Air Accidents Investigation Branch

AAIB Bulletin 10/2018

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CONTENTS

SPECIAL BULLETINS / INTERIM REPORTS

SUMMARIES OF AIRCRAFT ACCIDENT ('FORMAL') REPORTS

AAIB FIELD INVESTIGATIONS

COMMERCIAL AIR TRANSPORT

FIXED WING

ROTORCRAFT

GENERAL AVIATION

FIXED WING

ROTORCRAFT

SPORT AVIATION / BALLOONS

AAIB CORRESPONDENCE INVESTIGATIONS

COMMERCIAL AIR TRANSPORT

GENERAL AVIATION

CONTENTS Cont

AAIB CORRESPONDENCE INVESTIGATIONS Cont

GENERAL AVIATION Cont

SPORT AVIATION / BALLOONS

UNMANNED AIRCRAFT SYSTEMS

MISCELLANEOUS

ADDENDA and CORRECTIONS

(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:	AS350 B3e Ecureuil, G-MATH
No & Type of Engines:	1 Turbomeca Arriel 2D turboshaft engine
Year of Manufacture:	2016 (Serial no: 8274)
Date & Time (UTC):	5 May 2017 at 0830 hrs
Location:	Wycombe Air Park, Buckinghamshire
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - 1
Injuries:	Crew - 1 (Fatal) 1 (Serious) Passengers - 1 (Serious)
Nature of Damage:	Extensive
Commander's Licence:	Commercial Pilot's Licence (Helicopters)
Commander's Age:	45 years
Commander's Flying Experience:	5,747 hours (of which 579 were on type) Last 90 days - 53 hours Last 28 days - 17 hours
Information Source:	AAIB Field Investigation

Synopsis

The accident occurred whilst the helicopter was engaged in hydraulic failure training. An instructor was in the left seat of the helicopter, a pilot under training in the right seat and another pilot under training, who was a passenger on this flight, was seated in the rear.

The right-seat pilot was performing a hydraulics-off approach, to finish in a run-on landing. The instructor became dissatisfied with the approach parameters and took control in the latter stages, performing a hydraulics-off go-around into a left-hand circuit, before lining up the helicopter on final approach for the pilot to make a second attempt. Once again, the instructor took control late in the approach and performed another go-around. On this occasion, the left turn onto the downwind was flown with a higher angle of bank (AOB). The instructor was unable to control the roll attitude and the helicopter rolled left, beyond 90° AOB, descended rapidly and struck the ground, coming to rest on its left side.

All three occupants were seriously injured. The right-seat pilot died some weeks later from injuries sustained in the accident.

No technical issues were identified and a definitive reason why the instructor was unable to roll the helicopter back to a level attitude could not be determined.

The investigation concluded that clearer instructions in the AS350 flight manual for hydraulics-off flight would help prevent similar accidents in future. In response to this accident, the helicopter manufacturer has taken safety actions including: amending the AS350 flight manual to limit the AOB to 30° during hydraulics-off flight and the inclusion of warnings not to conduct low speed manoeuvres with hydraulics off due to the danger of loss of control. It has also prepared a safety video describing how to perform hydraulics-off training.

History of the flight

Background

The purpose of the flight was type conversion training for two pilots who were converting onto the helicopter type. The training was being conducted by an instructor under the auspices of an Approved Training Organisation (ATO) based at Wycombe Air Park. The accident occurred during a revision flight in preparation for the pilots' Licence Skills Tests (LST).

G-MATH was equipped with a factory-installed 'Appareo Vision 1000' cockpit video and flight data recording system.

Accident flight

G-MATH departed Wycombe Air Park at 0805 hrs with the instructor in the left seat, one pilot in the right seat and the second pilot as a passenger in the centre left rear seat. This part of the training detail included autorotative exercises, practice engine failures, hover exercises and low-level circuit practice. It was completed uneventfully, after which the helicopter returned to Wycombe.

On arrival back at the airfield, the helicopter was routed south-west to position for a base leg approach to the grass area north of Runway 06 to commence hydraulic failure training. The instructor selected the ACCU TST switch ON and then OFF, in accordance with the AS350 flight manual procedure, to simulate a hydraulic failure. The flight manual procedure called for a '*flat approach into wind*', with a '*no-hover slow running landing at approximately 10 kt*'. The pilot in the right seat was at the controls and, in accordance with the procedure, he selected the HYD CUT OFF switch on the right collective lever to OFF to depressurise the hydraulics. He continued the approach and reduced speed for a planned run-on landing at low speed.

During the latter stages of the approach, the instructor felt that the right-seat pilot was allowing the aircraft to yaw and reduce speed too much, so the instructor took control and initiated a go-around. Recorded data show that this was followed by a left-hand circuit, flown with up to 32° AOB, to reposition the helicopter for a second attempt. The hydraulic system remained unpressurised. During the go-around the right-seat pilot kept his hand on the cyclic, although the instructor stated that he had briefed him not to do so.

Once re-established on final approach, the instructor handed over control to the right-seat pilot for a second attempt. Once again, the instructor was not content with the pilot's control of yaw and speed in the latter stages, so he took control and initiated another hydraulics-off go-around, quickly followed by a left turn downwind. The right-seat pilot kept his hands and feet on the controls. The roll rate in the turn was initially similar to that of the first go-around, but on this occasion the AOB increased. As the AOB reached 48°, the recorded image data showed the instructor changing his grip on the cyclic stick and leaning his body to the right, as if attempting to increase the amount of right control force input. The AOB stabilised briefly, after which the helicopter rolled further to the left, descended and struck the ground on its left side.

All three occupants were seriously injured. The instructor and the passenger in the rear seat survived, but the pilot in the right seat died some weeks after the accident as a result of his injuries.

When interviewed, the instructor stated that he had been unable to move the cyclic control to the right to arrest the roll to the left.

Accident site

The accident site was located within the airfield boundary, about 200 m north of the centre of Runway 06/24. The helicopter had struck the ground on its left side with little forward speed (Figure 1). The ground impact marks showed that the main rotor blades had struck the ground first when the helicopter was in a near 90° left bank, and the damage to the blades was consistent with them being powered. The tail boom had failed as a result of the inertia loads of the impact but there was no damage to the tail rotor. The fuselage came to rest on a heading of 019°(M).

Figure 1

G-MATH accident site
(Image on the left is a view to the east, taken a few hours after the accident.
The image on the right was taken the day after the accident,
after the lower fuselage panels had been removed)

Aircraft information

G-MATH was an Airbus Helicopters AS350 B3e; a variant of the AS350 B3 with an uprated Arriel 2D engine. The AS350 B3 was certified in 1997 and was a significantly upgraded version of the original AS350 B, first certified in 1977. G-MATH was equipped with six seats; two pilot seats with dual controls in the front, and four passenger seats in the rear.

The helicopter had a single hydraulic system operated by a belt-driven hydraulic pump. In the event of a pump failure or hydraulic leak, the flight controls can be operated mechanically, but the control forces are higher. In the event of a loss of hydraulic pressure, or low hydraulic pressure (below 30 bar), a steady red 'HYDR' caption illuminates on the Warning-Caution-Panel (CWP) and a warning gong sounds.

The cyclic pitch control stick and collective pitch control lever operate three main servo actuators via a series of push-pull rods, bellcranks and a mixer unit (Figure 2). Moving the cyclic fore and aft actuates the forward servo actuator; this actuator controls pitch attitude by tilting the main rotor swash plate fore and aft. Moving the cyclic left and right actuates the left and right servo actuators; these actuators control roll attitude by tilting the swash plate left and right. The collective lever actuates all three servo actuators together to increase blade pitch, and it also increases engine power, with a resulting increase in rotor thrust.

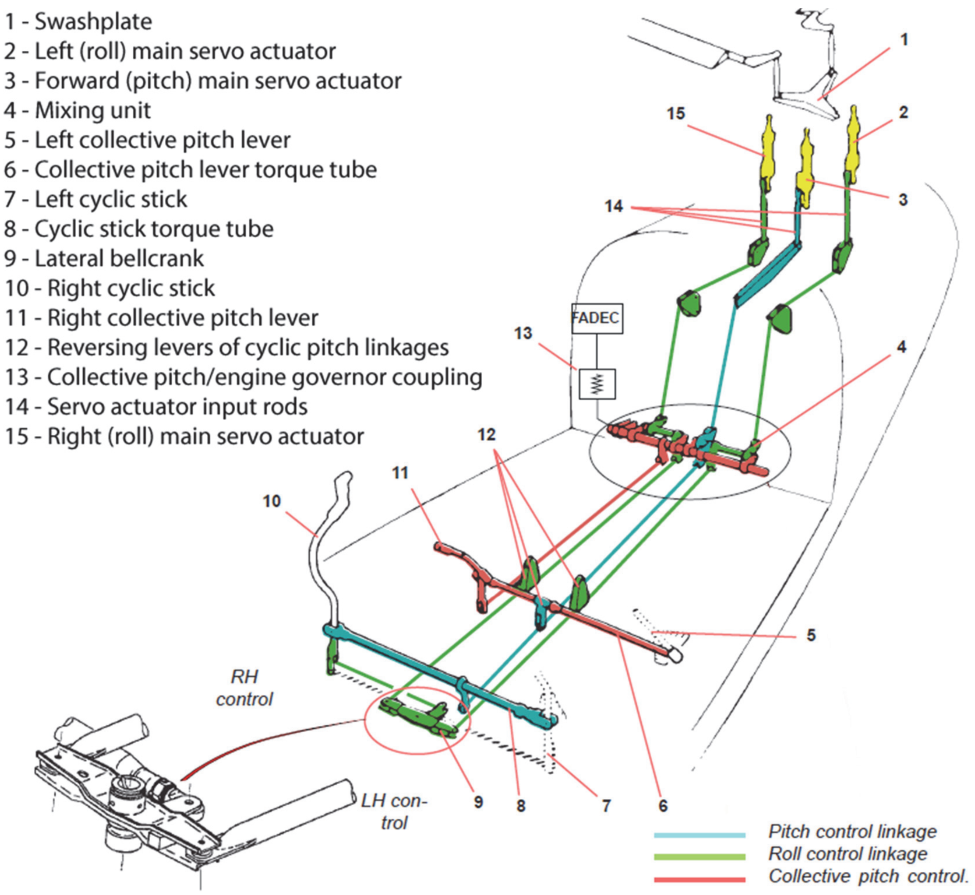

Figure 2

Diagram of the AS350 B3e main rotor flight controls
(Image courtesy Airbus Helicopters)

In normal flight with the hydraulics on, the main servo actuators are hydraulically powered. Each actuator has an accumulator which provides a short period of hydraulic pressure reserve to reach the safety speed in the event of a hydraulic failure.

A guarded hydraulic cut-off (HYD CUT OFF) switch is located on the right collective lever. When this is selected OFF the HYDR caption illuminates, the hydraulic system is depressurised and the main servo accumulators are depressurised simultaneously. This loss of pressure causes a locking pin inside each servo to drop into place, enabling the control input rods to be locked and move the servo actuators mechanically. The cyclic control forces required to move the servos are higher with the hydraulics off.

The tail rotor pitch is controlled by foot pedals which mechanically actuate a hydraulic servo actuator in the tail boom. A yaw load compensator is connected in parallel with the servo to reduce control loads in the event of hydraulic pressure loss. The yaw load compensator retains its pressure when the HYD CUT OFF switch is selected OFF. Keeping this pressurised is important to assist with yaw control when practising hydraulics-off flight.

When the accumulator test (ACCU TST) button is pressed the red HYDR caption flashes on the CWP and the hydraulic system and yaw load compensator are depressurised, but the main servo accumulators remain pressurised for a limited time, allowing the pilot to reach the safety speed. To simulate a hydraulic system failure, during the first part of a hydraulics-off training procedure this button is selected on and then off once safety speed is reached.

The manufacturer's recommended safe airspeed range (safety speed) for manoeuvring with the hydraulics off is 40 to 60 kt. In this speed range, to maintain level flight the pilot needs to hold a cyclic force of about 4 to 6 kgf to the left and 5 kgf forward. These forces increase at higher airspeeds and also at low speeds near the hover.

The collective lever has a neutral force position at about 40% torque and any movement up or down from that position requires increasing amounts of force.

There is an adjustable cyclic friction ring at the base of the right cyclic which allows the pilot to adjust the force required to deflect the cyclic (when the hydraulics are on, there are no feedback control forces).

The helicopter was fitted with an aftermarket 2-axis HeliSAS autopilot and stability augmentation system using a Supplemental Type Certificate. This system consists of a pitch and a roll servo which are connected to the cyclic's pitch and roll control rods beneath the cabin floor. When the HeliSAS system is turned off by the pilot, electromagnetic clutches disconnect the servo motors from the cyclic control system. When engaged, the servo motors apply loads of about 1.4 kgf at the cyclic grip.

The aircraft was fitted with a Vehicle and Engine Management Display (VEMD). The amount of engine torque, N1 or T4 was depicted on a 'First Limitation Indicator' (FLI) gauge, on a scale of 0 to 12, where 10 was the maximum allowable.

There is a dual hydraulic system option that can be fitted to the AS350 B3 and B3e. When this is fitted there is no requirement to carry out 'hydraulics-off' training.

Recorded information

G-MATH was equipped with an 'Appareo Vision 1000' system, which recorded cockpit video, audio and flight data parameters. It was fitted by the helicopter manufacturer to allow the operator to review previous flights and to aid accident investigators. Unlike an FDR or CVR, the Vision 1000 system is not a certified, crash-protected recording system.

The unit was mounted centrally in the cabin roof, behind the pilots' seats, and provided a camera view of the instruments, flight controls and windows. Recorded information included video at four frames per second (fps), ambient cockpit audio from an onboard microphone, GPS position and GPS altitude information. Attitude and acceleration data were also measured and recorded. Recording commenced when electrical power was applied on the helicopter. In addition to cockpit audio, it can also record from external audio sources such as the helicopter's intercom and/or radios. In G-MATH, this option had not been fitted, so only cockpit audio was recorded.

The device was found at the accident site, detached from its cockpit mount and hanging from a cable. This meant that switch positions and the normal view of the occupants could no longer be seen on the video once the helicopter had struck the ground.

The device was successfully downloaded and contained just over two hours of audio and video, along with flight data from several flights, including the accident flight. These recordings were used in preparing the History of the flight (see above). In addition to the data recorded from the Vision 1000's attitude and acceleration sensors, information was read from the cockpit airspeed indicator (ASI) and FLI gauges. ASI data was not discernible below 20 kt due to the scaling of the gauge.

The ambient cockpit audio recording levels were low, meaning only loud sounds from the helicopter's engines/transmission were recorded and no flight crew speech was audible on the recordings.

Hydraulics-off approach and go-around

The Vision 1000 recorded image and flight data were analysed to compare the two go-arounds. Throughout both manoeuvres, no unexpected warnings or cautions were present and the main rotor rpm was as expected. The white 'SAS'[1] light was ON, (signifying the HeliSAS system was powered, but on standby (as it had been since takeoff)) and there was approximately 218 kg[2] of fuel on board. Prior to the first approach, the recorded video shows the instructor correctly performing the flight manual 'ACCU TST' procedure. At 0829:50 hrs, the right-seat pilot selected the 'HYD CUT OFF' switch to OFF and the red HYDR caption was illuminated on the CWP.

First go-around

The instructor took control for the go-around with the helicopter approximately 5 ft agl and groundspeed of approximately 13 kt (airspeed was not registered on the ASI). The

Footnote

1 Stability Augmentation System.
2 Fuel quantity was estimated from the quantity indication bar on the VEMD.

helicopter pitched down to 12° nose-down, FLI increased to a maximum of 6.3 and the aircraft rolled left, reaching 29° AOB at approximately 27 ft agl. As the speed increased, pitch attitude returned to approximately level and the GPS groundspeed stabilised at 43 kt. The indicated airspeed read from the cockpit gauge remained at or below 20 kt for most of this manoeuvre. The helicopter then rolled to the right to arrest the turn on the downwind leg, continuing to climb to a maximum GPS-recorded height[3] of 74 ft agl.

The recorded images showed that as the instructor took control, the right-seat pilot initially relaxed his grip on the controls and then removed them briefly from the cyclic and completely from the collective until taking control for the second approach.

The base leg turn was a continuous manoeuvre with the helicopter rolling left to 32° AOB and commencing the approach descent as it turned onto the final approach heading. The airspeed only began to increase once the instructor had lined the helicopter up on the approach heading.

Comparison of first and second go-arounds

When the instructor took control for the second go-around, the helicopter was at approximately 35 KIAS and approximately 20 ft agl. This occurred with the helicopter positioned slightly to the north-east of the first circuit. (Figure 3).

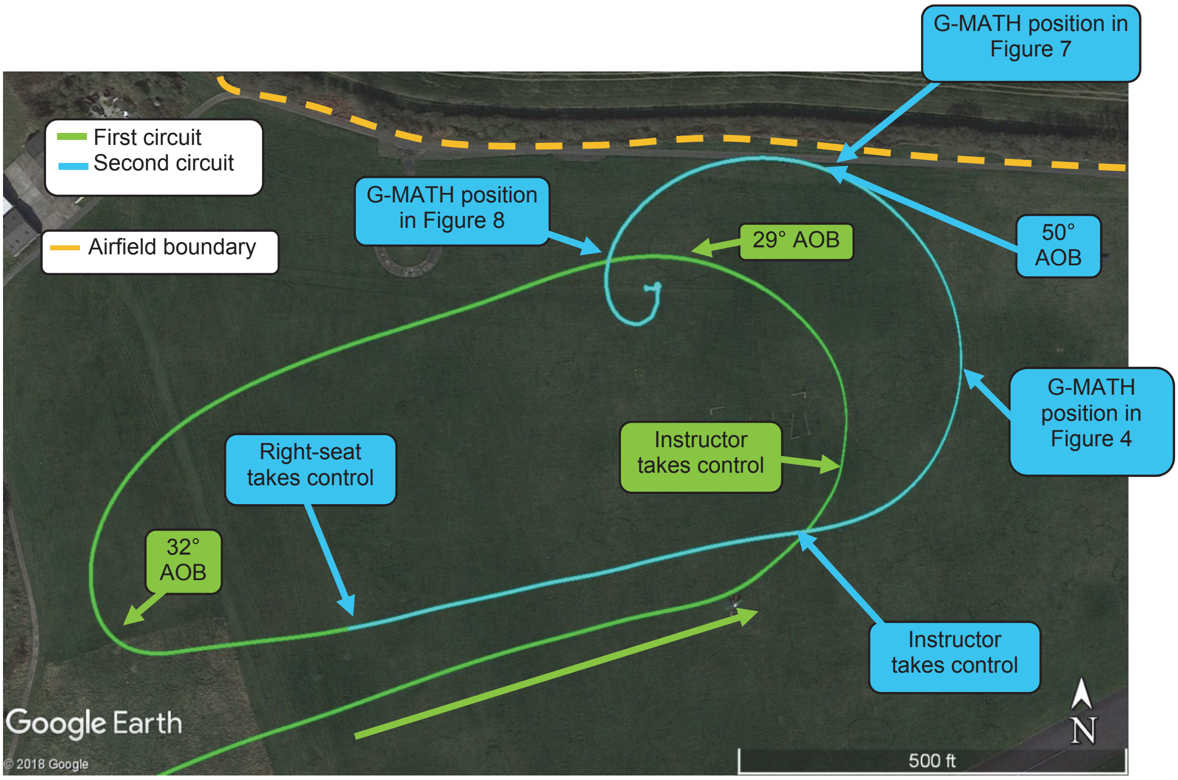

Figure 3

Final 90 seconds of G-MATH flight data

Footnote

3 GPS height was calculated from current GPS altitude minus the GPS altitude at impact.

The instructor applied left and forward cyclic, left pedal and raised the collective, producing a corresponding increase in FLI. Indicated airspeed and altitude began to increase as the helicopter pitched nose-down and rolled left. The left roll was initiated at a height of approximately 20 ft agl and reached 30° at approximately 47 ft agl. Throughout the initial stages of the second go-around, the right-seat pilot's hands and feet were still on the controls but his grip on the cyclic was seen to loosen (Figure 4).

