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# ***AAIB Bulletin***

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***9/2021***

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## **AAIB Special Bulletins / Interim Reports**

AAIB Special Bulletins and Interim Reports

This section contains Special Bulletins and Interim Reports that have been published since the last AAIB monthly bulletin.





The DDG procedure required the cockpit landing gear selection lever to be cycled with hydraulic power applied to the aircraft. To prevent the landing gear from retracting, the procedure required pins to be inserted in the nose and main landing gear downlocks. However, the NLG downlock pin was installed in the NLG downlock apex pin bore which was adjacent to the correct location to install the downlock pin. When the landing gear selector was cycled the NLG retracted.

An Airworthiness Directive had been issued, with a 36-month compliance from 16 January 2020, to install an insert over the apex pin bore to prevent incorrect installation of the downlock pin, but this had not yet been implemented on G-ZBJB.

### **Sequence of events**

The aircraft was on stand being prepared for a cargo flight from London Heathrow to Frankfurt. At approximately 0620 hrs the crew arrived at the aircraft and found three ground engineers on the flight deck engaged in maintenance activity to clear three status messages associated with an ADD for a NLG door-closed solenoid valve. The crew discussed the situation with the engineers and established that the rectification work would take approximately 40 minutes to complete. Consequently, the off blocks time was revised to 0725 hrs. The commander, the Overseas Engineer (OSE) positioning with the aircraft, and two ground engineers left the flight deck, leaving the co-pilot in the right seat and the lead ground engineer in the left seat.

The commander performed a walk-round inspection of the aircraft and returned to the forward cabin along with the dispatcher and a ground technician, the fourth member of the ground engineering team. The ground technician reported to the Lead Engineer that the walk-round inspection of the aircraft had been completed and then sat in the forward cabin to observe proceedings. The OSE was in the mid-galley.

Throughout the preparations for the flight, cargo loading was progressing with one of the four personnel from the cargo loading team working on the aircraft pallet loader positioned under the forward cargo door on the right side of the aircraft. One of the loading team was at the rear of the aircraft pallet loader operating the Tarmac Transfer Vehicle (TTV), used to transfer cargo and unit load devices (ULDs) onto the pallet loader. A third team member was supervising the onload and assisting with the transfer of cargo onto the TTV. The fourth team member was tasked with opening the rear cargo hold doors.

The lead ground engineer sat in the left seat on the flight deck was working through the NLG status messages on the ground maintenance laptop. In order to defer the three defects highlighted by the status messages, the DDG for the aircraft required hydraulic pressure to be applied and the cockpit landing gear lever to be cycled from down to up then returned to down. The Lead Engineer instructed the lead mechanic (Mech 1) and another mechanic (Mech 2) to fit the landing gear locking pins. This would prevent the landing gear retracting when the landing gear lever was cycled. They were also instructed to attach the ground communications headset to the external connection in the NLG bay. Mechs 1 and 2 located the five landing gear locking pins and proceeded to the NLG to fit the first pin. As Mech 1 was not tall enough to reach the NLG locking pin hole without steps, he

pointed to the location of the hole and Mech 2 fitted the NLG locking pin. As Mech 1 and 2 proceeded to the right main landing gear (MLG), Mech 1 informed the load team member on the pallet loader that they were going to apply hydraulic power to the aircraft and he should stand clear of the aircraft and lower the pallet loader to prevent contact with the cargo door. The application of hydraulics causes the aircraft to move slightly and can result in control surfaces and landing gear doors moving suddenly as the system is pressurised.

With the aid of some portable steps, Mech 1 fitted the two right MLG downlock pins before repeating the process on the left MLG as Mech 2 observed. Mech 1 returned to the flight deck to inform the Lead Engineer that the pins had been fitted. Mech 1 and Mech 2 then walked to the left of the NLG and Mech 1 plugged in the ground headset. The Lead Engineer requested further confirmation from Mech 1, through the headset, that the landing gear pins were fitted. Mech 1 confirmed that the pins were fitted. Mech 2 then stepped away from the aircraft and walked to nearby vehicles to observe.

The Lead Engineer was reading the appropriate section of the Aircraft Maintenance Manual (AMM) on the maintenance laptop when he received confirmation that the landing gear pins were fitted. The Lead Engineer applied hydraulic power but before selecting the landing gear lever he requested final confirmation, through the headset, from Mech 1 that the ground locking pins were in place and the aircraft loading team was clear of the aircraft. From his position next to the NLG on the left side of the aircraft, Mech 1 visually checked that he could see the warning flags for each of the landing gear locking pins. His view of the pallet loader was limited to just above the load platform, so he checked that no feet were visible to indicate the load team were clear. He then confirmed to the Lead Engineer that the pins were fitted and that the pallet loader was clear of personnel. On pressing LOCK OVRD and selecting the landing gear lever to UP, the NLG retracted, and the aircraft nose struck the ground.

### **Injuries and aircraft damage**

One of the ground loading team who was on the pallet loader and under the cargo door was slightly injured as the door moved down with the fuselage (Figure 1). The co-pilot, sat in the cockpit received a minor injury and the three personnel who were stood in the forward cabin and galley fell to the floor but were otherwise uninjured.



**Figure 1**

Pallet cargo loader positioned at the forward cargo door

The aircraft's nose came to rest on the articulated arm of a ground power unit, crushing the cable arm. The aircraft sustained damage to the lower forward fuselage, NLG doors and both engine cowlings, which had also struck the ground. Door 2L had been severely damaged by contact with the stairs positioned at the door aperture as the aircraft sank onto its nose (Figure 2). The door hinges and actuating mechanism had failed and the door, which was resting on the top platform of the stairs, remained attached to the fuselage by the remains of its wiring loom.



**Figure 2**

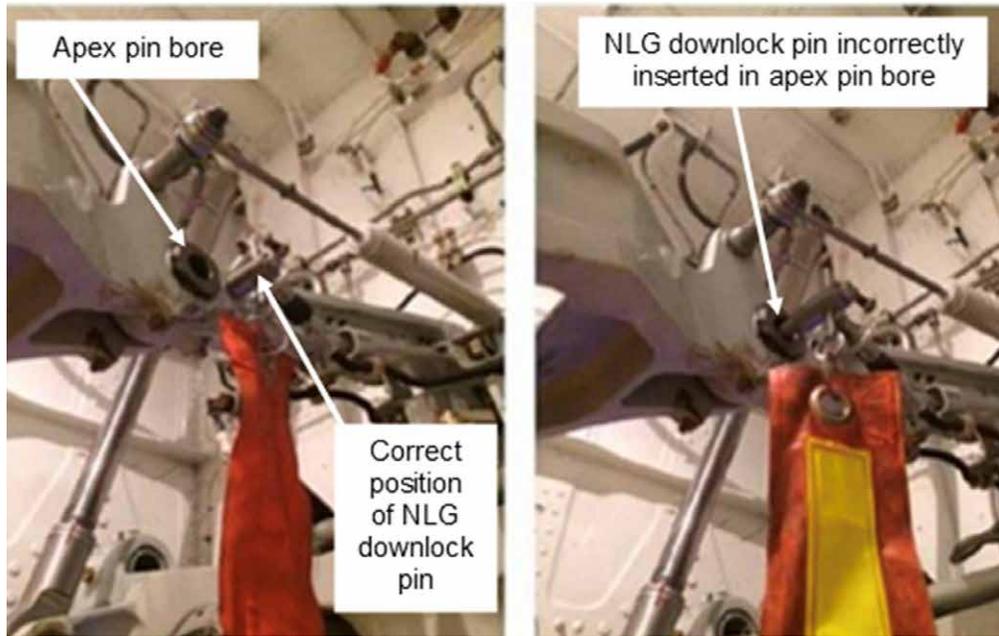
G-ZBJB with stairs in position at Door 2L

When the aircraft nose was lifted, during the recovery operation, the NLG was examined and the NLG downlock pin was found fitted in the NLG apex pin bore (Figure 3). With the downlock pin inserted in this position, when the LOCK OVRD is pressed and the landing gear lever selected to UP with hydraulic power applied, the NLG will retract.

### **Previous event and preventative measures**

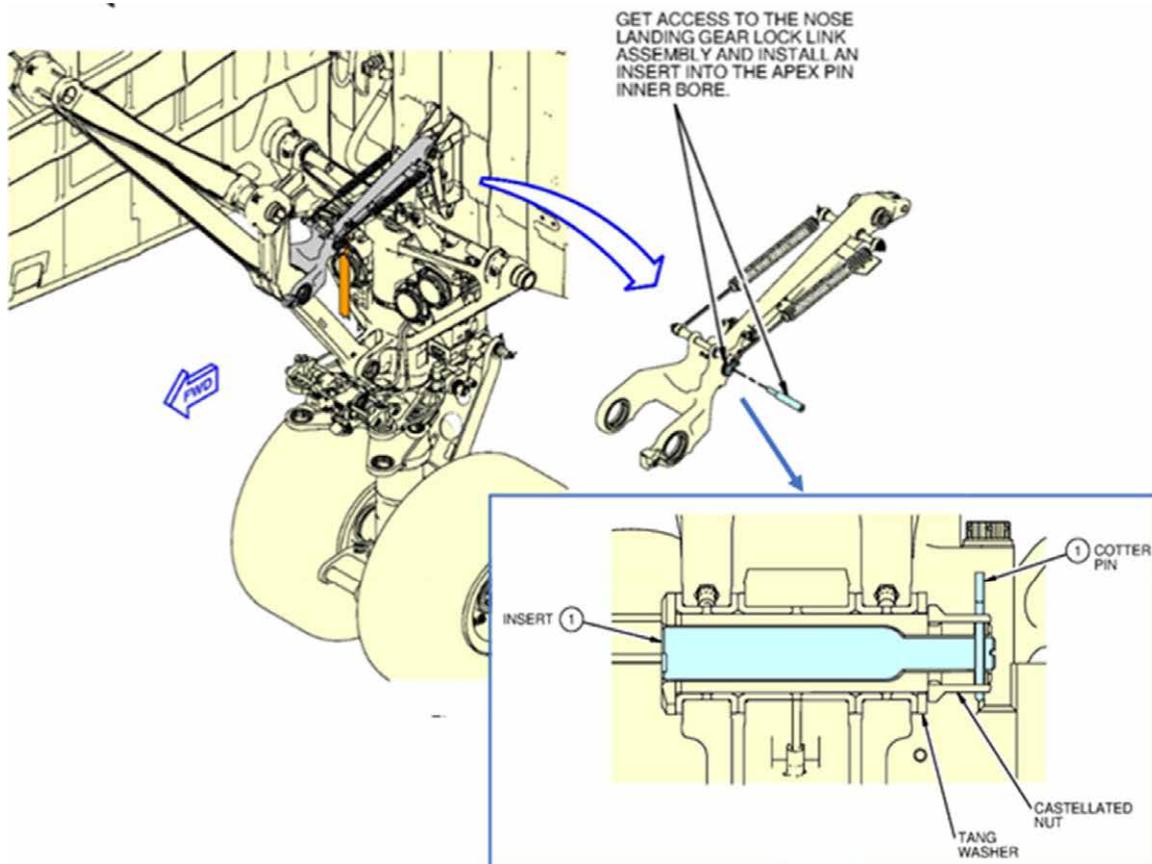
In 2018, another Boeing 787 experienced a retraction of the NLG while the aircraft was on the ground which had been caused by the NLG downlock pin being accidentally installed in the apex pin inner bore, which is adjacent to the correct hole for the downlock pin in the NLG lock link assembly (Figure 3).

