ACCIDENT

Aircraft Type and Registration:	Cessna 152, G-UFCO
No & Type of Engines:	1 Lycoming O-235-L2C piston engine
Year of Manufacture:	1978 (Serial no: 152-81734)
Date & Time (UTC):	19 April 2018 at 1119 hrs
Location:	Near Crumlin, County Antrim
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Fatal) Passengers - 1 (Fatal)
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	77 years
Commander's Flying Experience:	18,383 hours (of which 900 were on type) Last 90 days - 5 hours Last 28 days - 4 hours
Information Source:	AAIB Field Investigation

Synopsis

The purpose of the flight was to carry out aerial photography. During a manoeuvre at low level the aircraft stalled and descended rapidly, passing through some trees, before striking the ground. There was a post-crash fire and neither occupant survived.

History of the flight

Background

The pilot had arranged to hire the aircraft, for a flight with himself and a passenger, from a local flying club based at Newtownards Airport. The passenger was a professional photographer specialising in aerial photography. He would arrange to be flown as a passenger in an aircraft to photograph properties with the intention of subsequently selling the photographs. The passenger had flown regularly with the pilot of G-UFCO, around 15 times a year for the last 14 years. The arrangement was that the passenger would provide a route plan, around various properties, and the pilot would then fly the route. It is not known what, if any, financial arrangements were made between the pilot and the passenger.

On the day of the accident the pilot went in to the clubhouse where he was seen by several people. However, those there could not recollect having seen his passenger, so it is likely that he went directly to meet the pilot at the aircraft.

The weather conditions were fine with good visibility and some scattered cloud.

Accident flight

The aircraft took off from Newtownards at approximately 1047 hrs and flew in a north-westerly direction. At 1049 hrs the aircraft was recorded on radar 1.5 nm north-west of Newtownards Airport at an altitude of about 800 ft amsl. This coincided with the pilot making initial radio contact with Belfast City ATC, who the pilot advised that they were operating a photographic flight near Nutts Corner (a disused airfield located 3 nm south-east of Belfast International Airport). The aircraft subsequently transited the Belfast City Control Zone at an altitude of about 1,300 ft amsl, before being transferred to the Belfast International approach frequency. The pilot requested clearance to operate between Nutts Corner and Loanends (Figure 1 and 2), which was granted and the aircraft entered controlled airspace.

Figure 1

Radar track of flight from Newtownards Airport

At 1058 hrs the pilot was transferred to the Belfast International tower frequency. A few minutes later at 1102 hrs, as the aircraft approached Nutts Corner, the pilot was instructed to hold position as an aircraft was on approach to land at Belfast International Airport. Having held at Nutts Corner for several minutes, flying at an altitude of about 1,100 ft amsl (a height of approximately 650 ft agl), the pilot reported that he was visual with the other aircraft and at 1106 hrs was cleared to proceed towards Loanends (Figure 2).

The aircraft was then flown in a series of clockwise, circular and oval shaped turns at bank angles of up to 30° at heights between approximately 350 ft and 600 ft agl and at an estimated airspeed of about 60 kt TAS; based on a wind[1] from 220° at 11 kt. The passenger was seated in the right seat and therefore clockwise turns would have facilitated a better view of properties during photography.

Footnote

[1] Obtained from the Belfast International Airport METARs timed at 1050 UTC and 1120 UTC.

