AAIB
Air Accidents Investigation Branch

AAIB Bulletin 7/2019

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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.

ACCIDENT

Aircraft Type and Registration:	Cessna 150M, N66778
No & Type of Engines:	1 Continental O-200-A piston engine
Year of Manufacture:	1974 (Serial no: 15076271)
Date & Time (UTC):	18 July 2018 at 2017 hrs
Location:	Terrance B. Lettsome International Airport, Beef Island, Tortola, British Virgin Islands
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:	FAA Private Pilot Licence
Commander's Age:	33
Commander's Flying Experience:	343 hours (of which 17 were on type) Last 90 days - 19 hours Last 28 days - 17 hours
Information Source:	AAIB Field Investigation

Synopsis

N66778 was taking off from Beef Island, in the British Virgin Islands (BVI), on the sixth sector of a delivery trip from Florida to Argentina. After takeoff the aircraft was seen to fly along the length of the runway at slow speed in a nose-high attitude. It then turned left before entering a steep nose dive and hitting the sea.

The investigation concluded that the aircraft stalled during the left turn. No evidence of any mechanical failure was found.

The aircraft was likely to have been operating slightly above the Maximum Takeoff Weight and with the centre of gravity aft of the approved limit. Several items were not secured in the cabin which could have shifted aft during the takeoff roll moving the centre of gravity further aft. It is possible that this aft centre of gravity caused control difficulties resulting in the stall. Improvements in emergency communications on BVI have been made following the accident.

History of the flight

N66778 had recently been sold to a new owner in Argentina, having previously been based in Florida. The accident occurred whilst the aircraft was being delivered from Miami, Florida to Argentina. It was being delivered together with two Piper PA-38 Tomahawk aircraft. One of the pilots had previously made a similar delivery flight.

The three aircraft left Miami Opa Locka International Airport on 17 July 2018 and flew to Exuma International Airport in the Bahamas, then to Providenciales on the Turks and Caicos Island and finally to Puerto Plata in the Dominican Republic, where the three pilots spent the night. On 18 July 2018, the aircraft flew from Puerto Plata to Punta Cana, and then to Beef Island in the BVI (Figure 1).

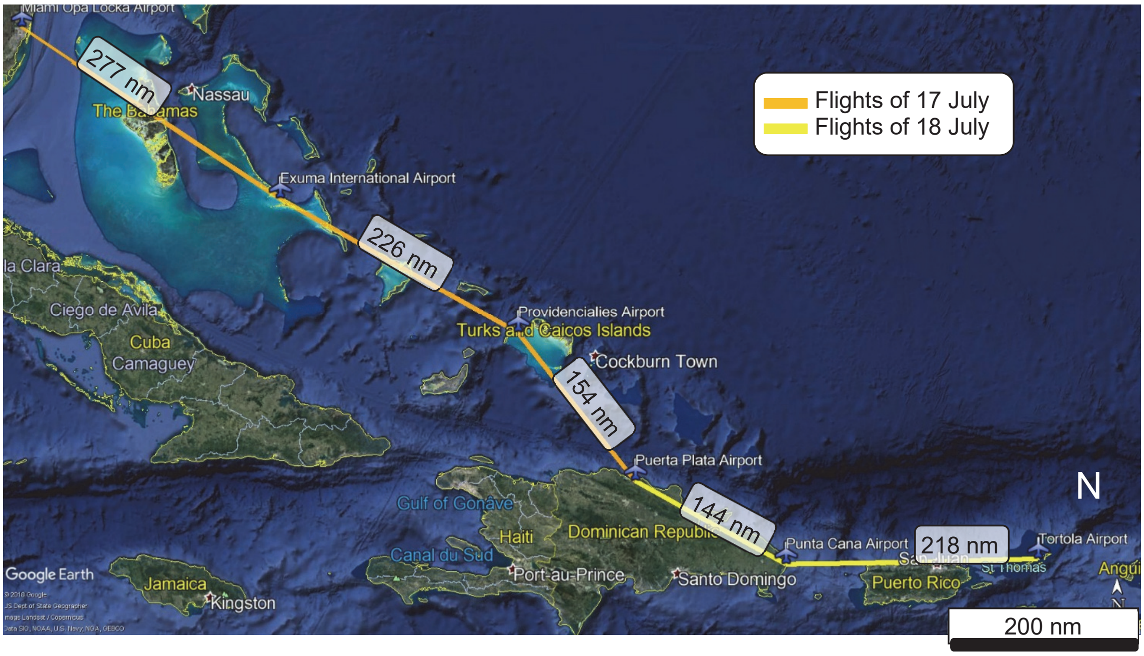

Figure 1

N66778 flights on 17 and 18 July 2018

The final sector of the day was planned from Beef Island to Pointe-à-Pitre in Guadeloupe. The accident occurred on takeoff from Beef Island. The same pilot flew N66778 solo on each sector from Miami; the aircraft and an auxiliary fuel tank, which had been fitted for the ferry flights, were fully refuelled prior to each flight.

The pilots of the other two aircraft reported that the five sectors to Beef Island were uneventful, except they recalled N66778 was high on approach to Puerto Plata and that there was some confusion regarding the aircraft's altitude.

ATC reported that the landing in Beef Island appeared to be normal and the aircraft vacated at Taxiway D (Figure 2). After refuelling in Beef Island, the pilot of N66778 called for taxi at 2010 hrs (1610 hrs local) then taxied to holding point D, entered and backtracked Runway 07. The ATC controller reported that radio transmissions from N66778 were almost unreadable and several instructions were repeated.

The pilot of N66778 started his takeoff roll from the start of Runway 07. The pilot of another aircraft, who was holding on Taxiway C, reported seeing N66778's rear fuselage touch the runway as the aircraft rotated. He described seeing the aircraft then climb with slight oscillations in pitch. He reported that the aircraft was at approximately 50 ft when it passed Taxiway C and the flaps were up[1] (Figure 2).

Figure 2

Terrance B. Lettsome International Airport (Beef Island) showing the accident location

Other witnesses, including other pilots, saw the aircraft initially climb to approximately 100 to 200 ft. They then describe the aircraft flying along the remaining length of the runway at slow speed, in almost level flight and in a nose-high attitude. When the aircraft reached the far end of the runway it was seen to turn left. As the aircraft turned through approximately 90º the nose was seen to pitch up before the left wing dropped and the aircraft entered a steep dive. The aircraft was seen to hit the water in a steep nose-down attitude. The accident occurred at 2017 hrs.

Witnesses near the accident site reported they could hear the engine running throughout the flight and that it sounded "normal".

Two divers, who were in a small boat moored nearby, were the first to reach the accident site. However, realising they would need dive equipment to reach the pilot, returned to their

Footnote

[1] Flaps up takeoff is an approved takeoff technique in the Pilot's Operating Handbook.

main boat to collect equipment. By the time they returned to the accident site the Airport Fire Service had launched their boat and were on scene. The diver was able to reach the pilot and brought him to the surface but attempts to resuscitate him were unsuccessful. The diver confirmed the pilot was wearing a lap strap but no shoulder restraint.

The duty ATC officer attempted to request the services of the police, ambulance and VISAR[2] by calling 911. This was in accordance with the airport emergency plan. When contacted, the 911 operator is required to contact VISAR who will launch boats to attend any accident on water. However, they were initially unable to contact 911. VISAR were made aware of the accident via the US Coast guard who heard about the accident on the marine distress radio channel. VISAR launched two boats at 2032 hrs and 2043 hrs respectively which attended the scene. The BVIAA[3] also contacted their dive contractor who attended the scene to confirm there were no other occupants and to recover the wreckage.

Accident site

The aircraft had come to rest in approximately 5 m of water, 250 m north of the Runway 25 threshold (Figure 2). The wreckage was recovered to shore by local salvage personnel on the day of the accident; this was overseen by representatives of the BVIAA. It was raised to the surface using floatation bags before being pulled to the shore and loaded onto a truck by crane. The wreckage was moved to a secure location within the airport grounds where detailed examination of the wreckage could be carried out.

Recorded information

The pilot used a flight planning and navigation App on his mobile phone and tablet computer. This App normally records aircraft position, altitude and time, which can be uploaded to a cloud account once the flight has been completed. Both the phone and tablet computer were recovered from the wreckage, but due to the impact damage and exposure to the sea water no information could be recovered.

The flights that had been uploaded to the cloud on 17 and 18 July were recovered from the pilot's cloud account. Complete flight path data from the first four flights of the trip was available. Takeoff data from each of these was reviewed with nothing abnormal noted.

Only the last 42 minutes of the inbound flight to the BVI was available from the cloud account so the takeoff for this flight could not be examined. No recorded data was available for the accident flight from the cloud account.

No recorded radar data was available due to limitations of the low-level coverage. Recorded radio transmissions were provided which have been used to help recreate the history of flight.

Footnote

2 Virgin Island Search and Rescue – a volunteer search and rescue service.
3 British Virgin Island Airport Authority.

Aircraft information

The Cessna 150M is a two-seat, high wing monoplane with conventional controls. The passenger compartment has room for two occupants seated side by side with an area behind the seats for storage. It is powered by a naturally aspirated, air cooled, horizontally opposed four-cylinder engine driving a two-bladed, fixed pitch propeller. Fuel is gravity fed to the engine from two 13 USG integral wing tanks. The wing tank vents and outlets are linked and therefore fuel is drawn from both tanks simultaneously, allowing the tanks to maintain equal levels.

N66778 (pictured in Figure 3) held a valid Export Certificate of Airworthiness (ECofA) issued by the FAA on 13 February 2018. When the ECofA was issued, the aircraft had accumulated 2,556.1 flying hours, as had both the engine and propeller. The aircraft and engine log books were not recovered during the investigation, so an accurate indication of the aircraft accumulated hours at the time of the accident could not be determined. The ECofA referred to three major repairs and alterations, these were for the installation of wingtip fairings, a voltage controller and tinted sun visors. There were no records made available to the investigation indicating the approval of fitment of any other repairs, alterations or additions.

Figure 3

N66778 prior to the accident (image used with permission)

Aircraft examination

The aircraft had been recovered to an area of grass within the airport grounds (Figure 4). The rear fuselage structure had separated from the front fuselage aft of the seats and was only connected by control cables. Significant leading edge crumpling on the right wing was consistent with the aircraft striking the water at a near vertical attitude, right wing first. Hydrostatic forces were sufficient to rupture the lower surface of the right wing as it struck the water.

Figure 4

N66778 after recovery

The primary control surfaces and control runs were all examined and confirmed to have been intact prior to the accident. The elevator trim control was intact; but it was not possible to determine the trim position due to disruption in the cockpit. The elevator trim tab was neutrally positioned suggesting the trim position was not excessive.

The right-wing flap was up and left-wing flap was down. The synchronisation cable connecting the left and right flaps had snapped at the left-wing root. Examination of this cable indicated that it had failed in overload and was consistent with the impact. The right flap was fixed and remained connected to the flap actuator which was in the retracted position. The flap position was therefore determined to have been UP at the time of the accident.

The cabin area was severely disrupted, however the instrument panel remained largely intact. The engine controls were found as follows: mixture RICH, carb heat COLD, throttle at idle, the key was in and selected to BOTH magnetos. Due to the disruption and possibility of movement during wreckage recovery, it was not possible to determine if these were the control positions at the time of impact.

Auxiliary fuel tank

An auxiliary fuel tank was recovered with the wreckage (Figure 5). It was of rubberised fabric construction and was fitted with an electric pump to allow transfer of its contents to the aircraft's integral fuel tanks during flight.

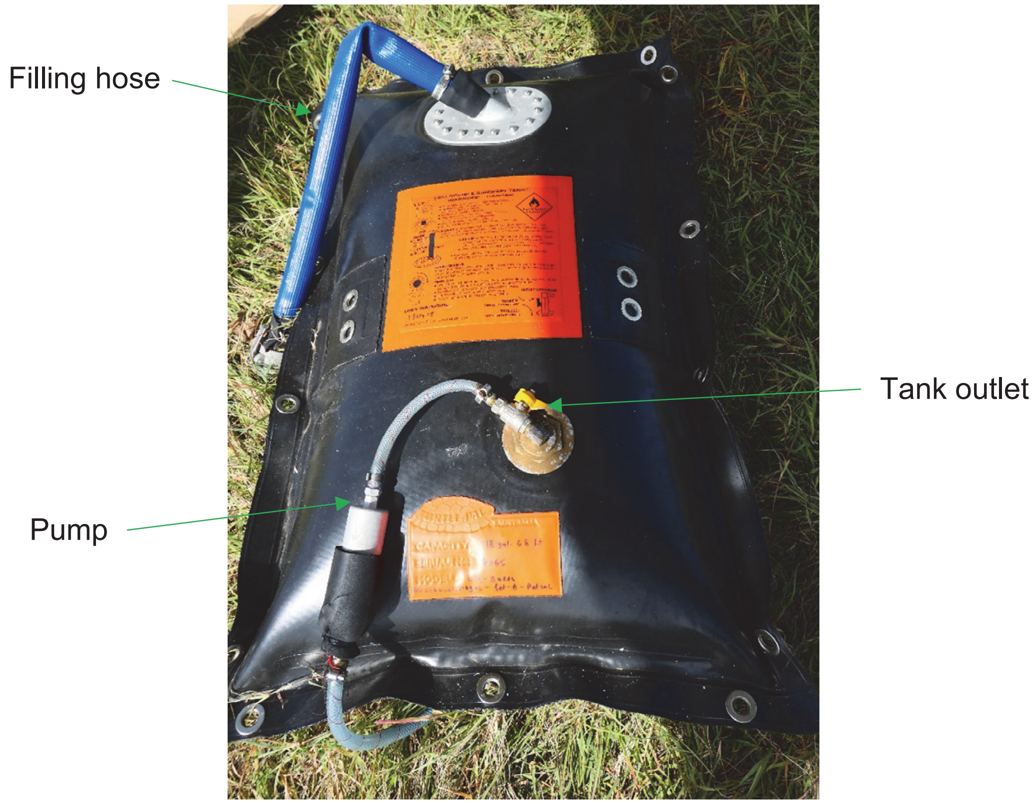

Figure 5
Auxiliary fuel tank

The pump outlet was connected to an inline filter which in turn was connected to tubing that ran under the left door sill, up the left door forward pillar, through the left cockpit air vent and out of the air scoop on the leading edge of the left wing. The tube then ran from the leading edge to an elbow union connected to a modified over wing fuel tank cap (Figure 6). The tubing was still in position, however during the accident the auxiliary tank became dislodged from its original location, becoming disconnected at the fuel filter outlet.

The electrically powered transfer pump was connected to the aircraft's electrical system using automotive type crimp connectors. A control box with a toggle switch, which activated the pump, was found within the cockpit. A length of Velcro-like loop tape was fixed to the underside of the control box with a similar sized piece of hook tape located on the centre of the left control yoke. It is possible that the control box was fixed to the left control yoke, however this cannot be confirmed. The control box was connected to the aircraft with a wire which passed underneath the instrument panel and connected to the aircraft 12 V supply. A wire then led from the control box to the transfer pump.

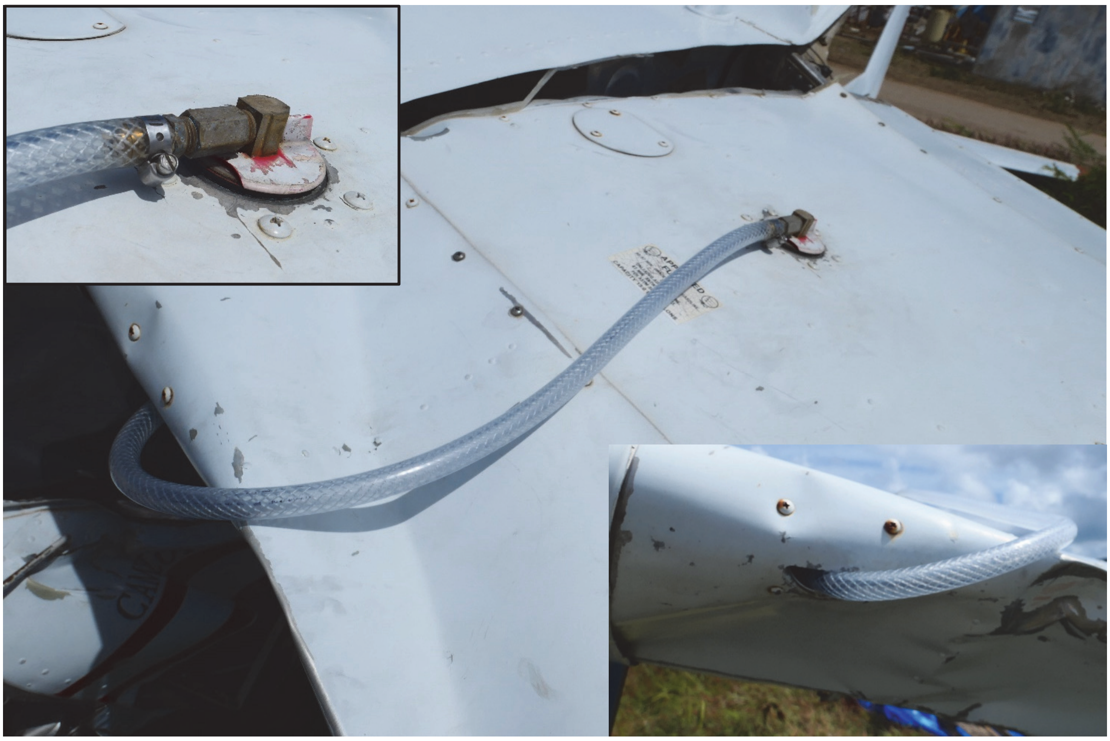

Figure 6

Routing of auxiliary fuel tank tubing over leading edge of the left wing into the left fuel tank

The weight of the tank when filled with fuel to its rated capacity of 68 litres (18 USG) should be 124.6 lbs; however, the tank on N66778 was found to weigh 137.6 lbs. This equated to containing approximately 76 litres (20 USG) of fuel. The auxiliary tank manufacturer advised that although the tank can be filled to 80 litres it is only rated to 68 litres to allow for expansion and shock loading in the event of an accident. The guidance leaflet provided with the auxiliary tank states *'Only fill to the lesser rated capacity and the maximum allowed by weight & balance data or specific operational approval'.* The outlet valve was found to be open, so the possibility of water entering the tank or fuel leaking from the tank whilst it was submerged was considered. When the tank was recovered, no fuel leaked from the tank and it was concluded that it was unlikely that the contents of the tank had changed since the accident.

