Air Accidents Investigation Branch

# AAIB Bulletin 7/2025

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*Cover picture courtesy of Niall Robertson*



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### SPORT AVIATION / BALLOONS

None

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None

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## 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:** | ATR 42-500 (600 version), G-LMSA |
| **No & Type of Engines:** | 2 Pratt & Whitney Canada PW127M turboprop engines |
| **Year of Manufacture:** | 2017 (Serial no: 1213) |
| **Date & Time (UTC):** | 23 July 2024 at 1230 hrs |
| **Location:** | Aberdeen International Airport |
| **Type of Flight:** | Commercial Air Transport (Passenger) |
| **Persons on Board:** | Crew - 3 Passengers - 30 |
| **Injuries:** | Crew - None Passengers - None |
| **Nature of Damage:** | Significant damage to No 1 engine turbine assemblies and fire and heat damage to No 1 engine inside cowlings |
| **Commander's Licence:** | Airline Transport Pilot's Licence |
| **Commander's Age:** | 40 years |
| **Commander's Flying Experience:** | 2,700 hours (of which 210 were on type)<br>Last 90 days - 181 hours<br>Last 28 days - 62 hours |
| **Information Source:** | AAIB Field Investigation |

## Synopsis

Whilst in the cruise, the aircraft suffered a contained failure of the No 1 engine and a subsequent fire inside its cowlings due to a leak from the fuel return line which had become sufficiently loose following the engine failure to result in fuel leakage. The flight crew correctly followed the checklist procedures to shut down the engine, and the fire was extinguished. The aircraft landed without further incident.

Although this is the only known instance of this fuel line becoming loose, the aircraft manufacturer has commenced a safety review to identify any possible safety actions which would further reduce the likelihood of leakage from the fuel return line.

## History of the flight

The crew were operating their fourth sector of the day on a return flight to Glasgow Airport from Sumburgh Airport in Shetland. The aircraft took off from Runway 27 at 1129 hrs, then turned onto a southerly track, climbing to FL180 in the Y905 airway to the Aberdeen VOR. The commander was the pilot flying while the co-pilot was the pilot monitoring.

At approximately 1201 hrs, approaching RISDU, a reporting point 28 nm north-east of Aberdeen Airport, the commander described hearing a “big thump”, or a “muffled bang”. The aircraft immediately yawed to the left, which was corrected by the rudder trim under the control of the autopilot. The commander noticed an amber HBV[1] label had replaced the digital counter on the No 1 engine torque indicator and that the torque had reduced to nearly zero. At the same time, the No 1 engine Interstage Turbine Temperature[2] (ITT) was increasing rapidly. The co-pilot announced that there was an ENG 1 OVER LIMIT caution. They cancelled the Master Caution attention getter[3] and started the relevant abnormal checklist procedure displayed on the Engine and Warning Display (EWD). However, the checklist was interrupted by an ENG 1 FIRE warning. The crew completed the emergency checklist procedure for an engine fire in flight (Figure 1). Both fire bottles had to be discharged before the ENG 1 FIRE warning extinguished.

**ENG 1(2) FIRE OR SEVERE MECHANICAL DAMAGE IN FLIGHT** **E70.02**

- ► PL (affected ENG)............................................................................ FI
- ► CL (affected ENG)......................................................... FTR THEN FUEL S.O.
- ► FIRE HANDLE (affected ENG)........................................................... PULL
- ■ **If fire persists after 10 s**
  - ► AGENT 1 (affected ENG)............................................................ DISCH
  - ■ **If fire persists 30 s after AGENT 1 DISCH**
    - ► AGENT 2 (affected ENG)........................................................ DISCH
- ► **LAND ASAP**
- ► ATC.............................................................................................. NOTIFY
- ► ENG (affected) : DO NOT RESTART
- ► SINGLE ENG OPERATION procedure ( A70.12 ) ................................. APPLY

**Figure 1**

Engine fire or severe mechanical damage in flight checklist

**Footnote**

1 Handling Bleed Valve: ensures correct operation of the low-pressure turbine stage. The amber HBV label indicates that the electronic engine control cannot control the valve.

2 ITT is the gas path temperature between the high pressure and the low-pressure turbines.

3 There is a Master Warning/Master Caution panel located above each PFD. Each panel has a Master Warning Light and Master Caution Light (the ‘attention getters’) that provide a visual indication to alert the pilot that a warning or caution has been generated. When pressed, the light will turn off and associated aural warnings will be cancelled.

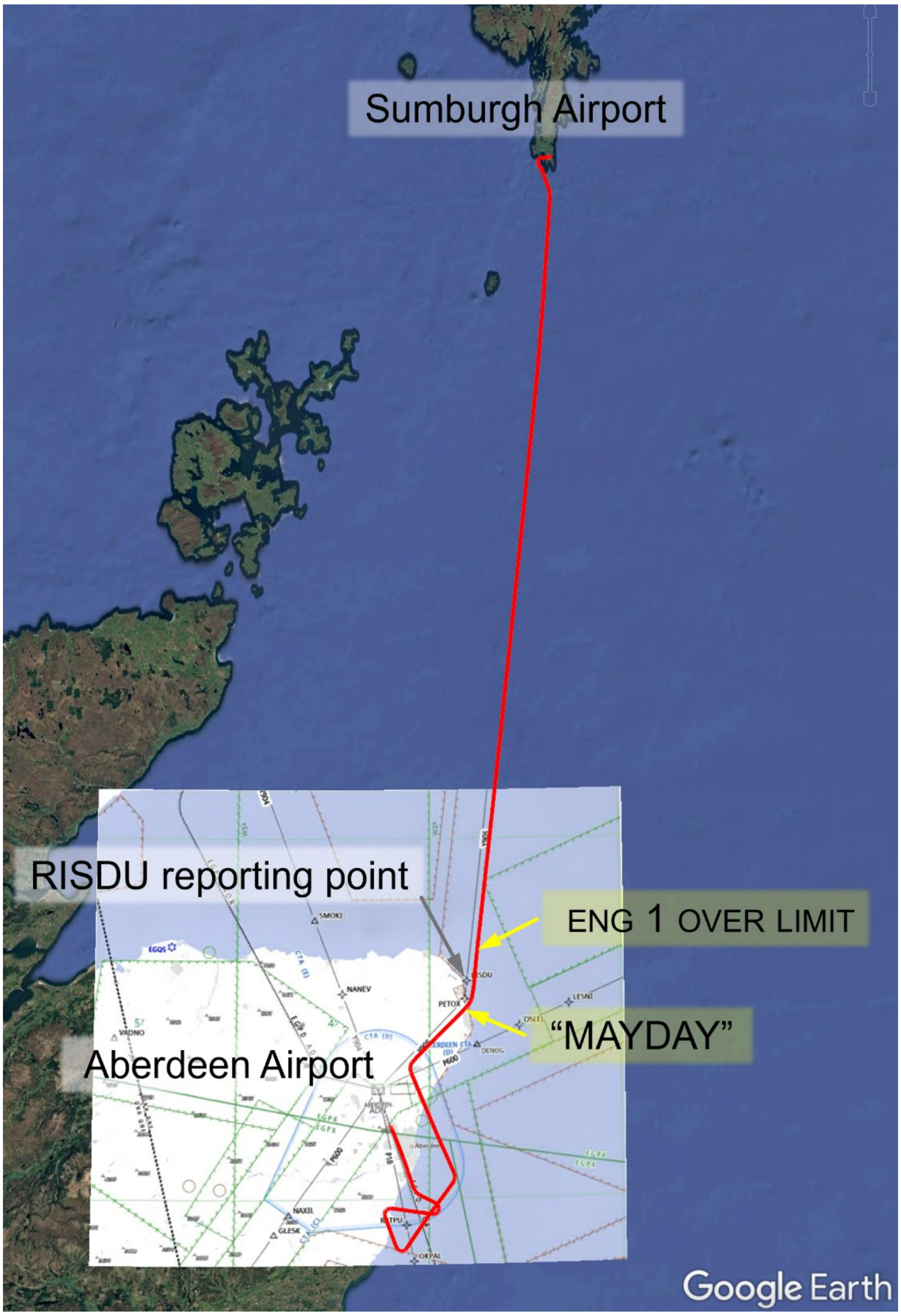


**Figure 2**

Reporting points near Aberdeen Airport
(Map data: Google, Jeppesen)

The co-pilot declared a MAYDAY to Scottish Control while the commander initiated a descent and called the cabin crew to stations. The commander indicated to ATC that they intended to divert to Aberdeen, now approximately 24 nm to the south-west (Figure 2). Scottish Control instructed a descent to FL130 and transferred control to Aberdeen Radar. Concurrently, the co-pilot carried out the Single Engine Operations checklist (Figure 3).

**A70.12** | **SINGLE ENG OPERATION**

- ▶ PWR MGT ........................................ MCT
- ▶ **LAND ASAP**
- ▶ FUEL PUMP (affected ENG)........................ OFF
- ▶ DC GEN (affected side)........................ OFF
- ▶ ACW GEN (affected side)........................ OFF
- ▶ PACK VALVE (affected side)........................ OFF
- ▶ BLEED VALVE (affected side)........................ OFF
- ▶ APM ........................................ OFF
- ▶ TCAS ........................................ TA ONLY

**Note**
*Refer to Single Engine Gross Ceiling to determine single engine gross ceiling.*

■ **If icing conditions**
- ▶ FLAPS........................................15

TO IMPROVE DRIFT DOWN PERFORMANCES & SINGLE ENGINE CEILING.

- ▶ FUEL BALANCE : MONITOR

MAXIMUM RECOMMENDED FUEL UNBALANCE IS 200 kg (440 lb).

● **When FUEL X FEED is required**
- ▶ FUEL PUMP (affected ENG)........................ ON
- ▶ FUEL X FEED........................................ ON
- ▶ FUEL PUMP (operating ENG)........................ OFF

● **For approach**

**Note**
*Refer to STEEP SLOPE APPROACH to check steep slope approach limitation applicable to your aircraft.*

- ▶ BLEED VALVE (operating side)........................ OFF
- ▶ CL (operating ENG)........................ 100 % OVRD
- ▶ $V_{APP}$ ........................ NOT LESS THAN $V_{GA}$

■ **If affected engine NP above 10 %**
- ▶ $V_{APP}$ ........................ NOT LESS THAN $V_{REF}$ + 10 kt

● **When $V_{APP}$ is increased**
- ▶ LDG DISTANCE........................ MULTIPLY BY 1.15
- ▶ ILS CAT 2 : PROHIBITED

● **At touchdown, until nosewheel touches the ground**
- ▶ PL : MAINTAIN AT OR ABOVE FI

**Figure 3**

Single engine operation checklist

Given the proximity of the aircraft to Aberdeen at the time of the engine malfunction there was no requirement to cross-feed fuel. On contact with Aberdeen, the commander downgraded the emergency to a PAN and the aircraft was vectored to an approach on Runway 34. While being vectored, the crew noticed a FUEL FEED LO PR master caution, accompanied by a FEED LO PR light[4] on the fuel panel for the No 2 engine. The engine was running normally so the crew decided to prioritise the One Engine Inoperative (OEI) landing, which was accomplished at 1228 hrs without further incident.

After shutting down the aircraft, the crew were informed by a ground engineer that fuel was leaking from the area of the No 1 engine.

**Footnote**

[4] Fuel feed low pressure: in case of fuel delivery pressure below 4 psi, the light illuminates amber. This indicates a fuel pump failure or fuel starvation.

## Recorded information

Following the event, the aircraft's FDR and CVR were removed from the aircraft to be downloaded at the AAIB. A copy of the quick access recorder (QAR) data (containing the same data recorded by the FDR) for the event flight was also provided by the operator. Data for the event is plotted in Figure 4.

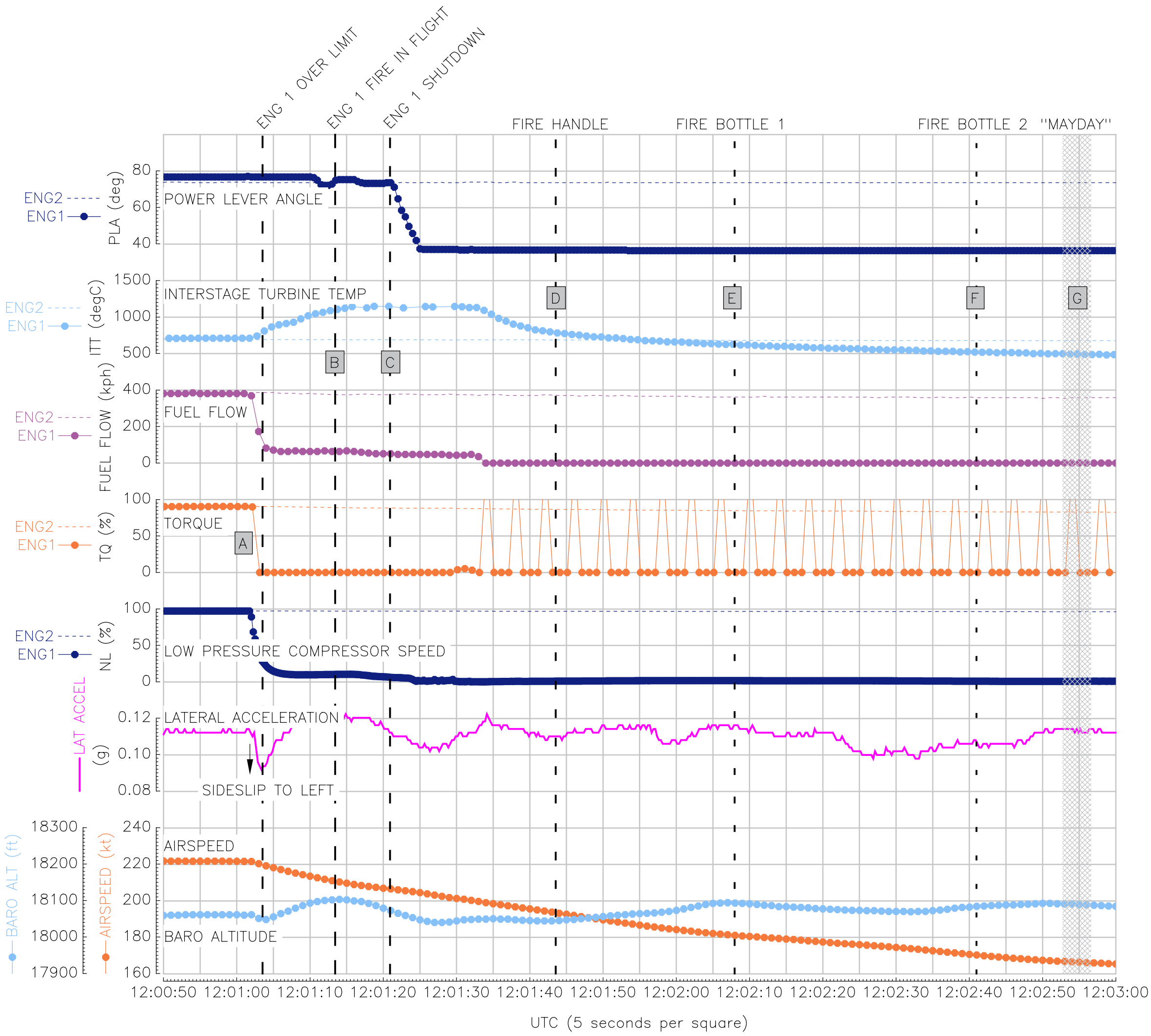


**Figure 4**

Recorded data for the event

The key points from Figure 4 are:

> [A] 12:01:02 (t0) – The torque on No 1 engine reduced from 90 to 0% within one second, with corresponding drops in fuel flow and $N_L$, a rise in No 1 engine ITT, and aircraft sideslip to the left. This was followed by a master warning and ENG 1 OVER LIMIT message just over one second later.
>
> [B] 12:01:13 (t0+11) – Master warning and ENG 1 FIRE IN FLIGHT message.

[C] 1201:21 (t0+19) – Master warning and ENG 1 SHUTDOWN message.

[D] 1201:43 (t0+41) – (From CVR) crew stated fire handle 1 pulled.

[E] 1202:08 (t0+66) – (From CVR) crew stated engine fire bottle 1 discharged.

[F] 1202:41 (t0+99) – (From CVR) crew stated engine fire bottle 2 discharged.

[G] 1202:53 (t0+111) – (From CVR) crew declare a MAYDAY.

Also, from the CVR, the crew are heard actioning the Single Engine Operation checklist about four minutes after the first (No 1 engine) fire bottle was discharged. 20 seconds later, the co-pilot confirmed the No 1 engine fuel pump was OFF.

## Aircraft information

The ATR 42-500 (600 version) is a twin-engine turboprop, short-haul regional airliner seating up to 48 passengers.

*Engine*

The Pratt & Whitney Canada PW127M turboprop engine is a two-spool gas turbine engine with two stage centrifugal compressors (also known as impellers) each driven by a separate turbine. A separate two stage power turbine powers the propeller via a reduction gearbox (Figure 5). Each of the rotating assemblies is supported and located by sets of roller and ball bearings. The No 1 engine was installed in the aircraft in February 2024. The fuel return line was installed at this time and had not been disturbed since.

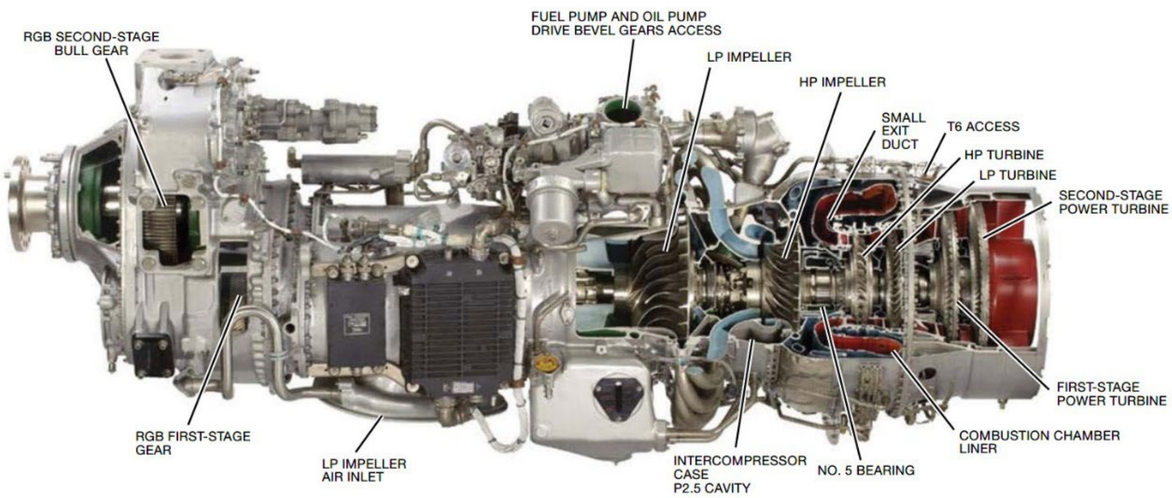


**Figure 5**

Cut away view of general engine arrangement
(used with permission)

*Engine fire detection and extinguishing*

The fire detection controls and indications are located in the flight deck.