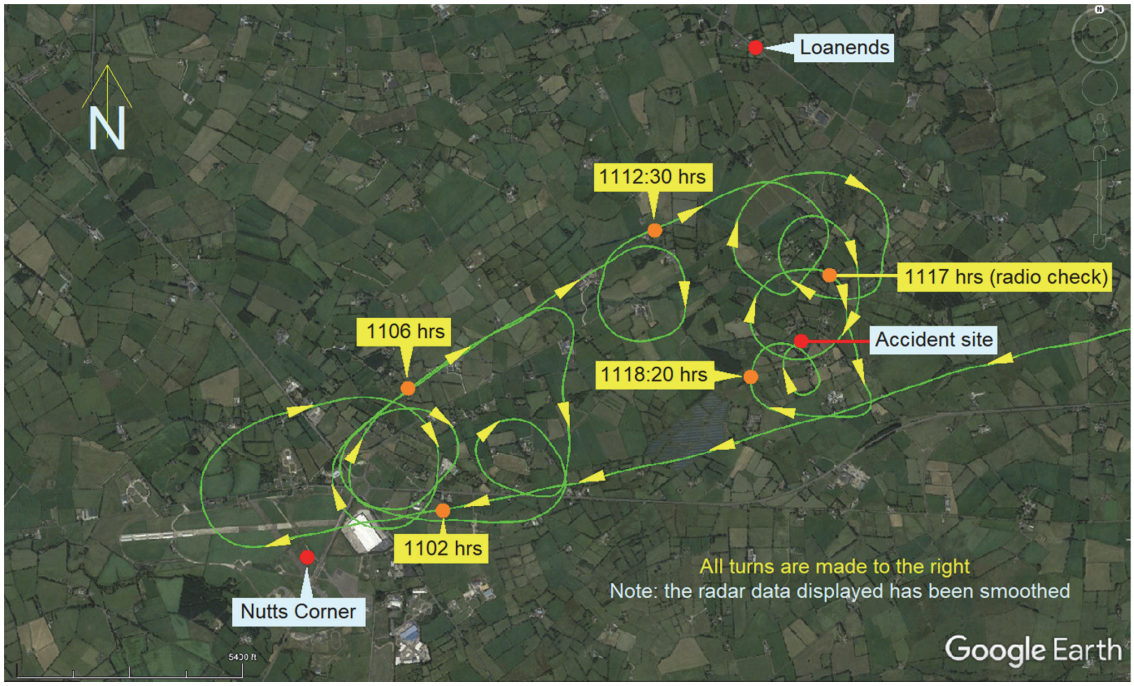

Figure 2

Radar track of the last 19 minutes of the flight

At 1117:10 hrs, the pilot contacted the controller to request a radio check (there had been a period of about 10 minutes with no radio traffic on that frequency). The pilot was advised that they were the only aircraft currently on frequency. This was the last radio communications received from G-UFCO.

Radar recordings showed that during the next 90 seconds the aircraft maintained an altitude of about 900 ft amsl (approximately 400 ft agl), whilst making turns to the right. At 1118:44 hrs the turn rate increased to an estimated bank angle of about 45° right wing down, before reducing to about 20° right bank. The radar data indicates that the aircraft continued with a gradual turn to the right and at 1119:03 hrs the final radar point was recorded. The aircraft was at an altitude of about 810 ft +/- 50 ft (260 ft +/-50 ft agl) (Figure 3).

Witnesses on the ground in the area of the accident saw the aircraft circling. Several reported seeing it flying apparently normally before suddenly “nose-diving” towards the ground. Two witnesses close to the accident site also reported hearing the engine “spluttering” as the aircraft passed overhead at a low height. After the aircraft struck the ground these witnesses heard a “popping” noise and then a larger explosion.

There was an intense fire in the cockpit area and bystanders who arrived on the scene were not able to assist the occupants of the aircraft.