As a result of this event the aircraft manufacturer published Issue 01 of Service Bulletin (SB) B787-81205-SB320040-00 on 12 March 2019. The SB provides instructions to install an insert into the NLG lock link apex pin inner bore (Figure 4). The insert prevents the NLG downlock pin from being inserted in the apex pin bore instead of the adjacent NLG downlock pin hole. Issue 02 of the SB was subsequently published on 23 October 2020.



**Figure 3**

Illustrative image of the correct and incorrect installation of NLG downlock pin



**Figure 4**

Installation diagram of NLG apex pin inner bore insert

Incorporation of SB B787-81205-SB320040-00 was subsequently mandated by FAA Airworthiness Directive (AD) 2019-23-07, published on 16 January 2020. The AD specified a compliance time of 36 months from the date of publication. This had not yet been implemented on G-ZBBB.

### Safety actions

The operator had issued a Technical News leaflet 10279007 – ‘787 NLG Downlock Pin Installation’ on 9 April 2020 which showed the correct and incorrect position of the NLG downlock pin and referenced the FAA AD and the SB. The leaflet included the illustrations in Figure 4 taken from AMM task B787-A-32-00-30-00A-720A-A – ‘Landing gear downlock pin installation.’ The Technical News was re-issued on 9 December 2020 with an expiry date of 9 June 21.

As a result of this accident the operator re-issued Technical News leaflet 10279007 on 19 June 2021. The operator is now planning to expedite the incorporation of AD 2019-23-07.

### Further investigation

The investigation continues and will consider the safety procedures associated with landing gear maintenance, and the factors which may have contributed to the NLG downlock pin being incorrectly installed in the apex pin inner bore. A final report will be published in due course.

*Published 14 July 2021.*

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## **AAIB Correspondence Reports**

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

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

The accuracy of the information provided cannot be assured.



## SERIOUS INCIDENT

<b>Aircraft Type and Registration:</b>	Reims Cessna F406, G-FIND	
<b>No &amp; Type of Engines:</b>	2 Pratt & Whitney Canada PT6A-112 turboprop engines	
<b>Year of Manufacture:</b>	1989 (Serial no: 45)	
<b>Date &amp; Time (UTC):</b>	4 April 2021 at 1125 hrs	
<b>Location:</b>	Near St Neots, Cambridgeshire	
<b>Type of Flight:</b>	Specialised Operations	
<b>Persons on Board:</b>	Crew - 1	Passengers - 1
<b>Injuries:</b>	Crew - None	Passengers - 1 (Minor)
<b>Nature of Damage:</b>	None	
<b>Commander's Licence:</b>	Commercial Pilot's Licence	
<b>Commander's Age:</b>	24 years	
<b>Commander's Flying Experience:</b>	788 hours (of which 317 were on type) Last 90 days - 88 hours Last 28 days - 29 hours	
<b>Information Source:</b>	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB	

### Synopsis

During an unpressurised aerial photography flight at 12,000 ft the task specialist lost consciousness. The pilot commenced a rapid descent and diverted to London Luton (Luton) Airport. During the descent the task specialist regained consciousness. The aircraft landed normally.

The pilot was using supplementary oxygen during the flight whereas the task specialist was not. It could not be determined what caused the loss of consciousness.

Following the incident, the operator took safety action to require task specialists and survey operators to use supplementary oxygen for all unpressurised flights above 10,000 ft.

### History of the flight

The purpose of the flight was to undertake aerial photographs over Northamptonshire. The aircraft was fitted with a camera system mounted in the cabin which took photographs through holes in the bottom of the fuselage. The flight was operated by a single pilot and a task specialist. During the flight the task specialist was sitting in the cabin and was monitoring the camera system via a laptop computer. The task required the aircraft to fly in a series of parallel straight lines at 12,000 ft.

The pilot and task specialist met at East Midlands Airport and prepared for the flight. Because the flight was intended above 10,000 ft the pilot planned to use supplementary oxygen. The pilot asked the task specialist if he would be using oxygen. The task specialist said that the advice he had been given by the operator was that he was not required to do so below 13,000 ft. The aircraft was not fitted with a built-in oxygen system so supplementary oxygen was supplied via portable oxygen bottles and nasal cannula<sup>1</sup>.

The aircraft took off from East Midlands Airport at 0815 hrs and commenced the survey as planned. The flight proceeded normally for several hours during which the pilot and task specialist were in regular conversation. However, at approximately 1125 hrs the task specialist told the pilot he was feeling unwell. Within a few seconds he lost consciousness and fell into the aisle. The pilot declared an emergency to ATC and commenced a rapid descent. ATC initially offered Cambridge Airport as a diversion but subsequently advised this was now closed and offered Luton or Stansted Airports. The aircraft was closer to Luton Airport, so the pilot decided to divert there. As the aircraft reached approximately 6,000 ft, the task specialist started to regain consciousness and the pilot was able to shout "are you okay?", to which the task specialist was able to mouth "yes" and give a thumbs-up. By the time the aircraft was at 3,000 ft and approximately 15 - 20 nm from Luton the task specialist was able to retake his seat and was speaking normally. The aircraft landed at Luton Airport at 1145 hrs and, as a precaution, the task specialist was taken to hospital.

## Hypoxia

One possible explanation for the task specialist loss of consciousness is that he was experiencing hypoxia.

Hypoxia is defined as a state of oxygen deficiency in the body sufficient to impair function of the brain and other organs<sup>2</sup>. Whilst there can be a number of medical causes of hypoxia which could occur at any time, hypobaric hypoxia is altitude related. As the altitude increases and barometric pressure decreases, the partial pressure of oxygen decreases. This reduction in partial pressure means there are fewer oxygen molecules per volume of air as altitude increases. It becomes increasingly difficult for the human body to supply its oxygen needs as an aircraft climbs if supplementary oxygen is not used.

The brain is usually the first organ to suffer from the diminished oxygen supply. Even at 8,000 ft altitude, where there is a 25% reduction in the partial pressure, it is possible to detect early impairment in some mental performance tasks. However, it would be unusual for a fit and healthy individual to suffer transient loss of consciousness due to hypoxia at 12,000 ft unless there is concomitant significant hyperventilation (over-breathing).

People react differently to lack of oxygen, and some are more sensitive to hypoxia than others. This can vary from day to day. Personal factors are numerous: acclimatisation to high altitude, smoking, stress, anxiety, illness, medication, and hydration can all affect an individual's tolerance of exposure to altitude.

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### Footnote

<sup>1</sup> The operator was in the process of installing a built-in supplementary oxygen system in their aircraft when this incident occurred.

<sup>2</sup> [https://www.easa.europa.eu/sites/default/files/dfu/210635\\_EASA\\_HYPOXIA\\_BROCHURE.pdf](https://www.easa.europa.eu/sites/default/files/dfu/210635_EASA_HYPOXIA_BROCHURE.pdf) [accessed August 2021]

There are many other reasons why an individual may faint or briefly lose consciousness. In the absence of a medical condition that causes transient loss of consciousness, it is possible that a higher natural tendency to faint could combine with mild hypoxia to cause an individual to lose consciousness at altitude.

### Personnel information

The task specialist was 25 years old and described himself as fit and healthy. He had passed a medical for the role within the last 12 months and had no history of any underlying medical conditions. He had flown unpressurised flights up to 10,000 ft in the past and had flown with supplementary oxygen above 13,000 ft, but this was the first time he had flown without oxygen at 12,000 ft.

He recalled feeling well prior to the flight and that the first few hours of the flight were uneventful. He did not think he was stressed or suffering from anxiety and he was well hydrated. After about three hours he remembered feeling dizzy and slightly sweaty. He sat back in his seat and told the pilot he felt unwell. He did not recall hyperventilating. His next memory was waking up as the aircraft descended into Luton.

After the flight he was taken to hospital but, despite extensive tests, a cause of the loss of consciousness was not found.

### Operational procedures

The operator's operations were partly covered by Part-CAT<sup>3</sup> regulations and partly by Part-SPO<sup>4</sup>. The requirements for the supply of and use of supplementary oxygen on unpressurised flights are slightly different in the two parts of the regulations. The operator had chosen to use the requirements in Part-CAT in all its operations. However, this part of the regulations does not specifically mention task specialists. The Part-SPO regulations include a requirement for task specialists to use supplemental oxygen whenever the cabin altitude exceeds 10,000 ft for a period of more than 30 minutes (SPO.OP.195) but this requirement was not incorporated in the operator's operations manual accepted by the CAA.

Figure 1 shows all the requirements in the operator's operations manual regarding supplementary oxygen on non-pressurised flights. Under these rules the task specialist's company considered task specialists to be 'additional crew' and therefore were not required to use oxygen below 13,000 ft.

