S)** **G-OSGC** Portmoak Airfield, Kinrosshire

Prior to commencing aerotow operations, the pilot conducted a partial runway inspection and determined that the surface conditions were suitable for the intended flying. While landing from his fifth aerotow of the day, the pilot encountered unexpectedly soft ground as he slowed through 25 kt. The aircraft "rapidly decelerated" causing the its tail to lift. The pilot did not have enough elevator authority to counter the rotation. The aircraft continued pivoting about the main wheels before coming to rest inverted.

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

3/2014 Agusta A109E, G-CRST
Near Vauxhall Bridge,
Central London
on 16 January 2013.

Published September 2014.

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

Published July 2015.

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

Published August 2015.

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

Published October 2015.

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

Published March 2016.

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

Published September 2016.

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

Published March 2017.

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

Published March 2018.

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.

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
DFDR	Digital Flight Data 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)
FIR	Flight Information Region
FL	Flight Level
ft	feet
ft/min	feet per minute
g	acceleration due to Earth's gravity
GPS	Global Positioning System
GPWS	Ground Proximity Warning System
hrs	hours (clock time as in 1200 hrs)
HP	high pressure
hPa	hectopascal (equivalent unit to mb)
IAS	indicated airspeed
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
IP	Intermediate Pressure
IR	Instrument Rating
ISA	International Standard Atmosphere
kg	kilogram(s)
KCAS	knots calibrated airspeed
KIAS	knots indicated airspeed
KTAS	knots true airspeed
km	kilometre(s)
kt	knot(s)
lb	pound(s)
LP	low pressure
LAA	Light Aircraft Association
LDA	Landing Distance Available
LPC	Licence Proficiency Check
m	metre(s)
mb	millibar(s)
MDA	Minimum Descent Altitude
METAR	a timed aerodrome meteorological report
min	minutes
mm	millimetre(s)
mph	miles per hour
MTWA	Maximum Total Weight Authorised
N	Newtons
N_R	Main rotor rotation speed (rotorcraft)
N_g	Gas generator rotation speed (rotorcraft)
N_1	engine fan or LP compressor speed
NDB	Non-Directional radio Beacon
nm	nautical mile(s)
NOTAM	Notice to Airmen
OAT	Outside Air Temperature
OPC	Operator Proficiency Check
PAPI	Precision Approach Path Indicator
PF	Pilot Flying
PIC	Pilot in Command
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

Air Accidents Investigation Branch