The pilots of the other aircraft flying with N66778 identified that the tank had been positioned in the storage location to the rear of the pilot's seat and was orientated so its long edge was along the length of the compartment. Examination of the cabin area did not identify any evidence of the tank being secured into the aircraft. A tank carry bag[4] was located within the aircraft. It was found to contain webbing ties supplied with the tank to secure it to the aircraft; however, their condition suggested they had never been used. The floor of the luggage compartment was carpeted. This would not have provided any significant friction to restrain the tank during aircraft manoeuvring.

Footnote

[4] The bag in which an empty auxiliary tank could be rolled and stored.

For FAA registered aircraft alterations such as the installation of an auxiliary tank should have been approved via an FAA Form 337. A Form 337 associated with this alteration was not received by the FAA.

Propeller and engine

The propeller was intact, with one of the blades exhibiting a slight rearward bend. The engine was also intact, with no evidence of casing rupture. The cylinders, when inspected through the spark plug ports, showed signs of salt water ingestion consistent with the engine operating at the time of impact with water.

The engine was removed from the aircraft and returned to the AAIB's facilities in the UK for a full strip examination with an engineer from the engine manufacturer present. Other than a seized exhaust valve on the No 4 cylinder, which was determined to have corroded in this position due to salt water immersion, there were no issues identified that could have affected the engine power

Fuel

The aircraft had been fully fuelled from the airport fuel supply prior to the accident flight. Witnesses described that a fuel additive, Marvel Mystery Oil, had been added to the fuel at this time. Samples of the fluid within the aircraft main tanks were taken; however, as the tanks had been immersed in salt water it was not viable to determine the quality of the fuel being delivered to the engine. The engine manufacturer's Standard Practices Maintenance Manual states that:

> *'With the exception of the use of isopropyl alcohol or diethylene glycol monomethyl ether (DiEGME) compound, we do not recommend the use of additives or concentrates in any of our aircraft engines.'*

Other aircraft had refuelled from the same source on the day of the accident with no reported issues with the fuel quality.

Pathology

The post-mortem report stated the cause of death was *'multiple blunt trauma to* [the] *body as a result of* [an] *airplane crash'*. A contributory cause was *'cerebral haemorrhage'*.

Survivability

The aircraft struck the water in a near vertical attitude. The pilot was not wearing his shoulder harness and suffered a major head injury in the impact. It could not be determined if the pilot would have survived the impact if he had been wearing his shoulder harness.

Weight and balance

The aircraft weight and balance schedule, issued in 2003, was recovered from the aircraft. The aircraft was fully refuelled prior to the flight. The wing fuel tanks contain 22.5 USG of usable fuel. The auxiliary fuel tank, located in the aft cabin, weighed 137.6 lbs.

The aircraft also contained a suitcase, life raft, emergency marine kit, machete, five one-quart engine oil bottles and the pilot's personal effects. Witnesses report the aircraft also contained a crate of water bottles, a box of food and a bottle of fuel additive, although none of these were recovered. None of these items were secured. Witnesses report that, on previous flights, the suitcase had been on the passenger seat and that the water, food, oil and fuel were behind the seats, however, it could not be confirmed where they were located during the accident flight. The life raft was found in the right footwell.

A weight and balance calculation was made during the investigation (Table 1). It has been assumed that each item was located in the most forward plausible location based on the witness reports from previous flights. However, it is possible that these items where located further aft or had moved during the flight.

ITEM	WEIGHT (lbs)	ARM (inches)	MOMENT/1,000 (lbs/inch)
Empty Weight	1,100.4		37.83
Engine Oil	11.0		-0.10
Wing Fuel Tanks	137.0		5.70
Pilot	199.0	39	7.76
Auxiliary Fuel Tank (behind seat)	137.6	71.9	9.89
Suitcase (on front seat)	28.6	39 *	1.12
5x Oil Cans	15.0	84 *	1.26
Life Raft	20.3	25 *	0.51
Water	6.2	64 *	0.40
Personnel Effects plus emergency marine kits, machete & documents	10.0	39 *	0.39
TOTAL	**1,665.1**	**38.89**	**64.75**

Table 1

N66778 Weight and Balance Calculation
('*' location not certain, most forward plausible location assumed)

The Maximum Takeoff Weight for the Cessna 150M is 1,600 lbs. The calculation for N66778 was 4% above the maximum weight. The centre of gravity limits at Maximum Takeoff Weight for the Cessna 150M are 32.8 to 37.5 inches. The calculation for the centre of gravity position for N66778 was at least 1.39 inches beyond the aft limit. If some items had been loaded further aft or if items moved during the takeoff the centre of gravity could have been even further aft.

The baggage area behind the pilot's seat is divided into two areas for weight and balance calculations. The maximum load for the front area is 120 lbs, the maximum load for the aft area is 40 lbs, but the maximum total load for the whole baggage area is 120 lbs (Figure 7). Based on the witness reports that the auxiliary fuel tank, oil cans and the crate of water were stored behind the pilot's seat, N66778 had at least 158.8 lbs of weight in the baggage area.

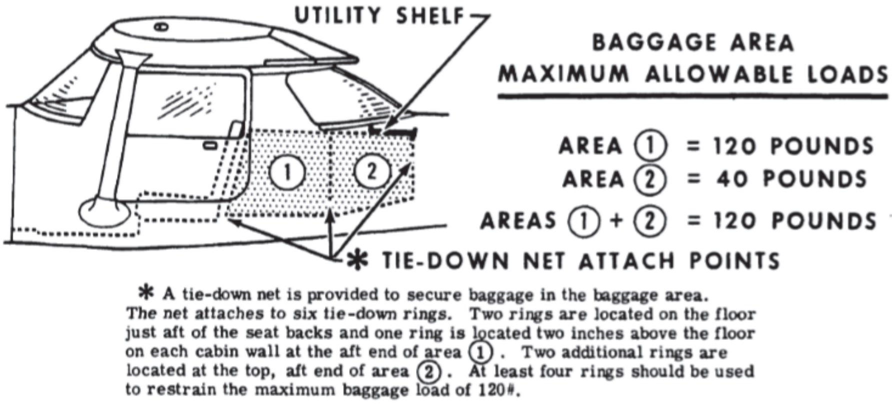

Figure 7

Baggage Loading Restriction

It is not possible to establish if the pilot completed a weight and balance calculation prior to the accident flight or any of the previous flights from Miami. Witnesses reported that the aircraft had carried the same items since it left Miami.

Meteorology

The METAR at Terrance B. Lettsome International Airport issued by air traffic control 17 minutes before the accident recorded surface wind from 100° at 10 kt, visibility 10 statute miles, cloud scattered at 1,900 ft, temperature 32°C, dew point 24°C and sea level pressure of 30.02 inches. There had been no significant change in the weather since the aircraft landed at Beef Island.

The tower controller reported the surface wind as 100° at 9 kt when clearing N66778 for takeoff.

Witnesses report the weather conditions as a "normal Caribbean day, lights winds with a few gusts".

Airfield information

Terrance B. Lettsome International Airport is located on Beef Island at the eastern end of Tortola in the BVI. The airport has a single 30 m (100 ft) wide asphalt Runway orientated 07/25. Runway 07 has a takeoff distance available of 1,506 m (4,940 ft). There are hills around the runway, with the highest peak within 10 nm at 1,263 ft.

The distance from the start of Runway 07 to Taxiway C, where the aircraft was observed to pass 50 ft, is approximately 2,200 ft.

All VFR aircraft departing Runway 07 are required not to commence any turn until reaching or passing 1,000 ft agl. Circuits are conducted to the south of the airfield.

The airport has a Category 5[5] Rescue and Fire Fighting Service. The Airport Fire Service has a rescue boat which is stored on a trailer at the airport fire station. The boat can be launched from jetties at either end of the runway in the event of an emergency. In the event of an emergency on water the airport emergency plan requires the duty air traffic control officer to contact 911 and request the operator to contact VISAR. VISAR have rescue boats located at Tortola and Virgin Gorda which are able to respond in the event of an emergency on the water.

Pilot information

The pilot held a valid FAA Private Pilot's Licence with an 'Airplane Single Engine Land' rating and an 'Instrument Rating'. His last bi-annual flight review was completed on 10 August 2016. He passed his Instrument Rating skills test on 28 March 2018.

The pilot's logbook records that he had completed 329.9 flying hours prior to starting this trip. Prior to July 2018 all his flying experience was on Cessna 172 aircraft. Before commencing the delivery trip, the pilot flew N66778 on three occasions totalling 4.4 hours. The pilot's next of kin reported that he was building flying hours with a view to obtaining his Commercial Pilot's Licence.

The two pilots flying the other delivery aircraft reported concerns regarding the accident pilot's approach into Puerto Plata. They reported that he was high on approach and incorrectly reported his altitude to ATC. They also reported that he was having problems with his radio. ATC in Beef Island reported problems communicating with the pilot of N66778. It is not known if the reports concerning the approach to Puerto Plata were caused by the radio problems.

The pilot had flown for 9.6 hours on 17 July and had already flown for 3.5 hours on 18 July prior to the accident flight. Long distance flying in small aircraft without an autopilot can be tiring, particularly if the pilot is not experienced at long range flying. Before the start of this trip the longest flying day the pilot had completed was 4.8 hours. It is possible that the pilot was suffering from fatigue[6], although there is no evidence to confirm this hypothesis.

Medical

The pilot held a valid FAA Class 3 medical which was issued on 17 January 2018[7]. His next of kin reported that the pilot was in good health prior to the trip.

Footnote

5 ICAO Annex 14 defines the RFF category based on the largest aircraft that operates into the airport. Category 5 is for aircraft with an overall length 24 m - 28 m.

6 Federal Aviation Administration – '*Fatigue in Aviation*', available https://www.faa.gov/pilots/safety/pilotsafetybrochures/media/Fatigue_Aviation.pdf (accessed 5 December 2018)

7 FAA Class 3 Medical is valid for 60 months from the date of issue.

Other information

Stall Speed

The Cessna 150M owner's manual quotes the aircraft stall speed with flap UP and power off to be 55 mph (48 kt). N66778 was operating above the maximum weight which would increase the stall speed, but the aft centre of gravity would reduce the stall speed. It is not possible to quantify if the combined effect would be an increase or decrease in the stall speed.

N66778 had a fuel pipe positioned over the leading edge of the left wing. This pipe would disturb the airflow over the left wing and could affect the stall speed of the aircraft. If the aircraft stalled in balanced flight it is possible that this modification would cause the left wing to stall first resulting in a wing drop to the left.

When the aircraft is being flown at a slow speed, below the minimum drag speed, the total drag increases as the speed decreases. The slower the aircraft flies the more power is required to maintain speed in level flight. In this regime, the aircraft is speed unstable because a decrease in speed will cause a further decrease in speed without pilot intervention.

Aircraft Handling with Aft Centre of Gravity

N66778 was likely to have been operating with the centre of gravity aft of the aircraft's approved limit. The aircraft manufacturer does not have any test data to confirm how the aircraft would behave in this condition. However, as the centre of gravity moves aft the aircraft would be less stable in pitch and the control forces would become lighter. As the centre of gravity moves further aft the aircraft's response to small control movements would become larger and the aircraft would become difficult to fly. If the centre of gravity is moved sufficiently aft the aircraft would become unstable in pitch.

Analysis

Airframe and engine

Examination of the aircraft and engine did not identify any pre-existing issues which could have caused the accident, in particular there was no evidence of any mechanical issue with the flight controls. The auxiliary fuel tank which had been fitted to extend the range of the aircraft for the delivery flight, had not been installed in accordance with approved FAA standards. There were no measures to secure the tank within the airframe and there was no evidence that procedures to maintain aircraft weight and balance within limits were in place.

Fuel additive

Reports were received that a fuel additive was added to the fuel when the aircraft was refuelled, however, an analysis of the fuel being provided to the engine could not be carried out. Although the engine manufacturer's advice is not to use fuel additives, the aircraft had been flown on five previous legs without any reported issues with the additive used for all of these flights. This suggests that the use of a fuel additive did not cause a loss in engine power on the accident flight.

Accident flight

The witnesses' descriptions of the accident are consistent with the aircraft experiencing an aerodynamic stall whilst attempting to turn left at the north-eastern end of the runway. Prior to the stall the aircraft was observed flying along the remaining length of the runway, maintaining low speed and a nose-high attitude, before commencing the left turn.

The pilot had recorded over 300 flying hours mostly on Cessna aircraft and had passed his Instrument Rating in March 2018. It is unlikely that a pilot with this experience would intentionally fly the aircraft at a low speed, with a nose-up attitude near to the ground. Under normal conditions a pilot would be able to lower the pitch attitude and accelerate, however, this did not occur. This suggests that the pilot was having difficulty controlling the aircraft.

It was not possible to precisely calculate the weight and centre of gravity for the aircraft however it was very likely to have been operating above the Maximum Takeoff Weight and with the centre of gravity beyond the aft limit. It is possible that this caused the control difficulty. One of the other pilots, who was waiting at holding point C, described seeing the aircraft strike its rear fuselage on the runway as the aircraft became airborne and then climb with slight pitch oscillations. It is possible that when the pilot rotated for takeoff, the lighter control forces due to the aft centre of gravity position, caused the aircraft to over-rotate resulting in the tail striking the runway. The aircraft's nose-high attitude and slight pitch oscillations could have been caused by reduced pitch stability.

The witnesses then describe the aircraft in almost level flight and with a nose-high attitude. A possible explanation is that the aircraft pitch stability had reduced significantly making it difficult to control. However, this would require the centre of gravity to be significantly aft.

Witnesses report that the aircraft was carrying the same items as the previous sectors. However, it is possible that the aircraft was loaded differently on the accident flight moving the centre of gravity further aft than the previous sectors. Many of the items in the cabin were not secured, so it is also possible that some may have moved during the takeoff which could have shifted the centre of gravity further aft. The observed tail scrape also could have triggered items to move aft in the cabin.

The aircraft was observed to turn to the left at the north-eastern end of the runway. The pilot's intended route was slightly right of the takeoff track. The most likely explanation for the left turn is that the pilot was attempting to return to the airport. Normal circuit direction at the airport is to the right, however, it is possible the pilot was not aware of this or he considered a left turn to be a safer option.

When the aircraft commenced a turn, in level flight, the stall speed would have increased. The fuel pipe running over the leading edge of the left wing might also have increased the stall speed. The aircraft was also seen to 'pitch up' during the turn which would cause the airspeed to decrease. The aircraft's speed instability at these low speeds would cause the speed to further reduce. These effects are likely to have combined to cause the stall during the turn.

It is likely that centre of gravity position was a factor in this accident; CAA Safety Sense Leaflet 9 – '*Weight and Balance*'[8] highlights the importance of accurate weight and balance calculations.

Decision to fly

The pilot had agreed to undertake a delivery flight from Miami to Argentina with two other pilots, one of whom had flown a similar route before. Decisions made prior to the flight from Miami were therefore likely to affect the subsequent flights. No evidence was found of a weight and balance calculation completed by the pilot. All the pilot's previous flying experience was on the Cessna 172 aircraft which has a higher Maximum Takeoff Weight and a wider centre of gravity range. It is possible that the pilot was not aware of the more restrictive limitations of the Cessna 150.

The aircraft contained an auxiliary fuel tank which had not been installed to any approved FAA standards for repairs or modifications. This installation included a tube that ran over the wing leading edge to the fuel filler cap; the pilot's pre-flight checks could have been an opportunity to question the installation.

The pilot had been having difficulty with the radio on the previous sector and his radio transmissions were almost unreadable on the accident flight prior to takeoff. However, the pilot did not appear to take any action to resolve the radio problems before continuing with the flight.