Following this incident, the operator has updated this section of its manual to state that '*Task Specialists and Survey Operators are required to use supplementary oxygen at all times above 10,000 ft.*'

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#### Footnote

- <sup>3</sup> Part CAT (Commercial Air Transport) applies to aircraft operation to transport passengers, cargo or mail for remuneration or other valuable consideration.
- <sup>4</sup> Part SPO (Specialised Operations) applies to any aircraft operation, other than commercial air transport, where the aircraft is used for specialised activities such as agriculture, construction, photography, surveying, observation, patrol or aerial advertisement.

**8.8 Oxygen Requirements (SPO.OP.195)**

Non-pressurised aeroplanes operated at pressure altitudes above 10 000 ft shall be equipped with supplemental oxygen equipment capable of storing and dispensing the oxygen supplies in accordance with the table below

**8.8.1 Oxygen minimum requirements for non-pressurised aeroplanes.**

Supply for	Duration and cabin pressure altitude
Occupants of flight crew compartment seats on flight crew compartment duty and crew members assisting flight crew in their duties	The entire flying time at pressure altitudes above 10 000 ft.
Required cabin crew members	The entire flying time at pressure altitudes above 13 000 ft and for any period exceeding 30 minutes at pressure altitudes above 10 000 ft but not exceeding 13 000 ft.
Additional crew members and 100 % of passengers (*)	The entire flying time at pressure altitudes above 13 000 ft.
10 % of passengers (*)	The entire flying time after 30 minutes at pressure altitudes above 10 000 ft but not exceeding 13 000 ft.
(*) Passenger numbers in this table refer to passengers actually carried on board, including persons younger than 24 months.	

**Figure 1**

Extract from the operator's Operations Manual regarding supplementary oxygen on non-pressurised flights

## Analysis

During an unpressurised flight at 12,000 ft the task specialist lost consciousness. The pilot commenced a rapid descent and the task specialist regained consciousness during the descent.

The cause of the loss of consciousness could not be determined. Hypoxia was considered as a possible explanation, but it is unlikely a fit and healthy individual would suffer a transient loss of consciousness due to hypoxia at 12,000 ft. It is possible that a higher natural tendency to faint could have combined with mild hypoxia to cause the loss of consciousness. Following the incident, the operator has clarified its procedures to require task specialists to use supplementary oxygen for all unpressurised flights above 10,000 ft.

## Safety action

The operator has updated its Operations Manual to require Task Specialists and Survey Operators to use supplementary oxygen at all times during unpressurised flights above 10,000 ft.

**SERIOUS INCIDENT**

<b>Aircraft Type and Registration:</b>	Spitfire Mk 26, G-CLKN	
<b>No &amp; Type of Engines:</b>	1 Isuzu 6VE1 piston engine	
<b>Year of Manufacture:</b>	2019 (Serial no: PFA 324-14634)	
<b>Date &amp; Time (UTC):</b>	22 April 2021 at 1455 hrs	
<b>Location:</b>	Brighton Airfield, Brighton, Selby	
<b>Type of Flight:</b>	Private	
<b>Persons on Board:</b>	Crew - 1	Passengers - None
<b>Injuries:</b>	Crew - None	Passengers - N/A
<b>Nature of Damage:</b>	Propeller broken and damage to left wing	
<b>Commander's Licence:</b>	Airline Transport Pilot's Licence	
<b>Commander's Age:</b>	65 years	
<b>Commander's Flying Experience:</b>	22,000 hours (of which 6 were on type) Last 90 days - 24 hours Last 28 days - 15 hours	
<b>Information Source:</b>	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB	

**Synopsis**

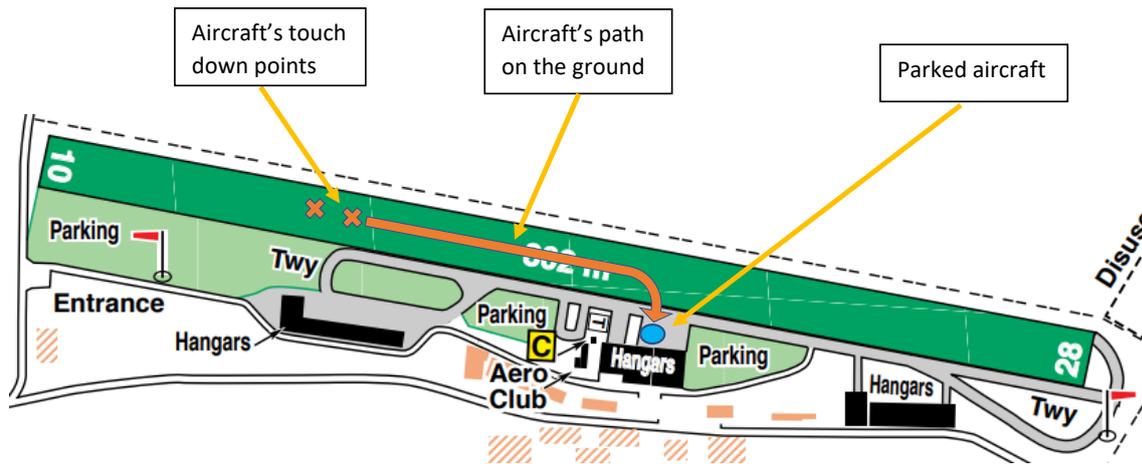
During a bounced 'three-point' landing the pilot applied momentary full rudder which caused the tailwheel steering to disengage. The aircraft veered off the runway and struck a parked aircraft. Information from pilots of the type indicates the aircraft may be best suited to 'wheeler' landings.

**History of the flight**

G-CLKN was performing its eleventh test flight since being built, with the purpose of achieving its Permit to Fly<sup>1</sup>. The wind was variable at 5 kt. The pilot reported flying an approach to Brighton Airfield's grass Runway 10 at an airspeed of 80 mph, with full flap selected, for a three-point<sup>2</sup> landing. The aircraft bounced slightly as it touched down on the runway, then settled on all three wheels, initially straight ahead. Around 100 m into its landing roll, it veered right. The pilot applied opposite rudder and brake, and thereafter a "burst of power" (with the intention of increasing the rudder's effectiveness). However, the aircraft left the runway and struck a parked aircraft (Figure 1).

**Footnote**

- <sup>1</sup> Permit to fly – allows non-commercial flying on certain aircraft types for which a Certificate of Airworthiness or Restricted Certificate of Airworthiness is not appropriate.
- <sup>2</sup> Three-point landing – the main landing gear and the tailwheel touch the ground simultaneously. As opposed to a 'wheel landing' where the main landing gear touch down first.



**Figure 1**

Pilot's description of the incident

### Aircraft information

The Spitfire Mk 26 is a two seat reduced scale replica of the original Spitfire fighter aircraft. Each is manufactured as a kit for private construction.

The aircraft has retractable main landing gear with differential braking, and a steerable tailwheel. The tailwheel is connected to the rudder through its normal range of movement but disengages when the steering arm reaches full deflection. Once disengaged the tailwheel will castor.



**Figure 2**

G-CLKN (image used with permission)

### **Additional information**

The pilot reported having extensive experience on tailwheel aircraft. He had first flown the Spitfire Mk 26 while test flying G-CLKN and described it as tending to land on its main landing gear first. During G-CLKN's more recent test flights, including one at Brighton earlier that day, he had been practising three-point landings instead. He believed that a small ridge in the grass runway surface contributed to the bounced landing, during which he briefly applied full rudder, causing the tailwheel steering to disengage.

Pilots of the Spitfire Mk 26 described wheel landings as being preferable on the type.

The AAIB report of the accident involving G-HRLI<sup>3</sup> describes factors affecting the behaviour and control of tailwheel aircraft on landing.

### **Conclusion**

It is not clear what caused the loss of control. Wheeler landings may be preferable on the type, and disengagement of the tailwheel steering during a bounced three-point landing could have been a factor.

---

#### **Footnote**

<sup>3</sup> <https://www.gov.uk/aaib-reports/aaib-investigation-to-hawker-hurricane-1-g-hrli> [accessed June 2021].

**ACCIDENT**

<b>Aircraft Type and Registration:</b>	Head AX8-88B hot air balloon, G-TIMX	
<b>No &amp; Type of Engines:</b>	N/A	
<b>Year of Manufacture:</b>	2008 (Serial no: 384)	
<b>Date &amp; Time (UTC):</b>	20 April 2021 at 0905 hrs	
<b>Location:</b>	Welton, Daventry, Northamptonshire	
<b>Type of Flight:</b>	Private	
<b>Persons on Board:</b>	Crew - 1	Passengers - 2
<b>Injuries:</b>	Crew - None	Passengers - 1 (Serious) 1 (None)
<b>Nature of Damage:</b>	None	
<b>Commander's Licence:</b>	Private Pilot's Licence	
<b>Commander's Age:</b>	32 years	
<b>Commander's Flying Experience:</b>	407 hours (of which 70 were on type) Last 90 days - 4 hours Last 28 days - 4 hours	
<b>Information Source:</b>	Aircraft Accident Report Form submitted by the pilot	

**Synopsis**

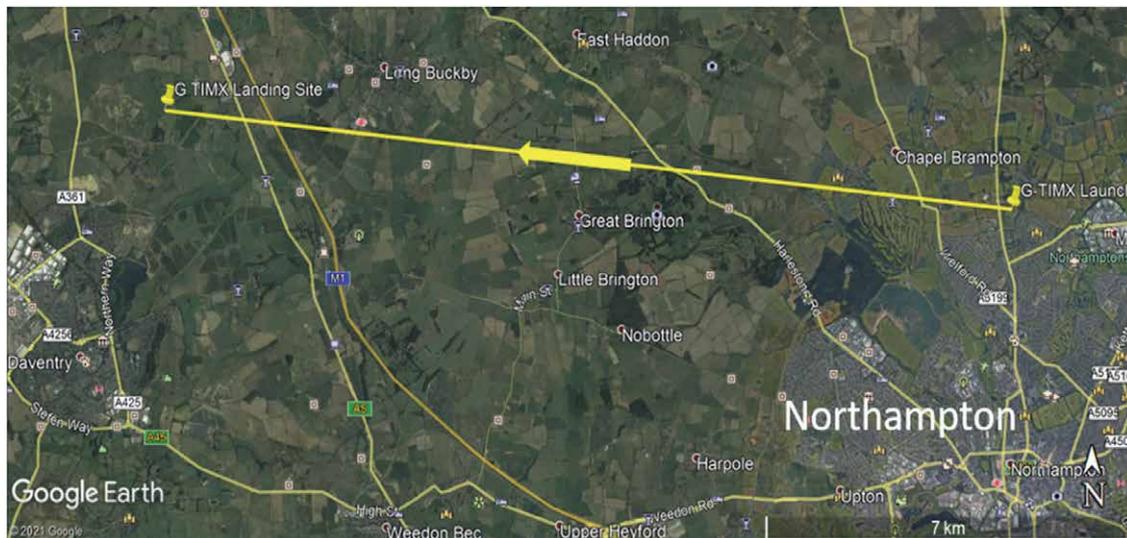
While approaching to land the pilot chose to fly the balloon into contact with a hedgerow to reduce speed for touchdown. During the landing one passenger suffered a serious lower leg injury.