Each engine has a fire detection system which consists of two continuous loops in parallel connected to an electronic control unit. Each loop consists of five sensing elements connected in series. The elements are made of coaxial cable whose properties are sensitive to temperature. The fire detection control unit processes signals from the sensing elements and, if required, triggers corresponding indications in the flight deck.

A fire extinguishing system is installed on each engine and the extinguishant[5] is stored in two sealed bottles, one in each wing fairing. Each bottle's contents can be directed to either engine depending on selections made by the flight crew.

*Fuel system*

Fuel is contained in a main tank and a feeder compartment in each wing. Each main tank is vented to atmosphere through a vent surge tank.

Fuel is supplied to the engine from the feeder compartment which is continually replenished with fuel from the main tank either by the feeder tank jet pump[6] or through flap valves in the tank wall.

An electric fuel pump is used for engine starting but the engine feed jet pump takes over once a motive flow of fuel is established at sufficient pressure from the hydro-mechanical unit[7] (HMU) via the motive flow valve. The electric fuel pump is then automatically shut down and the engine feed jet pump supplies fuel to the engine.

If required, a Low Pressure (LP) fuel valve can be closed, by operating the fire handle in the cockpit, to shut off the fuel supply to the engine.

For engine starting the electric fuel pump push-switch is pressed IN, causing the electric fuel pump to operate and supply fuel to the engine. The RUN caption of the push switch is illuminated, and the motive flow valve is de-energised (Figure 6).

**Footnote**

5 Mono-bromo-triflouromethane (CF3 Br).

6 A jet pump has no moving parts and consists of a venturi into which a jet of fuel under pressure is directed. This jet causes a pressure drop in the venturi which is used to draw a larger flow of fuel into the venturi and on to the outlet.

7 The aircraft manufacturer uses the term HMU in its manuals, but the engine manufacturer refers to the unit as the manual fuel control unit (MFCU). It notes the term HMU is used on the smaller PW100 series engines and the term MFCU is used on the larger PW100 series engines such as the PW127 fitted to this aircraft; both units perform a similar function. For consistency with the aircraft manufacturers diagrams shown in this report, the term HMU is used.

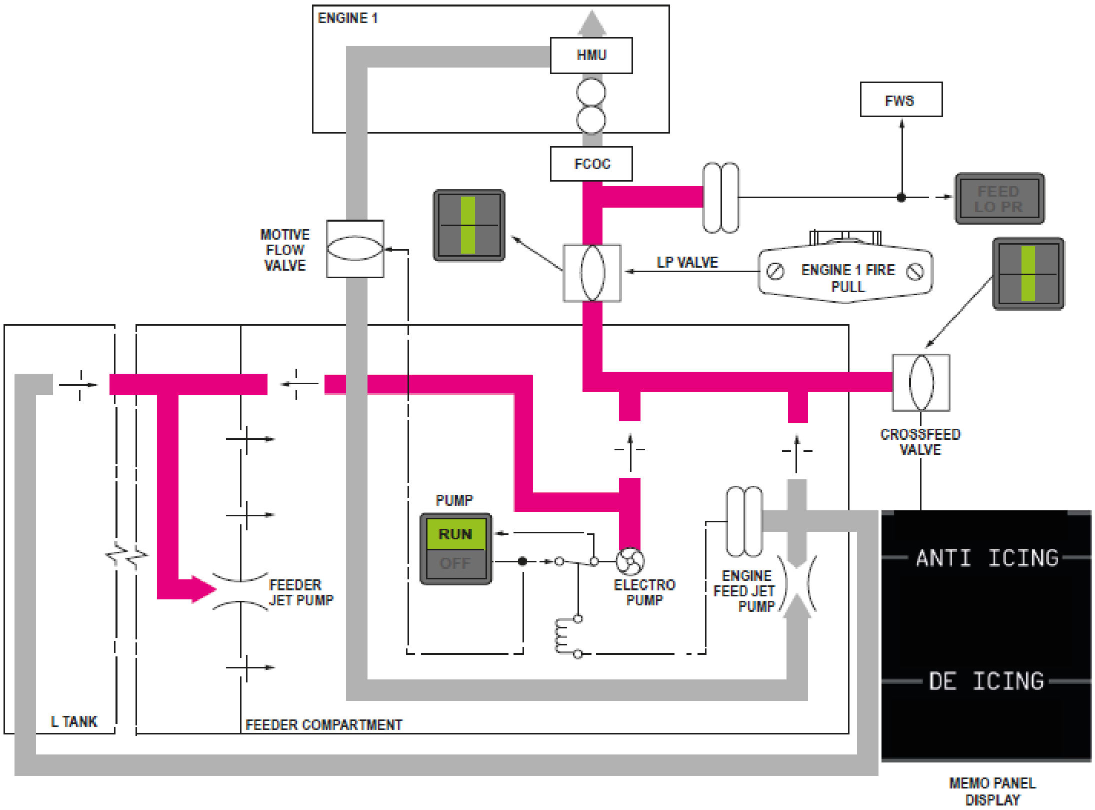


**Figure 6**

Schematic of No 1 engine fuel system, engine starting
(used with permission)

As the engine starts, fuel from the HMU is fed to the de-energised motive flow valve causing it to fully open and supply fuel to operate the engine feed jet pump. Once the feed from the fuel feed jet pump has sufficient pressure, the electric fuel pump is automatically switched off and the RUN caption is extinguished as the electric pump is no longer operating; the switch remains in the IN position.

In normal operation, fuel is fed to the respective engine by the engine feed jet pump which is powered by a motive flow of fuel via the motive flow valve (Figure 7). If the fuel pressure from the engine feed jet pump reduces, the electric pump will automatically restart to provide fuel flow, and its RUN caption will illuminate.

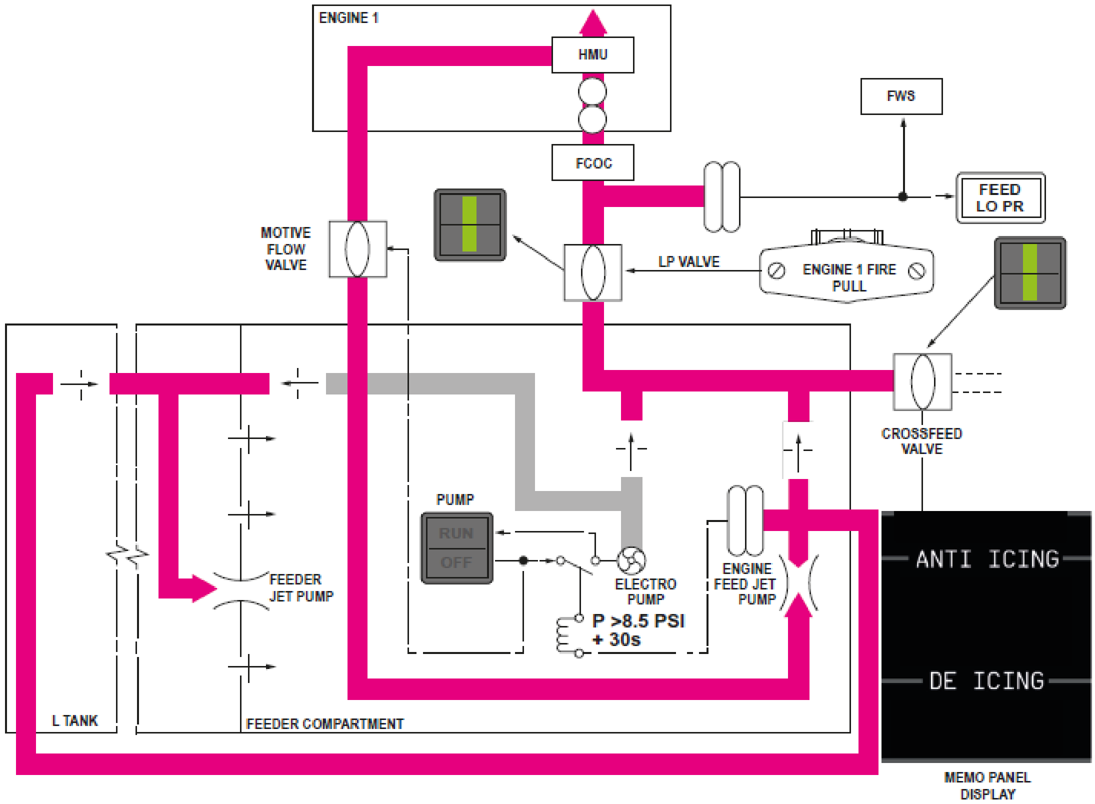


**Figure 7**

Schematic of No 1 engine fuel system, engine normal operation (used with permission)

*The motive flow valve*

The motive flow valve is used to control the motive flow of fuel from the HMU to the engine feed jet pump. The inlet is connected to the fuel return line from the HMU on the engine, and the outlet is connected to the engine feed jet pump in the header tank. The valve is controlled by an electrical solenoid and motive flow fuel pressure (Figure 8).

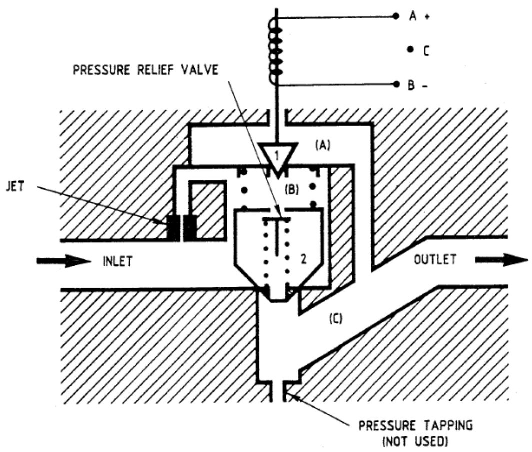


**Figure 8**

Schematic of the motive flow valve (used with permission)

The solenoid is de-energised when the electric fuel pump press switch is selected IN; this is the normal flight condition. In this de-energised condition, the needle valve (1) opens and allows the fuel pressure in the valve chambers to equalise. Fuel pressure from the HMU can then push up piston (2) which allows fuel to flow to the engine feed jet pump in the header tank. In this condition when there is no fuel flow from the HMU, a small flow of fuel from outlet to inlet is expected due to the valve design.

If the electric fuel pump is selected OUT (OFF), the solenoid is energised, and the needle valve (1) closes causing the motive flow valve to fully close.

**Aircraft examination**

There was evidence of fire around the No 1 engine cowlings and an inspection of the area inside the cowling revealed additional fire damage and sooting. The fuel return line was found loose and leaking at the HMU outlet.

With the motive flow valve de-energised, the flow of fuel leaking from the motive flow pipe when disconnected was measured at 165 ml/min. It was not possible to determine the flow rate at the time of the fire as the connection had been re-tightened to stem the leak whilst the aircraft was parked.

The end fitting had been marked with indicator material. When the fitting was re-tightened, the marks aligned, and the leak stopped.

Due to the routing of the fuel return line away from the end fitting, a 90° elbow, it was possible to use the line as a lever to manually loosen the fitting (Figure 9).

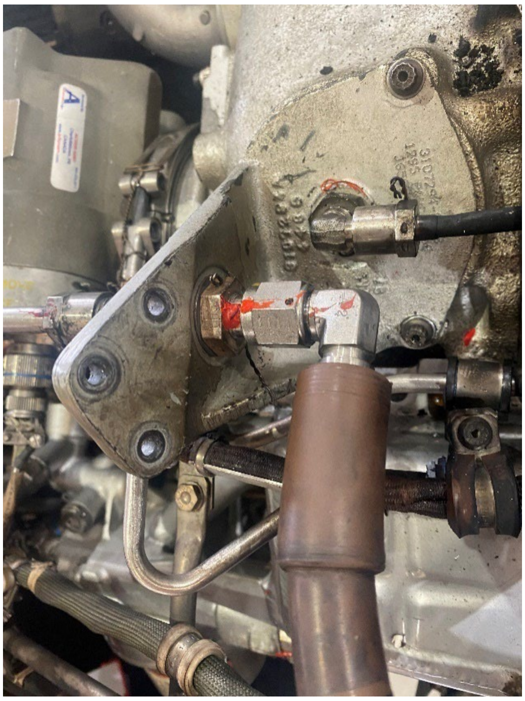

**Figure 9**

Fuel return line connection to HMU after engine removed from aircraft
(line temporarily fitted to show routing)

The aircraft manufacturer reported that they had no recorded in-service instances of this fuel return line fitting becoming loose.

*Engine examination*

Initial inspection of the engine identified that the second stage power turbine had suffered significant damage, and further damage was visible to the other turbine stages (Figure 10).

**Figure 10**

Damage to No 1 engine second stage power turbine, looking from exhaust outlet

The engine was removed from the aircraft and sent to the engine manufacturer's facility where it was disassembled for detailed inspection under supervision of the Transport Safety Board (TSB) Canada.

The elastomer material in the engine vibration isolation system showed signs of cracking indicating large forces had been exerted on them.

The disassembly inspection identified that the No 6 main bearing, located aft of the low-pressure turbine, had suffered significant degradation resulting in the loss of location of the turbine assembly which then contacted the surrounding parts causing the damage seen to the turbines and their casings. This bearing has been sent to the engine manufacturer's laboratories for detailed failure analysis under supervision of TSB Canada.

*Fuel system indications*

The crew reported that a No 2 engine FEED LO PRESS warning and that an amber box was displayed around the No 2 engine feeder tank. This was a parameter recorded by the FDR, but the recording from the event showed no change in status which would have indicated that a warning was displayed.

The amber box around the feeder tank means there was more than 160 kg in the No 2 tank, but that the No 2 feeder tank was not full. The feeder tank is normally kept topped up by a separate jet pump and, if this fails, the feeder tank is kept topped up via flap valves from the main tank when the feeder tank level falls below the main tank level to ensure fuel supply to the engine is maintained.

The crew checklist action for a FEED LO PRESS is to ensure the electrical fuel pump is ON which they did, and no issues were experienced with this engine.

The indication was not displayed on the ground, no work was done on the No 2 fuel system, and no issues were reported on return to service. The cause of the fuel indications for the No 2 engine was not determined.

*Certification of engine shutoff*

The aircraft manufacturer advised for the ATR 42, the applicable certification basis is JAR 25 change 13, paragraph 25.1189, *Shut-off means*. Paragraph (a) requires,

> *'Each engine installation and each fire zone specified in JAR 25.1181(a) (5) must have a means to shut off or otherwise prevent hazardous quantities of fuel, oil, de-icer, and other flammable fluids, from flowing into, within, or through any designated fire zone….'.*

The manufacturer was able to demonstrate compliance for the primary fuel supply line to the engine with the fuel shutoff valve. This valve can be used to cut off the primary fuel supply to the engine and therefore isolate it from further risk of fire.

The motive flow valve allows a small fuel leakage, when it is not energized (normal condition during flight), to the fuel return line which, when properly connected, is sealed. Compliance for this line was provided by the line being made of fire-resistant material and its integrity is guaranteed by the installation and the associated maintenance procedures to install it.

## Analysis

*Engine*

The disassembly of the engine identified that the No 6 bearing had suffered significant degradation resulting in the loss of location of the high-pressure turbine assembly and the damage seen to the turbines and their casings.

The No 6 bearing has been sent for more detailed examination and the results of this work will be used to inform the established airworthiness and reliability processes of the engine manufacturer. If the findings of this work require it, an addendum to this report will be issued.

*Motive flow valve*

Testing of the motive flow valve confirmed it was operating normally and that, with the valve de-energised, a small flow from outlet to inlet is expected due to the valve design. The leak from the loose fuel return line connector to the HMU was consistent with this flow rate. In normal conditions this connector would be secure, and the fuel would remain contained in the line. In this event as the connector was loose, the fuel leaked into the cowling area and then ignited.

During this event and following the engine failure, the crew followed the relevant procedure, '*Engine Fire or Severe Mechanical Damage'*, to shut down the engine.

Operating the fire handle closed the LP fuel valve and thereby shutoff the main fuel supply to the engine. Once the engine was shut down, there was no motive flow from the HMU, and the motive flow valve piston would drop closing off the valve. However, in this de-energised condition, fuel would still flow from the outlet to the inlet of the valve and leak through the loose fuel return line connection due to gravity as the fuel tank is higher than the loose connection.

It was only later in the crew procedures, and after the fire had been extinguished, the crew moved on to the Single Engine Operation checklist. This checklist requires the crew to select the fuel pump push switch OFF. This selection energised the motive flow valve solenoid causing it to fully close the motive flow valve and stop the flow of fuel from the loosened fuel return line.

The fuel flow would be stopped for the remainder of the flight providing the fuel pump switch remained OFF.

If the crew had subsequently needed to cross-feed fuel to maintain lateral balance, the fuel pump for the failed engine would need to be selected ON to feed fuel from that tank. This selection would de-energise the motive flow valve and allow the leak to recommence. It would stop again when the electrical fuel pump press switch was selected OFF after the completion of fuel transfer.

The time taken from the fire warning until the electrical fuel pump being selected OFF was approximately five minutes.

The crew completed the required checklists in a timely and accurate manner and successfully extinguished the fire using both fire bottles at the required intervals. The crew remained unaware of the leaking fuel until after the aircraft was parked. Their prompt completion of the Single Engine Operation checklist ensured the fuel leak in flight was stemmed and prevented a potential escalation of the emergency. Due to the proximity of the diversion airport, fuel transfer was not required.

Later, when the aircraft was parked and electrical power removed, the motive flow valve solenoid became de-energised, and the leak recommenced. Maintenance staff were able to stem the leak by re-tightening the connection.

The motive flow valve will only be fully closed when it is energised following flight crew selection of the electric fuel pump to OFF. Should the crew need to cross-feed to maintain lateral balance the electric fuel pump would need to be selected ON again and then motive flow valve would be no longer shut-off.

*Fuel return line*

The engine failure was violent as witnessed by the rapid reduction in torque and tears in the elastomer anti-vibration mounts and it is considered possible that the reaction to this sudden reduction in torque could have caused the fuel return line to 'whip' and loosen the connection and for consequent engine vibrations to have loosened it further. There is no secondary locking on the connection and the line leaves the HMU via a 90° elbow which would add leverage to any loosening forces.

It is also possible that the connection was not correctly torqued during installation, but maintenance records indicated it had been and there were no reports of leakage before the event. The operator had also conducted a check of its fleet of similar aircraft and found all the fuel return lines had been correctly installed.