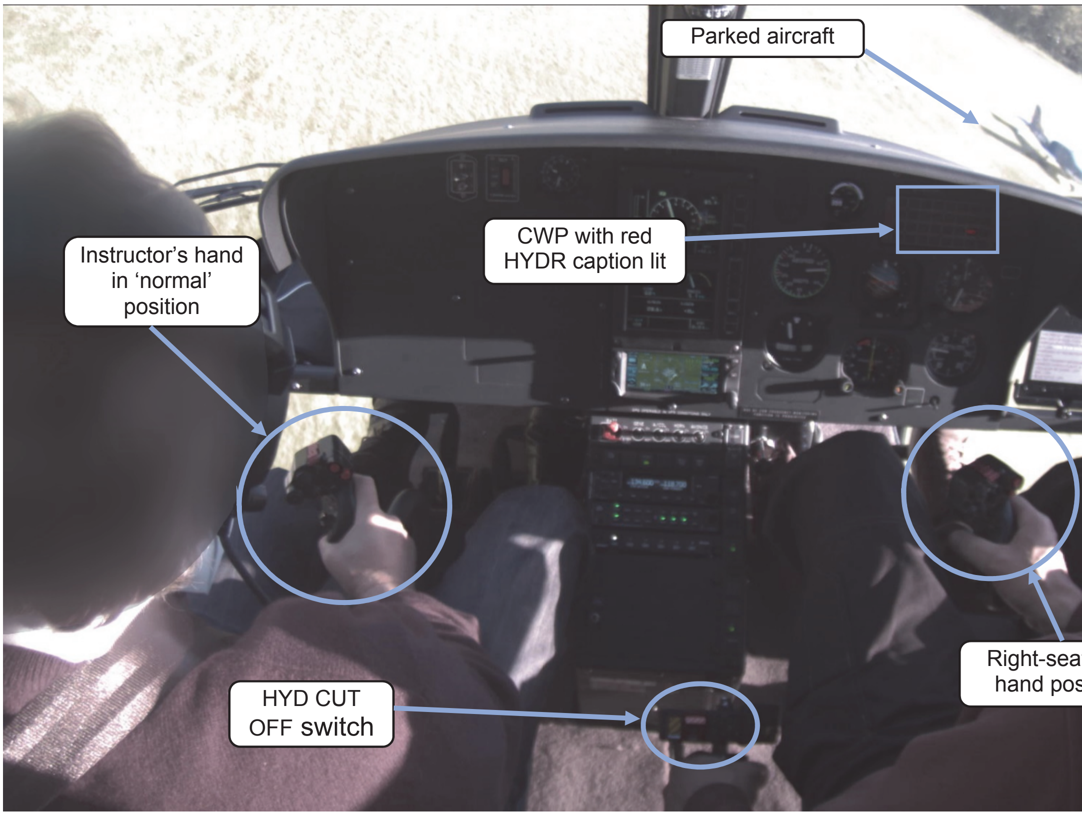

Figure 4

Second go-around showing right-seat pilot with hands and feet on the controls (instructor's head has been blurred).

Figure 5 presents data from both go-arounds, aligned at the point when the helicopter began to pitch nose-down. This figure shows that the helicopter attitude during the initiation of the go-around was similar on both occasions. The helicopter pitched down and rolled to the left to approximately the same attitudes and at similar rates in the first 7.5 seconds of the turn. The rates of turn were -11.9°/sec and -10.6°/sec respectively.

The recorded data shows a divergence in parameters between the two go-arounds after the first 7.5 seconds. In the first go-around, the pitch and roll attitudes began to return to zero as the helicopter rolled out of the turn onto the downwind leg. In the second go-around, the roll and nose-down pitch continued to increase; this commenced at 0832:50 hrs.

The main differences between the two manoeuvres at the point of divergence was the airspeed, which was below 20 KIAS for the first go-around but 47 KIAS for the second, and height, with the helicopter approximately 25 ft higher on the second go-around. The Vision 1000 data also showed the instructor applying more left pedal in the second go-around.

The ground track and turn radius of the first 180° turn of each circuit were similar despite the difference in the AOB; this was due to the higher airspeed on the second go-around. The second go-around was commenced when on the final approach heading.

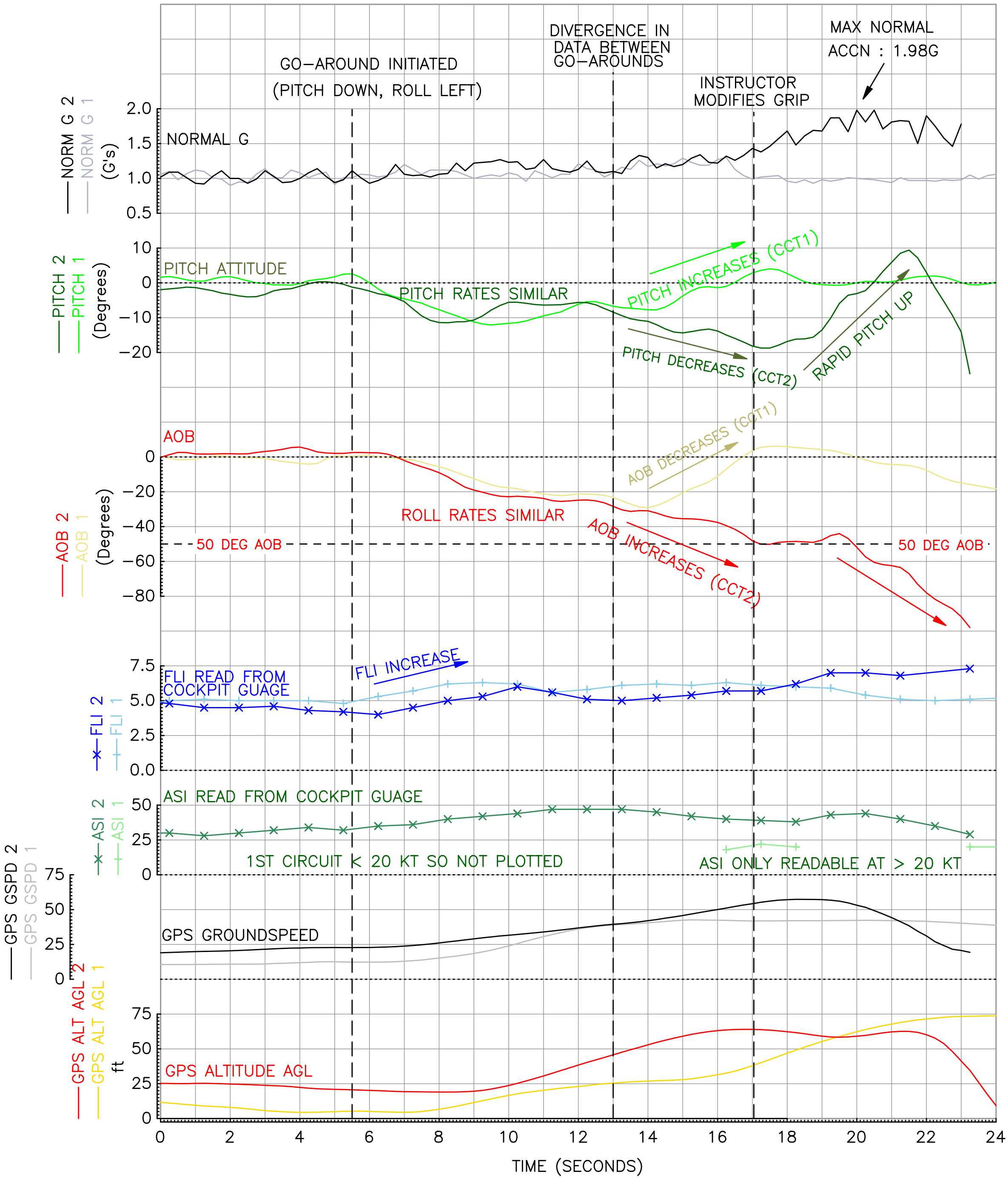

Figure 5

G-MATH comparison of two go-around manoeuvres.
Lighter coloured lines and '1' denote first circuit; darker lines and '2' denote second circuit.
(Data ends at impact)

Last 10 seconds of recorded data

In the final stages of the second go-around (Figure 6) the AOB increased to 50° left and the helicopter pitched down to -19° over four seconds. (The view from the cockpit video and recorded position at this point showed the helicopter was just inside the airfield boundary hedge). The recorded height was 64 ft agl.

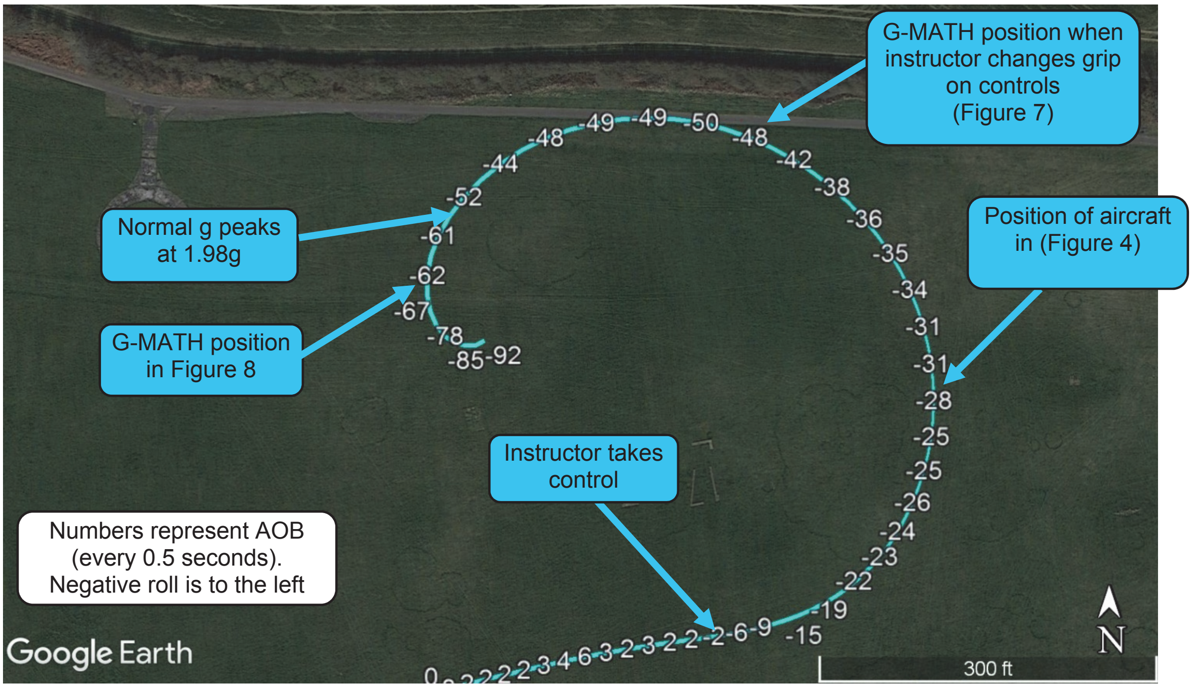

Figure 6

G-MATH final go-around manoeuvre showing AOB

At 0832:54 hrs the video showed the instructor changing his grip on the cyclic (Figure 7). The AOB then briefly stabilised at approximately 49° left as the helicopter began to pitch up. The AOB then briefly recovered to 44° (Figure 6).

From this point, the cyclic is seen to move to the right and aft but the AOB continued to increase as the helicopter pitched up and the recorded normal acceleration increased, reaching a maximum of 1.98 g at 52° left AOB. One second later, the right-seat pilot tightened his grip on the cyclic and maintained his grip until the helicopter struck the ground 3.5 seconds later.

After the instructor's grip on the cyclic had changed, his body also leant to the right (Figure 8) and for the final 3 seconds prior to the accident, obscured the Vision 1000's view of the right collective lever and the position of the hydraulic cut-off switch on the end of the right collective. The view of the CWP was not obscured and the red HYDR light remained illuminated until the end of the recording.

The helicopter struck the ground at 0833:01.5 hrs at a recorded vertical speed of -1,900 ft/min and 97° left AOB. Impact acceleration was not captured, possibly due to the recording sample rate of only 4 Hz, or the camera becoming detached from its mount.

Figure 7

G-MATH at 0832:54 hrs during second go-around showing changed grip for instructor (compare with Figure 4). (Instructor's head has been blurred)

Figure 8

G-MATH at 0832:58 hrs during second go-around showing instructor's right lean (62° AOB). (instructor's head has been blurred)

Control inputs

Position data of the control inputs (cyclic and collective) were not recorded by the Vision 1000 but the controls are visible in the video. Given that the instructor reported not being able to recover the helicopter to a level attitude, the position of the cyclic throughout this manoeuvre was of interest. Ordinarily, a comparison could be made between cyclic position during a 'full and free' control check prior to takeoff; however, on this helicopter type this check is not required to be performed, nor can it be due to the nature of the control system. It was also not possible to perform this on G-MATH after the accident due to the damage to the helicopter.

An AS350 B3e was selected which the manufacturer advised had controls representative of those fitted to G-MATH, but a different cockpit avionics fit. The flight controls were disconnected to allow them to be moved to the limits of travel and the Vision 1000 alignment was checked to be as close to G-MATH as possible. This was verified using a live link to the camera. This was not a precise setup and so an exact match could not be achieved, but the setup was nevertheless considered to be representative. Video recordings of full cyclic and control movements were then made.

During the final stages of the flight, only the right-seat pilot's cyclic was visible as the instructor had changed his hand position, obscuring the Vision 1000 view of his controls. The video imagery showed that at 0832:58 hrs and a left AOB of 62° (3.5 seconds prior to impact), the right-seat pilot's cyclic was positioned in the furthest right position which is shown in Figure 9. This figure also shows how his grip had tightened on the cyclic. While the exact cyclic position could not be established, when comparing to the 'full and free' check performed on the test helicopter, it shows that the cyclic had not reached its right limit (Figure 10).

Pilot interviews

The instructor and surviving pilot were interviewed by the AAIB. Initial interviews were conducted in hospital in the hours immediately following the accident. More detailed interviews were conducted subsequently after they had left hospital and were recovering from their injuries. Their recollection of the sequence of events was similar, though both differed from the events recorded by the Vision 1000 system.

Instructor

The instructor stated that he was conducting a Type Rating course for the two pilots. He had conducted two days of ground school interspersed with some flying with both pilots. He specifically recalled that hydraulics-off flight had been "an issue" for the right-seat pilot. For the day of the accident, the instructor recalled departing the circuit to the north to conduct some emergency handling exercises. He could not recall the exact content but felt that these exercises would have been suitable for the Skills Test which the pilot was due to take that afternoon. The instructor subsequently stated that he had briefed the students prior to the exercise that there was only one hydraulic cut-off switch, located on the right collective lever and that they should only turn the hydraulics back on if he requested them to do so.

Figure 9

G-MATH Vision 1000 view showing right-seat pilot's cyclic position at its furthest right during the second go-around

Figure 10

View from exemplar helicopter Vision 1000 showing full right cyclic in mid fore-aft position

The helicopter then returned to the airfield and the instructor initiated the hydraulics-off training exercise. His recollection of the procedure was correct, as confirmed by the Vision 1000 data. He recalled that the exercise went well until the final stages, at which point he intervened as the right-seat pilot was allowing the helicopter to crab sideways and was not maintaining a level attitude. He then believed that he had landed the helicopter to debrief the pilot and to reset the hydraulic system; however, the Vision 1000 video showed that this did not occur.

For the second attempt, the instructor recalled performing a tight circuit to reposition on final approach to allow the pilot to repeat the approach and landing. He stated:

> "once again he allowed the speed to drop too far and allowed the approach to get crooked. The exercise requires quite a lot of forward cyclic since Hyd Off the aircraft tries to slow very quickly at slower speeds. I felt the approach was very marginal so I took control again."

He believed that he initiated an early left turn and explained that the right-seat pilot had been briefed not to restore hydraulics as he took control because of the low height and speed in a regime where significant forces are required on the controls. He stated that usually the helicopter is quite docile above 40 kt and that a hydraulics-off go-around is usually no problem.

In describing the final moments of the flight, the instructor stated:

> "Shortly after initiating a climb and then left turn, the aircraft rapidly and involuntarily banked to the left (possibly in excess of 70°) and I was unable to correct the attitude of the aircraft through any amount of physical force. The controls seemed to be completely jammed. As far as I recall the aircraft maintained this extreme angle of bank to the left until it impacted the ground as I was unable to influence any control upon the aircraft's flight trajectory."

Following review of the AAIB draft report, the instructor stated that:

> "by the time the aircraft had reached 30 degrees AOB, we had already lost control."

The instructor stated that the majority of the 580 hours he had accumulated on AS350 aircraft was on the B/B2 variant, although the majority of the training he had conducted was on the B3. He acknowledged that the hydraulics-off control loads could be "quite high".