**History of the flight**

The pilot and passengers met at the recreation ground from which takeoff was planned. Before the balloon was inflated the pilot gave both the passengers a safety briefing and explained the brace position to be adopted for landing, which was to face sideways holding the rim of the basket and with knees bent. The pilot had obtained a weather forecast which indicated a wind between 5 and 10 kt varying in direction from 060° to 120°. There were only small amounts of cloud, at altitudes above 4,000 ft amsl, and the visibility was greater than 10 km. The maximum windspeed for takeoff is 7 mph (6 kt) and the maximum windspeed for landing is 12 mph (10 kt) so the weather conditions were suitable for flight. The approximate route is shown in Figure 1.

The inflation was normal, and the balloon took off at 1830 hrs. During the flight the balloon generally flew at altitudes between 800 ft and 1,500 ft amsl and reached a maximum of 2,000 ft amsl to allow for a fuel cylinder change over. The pilot stated that on two occasions he descended the balloon close to the ground to assess the low-level wind that

would affect the landing. On both occasions he assessed the low-level wind as within limits for landing.



**Figure 1**

Approximate track of the balloon

As the balloon approached the M1 motorway the pilot was preparing to select an area for landing. He discounted an area of fields adjacent to and west of the motorway due to the presence of a horse and concerns that the balloon crossing the road at low-level would constitute a distraction for drivers. Just west of the motorway there is a set of high-tension electricity cables and the pilot decided to land to the west of these. Many of the fields were planted in crop and to avoid damage to crops the pilot chose a narrow grass field. The western edge of the field was bounded by low, domestic electricity cables, so the pilot intended to land in the first quarter of the field to allow room for the balloon to deflate without becoming entangled in the cables. The landing site is shown in Figure 2.



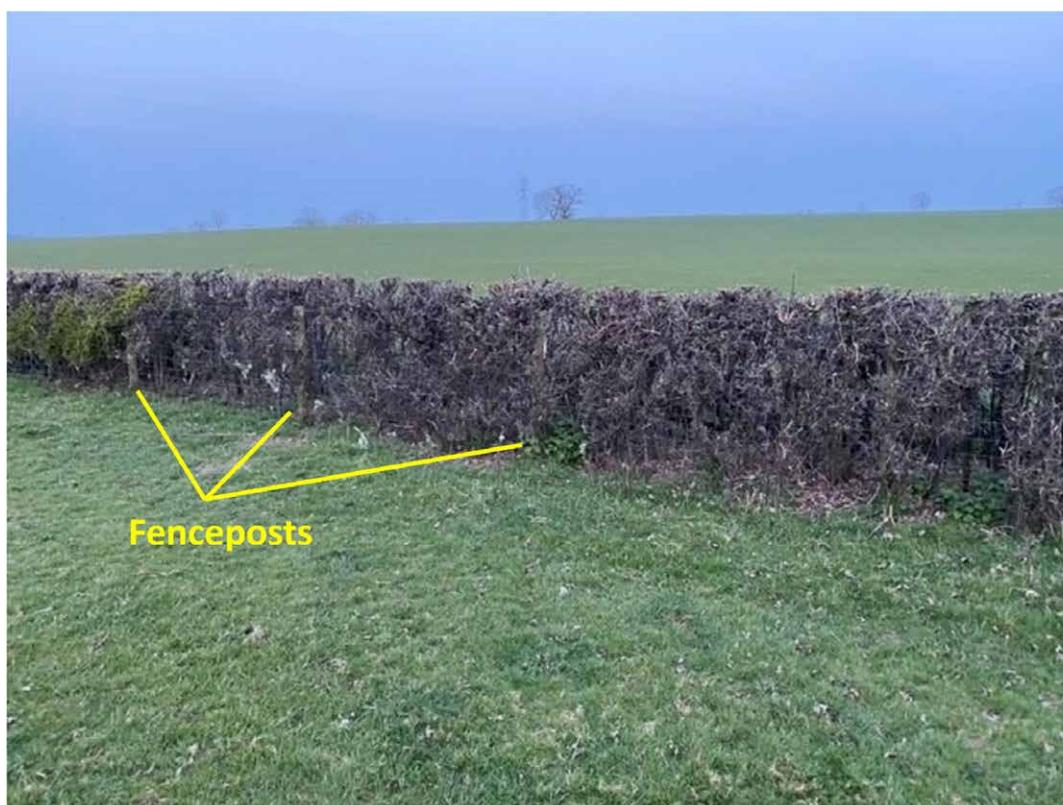
**Figure 2**

Landing site

Before crossing the high-tension cables, the pilot warned the passengers that he was preparing to land and that they would be told when to adopt the brace position for touchdown.

After crossing the high-tension cables, the pilot descended to approximately 80 ft agl. His handheld GPS indicated a groundspeed of 8 to 9 kt, which was below the limit for landing. As the balloon approached the chosen landing field the pilot instructed the passengers to adopt the brace position. The eastern side of the landing field is bounded by a hedgerow and the pilot decided to allow the balloon basket to make contact with this to reduce the groundspeed for touchdown. The hedge and landing area are shown in Figure 3, which shows a view looking upwind. There were fence posts embedded in the hedge which were not visible to the pilot.

He reduced the height of the balloon to bring the basket level with the top of the hedge and made contact as he intended. One passenger described the impact with the hedge as “hard” and believed it dislodged her from the brace position. As a result, the passenger did not believe she was in the planned brace position when the basket struck the ground. The wind then carried the balloon past the hedge pulling the basket clear and it dropped approximately one metre into the field. The pilot described the touchdown as a “small bump on the landing which is normal and expected with the wind conditions”. During touchdown the basket fell onto its side and the balloon then deflated normally.



**Figure 3**

Hedge and fenceposts bordering landing site

After landing, one of the passengers complained of pain in her ankle. The pilot, a trained first aider, recognised from the deformity in the passenger's ankle that it was broken. He called for an ambulance but was told that, due to a road traffic accident on the M1 motorway, no ETA could be given for an ambulance and that he should wait for a clinician to call back. After 30 minutes no call back had been received by the pilot. Due to the failing light and the pain the passenger was suffering the pilot carried out first aid in the field. Then, with the assistance of the balloon's ground party, the passenger was carried to a private motor vehicle and driven to hospital where the injuries required surgical intervention.

### Aircraft information

The balloon is a Head AX8-88B. It has a 90,000 ft<sup>3</sup> envelope with a diameter of 57 ft, and when inflated is 72 feet 8 inches tall, including the basket. An image of the balloon is shown in Figure 4.



**Figure 4**  
Head AX8-88B

### Fast landing technique

The British Balloon and Airship Club (BBAC) Pilot Training Manual contains a chapter on technique for landing at speeds above 8 kt. It recommends bringing the balloon very low across the landing field so that there is little or no vertical velocity then opening the balloon rip panels to release hot air and so rapidly reduce buoyancy. The balloon basket should then slow down rapidly due to friction with the ground. The manual does not suggest using

a planned collision with trees or hedges to reduce touchdown speed. This technique is, however, widely discussed and accepted amongst the hot air balloon community.

The CAA Flight standards Officer (Balloons) (CAA FSO) was consulted with regard to fast landing techniques. In their view, using planned collision with trees or hedgerows to decelerate is likely to introduce more challenges than benefits and has limited effect on reducing groundspeed. A particular risk is judging how severe that collision is likely to be, due to the unknown strength of the object into which the balloon will collide. The CAA FSO believed the technique described in the BBAC Pilot Training Manual to be more appropriate.

### **Analysis**

During flight the pilot made two descents to low-level to assess the wind conditions for landing. The forecast and the actual wind were within limits for operation of the balloon, the 9 kt shown by the pilot's GPS equates to 10.5 mph against a limit of 12 mph. The passengers had been briefed before flight by the pilot on an appropriate brace position for landing. The pilot chose a landing side which avoided livestock, causing a distraction on the M1 motorway, and landing in crops.

As the balloon approached the landing site the pilot told the passengers to adopt the brace position for landing and warned them of his intention to allow the balloon basket to touch the hedgerow to reduce landing speed. This manoeuvre was executed successfully, but the passenger described the contact with the hedge as being sufficiently hard as to dislodge her from her prepared brace position.

As the wind carried the balloon past the hedge, the basket swung down into the field from a height of approximately one metre. While the landing was described by the pilot as no more severe a touchdown than expected for the conditions, if the passenger was dislodged from her brace position during the collision with the hedge, it is likely that she was not correctly braced for the touchdown and the likelihood of injury during landing was greater.

It is difficult to assess the hazard posed by the possibility of solid obstructions within a hedge line and so CAA FSO considered that the fast landing technique as described in the BBAC Pilot Training Manual would have been preferable.

### **Conclusion**

It is likely that the passenger was disturbed from her planned brace position as a result of the contact with the hedge. Accordingly, she was not correctly braced for the touchdown and suffered a serious injury.