The design of the fuel return line installation complied with the certification standards in place at the time of certification. However, as was seen in this event, loosening of the fuel return line was not identified as a risk as the integrity of the line was assured by the use of fire-resistant materials, the installation and associated maintenance procedures.

The aircraft manufacturer confirmed that they were not aware of any events where the motive flow fuel line had become loose and leaked. Interviews with maintenance staff, checks of maintenance documentation and inspection of the connection, confirmed that it was likely this connection had been correctly installed and tightened when the engine was installed in the aircraft in February 2024.

**Conclusion**

The No 1 engine suffered a contained failure. This was due to significant degradation of its No 6 main bearing which resulted in the rotating high-pressure turbine being no longer correctly located. This allowed the rotating parts to contact adjacent parts causing significant damage to the turbine stages.

There was an under-cowling fire which was due to leaking fuel igniting on hot engine parts. It was detected and extinguished by the crew using onboard systems; both fire bottles were discharged.

The fuel leak was from the connection between the HMU and the fuel return line which had become loose. The reason for this could have been either that the connection had not been tightened correctly when it was installed or that it had become loose due to the forces of the engine failure 'whipping' the fuel return line. Maintenance records, interviews with the maintenance staff and indicator markings appeared to confirm that it had been tightened correctly, and the aircraft manufacturer was not aware of any other cases where this connection had become loose.

Due to the fuel system design, specifically that of the motive flow valve, fuel continued to leak from the loosened fuel return line after the crew, as part of the Engine fire or Severe Mechanical Damage checklist, operated the fire handle to shut down the engine. It continued to leak until the crew selected the No 1 engine electrical fuel pump OFF as part of the Single Engine Operation checklist, as it was this selection to OFF that fully closed the motive flow valve. The fuel leak would have recommenced if the crew had needed to cross feed fuel to maintain the lateral balance of the aircraft as this process requires the electrical fuel pump to be selected ON, thereby allowing the motive flow valve solenoid operated needle valve to open which would then allow fuel to leak through it from the feeder tank and out of the loose connection.

**Safety action**

The aircraft met certification requirements in place at the time of certification, and there have been no other similar events in the history of the aircraft. However, the aircraft manufacturer has initiated the following safety action:

> The aircraft manufacturer has commenced a safety review to identify any possible safety actions which would further reduce the likelihood of leakage from the fuel return line. This review will be completed by the end of 2025.

*Published: 19 June 2025.*

## Accident

| | | |
|---|---|---|
| **Aircraft Type and Registration:** | Piper PA-18-150, G-CUBX | |
| **No & Type of Engines:** | 1 Lycoming O-320-A2B piston engine | |
| **Year of Manufacture:** | 1981 (Serial no: 18-8109006) | |
| **Date & Time (UTC):** | 27 August 2024 at 0932 hrs | |
| **Location:** | Croft Farm Airstrip (Defford Airfield), Worcester | |
| **Type of Flight:** | Private | |
| **Persons on Board:** | Crew - 1 | Passengers - None |
| **Injuries:** | Crew - 1 (Fatal) | Passengers - N/A |
| **Nature of Damage:** | Aircraft destroyed | |
| **Commander's Licence:** | Private Pilot's Licence | |
| **Commander's Age:** | 65 years | |
| **Commander's Flying Experience:** | 1,520 hours (of which 3 were on type)<br>Last 90 days - 9 hours<br>Last 28 days - 1 hour | |
| **Information Source:** | AAIB Field Investigation | |

### Synopsis

G-CUBX tracked to the left on the runway during takeoff and within two seconds of getting airborne it was in a left turn tracking toward obstacles south of the runway. Witnesses reported seeing the aircraft adopt a steep nose-up attitude, but it was not able to climb above a tree which was one of the obstacles in its path. G-CUBX appeared to have struck the tree at the apogee of its flight path before descending steeply, nose-first, into the ground. The pilot suffered fatal injuries at the point of ground collision.

It was not possible to conclusively establish why the aircraft diverged left during and after takeoff. Nonetheless, the investigation considered it likely the relatively low lift off speed of approximately 34 kt contributed to the pilot having insufficient aerodynamic control authority to effectively counter the flight path divergence. Being in a turn rather than wings level would have compromised the aircraft's climb rate resulting in it being unable to climb above the obstacles it was turning toward.

The investigation was unable to find evidence of any pre-accident fault with the aircraft.

### History of the flight

The accident occurred on the pilot's second flight in G-CUBX. The first time he flew the aircraft he occupied the rear seat with an instructor in the front. On the accident flight he flew solo from the front seat.

On the morning of the accident, the pilot used a remote-controlled aircraft tug to manoeuvre G-CUBX out of its hangar before completing his pre-flight checks. After initially having trouble starting the engine, he taxied out for departure from Runway 28. As the aircraft entered the runway to backtrack, its wing flaps were retracted (Figure 1).

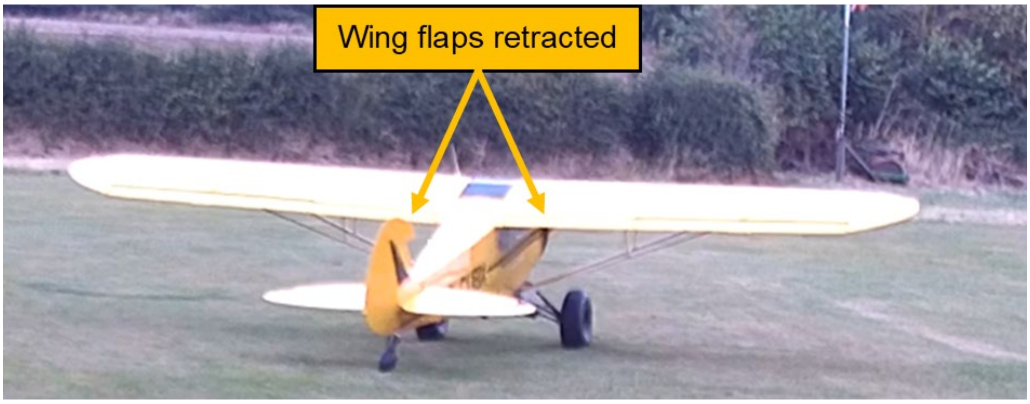


**Figure 1**

CCTV snapshot showing G-CUBX entering Runway 28 to backtrack for departure

Captured on CCTV, while at low speed during the initial phase of the takeoff roll, the aircraft swung to the left before being re-aligned to the runway by the pilot (Figure 2).

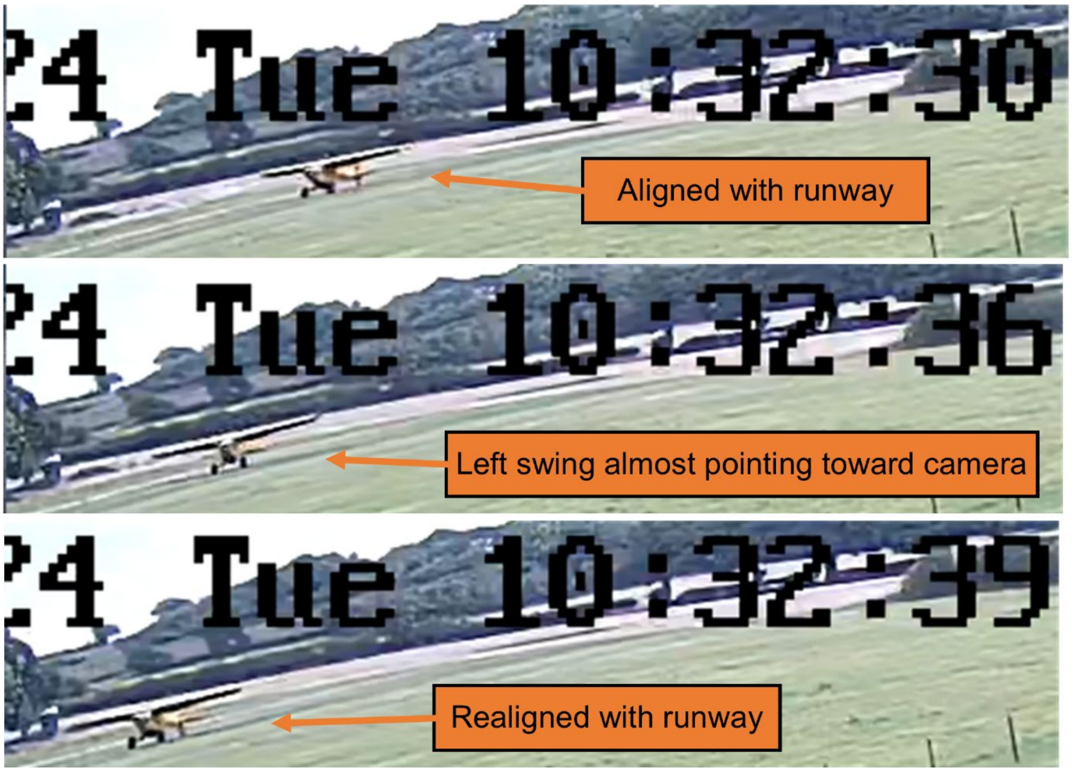


**Figure 2**

CCTV snapshots of G-CUBX at the start of its takeoff roll
(CCTV shows approximate local time)

After this early yaw divergence, the remainder of the takeoff roll captured on CCTV appeared to progress normally, with the aircraft's tailwheel lifting off just before the aircraft went out of view (Figure 3). Approximately nine seconds later the aircraft reappeared in the CCTV image, close to the camera and in a steep nose down attitude just before it struck the ground. While the CCTV footage was not of a sufficiently high definition to reach a definitive conclusion, it appeared to show G-CUBX's wing flaps in the retracted position before it struck the ground.

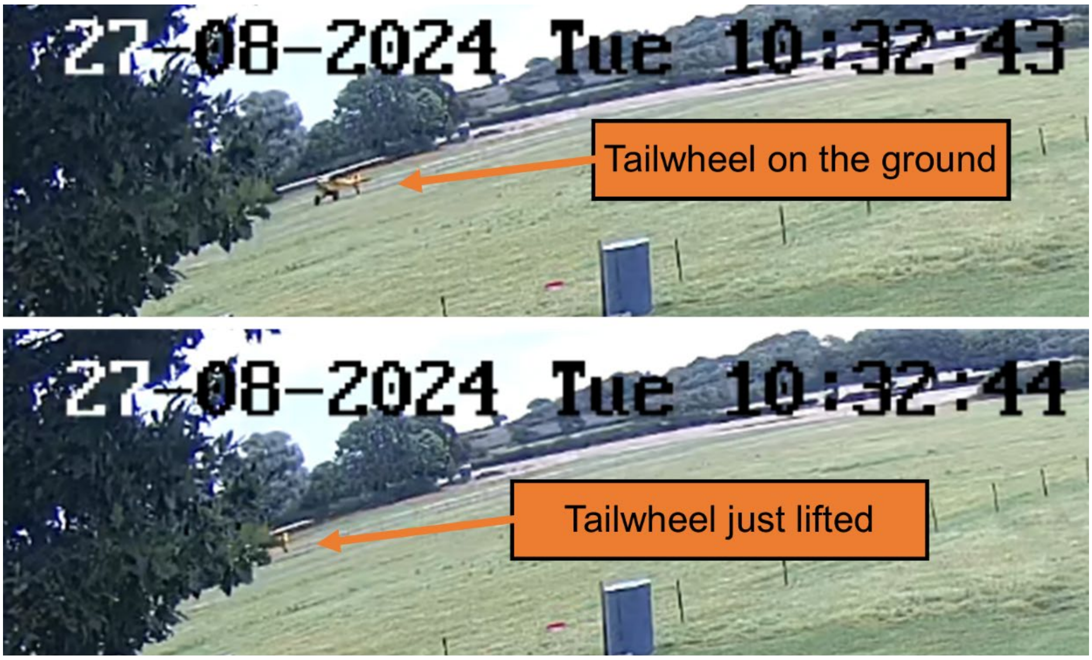


**Figure 3**

CCTV snapshots of G-CUBX showing its tailwheel being lifted from the runway

Two eyewitnesses described the aircraft's initial climb away from the ground as being steeper than expected. They both reported the engine note sounded normal throughout the short flight. One of the eyewitnesses was inside a hangar, so their view of the aircraft after its initial climb away from the ground was limited by the building structure. The second eyewitness described how, at a low height, G-CUBX's left wing dropped and the aircraft entered a steep left turn. It then descended, striking the ground in front of where he was stood.

CCTV footage revealed that the fire which subsequently consumed the aircraft started near the cockpit area within three seconds of ground impact.

**Accident site**

While video footage of the accident shows the aircraft initially coming to rest on its nose with the tail almost vertically above it, during the subsequent post-accident fire the tail settled to the ground with the top of the vertical stabilizer resting on the floor. The fuselage was inverted and there was significant damage to the structure (Figure 4).

**Figure 4**
G-CUBX showing significant post impact fire damage

Ground impact marks show the point where the leading edge of the left wing tip struck the ground before the fuselage pivoted around this initial contact point causing the spinner dome of the propeller to hit the ground. One of the two blades of the propeller was embedded in the ground and, once recovered, showed evidence of twisting consistent with the engine being under power when the aircraft struck the ground.

Twigs from a nearby tree were caught in the tail wheel giving a good indication of the flight path of the aircraft and the height at the point contact was made with the top of the tree. A continuity check revealed that all flight controls remained connected to their respective control surfaces. The exception was the right flap where the bell crank was missing and most of the flap had melted away. The left flap had also partially melted but remained attached to the wing with the control cables still connected between the bell crank and flap control lever in the cockpit.

The left wing and wing struts remained attached to the fuselage, although the right wing was detached at its root. The right wing struts, although bent and showing signs of significant fire damage, also remained attached to the wing and the fuselage.

Nearby, where the aircraft had been parked prior to the flight, there was a small patch of dead grass which was likely to have been caused by fuel dripping onto the ground during attempts to start the engine. CCTV footage showed that the technician who replaced the ignition harness attended the aircraft while the pilot was struggling to start the engine. He stated that when he lifted the cowlings, there was fuel dripping onto the air box. He regarded the dripping fuel as a sign of a potentially flooded engine. According to the O-320 engine operator's manual[1], '*Cranking periods must be limited to ten (10) to twelve (12) seconds with a five (5) minute rest between cranking periods.*' Whilst there were multiple attempts made to start the engine, there was very little time between cranking attempts which was likely to have exacerbated the difficulty the pilot had in starting the engine.

**Recorded information**

The pilot was using a flight-planning and navigation app on a tablet device which recorded the aircraft's GPS flight path. The ground track is shown in Figure 5. Note that the path stops short of the accident site by about three seconds as the recorded positions during this period were unreliable, probably as a result of the aircraft's banked attitude limiting the tablet's view of the GPS satellites.

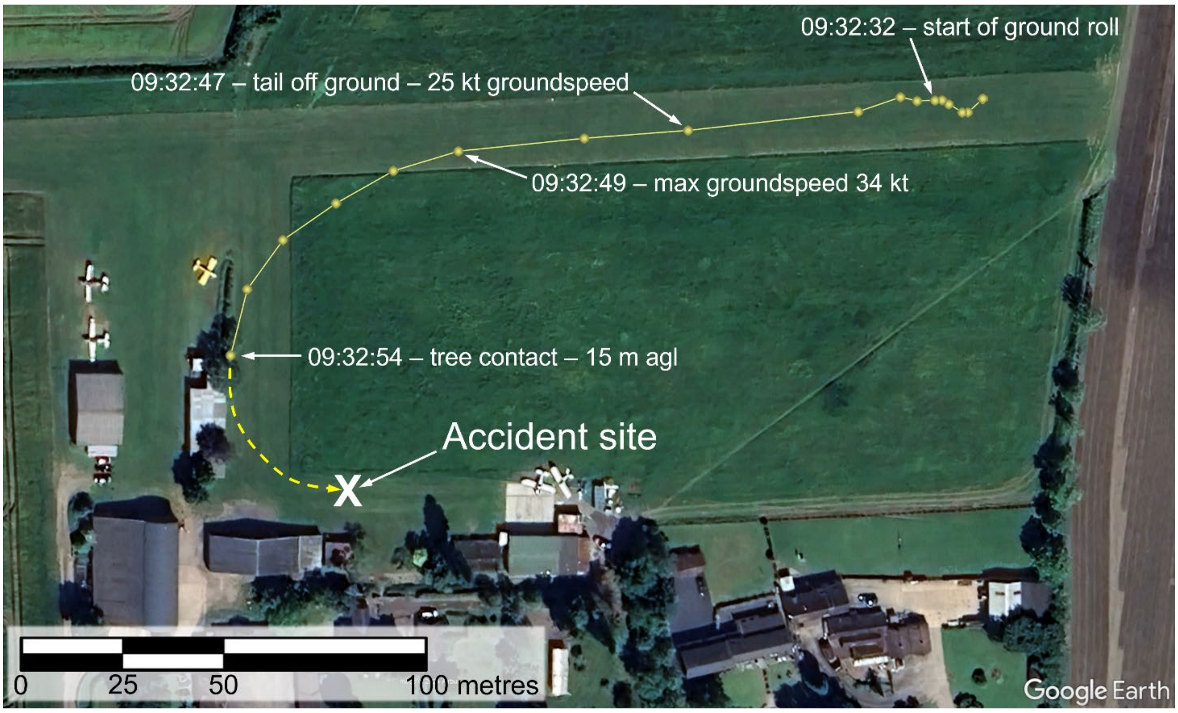


**Figure 5**

GPS derived ground track of the flight
(© 2025 Google, Image © 2025 Airbus)

**Footnote**

1 Lycoming Operator's Manual O-320 Series, part number 60297-30, 3rd Edition, October 2006, Section 3, paragraph 3, '*Starting procedures.*'

A side profile of the flight path is presented at Figure 6 together with other GPS derived data. These data show the aircraft initially lining up on the grass strip before beginning the take off at time 09:32:32.

After five seconds of gentle manoeuvring right, left and right again, the aircraft accelerated down the grass strip, veering slightly left, with the tail of the aircraft coming off the ground 10 seconds later (before going out of view of the CCTV). Within two seconds, the aircraft was airborne, after which it climbed at an average flight path angle of 14° and reached the maximum recorded groundspeed of 34 kt. Now turning left, the rate of climb reduced with the aircraft flying over the left edge of the grass strip at just over 10 m height.

The last recorded reliable position was four seconds later when the aircraft contacted a tree, 40 m to the left of the grass strip edge, at a height of about 15 m. Continuing to turn, and roll left, the aircraft came back into CCTV view descending vertically in a nose-down attitude, wings aligned with the grass strip, left wing first.