Passenger

The other pilot under training, who was a passenger on the flight, was seated in a rear passenger seat. His recollection of the accident flight was that the helicopter initially went to the north of Wycombe Air Park to conduct confined area training and an autorotation. On returning to the airfield, he heard the instructor tell the right-seat pilot that they would do a hydraulics-off drill. His recollection was that this was done exactly as the flight manual states and that the speed was reduced to approximately 50 kt. He recalled that the speed should be around 10 to 15 kt in the latter stages and that the instructor emphasised speed control. The passenger thought the approach seemed good, but that in the later stages the speed was reducing excessively. He remembered the instructor telling the pilot to increase speed and then helping him with speed control. He also recalled that the aircraft landed after this exercise.

On the second go-around he recalled that the helicopter went forward and quickly left. Around 40° AOB he felt the bank was greater than usual and excessive. The helicopter continued to bank left and then struck the ground.

Hydraulics-off procedures

Hydraulic failure training procedure

Supplement 7 to the AS350 B3e Flight Manual[4] contained the hydraulic failure training procedure:

STEP 1: FAILURE SIMULATION

- **In steady flight conditions:**

1. Instructor.. **[ACCU TST]**: ON position:
   - CHECK HYDR flashes + Gong
2. Trainee .... **Safety speed** to between 40 and 60 kt (74 and 111 km/h)

- **Once safety speed reached:**

3. Instructor.. **[ACCU TST]**: Reset to OFF position:
   - CHECK HYDR

STEP 2: HYDRAULIC FAILURE TRAINING PROCEDURE

4. Hydraulic cut-off switch............................ OFF:
   - CHECK HYDR + Gong
   - Control loads are increased
5. Perform a flat approach into wind
6. Make a no-hover, slow running landing at around 10 kt (18.5 km/h)

Do not perform hover or taxi without hydraulic pressure.

- **After landing:**

7. Hydraulic cut-off switch............................ Reset to ON to restore hydraulic assistance before subsequent takeoff or hovering flight
   - CHECK HYDR within 3 sec.

The training procedure stated that the limitations and emergency procedures in the basic flight manual and supplements remained applicable. At the time of this accident, the training procedure did not state whether the hydraulics should be reinstated during a go-around.

Footnote

4 Flight manual revision status 31 January 2017.

AS350 B3e Flight Manual Emergency Procedures

Chapter 3.6 of the Emergency Procedures section of the flight manual contained the emergency procedure for a hydraulic failure:

FLIGHT MANUAL

3 HYDRAULIC ALARMS

WARNING PANEL	CORRECTIVE ACTIONS
HYDR Loss of hydraulic pressure or pressure < 30 bar (435 psi)	**Keep aircraft at a more or less level attitude.** **Avoid abrupt maneuvers.** **CAUTION** **Do not use [ACCU TST] pushbutton as this will depressurize the yaw load compensator resulting in heavy pedal control loads.** **Do not attempt to carry out hover flight or any low speed maneuver.** **The intensity and direction of the control feedback force will change rapidly. This will result in poor aircraft control and possible loss of control.** **As control loads increase, be careful not to inadvertently move twist grip out of FLIGHT position (TWT GRIP light off).** **NOTE** **The accumulators contain sufficient pressure to secure flight and to reach the hydraulic failure safety speed.** • **HIGE, Takeoff, Final**: (if immediate landing is possible) 1. Land normally 2. Twist grip............................ Set to IDLE position 3. Collective pitch.................... LOCK 4. Engine starting selector ...... OFF • **In flight**: Smoothly, 1. IAS .... SET to between 40 and 60 kt (74 Km/h and 111 Km/h) (hydraulic failure safety speed) 2. Hydraulic cut-off switch (collective pitch).................. OFF Pilot has to exert forces: - on collective increase or decrease around no force feedback point, - on forward and left cyclic. **LAND AS SOON AS POSSIBLE** **NOTE** **Speed may be increased as necessary but control loads will increase with speed.** 3. Approach and landing: over a clear and flat area - Perform a flat approach into wind - Make a no-hover slow running landing at around 10 kt (18.5 km/h) - **Do not perform hover or taxi without hydraulic pressure** 4. After landing: - Collective pitch .... LOCK - Shutdown procedure .... Apply

APPROVED 350 B3e **3.6**

The emergency procedure stated that the helicopter should be kept at a '*more or less level attitude*' and to '*avoid abrupt manoeuvres*'. In contrast, the French language version of the flight manual procedure stated that the attitude should be maintained at approximately zero degrees[5].

There was no advice in the flight manual pertaining to a go-around from a hydraulics-off approach. The flight manual stated that hydraulic assistance could be recovered at any stage by selecting the HYD CUT OFF switch to ON.

AS350 B3e Flight Manual Limitations

The Limitations section of the flight manual did not specify any bank angle limits for flight with or without hydraulics. It did include a general limitation stating that aerobatic manoeuvres were forbidden.

EASA Operational Evaluation Board Report (OEBR)

The AS350 OEBR, produced by the EASA Certification Directorate, contained Teaching Areas of Special Emphasis (TASE). These identified training procedures which should receive special attention. One of those highlighted was simulated hydraulic failure training.

On this topic the OEBR included the information that, if necessary during the training exercise, hydraulic assistance could be recovered immediately by resetting the hydraulic cut-off switch to ON.

It also included the notes:

> ***'Left hand collective lever is not equipped with 'HYD' switch,***
>
> - To be *well prepared, brief your Trainee for setting the collective lever HYD switch to on, if necessary.*
> - *If the Instructor decides to take over the controls, he must plan to continue the flight up to the landing without hydraulic assistance.*
> - *CAUTION: when hydraulic pressure is restored in flight, the forces disappear which can lead to an abrupt left roll movement.'*

The OEBR contained, amongst others, the following caution in respect of hydraulics-off training:

> - *'The statistics show that failure to strictly comply with the procedure consequently increases the risk level. '*

The OEBR did not state whether a go-around should be performed with hydraulics off or on.

Footnote

5 It stated in French: '*Maintenir l'appareil à assiette ≈ 0.*'

Aircraft examination

The left side of the cabin floor was significantly deformed and crushed in the accident sequence.

The HYD CUT OFF switch on the right collective was found in the forward, hydraulics on, position, but it could have been switched back on during the last 3 seconds before impact or it could have been knocked during the impact or during evacuation[6]. The spring-guarded ACCU TST switch was off.

All the flight control linkages were connected. Some control rods were deformed due to ground impact loads and there were two overload failures (left pedal pitch link and tail rotor gearbox input lever) which were also the result of ground impact. There was resistance to moving the right cyclic stick, so the cyclic friction was removed to facilitate movement, but the number of turns of the ring was not recorded. The control resistance was due to deformation of the cabin floor and the control rods beneath it, rather than cyclic friction. An inspection for foreign objects that might have jammed the cyclic controls did not reveal anything. The HeliSAS control servos and control rods were properly connected; when they were disconnected the servos moved freely with no resistance. As the HeliSAS was off during the flight no further investigation of the system was carried out.

The main servo accumulators were in good condition and the nitrogen charge was correct at about 13 bar for each of them. The tail rotor accumulator pressure was measured at 19 bar. When the ACCU TST switch was pressed with electrical power on the aircraft, the pressure reduced to 12 bar which indicated that the tail rotor accumulator was pressurised at the time of the accident.

The hydraulic system was tested by using a drill and special adaptor to drive the hydraulic pump. The system pressurised to normal pressure and the HYDR warning caption in the cockpit extinguished. Turning the hydraulics off with the collective mounted cut-off switch depressurised the system and depleted the three main servo accumulators (as designed) and caused the HYDR warning caption to illuminate.

Due to the deformation in the flight control rods, the servo actuator input rods were disconnected from the main servos. Hydraulic pressure was applied and the servos were actuated by moving the input lever by hand. The input levers moved freely but the front servo actuator piston rod did not extend or retract due to a bend in the piston rod which was the result of ground impact loads. The right servo actuator also had a bent piston rod which meant that full extension was not possible, but full retraction was possible with the head disconnected. The left servo actuator and tail servo actuator piston rods moved freely full range.

When hydraulic pressure was removed the servo actuator locking pins operated normally on all servos, locking the input levers, which meant that that the servo actuator could be operated manually without hydraulic assistance.

Footnote

6 The HYD CUT OFF switch has a fixed guard around the switch to help prevent the hydraulics being inadvertently turned off, but the guard does not prevent the switch from being knocked ON.

No pre-impact faults were found that would have prevented normal operation of the flight controls with the hydraulics on or off.

The powerplant was not examined as there was clear evidence from the Vision 1000 video that the engine and main rotor were producing power at impact.

The hard plastic fuel tank had cracked open at its base and most of the fuel contents had drained away.

Survivability

The occupants did not wear helmets and there was no requirement for them to do so.

The left front seat harness had been cut to release the instructor, while the right front seat harness was undone. There were conflicting witness reports about whether the right front seat harness was fastened when the emergency services arrived. A review of the cockpit imagery revealed that the right front seat harness was highly likely to have been fastened at impact. When checked, the right front seat harness operated normally.

The aircraft was fitted with stroking crashworthy seats, but due to the sideways impact direction these had not provided any force attenuation. All seats had remained secure on their mountings. The left side of the cabin was extensively damaged due to the impact.

The airfield fire and rescue service responded quickly and were on scene within a few minutes. They were subsequently supported by the local authority fire brigade and ambulance service. Others at the airfield also came to assist.

When the emergency services reached the scene, the passenger in the rear seat was standing up through the right passenger door of the helicopter. He had suffered multiple injuries, including a fractured pelvis and serious facial injuries. He was assisted out by the fire service and then laid on the ground nearby, while the emergency services assisted the other occupants.

The instructor had suffered multiple serious lacerations, broken ribs and collarbone and was semi-conscious.

The pilot in the right seat was unconscious and not breathing when first responders arrived on scene. He was extracted from the aircraft and resuscitated before being transferred to hospital by air ambulance. He died as a result of his injuries some weeks later.

Medical information and pathology

The pathology for the pilot who was fatally injured indicated that he had sustained extensive thoracic injuries during the accident. These injuries may have contributed to the cardiac arrest which he suffered. The findings strongly suggested that the cause of death was a grave hypoxic injury resulting from a lengthy cardiac and respiratory arrest. The pathology report stated there was no evidence of previous cardiac disease and that no evidence was found to suggest that the pilot had suffered a heart attack prior to the accident.

A quantity of a prescription drug was found at the accident site. In his statement to the AAIB, the instructor stated that he was taking the drug under the supervision of a doctor who was not an Aviation Medical Examiner (AME). The instructor stated that he was using the drug infrequently in a very low dose and had not taken it for four or five days before the accident. A CAA AME consulted by the AAIB stated that if taken with a dosage as reported by the instructor, the drug would not have been detrimental to the instructor's performance.

Personnel

The instructor and pilots under training held valid and current EASA CPL(H)s and current Class 1 medical certificates. The instructor, who held a Flight Instructor (Helicopters) rating, was not an employee of the ATO at Wycombe Air Park but was trained in and had signed up to the ATO's Operations Manual procedures.

Weight and balance

G-MATH's estimated weight and centre of gravity at the time of the accident were 1,836 kg and 3.31 m, respectively. The estimated weight included the weight of the occupants, baggage and 218 kg of fuel. The allowable CG range at this weight is 3.27 to 3.48 m. The maximum takeoff weight (MTOW) is 2,250 kg.

Meteorology

No METAR or TAF is published for Wycombe Air Park. When the ATC log was opened at 0800 hrs, the following weather was recorded: wind 050° at 12 kt, cloud FEW 050, QFE 1004 hPa, QNH 1023 hPa. When G-MATH lifted off at 0803, ATC passed the following weather information: QNH 1023 hPa and wind 060° at 8 kt. At 0832 hrs, ATC reported a wind of 060° at 12 kt to another aircraft on approach to Wycombe.

Airfield information

The Aerodrome Control Section of Manual of Air Traffic Services Part 2 sets out the procedures for helicopter operations at Wycombe Air Park. The helicopter training area in use on the day of the accident is defined as area 'NOVEMBER'. It is used when Runway 06/24 is active and is centred at a position 120 m west of the Runway 35 stop end markers (western edge). It extends from 30 m north of Runway 06/24 out to the boundary of the aerodrome. There is no restriction to crossing the boundary during circuits.

Additional information

Previous AS350 hydraulics-off training accident

The Transportation Safety Board of Canada (TSB Canada) published Aviation Investigation Report A13Q0021, concerning a hydraulics-off training accident which occurred on 3 February 2013, which bore some similarity to the G-MATH accident.

The helicopter involved was an AS350 BA helicopter, registration C-GPHN. A training flight was being conducted, with an instructor and two pilots under training on board. During the hydraulics-off training detail the instructor took control of the helicopter and flew a tight left-hand circuit at low altitude and low speed without hydraulic pressure assistance. There was no Vision 1000 camera fitted. The instructor reported that, in the moments following the start of the final approach, the cyclic stick moved sharply forward and to the left out of the palm of his hand. The instructor grabbed the cyclic stick to re-establish level flight, since the helicopter was quickly banking to the left in a nose-down attitude. The main rotor blades struck the runway and the helicopter came to rest on its left side. The instructor was seriously injured, whilst the other two pilots sustained minor injuries.

The TSB Canada report included the following observation:

> *'The investigation also revealed that some flight instructors were not fully aware of the risks associated with manoeuvres at low altitude and in hover without hydraulic pressure assistance.'*

The report findings included the following statement:

> *'The helicopter's flight profile deviated from the flight profile recommended by the aircraft manufacturer when the hydraulic system is depressurised. As a result, the flight instructor encountered heavy, unpredictable flight control feedback forces.'*

Another recorded finding was that the left collective lever does not have a HYD CUT OFF switch and so the instructor was unable to easily restore hydraulic pressure.

Established UK-based AS350 operator's hydraulics-off procedures

A large, long-established AS350 operator in the UK was consulted by the AAIB regarding their procedures for hydraulics-off training flight. While their operations manual reflected the helicopter manufacturer's, they advised anecdotally that it was their practice that go-arounds be flown straight ahead, and that the hydraulic system is re-selected on prior to manoeuvring. They also recommended the use of no greater than 20° AOB for hydraulics-off flight. Additionally, their helicopters had been fitted with a second HYD CUT OFF switch[7] on the left collective lever, so that the instructor can quickly re-select the hydraulics on if necessary.

Estimate of right lateral cyclic force that could be applied

The G-MATH instructor stated that he had been unable to move the cyclic any further to the right during the second go-around. A test was set up to measure how much lateral force a person could apply to the cyclic with a normal grip position, and with a modified grip position with a right lean as applied by the instructor about 7 seconds before impact. Four male individuals took turns applying their maximum possible right cyclic force using the normal and modified grip positions. The maximum force they applied ranged between 6.6 to 10.1 kgf

Footnote

[7] The two HYD CUT OFF switches are connected in series so that if either switch is off, the hydraulics are depressurised. In a practice hydraulic failure, after the student selects their switch to OFF, the instructor selects his switch off and resets the student's switch to ON. This leaves the hydraulics depressurised, but the instructor is able to turn on the hydraulics as necessary with his switch.

with the normal grip position and 8.9 to 17.6 kgf with the modified grip position. These measurements were taken without the individuals operating the collective or yaw pedals.

Certification requirements for control loads following loss of hydraulic pressure

When the AS350 B1 variant was being developed in 1985, the French Directorate General for Civil Aviation (DGAC) attached some special conditions to its certification concerning the control loads in the event of a loss of hydraulic pressure[8]. It stated that the cyclic control loads should not exceed 6.7 daN (6.8 kgf) in roll or 11.1 daN (11.3 kgf) in pitch during a 'protracted application', and should not exceed 13.3 daN (13.6 kgf) in roll or 26.7 daN (27.2 kgf) in pitch during a 'temporary application'. The former requirements for 'protracted application' were similar to the loads specified in the British Civil Airworthiness Requirements Section G2 of 1975. It stated that *'in the event of a failure in the power-control system it should be possible to continue steady flight and execute a normal landing without exceeding the following control forces:'* 70 N (7.1 kgf) for lateral controls and 111 N (11.3 kgf) for longitudinal controls.

The current certification requirements for small rotorcraft in EASA CS-27[9] do not specify control force limits related to handling requirements without hydraulic assistance. AC 27.695[10] states that for a rotorcraft with a single hydraulic system:

> *'A manually operated mechanical system may be used as the alternate system to a single hydraulic system if, after the loss of the single hydraulic system, the pilot can control the rotorcraft without exceptional piloting skill and strength in any normal maneuver for a period of time as long as that required to effect a safe landing.'*[11]

Flight test controls loads during certification of AS350 B1

To meet the DGAC's special conditions for control forces following loss of hydraulic pressure, the aircraft manufacturer conducted a flight test in an instrumented AS350 B1 in 1985. Cyclic forces were not measured directly but were calculated from the forces measured at the servo actuators. The data showed that the lateral cyclic control force required to maintain level flight at 45 kt was 5 kgf to the left which increased to 12.7 kgf to the left at 130 kt. The AOB was not recorded during any of the manoeuvres, nor were the control forces measured or calculated in a bank.

The aircraft manufacturer stated that, in the time between these flight trials and the accident to G-MATH, no measurements or calculations of the control loads in a bank without hydraulic assistance had been made.

Footnote

[8] DGAC letter SFACT/TC No 53639 dated 25 June 1985.

[9] Certification Specification 27, Amendment 4, 30 November 2016.

[10] The Acceptable Means of Compliance (AMC) in CS-27 consist of Federal Aviation Administration (FAA) Advsiory Circular AC 27-1B Change 4 dated 1 May 2014 with some changes and additions. AC 27.695 refers to a sub-section of AC 27-1B.

[11] The following sentence states that '*The control forces should not exceed those specified in § 27.397'*, but these are very high loads (298 N lateral and 445 N longitudinal) which relate to strength requirements rather than handling requirements.

Aircraft manufacturer's calculation of control loads after the accident to G-MATH

As a result of the accident to G-MATH, the aircraft manufacturer performed some calculations to try and estimate the cyclic control forces a pilot would experience at the increased 'g' levels in a bank flown at constant altitude. The manufacturer had obtained main servo actuator force data during flight trials in an EC130 which has the same rotor and servo actuators as the AS350 B3e. This data was obtained with the hydraulics on, but the measured forces on the servos could be used to calculate approximately what the cyclic force would be with the hydraulics off, using the geometry of the mechanical control system. From this data they determined that at an airspeed of about 40 kt, the left cyclic force that is normally required to maintain level flight will reverse direction to a right cyclic force at high 'g' levels. This would mean that in a left bank, the pilot would start by increasing the left cyclic force to roll left and would be maintaining a left cyclic force to stay in the bank. However, as the AOB and 'g' level increased the pilot would need to start applying right cyclic to maintain bank.