## ACCIDENT

<b>Aircraft Type and Registration:</b>	Rans S6-ES Coyote, G-CCJN	
<b>No &amp; Type of Engines:</b>	1 Rotax 582-48 piston engine	
<b>Year of Manufacture:</b>	2005 (Serial no: PFA 204-13575)	
<b>Date &amp; Time (UTC):</b>	18 October 2020 at 1215 hrs	
<b>Location:</b>	500 m east of Insch airfield, Aberdeenshire	
<b>Type of Flight:</b>	Private	
<b>Persons on Board:</b>	Crew - 1	Passengers - 1
<b>Injuries:</b>	Crew - None	Passengers - None
<b>Nature of Damage:</b>	Collapsed nose landing gear, damaged right landing gear leg and dented engine cowling	
<b>Commander's Licence:</b>	Light Aircraft Pilot's Licence	
<b>Commander's Age:</b>	67 years	
<b>Commander's Flying Experience:</b>	702 hours (of which 1 was on type) Last 90 days - 40 hours Last 28 days - 15 hours	
<b>Information Source:</b>	Aircraft Accident Report Form submitted by the pilot	

## Synopsis

Shortly after takeoff the engine suddenly stopped. The pilot, unable to find a suitable landing site ahead, turned back and carried out a forced landing in a field during which the nose gear collapsed. The engine stoppage was likely to have been caused by a piece of material in the fuel line between the fuel tank and the tank selector valve.

## History of the flight

The owner had recently removed the aircraft from storage and had a permit renewal inspection carried out. The LAA inspector advised the owner to replace the aircraft fuel lines and the fuel filter. This maintenance was carried out by the owner and a permit renewal check flight was then carried out.

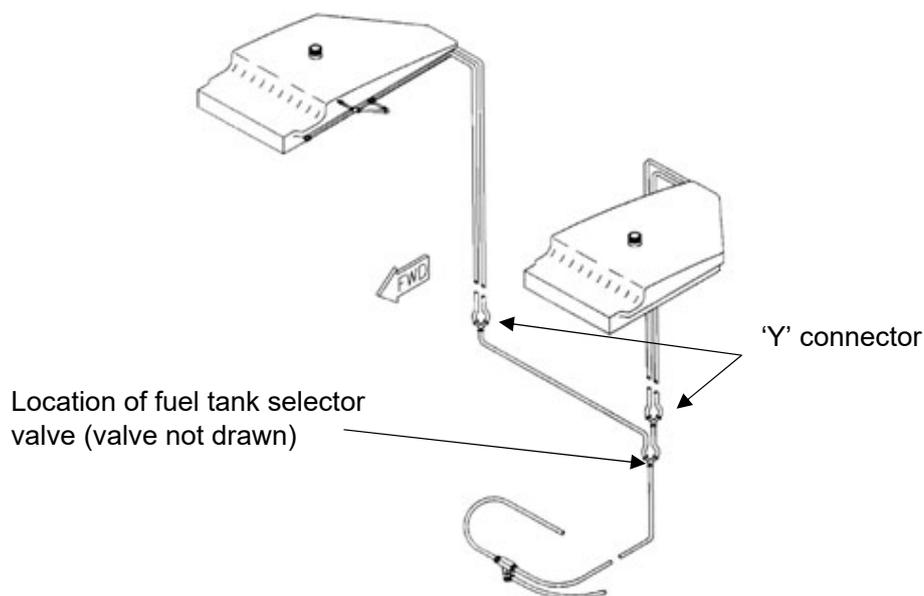
With the check pilot in the right seat, and the owner in left, the engine was started with fuel from the left tank selected. An extended engine warm up and power check was conducted with no abnormalities identified.

The pilot reported that the takeoff and initial climb proceeded normally until approximately 180 ft agl when the engine stopped suddenly. He immediately lowered the nose to achieve a 60 mph glide and prepared for a forced landing. He assessed that there were no viable landing locations within 45° of his heading so decided to find a suitable one behind him.

He commenced a 180° turn and identified a suitable field. With limited time available, the pilot reported that he focused on the forced landing and did not attempt to change the fuel tank and a restart. On landing the nosewheel dug into waterlogged ground causing the leg to collapse. The aircraft came to rest in a tail high attitude and the occupants exited with no injuries.

### Aircraft fuel system

The Rans S6-116 Coyote II is a high-wing, strut-braced aircraft with two side-by-side seats. G-CCJN had two fuel tanks mounted in the root of the wings (Figure 1). Each tank had a forward and rear outlet to allow fuel to be drawn throughout the pitch envelope. The outlet pipes ran down the rear fuselage structure and were combined at a 'Y' connector. The combined outlet pipes from each tank were connected to the fuel tank selector valve.



**Figure 1**

Rans S6 Coyote II fuel tank configuration  
(Image from Rans S6ES Coyote II manual<sup>1</sup>)

### Aircraft examination by the owner

To facilitate the recovery of the aircraft from the field the fuel tanks were drained. The combined outlet of the left tank was disconnected but it was found that no fuel would flow from the pipe when the aircraft was in a nose high attitude, even though fuel was visible in the tank. When the aircraft was placed in a level attitude fuel was able to flow from the tank.

Examination of the fuel lines by the owner found a sliver of material within one of the pipes that ran from the combined left tank outlet to the fuel selector valve (Figure 2). It is likely that this obstruction caused the engine to stop in flight.

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#### Footnote

<sup>1</sup> <https://skycraft.ltd/acatalog/RANS-Manuals.html> [accessed June 2021].

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**Figure 2**

Sliver of material found in the fuel pipe between the left tank and engine  
(photograph reproduced with permission)

### **Comment by the AAIB**

Although an extended engine ground run and power check was completed on the aircraft prior to the flight, carrying out an aircraft fuel flow assessment, such as that detailed in LAA Technical Leaflet TL 2.20– LAA<sup>2</sup> might have identified the restriction. TL 2.20 '*Carrying out a fuel flow check to a pumped fuel system*' provides guidance on ensuring that there is at least 125% of the maximum engine fuel flow through each tank outlet.

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<sup>2</sup> LAA Technical Leaflets can be found here: [http://www.lightaircraftassociation.co.uk/engineering/technical\\_leaflets.html](http://www.lightaircraftassociation.co.uk/engineering/technical_leaflets.html) [accessed June 2021]

**SERIOUS INCIDENT**

<b>Aircraft Type and Registration:</b>	Parrot Anafi USA	
<b>No &amp; Type of Engines:</b>	4 electric motors	
<b>Year of Manufacture:</b>	2020 (Serial no: PF728210AB1A000399)	
<b>Date &amp; Time (UTC):</b>	18 April 2021 at 0450 hrs	
<b>Location:</b>	Near Princes Risborough, Buckinghamshire	
<b>Type of Flight:</b>	Commercial Operations (UAS)	
<b>Persons on Board:</b>	Crew - None	Passengers - None
<b>Injuries:</b>	Crew - N/A	Passengers - N/A
<b>Nature of Damage:</b>	Damage to rotor blade, propeller arms, and battery locking mechanism	
<b>Commander's Licence:</b>	Other	
<b>Commander's Age:</b>	35 years	
<b>Commander's Flying Experience:</b>	6 hours (of which 3 were on type) Last 90 days - 6 hours Last 28 days - 3 hours	
<b>Information Source:</b>	Aircraft Accident Report Form submitted by the pilot and further analysis by the AAIB	

**History of the flight**

The unmanned aircraft (UA) was operating at 60 m agl with an observer maintaining visual line of site and an operator controlling the aircraft and camera. The weather was overcast but with good visibility and low wind. The UA had been conducting a survey of nearby fields and woodland and had been flying for approximately 11 minutes. It was stable and hovering as the operator yawed the aircraft to pan the camera around. The controller suddenly lost connection with the UA and the tablet screen showing the camera picture displayed "white noise". The operator noticed that the UA's Wi-Fi signal had reduced from green to red but there was no other information displayed.

The observer watched as the UA pitched forwards and rapidly descended into the ground in nearby woodland. The aircraft was found 300 m away upside down. One rotor blade had snapped, a rotor arm had been dislodged, the rotor arms were unable to fold out and the battery had been released and was located next to the aircraft. (Figure 1).



**Figure 1**

UA showing damage to rotor and dislodged battery

### **Aircraft examination**

The UA was recovered and sent to the manufacturer for examination. The manufacturer reported it was likely that during the component surface mounting process, an abnormal solder connection between the UA's battery and the aircraft's printed circuit board (PCB) power circuit caused the UA to lose power during flight.

The manufacturer has completed a check of every unit and PCB in its facility as well as their surface mounting technology process and equipment. A sample check of the UAs in storage awaiting sale, including their demonstration fleet and those units returned for after sales service, was also completed without finding any further abnormalities. There had been no previous reports of failures linked to abnormal soldering.



## **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 June - July 2021**

- 19-Dec-20**     **Aeryon SkyRanger**     Surbiton, Surrey  
The battery latch became disconnected in flight resulting in a loss of power and control. Photographs of the UA at the accident site and data from the UAS manufacturer indicates that the most likely cause was that the battery had not been correctly latched prior to flight.
- 22-Mar-21**     **DJI Mavic 2 Enterprise**     Dudley, West Midlands  
The UA was being flown in a disused quarry and the battery charge was 35% at takeoff. After about 4 minutes the UA automatically initiated a 'Return-to-home'. It didn't climb to its pre-programmed height of 80 m and collided with a tree at the top of the quarry, then fell 4 m to the ground.
- 6-May-21**     **DJI M300 RTK**     New Malden, Surrey  
The UAS was being operated at night. Whilst manoeuvring to land the UA collided with some unseen telephone wires causing it to fall to the ground and collide with a parked car. There was substantial damage to the UA.
- 28-May-21**     **MA Graupner Huskey 1800**     Leatherhead, Surrey  
During a training flight the model aircraft lost power and veered off course towards a recycling centre. The instructor took control but the aircraft did not respond. It continued to lose height before it stalled and crashed into the public area of the recycling centre. The aircraft was destroyed by fire.
- 29-May-21**     **MA ASW28 RC Glider**     Near Higham, Northamptonshire  
After launch, when the model glider was at approx 80 - 90 m, the operator tripped whilst walking forward and lost sight of it. The model aircraft had not been found at the time the occurrence was reported.
- 29-May-21**     **Aeryon SkyRanger R60**     Burnley, Lancashire  
After takeoff at approximately 1 m agl the UA moved without command, striking a wall and a parked car. Two propellers and mounting arms were damaged.
- 30-May-21**     **DJI Phantom 4 Pro**     Llanhilleth, Blaenau Gwent  
The pilot reported that the video feed flashed and there was a series of warnings before the UA struck the ground. The right rear propeller was missing. The pilot stated that because of previous damage the propeller mounting had recently been replaced with a third-party version as the DJI manufactured unit could not be sourced.