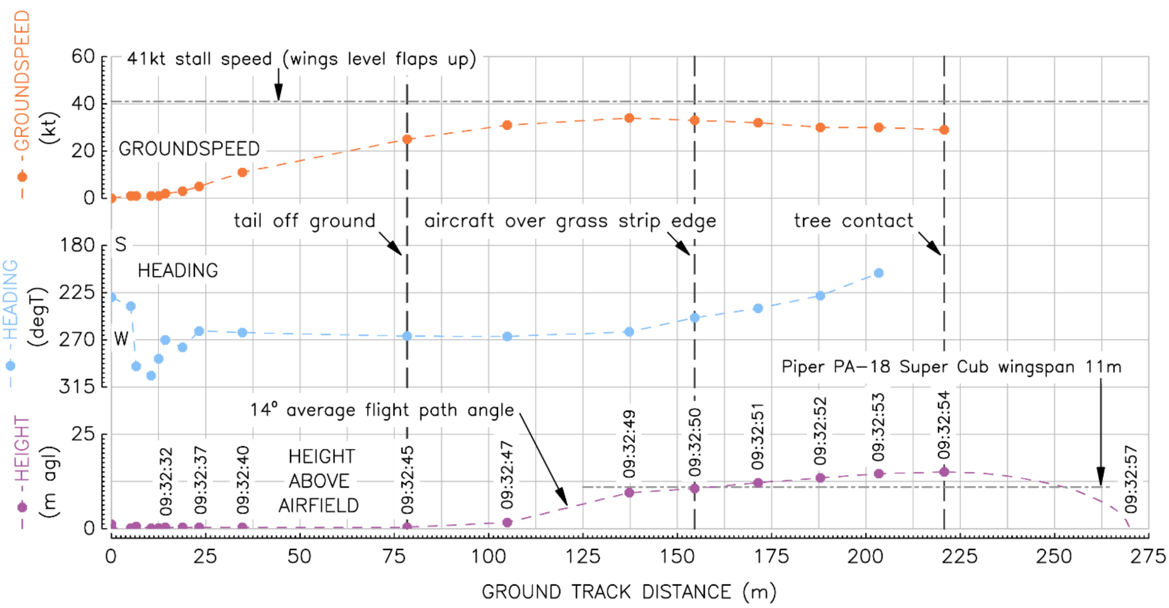


**Figure 6**

GPS derived data of flight
(PA-18 clean stall speed and wingspan indicated for reference)

## Aircraft information and brief history

The aircraft was a Piper PA18-150 Super Cub with a Lycoming O-320 horizontally opposed four-cylinder engine. Built in 1981 and first registered in Greece, it had three previous registrations before being transferred from Germany to the UK and being re-registered as G-CLYI in 2021. It was modified to include an Alaskan Bush fit which included large tundra tyres, Alaskan tail wheel, modified heavy duty landing gear and a 31.5 USG belly fuel tank.

G-CLYI was involved in a landing accident in May 2023[2] where it flipped over onto its back whilst braking shortly after touching down on a grass landing strip. The aircraft spent 13 months undergoing repairs during which it was re-registered as G-CUBX in June 2024 (Figure 7). The engine was shock load tested by an approved engine workshop and refitted during the repairs. To improve stall performance and enhance the short takeoff and landing capability of the aircraft, vortex generators had been fitted just aft of the wings' upper leading edges and on the lower surfaces of the horizontal stabilizer, forward of the elevator hinges. These were also replaced during the repair process. G-CUBX received a CAA UK Airworthiness Review Certificate (ARC) on 11 July 2024.


**Figure 7**

G-CUBX after repair showing features of the Alaskan Bush fit

After handing over the repaired aircraft to the new owners, the aircraft was returned to the repair workshop on 22 July 2024 because the owner reported '*The aircraft rolls to left in flight*[3].' During the original repairs, the right forward wing strut had been replaced. Subsequent comparison of the left and right wingtip incidence angles, called 'wash-out'[4], showed a 2.5º difference between them. The right wing aft strut was adjusted to remove the incidence difference and the aircraft was flown to confirm that the roll to the left had been eliminated. This was re-confirmed by the owner during the return flight home to Croft Farm Airstrip.

**Footnote**

2 https://www.gov.uk/aaib-reports/aaib-investigation-to-piper-pa-18-150-g-clyi [Accessed 12 May 2025].
3 G-CUBX Worksheet dated 22 – 30 July 2024.
4 '*Inbuilt wing twist resulting in angle of incidence reducing towards tips',* The Cambridge Aerospace Dictionary, Second Edition, page 768.

On 16 August 2024, multiple problems were found with the ignition system including inoperative spark plugs, poor condition of the ignition harness and timing problems with the right magneto. The ignition harness and spark plugs were replaced and the right magneto removed, reset and refitted. Engine ground runs were carried out to verify the ignition system was functioning correctly and the two magnetos produced the correct reduction in engine rpm when 'mag-drop' checked. During the ground run, the technician believed he had witnessed a slow deployment of the left flap when compared to the right, although both flaps appeared to stop in their correct, fully deployed positions.

## Aircraft examination

*Engine*

The engine was subject to a strip examination. Nothing significant was found with the mechanical and electrical components that could not be attributed to damage sustained when the aircraft struck the ground or the post-impact fire.

*Airframe*

According to the FAA Supplemental Type Certificate[5], if more than five Vortex Generators are missing or damaged, the aircraft is not airworthy. It was not possible to check the Vortex Generators because they had been glued to the fabric of the wing and the horizontal stabiliser but the fabric had burned away in the fire. Pictures taken shortly after delivery of the restored aircraft show most of the generators fitted to the wings and left horizontal stabiliser. In addition, the pilot could be seen checking the aircraft surfaces as part of his pre-flight inspection of the aircraft, therefore, he would likely have noticed if any were missing or damaged.

Whilst the right flap bell crank was missing (Figure 8), the turnbuckle that should have attached the flap control cable to the bell crank was intact and still attached to the control cable, link and return spring. The bell crank hinge bracket remained in place and attached to the wing. The push pull flap rod, which should have connected the bell crank to the inboard flap hinge bracket, remained attached to the bracket but the bracket had separated from the flap. The left flap control assembly was still connected to the left bell crank and flap although the wing spar section that held bell crank hinge bracket had melted releasing the bracket and bell crank.

**Footnote**

5 FAA STC SA00530SE issued 26 June 1998 and emended 29 May 2009.

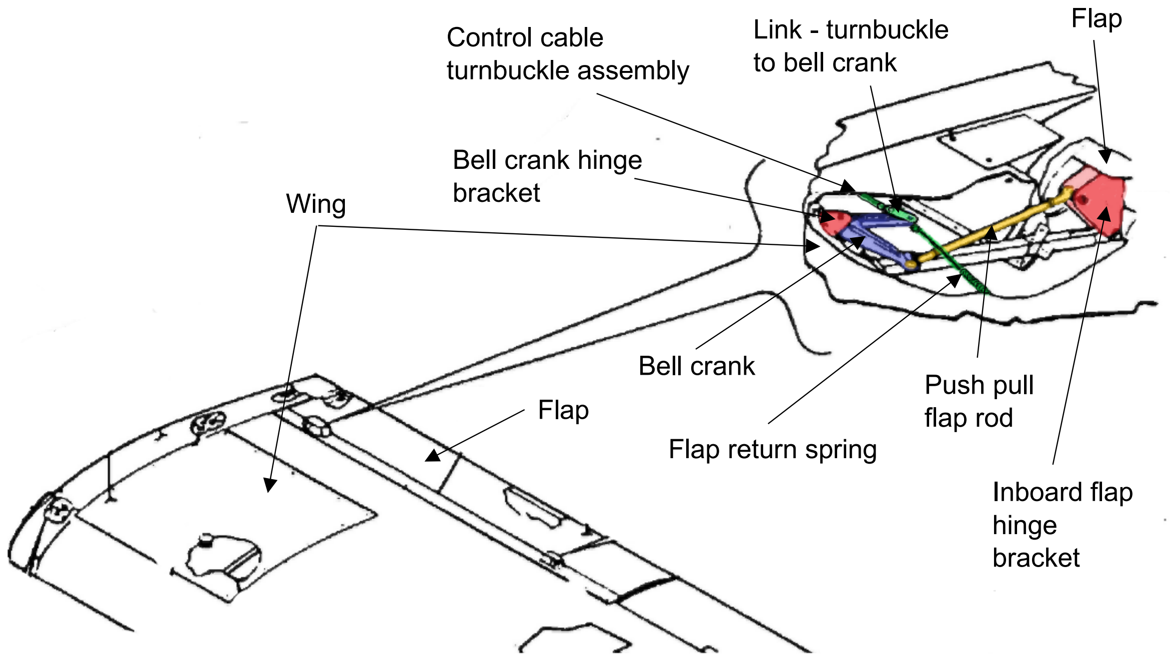


**Figure 8**
Flap control assembly diagram

It was not possible to examine the seat harnesses or any of the seat fabric because they had all been destroyed in the fire. The front seat had been torn from its mounting and distorted by the impact and the fire. Cockpit instrument panels, switches, control system levers and electrical wiring were also significantly damaged or destroyed.

On examining the various control cables from the cockpit controls to the control surfaces in more detail, no pre-existing restriction or incorrect routing was found. The slow left flap deployment issue reported by the technician who replaced the ignition harness could not be confirmed due to the absence of the left flap bell crank and the significant damage to both left and right flap systems, structure and control surfaces. A comparison of the tension force of the flap control return springs could not be made as both springs were damaged. Whilst most of the airframe and wings were badly damaged, the wings, tail and fuselage structure, including their drag support wires, were still present and no pre-existing faults were found.

The pitch trim, elevator, vertical stabiliser and rudder connections were still functional, and no issues were identified that were not caused by the accident or the fire. Whilst both ailerons had also been damaged by the fire, they remained connected to their respective cockpit controls and control cables.

**Survivability**

The post-mortem confirmed that, despite the pilot wearing a four-point seat safety harness, at the point of collision he sustained multiple injuries which were not survivable.

## Aircraft performance

The Owners' Handbook (OH) for the aircraft states that at maximum gross weight, the '*power off stalling speed with full flaps in the Super Cub "150" is 43 mph* [(37.4 kt)]*: with flaps up the stalling speed increases* [by] *about 4 mph* [(3.5 kt)].'

G-CUBX was fitted with vortex generators to improve its short takeoff and landing performance. The Supplementary Type Certificate documentation for the vortex generator modification indicated that fitting them would reduce the aircraft's stalling speed by 16%.

In 2019 a PA-18-50 fitted with vortex generators like those on G-CUBX was destroyed when it lifted off unexpectedly while stationary on the ground with its engine running[6]. The accident pilot ascribed the unexpected lift off to strong winds and opined that '*a gust of 25 kt would be sufficient to lift the aircraft into the air but that in a pre-take-off scenario there is not the necessary airspeed to the ailerons to counteract a rolling tendency once the wind has lifted the aircraft into the air*.'

Regarding flap deployment for takeoff, the OH is not prescriptive, stating that '*the flaps can be lowered if desired, but should be retracted as soon as climbing airspeed has been reached...*'.

Ground effect may lead to an initial airborne state which cannot be sustained as distance from runway surface increases and the additional lift attributable to ground effect reduces.[7] For fixed wing aircraft, this additional lift reduces to zero at a height above the ground equivalent to the wingspan of the aircraft, which for the PA-18 is 11 m (Figure 6).

## Meteorology

At the time of the accident good weather prevailed. There was no low cloud, and visibility was more than 10 km. While generally from a southerly direction, the surface wind was light and variable, giving a maximum estimated crosswind component of 5 kt.

## Airfield information

Croft Farm Airstrip (also known as Defford Airfield) is a private unlicensed airfield with a single grass strip 570 m long and 18 m wide, designated Runway 10/28. Extending for approximately 200 m from the threshold, an electrified livestock fence initially delineates the left (south) edge of Runway 28 (Figure 11).

**Footnote**

6 Accident report available at AAIB investigation to Piper PA-18-150, N162AW - GOV.UK [Accessed 3 February 2025].

7 https://skybrary.aero/articles/ground-effect [Accessed 3 February 2025].

## Personnel information

The accident pilot had over 1,500 total flight hours gained in non-commercial flying. His recent flying experience was exclusively on tailwheel aircraft including the Piper J3-65 Cub, Harvard and P51 Mustang types. He had regularly flown from and was familiar with operating at Croft Farm. He did not have any significant underlying medical issues, and the post-mortem did not find evidence of chronic or acute conditions to indicate pilot incapacitation as a causal factor.

## Other information

*Adverse aileron yaw*

When an aileron is deflected downwards the drag it generates increases. This results in a drag differential between the two wing surfaces which generates a yawing moment in the opposite sense to the applied roll. With a right roll input the left aileron is deflected downwards and the resulting yawing moment is to the left.

*Swing on takeoff*

Due to a combination of factors, propeller-driven aircraft tend to 'swing' to one side on take-off, this requires pilots to compensate with opposite rudder. For nosewheel-equipped aircraft, the two primary factors generating swing on takeoff are slipstream effect and torque reaction. These effects are explained below and assume the aircraft is equipped with a clockwise rotating propeller (the same as G-CUBX). On aircraft with propellers which rotate in an anticlockwise direction, the divergent effects are in the opposite sense ie to the right.

- Slipstream effect: the propeller's rotation produces an asymmetric flow over the fin and rudder, thereby inducing a left yawing moment (Figure 9).

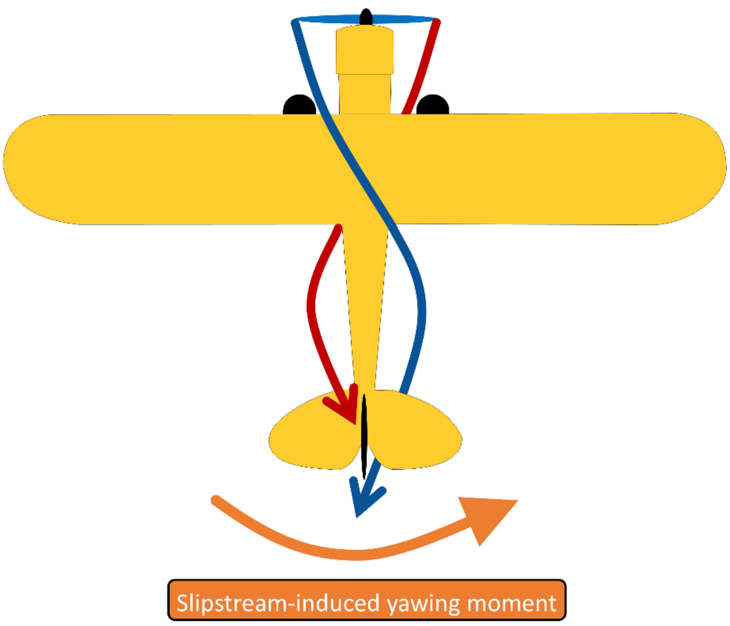


**Figure 9**

Left yaw due to propeller slipstream (viewed from above the aircraft)

- Torque reaction: torque reaction from driving the propeller imparts a left rolling moment on the aircraft (Figure 10). During the takeoff roll this results in more weight being supported by the left wheel thereby increasing its rolling resistance and giving rise to a tendency to swing left until the aircraft is airborne.

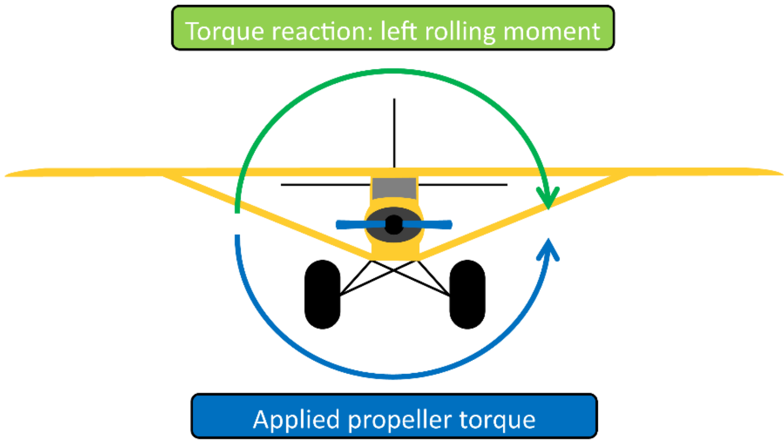


**Figure 10**

Torque reaction producing rolling moment

For tailwheel aircraft there are two additional factors that can affect swing during the takeoff roll:

- Asymmetric blade effect: while the aircraft's tail is down, the plane of rotation of the propeller is not at right angles to the direction of forward motion. This means the down-going propeller blade has a higher speed relative to the airflow than the upgoing blade, this produces more thrust for given angle of attack and leads to an asymmetric left yawing moment. As the tail is raised and the propeller's plane of rotation becomes more perpendicular to the relative airflow the asymmetric blade effect reduces towards zero.

- Gyroscopic precession: as the tail is raised, a force is applied to the top of the propeller disc in a nose-down sense. The resulting gyroscopic precession force induces yaw/swing to the left.

## Analysis

Despite the difficulty experienced by the pilot when initially starting the engine, eyewitness reports indicated it was operating normally throughout the brief flight. CCTV evidence was inconclusive, but the aircraft did not appear to have its wing flaps selected down for takeoff. The Owners' Handbook stated that the power off stalling speed with flaps retracted would have been approximately 41 kt at maximum takeoff weight, but did not contain a means for interpolating stalling speeds based on gross weight, or intermediate flap settings. Applying the 16% stall speed reduction stated in the vortex generator Supplemental Type Certificate documentation to the OH figures, would give a power off stalling speed of 34.5 kt in the clean configuration.

The investigation did not find conclusive evidence to explain why the pilot lifted off at 34 kt groundspeed or for the steep climb and apparent loss of effective control. The investigation considered the aircraft's ground roll track converging with the electrified fence bordering the southern edge of the runway (Figure 11) could have been a contributory factor if the pilot decided to lift off earlier than perhaps he originally intended.