There are several possible reasons why the pilot decided to continue with the flight despite these issues. The pilot was building his flying hours with a view to obtaining his Commercial Pilot's Licence. This delivery trip was an opportunity to obtain additional flying hours with limited cost. It is likely this was a strong influence when deciding to undertake the flights. The pilot was also flying the route with two other pilots who were flying other aircraft, one of those pilots had flown this route previously. When operating in groups people may be more likely to accept risks, and it is possible that this affected the pilot's decision to fly the aircraft.

The pilot had completed over 13 hours of flying in the two days prior to the accident. It is possible that the pilot was suffering from fatigue and this may have reduced his ability to manage the flight, particularly if the aircraft handle characteristics were not as expected.

CAA Safety Sense Leaflet 23 – '*Pilots – It's your decision!*'[9] discusses these and other issues that can affect a pilot's decision to fly.

Survivability

The pilot was not wearing his shoulder harness. It could not be determined if the pilot would have survived the accident if he had been wearing his full harness.

Footnote

8 http://publicapps.caa.co.uk/docs/33/20130121SSL09.pdf (accessed 25 March 2019).
9 http://publicapps.caa.co.uk/docs/33/20130121SSL23.pdf (accessed 25 March 2019).

The airport rescue boat arrived at the accident site within a few minutes of the accident. With the assistance of divers who were nearby, they were able to recover the pilot from the aircraft. There was initially some difficulty alerting VISAR although they were notified by the US coastguard.

Conclusion

The aircraft stalled, during a left turn, shortly after taking off from Runway 07. No evidence was found of any pre-existing defect with the aircraft or engine which would explain the accident.

The aircraft was likely to have been operating slightly above the Maximum Takeoff Weight and with the centre of gravity aft of the approved limit. Several items were not secured in the cabin which could have shifted aft during the takeoff roll moving the centre of gravity even further aft. It is possible that this aft centre of gravity caused control difficulties resulting in the stall.

The accident highlights the importance of the pilot in command of any aircraft ensuring their aircraft operates within weight and balance limits and that all items in the aircraft are secured.

The pilot had completed over 13 hours of flying in the two days prior to the accident and it is possible that fatigue was a contributing factor in this accident.

Safety action

As a result of this accident the BVIAA has taken action to ensure that VISAR can now be contacted directly by ATC if they cannot be alerted via the 911 operator.

Published 20 June 2019.

ACCIDENT

Aircraft Type and Registration:	Grob G109B, G-KHEH
No & Type of Engines:	1 Grob 2500 E1 piston engine
Year of Manufacture:	1986 (Serial no: 6436)
Date & Time (UTC):	10 June 2018 at 0959 hrs
Location:	Near Raglan, Monmouthshire
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - 2 (Fatal) Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	68 years
Commander's Flying Experience[1]:	550 hours (of which 27 were on type) Last 90 days - 7 hours Last 28 days - 2 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft collided with a dead tree whilst conducting a field landing exercise. It has not been possible to determine conclusively whether the aircraft was suffering from an engine problem, most likely carburettor icing, during the descent, however, the engine was under power at the point it collided with the tree. Had it been necessary, the aircraft should have been able to avoid the tree and carry out a landing in the field beyond. It was considered most likely that the pilots did not see the tree until it was too late to avoid it.

History of the flight

The instructor arrived at Usk Airfield at about 0800 hrs on the morning of the accident and at 0900 hrs attended the airfield brief, held to advise club members of airfield information, local NOTAMS and the plan for the day's club flying.

The instructor owned a touring motor glider (TMG) which he used at times to provide training to club members. At the end of the briefing he was approached by one of the club members, a qualified glider pilot[2], who asked if he could do some practice field landings in the TMG with the instructor that morning. The instructor agreed.

Footnote

1 Powered flight hours only. The commander also had approximately 2,100 hours flying gliders.
2 Referred to in this report as the student.

It is not known whether a brief took place or the details of the intended flight, but the TMG took off from Usk Airfield at about 0947 hrs with the instructor and student on board. Witnesses report seeing the aircraft shortly after this time near the town of Raglan, about 4 miles north of the airfield. Recovered flight data shows the aircraft flew an orbit over an area of fields approximately 1.5 miles to the north-west of the town, before commencing an apparent final approach for a practice force landing into a large field (Figure 1).

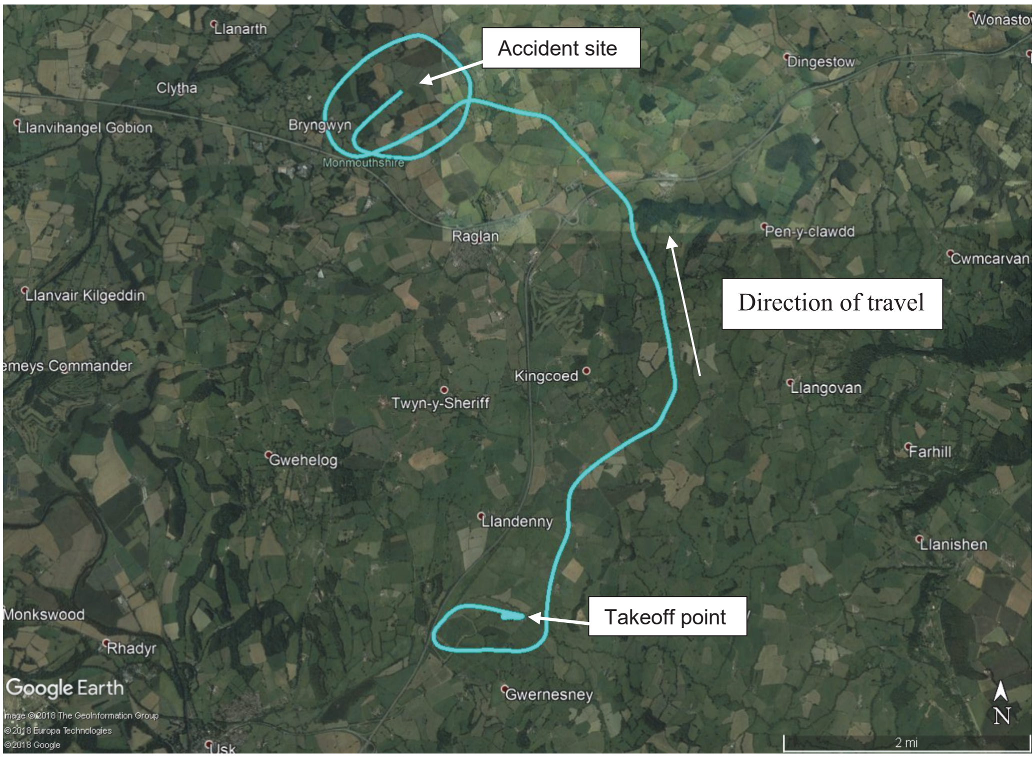

Figure 1

G-KHEH flight of 10 June 2018

The aircraft was also seen by several witnesses flying low along its final track towards the selected field. One of these witnesses, who was standing outside some farm buildings about 1,200 m from the accident site, saw the aircraft pass close-by and described hearing the engine spluttering, as if it was running out of fuel.

The aircraft was also seen by two witnesses who were standing outside their house about 500 m from the accident site and were surprised to see the aircraft pass low overhead. They described hearing the engine misfire or splutter, as if it was being restarted. However, one of these witnesses also described the aircraft as being quiet as it flew overhead and the other that it was making a loud noise. The aircraft passed out of sight and both witnesses reported that a few seconds later they heard the engine noise increase, so they expected to see it climb away. Instead they heard the sound of an impact.

Another witness in the garden of a house about 260 m from the accident site also saw the aircraft fly overhead. They reported the engine sounded 'sluggish' but not spluttering. They stated the aircraft was very low and descending, so they assumed it was in the process of landing in the field. They stated that shortly after losing sight of the aircraft it sounded as if the engine had stopped, followed a few seconds later by the sound of an impact.

The aircraft was also seen by the driver of a car travelling on a lane running adjacent to the accident site. He had stopped when he saw the aircraft approach the boundary of the field appearing as though it was attempting to land. He described it flying towards the gap between a large dead oak tree and a mature tree to its right[3] (Figure 2). He did not consider the gap was wide enough for the aircraft to pass through and watched as it changed course, just before the trees, to the left. He then saw the right wing clip the dead tree and the aircraft invert before coming to rest in the field beyond. The driver made his way quickly to the accident site to offer assistance where he was joined by another person, but it was soon apparent that neither of the occupants had survived.

Accident site

The field in which the accident site was located had a hedge running along its south-western perimeter in which there were several mature trees, one of which was a dead oak tree (Figures 2 and 3). A 2 m section of the aircraft's right wingtip was found in this tree suspended together with a broken bough, both having been entangled in the tree by some aircraft wiring. Photogrammetry assessment of the dead tree and examination of the damage to the right wing determined the height of the impact with the tree was approximately 57 ft agl.

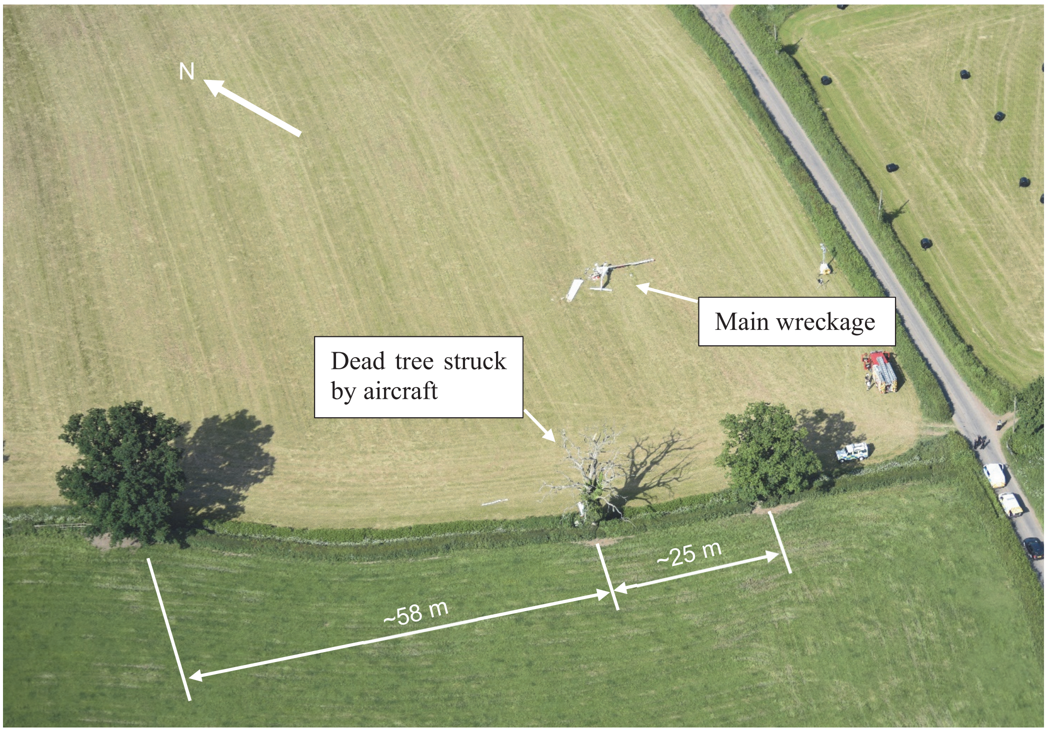

Figure 2

Accident site
(image courtesy of South Wales Police)

Footnote

3 Descriptions from the pilots' perspective.

Figure 3

Accident site showing impact point with tree and wreckage
(image courtesy of South Wales Police)

The aircraft had come to rest, inverted, approximately 55 m from the hedge line. There was no post-impact fire. Impact marks showed that the aircraft had struck the ground at a steep angle, inverted. The right wing, which had separated during the impact sequence, was found close to the fuselage.

The engine and forward section of the cockpit lay to the side of the fuselage, connected to it by the fuel supply tube and electrical wiring. The instrument panel was recovered from within the severely disrupted cockpit area, the switches were all found in the OFF position and the ignition key in PARK. It is considered likely that the switch positions were altered during the accident sequence and subsequent recovery. The carburettor heat selection knob was partially extended and had been bent forward. The choke was fully closed. The position of the throttle control levers could not be determined due to the level of disruption in the cockpit.

The airbrake control lever was found in the stowed position. The left airbrake was found deployed but it was considered that this was due to the wing coming to rest inverted.

Ground marks at the main impact location indicated that the propeller was rotating at the time it contacted the ground. The composite wooden propeller had fragmented and one of the propeller blade tips was located 16 m from the initial impact point (Figure 4), indicating that the engine had been producing power at the time of impact.

Fuel was found in the fuel supply line to the engine and more than 50 litres of fuel were drained from the fuel tank.

Figure 4

Location of propeller blade tip in relation to wreckage

Aircraft information

The Grob 109B is a two-seat side-by-side, dual control touring motor glider with a T-type horizontal stabiliser and fixed, tail dragger landing gear (Figure 5). It can be used as a conventional powered aircraft for touring but can also be used as a glider, during which times the engine is shut down and the drag minimised by feathering the propeller. The aircraft is constructed mainly from glass-reinforced plastic. Its wings are detachable with a wingspan of 17.4 m and air brakes which extend out of the upper surface. It is powered by a Grob 2500 E1 air cooled engine with a Hoffman HO-V 62 R variable pitch propeller. The engine and fuel system are designed to run on AVGAS 100LL fuel.

Figure 5

Example of a Grob 109B

The Grob 2500 E1 is a four-cylinder, 2.5 litre, twin carburettor, single magneto engine. The controls for throttle, choke and carburettor heat are operated from the centre console, with an additional throttle control on the left instrument panel combing. The engine controls actuate three transverse control rods which synchronise the inputs to the dual carburettors situated either side of the engine. The engine is not particularly loud when running, especially when at low power settings.

The propeller pitch can be set to CLIMB, CRUISE or FEATHER positions, and the position is altered by pulling one of two handles located on the centre console in the cockpit (Figure 6). The CRUISE propeller position is set by pulling the propeller control handle (also referred to as the 'prop control knob') when the engine is set above 2,300 rpm. The CLIMB position is set by pulling on the propeller control handle whilst the engine speed is at or below 1,400 rpm. The FEATHER setting is used when the aircraft is gliding and the engine has been shut down. It is set by pulling the 'prop feather handle' then turning it through 90º.

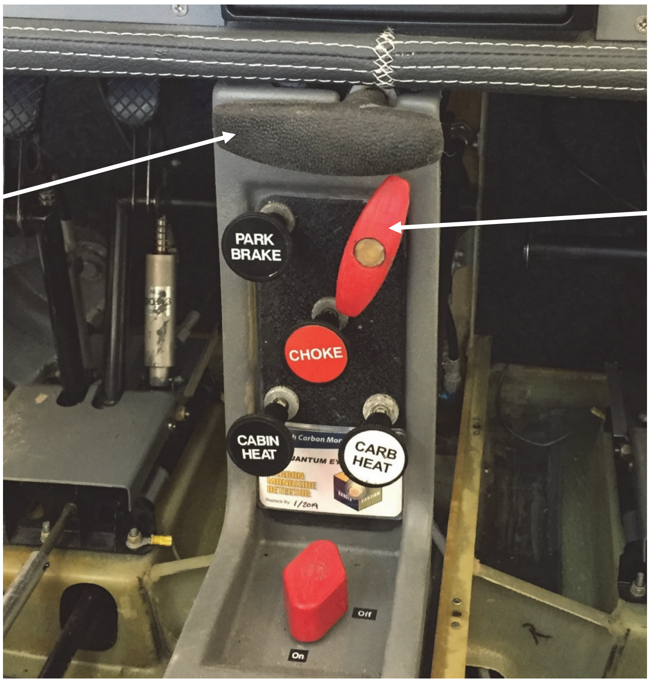

Figure 6

Grob 109B propeller pitch controls

The aircraft's flight manual provides the following reference speeds:

- Stall speed (airbrakes retracted) 39 kt
- Normal range 45-92 kt
- Approach speed 62 kt
- Best climb (prop in CLIMB) 59 kt

The manual also states the aircraft has a glide ratio of 1:28 at 62 kt and a minimum sink rate of 217 ft/min and 58 kt.

Aircraft examination

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

Examination of the flying controls did not reveal any pre-impact issues.

Examination of the engine was conducted by the AAIB with the representatives from the manufacturer present; no issues were found that may have degraded the engine performance. The carburettor heat baffles for the left and right carburettors were found in the HOT and COLD positions respectively. Internal witness marks within the units confirmed that the baffles were both in the HOT position at the time of impact, which corresponded with the position of the carburettor heat knob in the cockpit. It is considered the right baffle subsequently moved during the impact sequence.

The magneto was removed for assessment at an approved overhaul facility. Due to impact damage it could not be tested, however, strip examination determined that it was likely to have been functioning normally prior to the accident.

The propeller pitch mechanism was examined and determined to have been in the CLIMB position.

Analysis of the fuel sampled from the aircraft fuel tank found that the fuel was predominantly AVGAS 100LL aviation gasoline, however, the results suggested there were small traces of automotive gasoline (MOGAS) present in the sample.