**Record-only UAS investigations reviewed June - July 2021**

- 3-Jun-21**     **DJI Phantom 4**     Barnham, Suffolk  
The four rotor UA lost a rotor during flight and fell through a tree. During replacement of all the rotors it was noticed that one appeared to lock in place with half a turn. However, by holding the motor and applying pressure to the rotor it became unlocked.
- 5-Jun-21**     **MA Douglas Skyraider replica**     Alcester, Warwickshire  
Whilst performing a display of a radio controlled scale replica of a Douglas Skyraider aircraft involving ground based pyrotechnics, a sudden wind change caused the pilot to temporarily lose sight of the aircraft and it crashed. The incident occurred well away from any spectators.
- 7-Jun-21**     **Mavic Pro 2**     Congleton, Cheshire  
The UAS was being used for filming when the UA clipped a tree and fell to the ground.
- 9-Jun-21**     **Custom aircraft**     Millbrooke, Bedfordshire  
The UAS was being used to record two moving road vehicles on a film set. After completing two successful rehearsals without the vehicles a third rehearsal was made with both vehicles. The pilot, who was positioned next to the roadside, was not aware that one of the vehicles had a large antenna fitted to the roof. He was unable to react in time and the UA struck the antenna and fell to the ground.
- 20-Jun-21**     **DJI Mavic Enterprise Zoom**     West Overton, Wiltshire  
The UA was at about 3 m agl as the operator carried out the pre-task checks. Without warning the UA tilted and travelled forwards whilst descending at the same time. It then hit and damaged the operator's car, before dropping to the ground. The battery detached and its casing split open. One of the arms and a rotor were also damaged. The operator suspected one of the motors had failed.
- 22-Jun-21**     **DJI Phantom 4 V2**     Perth, Perth and Kinross  
At a height of approximately 18 m, and at a distance of about 20 m from the operator, the UA reportedly lost all power and fell to the ground, sustaining extensive damage.
- 28-Jun-21**     **Evolve Dynamics Skymantis**     Bedminster, Bristol  
The UA suffered a power loss and was seen to spiral to the ground. The power loss was likely caused by the incomplete insertion of the battery which then worked its way loose during the flight.

**Record-only UAS investigations reviewed June - July 2021**

- 1-Jul-21**      **DJI Mavic 2 Pro**      Woolwich, Greater London  
While being used to inspect the roof of a building, the UA struck the building and fell to the ground.
- 8-Jul-21**      **MA Electric powered type unknown**      Amber Valley, Derbyshire  
After takeoff, the aircraft became uncontrollable in roll and it hit the ground in a nearby garden. The aircraft was destroyed.
- 11-Jul-21**      **MA type unknown**      Bromsgrove, Worcestershire  
The wings separated from the fuselage while the aircraft was in a shallow dive to clear an updraft. The fuselage fell to the ground separately to the wings and was not found.
- 15-Jul-21**      **Holy Stone HS100**      Wells, Norfolk  
UAS became stuck in trees during flight and could not be recovered.



## **Miscellaneous**

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

The complete reports can be downloaded from the AAIB website ([www.aaib.gov.uk](http://www.aaib.gov.uk)).



## ACCIDENT

<b>Aircraft Type and Registration:</b>	Guimbal Cabri G2, G-PERH
<b>No &amp; Type of Engines:</b>	1 Lycoming O-360-J2A piston engine
<b>Year of Manufacture:</b>	2016 (Serial no: 1164)
<b>Date &amp; Time (UTC):</b>	8 June 2018 at 1433 hrs
<b>Location:</b>	Goodwood Aerodrome, Sussex
<b>Type of Flight:</b>	Training
<b>Persons on Board:</b>	Crew - 2                      Passengers - None
<b>Injuries:</b>	Crew - 2 (Serious)      Passengers - N/A
<b>Nature of Damage:</b>	Damaged beyond economic repair
<b>Commander's Licence:</b>	Commercial Pilots Licence
<b>Commander's Age:</b>	59 years
<b>Commander's Flying Experience:</b>	8,920 <sup>1</sup> hours (of which 69 were on type) Last 90 days - 30 hours Last 28 days - 7 hours
<b>Information Source:</b>	AAIB Field Investigation

**Note:** Following a review, this report has been amended. This is the reissued report, published online on 5 August 2021. The original version of the report can also be found online and in the October 2019 AAIB Bulletin.

## Synopsis

While conducting a Simulated Engine Failure from the Hover (SEFH) the helicopter yawed rapidly to the left. Despite the actions of the pilots the helicopter continued to yaw rapidly, and control was not recovered. The helicopter was seen to climb while spinning before descending rapidly and contacting the ground, sustaining severe damage. Both occupants suffered serious injuries.

The manufacturer has subsequently issued service letter SL 19-001, *Throttle management during simulated engine failure*, and SL 19-002, *Controllability in yaw at low rotor speed*.

## History of the flight

On the day of the accident the commander and a student pilot were conducting a PPL(H) skills test; they were in the helicopter's left and right seats respectively.

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### Footnote

<sup>1</sup> The commander's total flying hours are a combination of fixed and rotary wing hours, with 4,420 rotary wing hours.

The helicopter departed Goodwood Aerodrome at about 1300 hrs for a navigation exercise and then returned to the aerodrome to complete the remaining exercises, which included an SEFH. The SEFH was completed to a satisfactory standard, but the commander noted that the helicopter yawed slightly to the right<sup>2</sup>. At the time the weather was fine with the wind from about 050° at 5 kt.

Once all the required exercises had been completed the commander asked the student whether there was anything else he would like to do. He asked if he could attempt another SEFH, as he felt he was able to fly the manoeuvre to a better standard; the commander agreed.

The student commented that during the subsequent SEFH, he recognised the helicopter starting to yaw to the right and applied left pedal to counteract this, after which the aircraft began to descend gently. His intention was to raise the collective to cushion the landing at about 1.5 ft agl. However, the helicopter started to rapidly yaw left. He applied full right pedal before handing control to the commander, who was already on the controls with full right pedal applied. The commander believes she moved the cyclic forward slightly to try to keep the helicopter level, but she could not remember what collective inputs she may have made. Witnesses in the control tower saw the helicopter spin and climb to about 40 ft agl, before descending and contacting the ground.

Once the helicopter had come to rest the commander secured it. The airfield's emergency response vehicles quickly arrived on the scene. They were followed shortly thereafter by local authority ambulances. Both pilots were seriously injured and, after being extracted from the helicopter, were taken to hospital by road.

## **Pilots' comments**

### *Student pilot*

The student pilot stated that the first SEFH landing felt "a bit firm" to him and he felt he could do better, so he took the opportunity to repeat the manoeuvre.

On the accident SEFH, after the helicopter start to yaw rapidly to the left, he also felt it climb. He felt that the application of the right pedal did cause the rate of left yaw to slow down. He tried to keep the helicopter steady with the cyclic but did not recall handing control to the commander. He reported that the forces involved were so violent that he was forced sideways to his right.

He added that he is "reactive" to the yaw during engine-off exercises and waits for the yaw to commence before applying the appropriate pedal to counteract it.

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## **Footnote**

<sup>2</sup> The Cabri G2's main rotor blades rotate in a clockwise direction when viewed from above. The torque effect is a tendency of the main rotor to yaw the fuselage in the opposite direction from the rotor. The tail rotor provides thrust to counteract this. After an engine failure the torque effect is reduced, resulting in a tendency for the helicopter to yaw in the direction of the main rotor blades, to the right in a Cabri G2. Hence some left pedal is required after the failure.

### Commander

The commander stated that for a SEFH, once the student had established the helicopter in a stable hover, at approximately 7 feet agl, she announces “engine failure in 3, 2, 1, GO”. On “GO” she closes the throttle ensuring it goes through the detent<sup>3</sup>.

The commander stated the student had been a bit slow in applying the left pedal on the first SEFH. She believes that on the accident SEFH, she had not fully closed the throttle before the helicopter started to yaw to the left and thinks the student may have anticipated the left pedal and applied it before she said “GO” and the throttle was closed.

### Instructor’s comments

The student’s instructor, who had flown the six instructional flights with him prior to the accident, commented that the student was very conscientious and always well prepared. He added that he could, at times, “over-analyse” some of his performances and be excessively critical on himself despite the skills demonstrated being generally of an acceptable standard.

### Helicopter’s Flight Manual

Section 4 of the Cabri G2’s Flight Manual, *Normal Procedures*, states:

#### ***‘Training***

...

#### ***Power failure in hover in ground effect practice***

- 1. Roll-off throttle frankly<sup>4</sup> until on its stop,*
- 2. Counteract yaw motion by applying left pedal,*
- 3. Increase collective as ground approaches, to smooth landing,*
- 4. Push collective down once landed.*

**Note 1:** *If the helicopter is light, it may bounce after a first touchdown.*

**Note 2:** *The Cabri G2 has no natural tendency to depart in roll or pitch after failure. No systematic corrective cyclic action is needed.*

*A slight forward motion at impact is recommended for better control.*

**Note 3:** *For a forgiving practice, respect a maximum of 5 feet height.*

...’

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#### Footnote

<sup>3</sup> See *Helicopter information* for a description of the Cabri G2’s throttle.

<sup>4</sup> The manufacturer commented that ‘frankly’ means that the throttle should be closed in one motion and without hesitation.

## Accident site

The accident site occurred in the Helicopter Training Area at Goodwood Aerodrome. The helicopter came to rest upright with the right side of the fuselage in contact with the ground and pointing in a north-east direction. The landing gear had penetrated the fuselage on the left side and the right passenger door had broken and become detached. The fenestron tail rotor had detached from the tail boom and there was evidence that two of the main rotor blades had struck the ground (Figure 1). Both landing skids had dug into the ground with no evidence of movement after contact.