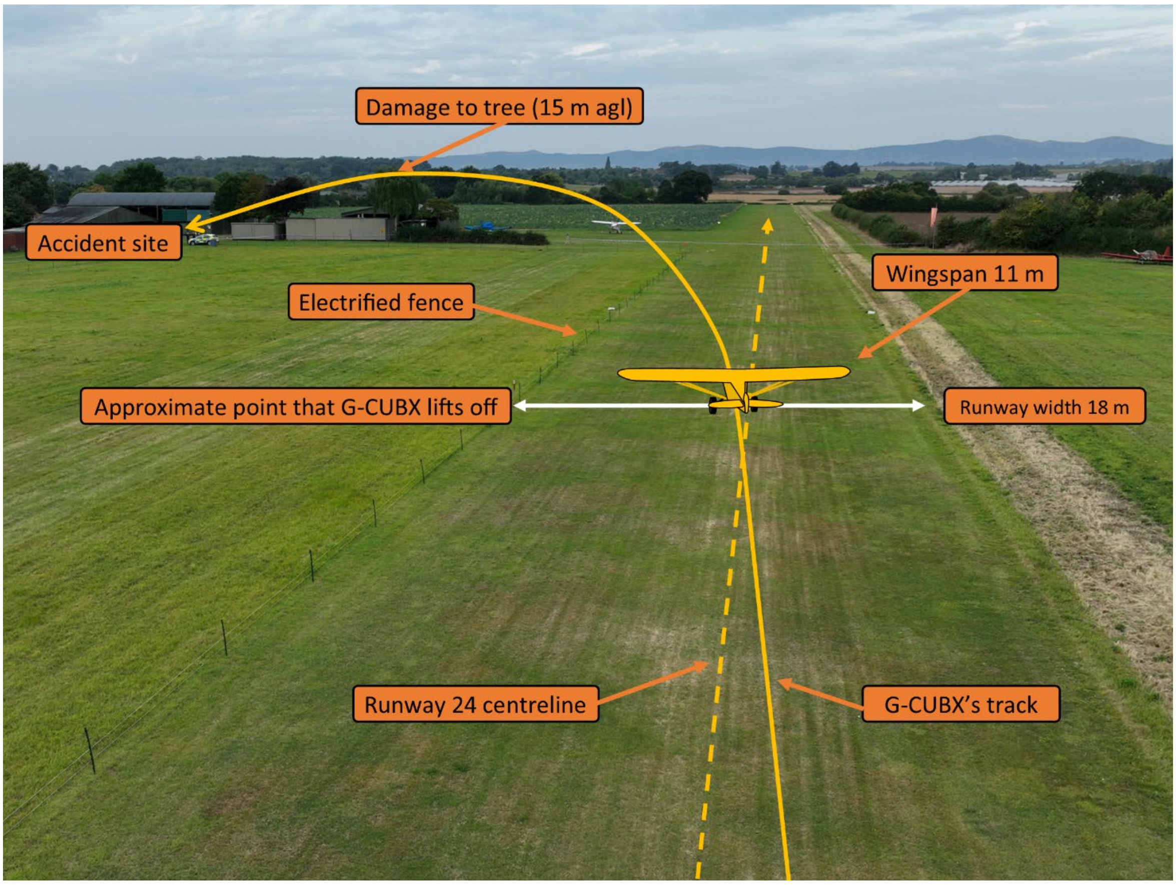


**Figure 11**

G-CUBX's approximate ground track and flightpath (aircraft drawn to scale)

Getting airborne at relatively low speed, potentially without wing flaps deployed and in a semi-stalled condition, would likely have generated only limited aerodynamic control authority for the pilot to correct the heading divergence which appears to have occurred almost immediately after lift-off. Applying right aileron to level the wings could have led to adverse aileron yaw exacerbating any tendency for the aircraft to swing and roll left. Using right rudder, rather than aileron, to correct the heading divergence would have been an appropriate action, although limited aerodynamic directional control authority would have made such a correction more difficult. The investigation considered it likely some of the adverse factors pre-disposing the aircraft to swing left on takeoff were contributory factors in the pilot not being able to re-establish a safe longitudinal trajectory. However, lacking evidence to support detailed analysis, it was not possible to reach a definitive conclusion in this regard.

Once the aircraft had started turning left towards the trees and buildings the pilot needed to reverse the turn or climb to avoid a collision. As the aircraft climbed through approximately 11 m any lift benefit from ground effect would have been lost and being in a turn would have further compromised the aircraft's achievable rate of climb.

At very low height and heading toward obstructions, pulling up to try and clear the obstacles would have been an instinctive pilot reaction. Given that twigs were found in the tail wheel landing gear it is very likely that the aircraft was not able to avoid the trees.

There were no pre-existing mechanical issues identified with the aircraft during detailed examination after the accident that would explain the deviation from the runway centreline or the subsequent circumstances leading to the accident. Evidence from eyewitnesses, CCTV footage and ground marks, plus the damage caused to the engine and propeller, indicate that the engine was under power when the ground collision occurred.

**Conclusion**

G-CUBX tracked to the left on the runway during takeoff and within two seconds of getting airborne it was in a left turn tracking toward obstacles south of the runway; one of these obstacles was the tree which G-CUBX appears to have struck at the apogee of its flight path. It was not possible to conclusively establish why the aircraft diverged left during and after takeoff. Nonetheless, the investigation considered it likely the relatively low lift off speed contributed to the pilot having insufficient aerodynamic control authority to effectively counter the flight path divergence. Being in a turn rather than wings level would have compromised the aircraft's climb rate resulting in it being unable to climb above the obstacles in its flight path.

The investigation was unable to find evidence of any pre-accident fault with the aircraft.

*Published: 29 May 2025.*

**Accident**

| | | |
|---|---|---|
| **Aircraft Type and Registration:** | Mini Nimbus C, G-CFHG | |
| **No & Type of Engines:** | None | |
| **Year of Manufacture:** | 1981 (Serial no: 140) | |
| **Date & Time (UTC):** | 5 June 2024 at 1013 hrs | |
| **Location:** | Barlavington, 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:** | BGA Bronze plus cross-country | |
| **Commander's Age:** | 73 years | |
| **Commander's Flying Experience:** | 100 hours (of which 19 hours 43 mins were on type)<br>Last 90 days - 25 hours<br>Last 28 days - 13 hours | |
| **Information Source:** | AAIB Field Investigation | |

## Synopsis

The pilot took off with the intention to conduct an endurance flight lasting five hours. In the early stages of the flight the pilot successfully gained height in two separate thermals. After approximately 30 minutes of flying, the pilot turned 180° to track back towards the airfield. Without any further significant height gains, the glider eventually descended through the height at which BGA guidance suggests a field landing should be initiated. The glider's flightpath suggests the pilot did not intend to commit to a landing and at low level an apparent attempt was made to gain height in a thermal. The glider gained a small amount of additional height, but during this manoeuvre two loss of control events occurred, both consistent with a stall and wing drop. The pilot appeared to recover controlled flight during both incidents but lost height and following the second recovery, the glider came into contact with the tops of trees. This resulted in significant damage to the glider, and it struck the ground causing fatal injuries to the pilot. The pilot was appropriately trained, experienced and qualified to conduct the flight and the weather was suitable, although described as challenging by other pilots who flew that day. Whilst not considered to be causal, a contributory medical factor could not be excluded. It was not possible to determine why the pilot elected not to follow the relevant training to conduct a field landing at the appropriate opportunity.

## History of the flight

The pilot attended a local gliding club, where he was a member, on the morning of 5 June 2024 with the intention to complete an endurance flight of five hours. This was one of the requirements for obtaining his British Gliding Association (BGA) Silver badge, which was the next step in advancing his gliding qualifications.

A club member who arrived shortly after 0800 hrs recalled seeing the pilot's glider, G-CFHG, among the other gliders lined up for takeoff on Runway 04. A morning briefing was given at 0900 hrs by the duty instructor. Although no witness specifically recalled the pilot being present, it was normal practice to attend, and no evidence was identified to suggest the pilot had not attended[1]. Members of the gliding club stated that the day of the accident was expected to be the "the best of the year" in terms of favourable gliding conditions. While it was not anticipated there would be much lift derived from the ridges of the South Downs, owing to the westerly wind direction. It was expected there would be very good thermals[2] given the cool ambient air temperature, the sunlight, and a high cloud base over a wide local area.

Various club members reported that they spoke with the pilot at the launch site. They all reported that he seemed relaxed, his usual self and in good demeanour. One witness recalled assisting the pilot with the positive flying control check at the launch site, with no problems identified. More than one witness reported that he spoke to them of his plans to complete his endurance flight for his Silver badge. A couple of witnesses mentioned that rather than flying locally he intended to fly west towards Lasham and Petersfield. Another stated that the pilot had said that his intent was to fly cross-country since *"soaring locally for five hours would become boring"*.

**Footnote**

1 Attendance at the morning briefing was not mandatory if a pilot intended to go gliding, however pilots were expected to speak with the duty instructor if not attending. The duty instructor did not recall individually briefing the accident pilot.

2 Thermals are pockets of air which are warmer than the atmosphere around them, resulting in localised rising airflow.

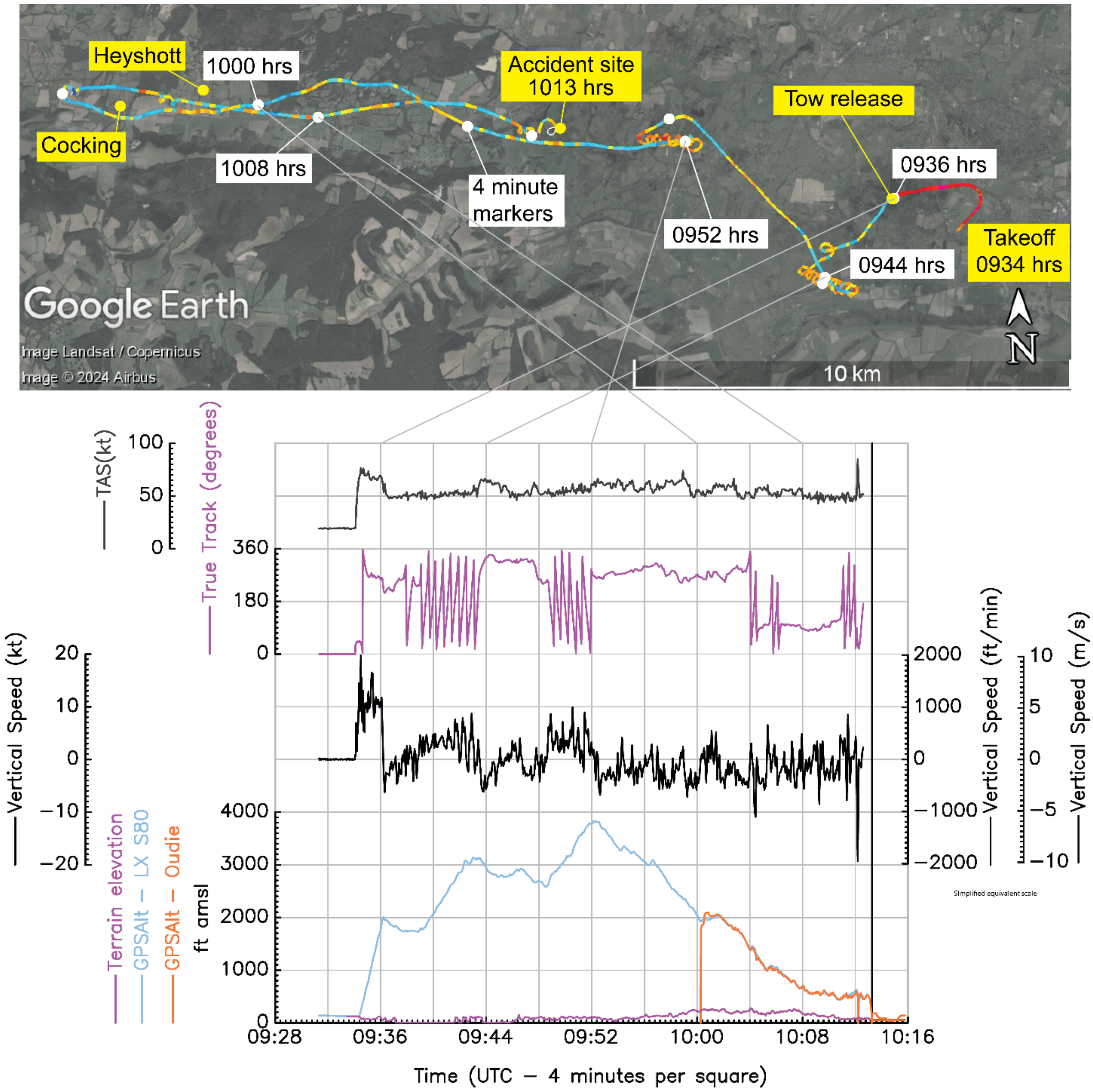


**Figure 1**

Flightpath of G-CFHG (colour coded to show climb and descent rate) and overview data plot

The top half of Figure 1 shows the flightpath of G-CFHG, coloured[3] to indicate the areas and degree of lift and sink[4] the pilot encountered. The bottom plot shows the various other parameters for the flight. The pilot launched using an aerotow at 0934 hrs. After being released from the aerotow at about 2,000 ft amsl, he then tracked south-west before entering a thermal. The pilot completed eight orbits to stay within the rising airflow, climbing from approximately 1,700 ft amsl to about 3,100 ft amsl. He then tracked north-west for about 4 minutes before entering a second thermal at about 2,600 ft amsl. The aircraft climbed to

**Footnote**

3 Increasingly warm colours (yellow/orange/red) denote increasingly greater climb rates, increasingly cool colours (blue/dark blue) denote increasing rates of descent.

4 Lift and sink are terms used by the gliding community to refer to rising and descending airflows, respectively.

its peak altitude of 3,800 ft amsl before continuing west. The pilot flew approximately west for a further 12 minutes. The average rate of descent encountered was slightly less than -2 kt (about -200 ft/min or -1 m/s). There were periods where the glider transitioned through areas of occasional lift, however, the pilot did not make any further orbits as he flew west.

The pilot turned back towards the east just beyond the village of Cocking, descending through about 1,200 ft agl. Shortly afterwards, the glider encountered slight lift and the pilot orbited once, before conducting a further two orbits about 2 km further east, after again briefly encountering lift. At this point he was at about 800 ft agl and less than 1 km south-west of Heyshott. The flight continued downwind to the east for 8 km before orbiting at about 400 ft agl, when a sequence of apparent loss of control incidents resulted in the glider coming into contact with trees before impact with the ground. The final manoeuvres are described in more detail in the Recorded Information section.

*Overdue search*

At about 1330 hrs a member of the gliding club, who was following the progress of the club's gliders remotely online, noticed that the flight track of the accident glider had stopped. He stated that he assumed the pilot had landed out and would be arranging his own recovery of the glider, as was normal practice. When the member arrived at the club's airfield later that afternoon, he asked about the accident pilot. Since the pilot was known to be attempting a five hour duration flight, it was only just approaching the time he was expected to return, so nobody at the club had checked on his status. After viewing the online tracking website again and confirming the glider was still stationary in the same location, the member called the pilot's phone. When there was no response after 15 minutes, and no-one else had heard from the pilot, the member and a pilot took off in the club's tug aircraft and began a search. They located the glider in a wooded area and declared a MAYDAY on the Distress and Diversion radio frequency at 1658 hrs.

At the time the gliding club member was ringing the accident pilot's phone, a dog walker was passing the accident site. He hadn't observed the glider from the road because it was shielded from view by trees. However, alerted by the phone ringing, he entered the woods and found the glider, with the pilot unresponsive in the cockpit. The dog walker called 999 and initiated the emergency services' response. The Police arrived on scene at 1706 hrs.

**Reported actual gliding conditions for the area**

A club member who launched shortly after the accident pilot, commented that the conditions were "challenging; with strong wind gusts, heavy sink in places and a strong westerly wind at height." Other members who flew in the same area commented that while there were some strong thermals, there was also some corresponding strong sink. Two members who were flying in the same area between the club and Lasham reported that two hours after the accident time they had 'landed out'[5] in fields near to the accident site, after encountering a broad area of sink. One club member who flew between the club airfield and Lasham later in the day described the conditions as "marginal" with areas of heavy sink.

Footnote

[5] Landing out also known as a field landing, refers to landing at a location other than an airfield, typically in a farm field.

**Recorded information**

Flightpath data was downloaded from three devices recovered from the glider. A Naviter Oudie 2 LITE recorded Global Navigation Satellite System (GNSS) based position data and pressure altitude every second. It did not record the first part of the flight but carried on recording until after the accident. An LXNAV S80 recorded additional parameters including TAS, pressure altitude, pitch and roll parameters but only once every five seconds (except at launch where once per second data was recorded). The recording recovered from the S80 included the launch but stopped approximately 30 seconds before the accident, likely due to power being lost in the accident before buffered data was written to the memory. An LXNAV FlarmMouse recorded GNSS and pressure altitude data every 4 seconds, ending at about 400 ft agl in the final descent. The pressure altitudes recorded by the FlarmMouse and S80 were offset to be consistent with GNSS altitudes during stable flight.

*Accident flight*

An overview of the flight profile is shown in Figure 1. Figure 2 provides more specific detail of the final manoeuvres before impact with the ground.

In the final phase of the flight, a sequence of turns was initiated at a height of 400 ft agl. After completing three turns, having gained approximately 200 ft in altitude, the data indicates a dynamic event occurred. Maximum values of 25° pitch and 70° right roll were recorded. However, the pitch and roll parameters were only sampled once every 5 seconds. As such, it was not possible to identify the relative sequence of these parameters nor is it likely that these were the absolute peak values achieved. The pressure altitude parameters recorded a drop of approximately 280 ft in four seconds, though again sample rate limitations indicate it's likely more altitude was lost. The next recorded value of TAS showed an increase from the initial 50 KTAS prior to the event to 85 KTAS. The recorded GNSS data was erratic, indicating the system had lost track of the satellite signals required to accurately calculate its location. This can typically be due to masking of the antenna when the fuselage reaches an extreme attitude. Prior to the dynamic event the glider was in a right orbit, afterwards the flightpath had abruptly changed to the left, which was inconsistent with normal flight manoeuvres. A high normal acceleration was also recorded, likely during an exchange of speed for height during the upset recovery.

The recovery manoeuvre from the event was followed by the glider flying a wide right hand turn that then tightened. There was no recorded pitch or roll data for this final turn but soon after the glider track passed through an easterly heading, the recorded GNSS track became erratic once more. The GNSS fix accuracy parameter, though not always a robust indicator of a problem, started degrading at 1013:07 hrs with the aircraft below 400 ft agl and descending (as recorded by the FlarmMouse pressure altitude). This was followed by anomalous GNSS data, a sign of the system having trouble fixing the aircraft location, again associated with dynamic manoeuvres such as the one experienced a minute earlier.