Based on their calculations a right cyclic force of 4.3 kgf would be needed to maintain bank in a left bank of about 60° at 2g (based on G-MATH's weight of 1,836 kg). However, the manufacturer stated that there are many assumptions and potential inaccuracies in the calculation method such that this value should only be taken as an indication of the possible force.

Aircraft manufacturer's informal flight test to evaluate hydraulics-off control loads in a steep bank

In September 2017, one of the aircraft manufacturer's test pilots carried out an informal flight test in an H125 helicopter ('H125' is the new name for the AS350 B3e). The flight was to qualitatively assess the hydraulics-off cyclic control forces in left turns up to 60° AOB[12]. There was no instrumentation and the data from the Vision 1000 was not provided to the AAIB. The test pilot reported that up to 45° AOB the cyclic control forces were similar to that in level flight; about 4 to 6 kgf needed to be applied in the forward and left direction. Beyond 45° AOB, these control forces started to reduce and reaching 60° AOB the forces were unstable in both the longitudinal and lateral directions, but they were assessed as quite light, at less than 2 kgf. He estimated that the reversal in control force direction occurred at 1.7 to 1.8 g[13] and the airspeed range was 45 to 70 kt. He stated that the helicopter remained fully controllable.

Human performance - startle effect

The possible effects of 'startle' on the instructor's performance were considered. Startle is defined in US Federal Aviation Authority Circular 120-111[14] as:

> *'an uncontrollable, automatic muscle reflex, raised heart rate, blood pressure, etc., elicited by exposure to a sudden, intense event that violates a pilot's expectations.'*

Footnote

12 The aircraft's weight was 1,820 kg, pressure altitude 1,200 ft, QNH 1015 hPa, temperature 24°C.
13 Estimated g force. The instruments do not display g.
14 Federal Aviation Administration (2015). Advisory Circular 120-111 Upset Prevention and Recovery Training. https://skybrary.aero/bookshelf/books/3175.pdf (accessed September 2018)

According to Martin, Murray, Bates and Lee (2016)[15] a physical startle response starts with an eye blink followed by an aversive movement away from the stimulus and orientation of attention towards the startling stimulus.

Startle can result in impaired human performance and if the startle is associated with a threat then the resulting fear can further increase the effects. This is called 'fear potentiated startle'. Research cited in Rivera et al (2014)[16] suggests that psychomotor and cognitive performance can be impaired for 30 to 60 seconds after a startling stimulus. Thackray and Touchstone (1969)[17] showed that startle resulted in a 65% increase in the error rate on a psychomotor tracking task, using a joystick, five seconds after a startling stimulus (psychomotor impairment).

Analysis

Pilot handling aspects

The accident occurred during a hydraulics-off training detail. The instructor was dissatisfied with the right-seat pilot's first approach and took control of the helicopter to perform a hydraulics-off go-around and a left-hand circuit to reposition for a second attempt. On the first circuit, a maximum AOB of 32° was recorded.

The instructor again took control in the latter stages of the second approach before commencing another left-hand circuit. As the turn developed, the instructor reported that he had been unable to move the cyclic to the right to reduce the bank angle. He stated later that control was lost by the time the helicopter reached 30° AOB. The roll rates up to 30° AOB were similar on both go-arounds and on the second go-around the roll rate remained approximately constant up to 40° AOB. It could not be determined from the cockpit imagery at what AOB the instructor started to apply right cyclic force to either arrest or reduce the left bank angle, but it showed the instructor changing his grip and leaning to the right in a possible attempt to apply greater right lateral force to the cyclic when the AOB reached 48°. The AOB stabilised at 50° then reduced briefly, before increasing again, despite the instructor's apparent continued efforts and the helicopter descended rapidly and struck the ground at 97° AOB. The low height at which the hydraulics-off left turns were performed meant that little height was available to attempt a recovery following a loss of control.

The cockpit images showed that the right-seat pilot kept his hand on the cyclic during both go-arounds, contrary to the briefing, but he appeared to relax his grip when the instructor

Footnote

15 Martin, Murray, Bates, Lee (2016). A flight simulator study of the impairment effects of startle on pilots during unexpected critical events. Aviation Psychology and Applied Human Factors, 6(1), 24-32. https://econtent.hogrefe.com/doi/pdf/10.1027/2192-0923/a000092 (accessed September 2018)

16 Rivera, J., Talone, A.B., Boesser, C.T., Jentsch, F., Yeh, M. (2014). Startle and surprise on the flight deck: Similarities, differences and prevalence. Proceedings of the Human Factors and Ergonomics Society 58th Annual Meeting 2014, 1047 – 1051. https://www.skybrary.aero/bookshelf/books/3748.pdf (accessed September 2018)

17 Thackray, R.I. and Touchstone, R.M. (1969). Recovery of motor performance following startle. Federal Aviation Administration, Office of Aviation Medicine https://www.faa.gov/data_research/research/med_humanfacs/oamtechreports/1960s/media/AM69-21.pdf (accessed September 2018)

took control. Whilst this did not appear to be significant for the first go-around according to the cockpit imagery, it was not possible to determine if his hand on the cyclic had been influential during the second go-around. It was only in the final 3.5 seconds before impact that the right-seat pilot appeared to tighten his grip on the cyclic.

Control forces

The evidence from the instructor and the Vision 1000 suggests that at 50° AOB and beyond, even while trying to apply full right cyclic, the instructor was unable to move it to the right and he could not roll the helicopter level.

A detailed examination of the helicopter did not reveal any technical faults that would explain the high control forces reported by the instructor, nor why the instructor was unable to move the cyclic further to the right during the final manoeuvre.

The control force measurements carried out during the investigation revealed that modifying the cyclic grip and leaning to the right, in the manner performed by the instructor, increased the amount of right cyclic force that could be applied. The maximum force the four tested individuals were able to apply ranged between 8.9 and 17.6 kgf.

The hydraulics-off certification requirements for the helicopter allowed a maximum lateral cyclic force of 6.8 kgf during protracted application and 13.6 kgf in a temporary application. However, there was no requirement to measure the control forces in a steep bank and therefore AOB was not recorded during the certification flight tests.

During the investigation, the manufacturer attempted to calculate the control loads as a function of ‘g’ using EC130 flight test data. This determined that a control force reversal occurred as the ‘g’ increased (to maintain height in a turn, the ‘g’ will increase with increasing AOB). This meant that in a left bank the pilot would need to apply and hold a left cyclic force to keep it in a left bank, but as the AOB increased the pilot would need to apply a right cyclic force to stop the AOB from increasing. The calculations determined that a right cyclic force of 4.3 kgf would be needed to maintain a left bank of 60° at 2g. This is below what the instructor should have been able to apply, especially with the right lean and modified grip position.

The manufacturer cautioned that there were many assumptions and potential inaccuracies in the calculation method, so they performed an informal flight test to investigate the control loads in a bank. The flight test involved left rolls up to 60° AOB in an airspeed range of 45 to 70 kt. The control loads were assessed as light; less than 2 kgf but varying between the left and right direction. It is not known if the specific airspeed, ‘g’ and bank angle combination of the accident manoeuvre was attained during this informal flight test.

It is possible that there are conditions in steep bank angles where the control forces are higher than those determined during the brief informal flight test. The manufacturer’s test pilot was expecting some control force reversal during the manoeuvres which the instructor of G-MATH would not have been expecting.

Human performance aspects

It is possible that an unexpected control force reversal, the sudden steep AOB, and the proximity of the ground caused the instructor to become startled. The instructor's right lean, away from the approaching ground, could be interpreted as an 'aversive movement', as would be expected in a startle response. It may have been theoretically possible for the instructor to exert sufficient control force to recover, but the possible startle may have resulted in a psychomotor impairment that prevented him from doing so. The amount of time available to the pilot to recover from the high AOB was less than five seconds and this is consistent with the period where impairment may be expected.

Previous accident to C-GPHN

The accident to C-GPHN, investigated by TSB Canada, bore similarities to the G-MATH accident in that both accidents involved the helicopter being manoeuvred close to the ground during hydraulics-off training. In both cases, control was lost, with insufficient height available to recover. The TSB Canada investigation report stated:

> *'Past experience and the interpretation of the RFM might lead pilots to believe they can control the aircraft at any stage of flight without hydraulic pressure assistance, without factoring in the unpredictable nature of flight control loads.'*

It is possible that the hazards of hydraulics-off operation are not as widely appreciated as they should be amongst AS350 instructors and pilots in general.

Flight Manual instructions

Hydraulics-off training

The hydraulic failure procedure contained in Chapter 3.6 of the Emergency Procedures section of the AS350 B3e flight manual stated that the aircraft should be kept at a more or less level attitude and abrupt manoeuvres should be avoided. It also cautioned against attempting any low speed manoeuvre and that the intensity and feedback of the control feedback force will change rapidly, resulting in poor aircraft control and possible loss of control.

A '*more or less level attitude'* is open to interpretation. It is not a clear limit, and therefore operators have had to establish practical limits. Maintaining a level attitude is not reasonable because it may be necessary to manoeuvre to land. The large well-established UK-based AS350 operator consulted by the AAIB stated that they restored the hydraulics for go-arounds from hydraulics-off training approaches and also limited the AOB to 20° for hydraulics-off flight.

The hydraulics failure training procedure contained in Supplement 7 stated that the limitations and emergency procedures in the basic flight manual and supplements remain applicable. However, the documents required pilots to cross-reference both to obtain all the relevant information pertaining to hydraulics-off flight.

An amendment to the Supplement 7 training procedure to include the instructions and cautions from the hydraulic failure emergency procedure would remove the need for any interpretation and serve to better highlight the actual risks associated with hydraulics-off training.

Go-arounds during hydraulics-off training

The Supplement 7 hydraulic failure training procedure instructions stated that the HYD CUT OFF switch should be reset to ON to restore hydraulic assistance before subsequent takeoff or hovering flight. At the time of this accident, there were no instructions on how to perform a go-around from an unsatisfactory hydraulics-off training approach.

The EASA A350 OEBR TASE included additional information not included in the Supplement 7 procedure. This included briefing the student to set the collective lever HYD switch to ON if necessary and provides a caution that:

> *'when hydraulic pressure is restored in flight, the forces disappear, which can lead to an abrupt left roll movement.'*

The TASE did not contain any instructions on how to perform a go-around from an unsatisfactory hydraulics-off training approach.

Amendments to the AS350 flight manual to introduce a clear AOB limit for hydraulics-off flight and to describe how to perform a go-around from a practise hydraulics-off approach would provide an increased level of safety during hydraulics-off operations.

Conclusion

No technical issues were identified with the helicopter. The investigation was unable to determine the reason why the instructor was unable to roll the helicopter back to a level attitude during the second hydraulics-off go-around, which was flown at a greater AOB than the first. However, it is possible the pilot suffered a startle effect from the unexpected control force reversal, the sudden steep AOB, and the proximity of the ground.

The C-GPHN and G-MATH accidents involved the helicopter being manoeuvred close to the ground during hydraulics-off training. In both cases, control was lost, with insufficient height available to recover. It is possible that AS350 pilots and instructors are not universally aware of the hazards of manoeuvring the helicopter at low height with hydraulics off. Clearer instructions in the AS350 flight manual on how to perform hydraulics-off flight would help to prevent similar accidents in the future.

Safety actions

The helicopter manufacturer stated that the analysis of the G-MATH accident has revealed that the flight conditions and safety requirements already contained in the AS350 hydraulic failure procedure and Flight Manual Supplement 7 hydraulic failure training procedure were not well enough highlighted, possibly leading to misinterpretation and hence flight outside the dedicated flight envelope for these procedures.

Consequently, Airbus Helicopters has taken the following safety actions intended to prevent reoccurrence:

The AS350 flight manual has been amended to:

- Include a clear angle of bank limitation of 30° for hydraulics-off flight;
- Include warnings to clearly emphasize the risk of loss of control of the helicopter if the hydraulic failure or hydraulics-off training procedures are not complied with;
- State: '*In case of a go-around during hydraulic failure training procedure, it is recommended to abort the training and to reset the hydraulic cut-off switch to 'ON'*
- Include the note: '*When resetting the hydraulic cut-off switch to ON, be prepared for a significant decrease of cyclic and collective control loads*'.

Airbus Helicopters has taken the further safety actions of publishing Safety Information Notice No. 3246-S-29 highlighting these flight manual changes and preparing a video[18] on how to conduct hydraulics-off training safely.

Footnote

[18] A link to this video is at: https://dai.ly/k35kJCQ5f47SQcrffPU (accessed September 2018)

AAIB Correspondence Reports

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

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

The accuracy of the information provided cannot be assured.

ACCIDENT

Aircraft Type and Registration:	Auster 6A Tugmaster, G-APRO
No & Type of Engines:	1 De Havilland Gipsy Major 10 mk.1-1 piston engine
Year of Manufacture:	1946 (Serial no: WJ370)
Date & Time (UTC):	19 July 2018 at 1413 hrs
Location:	Old Buckenham Airfield, Norfolk
Type of Flight:	Private
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Collapsed landing gear, damage to engine cowling and propeller
Commander's Licence:	Private Pilot's Licence
Commander's Age:	67 years
Commander's Flying Experience:	294 hours (of which 83 were on type) Last 90 days - 43 hours Last 28 days - 17 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot reported that during the final approach to land on Runway 07L (Grass) at Old Buckenham Airfield, the airspeed was too low. This resulted in the aircraft stalling and dropping to the ground from a height of approximately 10 ft, damaging the landing gear, engine cowling and propeller. The pilot stated that the accident had resulted from a misjudgement of the landing.

ACCIDENT

Aircraft Type and Registration:	Beech A36 Bonanza, G-CDJV
No & Type of Engines:	1 Continental Motors Corp IO-520-BA piston engine
Year of Manufacture:	1976 (Serial no: E-951)
Date & Time (UTC):	26 June 2018 at 0910 hrs
Location:	Benwick Airstrip, Cambridgeshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Main landing gear, locker doors hinges and ribs and propeller damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	56 years
Commander's Flying Experience:	530 hours (of which 2 were on type) Last 90 days - 10 hours Last 28 days - 6 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

At takeoff power, on departure, the engine began misfiring but ran more smoothly when throttled back. Despite it sounding better, the pilot assessed that the engine was not running normally and elected to return to Benwick. On left base, the engine started misfiring, so the pilot switched from left to right tank fuel feed. Switching fuel supplies did not cure the misfiring. With the engine delivering insufficient power to maintain height, the pilot turned immediately for the runway, extending the flaps and landing gear on short finals. At touchdown, the undercarriage was in the latter stages of lowering and not locked down. During the ground roll the landing gear collapsed and the aircraft slid to a halt on its belly.

The pilot had found no evidence of fuel contamination during his pre-flight checks but recovered approximately 50 cc of dirt-contaminated water from the aircraft's gascolator[1] after the accident. While it was not possible to determine the precise cause of the engine failure, the owner's contracted maintenance engineer believed fuel contamination was a factor. The source of the water in the gascolator was not positively identified.

Footnote

[1] Filter fitted at the lowest point of the fuel system.

ACCIDENT

Aircraft Type and Registration:	CEA DR221B Dauphin, G-RRCU
No & Type of Engines:	1 Lycoming O-235-C2A piston engine
Year of Manufacture:	1968 (Serial no: 129)
Date & Time (UTC):	3 June 2018 at 1145 hrs
Location:	Tatenhill Airfield, Staffordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Left landing gear collapsed, propeller grazed the ground
Commander's Licence:	Private Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	507 hours (of which 10 were on type) Last 90 days - 4 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot was flying solo circuits from Runway 26 at Tatenhill Airfield. It was a warm day with a temperature of 24°C and sunny conditions.

Having completed a circuit and landing, the pilot prepared for the subsequent takeoff by raising the flaps. He then applied full power and began the takeoff roll. Just as the pilot lifted the tail off the runway, he experienced a cramp spasm in his right leg which caused him to straighten his leg to try and stop what he described as "excruciating pain". This resulted in him increasing pressure on the right rudder pedal and the right brake. Despite quickly closing the throttle, the aircraft turned rapidly through 90°. Although it remained on the runway, the left landing gear collapsed as the aircraft slowed, causing it to rotate further and the propeller to contact the ground.

The pilot reported that there was little airflow in the cabin which, combined with the hot weather and a lack of fluid intake, might have contributed to the onset of cramp.

ACCIDENT

Aircraft Type and Registration:	Cessna F172H Skyhawk, G-AWUX
No & Type of Engines:	1 Continental Motors Corp O-300-D piston engine
Year of Manufacture:	1968 (Serial no: 577)
Date & Time (UTC):	19 April 2018 at 1338 hrs
Location:	3 miles southwest of Perranporth airfield, Cornwall
Type of Flight:	Private
Persons on Board:	Crew -1 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Damage to propeller, nosewheel, cowling, left wing strut and tailplane
Commander's Licence:	Private Pilot's Licence
Commander's Age:	80 years
Commander's Flying Experience:	186 hours (of which 108 were on type) Last 90 days - 0 hours Last 28 days - 0 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

When applying full power, following a descent at idle power there was a sudden bang and heavy vibration. The vibration eased on reducing power but increased again as power was applied. The pilot declared a MAYDAY and initiated a forced landing. At 50 ft, the pilot realised that his selected field was unsuitable so he veered left and landed in a harrowed field. The wheels dug in and the aircraft flipped inverted. The cause of the engine problem could not be determined.

History of the flight

The pilot carried out power checks and then departed from Perranporth Airfield on a local flight. He levelled off at 2,200 ft and headed west in clear air and VMC conditions. He could see a broken cloud layer 800 ft below him over the coast moving in from the southwest. After reaching the coast north of St Agnes, he tracked southbound along the coastline before deciding to return to Perranporth to avoid needing to fly below the incoming cloud layer. He selected idle power and started a descending left turn onto a south-easterly heading.

When he reached 1,200 ft (QFE) he decided to level off and applied full power. He reported that on applying power there was a "an explosive bang and heavy, violent vibration and shuddering". He immediately selected idle power and the shuddering eased but the vibration continued at a reduced but still severe level. When he tried to increase the power the vibration worsened to the point where it was difficult to read the flight instruments and hold the yoke, with no perceived benefit in reducing height loss. He re-selected idle power, made a MAYDAY call and started to prepare for a forced landing.

The terrain to his right and behind him was mainly heathland, and ahead of him were many small walled fields. He lined up to land on a long narrow grass field but at about 50 ft he noticed stone hedges across its width, so he veered left towards a harrowed field. On touchdown the wheels dug in, the nosewheel was ripped off, and the aircraft nosed over onto its back. The pilot was able to vacate the aircraft via the passenger door.