**Figure 1**

G-PERH at the accident site

## Helicopter information

The Guimbal Cabri G2 is a light two-seat helicopter primarily used to train private pilots and for aerial photography and observation. It is the first helicopter to be primarily certified to EASA CS27 and then to achieve FAA FAR-27 certification for helicopters with a maximum takeoff weight of less than 3,175 kg (7,000 lbs).

The airframe is composed of three sections; main fuselage, engine section, and tail boom. The main fuselage is a carbon-fibre reinforced monocoque, constructed in five parts. In the cabin there are two side-by-side seats, with the pilot occupying the right position. The main fuselage also includes a central structure, baggage compartment and fuel tank. The engine section is isolated from the cabin by a firewall with the engine supported on a tubular steel frame. The composite tail boom incorporates a Fenestron tail rotor, vertical fin and a horizontal stabilizer.

The landing gear is composed of two tubular bows with skids. It is attached to the fuselage by soft elastomeric mounts, to avoid potential ground resonance problems. The landing gear is designed to withstand vertical landing loads combined with smaller longitudinal and lateral loads.

## Seats

The seats have been designed to reduce the forces on the passengers in the event of an impact and are capable of absorbing loads up to 19 g forward and up to 30 g vertical, which corresponds to a free fall rate of about 10 m/sec (2,000 ft/min). The seats comprise a composite shell with minimal cushioning added for comfort. The seat shell is attached to the bulkhead by two seat rails, which allow it to move vertically and is restrained by an energy absorbing strut (Figure 2).



**Figure 2**

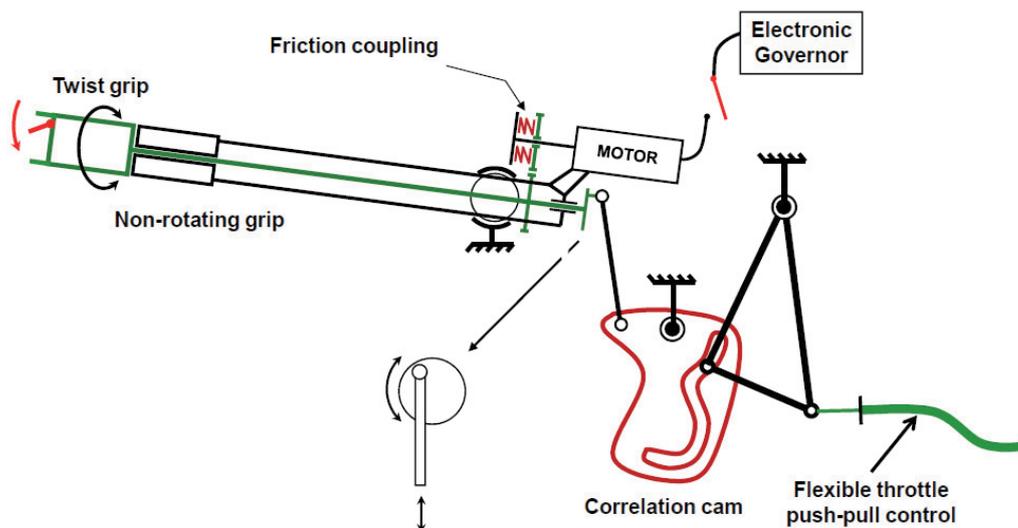
Left seat composite shell and seat rails with energy absorbing strut

## Engine and controllers

The helicopter is powered by a four-cylinder, air-cooled Lycoming O-360-J2A engine. It is installed aft of the main gearbox, with its crankshaft facing forward and is supported on elastomeric vibration mounts.

To reduce pilot workload the helicopter is equipped with an electronic engine governor to maintain the engine at the nominal speed regardless of power demand. The governor regulates the engine speed to 2,650 rpm using data from an engine speed pickup, rotor speed pickup and the throttle position. If the engine speed is commanded to below 2,000 rpm (such as for shutdown) the engine governor disengages but will re-engage and accelerate the engine to the nominal running speed once the speed is above 2,000 rpm.

The engine throttle control is on the collective lever and is operated by a conventional twist-grip (Figure 3). The twist grip rotates a shaft which, through a system of cams and levers, operates the engine throttle cable. At the extreme clockwise rotation of the twist grip, a detent gives the pilot a physical indication that the throttle has fully closed. The twist grip must be rotated through approximately 160 degrees from the powered flight position to reach the idle mechanical stop. A motor, controlled by the governor, is connected to the twist grip shaft and there is a friction coupling which allows the pilot to overcome the governor if required. A switch on the end of the collective activates or deactivates the engine governor.



**Figure 3**

Engine throttle control system

### *Correlation cam*

The output of the throttle shaft from the collective lever is connected by a linkage to a correlation cam so that when the collective is raised the throttle will increase the engine power. The cam profile is designed to aid the function of the engine governor and to minimise the pilot work should the governor fail. When the collective lever is raised with the throttle twist grip fully closed, the cam profile is designed to have no effect on the engine throttle.

### *Tail rotor effectiveness*

The manufacturer commented that the main rotor can produce lift in a hover at rotor speeds well below its authorised speed range of 515 to 540 rpm and even below 450 rpm<sup>5</sup>. However, in such a situation, the Fenestron thrust will not be sufficient to maintain effective yaw control and even with full right pedal, the helicopter will start spinning uncontrollably to the left. In addition, if such a loss of control in yaw occurs, raising the collective will lower the rotor speed even more and will aggravate the situation by increasing the spin rate to the left.

## **Helicopter examination**

### *Airframe*

The airframe was subjected to a visual examination at the AAIB facilities to assess the damage sustained during the impact. The monocoque structure was largely intact with evidence of crushing on the aft right underside. All access panels were in place except for the luggage door and right passenger door, which was broken in two pieces. There was evidence on the underside of penetration from the landing gear bows at both mounting locations. The front landing gear bow had caused minor damage to the central console in the cabin and the aft bow had penetrated the luggage bay and the fuel tank volume. The

### **Footnote**

<sup>5</sup> 450 rpm is the minimum authorised rotor speed in autorotation.

flexible fuel tank liner had deformed around the bow without perforation and no fuel had leaked. The Fenestron had detached from the tail boom and there was impact damage to the tips of two main rotor blades.

Following the visual examination, the helicopter was digitised using a '3D' structured light scanning system to quantify the structural deformation. All exterior surfaces were scanned, as well as the landing skids, engine bay and cabin interior. The results of the scan were then compared with the original design data obtained from the helicopter manufacturer (Figure 4).



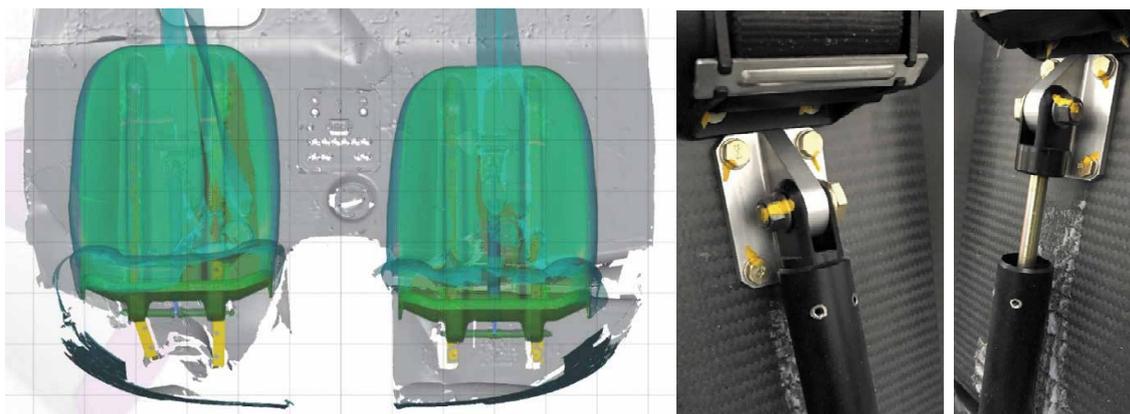
**Figure 4**  
Digital analysis of G-PERH

The results of the scanning showed that the tail boom of the helicopter was misaligned by approximately 3° to the left of nominal and bent slightly upwards. The cabin bulkhead showed evidence of multiple damage locations of crushing, cracking and delamination.

#### *Seats and attachments*

The position of the seats was recorded with the cushions removed to enable accurate measurements to be taken from the composite shell (Figure 5). Once the seat shells were removed, the length of the energy absorbing struts was measured:

Strut	Nominal Length	Measured Length	Extension
Left	302 +/- 0.5 mm	351.6 mm	49.6 mm
Right		304.5 mm	2.5 mm



**Figure 5**

Seat position and energy absorbing strut extension

The right seat shell was examined, and several damage locations were identified. The left seat was undamaged.

The lower end of the right seat, outboard track was bent inwards and forwards by approximately 20° and the lower end of the inboard track showed minor deformation. The bend was located at the lower attachment to the seat and a witness mark was evident on the seat shell from the track. The deformation of the right seat tracks was coincident with the crushing deformation of the lower section of the monocoque and cabin bulkhead.

*Landing gear*

The landing gear assembly was intact and removed from the helicopter at the accident site. There was evidence of bending of the tubes and local buckling at the joints. It was noted that the landing skids fitted to the accident helicopter were of a later modification standard which was introduced to prevent the bow tubes from failing, which had occurred in previous accidents. The geometry of the landing gear assembly was measured using the 3D structured light system and it was found that the right skid was straight, in accordance with the design, whereas the left skid was curved. The aft end of the left skid was bent upwards by approximately 5 mm and was forward of the right skid by more than 350 mm. The profile of the two bows between the skids showed evidence of the right skid being bent outwards whereas the left side showed no such deformation.

*Engine bay*

The engine bay was covered by three composite access panels and the Lycoming engine was supported by a steel tubular frame attached to the monocoque. The frame also supported some ancillary equipment and the Fenestron drive shaft. Visual examination and digital analysis of the frame identified several members were bent and the right lower monocoque attachment point was deformed in the impact. The friction lining of the Fenestron drive braking system was damaged due to misalignment of the drive shaft and it was noted that the main drive belt was not correctly aligned on the upper pulley.

## Survivability

There are four requirements to survive a crash:

1. Maintain a liveable volume for the occupant throughout the crash sequence.
2. Restrain the occupant.
3. Keep the crash loads experienced by each occupant within human tolerance.
4. Provide time to escape. Primarily, this is time to escape a post-crash fire.