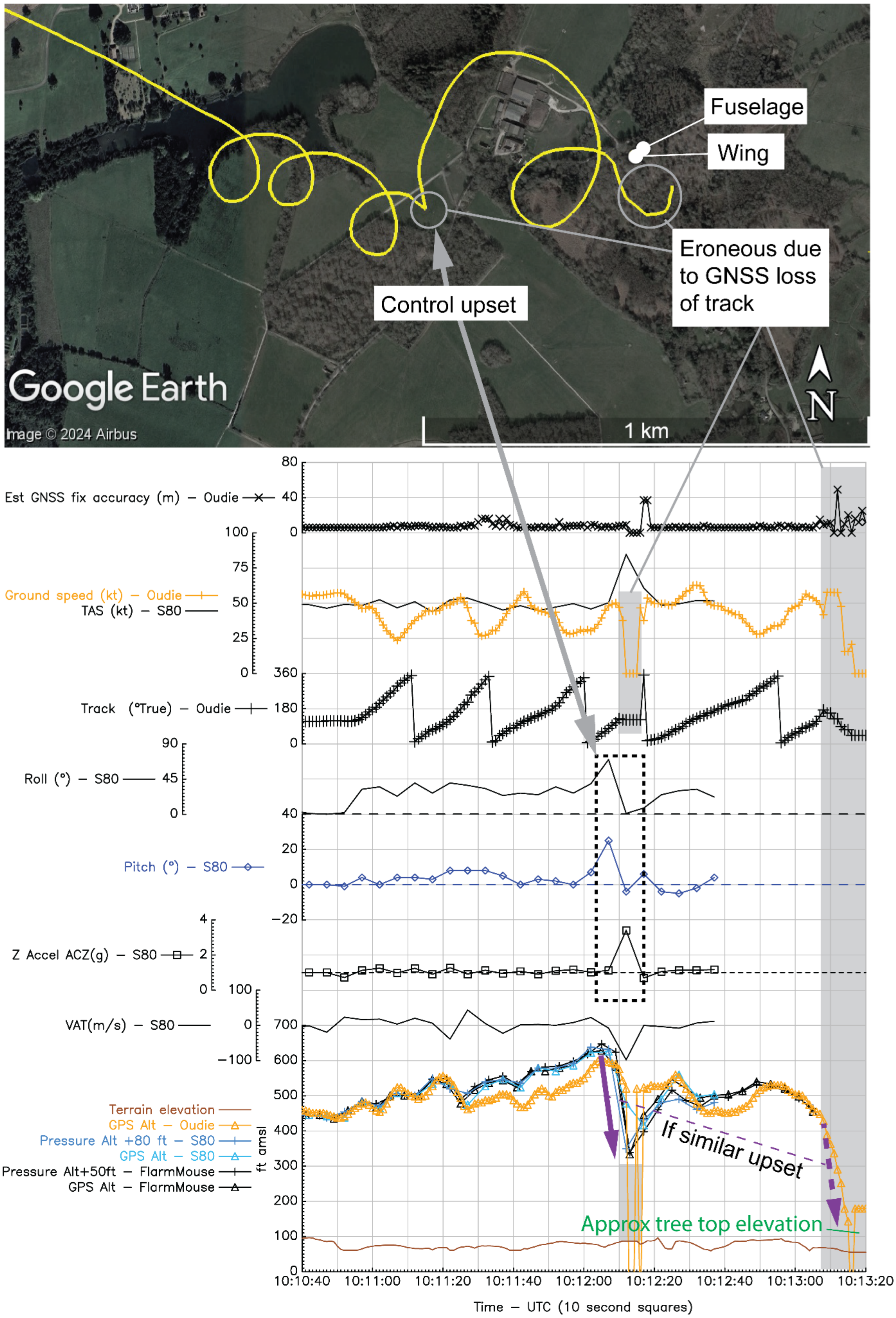


**Figure 2**

Flightpath of the end of the flight and associated data plot

The GNSS track carried on recording a path that indicated the glider flew away from the direction of the accident site before a turn to the left. However, this was unreliable data, as demonstrated by the issues recorded during the earlier dynamic manoeuvre and the direction of travel after the recovery. A similar recovery flightpath to the previous dynamic manoeuvre, if also assumed for this manoeuvre, is consistent with the orientation of the wreckage and the direction of travel indicated by the location of the detached wing relative to the fuselage final location. The aircraft likely reached the accident site at approximately 1013:15 hrs, which is consistent with the GPS altitude approaching the terrain elevation.

*Previous land out*

The data recovered for a flight on 23 May 2024, involved a landing away from an airfield. This is shown in Figure 3. The flight profile prior to the landing has similarities to the accident flight profile prior to the upset events. The final phase of the flight from the last time the glider gained height in a thermal is highlighted in yellow. This is the sequence shown in detail in the data plot below.

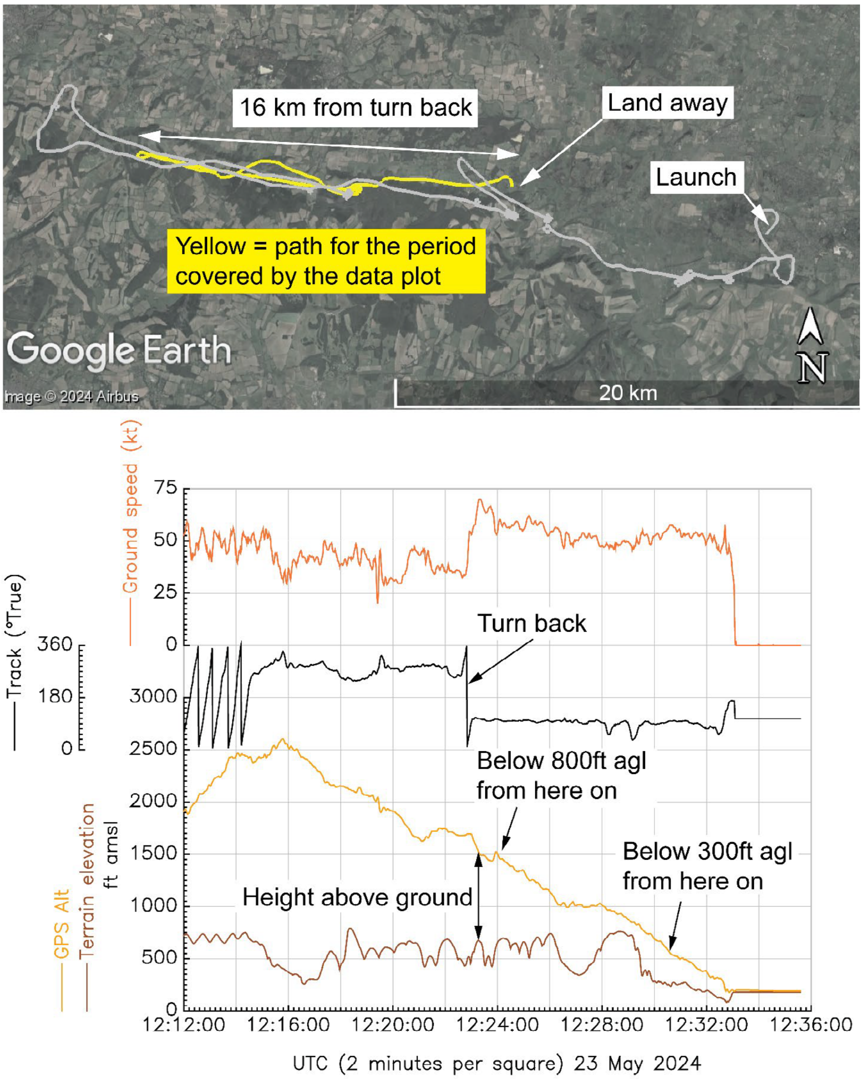


**Figure 3**

Previous land away flight (23 May 2024) and associated data plot

The final descent was from a height of more than 2,000 ft agl whilst heading in a westerly direction. At just above 1,000 ft agl, an orbit was flown and then an easterly flightpath back towards the launch site. Descending through approximately 150 ft agl, the glider turned south and landed in a field. The field was approximately 2 km west of the accident site.

**Accident site and wreckage inspection**

During the final stages of the accident flight, the glider descended into a wooded area and started to come into contact with the treetops. This was evidenced initially by broken branches and small pieces of debris from the glider's structure, which had fallen to lower levels in the trees or down to the ground. As the glider continued to descend, it came into contact with more substantial branches of the trees resulting in significant damage to both wings, with the right wing becoming completely detached close to its root and falling to the ground. The left wing broke in half, but the outer section remained attached by the flying control tube.

The fuselage of the glider continued to travel forward from the location of the right wing, until it hit the ground with significant force, leaving a ground mark, and then bouncing forward to its final position. There was impact damage from the trees on the right side of the vertical stabiliser, on the vertical tail and the rudder. The final impact with the ground had resulted in extensive damage to the forward fuselage structure under the cockpit, and the canopy had shattered.

The severe damage to all the flying control surfaces, meant it was not possible to confirm pre-impact control continuity or flap and airbrake positions. The landing gear wheel was partially deployed, and the gear doors had broken off. The gear lever in the cockpit was out of the 'gear up' detent, but both the lever and the detent had damage consistent with the lever being forced out of this position during the final impact sequence.

**Aircraft information**

The Mini Nimbus C is a single seat glider with a 15 m wingspan, and a large side hinged perspex canopy. It is constructed from carbon and glass fibre, with a maximum takeoff weight of 500 kg. Rather than conventional airbrakes which deploy from the middle of the top surface of the wing, the Mini Nimbus C has combined trailing edge spoilers and flaps. This system was designed to allow a steeper landing approach angle and better landing performance. The flaps have four position settings -7°, -4°, 0° and +8°. The -7° position is used to reduce drag in high-speed flight. Minimum sink flap position is +8°, this is the setting recommended by the Flight Manual for flying in thermals.

The flying controls have a positive engagement safety feature, which ensures they connect properly when the glider is rigged. The glider has a published maximum load factor of +5.3 with airbrakes closed or +3.5 with air brakes extended but was designed with a structural safety factor of 1.5 above these operating limits.

G-CFHG was manufactured in 1981 and was purchased by the pilot in November 2023 when it had 2,481 hours since new.

The glider's stall speeds in kt are shown in an extract from the Flight Manual below:

| Takeoff weight | 335 kg | 500 kg |
|---|---|---|
| C.G. position | 380 mm | 320 mm |
| Stall Speed | knots | |
| Air brakes retracted, flap positions (degrees) | | |
| +8 | 33 | 42 |
| 0 | 36 | 45 |
| -7 | 42 | 49 |
| Air brakes extended, flap position (degrees) | | |
| +8 | 31 | 38 |

**Table 1**

Flight Manual extract showing stall speeds (kt)

In a banked turn the load factor on the glider increases. For a 45° banked turn this results in the load factor increasing to 1.41. Increased load factor has the effect of increasing stall speed by the square root of the load factor.[6] This would increase the stall speeds as shown in Table 2:

| Takeoff weight | 335 kg | 500 kg |
|---|---|---|
| C.G. position | 380 mm | 320 mm |
| Stall Speed | knots | |
| Air brakes retracted, flap positions (degrees) | | |
| +8 | 39 | 50 |
| 0 | 43 | 54 |
| -7 | 50 | 58 |
| Air brakes extended, flap position (degrees) | | |
| +8 | 37 | 45 |

**Table 2**

Approximate increased stall speeds (kt) at 45° bank angle

The Flight Manual highlights control can be lost by the wing dropping during a stall.

## Airfield information

The gliding club is based in a field to the west of Storrington. It is a grass field with a runway oriented 04/22. It has a hangar large enough to store gliders pre-rigged. The pilot kept the accident glider, G-CFHG, continuously rigged in the hangar rather than assembling it prior to each flight.

**Footnote**

[6] Figures quoted in the FAA Airplane Flying Handbook (FAA-H-8083-3C) Airplane Flying Handbook (3C) Chapter 10 [accessed 10 June 2025].

**Meteorology**

*Aftercast*

The Met Office provided an aftercast for the area of Storrington on the day of the accident.

The weather for the day was affected by a high pressure centred in the mid-Atlantic with low pressure to the northeast of the UK, resulting in a light unstable north westerly flow across the area. The area experienced westerly winds of 15-20 kt up to 5,000 ft at the time of the flight.

The area had good visibility with few or scattered[7], but occasionally[8] broken[9] cloud between 2,500 and 4,500 ft. The Shoreham METAR showed that visibility remained above 10 km throughout, with few or scattered cloud reported at 3,200 ft and above at the time of departure of the accident flight, lifting to 4,800 ft by 1020 hrs.

The satellite images showed convective cloud developing by 1000 hrs, increasing in both coverage and height through the remainder of the day, although the deeper convection remained mainly to the north and west of the area of interest.

The ballooning forecast for the ballooning site at Ebernoe, approximately 12 km to the northwest of Storrington indicated moderate thermals (+200 to +400 ft/min) would start to develop from 0700 hrs initially to a height of 2,000 ft increasing to 5,000 ft by 1000 hrs.

*Regional Atmospheric Soaring Prediction (RASP)*

The RASP website[10] provides a visual depiction of the predicted thermal activity, with high levels of activity shown in red through to low levels in blue. This website is one of the free sites for weather information provided as a link on the BGA website.

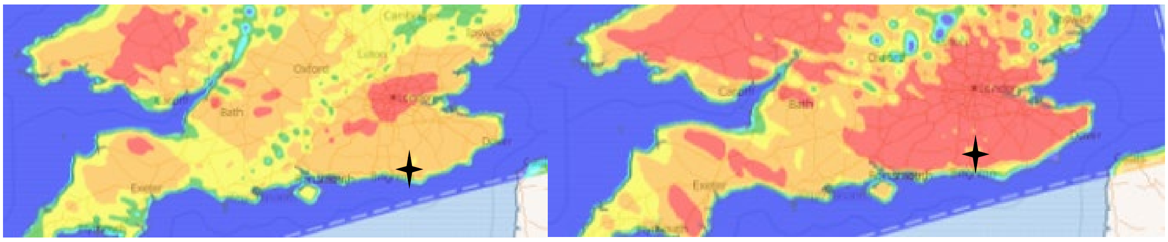

**Figure 4**

RASP forecast for convective activity (STAR Rating),
valid 5 June 2024 at 1000 hrs (left) and 1300 hrs (right)

**Footnote**

7 Few and scattered indicates that less than half the sky was obscured by cloud.
8 Occasional (OCNL) implies infrequent conditions which can be avoided. Used to describe convective and non-convective types. 25-50% of the area affected.
9 Broken (BKN) indicates that more than half the sky was obscured by cloud, but not completely.
10 https://rasp.stratus.org.uk/index.php/rasptable-desktop [accessed 10 June 2025].

Figure 4 shows a picture of the RASP forecast on the day of the accident. It could not be established which, if any, sources the pilot had used to review the weather forecast, but witnesses stated the RASP website was routinely used at the gliding club.

**BGA guidance material**[11]

The BGA field landing training syllabus[12] covers the following elements:

- Gliding range.
- Decision to land out.
- Determination of wind direction.
- Field selection, suitability and hazards.
- Circuit and approach judgement.
- Considerations for landing on slope.

The BGA provide access to several videos[13] that illustrate the planning and decision-making for landing out in a field. The BGA also publishes a '*Safety Briefing: Field landing*'[14]. It states to '*Plan Ahead - and Above All, Fly the Glider*'. It continues:

> *'Late field selection is a known cause of many field landing accidents. It's obvious why. Planning ahead helps any pilot reduce the pressure and reduce distractions.*
>
> - *Before flight, think what are the fields are like at the time of year and in your area. Is the wind likely to be light or strong during the flight? Light means longer landing areas and it's easier to get the direction wrong. Strong might mean challenging turbulence and wind gradients on approach.*
> - *Always fly a glider so that, if necessary, you can comfortably reach a suitably flat and unobstructed area that you can be confident of landing on safely. Remember that you will normally cover far more ground if you fly down wind.*
> - *Incorporate field landings into your soaring plan. Once you have surveyed the sky ahead, spare a thought for the terrain below – even if you are fairly high. When the signs are trying to tell you that you are not going to be airborne for much longer, it is important to accept that you will soon need somewhere to land. Denial or misplaced self-belief can result in dangerously late decisions.*
> - *Inadvertent stall/spin is a known cause of many life-changing injuries. At all times and above all else, FLY THE GLIDER.'*

**Footnote**

[11] The text for all quoted material was correct at the time of publication and was the relevant guidance at the time of the accident. For operational use the BGA website should be consulted for the latest revision.
[12] BGA Gliding Syllabus - Pilot & Club Info [accessed 10 June 2025].
[13] https://members.gliding.co.uk/field-landing/ [accessed 10 June 2025].
[14] https://members.gliding.co.uk/library/safety/field-landing/ [accessed 10 June 2025].

On field selection it states:

> *'Well before reaching circuit height, identify an area with 2 or 3 potentially suitable landing fields.'*

The BGA Student Pilot Manual uses the following diagram (Figure 5) to illustrate the field landing decision process based on height above the ground, which is referred to as the field landing decision-making funnel.