The pilot could not recall whether he had selected the carburettor heat on prior to his descent from 2,200 ft, but he stated that he normally did so.

Engine examination

The engine was a Continental O-300-D which has six cylinders and a carburettor. As of 18 December 2017 it had accumulated 1,397 hours since last overhaul. A maintenance engineer examined the engine at the accident site. The was no external damage to the engine apart from the carburettor, which had broken off. The oil level was in the normal operating range and there were no oil leaks. The engineer turned the propeller by hand and felt six compressions; he then activated the starter motor and the engine turned normally. He stated that the Continental O-300 series of engines were prone to carburettor ice due to the carburettor's narrow throat and high gas-speed induction system.

An insurance loss adjustor subsequently examined the engine after the aircraft had been moved from the site. He confirmed the oil level and that the engine turned over on the starter motor with "no abnormal sounds or mechanical interference". The exhaust and exhaust manifold were firmly attached. He removed all six upper spark plugs and they all had a layer of dark soot which is indicative of the engine running over-rich. He stated that he believed it was a short term over-rich condition as the electrode insulators were not completely covered in soot.

Meteorology

About 10 minutes after the accident the temperature and dewpoint at Newquay (8 nm north-east of Perranporth) were 14°C and 11°C respectively. An upper air sounding for Camborne (11 nm south-west of Perranporth) measured a temperature and dewpoint of 9.8°C and 9.2°C respectively at 2,000 ft, and 11°C and 10.5°C at 1,000 ft. These conditions placed the risk of carburettor icing as '*serious icing - any power setting*' according to CAA Safety Sense Leaflet No 14, '*Piston Engine Icing*'.

Analysis

The engine examinations carried out by an engineer and the loss adjustor did not reveal any mechanical defects that would explain the heavy vibration reported by the pilot.

The meteorological conditions were conducive to carburettor icing and according to a maintenance engineer the engine type was prone to carburettor ice. If the pilot had forgotten to select carburettor heat before reducing the engine power to idle prior to the descent, then carburettor ice was more likely to form. Carburettor ice formation results in a restriction of airflow and causes the engine to run rich; there was evidence from the spark plugs that the engine was running rich. A rich-running engine typically leads to rough running and can cause the engine to stop. The symptoms reported by the pilot of severe vibration are not typical of carburettor ice; however, most aircraft engines with carburettors are four-cylinder engines, whereas this was a six-cylinder engine, so it is possible that the symptoms would be different. The sudden bang might have been caused by detonation in the exhaust system due to incomplete combustion in the cylinders from an over-rich mixture. It is also possible that there was a fault with the engine, possibly related to the valves, that only a full engine teardown would reveal.

ACCIDENT

Aircraft Type and Registration:	Dyn'Aero MCR01, G-CWMT
No & Type of Engines:	1 Rotax 912 ULS piston engine
Year of Manufacture:	2007 (Serial no: PFA 301-14347)
Date & Time (UTC):	10 March 2018 at 1600 hrs
Location:	Old Park Farm Airfield, near Port Talbot, South Wales
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damaged beyond economical repair
Commander's Licence:	Private pilot's licence
Commander's Age:	59 years
Commander's Flying Experience:	1,568 hours (of which 33 were on type) Last 90 days - 6 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

During landing after a short local flight, the pilot reported that the aircraft experienced windshear during the flare which caused the left wing to drop. He countered this, but then the right wingtip touched the ground whilst the nose was in a higher than normal attitude. The pilot added power to recover control and then landed again, but there was insufficient distance remaining to stop. The runway is approximately 340 m long. The aircraft came to rest against an earth bund at the base of a fence. The pilot was unharmed and able to vacate the aircraft normally. The aircraft was damaged beyond economical repair.

A similar accident involving windshear at the same airstrip is reported in AAIB report EW/G2013/09/14, published in the December 2013 Bulletin.

CAA Safety Sense Leaflet 12, '*Strip Flying*', contains useful information and guidance for pilots operating at private airfields and airstrips, including:

> *'DO be ready for unexpected effects from trees, barns, windshear, downdraught, etc'*

and

> *'…if you find a problem with turbulence or crosswind, surface or slope, do not hesitate to go around in accordance with normal aviation practice.'*

ACCIDENT

Aircraft Type and Registration:	Groppo Trail, G-CIGR	
No & Type of Engines:	1 Sauer S 2400 UL piston engine	
Year of Manufacture:	2015 (Serial no: LAA 372-15229)	
Date & Time (UTC):	14 July 2018 at 1420 hrs	
Location:	South Longwood Farm, Owslebury, Hampshire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 1
Injuries:	Crew - 1 (Minor)	Passengers - None
Nature of Damage:	Extensive	
Commander's Licence:	Light Aircraft Pilot's Licence	
Commander's Age:	74 years	
Commander's Flying Experience:	3,228 hours (of which 164 were on type) Last 90 days - 7 hours Last 28 days - 24 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

Synopsis

The aircraft took off from a farm strip but did not climb sufficiently to clear a high hedge beyond the end of the runway.

History of the flight

On the morning of the accident the pilot and a passenger flew from a farm strip in Wiltshire, where the aircraft was usually kept, to West Tisted Airfield which was hosting a fly-in. The weather was fine and warm with light winds and the ground conditions were very dry as there had been a prolonged spell of hot dry weather in the south of England. The flight was uneventful. The aircraft later took off from the westerly runway at West Tisted and flew directly towards the next destination, South Longwood Farm strip, Owslebury, where it landed. The pilot reported there had not been any problems with the aircraft on either flight.

The pilot and his passenger set off from South Longwood in the early afternoon. The pilot calculated that the aircraft weighed 516 kg, 4 kg below the maximum takeoff weight of 520 kg. At the western end of grass Runway 06 are several steel-framed hangars, and at the eastern end is a public road with a high hedge on the far side. A windsock near the hangars at the western end indicated a light crosswind from the north (left for Runway 06), and the pilot assessed the wind locally as light and variable. He also assessed there was a downslope on Runway 06 and decided to take advantage of it and take off in an easterly direction. The temperature was around 27°C.

The pilot and passenger pushed the aircraft back towards the hangars to make maximum use of the available runway. The takeoff roll started normally and the aircraft lifted off, as the pilot expected, around the mid-point of the 650 m runway. The aircraft climbed to about 15 - 20 ft, but then stopped climbing. The pilot could see trees ahead across a road beyond the end of the runway and turned slightly left to try to avoid them. The aircraft crossed above the public road and struck a telegraph pole. The pole gave way and the aircraft dropped into the hedgerow. The fuselage was significantly damaged but the occupants, who were wearing full four-point shoulder harnesses, were not injured and were able to exit the aircraft unassisted. A search party took some time to locate the aircraft because it was hidden from view by surrounding foliage.

Aerodrome information

South Longwood is a privately owned and operated farm strip located at the bottom of a valley with steep hills nearby. It is situated within the Southampton Control Zone and Southampton ATC must be contacted for entry or departure instructions. The pilot, before his flight, had contacted the airstrip operator and received a texted briefing about the airstrip. The passenger had visited the airstrip previously.

The grass runway orientated 060/240°M has a length of 650 m, width of 14 m and a downslope for the first 200 m of Runway 06. There is also a down slope from left to right for the first half of Runway 06. The airfield windsock is located by buildings at the western end of the airstrip.

There was no telephone landline available at the airfield at the time of the accident and the mobile reception was poor.

Other information

The Groppo Trail is a high-wing, tailwheel aircraft with two tandem seats. The Sauer S 2400 UL piston engine has a power output of 100 hp at 3,500 rpm; no performance data is available for the aircraft when fitted with this engine.

The 1420 hrs METAR from Southampton Airport, 6 nm to the south west, indicated a surface wind from 220°M at 8 kt. A pilot, who landed on Runway 24 at South Longwood soon after the accident, recalled being advised by Southampton ATC of a surface wind at Southampton Airport of 200°M at 4 kt.

A witness who observed the departure commented that the aircraft did not seem to lift off until nearly ⅔ of the way along the runway and that it then remained in a nose high attitude and did not climb. He saw it enter the hedgerow and heard the sound of a collision. He alerted the emergency services and Solent Radar using his mobile telephone; to obtain a signal he had to stand on a filing cabinet in the airfield hangar. He then went by car to the accident location but was unable to see the aircraft from the road. Tall saplings had folded and sprung back into position, concealing the wreckage.

When the aircraft was recovered from the hedgerow the broken telegraph pole was examined. Witness marks from the impact indicated that the leading edge of a wing had struck the pole at a point 6 m above ground level.

Analysis

The aircraft was taking off at maximum weight on a warm day in light winds from a grass airstrip which had obstacles at either end. The pilot and his passenger had pushed the aircraft as far back along the runway as possible before starting the takeoff, which suggested they may have had some concern about the length of the strip.

The strip is 650 m in length but obstacles at either end were such that the takeoff distance to 50 ft should be considered as being within the runway length. Tailwind, temperature and takeoff weight would all have influenced the takeoff distance to 50 ft. The downslope on Runway 06 would have a performance benefit for the initial part of the takeoff roll, although this is likely to have been neutralised by the cross slope, but further along the slope is negligible.

The wind at nearby Southampton Airport was south-westerly and may indicate the general airflow in the area, although South Longwood is in a valley location and subject to variable local winds. The windsock was located close to the hangars and likely to have been shielded in a south-westerly airflow, which could have given the pilot a false indication of overall wind conditions. As the aircraft travelled along the runway it may have become subject to a tailwind, which would have increased after lift-off. In a westerly airflow local heating effects from the hangars and hard standing at the western end of the runway could also have affected the runway environment.

It is likely that a combination of factors on a warm day with light winds resulted in insufficient performance being available for the aircraft to climb above the line of trees at the end of the runway.

There was a potential difficulty in notifying the emergency services in the event of an accident at South Longwood.

Conclusion

The aircraft was very close to its maximum takeoff weight when it began its takeoff roll in conditions of light wind and with a temperature of approximately 27°C. After lift-off the aircraft climbed by no more than about 15 - 20 ft and, after crossing a public road, it struck a telegraph pole and dropped into the hedgerow below. It is likely that the light wind and high temperature adversely affected the aircraft's takeoff performance.

Safety action

Following the accident, the following Safety Action was taken:

> The operator of South Longwood airstrip decided to produce a briefing document for visiting pilots. A draft version, dated 18 July 2018, showed a diagram of the airstrip, runway and circuit information and warning text in a red box which included the following guidance:

> *'South Longwood is a challenging farm-strip suitable for experienced pilots flying aircraft of sufficient performance to safely negotiate the obstructions on approach and departure. It is unlikely that any aircraft that requires a landing or takeoff run of more than 300m will be suitable.'*

and

> *'Due to the valley location, the windsock does not always provide reliable indication of wind direction or strength.'*

The airstrip operator had been negotiating for a landline to be installed prior to the accident and re-contacted the supplier to ask for the installation to be carried out as soon as possible.

The windsock was to be relocated to a position more central to the runway and would be set on a higher mast.

Comment

A similar accident involving a Pierre Robin R2100A, G-BICS is reported in this Bulletin (EW/G2018/05/06). It has a general AAIB comment on take off performance in general aviation aircraft at the end of the report.

ACCIDENT

Aircraft Type and Registration:	Pierre Robin R2100A, G-BICS
No & Type of Engines:	1 Lycoming O-235-H2C piston engine
Year of Manufacture:	1977 (Serial no: 128)
Date & Time (UTC):	6 May 2018 at 1100 hrs
Location:	Eaton Bray Farm Airfield, Bedfordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Substantial
Commander's Licence:	Light Aircraft Pilot's Licence
Commander's Age:	55 years
Commander's Flying Experience:	876 hours (of which 274 were on type) Last 90 days - 7 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During takeoff, the aircraft did not attain flying speed and collided with a hedge at the far end of the runway. Performance calculations by the AAIB indicated that, although the ground run required was less than the runway length available, the takeoff distance required exceeded the takeoff distance available.

History of the flight

The pilot reported that he had planned a flight with a passenger from his home base at Eaton Bray Farm Airfield, Bedfordshire to Sandown Airport, Isle of Wight.

The pilot decided to use Runway 29, although it would involve a slight tailwind, as it would be away from buildings close to the threshold of the runway. After completing his checks, the pilot commenced the takeoff roll. The aircraft reportedly reached an airspeed of 40 kt approximately 400 m along the runway, but its acceleration did not continue as expected. The aircraft collided with a 2 m (6.6 ft) high hedge at the far end of the runway at an estimated airspeed of 45 kt. (The rotate speed for this aircraft is 49 kt and the best climb angle speed is 62 kt.) Both occupants, who were wearing four-point harnesses, were uninjured and able to vacate the aircraft unaided. The aircraft was substantially damaged, (Figure 1).

Figure 1
General view of the aircraft post-accident

The pilot commented that the engine was being operated on condition and, although worn, it appeared to be developing its normal engine speed for takeoff of 2,300 rpm on the day. The aircraft's flight manual states that maximum takeoff engine power is achieved at 2,600 rpm; the minimum engine speed for takeoff is 2,300 rpm.

Previous experience gained over 5 years and 250 takeoffs from the strip had led the pilot to become used to the aircraft's marginal takeoff performance. His normal procedure was to "pull" the aircraft into ground effect and accelerate away.

Later inspection by the pilot revealed that the flaps were fully extended, rather than being set for takeoff. The flaps are usually fully extended when the aircraft is parked, as this allows the occupants easier access to the cockpit. During checks prior to takeoff, the flaps are normally retracted to the TAKEOFF position. The pilot suggested that this omission may have been due to the distraction of having a passenger onboard.

Weather information

The weather conditions were reported as good; the wind was from the south-east at 0 to 2 kt and the temperature was 20 to 22ºC.

Weight and Balance information

The pilot's weight and balance calculations indicated that the aircraft was "heavy" but loaded within limits.

Airfield information

The runway is orientated 29/11 and has a grass surface. Its condition was reported as dry and newly rolled. The farm's website states the runway length is 600 yards (549 m). The pilot reported that he had measured the strip and found it to be 615 m long. Measurements taken from aerial imagery of the airfield more closely match the length stated on the farm's website. Adjacent to the Runway 29 threshold and under the approach path are a parking area and hangars, (Figure 2).

Figure 2

View of Eaton Bray Farm Airfield indicating runway length

Aircraft performance

The aircraft flight manual provides performance information when using a dry, hard runway, full throttle and flaps set to the TAKEOFF position. Data to account for various weights, headwind speeds and elevations is included. It also notes that the distance needs to be increased by 8% for every 10ºC increase in temperature above standard at the altitude concerned and by a further 8% when using a dry grass runway. No factor was stated for a tailwind, but CAA Safety Sense Leaflet 7c, '*Aircraft Performance*', recommends adding 20% for a tailwind component of 10% of the lift off speed. The leaflet also recommends that at least 150% of the tailwind component of the reported wind be used. As this aircraft's lift off speed is 49 kt, for every 5 kt of tailwind an extra 20% should be added to the takeoff distance required.

For the accident flight, and using the appropriate additional factors, the takeoff distance required to clear 50 ft was calculated to be 2,112 ft, or 644 m. The CAA also strongly recommends that an additional safety factor of 1.33 be used to account for a number of factors including: aeroplane/engine wear and tear and less than favourable conditions or technique. Using this additional safety factor, the takeoff distance required to reach 50 ft was 856 m (Figure 3 and Table 1).

Take-off performance		Dry, hard runway Flaps : T/O - Full throttle					
Max. weight	Front wind (kts)	S.L. - + 15°C (ft)		2500 ft - + 10°C (ft)		5000 ft - + 5°C (ft)	
		Run	50' clear	Run	50' clear	Run	50' clear
775 kg 1708 lbs	0 10 20	985 800 640	1790 1490 1200	1200 985 770	2200 1840 1475	1475 1215 950	2705 2265 2050
750 kg 1655 lbs	0 10 20	870 720 560	1590 1330 1065	1065 885 690	1970 1640 1330	1330 1100 870	2410 2020 1820
700 kg 1545 lbs	0 10 20	720 590 475	1310 1100 885	885 740 575	1610 1345 1085	1085 885 705	1985 1655 1330

NOTE : 1 - Increase distances by 8% for every 10°C increase of the standard temperature, at the altitude concerned.
2 - Take-off from dry grass runway. : increase distances by 8%.

1ft = 0.3048m

Flight Manual R 2100 A

Avions Pierre Robin

Edition 1 - Nov 1977

Figure 3

Extract from aircraft flight manual

Parameter	Reported value	Factor	Distance required
Takeoff weight	758 kg	from flight manual (sea level assumed)	1,654 ft
Temperature	22ºC	plus 8% per 10ºC above standard - 7ºC above standard = plus 5.6% (x 1.056)	1,747 ft
Surface	Dry grass	plus 8% (x 1.08)	1,886 ft
Headwind / Tailwind	2 kt Tailwind (lift off speed 49 kt)	CAA Safety Sense 7c, use 150% of reported tailwind, add 20% for tailwind of 10% lift off speed - 3 kt tailwind = plus 12% (x 1.12)	2,112 ft or **644 m**
Plus safety factor for **takeoff distance required**		plus 33% (x 1.33)	2,809 ft or **856 m**

Table 1

Summary of takeoff performance calculation

Information is also provided in the flight manual to calculate the ground run required. Using the same parameters and additional factors, a ground run of 470 m was calculated.

Other information

The CAA Safety Sense Leaflet 7c, '*Aeroplane Performance*'[1], includes useful information to assist a pilot in assessing if the proposed flight can be safely made. It discusses where to find and how to use performance data, performance planning and general points that may affect aircraft performance. It also includes a useful and easy to use summary of these factors and how they affect performance (Figure 4). The leaflet also discusses the importance of having a decision point so that a pilot can safely abandon a takeoff if the aircraft performance is not as expected. Similar information can also be found in UK Aeronautical Information Circular (AIC) 127 /2006 (Pink 110) '*Take Off, Climb and Landing Performance of Light Aeroplanes*'[2] and in the CAA's '*Skyway Code*'[3].

This leaflet also notes that the performance figures used in the flight manual are those achieved by the manufacturer using a new aeroplane and engine in ideal conditions flown by a highly experienced pilot (Figure 4).

Effect of flap on takeoff performance

An appropriate flap setting can be used to optimise an aircraft's takeoff performance, but only flap settings that are specified in the aircraft flight manual should be used.

For some aircraft, a greater flap setting can be specified for 'short' or 'soft' field takeoffs to minimise the ground roll. The increased lift from the increased flap setting allows the aircraft to become airborne at a lower speed, but the increased drag once airborne can degrade climb performance and therefore obstacle clearance.