Recorded information

A tablet computer was recovered from the aircraft wreckage and taken to the AAIB for examination. The device had suffered superficial damage but after replacing the screen, appeared to function correctly. The instructor was known to use SkyDemon, a flight planning and navigation App, which records aircraft GPS position, altitude and time. This information was successfully downloaded from the tablet for a number of flights.

Accident flight

The recording commenced at 0924:41 hrs with the aircraft on the ground at Usk Airfield. Takeoff commenced at 0947:31 hrs after which the aircraft tracked towards Raglan, achieving a maximum GPS altitude of 1,264 ft amsl.

Upon passing abeam Raglan, the aircraft commenced a right hand circuit overhead the accident site at approximately 1,100 ft amsl (Figure 7).

At 0957:02 hrs, while on the crosswind leg, the aircraft commenced a descent which continued for the rest of the flight. Vertical speed was calculated as the rate of change of GPS altitude to ascertain the rate at which the aircraft was descending throughout the manoeuvre. A negative vertical speed represented a rate of descent; a positive vertical speed a rate of climb.

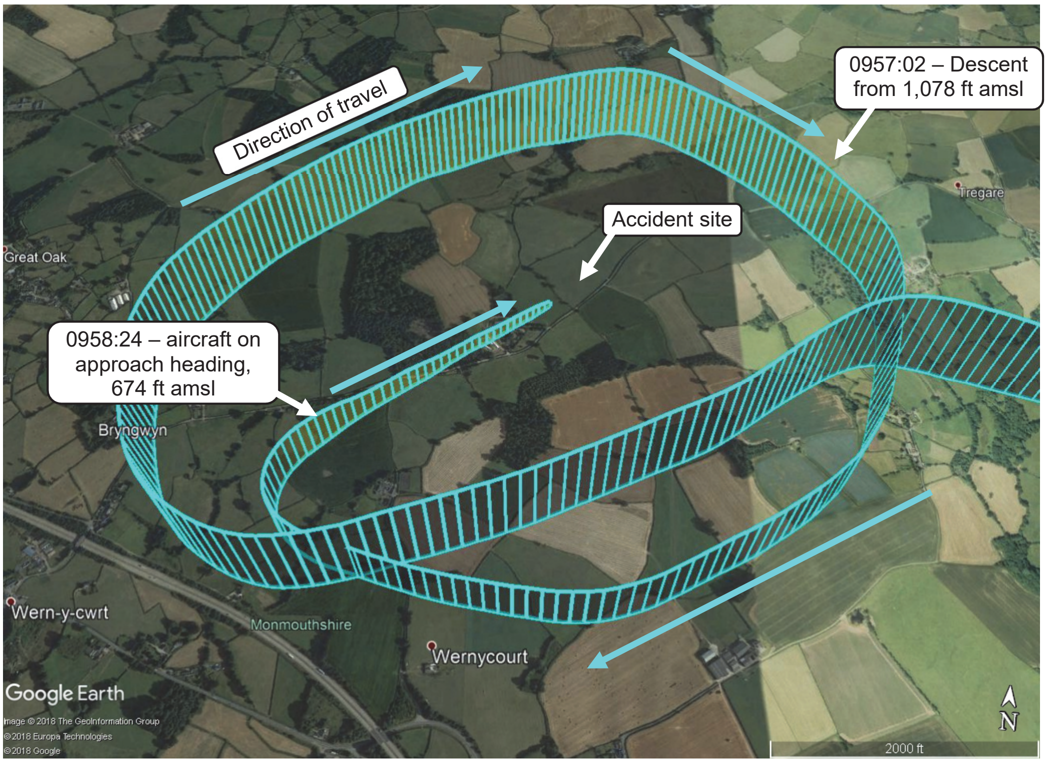

Figure 7

G-KHEH final stages of flight

Between the start of the descent and the turn to the final approach track, vertical speed varied at between +100 to -790 ft/min, with the aircraft descending 400 ft over one minute 20 seconds (Figure 8). Ground track covered over this period was approximately 1.6 nm, equating to an average ratio of 1:24. Calculated groundspeed varied between 54 kt and 77 kt.

At 0958:24 hrs the aircraft was positioned on the final approach track at an altitude of approximately 674 ft amsl (about 444 ft agl). The recorded aircraft positions do not show any significant deviation in the aircraft track during the last 30 seconds of the recording.

During the turn onto the final approach the groundspeed decreased and, shortly after becoming established on the final approach, this had reduced to about 53 kt. During the subsequent final 30 seconds of the flight, vertical and ground speeds are seen to fluctuate with the vertical speed varying between -100 and -2,000 ft/min and the groundspeed varying between 45 kt and 62 kt (Figure 7). In general, when the vertical speed decreased, the groundspeed increased and vice versa.

During the last four seconds, recorded data shows the aircraft in a descent with decreasing vertical speed and groundspeed increasing from 45 kt. The last recorded position was at 0958:56 hrs with the aircraft at 284 ft amsl (about 54 ft agl) located approximately 43 m before the tree.

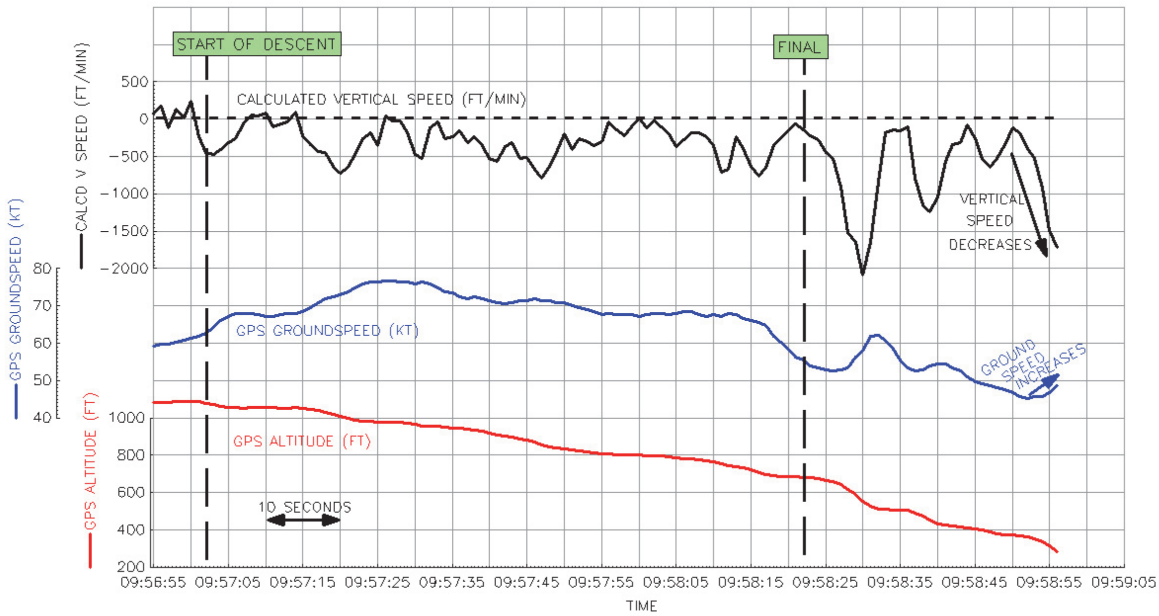

Figure 8

G-KHEH flight data parameters for the final two minutes of flight

Previous flight

The tablet computer contained a recording of a flight on 2 June 2018 where it was reported that the aircraft was performing practice fields landings. A review of this flight revealed that the minimum height achieved during these manoeuvres was 350 ft agl.

Pilot information

Instructor

The instructor was an experienced glider pilot and had qualified as a fully rated gliding instructor in 1999. He had previously held the position of Chief Flying Instructor at the South Wales Gliding Club at Usk Airfield. He had gained a Private Pilot's Licence in 1996 and qualified as a TMG instructor in 2003.

The instructor had owned a Hoffman H36 Dimona TMG from 2002 until it was destroyed in an accident in 2016 whilst being flown by another pilot[4]. He replaced it with G-KHEH later the same year.

It is unclear from the instructor's logbook entries how many flights he had made which had included training of field landings. His logbook recorded a field landing training flight on 2 June 2018, but he appears not to have conducted any other field landing training flights for over a year prior to this.

Footnote

4 See section on BGA Motor Glider Accident Statistics.

Student

The student had originally flown paragliders for many years before starting to fly gliders at Usk Airfield in 2007. He had flown a total of 260 hours in gliders and normally only flew in the vicinity of the airfield. His logbook records his only known landing at another airfield was in May 2011 in order to qualify for his British Gliding Association (BGA) Silver Badge, which he was awarded in the same month. He had completed his annual gliding check on 23 December 2017 and was described by one of the senior club instructors as a competent pilot.

The student's only recorded field landing practise took place in August 2009. The flight of one hour and forty-one minutes was in a Dimona TMG with the same instructor involved in this accident.

Field landing training

Gliders may, at times, have insufficient lift to be able to reach an airfield in order to land. On these occasions they are forced to make a field landing. The potential for having to conduct a field landing increases when flying away from the immediate vicinity of an airfield, for instance on a cross country flight. Pilots undertaking such flights therefore need to gain and practise the necessary skills. This procedure cannot readily be practised in a glider, however, the use of a TMG allows pilots to glide down to relatively low heights, leaving the engine at idle or low power, and then be able to climb away again by re-applying power.

Other instructors at the gliding club reported that when practicing field landings using a TMG they would conduct the takeoff and climb the aircraft to about 2,000 ft. They further reported that on reaching a suitable local area they would select the propeller pitch to fine before selecting the carburettor heat ON and closing the throttle, leaving the engine running at idle power. The student would then select a suitable landing area, flying a circuit to line up for an approach to the selected area. The approach would be continued until it was obvious whether the landing would have been successful, whilst remaining high enough to ensure sufficient clearance remained from obstacles to apply power and climb away. It was not uncommon for the aircraft to descend as low as 40 ft agl before climbing away.

Medical information

Post-mortem reports recorded no medical issues with either the instructor or student which may have contributed to the accident. It was noted that the instructor was found occupying the left seat of the aircraft and had his left hand gripping the control column.

Three pairs of prescription glasses and one set of sunglasses were recovered from the accident site. Two of the pairs of glasses were in cases, the third pair had been damaged and was found within the cockpit area.

The instructor held a valid LAPL medical certificate at the time of the accident. He had suffered an ocular choroidal melanoma of his left eye, although this had been successfully treated and visual field tests in July 2017 had shown him to be within normal limits in each eye.

A medical examination for his LAPL certificate revalidation on 28 November 2017 found the instructor to have normal distance vision corrected with glasses in both eyes separately. A limitation on his medical certificate required him to wear corrective lenses when flying and to carry a spare pair.

A review of the instructor's medical record by the CAA aeromedical department could find nothing to suggest from his visual history and examination findings that his vision, and in particular his history of eye melanoma, was a cause or contributory factor to the accident.

The student did not have, or require, a flying medical certificate and was reportedly in good health. He only required glasses for reading.

Meteorology

A Met Office aftercast reported the UK was subject to a slack north-easterly airflow on the day of the accident with generally benign conditions over the country. In the area of the accident there was good visibility, in excess of 9 km, and small areas of scattered or broken cumulus and stratocumulus cloud with a base of 2,000-4,000 ft amsl. The wind was light and variable, ranging between approximately 010-080º and 5-10 kt.

Temperatures and dew points at the time of the accident recorded at three airports, all about thirty miles from Raglan, ranged from 19ºC/13ºC (Gloucester Airport), 17ºC/15ºC (Bristol Airport) and 19ºC/14ºC (Cardiff Airport). The freezing level was 10,000 ft amsl.

The Sun's elevation at 1000 hrs was approximately 52º and during the aircraft's final approach to the field, its position was approximately 90ºs to the right of the aircraft's track.

Carburettor icing

Based on the range of reported temperatures and dew points at the time of the accident, serious carburettor icing would have been possible on an engine at descent power.

To protect against carburettor icing, the Grob G109B is fitted with carburettor heaters and additional protection is achieved through the configuration of the engine which, when the carburettor heaters are off, takes air from the rear of the engine bay where it is warmer than ambient air. The aircraft manufacturer reported that during their flight tests and marketing flights only one event of carburettor icing was known. On this occasion the aircraft had been flying at a high-powered cruise at 4,500 ft in heavy rain.

British Gliding Association (BGA) guidance

Part 2 of Version 2 of the BGA Motor Glider Handbook, published in May 2018, contained information on flight procedures. This included the following sections:

> *'CARBURETTOR ICING*
>
> *Carburettor icing is a constant threat in the climate of Northern Europe. Therefore engine handling techniques including use of carburettor heat should be understood and used effectively.*
>
> *Use of carburettor heat before well before of* [sic] *starting descent, when engine airflow is high, can clear the carburettor venturi of any ice. Subsequent use of carburettor heat in descent is necessary but will be less effective. Setting power several hundred RPM above idle will help to keep the engine warm, and also better simulates the performance of modern gliders.*
>
> *Some MGs are not fitted with carburettor heaters, eg Fourniers, Rotax engine types. In this case, the intake air will be drawn from a warm area of the engine compartment. This does not make these engines immune from carburettor icing. It is still important to use enough power to keep the engine oil temperature above the manufacturers quoted minimum.*
>
> *The CAA publish a series of safely* [sic] *leaflets, one of which contains further useful information on avoiding engine icing.*
>
> *OPERATION AT MINIMUM HEIGHT*
>
> *MGs are frequently used to train glider pilots in the techniques of field landing and aerotow rope breaks. Although this training is invaluable, it should be remembered that it is still subject to the rules of the air. These rules do not prohibit flying below 500 feet AGL, but it is illegal to fly within a 500 foot 'bubble' containing persons, vessels and structures. Farm animals probably merit an even bigger separation distance.'*

This information was reinforced by the publication of a document entitled '*Conduct of Field Landing Training*' in July 2018 (Appendix 1).

BGA motor glider accident statistics

Prior to this accident, there had been 106 reports of motor glider accidents and incidents to the BGA since October 2007; two involving fatalities and four involving serious injuries. Of these, two had involved motor gliders carrying out field landing training where the aircraft had been unable to climb away. One was caused by the aircraft's inability to clear trees at the far end of the selected field after having descended to about 50 ft agl before commencing the go-around. This was due to the marked upslope of the field and the prevailing weather conditions. The other involved a Dimona TMG owed by the instructor, but being flown by a different instructor, which, having descended to about 100 ft agl, attempted to go around, but was forced to make a forced landing after the engine failed to respond. No cause for the lack of response could be established although carburettor icing was considered possible[5].

Analysis

Evidence from the accident site and examination of the wreckage identified that the aircraft's right wing contacted the dead tree at an approximate height of 57 ft agl. This will have caused the aircraft to yaw rapidly to the right, increasing the lift from the left wing. At the same time, there will have been a marked decrease in lift from the right wing due to the damage it experienced and this, together with the possible effects of entanglement in the tree, caused the aircraft to roll. It is likely that the aircraft rolled through approximately 180º before impacting the ground at a near vertical attitude.

Examination of the aircraft did not identify any anomalies that would have affected the aircraft's ability to be controlled, prior to the impact with the tree. Witnesses also describe the aircraft to be seemingly under control.

The data indicates nothing unusual during the initial part of the descent. The reduction in groundspeed to 48 kt (equivalent to an airspeed of approximately 53-58 kt) coincided with the turn onto the final approach, after which both airspeed and vertical speed fluctuate for the remainder of the flight. This might be explained by the student's lack of experience on the aircraft or his attempts to position the aircraft to make the field, had he been flying it at the time. It could also indicate a distraction within the cockpit whilst dealing with an aircraft issue.

Witness statements varied in the description of what was heard. The aircraft engine is normally quiet, especially at idle power, as was described by some witnesses. Other witnesses however described it as loud or that it was misfiring or spluttering. Examination of the engine did not reveal any problems. There was fuel onboard and the small traces of automotive gasoline present would not have affected the operation of the engine. The nature of the damage to the propeller and the distance the propeller tip was thrown from the main wreckage also indicate the engine was producing considerable power at the time of the accident.

The ambient conditions were conducive to severe carburettor icing for an engine at idle power, although the information provided by the manufacturer suggests that the Grob G109B is less susceptible to this occurring. Had carburettor heating been selected during the descent then carburettor icing would have been even less likely to occur.

There is evidence that carburettor heating was selected at the time of the impact. It may have been selected for the duration of the descent, although it should normally have been returned to the COLD position at the point engine power was increased to climb away, to ensure full power was available. It is possible that carburettor heating had not initially been

Footnote

[5] AAIB Accident Report Reference EW/G85/08/08.

selected, allowing ice to restrict the flow of air into the engine. Had the carburettor heat then been subsequently selected ON later during the exercise then it may be that the engine was only able to increase power just before the point of the impact with the tree.

BGA guidance recommends maintaining a small amount of power during the descent to both keep the engine warm and to simulate a normal glider's performance. It also recommends carrying out occasional power checks during the exercise and describes this as essential around the base leg to ensure the engine still responds. The descriptions provided by other instructors at the gliding club and the student who flew the field landing exercise on 2 June 2018 suggest that the instructor was likely to have flown the exercise with the engine at idle power.