The manufacturer actively markets the safety features of the Cabri G2 helicopter and its compliance to survivability requirements of EASA CS-27 and FAA FAR-27. The carbon fibre monocoque provides a rigid structure for the protection of the occupants. In this accident the liveable cabin volume was not compromised, and the seat belts restrained the occupants. However, lateral movement of the right seat occupant during the impact sequence most probably resulted in the right passenger door being broken. It is not thought any injuries were sustained from this.

The lack of post-crash fire meant that there was no immediate urgency to evacuate the helicopter and the first responders were able to remove the occupants in a timely manner, limiting the potential for further injury.

The energy absorbing struts in the seat system are designed to reduce the loads on the occupants in the event of a vertical impact. The manufacturer states that in certification testing the '*occupants would survive a 2000 ft/min impact, equivalent to a 5 m free fall*'. In this accident the left seat strut extended to 116% whereas the right seat strut extended to 101%. However, the injuries sustained by both occupants were similar and so it is judged that the impact energy was absorbed by a different mechanism for the right seat occupant.

## Analysis

### *Loss of control*

The first simulated SEFH was completed to a satisfactory standard, but the helicopter yawed slightly right and, in the student's opinion, landed firmly. Given that the student tended to over-analyse some of his performances, could be highly self-critical and generally strived for excellence, it is likely he would aim for a gentler landing in any subsequent SEFH.

The accident manoeuvre was consistent with the application of left yaw pedal and raising the collective lever whilst the throttle was partially open. Lifting the collective before the throttle was fully closed would have resulted in the correlator cam increasing the engine speed until, at 2,000 rpm, the engine governor would have re-engaged. These actions would have caused an increase in engine speed resulting in the high rate of yaw and climb, which the student felt. Had the throttle been fully closed the correlator cam profile would have had no effect on the engine speed when the collective was raised.

The application of right pedal not stopping the yaw to the left indicates that the rotor speed had reduced, thus making the Fenestron less effective.

In the absence of recorded flight data, it was not possible to determine the exact sequence of events that led to the collective being raised whilst the throttle was partially open.

The investigation considered whether the examiner may have thought that the throttle mechanical stop had been reached when it had not. This was considered unlikely as the examiner was familiar with the mechanical characteristics of the throttle and the effort required to reach the mechanical stop. The examiner had closed the throttle uneventfully on the two previous SEFH exercises.

It takes a finite amount of time to rotate the throttle through the 160 degrees from the powered flight position to the fully closed position and the examiner recalls that during the accident manoeuvre she had not fully closed the throttle when the aircraft started yawing rapidly to the left. The student stated that he was reactive to the yaw in simulated engine failure exercises. It is probable that in this instance he applied left pedal and then started to raise the collective to cushion the landing before the throttle was fully closed.

### *Impact Sequence*

Immediately prior to ground impact, the helicopter was rotating with a high rate of left yaw, in a slightly nose-up attitude and rolled to the left. The first impact point was the aft end of the left landing skid and this deformed upwards. The aft bow penetrated the fuel tank volume, but the fuel quantity was such that the liner was able to deform without rupturing. It is likely that at this moment the left seat moved downward on the seat rails, absorbing the vertical energy for the occupant.

As the impact sequence progressed the helicopter pitched forward, and the left skid deformed further as it dug into the soft ground. Due to the yawing motion, the helicopter rolled to the right until the right skid contacted the ground and dug into the ground, deforming the right side of the bow. The helicopter fuselage still had inertia in yaw and consequently it slid around the profile of the landing gear bows until the right aft fuselage contacted the ground. As a result of this lateral motion, the lower part of the Fenestron struck the ground and applied a torsional load at the junction to the tail boom, resulting in failure of the composite structure. The fuselage was now inclined to the right and two of the main rotor blades hit the ground, the impact of the second causing the engine to stop.

As the aft right side of the fuselage contacted the ground, the remaining vertical energy was absorbed by the composite structure crushing and delaminating. This was clearly seen at the lower cabin bulkhead position and caused the right seat rails to deform. From the direction of the deformation it was possible to deduce that the loads were predominantly lateral. This was also demonstrated by the right seat occupants contact with the right door and the damage to the outside of the seat shell.

### *Survivability*

The seats fitted to the Cabri G2 are designed to absorb only vertical energy and, along with seat belts, restrain the occupants in the longitudinal direction. From analysis of the impact sequence it has been shown that the left seat occupant was subjected to vertical loads during the initial impact and the seat stroke was enough to survive the impact. As the accident progressed, due to the high rate of yaw, the loads became lateral in direction and so the energy absorbing seat became less influential for survivability. Further, the deformation of the seat rails did not impede the motion of the right seat as the loading was predominantly lateral. The remaining energy was absorbed by the distortion of the composite structure which kept the loads experienced by the right seat occupant below survivable limits.

### **Conclusion**

The accident was probably caused by application of the left yaw pedal and raising the collective lever whilst the throttle was partially open during a simulated engine failure exercise.

In this accident, the helicopter maintained a liveable volume for the occupants throughout the accident sequence and the first responders were able to extricate the occupants in a timely manner without risking further injury. The flexible fuel tank liner had not been compromised and there was no post-crash fire. The occupant retention system did not prevent the right seat occupant from contacting and breaking the access door, however he was retained within the cabin. A combination of the energy absorbing seat system and the destruction of the composite fuselage absorbed the vertical and lateral impact energy such that both occupants survived the crash with injuries which were serious but not life-threatening.

### **Safety actions**

As a result of this, and other similar events, the manufacturer published in February 2019 two Service Letters to prevent reoccurrence. They are available on its customer support portal.

SL 19001 - Throttle management during simulated engine failure.

This service letter provides an explanation of the engine governor / correlator system and the need to ensure the twist grip throttle is fully closed whilst practicing certain manoeuvres. It gives advice to flight instructors on how to position the hand on the throttle grip to enable the throttle to be closed in one movement and therefore ensuring the engine throttle does not open when the collective is raised.

SL 19002 - Controllability in yaw at low rotor speed.

This service letter provides advice on yaw control when operating with low rotor speeds. It includes a list of scenarios where yaw control could be lost and mitigating actions to prevent loss of control. One scenario is Simulated Engine Failure from the Hover. When operating at low rotor speeds with full or almost full right pedal applied it is recommended not to raise the collective but keep it as low as possible and increase forward airspeed by cyclic input, and not to increase the rotor speed by turning the twist grip.

*Originally published 19 September 2019.*

*Reissued: 5 August 2021.*

**BULLETIN ADDENDUM**

<b>Aircraft Type and Registration:</b>	Reims Cessna F406, G-RVLW
<b>Date &amp; Time (UTC):</b>	6 March 2021 at 1500 hrs
<b>Location:</b>	North Sea
<b>Information Source:</b>	Aircraft Accident Report Form

**AAIB Bulletin No 7/2021, pages 28 and 29 refer**

Following publication of this report, the AAIB received correspondence containing further information about pulse oximetry. Consequently, the report is amended as shown below.

**Amended text on page 28**

The penultimate paragraph on page 28 is amended to read:

The operator supplied finger pulse oximeters to allow the monitoring of oxygen levels. They provide a very rapid way of assessing the oxygen saturation in the bloodstream although they can be unreliable. They may underread the level of oxygen in the blood, especially with cold or dirty fingers, but this is considered a fail-safe condition which triggers action from the pilot to correct the perceived low oxygen level. However, they can also falsely indicate likely brain oxygenation in the presence of hyperventilation, which may be triggered by hypoxia. In this case cerebral oxygen delivery can be considerably lower (due to constriction of the cerebral blood vessels) than peripheral oxygen levels as measured by the pulse oximeters. This can produce a fail-unsafe condition which is a concern.

The original text read:

The operator supplied finger pulse oximeters to allow the monitoring of oxygen levels. They provide a very rapid way of assessing the oxygen saturation in the bloodstream. Whilst these can be unreliable in that they may underread the level of oxygen in the blood, especially with cold or dirty fingers, they do not overread the level.

**Amended text on page 29**

The following text is added to the end of the second paragraph of the Analysis on page 29:

However, it should also be noted that hyperventilation – one of the symptoms of hypoxia – may mean that a pulse oximeter does not indicate at the finger what it is purporting to ‘measure’ in the brain.

The online version of this report was corrected on 12 August 2021.



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

- |                                                                                                                                           |                                                                                                                                 |
|-------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|
| 1/2015 Airbus A319-131, G-EUOE<br>London Heathrow Airport<br>on 24 May 2013.<br>Published July 2015.                                      | 1/2017 Hawker Hunter T7, G-BXFI<br>near Shoreham Airport<br>on 22 August 2015.<br>Published March 2017.                         |
| 2/2015 Boeing B787-8, ET-AOP<br>London Heathrow Airport<br>on 12 July 2013.<br>Published August 2015.                                     | 1/2018 Sikorsky S-92A, G-WNSR<br>West Franklin wellhead platform,<br>North Sea<br>on 28 December 2016.<br>Published March 2018. |
| 3/2015 Eurocopter (Deutschland)<br>EC135 T2+, G-SPAO<br>Glasgow City Centre, Scotland<br>on 29 November 2013.<br>Published October 2015.  | 2/2018 Boeing 737-86J, C-FWGH<br>Belfast International Airport<br>on 21 July 2017.<br>Published November 2018.                  |
| 1/2016 AS332 L2 Super Puma, G-WNSB<br>on approach to Sumburgh Airport<br>on 23 August 2013.<br>Published March 2016.                      | 1/2020 Piper PA-46-310P Malibu, N264DB<br>22 nm north-north-west of Guernsey<br>on 21 January 2019.<br>Published March 2020.    |
| 2/2016 Saab 2000, G-LGNO<br>approximately 7 nm east of<br>Sumburgh Airport, Shetland<br>on 15 December 2014.<br>Published September 2016. | 1/2021 Airbus A321-211, G-POWN<br>London Gatwick Airport<br>on 26 February 2020.<br>Published May 2021.                         |

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are available in full on the AAIB Website

<http://www.aaib.gov.uk>



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## GLOSSARY OF ABBREVIATIONS

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

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