For lower powered aircraft and/or those with large flaps, the use of a flap setting greater than the specified takeoff setting can mean that once airborne, the increased drag is such that the aircraft is no longer able to climb.

The drag due to flap extension during the ground roll is small until rotation speed. When the aircraft is rotated nose-up to lift-off it increases significantly.

Analysis

The aircraft had its flaps in the fully extended position when the takeoff commenced. Although this was the incorrect position, it would have only had a small effect on the aircraft's acceleration whilst it was on the ground. Had it reached rotation speed, it is likely that the increased drag once airborne would have resulted in the aircraft not being able to accelerate further or climb out of ground effect.

Footnote

1 CAA Safety Sense Leaflet 7c can be found on the CAA's website http://publicapps.caa.co.uk/docs/33/20130121SSL07.pdf (accessed September 2018)

2 AIC 127/2006 can be found on the National Air Traffic Services (NATS) Aeronautical Information Service website http://www.ead.eurocontrol.int/eadbasic/pamslight-4119FE5438D1533E8F16B68C6D5E4401/7FE5QZZF3FXUS/EN/AIC/P/127-2006/EG_Circ_2006_P_127_en_2006-12-07.pdf (accessed September 2018)

3 The CAA's Skyway Code can be found on the CAA website https://www.caa.co.uk/General-aviation/Safety-information/The-Skyway-Code/ (accesssed September 2018)

The aircraft weight was towards its maximum weight, but within loading limits. A performance calculation, using the aircraft's weight and the conditions at the time, indicated that a minimum of 644 m was required to reach a height of 50 ft. When the recommended safety factor was added the takeoff distance required was 856 m, of which the ground run was 470 m. The aircraft did not reach its rotation speed of 49 kt and the pilot's unsuccessful attempt to 'pull' the aircraft into ground effect would have increased drag resulting in reduced acceleration.

10 SUMMARY:

FACTORS MUST BE MULTIPLIED e.g. 1.20 x 1.35

	TAKE-OFF		LANDING	
CONDITION	INCREASE IN TAKE-OFF DISTANCE TO HEIGHT 50 FEET	FACTOR	INCREASE IN LANDING DISTANCE FROM 50 FEET	FACTOR
A 10% increase in aeroplane weight, e.g. another passenger	20%	1.20	10%	1.10
An increase of 1,000 ft in aerodrome elevation	10%	1.10	5%	1.05
An increase of 10°C in ambient temperature	10%	1.10	5%	1.05
Dry grass* - Up to 20 cm (8 in) (on firm soil)	20%	1.20	15%⁺	1.15
Wet grass* - Up to 20 cm (8 in) (on firm soil)	30%	1.3	35%⁺ Very short grass may be slippery, distances may increase by up to 60%	1.35
Wet paved surface	-	-	15%	1.15
A 2% slope*	Uphill 10%	1.10	Downhill 10%	1.10
A tailwind component of 10% of lift-off speed	20%	1.20	20%	1.20
Soft ground or snow*	25% or more	1.25 +	25%⁺ or more	1.25 +
NOW USE ADDITIONAL SAFETY FACTORS (if data is unfactored)		**1.33**		**1.43**

Notes:
1. * Effect on Ground Run/Roll will be greater. Do not attempt to use the factors to reduce the distances required in the case of downslope on take-off or upslope on landing.
2. ⁺ For a few types of aeroplane (e.g. those without brakes) grass surfaces may decrease the landing roll. However, to be on the safe side, assume the INCREASE shown until you are thoroughly conversant with the aeroplane type.
3. Any deviation from normal operating techniques is likely to result in an increased distance.

If the distance required exceeds the distance available, changes will HAVE to be made.

Figure 4

Extract from CAA Safety Sense Leaflet 7c

Although the ground run required, including the safety factors, was less than the runway length, it does not account for the distance taken for the aircraft to accelerate to its climb speed and climb. The standard takeoff distance required to 50 ft (TODR) takes this into account and allows for the acceleration phase and an initial climb to clear a 50 ft obstacle. It is worth noting that the standard 50 ft height used is less than two wing spans for this and many common general aviation aircraft.

The pilot had previously measured the runway as 615 m long, but information provided on the farm's website indicated it was 600 yards (549 m) long. Measurements taken from a satellite image of the airfield more closely match the length stated on the farm's website. These measurements were all less than the minimum takeoff distance required for the aircraft's weight and the conditions on the day.

The pilot candidly commented that he had become used to the aircraft's marginal performance from this airfield. The engine was operating on condition and the engine speed achieved of 2,300 rpm, the minimum required for takeoff, indicated the engine was worn. As a result the aircraft's performance on the day would have been less than the figures shown in the flight manual which were recorded with a new aircraft and engine in ideal conditions.

Despite recognising that the aircraft's performance was not as expected, the takeoff was continued until the aircraft struck a 2 m high hedge at the far end of the runway.

Conclusion

During takeoff the aircraft failed to become airborne and struck a hedge at the far end of the runway. Performance calculations by the AAIB indicated that although the ground run required was less than the runway length available, the takeoff distance required to reach 50 ft exceeded the takeoff distance available.

The performance figures used in the flight manual are those achieved by the manufacturer using a new aeroplane and engine in ideal conditions flown by a highly experienced pilot. In this case, the worn engine and the unsuccessful attempt to pull the aircraft in to ground effect would have further reduced the aircraft's performance.

The inadvertent selection of full flap would have had a small effect on the aircraft's acceleration whilst it was on the ground. However, had the aircraft become airborne it would have led to a significant reduction in climb performance.

Discussion and AAIB comments

When calculating aircraft performance, it is recommended that the takeoff distance required to reach 50 ft (TODR) figures are used rather than the ground run figures. The ground run is the minimum distance required for the aircraft to become airborne and it does not include the distance required for the aircraft to accelerate to climb speed and commence its climb.

Any additional factors that are quoted in a flight manual should be considered as the minimum acceptable and more conservative factors, if used, give greater margins of safety.

It is strongly recommended that additional safety factors, like those required for commercial flights, be used to take account of aeroplane/engine wear and tear, less than ideal techniques and less than favourable conditions. CAA Safety Sense Leaflet 7c provides an easy to use table which summarises these additional factors, (Figure 4).

In addition to ensuring that the aircraft performance is sufficient, it is recommended that prior to commencing a takeoff the pilot has a clear decision point in mind from which the takeoff can be safely stopped in case of any anomalies. Any subsequent lack of performance, for whatever reason, should then be more easily recognised and allow the takeoff to be safely abandoned.

Before commencing any takeoff, care should be taken to ensure the aircraft is correctly configured.

ACCIDENT

Aircraft Type and Registration:	Piper PA-18-150 Super Cub, G-XCUB
No & Type of Engines:	1 Lycoming O-320-A2B piston engine
Year of Manufacture:	1981 (Serial no: 18-8109036)
Date & Time (UTC):	6 June 2018 at 1205 hrs
Location:	White Waltham Airfield, Berkshire
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Engine shock-loaded, tailwheel spring broken and damage to lower part of rudder
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	72 years
Commander's Flying Experience:	19,000 hours (of which 35 were on type) Last 90 days - 27 hours Last 28 days - 13 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft nosed over while stationary on the runway. Takeoff power had been applied during a 'stop-and-go' while the brakes were still on.

History of the flight

The instructor and a student were carrying out a circuit training detail. The instructor, in consideration of a busy circuit and of the possibility of aircraft behind on final approach, wanted to keep the process of 'stop-and-go' landings as quick as possible. He had developed a procedure whereby the student actions were to close the throttle during landing, bring the aircraft to a stop with the brakes, then raise the flaps and set carburettor heat to COLD. The instructor meanwhile would rewind the trim control for a zero flap configuration for takeoff. Then, when satisfied that the aircraft was safely configured for flight, he would give the command 'go' through the intercom. The student could then release the brakes and open the throttle to begin the takeoff.

On this occasion about six circuits with 'stop-and-go' landings had been completed successfully. The student landed the aircraft and came to a stop on the runway. The instructor was re-setting the trim for takeoff when power was applied. The brakes were on and the aircraft nosed over. The propeller struck the grass and stopped the engine. The tail rose into the air and then dropped back onto the runway, breaking the tailwheel spring and damaging the lower part of the rudder. The instructor made the aircraft secure and both pilots evacuated the aircraft.

Other information

The instructor, seated in the rear cockpit, has no sight of whether the front seat occupant has their feet on the brakes.

The instructor discovered, subsequent to the accident, that the standard operating procedure adopted by the operator of the aircraft is to not apply brakes on the runway in a Super Cub. Also that consideration given to circuit traffic should be secondary. A downwind call of 'stop-and-go' should be sufficient to warn following traffic to allow time for an aircraft to occupy the runway while being re-configured for takeoff.

ACCIDENT

Aircraft Type and Registration:	Piper PA-28-181 Cherokee Archer II, G-JJAN
No & Type of Engines:	1 Lycoming O-360-A4M piston engine
Year of Manufacture:	1986 (Serial no: 2890007)
Date & Time (UTC):	20 May 2018 at 1155 hrs
Location:	Solent Airport, Hampshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 3
Injuries:	Crew - None Passengers - None
Nature of Damage:	Nosewheel and propeller damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	45 years
Commander's Flying Experience:	118 hours (of which 61 were on type) Last 90 days - 21 hours Last 28 days - 10 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

After an approach to Runway 23R in fine weather, the aircraft touched down just after the numbers but bounced and became airborne again. The pilot allowed the aircraft to descend back onto the runway and, at touchdown, he reported hearing a "grinding/scraping noise" as the nosewheel was damaged. The aircraft bounced a second time before touching down and coming to a halt in a nose-low attitude.

The pilot and passengers were wearing lap and diagonal harnesses and were uninjured. The pilot considered his approach was too fast and, with the heavy landing considered, that a go-around could have prevented the accident.

ACCIDENT

Aircraft Type and Registration:	Piper PA-38-112 Tomahawk, G-BMVL	
No & Type of Engines:	1 Lycoming O-235-L2C Piston Engine	
Year of Manufacture:	1979 (Serial no: 38-79A0033)	
Date & Time (UTC):	12 May 2018 at 1215 hrs	
Location:	Caernarfon Airport, Gwynedd, Wales	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 1
Injuries:	Crew - 1 (Minor)	Passengers - 1 (Minor)
Nature of Damage:	Extensive	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	46 years	
Commander's Flying Experience:	199 hours (of which 57 were on type) Last 90 days - 15 hours Last 28 days - 8 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot, recorded CCTV and further enquiries by the AAIB	

Synopsis

The pilot in command, who was not a flight instructor, occupied the right seat, while the occupant of the left seat was an unqualified pilot[1], who attempted to land the aircraft at Caernarfon Airport. During the final stage of the approach, the pilot in command took control because the aircraft was going to land too far along the runway, and he attempted to go around, however the flaps remained in the landing configuration. With a nose-up attitude, the aircraft deviated to the left of the runway, stalled and hit the ground, before crossing a public road and coming to rest inverted.

History of the flight

The pilot in the right seat was not a flight instructor, while the occupant of the left seat was a senior work colleague and also a student pilot, who was not qualified to fly without supervision from a flight instructor. Although the unqualified pilot had received no instruction on this aircraft type, he conducted the takeoff from Blackpool Airport and flew the aircraft to Caernarfon, with the pilot in command monitoring his actions and making radio calls.

Footnote

[1] The left seat occupant was a student pilot who was in the process of learning to fly on another aircraft type and had logged 26 hours flying while under instruction.

Following an overhead join for Runway 25 at Caernarfon, the unqualified pilot manoeuvred the aircraft into the circuit, in good visibility and with an estimated crosswind from the left of 5 kt. Once the aircraft was established on final approach, the pilot in command suggested that they were too high and the unqualified pilot acknowledged this, but did not subsequently achieve the optimum approach path.

The pilot in command stated that shortly before touchdown he intervened on the throttle and selected idle power, before "following-through" on the flying controls. He then elected to take over control of the aircraft and applied full power, while informing the unqualified pilot they would go around, but he did not move the flap lever from the landing position. CCTV imagery showed that the aircraft's mainwheels made ground contact approximately one third of the way along the runway but the aircraft bounced. It then diverged to the left of the centreline, bouncing again twice, before flying over the left edge of the runway in a nose-up and left wing-low attitude.

The pilot in command stated that he realised the aircraft was not gaining altitude and that he saw a hangar ahead. He believed that he turned the aircraft away from the hangar before it descended and hit the airfield perimeter fence. The CCTV imagery indicated that the aircraft turned left as it departed the runway and it climbed to approximately 20 ft above the ground, before adopting a wings-level, nose-up attitude, and overflying a parallel taxiway. The aircraft then descended towards the ground and was obscured from the CCTV as it passed close to the western edge of two hangars.

The aircraft appears to have flown between the hangars and a mast, bounced on the grass and then struck the ground by the airfield perimeter fence. It then passed through the fence line, travelled across a public road and hit another fence on the southern side of the road (Figure 1). The aircraft then inverted and stopped abruptly, near a farm building, with its nose pointing back towards the airfield (Figure 2).

The unqualified pilot saw fuel leaking from the left wing and later estimated that it took him 20 seconds to undo his seat belt and to escape through an open window. The pilot in command made the engine and electric controls safe but was unable to undo his seatbelt, so the unqualified pilot returned to assist him. Once they were both clear of the aircraft, they received attention from paramedics, who arrived quickly from the locally-based air ambulance unit.

After the accident, the unqualified pilot assessed that the aircraft had been both too high and too fast and that, in retrospect, an early go-around decision would have been appropriate.

Pilot's assessment

In hindsight, the pilot in command realised that his decision to allow his colleague to fly the aircraft was probably influenced, sub-consciously, by the fact that this person was a senior work colleague. He was aware that this person was not a qualified pilot, so should not have manipulated the controls without being supervised by a flight instructor.

Other safety lessons highlighted by the pilot in command, were that a go-around should be initiated if it looks unlikely that touchdown will be made in the first third of the runway, and the vital need to make an appropriate flap selection when going around. The pilot in command noted that, although he was in the habit of moving the flap lever during touch-and-go landings, his actions on this occasion were affected by being in an unexpected, stressful situation and, because full flap was still set, he subsequently lost control of the aircraft.

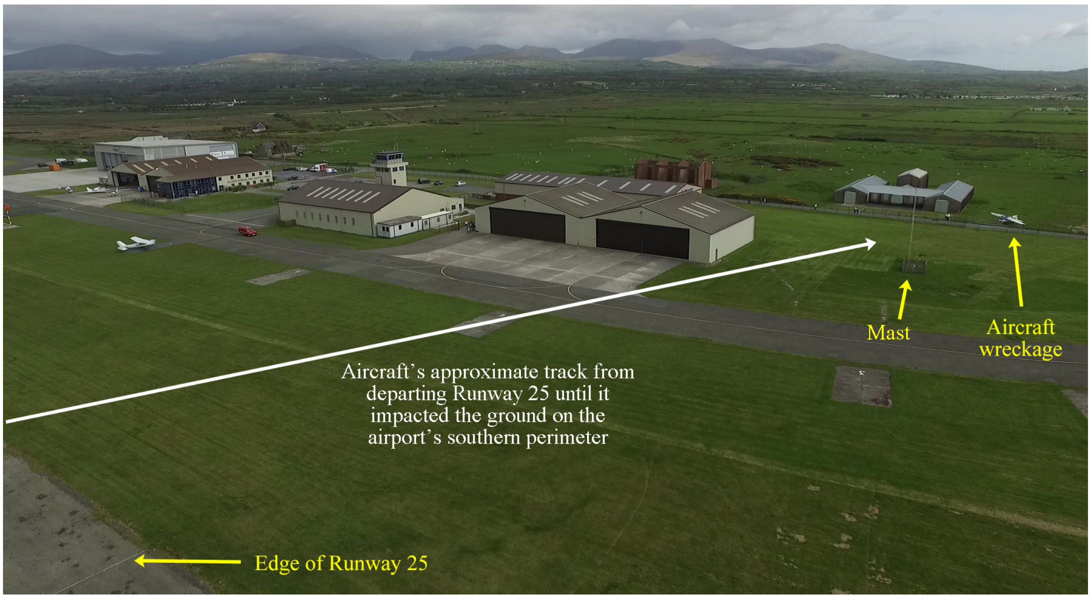

Figure 1

View of Caernarfon Airport from drone positioned above Runway 25, with camera orientated towards the southeast
(Picture courtesy of North Wales Police)

Figure 2

View of accident site from police drone
(Picture courtesy of North Wales Police)

ACCIDENT

Aircraft Type and Registration:	Piper PA-38-112 Tomahawk, G-RVRR	
No & Type of Engines:	1 Lycoming O-235-L2C piston engine	
Year of Manufacture:	1979 (Serial no: 38-79A0199)	
Date & Time (UTC):	15 May 2018 at 1600 hrs	
Location:	Compton Abbas Airfield, Wiltshire	
Type of Flight:	Training	
Persons on Board:	Crew - 2	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Damaged beyond economic repair	
Commander's Licence:	Commercial Pilot's Licence	
Commander's Age:	27 years	
Commander's Flying Experience:	656 hours (of which 626 were on type) Last 90 days - 127 hours Last 28 days - 57 hours	
Information Source:	Aircraft Accident Report Form submitted by the aircraft commander	

Synopsis

During a second attempted touch-and-go on grass Runway 08 at Compton Abbas Airfield, the aircraft failed to climb and struck a hedge. Both occupants were uninjured.

History of the flight

The aircraft commander, who held a Flight Instructor rating, was undertaking a grass runway familiarisation flight and currency check on another pilot. As part of this, the pilot-under-check planned a navigation exercise from Exeter to Compton Abbas, an airfield situated at 811 ft amsl with an 803 m long grass runway orientated 08/26.

The aircraft, at near the Maximum Takeoff Weight permissible, departed Exeter at 1502 hrs and arrived overhead Compton Abbas approximately one hour later. The weather was fine with a 10-15 kt wind from 350° and a temperature of 16°C. The pilot-under-check flew the first approach and landing to Runway 08 with two stages of flap selected. However, as the touchdown point was long into the runway, he immediately applied full power and went around. Two pilots on the ground also witnessed this touch-and-go and they estimated that the aircraft touched down in the last 200 m of the runway.