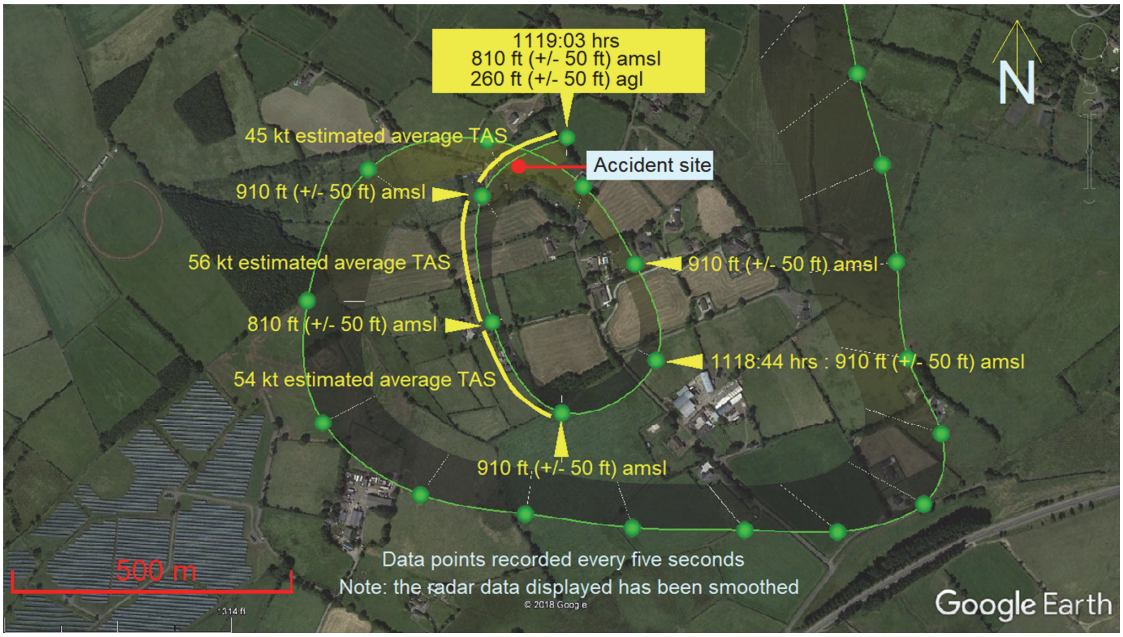

Figure 3

Radar track of the last 120 seconds of the flight

Aircraft information

G-UFCO was a Cessna 152, a two seat, dual control high wing monoplane powered by a horizontally opposed four-cylinder Lycoming piston engine driving a two-blade, fixed pitch propeller.

The aircraft was originally registered in the USA and was transferred to the UK register in June 2015. It had a valid Airworthiness Review Certificate, which was due to expire on 8 July 2018. At the time of the accident the aircraft had accumulated a total of 3,021 airframe hours and 598 engine hours. The last 50-hour check was carried out at 3,006 hours, on 27 March 2018 and the records showed no significant defects recorded. The technical log showed that the aircraft had flown regularly in the days leading up to the accident.

Carburettor heating system

During normal operation, air passes through a filter, is mixed with fuel in the carburettor and then goes into the engine but in certain atmospheric conditions, ice can form in the carburettor, restricting and ultimately preventing, fuel and air from reaching the engine. To provide protection against carburettor icing, the aircraft, in common with other piston engine aircraft, is fitted with a carburettor heating system. The cockpit carburettor heat selector is connected to a flap valve in the air intake box by a cable and lever arm (Figure 4). When the selector is moved to the ON or HOT position, the cable pulls the lever arm, rotating the valve and allowing air heated by the exhaust manifold to flow into the carburettor to melt any ice present.

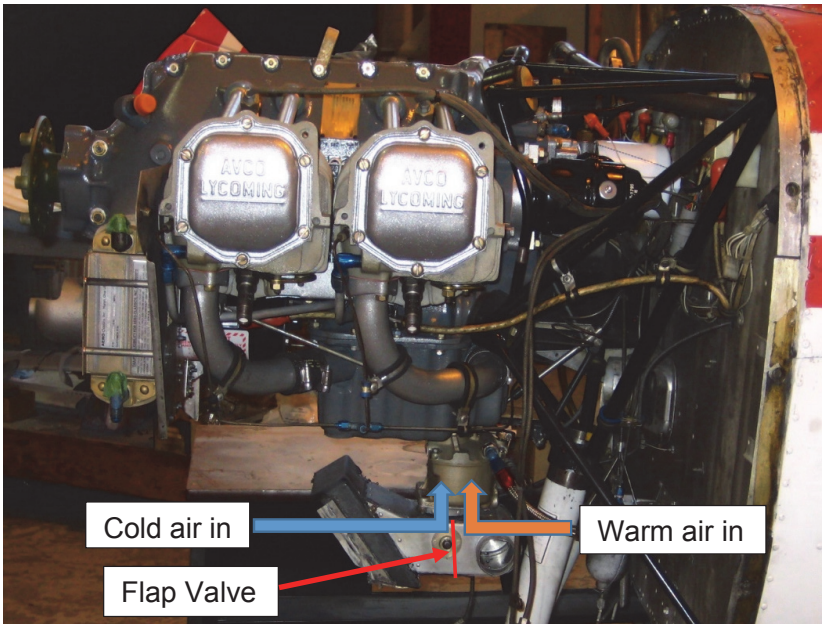

Figure 4
Carburettor heat valve

Flying controls and flaps

The Cessna 152 has conventional flying controls with inputs transmitted to the control surfaces via rods, cables and bell-cranks. It is fitted with inboard trailing edge flaps which are extended and retracted by a screw-jack actuator driven by an electrical motor, mounted in the inboard structure of the right wing. The actuator operates a system of cables and pulleys which move control rods attached to the flaps, with limit switches on the actuator removing electrical power to the motor when the flaps reach the fully extended [DOWN] or fully retracted [UP] position. The flap position is controlled by a cockpit mounted lever with detents at 10°, 20° and 30° increments and a feedback indicator-system which displays the actual flap position.