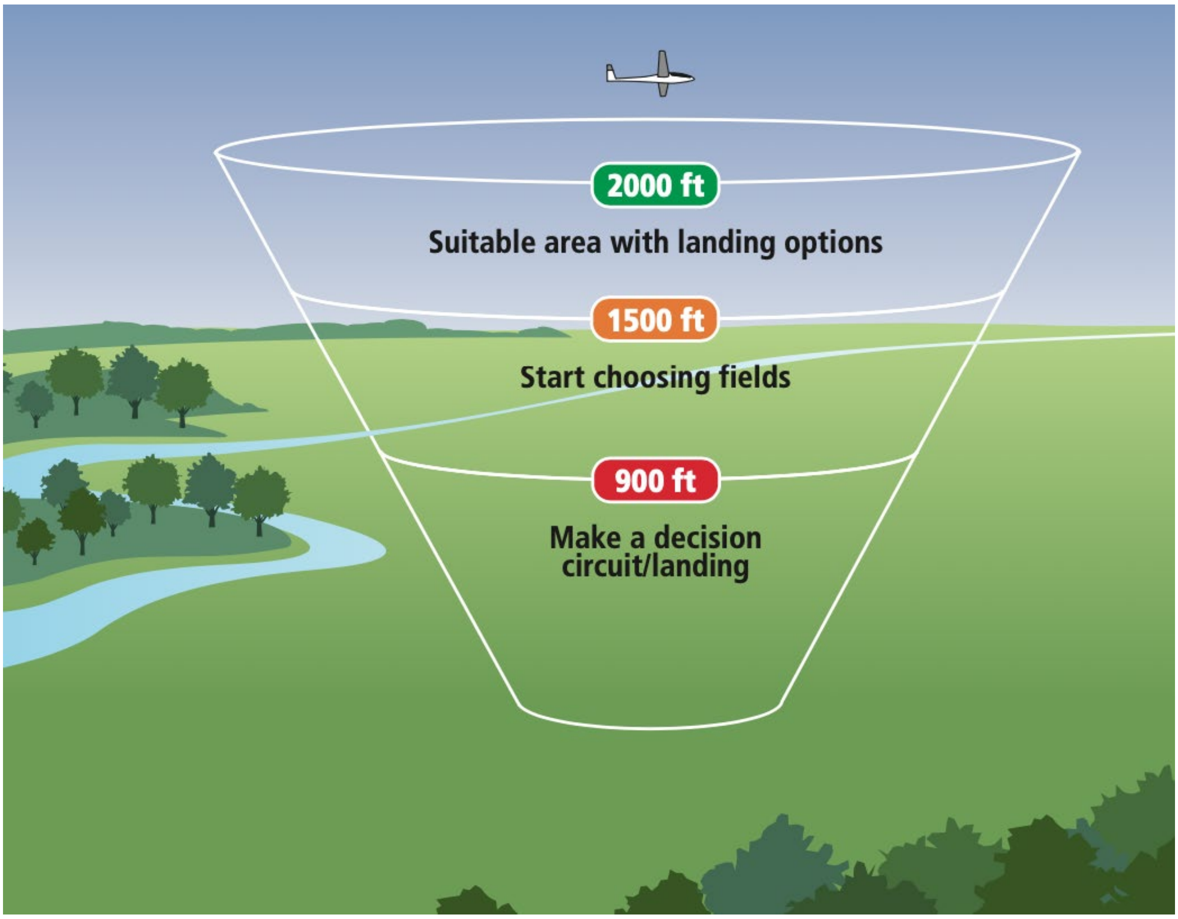


**Figure 5**

BGA student manual guidance on decision heights for field landings
(Courtesy of BGA)

The BGA Student Pilot Manual includes a useful checklist for pilots when selecting a landing site:

> *'Wind*
> *Pay close attention to the wind direction. Landing with a tailwind is strongly discouraged, because it leads to a greater landing distance.*

*Size*
*Your field must be big enough for at least the last part of the descent, a normal landing and a ground run without braking. It is best to choose a field that is as long as possible. In a compact field you have very little room for mistakes. If necessary, consider a landing from corner to corner.*

*Surface*
*Potentially good landing surfaces are: mown grain fields, stubble fields, grass fields and fields with short crop. Try to avoid long crops, such as rapeseed fields; these make keeping the wings level very difficult during the landing and ground run and they might damage your glider. Good advice is: if you can see earth through the crop it is generally okay for landing.*

*Slope*
*Slope is best seen from the side, rather than from above. Even steep slopes are hard to see from above. Any visible downslope is unacceptable. A slight upslope is acceptable, but keep in mind you need a different landing technique for upsloping terrain.*

*Obstacles*
*There are many sorts of obstacles to take into account: trees, power cables, buildings and hills that might create turbulence. If you have the choice, then it is wise not to approach over busy roads or crowds as this may cause problems and unwanted attention. Obstacles reduce the usable field length by at least 10 times the height you clear them. Power cables are almost invisible from the air. Pay close attention to the towers and poles to which they are attached.*

*Stock*
*Just as you never want to land near people, you also want to land as far away from animals as possible. Horses can be startled, sheep tend to spread in a field, cows are curious and can damage your glider.'*

The BGA Instructor Manual outlines the nominal circuit pattern for landing in any field. It defines the start of the downwind leg as the *'High Key'* position, commenced at 800-900 ft agl (Figure 6). The glider should be positioned to achieve an appropriate sight line angle to the landing reference point for the glider being flown. The manual states the final turn on to the straight in approach should be '*no lower than 300'…'* as *'Turns below 300' can be dangerous….'*

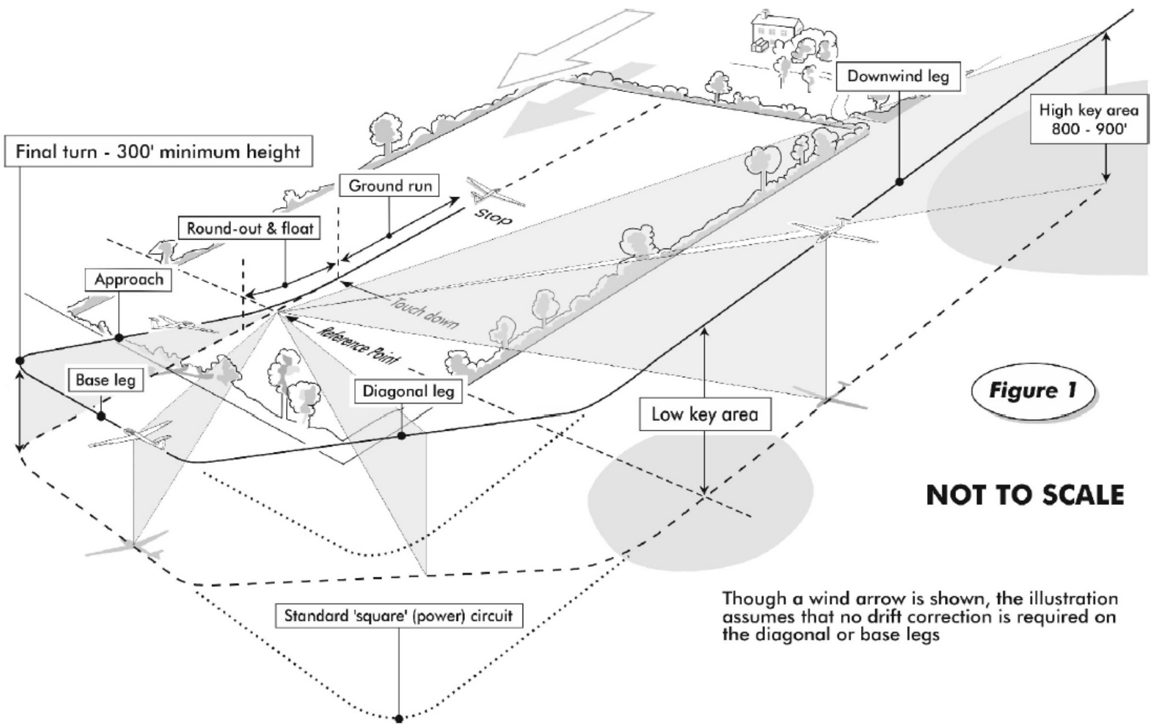


**Figure 6**

Circuit pattern for a field landing from the BGA Instructor's Manual
(*Courtesy of the BGA*)

*Stall/Spin guidance*

BGA guidance on stall/spin accidents states that:

> *'Together with winch launch related accidents and mid-air collisions, loss of control through inadvertent stalling and spinning accounts for approximately 80% of all fatal accidents in gliding.*
>
> *A key issue that comes from studying each individual stall/spin accident is that in almost all cases it appeared that the pilot was concentrating on something other than flying the glider at the time of the accident. In other words, in the majority of stall/spin accidents the pilot appears to have been distracted.'*

One of the issues that the BGA highlight as a possible cause of stall/spin is over-ruddered turns (skidding). Their guidance states:

> *'One common fault that is thought to lead to spinning off turns is the over-ruddered turn. Pilots under pressure, probably looking anywhere other than over the nose, can find themselves over-ruddering along with poor speed control. A possible cause of this fault is the visual effect of the lower wing which describes a forward track over the ground as we get lower, instead of backwards. This effect starts to occur around 200 feet, depending on all sorts of factors. Pilots looking into the turn may automatically apply more rudder to try to remedy the apparent*

> *problem. This leads to the nose being lower on the horizon (due to yaw) than normal for the speed, which may be why speed control also suffers. A slow, over-ruddered turn with apparently normal pitch attitude can result. Looking over the nose during the final turn to monitor attitude, indicated airspeed and balance helps pilots avoid these potential handling faults.'*

*BGA guidance on age*

The BGA provide guidance on '*Managing Flying Risk – Ageing pilots.*'[15] This highlights that evidence of the effect of age on flying and safety is not definitive. It states:

> *'Relatively little information exists pertaining specifically to pilots over the age of 70…. The picture that seems to emerge from a range of studies is of a mild but measurable decrease in overall performance with age, offset to varying degrees by expertise and good health.'*

However, on decision-making, it provides the following guidance:

- *'Although experience can have a real impact, ageing can also make it more challenging to handle decision-making tasks.'*

Guidance includes:

- *'Spend more time doing pre-flight and eventualities planning. Any "pre-thinking" you do will make things easier later.*
- *Fly when well-rested and make it a point to stay particularly alert to changes.*
- *Always have a solid "Plan B" ready to go ahead of time. Make sure it's realistic — something you're actually prepared to use.'*

## Organisational information

*BGA endorsements*

The BGA requirements for a cross-country endorsement include:

1. A soaring flight.
2. A field selection test where the '*candidate must demonstrate satisfactorily their ability to select or reject fields as to their suitability for landing. This exercise must be undertaken from the air but can be flown in a glider, motor glider or light aircraft.'*
3. A field landings test, which is normally completed as part of the field selection test, where the candidate *'must make a minimum of two successful approaches in a motor glider towards a field landing area selected by the*

**Footnote**

[15] https://members.gliding.co.uk/safety/managing-flying-risk-index/ageing-pilots/ [accessed 10 June 2025].

*candidate. The altimeter should be covered, or the scale offset for this exercise. To qualify for the endorsement, the approaches must be flown without any assistance or prompting from the instructor who must be satisfied that the candidate has demonstrated an adequate level of judgement and skill.'*

4. A navigation flight.

This endorsement can be achieved once a pilot has gained the Bronze endorsement. Once a pilot has both the Bronze and cross-country endorsements, they are considered a qualified glider pilot under the BGA progress pathway guidance.[16]

The BGA requirements for the award of the Silver badge include:

1. A duration flight of not less than 5 hours from release to landing.
2. A height gain of at least 1,000 metres (3,281 feet).
3. A straight distance flight of at least 50 km.

The first two requirements can be fulfilled any time after going solo, and the third once a pilot has obtained the cross-country endorsement.

*Gliding club supervision*

The pilot's gliding club used a card system to identify the experience status of pilots. A yellow card identified that pilots were able to fly on any day without a check flight, as long as they remained current.

**Pilot's experience**

The pilot obtained some initial flying experience when attending the Air Training Corp at school. He started gliding in 2018 and learnt to fly at the same gliding club where he was a member, though he had also done some gliding at Lasham. The pilot gained his Bronze endorsement in May 2023 and completed the requirements for the cross-country endorsement in the June. He had completed the distance and height gain requirements for the Silver badge. He held a yellow card under the club's supervisory system used for qualified pilots.

The pilot had owned a Schleicher Ka 6 in early 2023 but sold it towards the end of the year before buying the Schempp-Hirth Mini Nimbus C. Records indicated that the pilot had flown this glider (G-CFHG) 21 times since March 2024.

**Footnote**

16 This is the minimum requirement for a pilot to apply for a Sailplane Pilot Licence (SPL) in accordance with Part-FCL. This will become mandatory for glider pilots after September 2025.

The pilot's logbook was annotated with an entry by his instructor, detailing the stall and spin training which had been undertaken by the pilot in three flights on 22 May 2023. This included recovery from an underbanked, over-ruddered turn. The instructor commented that the pilot's recovery in each scenario had been satisfactory. A second entry on 29 June 2023 confirmed that the pilot had satisfactorily completed landing out field selection and landing training in a Super Dimona motor glider.

*Previous land out*

The pilot had landed out previously on 23 May 2024 in a similar area to where the accident occurred, west of the airfield[17]. The wind direction was recorded as westerly. Members that helped retrieve the glider reported that the pilot had explained that he was making an approach to a field just to the south of a primary school, which had suddenly become occupied by several school children. Consequently, at a late stage in the landing approach, at about 150 ft agl, he was forced to turn south and land in another field. A club member who was part of the retrieval team, reported that the pilot recognised in hindsight that he should have selected a field a mile or two earlier.

**Medical**

The pilot had a Civil Aviation Authority (CAA) Pilot Medical Declaration (PMD), based on fitness to drive and hold a UK driving licence. These declarations remain valid for 3 years. A new declaration is required once a pilot becomes 70 years of age. The pilot's PMD was valid until October 2026.

The pilot was taking prescription medication for hypertension (high blood pressure). One of the drugs prescribed was included in the CAA published guidance on potentially unsuitable medication for use by pilots required to hold a full CAA medical, though this category of medical is not a requirement for glider pilots. Dizziness and nausea are published common side-effects of the medication in question and can be exacerbated by other health related factors such as dehydration.

The pilot was a retired doctor and there was some anecdotal evidence that he may, on occasion, have been self-adjusting the dosage of the drugs to manage mild adverse side-effects, including dizziness. However, the medication was a long-term prescription and there was no evidence to suggest this had been a particular issue in the period prior to the accident flight.

Evidence from a number of witnesses who interacted with the pilot prior to the flight, offered nothing to suggest the pilot had felt unwell before he took off. The pilot's family stated that he took a very responsible attitude to flying and would not have set off on the flight had this been the case.

**Footnote**

[17] See 'Recorded information' section for a more detailed description.

*Postmortem*

The postmortem identified significant injuries to the pilot's head and pelvis, either of which was severe enough to have been fatal, but combined were considered to be the cause of death. The pathologist noted that the head injury was sufficiently severe to have caused immediate unconsciousness, rapidly followed by death.

The pathologist also considered the possibility of medical incapacitation in flight. His report concluded that:

> *'Whilst there was no positive pathological evidence of an acute medical episode, the possibility of medical incapacitation cannot be excluded. Dried vomitus or similar material found on the front of the deceased's clothing may indicate nausea related to an underlying medical event, but this may also be a terminal phenomenon or postmortem artifact.'*

The postmortem findings, the pilot's medication and medical history were reviewed with the CAA's medical expert. A similar conclusion was reached that whilst some of the evidence may support the possibility of a contributory inflight medical issue, there was insufficient evidence to reach a finding that this was the cause of the accident.

## Analysis

*Glider serviceability*

The last record of the glider being de-rigged was to recover it from the field landing in May 2024. The glider had been successfully flown multiple times since this date and had the added safety feature of a positive engagement mechanism on the flying controls, to ensure they were properly connected during re-rigging. While flying control continuity could not be confirmed post-accident due to the impact damage, there was no evidence of a control issue or mechanical or structural failure of the glider in the earlier phases of the flight.

*Medical issue*

Based on the medical evidence recovered and the opinions of two medical experts, a contributory health issue could not be ruled out, but there was no evidence to support a conclusion that this was the cause of the accident. The recorded data, medical and accident site evidence support a finding that the pilot was conscious and positively controlling the aircraft up until contact with the trees. As such, a complete loss of consciousness can be excluded. However, if present, a medical issue may potentially have been a source of distraction to the pilot during a critical phase in the flight.

*Training*

The pilot had completed the necessary field landing training in a motor glider with the gliding club and his last field landing check had taken place in June 2023. He had also undertaken stall and spin training, including over-ruddered turns in May 2023. No concerns about the pilot's decision-making or handling performance prior to the accident had been recorded or were raised by instructors from the club.

*Gliding club oversight*

The pilot was appropriately qualified and experienced and was conducting a private flight in his own glider. Active welfare checks on the pilot by the club only started after the full five hour anticipated flight time had elapsed. Whilst earlier identification of a problem was possible and would have been preferable, it would not have changed the outcome for the pilot in this case.

*Analysis of pilot's previous land out*

The pilot's previous field landing on 23 May 2024 did not follow the BGA recommended guidance to fly a circuit pattern staying above 300 ft until the final approach to land into wind. At just above 1,000 ft agl, an orbit was flown followed by a downwind easterly flightpath back towards the launch site. The glider continued to descend downwind until approximately 150 ft agl, when the pilot was forced to turn south due to a hazard in his originally selected landing field. It appears likely that the pilot committed to the field landing relatively late in the flight and witness evidence suggests he was aware that an earlier decision to land may have been a better option.

*Analysis of flight data for the final phase*

The data shows that in the final phase of the accident flight, the glider was below 400 ft agl when it commenced circling to the right, likely an attempt by the pilot to gain altitude in a thermal. This was initially successful in gaining some height. However, shortly after completing a third orbit, the data indicates that there was a dynamic event that resulted in the loss of about 300 ft and caused a significant increase in speed. The pitch and roll data showed significant deviations, followed by a high g manoeuvre recovering to about 400 ft agl and stabilising the speed. While the event had started in a right turn, the resultant track was to the left of the entry track. During the control upset the GNSS data showed behaviour indicative of the system not being able to reliably track its position, which is commonly caused by the aircraft's fuselage being at an extreme attitude.

While the data wasn't conclusive, it suggested an upset or loss of control event that was consistent with a wing drop in a stall. This is highlighted as a characteristic of the glider in the Flight Manual. The data showed a loss of height and increase in speed, followed by a high g pull up and return to controlled flight. This was consistent with the required recovery manoeuvre following a stall at low altitude.

A wider right hand turn was then flown, which tightened again, and the glider started to descend. Reaching about 350 ft agl, the GNSS behaviour once again indicated problems tracking its position. The S80 attitude data was not available for this final manoeuvre but the tracking issues evident in the behaviour of the GNSS data, and the relative position of the accident site location, is consistent with the same loss of control having occurred. The accident site evidence shows the glider was approximately wings level at the point where it came into contact with the trees, suggesting the pilot had again recovered control, but had insufficient height remaining to complete the manoeuvre.

*Analysis of circumstances leading to the accident*

During the accident flight, the glider reached the BGA recommended land out circuit entry height of 800-900 ft agl at the point shown approximately by the red marker in Figure 7.

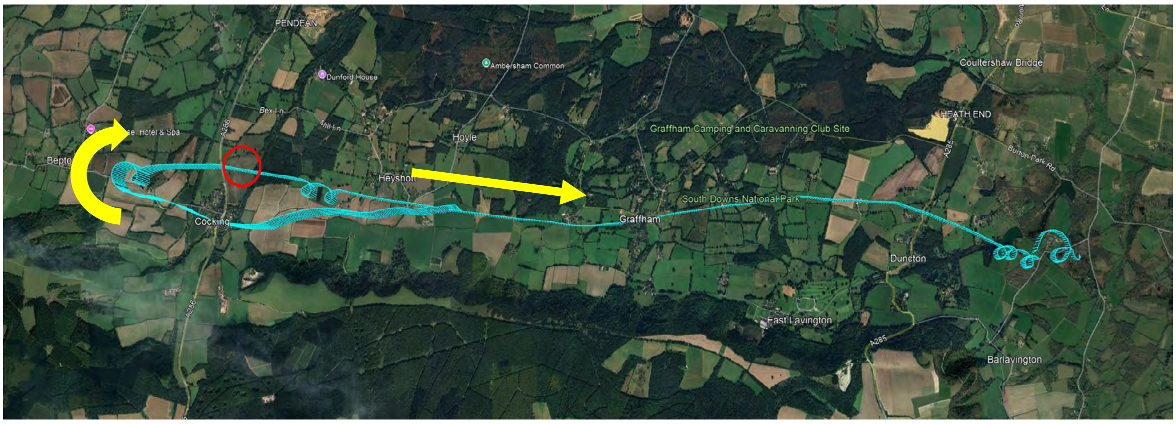


**Figure 7**

Image showing approximately where G-CFHG passed the BGA recommended 'High Key' point (red marker) and potential options for landing fields after this point.
(Image courtesy of Google Maps)

The flight continued for a further eight minutes transiting over an area with a number of open fields, which in theory[18] would have been suitable for use as a landing site. To provide the highest likelihood of achieving a safe landing, the preference would be to land into the prevailing wind whenever possible. As the glider was flying downwind from west to east, if the pilot was intending to land, the expectation would be that a circuit pattern, as illustrated in Figure 6, would be flown to end up heading approximately west/south-west for the final approach to land. Acknowledging that this may need to be modified to take account of the geometry of any landing field selected and any low level hazards present, such as tall trees or power lines. The final track of the glider does not show any indication that the pilot was attempting to fly this profile or to follow the BGA guidance on decision heights for a field landing.