On the second approach, the aircraft commander stated that the pilot-under-check landed the aircraft near to the beginning of the runway intending to perform a touch-and-go. After touchdown, the pilot-under-check selected one stage of flap for a short field takeoff and applied full power. However, the aircraft commander stated that although the aircraft accelerated and rotated normally, the aircraft barely climbed, and it collided with the top of a hedge that was over 400 m beyond the end of the runway. After the aircraft had come to rest, both occupants, who were wearing 3-point harnesses, were able to vacate the aircraft without assistance.

This landing was observed by a Flight Instructor who was approximately abeam the Runway 08 threshold, near some airfield hangars. He estimated that the aircraft was at 50 ft aal, 150 m beyond the landing threshold, although he did not see the aircraft touch down as he lost sight of it behind the hangars.

The aircraft commander is unsure why the aircraft failed to climb but, although he considers them unlikely, stated that possible factors may have been carburettor icing (despite the engine not appearing to run roughly) or an area of local sink caused by the interaction of the crosswind with the hill on which the airfield is situated.

ACCIDENT

Aircraft Type and Registration:	Rans S6S-116 Super Six Coyote II, G-XALZ
No & Type of Engines:	1 Rotax 912ULS piston engine
Year of Manufacture:	2010 (Serial no: PFA 204A-14378)
Date & Time (UTC):	25 June 2018 at 1615 hrs
Location:	Fishburn Airfield, County Durham
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Left landing gear sheared off, left wing tip rippled, two propeller blades fractured
Commander's Licence:	Light Aircraft Pilot's Licence
Commander's Age:	75 years
Commander's Flying Experience:	594 hours (of which 40 were on type) Last 90 days - 2 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot had not flown for several weeks and was flying with a local instructor for some circuit practise. After completing several circuits, the aircraft was on short finals to Runway 08 when the right wing dropped. The pilot corrected the wing-drop and applied power, but the left wing then dropped and the aircraft sank before the pilot could take corrective action. The aircraft touched down just before the beginning of the runway. The left wheel caught on a slight rise and the left landing gear leg broke away. The aircraft continued to slide with the left wingtip on the ground before coming to rest at 90° to the runway centre line, approximately 10 m along the runway. Both occupants were uninjured.

The runway at Fishburn has a significant slope with the threshold of Runway 08 being at the top of the slope. With the wind from the east, the approach can be affected by turbulence and rotor[1] effects. Both the pilot and instructor felt that G-XALZ may have been affected by this turbulence. The pilot commented that he could have made his approach higher as this would have given him more time to react to any turbulence.

Footnote

[1] Rotor: local air mass rotating about a substantially horizontal axis.

ACCIDENT

Aircraft Type and Registration:	1) Robinson R44 Raven, G-CTFL 2) Robinson R44 Raven, G-HYND
No & Type of Engines:	1) 1 Lycoming O-540-F1B5 Piston Engine 2) 1 Lycoming O-540-F1B5 Piston Engine
Year of Manufacture:	1) 2008 (Serial no: 1912) 2) 2016 (Serial no: 2433)
Date & Time (UTC):	5 May 2018 at 1125 hrs
Location:	Cumbernauld Airport, North Lanarkshire
Type of Flight:	1) Training 2) Training
Persons on Board:	1) Crew - 1 Passengers - 2 2) Crew - 1 Passengers - 3
Injuries:	1) Crew - None Passengers - None 2) Crew - None Passengers - None
Nature of Damage:	1) Extensive 2) Main rotor blade damaged
Commander's Licence:	1) Commercial Pilot's Licence 2) Commercial Pilot's Licence
Commander's Age:	1) 42 years 2) 58 years
Commander's Flying Experience:	1) 913 hours (of which 226 were on type) Last 90 days - 54 hours Last 28 days - 21 hours 2) 6,846 hours (of which 1,705 were on type) Last 90 days - 62 hours Last 28 days - 13 hours
Information Source:	Aircraft Accident Report Forms submitted by the pilots, recorded CCTV and radio transmissions and further enquiries by the AAIB

Synopsis

After lifting to a hover, the pilot of Robinson R44, G-CTFL reversed his helicopter, unaware that a second Robinson R44, G-HYND, had landed behind his position and was being shut down. One of G-HYND's rotor blades collided with G-CTFL's engine housing, startling the pilot of G-CTFL, with the result that he lost control, and the helicopter struck the ground several times before coming to rest in a tail-down attitude, next to a parked Robinson R22. Safety action has been taken by the helicopter operator to improve the helipad arrangement, procedures and RFFS response.

History of the flight

Robinson R44 G-CTFL had its rotors turning, prior to departing Cumbernauld for a trial lesson flight, when another helicopter of the same type, G-HYND, returned from a sightseeing flight. Because both helipads at the eastern end of the airport were occupied, the pilot of G-HYND landed on a grass area behind G-CTFL and then stated on the Air/Ground radio frequency "GOLF NOVEMBER DELTA SECURE ON THE GROUND COMPLETE".

The helicopter on the northern of the two helipads was a Robinson R22, which had recently flown and, shortly after G-HYND landed, the crew of the R22 walked in front of G-CTFL towards the helicopter operator's buildings. It was evident from recordings of the Air/Ground radio frequency that, one minute after the last radio transmission from G-HYND, the pilot of G-CTFL obtained the latest airfield information, but he was not alerted to the presence of another R44 which was parked on the grass. After acknowledging the airfield information, the pilot of G-CTFL announced "GOLF FOXTROT LIMA LIFTING FROM THE EASTERN HELIPAD TO ALPHA".

The pilot of G-CTFL stated that he was restricted from moving forwards and right onto Taxiway A, because of the position of the parked R22 helicopter and because of a stationary Cessna aircraft, which was in front of him and facing away with its propeller turning (Figure 1). There was a second light aircraft parked to the left of the Cessna and he did not wish to disturb these aircraft with his helicopter's downwash. The pilot knew that, when he boarded his helicopter, the area to the rear was clear and he had no recollection of hearing any radio transmissions from G-HYND, so he was not aware of its position and was not expecting another helicopter to be parked there. After lifting to the hover, the pilot decided to move rearwards and then taxi behind the R22. He did not turn his helicopter to check that the area to his rear was clear before reversing, because of the proximity of the R22 on his right and because he did not wish to turn his tail left towards the buildings, where some spectators had assembled.

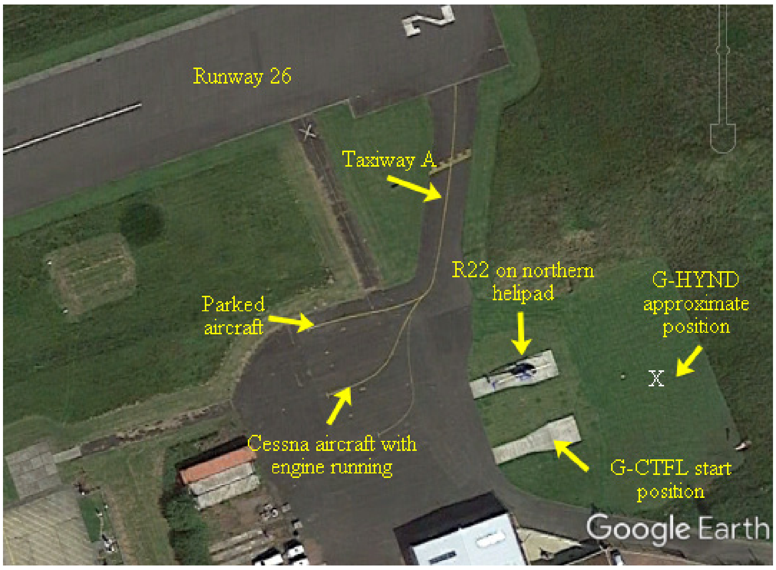

Figure 1

Approximate aircraft disposition in the vicinity of Apron A, at the eastern end of Cumbernauld Airport, before G-CTFL moved

CCTV recordings showed that G-CTFL lifted before moving slowly rearwards and slightly to the right, with its skids approximately 6 ft above the ground. The main rotor blades of G-HYND were still turning slowly and, as G-CTFL approached, one of them struck the engine housing of the hovering helicopter, below the tailboom on the left side.

The pilot of G-CTFL heard a bang and recalled that his helicopter pitched nose-up and right, so he made a forward cyclic control input to return towards the helipad and lowered the collective lever. He then realised the helicopter was pitching nose-down so he moved the cyclic stick aft, but the tail struck the ground, before the helicopter bounced forward off its skids, towards the R22. The pilot stated that he reacted by making a left cyclic stick input, but that the rotor blades then struck the ground and the helicopter vibrated violently, so he lowered the collective lever fully. G-CTFL landed heavily in a nose-up attitude, near the R22, with its tail resting on the ground (Figure 2).

After the helicopter stopped moving, the pilot made the engine and electric switches safe, applied the rotor brake and vacated using his door on the left side. Another of the helicopter operator's employees approached the right side of the helicopter, opened the doors and helped the student pilot and the passenger to escape.

Figure 2

G-CTFL after the accident, facing towards Apron A, with the R22 visible behind, on the northern helipad, and with loose debris in the foreground

The pilot of G-HYND had turned off his radio and had removed his headset while his rotor blades slowed. After writing post-flight notes, he looked up and saw G-CTFL moving towards him. He attempted to turn his radio on and replace his headset, so that he could warn the other pilot but, before achieving this, he observed one of his rotor blades strike the left side of G-CTFL's engine bay. The impact did not seem to affect his own helicopter and his passengers appeared uninjured so, when the rotor blades stopped rotating, they all disembarked normally.

CCTV recordings of the collision showed that G-CTFL pitched rapidly to approximately 45º nose-down but initially maintained its height above the ground, while moving away from

G-HYND, and towards the helipad. As it approached the pad it descended and the nose pitched up, the tail struck the grass and the rear of both skids hit the concrete. This caused G-CTFL to bounce approximately two feet from the ground, into a nose-down attitude, while the tail turned anti-clockwise towards the R22. Next, G-CTFL impacted the ground heavily, orientated at 90º to the pad, with the left skid hitting first and the helicopter then rolling onto its right skid and pitching nose-up until the tail struck the ground near the R22. G-CTFL now bounced a second time, its tail turned quickly clockwise and the helicopter rolled left until the main rotor blades struck the concrete pad. Finally, G-CTFL struck the ground between the two landing pads with its tail on the grass and close to the R22. The rotor blades stopped turning 33 seconds later.

During the accident sequence, the CCTV recording showed debris being thrown several metres across the surrounding area, with some falling onto Apron A. Approximately three minutes after the accident, the pilot of the Cessna aircraft taxied via Taxiway A to another position at the airport, for refuelling, after advising the Air/Ground operator of his intention.

The Cessna's pilot later recalled that he was aware the helicopter's "undercarriage" had collapsed but he did not observe the accident or see any debris, so had not considered the potential for his aircraft to have been damaged. With hindsight, he realised that he could have shut down and inspected his aircraft but, as he was not departing for a flight, he thought that with the situation under control, it would be best if he moved away. He assumed the taxiway was safe to use, as he had watched a Rescue and Fire Fighting Services (RFFS) vehicle being driven along it before he taxied.

RFFS response

The operator of Cumbernauld Airport had agreed that the helicopter operator would provide RFFS in respect of all associated helicopter operations and consequently the helicopter operator's own RFFS vehicle was available. This was situated outside the hangar, a few metres from the accident site, but the only trained RFFS personnel available were the pilots from the R22 and from G-HYND. Another employee was the first to reach the accident site and he saw no evidence of leaking fuel when he assisted the passengers to escape. Subsequently the R22 pilot reached the scene and determined there was no fire risk, so the operator's RFFS vehicle was not employed.

The airport's Air/Ground radio operator activated the airport crash alarm. He was also trained for RFFS duties and, when he did not see the helicopter operator's RFFS vehicle deploy, he passed his radio task to somebody else, and drove the airport's RFFS vehicle to the accident site. He estimated that he arrived within two minutes of the accident, to find that the helicopter's occupants had escaped, without injury, and that the helicopter operator did not believe there was a fire risk, so the local emergency services were not alerted.

Helicopter operator's investigation

The helicopter operator conducted an internal investigation which concluded that the accident could have been avoided if the pilot of G-CTFL had turned the tail of his aircraft and visually checked the area behind. The operator considers such a lookout turn to be a standard procedure before a helicopter is moved rearwards, but the pilot felt constrained from moving the tail of his helicopter left by the presence of spectators. However, the CCTV recordings showed nobody on the roadway or grass area immediately to the left of G-CTFL and the helicopter operator believed the tail could have been moved left, leaving a 5 m safety margin from any people or obstructions.

According to the helicopter operator, it was not unusual for helicopters to reverse from the southern helipad, if the other pad was occupied and Apron A congested.

The helicopter operator reported that its checklist for the R44 shutdown procedure does not clearly specify when the avionics should be switched off, so it was not unusual that the pilot of G-HYND had switched the radio off and removed his headset once the engine had stopped but with the rotors still turning.

Helicopter operator's safety actions

As a result of the accident, the following safety actions have been taken by the helicopter operator:

- The northern helipad was extended eastwards by 12 m, so a parked helicopter is further from the apron, leaving space for other helicopters to move between the parked helicopter and the apron.
- The prepared grass area east of the helipads has been extended, to ensure helicopters parked there can remain well clear of the pads.
- A mirror has been placed at the corner of the hangar, to assist pilots using either helipad see any activity to their rear.
- The helicopter operator no longer permits helicopters to reverse from the helipads.
- The helicopter operator's safety team is due to review the procedure for turning off the avionics systems while a Robinson R44 is being shut down.
- A review of the RFFS response to this accident has led to several changes being instigated. These are intended to ensure that two appropriately trained employees are available, on the ground, at all times there is helicopter activity and that fire-fighting equipment can be readily accessed by these employees.

Airport operator's report

An investigation by the airport operator established that immediately after the accident it would have been best to close the airport until appropriate inspections of the manoeuvring area and Apron A had been completed.

Scrutiny of the airport's emergency procedures following this accident highlighted some ambiguities and the operator undertook to review and revise the relevant guidance as necessary.

AAIB comment

The collision between the two helicopters occurred because the pilot of G-CTFL was not aware of G-HYND's position. However, the damage to G-CTFL did not appear to immediately effect the operation of its engine or flying controls. The pilot of G-CTFL stated that he recalled his helicopter pitching nose-up and he made a forward cyclic input in response, but CCTV showed that after hitting G-HYND's rotor blade, G-CTFL pitched nose-down. An excessive nose-down attitude ensued, close to the ground, before recovery action appears to have been initiated and the nose began to pitch up. However, the helicopter was now descending towards the helipad and, as the nose pitched up, the tail struck the ground and initiated the impact sequence.

It is likely that the pilot of G-CTFL was startled by the unexpected collision with the other helicopter. The 'startle effect'[1] is likely to have impaired his ability to comprehend the situation and also his psychomotor skills, leading to his loss of control.

When the helicopter operator's employees responded to the accident they did not take any fire fighting equipment to the scene, so it was fortuitous that there was no outbreak of fire before all the helicopters' occupants escaped. As a result, emergency response procedures have been changed, but this accident highlights the need to regularly review such procedures.

Footnote

1 Startle is defined in the Federal Aviation Authority's Advisory Circular 120-111 of 2015 as '*an uncontrollable, automatic muscle reflex, raised heart rate, blood pressure, etc., elicited by exposure to a sudden, intense event that violates a pilot's expectations*.' An overview of the '*startle effect'* and details of reference material can be found on the SKYbrary website at https://www.skybrary.aero/index.php/Startle_Effect (accessed September 2018)

ACCIDENT

Aircraft Type and Registration:	Vans RV-8, G-JBTR
No & Type of Engines:	1 Lycoming IO-360-M1B piston engine
Year of Manufacture:	2012 (Serial no: PFA 303-14562)
Date & Time (UTC):	23 June 2018 at 1630 hrs
Location:	Perth Airport
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Extensive
Commander's Licence:	Private Pilot's Licence
Commander's Age:	56 years
Commander's Flying Experience:	428 hours (of which 60 were on type) Last 90 days - 34 hours Last 28 days - 16 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft touched down in "almost" a three-point attitude, with an estimated crosswind from the right of 5 kt. Although it was drifting slightly to the right at touchdown, the aircraft initially tracked straight, with all three wheels in contact with the asphalt runway. Two or three seconds after touchdown, the pilot heard a tyre squeal and the aircraft turned quickly right and departed the runway, despite his attempts to correct the turn using both the rudder bar and the wheelbrakes.

The aircraft slid sideways and as it left the paved surface, moving at a groundspeed of approximately 40 kt, the left main landing gear collapsed, causing the left wing and the propeller to strike the ground. The occupants vacated without difficulty after the aircraft came to rest, orientated on a northerly heading (Figure 1).

No mechanical defects were evident, so the pilot suspected that he may have initiated the right turn by inadvertently applying right brake, with the left mainwheel possibly lifting during the turn. This may have meant his subsequent application of left brake was ineffective, while rudder authority was diminished as the aircraft decelerated.

Figure 1

G-JBTR showing evidence of damage to the propeller, the fuselage and the left wing

ACCIDENT

Aircraft Type and Registration:	Yakovlev YAK C11, G-OYAK
No & Type of Engines:	1 Ashenkov 21 piston engine
Year of Manufacture:	1945 (Serial no: 1701139)
Date & Time (UTC):	21 June 2018 at 1630 hrs
Location:	Field near Little Gransden Airfield, Cambridgeshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Minor) Passengers - None
Nature of Damage:	Damage to engine and supporting mounts, propeller, flaps and lower fuselage
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	3,700 hours (of which 150 were on type) Last 90 days - 40 hours Last 28 days - 20 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The engine started to misfire as the pilot joined the downwind leg at Little Gransden Airfield for a landing on Runway 28. The pilot flew a tighter circuit, but late during the final approach the engine lost power. As the aircraft could no longer reach the runway, the pilot made a successful wheels-up landing and the aircraft touched down 150 m short of the runway threshold (Figure 1). The loss of engine power was most probably due to the magneto coils starting to break down.

History of the flight

The pilot reported that he was undertaking the first flight following the annual maintenance with the intention of carrying out the flight test schedule. The owner, who held a private pilot's licence, was in the rear seat and the intention was to practice aerobatics on completion of the test schedule.

The engine power checks were satisfactory, and the aircraft climbed normally to around 8,500 ft. Following the flight test and aerobatics, the pilot returned to Little Gransden Airfield where he made a full-stop landing before backtracking to the threshold where he took off, with the passenger, to carry out the V_{NE} checks and fly a second session of aerobatics. On returning to the airfield, the pilot made an overhead join and at the start of the downwind leg the engine started to misfire. The pilot flew a tighter circuit with a short curving base leg and on the final approach moved the throttle to increase the engine power, but the engine did not respond. The pilot exercised the throttle several times, but there was still no increase in engine power. He therefore informed the passenger that he had an engine failure and selected the landing gear UP. The aircraft touched down 150 m short of the threshold of Runway 28 and as the aircraft travelled across the ground it slewed slightly as the propeller dug into the ground before coming to a halt. The passenger was uninjured, but the pilot, who was wearing a helmet, struck his head on the gun sight.