Whilst it was reported that it was not unusual during a field landing exercise to fly as low as 40 ft agl before climbing away, the data from the flight flown on 2 June 2018 showed that the instructor climbed away from a height of 350 ft agl. The instructor and student should have been aware of the low flying regulations.

The Standardised European Rules of the Air rule 5005(f) states that:

> *'Except when necessary for take-off and landing, or except by permission from the competent authority, a VFR flight may not be flown:*
>
> > *(2) […] at a height less than 150m (500ft) above the ground or water, or 150m (500ft) above the highest obstacle within a radius of 150m (500ft) of the aircraft.'*

The relevant element of CAA ORS-4 No.1174 states that:

> *The Civil Aviation Authority permits, under SERA.3105, SERA.5005(f) and SERA.5015(b), an aircraft to fly below the heights specified in SERA.5005(f) and SERA.5015(b) if it is flying in accordance with normal aviation practice and:*
>
> *(b) practising approaches to forced landings other than at an aerodrome if it is not flown closer than 150 metres (500 feet) to any person, vessel, vehicle or structure.*

It is clear from witness statements and the flight data that the aircraft was below 500 ft agl during its final approach when it passed over, or near, two houses and their occupants. It is possible that this was intentional, or that there was an issue with the aircraft meaning they were unable to avoid the descent below 500 ft.

With the evidence available, it cannot be conclusively determined whether the instructor intentionally allowed the aircraft to descend as low as it did as part of the exercise, or whether this had happened because of an unknown engine issue; most likely carburettor icing. With either scenario the aircraft was able to make a landing in the field, yet the aircraft's right wing collided with the dead tree, despite there being an adequate gap to the left for the aircraft to pass between the trees on the perimeter of the field. The dead tree was considerably less conspicuous than the live trees on either side, whose presence may also have drawn the pilots' attention away from the dead tree. The description of the aircraft banking away from the dead tree at the last moment indicates that one or both pilots saw it just before the collision. The collision was therefore probably due to the instructor and student not seeing the dead tree until it was too late, misjudging their distance from it or the engine failing to respond at the last moment when they expected to climb away and avoid impact.

Conclusion

It has not been possible to determine conclusively whether the aircraft was suffering from an engine problem, most likely carburettor icing, during the field landing exercise. The engine was however under power at the point it collided with the tree.

Irrespective of the presence of an engine problem, had the aircraft not collided with the tree it should have been able to carry out a landing in the field. It was considered that the collision was most likely due to the tree not being seen by the pilots until it was too late to avoid it.

Safety action

The BGA publication on 11 July 2018 in response to this and previous field landing accidents emphasises well the main hazards and precautions required in conducting field landing training.

Appendix 1: Conduct of Field Landing Training - BGA 11 July 2018

CONDUCT OF FIELD LANDING TRAINING

Introduction

Recent discussions and events have highlighted a need for more guidance on the way that field landing training is carried out in motor gliders (MGs). This is in addition to the advice given in the BGA Motor Glider Handbook (MGH), which will be amended in due course. While realism is desirable in any training context, the overriding consideration should always be the safety and legality of the flight. This paper will discuss how to achieve the balance between these sometime conflicting requirements.

Legality

The Rules of the Air State that aircraft should not fly closer than 500' to any person, structure, vehicle, or vessel, unless landing or taking off normally. It does not say the aircraft should stay above 500' at all times. Field landing training, and indeed simulated engine failure after take-off, does not qualify as normal aircraft operation and is therefore subject to the rule. It is worth noting that if an aircraft goes below 500' in an apparently remote area, and a person out of sight behind a hedge is approached within 500', the aircraft captain is liable to prosecution. If animals are present in the area, they may be frightened by the sudden appearance of a MG even if it is above 500'. This in turn may give a landowner reason to start legal action.

Engine Handling

Most MGs do not have the safety of twin magnetos or electronic ignition. All suffer to some degree from carburettor icing, whether or not they are fitted with a carburettor heater. Before even starting a descent, instructors should ensure that the carburettor is clear of ice by early use of the carburettor heater, and that the oil temperature is well above the minimum specified by the manufacturer. The carburettor heater should be used throughout the descent, and oil temperature monitored. A small amount of power should be continually used to keep the engine warm and to simulate the performance of the glider. An occasional application of full power will ensure a response is available. This response check is essential around the base leg. If the engine does not behave normally at this point, the exercise should be terminated and the instructor should land in the chosen field. The go around must be planned in such a way that an engine failure on climb out also results in a successful field landing.

Threat and Error Management

Field landing in gliders always carries a higher risk than landing on an airfield. Training for field landing in MGs carries a similar, but often higher risk factor as there are more things to consider for an instructor, and more opportunities to make mistakes. Risk increases exponentially as height is lost, particularly if the exercise is continued below 500'. A normal glider circuit descends through 500' somewhere between low key and base leg. As soon as the base leg is commenced, it should be obvious to both instructor and student whether the approach will be successful, so there is very little reason to continue lower, into the high-risk area. EVEN WHERE LEGAL, LOW APPROACHES CARRY TOO HIGH A RISK TO BE JUSTIFIED ON TRAINING GROUNDS. If a student cannot successfully fly the approach, the airfield is the right environment for remedial action. With more experienced pilots practicing field approaches, the exercise can usually be abandoned at low key, or earlier as the selection is likely to be the major learning point for them.

The Future

Much of our field landing training is carried out by MGIR instructors, who, provided they maintain their gliding Full Rating and licence privileges (inc any refresher training/checks), are not additionally checked as instructors in MGs. This system was adopted a number of years ago in the expectation that Part-FCL would be in place by now. As Part-FCL adoption is still nearly 2 years away, it is probable that the BGA will reintroduce a checking system for MGIR instructors sooner. In the short term, examiners using a MG for 5 yearly refreshers of MGIR qualified instructors, or FI SLMG/TMG revalidation, should require the candidate

> to teach field landing as a primary or secondary exercise. Further ahead, the MGH will be rewritten to encompass the best advice possible for MG instructors.
>
> Conclusion
>
> The MG accident rate has been too high for several years. Many of these accidents involve propeller strikes, all of which are unnecessary, but are not life threatening. Recently however, there has been an increase in serious accidents, none of which have been shown to have technical causes, but all potentially include issues of threat and error management, particularly at low altitude. A more considered approach to field landing training is essential if the gliding is to retain the independence to train and assess our pilots safely, and without overly restrictive regulation.
>
> 11 July 2018

Published 20 June 2019.

Bulletin Correction

The information in the paragraph on page 32, detailing the Standardised European Rules of the Air rule 5005(f) provided by the CAA, has been revised and a paragraph has been inserted following the original boxed quote. The section now reads:

The Standardised European Rules of the Air rule 5005(f) states that:

> *'Except when necessary for take-off and landing, or except by permission from the competent authority, a VFR flight may not be flown:*
>
> *(2) […] at a height less than 150m (500ft) above the ground or water, or 150m (500ft) above the highest obstacle within a radius of 150m (500ft) of the aircraft.'*

The relevant element of CAA ORS-4 No.1174 states that:

> *The Civil Aviation Authority permits, under SERA.3105, SERA.5005(f) and SERA.5015(b), an aircraft to fly below the heights specified in SERA.5005(f) and SERA.5015(b) if it is flying in accordance with normal aviation practice and:*
>
> *(b) practising approaches to forced landings other than at an aerodrome if it is not flown closer than 150 metres (500 feet) to any person, vessel, vehicle or structure.*

The online version of the report was amended on 13 February 2020 and a correction will also appear in the March 2020 Bulletin.

AAIB Correspondence Reports

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

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

The accuracy of the information provided cannot be assured.

SERIOUS INCIDENT

Aircraft Type and Registration:	Airbus Helicopters EC175B, G-EMEA
No & Type of Engines:	2 Pratt & Whitney Canada PT6C-67E turboshaft engines
Year of Manufacture:	2016 (Serial no: 5024)
Date & Time (UTC):	10 July 2018 at 1040 hrs
Location:	Aberdeen Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 2 Passengers - 16
Injuries:	Crew - None Passengers - None
Nature of Damage:	Nose landing gear collapsed and minor damage to forward fuselage
Commander's Licence:	Airline Transport Pilot's Licence (Helicopters)
Commander's Age:	54 years
Commander's Flying Experience:	276 hours on type Last 90 days -119 hours Last 28 days - 33 hours
Information Source:	Air Accident Report Form sent to the pilot, Incident investigation report carried out by the operator and subsequent enquiries

Synopsis

The helicopter was returning to Aberdeen after a routine passenger flight. During a normal approach to land the landing gear appeared to deploy normally but at touchdown the nose landing gear collapsed due to the failure of the A-frame pintle pin. Owing to a low fuel state the passengers were disembarked whilst the helicopter was in a low hover. The aircraft was then landed safely, using sandbags to support the fuselage.

During the subsequent investigation, the operator identified that a bush, which should have supported the pintle pin, had not been fitted into the A-frame when it was installed 50 flying hours before the incident flight (Figure 1). The investigation identified several human factors issues which contributed to the accident, including shift staffing levels, lack of experience and fatigue. The helicopter manufacturer subsequently published Service Information Notice 3259-S-32 notifying operators of this failure mode and an Alert Service Bulletin (ASB) 32A003, requiring an inspection to ensure the correct installation of the pintle pin bushing. The ASB was subsequently mandated by EASA Airworthiness Directive 2018-0190.

History of the flight

The helicopter had returned to Aberdeen and completed a normal approach to land. When the landing gear was selected DOWN, all the indications were normal but during the landing the flight crew heard a "crunching noise" and the helicopter appeared to settle in a more nose-down attitude than normal. The flight crew brought the aircraft back into the hover and requested assistance from their engineering organisation.

An inspection, conducted while the helicopter was hovering, confirmed that the nose landing gear actuator had separated from the A-frame and both were hanging from the landing gear bay. Due to a low fuel state, passengers were disembarked with the helicopter in a low hover. It was then hover taxied to another stand where it landed on sandbags, placed by ground engineers, to support the forward fuselage.

Investigation

A subsequent examination, carried out by the operators engineering organisation, identified that the separation of the A-frame from the actuator had been caused by failure of the pintle pin which secured the A-frame to the landing gear actuator (Figure 1). The head of the failed A-frame lower pintle pin was identified during an inspection of the landing site. The pintle pin bushing was found to be missing from the installation.

Approximately 50 hours prior to the incident flight, on 7 June 2018, the A-frame (Figure 1) had been replaced during a routine maintenance input following reports of "notchy" steering.

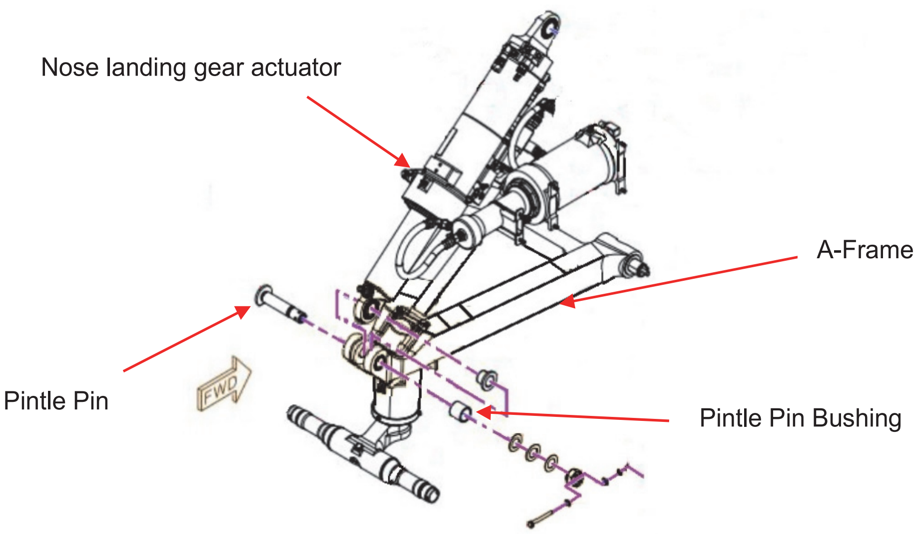

Figure 1

EC175 Nose landing gear actuator and A-frame

The operator's investigation identified that the Aircraft Maintenance Manual (AMM) procedure, detailed on a number of work cards, for the replacement of the A-frame had not been completed correctly. This details that on removal the pintle pin bushing has to be removed from the A-frame being replaced and installed in the replacement A-frame.

This transfer had not been carried out, so the A-frame fitted to G-EMEA did not have a pintle pin bushing fitted. The design of the nose landing gear is such that, when the nose landing gear actuator is attached to the A-frame confirmation of the presence of the pintle pin bushing is problematic. An independent inspection, carried out on completion of the task, did not identify that the bushing had not been installed. The lack of bushing caused wear and eventual failure of the pintle pin.

Information, obtained by the operator after this event, showed that, prior to this incident at least two other operators had experienced similar events. Following these events, the helicopter manufacturer issued an update to the AMM work cards relating to the A-frame replacement on 15 June 2018. The revisions made the wording relating to the re-installation more explicit and provided an additional diagram to highlight the correct installation of the bushing. The updated work cards were received by the operator on 18 June; 11 days after the replacement of the A-frame.

The investigation also identified that the engineer tasked with the replacement of the A-frame was also responsible for supervising a team of non-type rated engineers and had not completed the task before. In addition, the engineer had only taken two rest days over the preceding 31-day period. This had not been identified by the shift managers and contravened the company's fatigue management procedures. It is possible that these factors contributed to the failure of the engineer to transfer the bushing.

Safety action

Following this incident to G-EMEA, the operator revised its procedures regarding work time monitoring and reminded staff of their responsibilities to follow company fatigue management procedures. The operator introduced a 'complex task' job card for the H175 nose landing gear leg replacement task. Additionally, the operator reviewed the engineering manpower, supervision and experience levels needed for base maintenance inputs.

On 13 July 2018, the helicopter manufacturer published Safety Information Notice (SIN) No 3259-S-32 which notified other operators of this, and previous, nose landing gear pintle pin failures. The SIN highlighted the need to remove and reinstall the pintle pin bushing during A-frame replacement.

As a result of another operator identifying an incorrectly fitted pintle pin bushing, the helicopter manufacturer published Emergency Alert Service Bulletin (ASB) 32A003 in August 2018. This required a one-off inspection of the EC175 nose landing gear pintle pin bushing. In addition, operators were required to review helicopter maintenance records to identify any occasions where bushings had been misinstalled or found not fitted. ASB 32A003 was subsequently mandated by the EASA with the publication of Airworthiness Directive 2018-0190 on 31 August 2018.

SERIOUS INCIDENT

Aircraft Type and Registration:	DHC-8-402, G-JEDU
No & Type of Engines:	2 Pratt & Whitney Canada PW150A turboprop engines
Year of Manufacture:	2004 (Serial no: 4089)
Date & Time (UTC):	16 July 2018 at 0700 hrs
Location:	During takeoff from Düsseldorf Airport, Germany
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 4 Passengers - 77
Injuries:	Crew - None Passengers - None
Nature of Damage:	None reported
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	42 years
Commander's Flying Experience:	7,953 hours (of which 592 were on type) Last 90 days - 218 hours Last 28 days - 67 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

The co-pilot inadvertently raised the flaps instead of the landing gear after takeoff from Düsseldorf Airport. The commander was not immediately aware of this because the sun was in his eyes and the aircraft handling appeared normal. The operator has not taken any additional safety action following this occurrence.

History of the flight

During the initial climb from Runway 05R at Düsseldorf Airport the commander called for the landing gear to be raised and the co-pilot inadvertently raised the flaps instead. The commander reported that he did not notice the flaps being selected because the sun was shining into the cockpit, making the primary flight display difficult to see. Furthermore, particularly because he had used "normal takeoff power"' for departure, rather than a reduced[1] power setting, the performance of the aircraft masked the effects of the flap retraction.

Footnote

[1] Takeoff can be performed using a reduced power setting for reasons such as fuel economy, reduced departure noise and increased engine life.

The commander stated that he may have heard the co-pilot mention "flaps" at the time but because this occurred immediately after another standard operational call relating to flight guidance mode selection, he thought he had misheard. The takeoff sequence was otherwise completed normally.

Commander's comment

The commander indicated that he was not immediately aware of the early flap retraction. He characterised this as a "skill based error" and noted that it could lead the aircraft to stall.