In the final phase of the flight, the data shows the pilot suffered a loss of control likely caused by the wing stalling and dropping. It's not possible to determine why the glider reached the point of stall. The data shows the glider's airspeed was less than 50 kt TAS, with a 45° bank angle immediately prior to the loss of control, but the sampling rate didn't give sufficient detail to determine the actual airspeed at departure from controlled flight. Some possible explanations are:

- Intended or unintended movement of the flaps, increasing the stall speed.
- Overuse of rudder during the turn.

**Footnote**

[18] The actual suitability of these field on the day of the accident with respect to possible hazards couldn't be determined from the evidence available.

Given the lack of any apparent intention to land, it's likely the pilot was primarily focused on the task of remaining within the thermal to gain height. However, it's likely that the low height above the ground and wooded areas were a significant potential distraction. In response to the control loss, the pilot pulled approximately 3.4 g to recover the glider to stable flight, which was also likely influenced by the limited height available. Following this recovery, there was no further evidence in the data to suggest the pilot was now attempting to land. This was supported by physical evidence indicating the landing gear was likely still retracted.

The second upset event took place at a lower height while the glider was over a wooded area, with trees up to 50 ft tall. The accident site evidence suggests the pilot had likely been able to recover from the stall and level the wings, but the glider then came into contact with the tops of the trees, leading to catastrophic damage.

*Possible contributory factors*

The investigation considered possible factors as to why the pilot elected to continue the flight rather than commit to a field landing. It was not possible to determine with any certainty the extent to which these factors contributed specifically to this accident, if at all, but common issues identified in similar events are:

- Late awareness of reducing options and/or task focus leading to loss of situational awareness.
  - The specific objective of achieving a Silver badge qualifying flight, combined with challenging flight conditions on the day may have led the pilot to overly focus on finding lift to gain height and remain airborne. This may have distracted from the wider need to consider alternative options, particularly at an early stage, to increase the likelihood of achieving a safe outcome.
- Previous adverse experiences.
  - Whilst successful in terms of outcome, the previous field landing conducted by the pilot had not gone entirely to plan. This may have influenced his decision about committing to another landing in the same area.
- Effects of ageing on capacity and decision-making.
  - While the accident pilot was at the higher end of the age spectrum for pilots, there is limited evidence that this has a uniformly detrimental effect on decision-making performance. There was no evidence identified by the investigation that this was a particular concern for the accident pilot.

*BGA guidance*

The BGA provides extensive guidance on the field landing decision-making funnel and the trigger heights for committing to landing. The guidance highlights how late decision-making with respect to committing to a landing, results in increased pressure on the pilot and often results in poor outcomes.

**Conclusion**

The pilot was appropriately trained and qualified to conduct the flight and the weather was suitable, although described as challenging by other pilots who flew that day. No evidence was identified of a causal or contributory technical issue with the glider.

In the final stages of the flight the pilot overflew a number of potential landing sites, after the glider transitioned through the height indicated by the BGA guidance, as the point at which flying a circuit pattern to land should be initiated. In the final stages of the flight the pilot appeared to still be attempting to gain height in a thermal despite the low height above the ground, which potentially acted as a distraction and may have contributed to the likely loss of control of the glider in a stall.

Although the pilot appeared to have been able to recover from the stall and level the wings, the glider lost further height and came into contact with the tops of high trees, resulting in catastrophic damage to the glider’s wings and a severe impact of the fuselage with the ground. This resulted in injuries to the pilot which were likely to have been immediately or very quickly fatal.

Evidence shows the pilot was conscious and flying the glider in the final minutes of the flight. However, a contributory health issue acting as a distraction or impairment could not be ruled out.

It was not possible to determine why the pilot chose not to land at an earlier stage in the flight. The BGA guidance highlights that early decision-making with respect to field landings increases the likelihood of a positive outcome.

*Published: 19 June 2025.*

# 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.

## Accident

| | | |
|---|---|---|
| **Aircraft Type and Registration:** | Piper PA-28-161, G-SACS | |
| **No & Type of Engines:** | 1 Lycoming O-320-D3G piston engine | |
| **Year of Manufacture:** | 1988 (Serial no: 2841047) | |
| **Date & Time (UTC):** | 22 June 2024 at 1645 hrs | |
| **Location:** | Sherburn-in-Elmet Airfield, Yorkshire | |
| **Type of Flight:** | Training | |
| **Persons on Board:** | Crew - 1 | Passengers - 1 |
| **Injuries:** | Crew - None | Passengers - None |
| **Nature of Damage:** | Significant damage to wing, fuselage and landing gear | |
| **Commander's Licence:** | Commercial Pilot's Licence | |
| **Commander's Age:** | 27 years | |
| **Commander's Flying Experience:** | 356 hours (of which 245 were on type)<br>Last 90 days - 18 hours<br>Last 28 days - 7 hours | |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot | |

### Synopsis

On takeoff, the right main gear oleo and wheel assembly fell free from the landing gear cylinder, but remained attached to the aircraft by the brake hose. The cause was failure of both torque link attachment lugs due to fatigue cracking. A Service Bulletin issued by the manufacturer exists to inspect the lugs, but it is not mandated in the UK and the failure occurred outside of the inspection interval. Following previous occurrences, the Civil Aviation Authority (CAA) issued Safety Notice SN-2024/002 to raise awareness to owners and operators of affected aircraft, and it continues to monitor instances of cracking in the lugs.

### History of the flight

A student pilot and instructor were conducting a practice forced landing (PFL) lesson, which also included two touch-and-go landings. No issues were identified by the instructor or student, but immediately after taking off after the second touch-and-go the ground crew in a rescue vehicle radioed the aircraft to inform that the right main wheel had become detached and was hanging by a hose. The instructor took control and flew along the runway where the ground crew and the pilot of another aircraft visually confirmed the issue. She then flew several further circuits to burn fuel, and allow time for emergency services to arrive, before landing on grass Runway 28. Upon landing the aircraft veered to the right by approximately 90º and came to a stop with the right wheel detached from the hose. Both instructor and student exited the aircraft unharmed (Figure 1).

**Figure 1**
G-SACS after landing

## Aircraft information

The PA-28 is a low wing, four seat aircraft with a fixed tricycle landing gear. G-SACS is a Piper PA-28-161, manufactured in 1988, and had a valid ARC. It had 18,607 flying hours at the time of the accident and has been owned and operated by a flight training school since 1989.

## Aircraft examination

The torque link attachment lugs on the main landing gear cylinder had fractured, allowing the oleo and wheel assembly to fall free of the cylinder but remain attached to the aircraft by the brake hose.

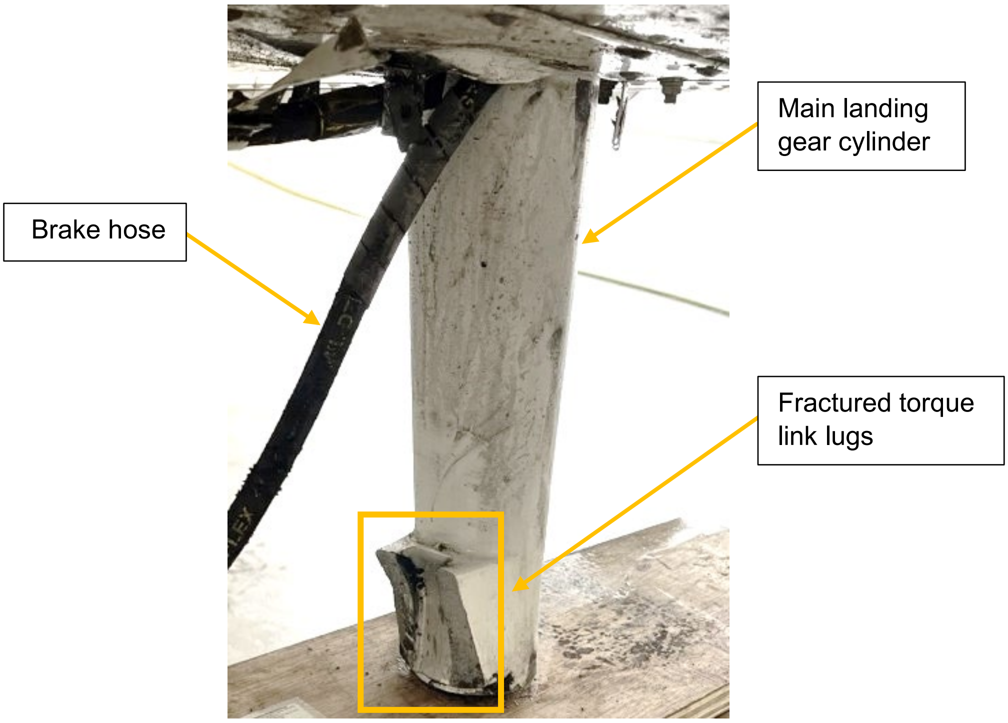


**Figure 2**
Fractured torque link attachment lugs

**Previous Occurrences and Safety Documentation**

Failure of the torque link attachment lugs due to fatigue is a known issue with the cast main landing gear cylinders fitted to PA-28 and PA-32 aircraft manufactured between 1961 and 1977. The cylinders were also fitted to PA-28-161 variants up to 1994, including G-SACS. The cast cylinders were superseded by forged cylinders which are not as susceptible to fatigue cracking of the lugs.

Piper Service Bulletin SB1131A specifies inspection of the cast cylinder torque link attachment lugs at 100 hour intervals, but is not mandated in the UK. It specifies visual inspection followed by dye penetrant if cracks are not detected by 10x visual magnification. The SB had been applied to G-SACS at its last annual inspection at 18,268 hours, followed by visual inspection only of the lugs at each subsequent 100 hour interval.

Two recent occurrences have been investigated by the AAIB[1] and Safety Recommendation 2024-001 was made to the UK CAA to assess whether an unsafe condition exists to mandate SB1131A. The CAA analysis concluded that the failure rate did not meet the threshold for an Airworthiness Directive. As cracking events were still occurring, the CAA issued Safety Notice SN-2024/002[2] on 3 June 2024 to owners and operators of affected aircraft to bring

**Footnote**

1 G-BRBA 4 September 2021: https://www.gov.uk/aaib-reports/aaib-investigation-to-piper-pa-28-161-g-brba and G-AXSG 7 April 2023: https://www.gov.uk/aaib-reports/aaib-investigation-to-piper-pa-28-180-g-axsg both [accessed 19 May 2025].

2 https://www.caa.co.uk/our-work/publications/documents/content/sn-2024002-version-2/ [accessed 19 May 2025].

the issue to their attention and to notify any occurrences of cracks to the CAA for monitoring. This Safety Notice notes that consideration should also be given for inspecting the area by applying a liquid penetrant dye to detect any signs of cracking.

Following this accident, the operator re-applied SB1131A including using dye penetrant to the six aircraft in their fleet and found two further aircraft with cracked torque link lugs. All the operator's aircraft are used for flight training. The operator has since noticed that within the Piper Airplane Parts Catalogue 761-538 for PA-28-151/161 Warrior aircraft, against the main landing gear cylinder, it states:

> *"Forged assemblies recommended for aircraft used in training operations per Piper Service Bulletin 1131 – Latest Revision"*

SB1131A does not refer to the recommended use of forged assemblies for aircraft used in training operations, nor does it account for the number of landings in addition to flying hours. The statement does not appear in the parts catalogues for other applicable aircraft models listed within SB1131A, including the catalogue for G-SACS.

**Analysis**

The torque link attachment lugs failed due to fatigue at 339 hours after the last dye penetrant inspection, that was made in accordance with Piper SB1131A, and outside of the 100 hour inspection interval. The two further cracked lugs found by the operator on other aircraft highlights the importance of using dye penetrant as cracks are not always visible solely under magnification.

Training aircraft typically see a high number of landing cycles which can accelerate fatigue failure once cracks have developed; both recent investigations by AAIB involved aircraft that had been used by flight schools. CAA SN-2024/002 provides additional detail and reporting of cracks so that the situation can be monitored to avoid an unsafe condition developing.

After reviewing the parts catalogues and maintenance manuals for affected aircraft types listed in SB1131A, the aircraft manufacturer is taking the following Safety Action:

**Safety Action**

At the next revision, Piper will revise all applicable parts catalogues and maintenance manuals to include the following statement that is present in the parts catalogue for the PA-28-161/181, Piper part number 761-538:

> *'Used if [cast] MLG Cylinder has not been replaced per Piper Service Bulletin 1131. For Service only. Forged assemblies recommended for aircraft used in training operations per Piper Service Bulletin 1131 - Latest Revision.'*

**Conclusion**

The right main landing gear torque link attachment lugs failed due to fatigue cracking, causing the wheel assembly and oleo to fall free of the landing gear cylinder during flight. The cracks were not identified by visual inspection. The CAA continues to monitor the occurrences of lug cracking on the PA-28 and PA-32 fleets.

**Serious Incident**

| | | |
|---|---|---|
| **Aircraft Type and Registration:** | Socata TB-20 Trinidad, G-BSCN | |
| **No & Type of Engines:** | 1 Lycoming IO-540-C4D5D piston engine | |
| **Year of Manufacture:** | 1990 (Serial no: 1070) | |
| **Date & Time (UTC):** | 25 January 2025 at 1756 hrs | |
| **Location:** | Blackbushe Airport, Hampshire | |
| **Type of Flight:** | Training | |
| **Persons on Board:** | Crew - 1 | Passengers - 1 |
| **Injuries:** | Crew - None | Passengers - None |
| **Nature of Damage:** | Abrasion to right wingtip flap, and aileron | |
| **Commander's Licence:** | Commercial Pilot's Licence | |
| **Commander's Age:** | 69 years | |
| **Commander's Flying Experience:** | 5,400 hours (of which 90 were on type)<br>Last 90 days - 2 hours<br>Last 28 days - 2 hours | |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot | |

**Synopsis**

The aircraft had been flown on a night navigation exercise and returned to Blackbushe Airport. The pilot was configuring the aircraft to land and selected landing gear DOWN. However, initially only the right main and nose landing gear indicated down and locked whilst the left gear down-and-locked light remained unlit, indicating an unsafe condition. Various attempts to rectify the problem by recycling the landing gear and using the emergency extension system were unsuccessful, with all three landing gears now showing as not locked down. During a low flypast the airfield staff confirmed the landing gear appeared down so the pilot decided to continue with a landing. Soon after touchdown the right landing gear collapsed and the aircraft came to a stop. The landing gear malfunction was caused by a failure of the electrically driven hydraulic power pack.

**History of the flight**

The owner of the aircraft was under instruction for a night qualification and was returning to Blackbushe Airport after a long night navigation exercise. After flying a circuit, the pilot was preparing the aircraft to land. When he selected the landing gear DOWN, only the right main and nose landing gear indicated down and locked. The left main gear down-and-locked light remained unlit indicating an unsafe condition.

The pilot recycled the landing gear but it continued to indicate an unsafe condition. The pilot flew out of the circuit and despite several more attempts, including using emergency extension procedures, none of the green landing gear down-and-locked lights illuminated. The single red landing gear unlocked warning light remained illuminated during the various attempts to raise and lower the landing gear. This showed that the nose, left and right main landing gear were now all in an unsafe condition.

Low fly pasts were carried out to enable the airfield staff to visually assess the landing gear condition and although it appeared to be down, it could not be determined whether it was in a safe condition. The pilot then flew a circuit and landed the aircraft. A couple of seconds after touchdown the right main landing gear collapsed. The right wing dropped and contacted the runway, slewing the aircraft to the right before quickly coming to a stop. The pilot and instructor were uninjured. The aircraft sustained abrasion damage to right wing flap, aileron and wing tip.

**Landing gear system description**

The aircraft is fitted with retractable tricycle landing gear. Landing gear extension and retraction is carried out by hydraulic actuators. Hydraulic pressure is produced by an electrically driven hydraulic power pack which starts and runs automatically when landing gear retraction and extension is selected. A pressure switch starts and stops the power pack to maintain a residual ‘up’ pressure within the system when the landing gear is retracted.

Landing gear position lights indicate the status during retraction and extension. When the landing gear is down and locked three separate green lights illuminate. A single red gear unlocked light illuminates when any of the landing gear is not locked down or not fully up.

Articulated spring-loaded latches fitted to the nose and main landing gear legs provide a mechanical locking in the down position. Microswitches are actuated by the latches which close the circuit when they are correctly in the locked position and the green status lights illuminate.

**Cause**

The aircraft landing gear system was examined, and functional checks performed whilst the aircraft was on jacks showed a malfunction of the electrically driven hydraulic power pack. It was found to run sporadically, stopping and starting at random. The emergency lowering system was also tested. This worked correctly provided the landing gear was in or near the fully up position. It was also demonstrated that if the power pack motor stopped before the down lock latches were made, the landing gear appeared visually to be down although indicating an unsafe condition. However, whilst in this position the emergency landing gear release was ineffective because the landing gear could not generate the momentum under gravity to engage the downlock latches.

# AAIB Record-Only Investigations

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

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

The accuracy of the information provided cannot be assured.

**Record-only UAS investigations reviewed: April - May 2025**

**26 Apr 2025** **DJI Matrice M30** Gainsborough, Lincolnshire

After approximately 10 minutes of flight, the UA stopped responding to control inputs from the remote pilot. A collision was heard, and the UA was subsequently found on the roof of a house.

**28 Apr 2025** **DJI Phantom 4 mulitspectral** Cairnfield, Banffshire

While conducting a survey of farmland at around a height of 100 m, control of the UA was lost and it spiralled down to the ground into an empty field.

**30 Apr 2025** **DJI Inspire 2** Near Padworth Common, Berkshire

Following completion of pre-flight checks, the UA took off and hovered at a height of about 10 m.  A climb was initiated but then all four propellers detached and the UA fell to the ground.

# Miscellaneous

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

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

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

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

Published October 2015.

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

Published March 2016.

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

Published September 2016.

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

Published March 2017.

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

Published March 2018.

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

Published November 2018.

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

Published March 2020.

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

Published May 2021.

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

Published September 2023.

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

Published November 2023.

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

http://www.aaib.gov.uk

# GLOSSARY OF ABBREVIATIONS

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

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