Figure 1

Accident site
(photograph provided by pilot)

Testing of magnetos

The magnetos were type BCM 7MJ, which were designed in the 1950s. The actual age of both magnetos was unknown.

Following the accident, the owner arranged for both magnetos to be removed from the engine to be visually inspected and tested. The testing was halted after both magnetos experienced a dead cut (suddenly stopped working). When the temperature of the magnetos was allowed to return to ambient room temperature, they both operated normally.

Right magneto

The rotor arm in the right magneto was found to be bent, however, this did not affect the operation of this magneto. The magneto was run for two hours at an ambient room temperature of 21°C. After one hour the magneto had reached a temperature of 46°C and after two hours it had reached a temperature of 62°C when a dead cut occurred.

Left magneto

The left magneto was run for one hour at an ambient room temperature of 22°C. After one hour the magneto had reached a temperature of 53°C when a dead cut occurred. It was noted that the coil in the magneto felt soft.

Comment

The passenger had owned the aircraft since 1992 and advised the AAIB that there had been no recent problems with either the aircraft or engine.

The testing of the magnetos indicates that that the most likely reason for the loss of engine power was a breakdown in the coils as the temperature of the magnetos increased. The pilot, who was an experienced YAK pilot, advised the AAIB that he had previously experienced misfiring and a loss of engine power on another YAK-type aircraft that was identified as the magneto coils starting to heat up and break down.

ACCIDENT

Aircraft Type and Registration:	Escapade 912(2), G-ECKB
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	2007 (Serial no: BMAA/HB/533)
Date & Time (UTC):	2 July 2018 at 1720 hrs
Location:	Private airstrip, Coate, near Devizes, Wiltshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Left wing, left main landing gear and propeller damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	69 years
Commander's Flying Experience:	1,949 hours (of which 1,116 were on type) Last 90 days - 42 hours Last 28 days - 14 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

While on final approach the aircraft sank in turbulence, and this alarmed the passenger who then, inadvertently, restricted the control stick from being moved rearwards. Consequently, the pilot could not prevent the aircraft from descending rapidly, and the left main landing gear detached in the ensuing ground contact with the grass runway. While this occurred the passenger was instructed to allow the pilot freedom to move the control stick and, after a single bounce, the pilot landed the aircraft on its right main landing gear and tailwheel. However, as the airspeed reduced, the aircraft settled onto its left wingtip and slewed left, before coming to rest at the edge of grain crop which adjoined the runway (Figure 1).

The pilot noted that he often provides air experience flights, and he had not anticipated that his passenger might unexpectedly "freeze" in such a manner, at a critical moment. He believes that if he had been more prepared for such an eventuality, he might have been able to overcome the restriction by exerting greater force to the control stick.

Figure 1

G-ECKB resting on its left wingtip at the edge of the grain crop

ACCIDENT

Aircraft Type and Registration:	EV-97 Teameurostar UK, G-CEDX	
No & Type of Engines:	1 Rotax 912-UL piston engine	
Year of Manufacture:	2006 (Serial no: 2827)	
Date & Time (UTC):	17 May 2018 at 1511 hrs	
Location:	Gloucester Airport, Gloucestershire	
Type of Flight:	Private	
Persons on Board:	Crew – 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Propeller, right wing and right landing gear damaged; aerodrome PAPI damaged	
Commander's Licence:	National Private Pilot's Licence	
Commander's Age:	76 years	
Commander's Flying Experience:	225 hours (of which 122 were on type) Last 90 days - 9 hours Last 28 days - 5 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

The pilot made an approach to Runway 09 at Gloucester Airport in good weather conditions, with the wind from 060°M at 5 kt. As he flared for landing, the pilot felt the aircraft lift slightly and yaw to the left, causing him to apply right rudder to counteract the yaw. He described the resulting touchdown as "harder than intended", following which the aircraft's heading was 20° to the left of the runway. The pilot applied the brakes but aircraft continued to turn left, resulting in an excursion to the left side of the runway and collision with a PAPI indicator.

The pilot considered that as he was applying right rudder at touchdown, he may not have had time to move his right foot onto the right toe brake, resulting in only the left brake being applied during the landing roll.

ACCIDENT

Aircraft Type and Registration:	Ikarus C42 FB80, G-HEVR
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	2015 (Serial no: 1510-7422)
Date & Time (UTC):	12 June 2018 at 1720 hrs
Location:	Lydd Aiport, Kent
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Nose leg, propeller and wingtip damaged
Commander's Licence:	Student
Commander's Age:	55 years
Commander's Flying Experience:	56 hours (of which 31 were on type) Last 90 days - 22 hours Last 28 days - 8 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and comments by flying instructor

The instructor reported that he carried out a dual training flight from Deanland to Lydd. The wind was almost directly down Runway 03 at Lydd. The student performed two good landings, one flapless and one with full flap, before being sent solo. This was the fourth occasion he had performed solo circuits.

The student completed two circuits uneventfully. On the third landing, the instructor observed the aircraft swinging sharply to the left and tipping up. The student stated that he had made power-off approaches and full-flap landings to simulate an engine failure situation. In his opinion, the approach and final landing went well, but unfortunately, as he attempted to retract the flaps from full to the takeoff setting, he believed he became slightly confused/disorientated and operated the wrong rudder pedal.

The C42 has a centrally-mounted stick, being effectively a right-hand sidestick for the left seat pilot. The flap control is also mounted centrally, just behind the top of the windscreen and utilises a latching arrangement, requiring careful manipulation to ensure the desired setting is achieved. Flap operation thus requires reaching across to the flap control with one hand whilst keeping the other on the stick.

ACCIDENT

Aircraft Type and Registration:	Quik GT450, G-CGSO
No & Type of Engines:	1 Rotax 912ULS piston engine
Year of Manufacture:	2010 (Serial no: 8540)
Date & Time (UTC):	6 July 2018 at 1550 hrs
Location:	Moss Edge Farm, Cockerham, Lancashire
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - 1 (Minor) 1 (Serious) Passengers - None
Nature of Damage:	Severe damage to wing; repairable damage to trike.
Commander's Licence:	Student
Commander's Age:	61 years
Commander's Flying Experience:	481 hours (of which 3 were on type) Last 90 days - 3 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The accident occurred on the fourth training flight for the front seat pilot who was converting from fixed-wing to flex-wing aircraft. After two uneventful touch and go landings, the student pilot positioned for an approach at Moss Edge Farm Airfield. On short finals the aircraft drifted left towards a field of barley and, electing to go around, the student selected full-power and instinctively pulled on the control bar. The aircraft descended rapidly and landed heavily in the barley field, coming to rest on its side. Both pilots were able to vacate the aircraft without external assistance despite the front seat pilot sustaining a broken arm.

One of the challenges of converting from fixed-wing to flex-wing aircraft is that the pitch and roll inputs required are in the opposite sense; for example, on a flex-wing aircraft the control bar is pushed rather than pulled to initiate a climb. The instructor assessed that this accident was caused by the student using an instinctive rearwards control input when the opposite was required. Due to the height at which the go-around was initiated, there was insufficient time available for the instructor to recover the situation.

Figure 1
G-CGSO on its side after the accident

ACCIDENT

Aircraft Type and Registration:	Rotorsport UK MTO Sport, G-CIHH
No & Type of Engines:	1 Rotax 912 ULS piston engine
Year of Manufacture:	2014 (Serial no: RSUK/MTOS/057)
Date & Time (UTC):	30 June 2018 at 1600 hrs
Location:	2 miles east-north-east of Blair Atholl, Perthshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Extensive
Commander's Licence:	Private Pilot's Licence
Commander's Age:	71 years
Commander's Flying Experience:	6,082 hours (of which 226 were on type) Last 90 days - 27 hours Last 28 days - 6 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The pilot carried out a controlled but unintended touchdown on hilly terrain having become distracted while checking on his livestock. The gyroplane was damaged but he was unhurt.

History of the flight

The pilot was carrying out a flight from his own airstrip to check livestock located on hilly ground on his farm. The weather conditions were fine with good visibility and light winds from the south. He noted that the gyroplane was performing well, being at a relatively light weight.

About 15 minutes into the flight, the pilot noticed some stock in an area where they should not have been. He began to count them but became focussed on the task and did not notice that his airspeed had reduced. While flying in a downwind direction he realised that he had inadvertently flown with reference to the groundspeed and now had a low airspeed. The gyroplane started to descend rapidly through 100 ft agl towards rising ground and he did not have sufficient height or room to manoeuvre to gain speed. He applied full power and kept the gyroplane straight, pointing uphill to avoid a possible rollover. Just before ground contact he increased the nose-up pitch attitude and the gyroplane landed hard with little forward speed. The pilot was not injured and was able to shut the gyroplane down and make a normal exit.

Analysis

The pilot provided the AAIB with his report of the circumstances of the accident and his carefully considered analysis of the causes.

The pilot estimated that the whole event from recognition of the problem to the accident had occurred over a period of only about five seconds. He assessed the primary cause of the accident as distraction while he was looking outside the gyroplane. As a result of this he had not noticed the build-up of adverse circumstances, notably: the tailwind which led to a higher groundspeed than airspeed, an increasing rate of descent with insufficient height to regain speed, and flying towards rising ground. He also noted that it was likely that the wind was stronger than it was from where he had taken off.

ACCIDENT

Aircraft Type and Registration:	Thruster T600N, G-MZNX
No & Type of Engines:	1 Rotax 503 UL-2V-DCDI piston engine
Year of Manufacture:	1998 (Serial no: 9098-T600N-026)
Date & Time (UTC):	5 August 2018 at 1045 hrs
Location:	Longside Airfield
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Nosewheel collapsed, damage to fibreglass pod and left wing tip
Commander's Licence:	Private Pilot's Licence
Commander's Age:	82 years
Commander's Flying Experience:	1,942 hours (of which 325 were on type) Last 90 days - 9 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot reported that he flew to Longside airfield in slightly thermic conditions and made an overhead join to view the windsock. He assessed the wind as 5 to 8 kt, varying around 225°, and positioned the aircraft to join the circuit for a landing on Runway 28. During the downwind leg the pilot experienced significant thermal activity and during the later stage of the final approach, while at a height of 10 to 15 ft agl, he experienced a high rate of sink and the aircraft bounced on the runway. The pilot initiated a go-around by applying full power while the aircraft was still in the air, but the aircraft descended into the grass at the side of the runway, where the nose landing gear collapsed and the left wing made contact with the ground. The pilot was uninjured.

ACCIDENT

Aircraft Type and Registration:	DJI Matrice 210 (UAS, registration n/a)
No & Type of Engines:	4 electric motors
Year of Manufacture:	2017 (Serial no: 0G0DE8CLD30212)
Date & Time (UTC):	20 December 2017 at 1610 hrs
Location:	Near Albert Bartlett Farm, La Route de la Trinite, St Helier, Jersey
Type of Flight:	Commercial Operation
Persons on Board:	Crew - None Passengers - None
Injuries:	Crew - N/A Passengers - N/A
Nature of Damage:	Damage to landing gear legs, front arms, two propellers, camera gimbal and battery case
Commander's Licence:	CI Aviation Permit
Commander's Age:	46 years
Commander's Flying Experience:	52 hours UAS (of which 1 was on type) Last 90 days - 17 hours Last 28 days - 6 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During a training flight with the battery level indicating 12 minutes of flight time remaining, a 'LOW VOLTAGE BATTERY WARNING' appeared, all four electric motors stopped and the UAS began a rapid descent. A second later the warning disappeared and the motors reactivated but there was insufficient time to prevent the UAS from crashing at "considerable speed". The UAS manufacturer determined that it was caused by a battery firmware problem and has issued an update.

History of the flight

The DJI Matrice 210 is a quadcopter UAS (Figure 1) with a maximum takeoff mass of 6.14 kg and fitted with dual batteries. For the accident flight the mass was 4.57 kg.

The UAS was being operated on a training flight and took off with 31 minutes of flight time remaining on the battery level indication. During the flight the UAS lost satellite lock intermittently and the UAS controller displayed the message 'compass error'. While hovering the UAS rotated about its yaw axis without controller input. This was a known issue and the pilot changed flight modes to resolve it. After a short time the pilot initiated a descent to land. He noted that the battery level was indicating 12 minutes of flight time remaining.

When the UAS reached a height of 84 m the pilot noticed a warning, which he recalled showed 'LOW VOLTAGE BATTERY WARNING'. At the same time all four electric motors stopped and the UAS began descending rapidly. The warning cleared after about a second and the system recovered and the motors re-started. The pilot tried to apply full power to arrest the descent but the UAS crashed into a field at "considerable speed". The UAS did not yaw, roll or pitch during the descent and hit the ground in a level attitude.

Figure 1
DJI Matrice 210

Investigation by the UAS manufacturer

The UAS was sent to its manufacturer for repairs and analysis of the onboard recorded data. The data revealed that the voltage measured by the main controller at the time of the accident was 23.4 V. Full batteries have a voltage of 26.3 V; however, 23.4 V is sufficient for continued flight. The data also revealed anomalous measurements for battery 2. During the accident flight the battery 1 voltage gradually reduced from 25.5 V to 23.3 V at the time of the accident, whereas the battery 2 voltage indicated a steady 22.6 V throughout the flight, while indicating a steady high current output. The UAS manufacturer could not explain this anomaly but stated that it was aware of a battery firmware issue that results in actual battery levels being "ignored" and power to the motors being cut because the system considers the battery level too low. The manufacturer issued a firmware update in January 2018 to address this issue.

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).

BULLETIN CORRECTION

Aircraft Type and Registration:	Boeing 747-8R7F, LX-VCF
Date & Time (UTC):	30 March 2017 at 1216 hrs
Location:	En route from Houston to Prestwick
Information Source:	AAIB Field Investigation

Following publication of the report the following two corrections were made.

AAIB Bulletin No 7/2018, page 11 refers:

The first sentence of the section titled '***Shipping of dangerous goods by air***' has been deleted and replaced to provide additional clarification. The original text read 'The International Air Transport Association (IATA) Dangerous Goods Regulations (DGR) describe the regulations governing the preparation, documentation and transportation by air of dangerous goods. The 58th edition of the DGR, ... '.

The text now reads:

> ICAO Annex 18 to the Chicago Convention describes the international standards and recommended practices relating to the *'Safe transport of dangerous goods by air'*. It requires that dangerous goods are carried in accordance with ICAO document 9284 *'Technical instructions for the safe transport of dangerous goods by air'* (known as the "Technical Instructions"), which contains requirements for the classification, preparation, packaging, documentation and transportation by air of dangerous goods. The International Air Transport Association (IATA) publishes the Dangerous Goods Regulations (DGR), a field manual which describes the requirements of the ICAO Technical Instructions, along with additional explanatory material. It is widely used by IATA member airlines and shippers and, is recognised as the industry standard guidance on the transportation of dangerous goods by air. The 58th edition of the DGR, ...

AAIB Bulletin No 7/2018, page 17 refers

Additionally, **Footnote 7** has been amended to provide additional clarification. The original footnote read ' The IATA Dangerous Goods Board reviews and determines standards and procedures necessary for the safe carriage of dangerous goods by air, and promotes the worldwide recognition, adoption of and adherence to those standards and procedures'.

The footnote now reads:

> The IATA Dangerous Goods Board reviews and determines standards and procedures necessary for the safe carriage of dangerous goods by air, and promotes the worldwide recognition, adoption of and adherence to those standards and procedures. It works closely with the ICAO Dangerous

Goods Panel, which sets the international requirements for transportation of dangerous goods by air and is responsible for reviewing proposed revisions to ICAO document 9284.

The online version of the report was amended on 15 August 2018.

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

1/2014 Airbus A330-343, G-VSXY at London Gatwick Airport on 16 April 2012.

Published February 2014.

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.

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

http://www.aaib.gov.uk

GLOSSARY OF ABBREVIATIONS

aal	above airfield level
ACAS	Airborne Collision Avoidance System
ACARS	Automatic Communications And Reporting System
ADF	Automatic Direction Finding equipment
AFIS(O)	Aerodrome Flight Information Service (Officer)
agl	above ground level
AIC	Aeronautical Information Circular
amsl	above mean sea level
AOM	Aerodrome Operating Minima
APU	Auxiliary Power Unit
ASI	airspeed indicator
ATC(C)(O)	Air Traffic Control (Centre)(Officer)
ATIS	Automatic Terminal Information Service
ATPL	Airline Transport Pilot's Licence
BMAA	British Microlight Aircraft Association
BGA	British Gliding Association
BBAC	British Balloon and Airship Club
BHPA	British Hang Gliding & Paragliding Association
CAA	Civil Aviation Authority
CAVOK	Ceiling And Visibility OK (for VFR flight)
CAS	calibrated airspeed
cc	cubic centimetres
CG	Centre of Gravity
cm	centimetre(s)
CPL	Commercial Pilot's Licence
°C,F,M,T	Celsius, Fahrenheit, magnetic, true
CVR	Cockpit Voice Recorder
DME	Distance Measuring Equipment
EAS	equivalent airspeed
EASA	European Aviation Safety Agency
ECAM	Electronic Centralised Aircraft Monitoring
EGPWS	Enhanced GPWS
EGT	Exhaust Gas Temperature
EICAS	Engine Indication and Crew Alerting System
EPR	Engine Pressure Ratio
ETA	Estimated Time of Arrival
ETD	Estimated Time of Departure
FAA	Federal Aviation Administration (USA)
FDR	Flight Data Recorder
FIR	Flight Information Region
FL	Flight Level
ft	feet
ft/min	feet per minute
g	acceleration due to Earth's gravity
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)
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
PNF	Pilot Not Flying
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
TGT	Turbine Gas Temperature
TODA	Takeoff Distance Available
UAS	Unmanned Aircraft System
UHF	Ultra High Frequency
USG	US gallons
UTC	Co-ordinated Universal Time (GMT)
V	Volt(s)
V_1	Takeoff decision speed
V_2	Takeoff safety speed
V_R	Rotation speed
V_{REF}	Reference airspeed (approach)
V_{NE}	Never Exceed airspeed
VASI	Visual Approach Slope Indicator
VFR	Visual Flight Rules
VHF	Very High Frequency
VMC	Visual Meteorological Conditions
VOR	VHF Omnidirectional radio Range

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