Information from operator

Standard operating procedures (SOPs)

The SOPs for landing gear retraction during takeoff were described in Table 9.2 of the Operations Manual, the relevant excerpt of which is as follows:

Event	***PF***	***PM***
Positive rate of climb		*Observes positive rate on altimeter and VSI* ***"Positive Climb"***
	Confirms positive rate of climb: ***"Gear up"***	*Selects gear up:* ***"Gear up – Lights Out"***

The SOPs for flap retraction were contained in Table 9.3 *'Initial Climb procedure'*, the relevant excerpt of which is as follows:

Event	***PF***	***PM***
Acceleration altitude		***"Acceleration Altitude"***
	Checks speed > V_{FRI} ***"Flap zero"*** ***"Autopilot engage"*** ***"Bleeds On/MIN"*** *or* ***Bleeds On/Norm"*** ***"Set Climb Power 900"***	*Confirms speed > V_{FRI}* *Selects Flap Zero.* ***"Flap Zero selected"*** *Engages AP, "Autopilot engaged" Selects Bleeds selected/confirmed On/MIN or On/Norm* ***"Bleeds White"*** *or* ***"Bleeds Amber"*** *(on ED)* *Sets Cond Levers to 900 rpm,* ***"Climb Power Set"*** *When flaps are zero calls* ***"Flaps Zero"***

Operator's comment

The operator commented that it categorised this type of event as low risk on the DHC-8-402. It stated that it had experienced a number of these events previously and determined that distraction was often a factor. However, it believed that the frequency of such events was now at a tolerable level. The operator indicated that it was reluctant to address the matter further because it believed that highlighting inadvertent flap selection to crew could lead to other similar events.

Other occurrences

NTSB accident report involving N135PT

The NTSB reported on an accident involving a Learjet 35A in 2003[2]. The report concluded that the co-pilot's inadvertent retraction of the flaps during low altitude manoeuvring caused the aircraft to stall and impact a residential home. The two occupants of the aircraft were fatally injured.

The report stated:

> *'After aborting the first attempt to land, under visual flight rules, the flightcrew performed a circling maneuver to attempt a second landing. According to the Gates Learjet Flight Training Manual, Circling Approaches section,*
>
> > *"…Many accidents have occurred while circling... It is extremely easy to become distracted in the abnormal or unusual traffic pattern situation."'*

AAIB serious incident report involving G-CFAF

The AAIB reported on a serious incident in which an inadvertent flap retraction in an Avro 146-RJ100 occurred after takeoff from Birmingham Airport in 2006[3]. The report stated that occurrences of mis-selection on the flight deck were a recurring problem, which may have been under-reported by operators. The under-reporting was suggested to be most likely because mis-selections tend to be quickly recognised and rectified before they lead to a more serious reportable incident. Therefore, the AAIB made the following Safety Recommendation:

> **Safety Recommendation 2006-002**
>
> It is recommended that the Civil Aviation Authority encourage operators to monitor possible mis-selections of gear and flap levers through established flight data monitoring programs in an attempt to identify the scale and severity of the problem.

Footnote

2 NTSB report N135PT (accident number NYC03FA173) [accessed 12 Feb 2019].
3 AAIB bulletin 4/2006, report G-CFAF [accessed 12 Feb 2019]

On 10 May 2006 the CAA published Follow-up Action on Occurrence Report (FACTOR) F15/2006 stating:

> *'The CAA accepts this recommendation. The CAA, through the UK FDM Operator's Group will alert them to the circumstances of this incident and encourage them to monitor possible mis-selections of gear and flap levers through their established FDM programmes. In addition, the CAA will ask the group for data concerning such mis-selections in an attempt to identify the scale and severity of the problem. The next meeting is scheduled for 6 June 2006.'*

Occurrences reported by another operator

A different operator to the one involved in this serious incident reported a number of inadvertent flap retractions after takeoff on a different aircraft type between February 2016 and June 2018[4]. That operator expressed concern about the risks associated with the aircraft being in a low energy state near to the ground, including the possibility that crew members could become confused leading to a loss of situational awareness. That operator stated initially that it wasn't clear how much performance margin would remain in the event of a loss of thrust in one engine, or a requirement to increase the climb angle to avoid an obstacle. Therefore, it carried out a safety study on flap mis-selection after takeoff, with assistance from the manufacturer.

The manufacturer concluded that:

> *'…the takeoff performance calculations used by the operator, when properly computed and applied, combined with the protections above, would allow the aircraft to climb safely should there be a repeat of this type of event even when combined with other adverse factors, such as obstacle or terrain avoidance.'*

The operator took the following safety actions:

1. Provided training and guidance to support crews in handling the aircraft in a low energy state at low altitude in simulator checks.
2. Incorporated 'active monitoring', focussing on switch selections and lever movements, into recurrent checks.
3. Amended its SOPs for flap and landing gear selection to establish a pause prior to selection of the lever.
4. Addressed the issue of distraction through active monitoring training, and enhanced briefing techniques focussing on 'how' the aircraft will be operated.
5. Raised awareness amongst pilots through two articles in its flight safety bulletin.

Footnote

4 AAIB bulletins: 8/2016, reports G-EZFA and G-EZTZ; 9/2017, report G-EZEW (and G-EZWM); 1/2019, report G-EZOZ [accessed 12 Feb 2019].

The resulting SOPs for landing gear and flaps selection (item 3 above) became a two-stage process *'so that the* [pilot monitoring (*PM*)] *cognitively confirms the proper lever has been selected'* and *'allows* [pilot flying (*PF*)] *to intervene if he or she notices an incorrect selection is about to be made'.*

An excerpt of the modified SOPs for flaps selection stated:

> *'To reduce inadvertent FLAPS selection, the PM places their hand on the FLAPS lever calls "FLAPS"… PM selects the commanded position and calls the Flaps position by checking the blue number on the ECAM Flaps indicator to confirm the correct selection has been made.'*

The SOPs for landing gear selection were similar.

In two of the events involving that operator, the pilots suggested that they may have been somehow primed to make the "action slip" – in one case because the commander had been thinking about an earlier mis-selection event by another crew while waiting for the instruction to raise the flaps, and in the other because the pilot monitoring (PM) had just finished training which focussed on avoiding this type of mis-selection shortly before the incident flight.

Although it was not possible to determine the reason for the inadvertent selections, the operator reviewed the safety action it had taken following the previous events and concluded that the training provided to manage the aircraft in a low energy state at low altitude had been effective in that incident. The commander in that case reflected that she would employ a longer pause in future to double check the correct lever selection and allow the PM to intervene should they see the wrong lever had been selected.

Conclusion

The Pilot Monitoring retracted the flaps instead of the landing gear after takeoff. This may have occurred because both actions are expected during this phase of flight. Takeoff into the sun may have caused the Pilot Flying some difficulty in noticing the slip.

The operator had previously found distraction to be a factor in such occurrences and believed that they were occurring less frequently than in the past. However, its standard operating procedures for flap and landing gear retraction involved the one stage selection and movement of a lever by the Pilot Monitoring in response to a call by the Pilot Flying.

Retraction of the flap instead of the landing gear is a human error and is not unique to this operator, aircraft type or stage of flight. Previous occurrences have resulted in action by operators to amend relevant procedures, and the UK CAA accepted the earlier AAIB Safety Recommendation 2006-002 to encourage operators to monitor landing gear and flap mis-selections.

ACCIDENT

Aircraft Type and Registration:	DHC-8-402 Dash 8, G-JECN
No & Type of Engines:	2 Pratt & Whitney Canada PW150A turboprop engines
Year of Manufacture:	2005 (Serial no: 4120)
Date & Time (UTC):	2 March 2019 at 1505 hrs
Location:	Southampton Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 4 Passengers - 59
Injuries:	Crew - None Passengers - None
Nature of Damage:	Impact marks to the fuselage behind the radome and nose landing gear door. No 2 propeller blades tip strikes
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	12,216 hours (of which 5,601 were on type) Last 90 days - 166 hours Last 28 days - 70 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and enquiries made by the AAIB

Synopsis

The aircraft had landed at Southampton and was being taxied to its allocated stand. The No 1 engine had been shut down in accordance with the operator's SOPs. As it approached the stand, at walking pace, the commander applied the brakes, which had no effect and the aircraft hit signage and the rotating No 2 (right) propeller struck a nearby ground power unit (GPU). The accident was caused by the aircraft standby (hydraulic) power unit (SPU) not being selected to ON. This selection was normally made during the approach checks. However, on this occasion, the approach checks were not completed prior to landing. This meant that the aircraft mainwheel brakes did not work with the No 1 engine shut down. During the collision the aircraft sustained damage to the nose fuselage behind the radome, a nose landing gear door and right propeller tips. There were no injuries to the passengers or crew.

History of the flight

The aircraft had arrived at Southampton Airport after completing the fourth and final sector of the day. After touchdown, and as the aircraft slowed to 60 kt, control was handed to the commander. The aircraft continued to slow down to 15 kt before exiting the runway. The aircraft was brought to a stop and the crew completed a routine over-speed governor (OSG) check. Once this was completed the No 1 engine was shut down and the aircraft was taxied the short distance to Stand 8 for a "nose-in" park. As the aircraft approached the stand at a "walking pace", the commander applied gentle braking, but this did not appear to slow the aircraft and he realised the brakes were not functioning. He increased his force on the brake pedals, but this had no effect and the aircraft continued moving towards the stand signage.

The commander had his hand on the No 2 engine power lever, next to the emergency brake lever, and instinctively applied full reverse thrust. This helped to slow the aircraft but was insufficient to prevent impact with signage damaging the left side of the forward fuselage and right nose landing gear door. At the same time the No 2 propeller tips hit the glass reinforced plastic cover of a GPU parked marginally outside its bay. At this point the co-pilot realised that the STBY HYD PRESS and PTU CNTRL were OFF and immediately switched them ON. The aircraft then rolled back slightly and stopped. The crew shut down the No 2 engine and the commander requested assistance from ATC. He also made a 'resume normal operations' broadcast over the public address system to the cabin crew. The airport fire service attended the aircraft and after an assessment of the situation and consultation with the fire officer, the passengers were allowed to disembark the aircraft. There were no injuries to the passengers or crew; but the aircraft had sustained damage to its left side fuselage and a panel just behind the radome. The right nose landing gear door detached and the propeller tips struck an GPU. The GPU cover was also damaged.

Systems description

The Bombardier Q400 aircraft is powered by two Pratt and Whitney 150A turboprop engines driving six-blade variable pitch-propellers. The propeller blades are of composite construction and are 4.1 m in diameter. The aircraft has two 3,000 psi hydraulic systems powered separately by a pump driven by each engine. The No 1 hydraulic system, in normal operation, powers the flying controls, flaps, inboard roll spoilers and wheel brakes. The No 2 hydraulic system also powers the flying controls, in addition, it powers the outboard roll spoilers, nosewheel steering, emergency parking brakes and landing gear.

The No 1 hydraulic system includes a SPU which pressurises the system when the No 1 (left) engine is not running. In between the two systems there is a PTU which consists of a hydraulic motor driven by the No 1 hydraulic system which drives a pump to deliver pressure into the No 2 hydraulic system.

Events leading to the accident

The aircraft was on the last of four revenue sectors from Jersey to Southampton. The flight had been routine and uneventful. It was configured by the crew for a Flap 35 landing and was stable at the 1,000 ft approach gate and at the 500 ft landing gate. However, although they had flown a normal approach pattern, neither pilot realised that the approach checklist had not been completed prior to configuring the aircraft for landing. The approach checklist should have been carried out between the altimeter checks and landing checks. Amongst other things, it requires the hydraulic and fuel pumps to be selection ON and then to confirm the SPU and PTU advisory lights are ON. It also requires a check of the cockpit display to ensure that standby hydraulic pressure is reading 2,800 – 3,000 psi. Because none of these actions were carried out, the backup for the No 1 hydraulic system or the PTU[1] for the No 2 hydraulic system were not available.

In accordance with the operator's SOP, the after-landing checks required the No 1 engine to be shut down and the aircraft taxied to the stand on the No 2 engine. However, the commander had realised, just as the No 1 engine was about to be shut down, that an OSG check was required as it was the last flight of the week[2]. As a result, the after-landing procedure was interrupted. This check would have led the crew to again check that the STBY HYD PRESS and PTU CNTRL advisory lights were ON and that the MFD was indicating a standby hydraulic pressure of 2,800 - 3,000 psi. However, because of the interruption, this was also overlooked. The No 1 engine was shut down after the OSG check and they continued to taxi the aircraft to the stand.

During the short taxi, prior to the OSG check with both engines running, the mainwheel brakes worked normally. However, after the No 1 engine shutdown with the standby system inoperative, hydraulic pressure was no longer being supplied to the No 1 hydraulic system services or the brakes.

Nevertheless, with the No 2 engine running, the emergency parking brake remained available throughout.

Analysis

There were a series of minor factors which coincided to cause this accident. The landing was the last of a day which had consisted of repeated and routine sectors. The absence of the approach checks meant that the aircraft was not configured correctly in preparation for the operator's SOP in which, after landing, the No 1 engine is shut down and the aircraft taxied to the stand on the No 2 engine. That did not predestine the aircraft to remain in this incorrect configuration. There was a further intervention during the after landing checks with the check of the STBY HYD PRESS and PTU CNTRL advisory light. However, this check was also overlooked when the crew were distracted by remembering that the aircraft required an OSG check after the last flight of the week which then interrupted the after landing checks. After this, there were no other prompts during the remainder of the taxi by which to indentify the situation. When the accident sequence was underway, and the crew realised what was happening, the co-pilot remembered the STBY HYD PRESS and PTU CNTRL were OFF and tried to switch them on, by which time it was too late.

Most of the damage to the aircraft was in the vicinity of the radome. It is not clear whether the propeller would have struck the GPU had it been fully positioned in its dedicated area.

Footnote

1 In this case the PTU not being selected ON did not influence the outcome of this accident. However, it not being selected, along with the fuel pumps during the approach checks, could have caused difficulties had there been an issue with the No 2 engine which required a shutdown and go around. The crew would not have been able to retract the landing gear which would have affected their single engine climb out performance.

2 The Operator's policy is to conduct an OSG check after the last flight on a Saturday of each week.

Commander's opinion

In the opinion of the commander, the cause of the accident was the loss of the main wheel brakes due to not having STBY HYD PRESS selected. When the No 1 engine was eventually shut down, hydraulic power was lost, rendering the brakes inoperative.

The commander identified the following contributory factors which, in his opinion, led to the event.

- Failure to adhere to SOPs. The approach checks were not carried out, possibly due to distraction, and the after-landing checks were interrupted by the OSG test.
- False confirmation. Until the OSG check, the brakes worked as both engines were still running.
- Sequence interruption. The short taxi to stand barely gave time for the after-landing sequence and it was not completed correctly.
- Complacency. This was a return to home base after four sectors. The previous three arrivals and taxi-in phases had all been normal.
- 'Startle factor'. Combined with having his right hand on the No 2 power lever, a 'startle factor' produced an instinctive response in the commander to apply reverse thrust rather than apply the emergency brake.

Operator's opinion and safety actions

The Operator considers several safety barriers failed in the lead up and during the accident. The approach checks and after landing checklist should have captured the incorrect aircraft configuration. The use of the emergency brakes may have prevented the outcome.

Because of this event, the Operator has carried out a safety study looking into previous occurrences. This has produced several additional observations to be considered, regarding the approach checklist design and the single engine taxi risk assessment.

In addition, a Notice to Air Crew (NOTAC) has been raised implementing a No 1 hydraulic system check during taxi.

SERIOUS INCIDENT

Aircraft Type and Registration:	DHC-8-402 Dash 8, G-PRPC
No & Type of Engines:	2 Pratt & Whitney Canada PW150A turboprop engines
Year of Manufacture:	2010 (Serial no: 4338)
Date & Time (UTC):	21 September 2018 at 1735 hrs
Location:	Edinburgh Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 4 Passengers - 70
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	38 years
Commander's Flying Experience:	6,302 hours (of which 6,143 were on type) Last 90 days - 161 hours Last 28 days - 26 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

Shortly after levelling at cruise altitude an audio warning sounded and the CABIN PRESSURE warning illuminated. The crew followed the QRH checklist and initiated an emergency descent, and a MAYDAY was declared. On reviewing their actions, the crew saw that the air conditioning system was off. After levelling at FL100, and after consultation with the operator, the crew decided to continue the flight to Edinburgh.

History of the flight

During the previous sector the crew had difficulty in controlling the flight deck and cabin temperature, causing passenger and crew discomfort. During a busy turnaround, the commander therefore undertook a reset of the air conditioning packs using the Q400 '*Supplemental Procedure Ground Reset Guide*'. The crew completed their procedures and departed from Belfast City Airport at 1805 hrs.

The departure was routine and the aircraft climbed to its planned cruise level of FL170. Shortly after reaching cruise level, at 1825 hrs the flight deck triple chime audio warning sounded and the CABIN PRESSURE warning illuminated. The flight crew immediately checked the cabin altitude and, when they confirmed that it was above 10,000 ft, they actioned the '*Rapid Depressurisation and Emergency Descent*' checklist from the QRH. A MAYDAY was declared.

During the descent the crew reviewed their actions and noticed that both air conditioning pack switches were selected to OFF. They selected both packs on and the aircraft began to pressurise. The aircraft levelled at FL100 just to the south of Glasgow. The cabin crew were informed of the situation but they told the flight crew that the passengers were unaware of the event (the Q400 has no passenger oxygen masks to drop down in front of passengers).

Via the handling agent in Edinburgh, the crew asked their operations department if they should continue to Edinburgh or return to Belfast. The company wanted them to continue to Edinburgh, and the flight arrived there at 1855 hrs.

Human factors

During the short turnaround the crew had to deal with a number of extraneous factors. The aircraft catering had run out of drinking water for the crew and there was difficulty in acquiring a resupply which caused the commander to leave the flight deck for a period. The destination for the sector had been changed and the new flight plans were not available, so the co-pilot left the aircraft to collect those from the terminal building. Due to the issues with temperature control the commander decided to reset the air conditioning system. During this he was interrupted by other flight deck activities and did not complete the procedure.

Organisational information

An earlier defect with the automatic control of cabin temperature had been deferred in accordance with the Q400 '*Minimum Equipment List*'. This information had been recorded in the company electronic maintenance system but was not reflected in the paper Technical Log carried aboard the aircraft. Therefore, the crew were not aware of the issue and had operated the air conditioning system in an inappropriate mode on the first sector, which had resulted in the inability to control temperature.

In reference to the fact that the deferred defect was not reflected in the aircraft Technical Log, the operator published the following text in a newsletter:

> *'…it's really important that all cabin defects are recorded as and when they are noticed. It's not enough to pass things on to the line engineers verbally – a formal record is the only reliable method of ensuring that the issue will be dealt with.'*

Analysis

During the turnaround preceding the incident sector the crew workload was influenced by numerous factors including a change in planned destination and issues with catering. These factors led to both flight crew members being absent from the flight deck for periods of time during the turnaround. As a consequence, their ability to work effectively as a team and trap each other's errors was significantly diminished.

The temperature control problem which the crew encountered in the preceding sector caused issues with both crew and passenger comfort. Due to the discrepancy in the maintenance system, however, the crew were unaware of the relevant technical issue. In an effort to resolve the problem during the turnaround, the commander undertook the reset procedure from the Q400 '*Supplemental Procedure Ground Reset Guide'*, but the conduct of the procedure added to the already elevated workload of the crew, and the commander was interrupted and it was not completed correctly.

When both pilots returned to the flight deck they were keen to try and make an on-time departure despite the issues that had affected the turnaround. Their workload was now significantly above the norm and while they believed they had completed all the relevant checklist actions correctly, it became apparent later that both air conditioning systems had been left selected OFF. The aircraft did not, therefore, pressurise and the Cabin Altitude warning sounded shortly after reaching the cruise flight level.

Conclusion

The aircraft departed Belfast with both air conditioning systems off and therefore did not pressurise. The fact that the systems were off was not detected during routine checks before departure. The effectiveness of the crew's actions was reduced by the high workload resulting from operational factors and by their attempts to deal with the symptoms of a technical issue with the aircraft, which had not been communicated to them.

ACCIDENT

Aircraft Type and Registration:	Cirrus SR20, G-GCDA
No & Type of Engines:	1 Teledyne Continental IO-360-ES piston engine
Year of Manufacture:	2008 (Serial no: 1962)
Date & Time (UTC):	19 October 2018 at 1300 hrs
Location:	Turweston Aerodrome, Buckinghamshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Fire damage to 'bolster' switch panel circuit board and insulation
Commander's Licence:	Private Pilot's Licence
Commander's Age:	49 years
Commander's Flying Experience:	492 hours (of which 248 were on type) Last 90 days - 10 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and enquiries made by the AAIB

Synopsis

The aircraft owner was collecting his aircraft after its annual inspection. The pre-flight checks and takeoff roll were normal. However, just as the aircraft lifted off, the pilot became aware of smoke in the cockpit. He landed immediately and despite shutting down all the electrical equipment, the smoke persisted. With the assistance of an engineer, the source of the smoke and a small fire was identified and extinguished. It was caused by a 'circuit track' in a switch panel, which had been electrically overloaded because of an unidentified problem with a diode in the standby battery wiring harness. The aircraft manufacturer has taken several safety actions to ensure the significance of the diode is understood and have included an additional circuit protection device. The aircraft manuals and circuit diagrams have also been amended to clarify the circuit maintenance information.

History of the flight

The pilot was collecting his aircraft from Turweston aerodrome after its annual inspection. The pre-flight checks, engine-start and power checks were normal. The pilot then lined the aircraft up on the runway and started the takeoff roll. As the aircraft lifted off, smoke emanated from a switch panel in front of the pilot, near the primary instrument display. He called Turweston air/ground radio and reported smoke in the cockpit and advised of his intention to perform a brief circuit to land. There was no other traffic to conflict and the pilot flew a low circuit and landed. On landing he switched all the electrical equipment off and opened the cabin door to clear the smoke. The smell of the smoke led him to believe that it may have been an electrical fire. He taxied the aircraft to the maintenance hangar and shut down. He noticed that despite all the electrical switches being turned off, the avionics still appeared to be powered. He then asked one of the engineers nearby for assistance. There was still a significant amount of smoke in the cockpit being generated from the switch panel. With assistance from the engineer, the engine cowling was removed and the main battery disconnected. Despite this, smoke continued to emanate from the switch panel which was then hurriedly removed. Material around the back of the switch panel had caught alight but was quickly extinguished.

Engineering investigation

Examination of the aircraft and switch panel, known as the 'bolster panel', found the fire had been caused in the circuit board behind the row of system master switches. One of the copper circuit tracks leading from the BAT 2 master switch had completely melted away and the heat generated had also damaged circuit board mounted components and tracks nearby. A small fire appeared to have taken hold in a fibrous insulation material below the circuit board.

System description

The Cirrus SR20 is fitted with two batteries to support the avionics system in normal and emergency situations. Cirrus aircraft are fitted with a ballistic parachute recovery system (BRS) known under the manufacturer's title as the Cirrus Airframe Parachute System (CAPS). The CAPS in this aircraft had been modified and is now electrically initiated, rather than the previous system in which a manual cable led from the cockpit to a percussion initiation device at the rocket. In the subject aircraft a diode was introduced as an integral part of the battery relay with the CAPS modification. This was fitted to suppress any possibility of a voltage spike on relay switch-over. When the relay manufacturer stopped including the diode within the relay, an external diode was introduced. It consists of a heat-shrink insulated diode with two spade connectors which connect it across the relay terminals. During the modification programme the aircraft circuit diagrams were updated by the manufacturer accordingly.

Discussion

During recent maintenance and prior to the flight, the No 2 battery relay was replaced to rectify a battery charging problem. Subsequent investigations suggest that a fault with the diode may have been the cause of the relay failure. It is also possible that its disturbance, during the relay replacement, could have led to a short within the diode and examination of the diode showed evidence of overheating. However, it is not clear exactly how or when the diode failed. Nevertheless, it appears to have allowed the No 2 battery load to pass through the relay coil and through the aircraft wiring to the circuit board track connecting the system to the BAT 2 switch. The circuit track was not designed to sustain an electrical load of this magnitude and subsequently overheated.

The awkward location and unremarkable look of the diode assembly meant that its significance could easily be overlooked.

Actions by the aircraft manufacturer

The aircraft manufacturer has examined the switch panel circuit and reviewed this sequence of events. The position and unremarkable look of the diode was understood by the manufacturer. In addition, they have also identified that there is a slight risk of mis-assembly. To address this risk and to inform owners, the following safety actions are being carried out:

> An update to the parts catalogue, wiring manual and electric CAPS service bulletins have been released.
>
> The addition of a fuse to the harness assembly to prevent damage. The engineering drawings for this are now released and will be used in new aircraft. Issuing new CAPS kits is planned but not released yet. Adding the fused harness will require another round of revisions for the service bulletins. The fused harness is field retrofittable and can be installed in existing aircraft and listed as the field spare.

ACCIDENT

Aircraft Type and Registration:	EuroFOX 912(S), G-CIRP
No & Type of Engines:	1 Rotax 912 ULS piston engine
Year of Manufacture:	2015 (Serial no: LAA 376-15337)
Date & Time (UTC):	24 October 2018 at 1550 hrs
Location:	Clench Common Airfield, Marlborough, Wiltshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Minor damage to propeller, fuselage and landing gear
Commander's Licence:	Private Pilot's Licence
Commander's Age:	41 years
Commander's Flying Experience:	144 hours (of which 31 were on type) Last 90 days - 21 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

When the pilot applied right pedal during the takeoff roll, the aircraft veered further to the right than anticipated. This resulted in it hitting a fence-post and strand of wire at the side of the runway. The aircraft suffered minor damage to the propeller, fuselage and landing gear. The pilot and passenger were unhurt.

History of the flight

Earlier in the day the pilot had flown with a friend in G-CIRP from his home airfield to Clench Common. He planned to make a return flight, via the Severn Bridge for some sightseeing. The weather at the time of the flight was reported by the pilot as CAVOK with a light north-north-westerly wind. All daily and pre-flight inspections were normal; the pilot had not encountered any control restrictions or brake sticking during the previous flight or prior to commencing the takeoff roll for the return flight.

At the start of the return flight, the pilot taxied to the threshold of Runway 33; the wind being light and aligned with the runway. After lining up on the runway and opening the throttle the pilot applied right pedal to counteract the initial yawing tendency. As G-CIRP accelerated the pilot pushed the nose forward to level it and applied more pedal as the tail lifted, to further counter the yawing tendency. However, as he applied the pedal, G-CIRP began to veer "sharply" to the right. The pilot was unable to correct the turn despite applying left pedal, which had the effect of reducing the right turn rather than reversing it.

At this point, the pilot noticed that the aircraft was not accelerating sufficiently to attain flying speed. Realising that he would not be able to correct the right turn before the aircraft left the runway, he decided not to attempt to take off to avoid the fence post that was approaching. G-CIRP struck the fence post and stopped as the pilot closed the throttle; it suffered minor damage to its propeller, landing gear and its fuselage on the port side. The pilot and passenger were unhurt.

Following the accident, an inspection of the runway revealed marks showing the track of the right wheel. The pilot believed that he had inadvertently applied pressure with his foot on the vertical bar of the right toe-brake at the same time he had applied further right pedal to counter the torque reaction during the takeoff run, and that he continued to apply the right toe-brake while he applied left pedal to counter the veer right.

Aircraft information

The EuroFOX LSA is a conventional, two-seat, high-wing, tractor monoplane. The aircraft is fabric covered and has an enclosed cockpit with side-by-side seating. The landing gear configuration is either conventional (tail-dragger, known as the '2K' variant) or tricycle with glass FRP main-wheel legs (known as the '3K' variant). Control is by rudder, elevator and manually operated flaperons. The dual rudder pedals provide tailwheel steering with toe-brakes fitted on the P1 side, operating dual hydraulic disc brakes.

G-CIRP was a EuroFOX 912(S) '2K', with tail-wheel steering. The MAUM was 560 kg and it was powered by a ROTAX 912 ULS 100 hp. It was operated and administered under the LAA Permit-to-Fly scheme.

G-CIRP had no modifications to its rudder and brake system, and had received an engine replacement in 2018, following the theft of the previous unit. The 100-hour service had been carried out under its previous ownership, and it had not reached the next 50-hour service interval at the time of the accident.

Airfield information

Clench Common Airfield is an unlicensed private airfield with two grass strips located 2 nm south-south-west of Marlborough, available to the public with prior permission. The pilot reported that the Runway 33 was firm with short grass at the time of the accident.

Conclusion

The aircraft struck a fence post after leaving the runway following the application of right pedal during the takeoff roll. It is likely that the pilot inadvertently applied pressure on the right toe-brake at the same time he applied further right pedal to counter the yawing tendency from the torque reaction during the takeoff roll.

ACCIDENT

Aircraft Type and Registration:	Tecnam P2006T, G-SACL
No & Type of Engines:	2 Rotax 912-S3 piston engines
Year of Manufacture:	2016 (Serial no: 152)
Date & Time (UTC):	17 March 2019 at 1619 hrs
Location:	Redhill Aerodrome, Surrey
Type of Flight:	Private
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to nose cone, left wing and left engine cowl
Commander's Licence:	Private Pilot's Licence
Commander's Age:	77 years
Commander's Flying Experience:	255 hours (of which 101 were on type) Last 90 days - 8 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

During taxi the aircraft's left wing struck a generator located at the edge of the apron. Contributory factors were a lack of taxi guidance for pilots and an aircraft parked near the opposite edge of the apron.

History of the flight

During taxi the pilot manoeuvred the aircraft to the left to avoid a Piper PA-28 parked on the right side of the taxiway (Figure 1). Whilst he was looking to the right to ensure sufficient clearance from the PA-28, he was also looking ahead to identify the centreline, which he found difficult due to road markings on the apron. The road markings were white and faded with older markings visible. As he was attempting to regain the centreline the aircraft's left wing tip struck a large metal generator which was positioned close to the left apron edge. The pilot stated that the colour of the generator blended with the hangar behind and he had not noticed it.

The aircraft slewed to the left and came to rest after the nose struck an articulated lorry parked next to the generator. The pilot shut down the aircraft and he and his safety pilot[1]

Footnote

[1] The pilot had a safety pilot as a condition of his medical certificate.

evacuated safely. The fire service arrived to make the area safe as there was fuel leaking from the fractured left wing tank.

Figure 1

Apron markings and location of parked Piper PA-28 on the right; location where the Tecnam (G-SACL) came to rest against the generator and lorry is at the left

Safety action

An aerodrome inspector from the CAA visited Redhill after the accident and inspected the apron. The following changes were agreed with the airport operator:

- the existing edge of white road marking will remain in front of the hangars
- a yellow taxiway centreline marking will be placed 6 m from this edge
- a red safety line (behind which aircraft will be parked) will be marked 6 m from the other side of the yellow centreline
- instructions to aircraft operators will be issued to ensure that the main wheels of parked aircraft are pushed back on to the edge of the grass
- a warning will be added to the UK AIP[2] to request that pilots unsure of wing tip clearance request assistance

Footnote

[2] Aeronautical Information Publication.

ACCIDENT

Aircraft Type and Registration:	Vans RV-6A, G-CKTF
No & Type of Engines:	1 Lycoming O-360-A1A piston engine
Year of Manufacture:	1999 (Serial no: 24431)
Date & Time (UTC):	31 March 2019 at 1053 hrs
Location:	Stapleford Aerodrome, Essex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to the nose landing gear, propeller and potential engine shock-loading
Commander's Licence:	Private Pilot's Licence
Commander's Age:	55 years
Commander's Flying Experience:	420 hours (of which 9 were on type) Last 90 days - 5 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot of G-CKTF had planned to fly to Calais-Dunkerque Airport but he elected to divert to Stapleford Aerodrome because of the worsening en route visibility near Rochester. He landed on grass Runway 03L at Stapleford but, whilst turning left to vacate the runway, the nose gear failed after it dug in to soft ground in a depression. The aircraft tipped onto its left wingtip and nose with the propeller striking the ground before it settled back on both mainwheels. No injuries were sustained by either the pilot or passenger.

Figure 1

Damage to nose landing gear

ACCIDENT

Aircraft Type and Registration:	Vans RV-7A, G-ELVN	
No & Type of Engines:	1 Lycoming YIO-360-M1B piston engine	
Year of Manufacture:	2015 (Serial no: LAA 323-14930)	
Date & Time (UTC):	21 May 2019 at 1315 hrs	
Location:	Drayton St Leonard Airfield, Oxfordshire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Nose gear collapsed, engine shock-loaded and damage to propeller	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	59 years	
Commander's Flying Experience:	1,965 hours (of which 44 were on type) Last 90 days - 40 hours Last 28 days - 21 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

The pilot reported that as he was about to land on grass Runway 24, the aircraft struck a medium sized bird at a height of approximately 20 ft agl. This surprised the pilot who momentarily pitched the aircraft up and to the left, before adjusting the aircraft's flightpath back towards the runway centreline to land with about 300 m of runway remaining. When the aircraft touched down it bounced and became airborne. The pilot decided to land rather than go around, due to the possibility that the aircraft may have sustained damage from the bird strike. The aircraft subsequently touched down heavily on the nose gear which collapsed. The aircraft came to a stop and the pilot vacated the aircraft unaided.

Figure 1
G-ELVN nose gear collapsed

ACCIDENT

Aircraft Type and Registration:	Cyclone AX3/503, G-MZEL	
No & Type of Engines:	1 Rotax 503-2V piston engine	
Year of Manufacture:	1996 (Serial no: 7250)	
Date & Time (UTC):	19 January 2019 at 1428 hrs	
Location:	Causeway Airfield, Coleraine	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 1
Injuries:	Crew - 1 (Serious)	Passengers - 1 (Serious)
Nature of Damage:	Nose destroyed, seat bases damaged	
Commander's Licence:	National Private Pilot's Licence	
Commander's Age:	68 years	
Commander's Flying Experience:	98 hours (of which 87 were on type) Last 90 days - 5 hours Last 28 days - 1 hour	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

During the takeoff from grass Runway 16, the windsock was indicating a wind speed of less than 5 mph. Once at circuit height, the pilot decided to abort the flight due to low cloud and rain. During the circuit the pilot estimated the wind to be 120° at 15 mph.

The approach back onto Runway 16 was uneventful until about 40 ft agl when the aircraft encountered "severe sink". The pilot applied full power but was unable to arrest the descent rate before the aircraft touched down heavily on the main gear. The aircraft bounced back into air, with a nose-up attitude, to a height of about 15 ft. It then pitched down and struck the grass runway in a nose-down attitude causing severe damage to the nose of the aircraft and cockpit area. Although both the pilot and passenger were wearing full harnesses, the pilot suffered fractured vertebrae, elbow, wrist, thumb, and the passenger suffered fractures to both legs.

The pilot advised that the seat cushions were made from standard low-density upholstery foam, which met the airworthiness requirements applicable to the aircraft design. The AAIB notes that the use of modern, energy-absorbing foam may have reduced the severity of the injuries the occupants received.

ACCIDENT

Aircraft Type and Registration:	Flight Design CT2K, G-TOMJ
No & Type of Engines:	1 Rotax 912ULS piston engine
Year of Manufacture:	2003 (Serial no: 7975)
Date & Time (UTC):	17 February 2019 at 1212 hrs
Location:	Sackville Farm Airstrip, Bedfordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Bent nose strut, slight damage to right wingtip
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	61 years
Commander's Flying Experience:	1,746 hours (of which 91 were on type) Last 90 days - 10 hours Last 28 days - 7 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot reported that he had undertaken a short cross-country flight and returned to Sackville Farm airstrip to find that the wind was stronger than forecast. He estimated that on landing there would be a 12 kt, 90° crosswind from the right. He made a wing-down approach with the aircraft initially touching down on the right mainwheel before all the wheels settled onto the ground. As the aircraft decelerated, the right mainwheel hit a mole hill which caused the aircraft to roll to the right and the right wingtip to touch the ground. The aircraft then performed a ground loop to the left before coming to a halt. The nose strut was found to be bent and there was slight damage to the right wingtip.

ACCIDENT

Aircraft Type and Registration:	Kolb Twinstar Mk III Xtra, G-MGPX
No & Type of Engines:	1 Jabiru 2200A piston engine
Year of Manufacture:	2010 (Serial no: PFA 205-14701)
Date & Time (UTC):	3 February 2019 at 1340 hrs
Location:	Thorney Island, West Sussex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Fuselage and wing damaged
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	57 years
Commander's Flying Experience:	386 hours (of which 13 were on type) Last 90 days - 4 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot reported that as full power was applied on takeoff, there was a momentary reduction in power followed by a rapid increase to full power. This caused the aircraft to veer to the left, after which the pilot reduced power to idle. The aircraft continued to the left and struck a wooden fence post to the side of the runway. The pilot was wearing a full harness and was uninjured.

ACCIDENT

Aircraft Type and Registration:	Quik GT450, G-TPWL
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	2006 (Serial no: 8187)
Date & Time (UTC):	12 May 2019 at 1340 hrs
Location:	Ashcroft Airfield, Cheshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to wing, trike nose pod, nosewheel and propeller blades
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	61 years
Commander's Flying Experience:	171 hours (of which 171 were on type) Last 90 days - 5 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot was returning to land following a local flight, during which he reported there had been occasional "short bursts of wind" from the west that had resulted in a "bumpy flight". Joining the airfield overhead, the pilot initially observed that the windsock near the centre of the airfield indicated a light wind from the north to north-west, and the windsock in the north-west corner indicated a light wind from the west. A few minutes later the pilot noted that smoke from a fire a few miles away indicated a light wind from the north and that both windsocks now indicated nil wind.

The pilot decided to land on Runway 31 and reported that the approach was normal, but shortly after moving the throttle lever to idle and at a height of about 10 to 15 ft above the runway a "burst of wind" caused the left wing to lift and the aircraft veered to the right. The pilot levelled the wing but the aircraft was now parallel to the runway and it touched down heavily into long grass. After a short landing roll the nose tipped forward before the aircraft rolled onto its right side. The pilot was unhurt and vacated the aircraft unaided.

Figure 1
G-TPWL after the accident

ACCIDENT

Aircraft Type and Registration:	DJI Matrice M210 RTK, (UAS, registration n/a)
No & Type of Engines:	DJI 3515 Electric motors
Year of Manufacture:	2017 (Serial No: EK290958468403)
Date & Time (UTC):	14 January 2019 at 1103 hrs
Location:	Colwyn Bay, Conwy
Type of Flight:	Aerial Work
Persons on Board:	Crew - N/A Passengers - N/A
Injuries:	Crew - N/A Passengers - N/A
Nature of Damage:	Extensive damage to aircraft and payload
Commander's Licence:	Other
Commander's Age:	32 years
Commander's Flying Experience:	21 hours (of which 4 were on type) Last 90 days - 4 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the remote pilot

Synopsis

The unmanned aircraft system (UAS) was fitted with a third-party lidar[1] pod for its planned survey mission which involved flights of around 8 minutes duration. As it commenced its pre-programmed route, it appeared to continue to climb above the 30 m height that had been set. The remote pilots observed that is was too high and attempted to land it immediately. The aircraft appeared unresponsive to the remote pilot's inputs and it then commenced an uncontrolled descent, rapidly increasing speed, until it struck the ground.

History of the flight

The same aircraft and lidar pod had been used to conduct two test flights three days previously. These flights were flown without incident.

On the day of the accident flight, the remote pilots established a suitable launch and recovery area and attached the third-party lidar pod to the aircraft, Figure 1. After completing pre-flight checks on the hardware, a flight was plotted and checked on the autonomous flight app being used to control the flight.

Footnote

1 Lidar is a surveying device that uses laser light to measure distances.

Figure 1

UAS with third-party lidar pod attached prior to flight

The aircraft was launched using the app and it initially ascended as expected, but then continued to climb to an estimated altitude of 70 m, which was above the 30 m maximum altitude that had been set. The remote pilots discussed this and checked the available data whilst maintaining visual contact with the aircraft. Both the remote control and the app indicated that the aircraft was at an altitude of 28 m.

The remote pilots recalled that the app reported a "critical battery/current error" or similar and decided to land the aircraft immediately by selecting the RETURN TO HOME on the remote control. The app confirmed the request and LAND was selected.

The aircraft appeared unresponsive and the remote pilots attempted to verify it was descending. The remote control and app indicated that it was at 28 m and 27 m, respectively, and the battery levels were OK, indicating between 85 to 100 %.

The aircraft then began to descend, rapidly increasing in speed until it struck the ground, causing substantial damage to it and the payload. There were no injuries or other damage.

Recorded information

The flight data stored by the aircraft was not available. It is possible that it may have been lost had the aircraft had been powered up again after the accident flight. However, a limited data set was available from the autonomous flight app.

This data showed that 14 seconds into the flight the motors were under heavy load - high current draw, and the battery voltage dropped to around 3V in each cell. A notification 'BATTERY VOLTAGE (20.556V) IS TOO LOW AT 84% - FAILURE MAY BE IMMINENT' was displayed.

The flight mode then changed to AUTO LANDING and it descended to 30 m, the voltage stabilised once it had levelled at this altitude. It then commenced a descent at less than 5 m/s.

The flight mode then changed to P-GPS (positioning mode), possibly as a result of manual control being taken, and it then climbed slightly and reached a maximum speed of 13.9 mph before commencing a rapid descent.

During the majority of the flight, the sonar (ultrasonic) altitude indicated between 0.3 ft and 1 ft and only when the speed started to increase, during the last 3 seconds of the flight, did the sonar altitude increase to 11.5 ft before there was a loss of this data for the last 1.5 seconds of the flight.

Aircraft information

The Matrice M210 RTK UAS has a maximum takeoff weight of 6.14 kg specified.

The aircraft has a positioning mode, ‘P-mode’ or ‘P-GPS’. In this mode it uses GPS signals and its forward and downward vision systems to locate itself, automatically stabilise, and navigate between obstacles.

The downward looking vision system consists of a stereo vision sensor and two ultrasonic sensors which it uses to help the UAS maintain its current position. The system is mounted on the underside of the main body and the fields of view are shown in Figure 2.

The lidar pod was supplied by a third-party company and was designed so that the downward view of the vision system was not obstructed by the pod or its mounting.

The pod was powered by a battery pack which, for this flight, had been attached to the end of the pod. There was a cable and connector connecting the battery to the pod. The installation can be seen in Figure 1.

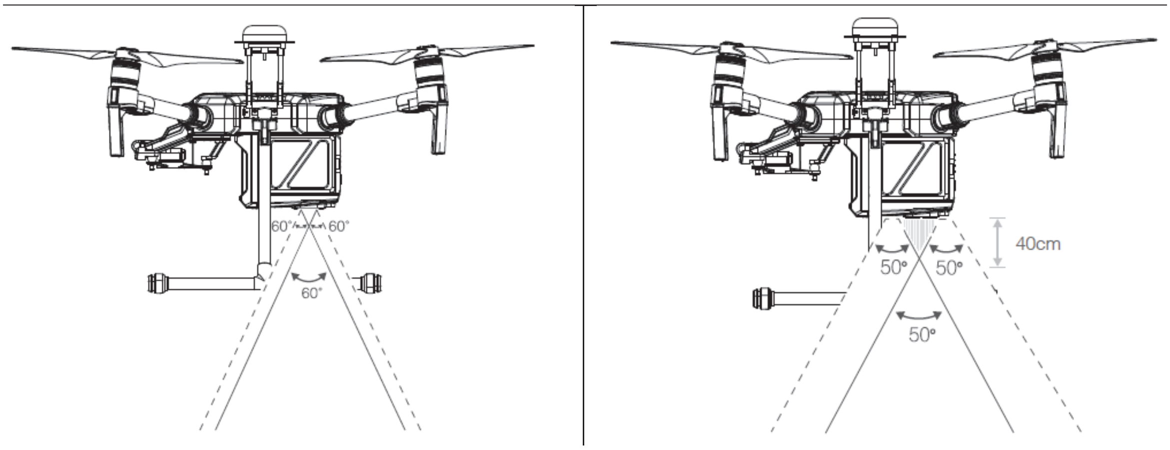

Figure 2

Field of view depiction, ultrasonic sensors (left) and stereo vision system (right)

Autonomous flight app

The app being used to control the flight was '*Litchi for DJI Drones*' and had been selected by the UK agent for use with the lidar. It was reported that this app offered the opportunity for a higher quality point cloud to be generated by the lidar, than by other apps, due to the way it managed corners on the planned route. The app developer's website listed a number of UAS' that were compatible with the app, but the accident type was not one of them.

The UK agent reported that they had been successfully using this app for some time with this type of UAS.

Weight and balance

The supplier of the lidar pod provided a weight calculation for the operating company as follows:

> *'M200/210 with single gimbal mount, lidar GPS, blades, TB50 battery = 4.15 kg*
>
> *M200 M8 lidar = 1.75 kg*
>
> *M8 lidar 2.7 amp power pack = 0.2 kg*
>
> ***AUW M200/210 with Lidar 6.1 kg'***

The UAS operator advised that they had specifically chosen the smaller capacity, and weight, TB50 batteries to maximise payload, as they were aware that with the lidar pod the UAS would be close to its maximum specified weight.

The AAIB asked the operator to weigh an equivalent aircraft fitted with the TB50 batteries. This was done using bathroom-type scales, which indicated a weight of 4.4 kg. The UAS manufacturer's website indicated the M210 RTK weight to be 4.42 kg with the TB50 battery.

If the total weight is calculated using the measured weight of the UAS, and the stated weight of the pod and battery pack, the ready to fly weight for the accident flight was 6.37 kg. This is above the maximum 6.14 kg specified by the manufacturer.

Meteorology

The wind was from 320° at 11 kt (5.8 m/s). The visibility was good, with some cloud cover and no precipitation. The temperature was 8.6 ºC and the QNH 1022 hPa.

Other information

There are no regulatory standards for compatibility testing of third-party equipment and software when used with a UAS.

Analysis

Due to the lack of detailed recorded data, it was not possible to determine the cause of this accident. There are, however, some points for discussion.

The aircraft was being operated at above its maximum specified operating weight. The autonomous flight software being used commanded a rate of ascent, this would lead to a high current draw as the electric motors work to achieve the programmed performance with the overweight aircraft. The high current draw seen during ascent may have led to the low battery voltage and its warning. The battery voltage recovered once the UAS had levelled and the electrical load reduced.

Although the lidar pod had been designed not to obscure the downward looking sensors, the data suggests that the ultrasonic sensors were picking up an obstruction between 0.3 ft to 1 ft range. This could have been the red and black cable and connector, seen below and to the side of the main body in Figure 1. This unsecured cable could have been blown in to the sensors field of view by the downdraft from the propellers. The obstruction appears to move when the speed increased, perhaps due to a change in airflow which may have moved the cable out of view.

The change to P-GPS mode approximately 3.2 seconds before the end of the flight and prior to the uncontrolled descent could suggest that manual control was unintentionally taken, and not realised, by the remote pilots.

The autonomous flight app being used did not list this type on its list of compatible UAS.

In the absence of any regulatory requirements, it is incumbent on UAS operators and remote pilots intending to add third-party equipment to a UAS to ensure that the equipment and any apps that are being used will not adversely affect the operation of the UAS in any way.

This accident appears to be in part due to the aircraft being operated above it's maximum specified takeoff weight. It would therefore be prudent if UAS operators and remote pilots, perhaps as part of the pre-use assessment of third-party equipment, check the actual weight of the intended combination to ensure operating limitations are not exceeded.

Conclusion

The aircraft was being flown with a payload which unintentionally meant it was being flown above its maximum specified weight. This could have caused the high load on the batteries which may have been the reason for the battery warning during its ascent. In response to this warning the remote pilots commanded a return to home which the UAS initially followed, but it then transitioned to a manual P-GPS mode and entered an uncontrolled descent to the ground. The autonomous flight app being used did not list this type on its list of compatible UAS'.

Safety actions

The UAS operator is updating its procedures to include the following checks:

1/ Before any new aircraft / payload combination is flown, its actual weight will be established and recorded, by weighing, to ensure it is within specified limits.

2/ Before any new app or software is flown, confirmation, in writing, of its compatibility with other equipment by either the airframe manufacturer or the app developer is required.

ACCIDENT

Aircraft Type and Registration:	Evolve Dynamics Sky Mantis (UAS, registration n/a)
No & Type of Engines:	4 electric motors
Year of Manufacture:	2019 (Serial no: ED/SM68-00212)
Date & Time (UTC):	7 February 2019 at 1022 hrs
Location:	Nailsea Fire Station, Somerset
Type of Flight:	Commercial Operations
Persons on Board:	Crew - N/A Passengers - N/A
Injuries:	Crew - N/A Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Other
Commander's Age:	27 years
Commander's Flying Experience:	7 hours (of which 4 were on type) Last 90 days - 5 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and subseqeunt AAIB enquires

Synopsis

During a demonstration flight, the UAS dropped to the ground from a height of 50 m when the electric motors stopped, despite the battery being fully charged. The UAS struck the ground and was destroyed in the subsequent post-impact fire. The UAS manufacturer determined that the loss of power was caused by the battery not being fully locked in place. It has updated the operations manual and intends to install sensors to prevent the aircraft from operating if the battery is not correctly locked in place.

History of the flight

The Evolve Dynamics Sky Mantis is an all-weather long endurance quadcopter UAS, which is still under development. It has a maximum takeoff mass of 6.9 kg and a 60-minute endurance (Figure 1).

The pilot, who works for the UAS manufacturer, was operating the UAS on a demonstration flight. It was the first flight of the day and prior to taking off, the battery level indication had indicated a 100 % state of charge and a voltage of 25.2 V. The UAS took off at maximum takeoff mass and indicating an available flight time of 60 minutes. The pilot climbed the UAS to a height of 50 m where it maintained a stable hover. It had been flying for approximately 5 minutes when the pilot initiated a control input to rotate the UAS about its yaw axis. Whilst yawing, the UAS appeared to suffer a complete power failure; all four electric motors stopped and the UAS began descending rapidly. There were no associated warnings displayed on the controller and the UAS did not respond to any control inputs by the pilot. It entered autorotation at approximately 10 - 15 m above the ground, but this was insufficient to arrest the rate of descent and it struck the ground hard. The onboard battery ignited and the UAS was destroyed in the ensuing fire.

Figure 1
Evolve Dynamics Sky Mantis

Investigation by the UAS manufacturer

The UAS manufacturer undertook an internal investigation to determine the cause of the power loss. It identified that the battery had not been fully locked in place during the accident flight and vibration had caused it to lose contact with the electrical connections, leading to the loss of power.

Safety action

> The manufacturer has since updated the Sky Mantis Operations Manual to include an instruction to check that the battery is locked in place and will include this requirement in customer training. It also intends to install sensors in the battery lock mechanism which will prevent the aircraft from being able to fly if the battery is not correctly locked in place.

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

2/2014 Eurocopter EC225 LP Super Puma
G-REDW, 34 nm east of Aberdeen,
Scotland on 10 May 2012
and
G-CHCN, 32 nm south-west of
Sumburgh, Shetland Islands
on 22 October 2012.

Published June 2014.

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

Published September 2014.

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

Published July 2015.

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

Published August 2015.

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

Published October 2015.

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

Published March 2016.

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

Published September 2016.

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

Published March 2017.

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

Published March 2018.

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

Published November 2018.

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

http://www.aaib.gov.uk

GLOSSARY OF ABBREVIATIONS

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

Air Accidents Investigation Branch