Stall warning system

The Cessna 152 is fitted with a stall warning system which gives an audio indication to the pilot of an impending aerodynamic stall approximately 5 kt to 10 kt before the stall speed is reached. The system consists of a small orifice in the leading edge of the left wing attached, via a tube, to a pneumatic horn. The horn emits an audible 'whistling' tone when negative air pressure at the wing leading edge causes reverse airflow through the horn.

Stall speeds

It was not possible to calculate the precise weight and balance of the aircraft at the time of the accident, but it was probably close to the maximum takeoff weight of 1,670 lb and towards the forward CG position. A range of stall speeds for the aircraft is shown at Table 1[2].

Footnote

[2] IAS is Indicated Air Speed, the speed displayed on the aircraft instruments. CAS is Calibrated Air Speed, IAS corrected for instrument and sensor position error.

Angle of bank	0°		30°		45°	
	IAS	CAS	IAS	CAS	IAS	CAS
Forward CG	36	48	39	**52**	43	57
Rearward CG	40	48	43	**49**	48	55

Table 1

Stall speeds in kt at maximum takeoff weight 1,670 lb and various angles of bank

Accident site

The aircraft accident site was in a field approximately 4 nm south-east of Belfast International Airport (Figure 5). The aircraft had passed through a stand of trees, which were approximately 30 ft high, before it struck the ground. A one metre section of the right wing was retained in the trees. The ground impact marks, made by the forward fuselage and the wing leading edges, indicated that the aircraft struck the ground in a steep nose-down attitude (Figure 6). The wreckage site was compact, the aircraft was upright with both wings showing evidence of leading edge compression.

Figure 5

Accident site

The aircraft tail section had separated from the fuselage during the impact and the right wing had been bent rearwards, but the remainder of the aircraft was largely intact. There was a post-crash fire which was confined to the cockpit and inboard section of the right wing which contained one of the aircraft's fuel tanks. Six litres of fuel were later recovered from the left wing tank. The left flap was displaced by approximately 5° from the trailing edge of the wing. It was not possible to measure the position of the right flap due to fire damage.

Figure 6
Accident site

Aircraft examination

The continuity of the flying control cables was confirmed before the aircraft was recovered to the AAIB facility for a detailed examination. No examination of the position of the cockpit controls was possible due to the severity of the post-crash fire.

Engine

The engine showed evidence of fire damage to some rear mounted ancillaries including the oil filter and one magneto, but was otherwise in good condition. The engine and carburettor were disassembled and inspected at an approved maintenance organisation under AAIB supervision, no defects were identified. The undamaged magneto was tested and found to be serviceable, the fire damaged magneto could not be tested.

The carburettor throttle valve was found in a position that corresponded to an engine speed of approximately 1,800 rpm although it is possible it may have moved during the accident. The engine manufacturers operating manual for the O-235 engine showed that, at this speed, the engine would be producing approximately 35% of its maximum power.

Carburettor heating system

During removal of the engine, the carburettor heat valve was examined to determine the position of the flap valve. The valve box had deformed during the impact and jammed the flap valve, retaining it in the COLD position (Figure 7).

Figure 7
Carburettor heat valve

Propeller

The propeller was removed from the engine and examined. The engine propeller attachment flange was deformed and five of the six threaded inserts into the flange had been pulled through and the spinner assembly was crushed flat by the impact. One blade tip was bent backwards about 45° from the midpoint of the blade and showed signs of damage from the post-crash fire. There was also was evidence of impact marks and scratches on its leading edge (Figure 8). The other blade was undamaged which was indicative of the engine operating at low power at impact.

Figure 8
Propeller blade comparison

Flaps

The flap system was powered by an electrically driven screw-jack actuator in the right wing. The position of the flaps can be determined by measuring the extension of the actuator, the measured extension on G-UFCO was 9.2 mm (Figure 9).

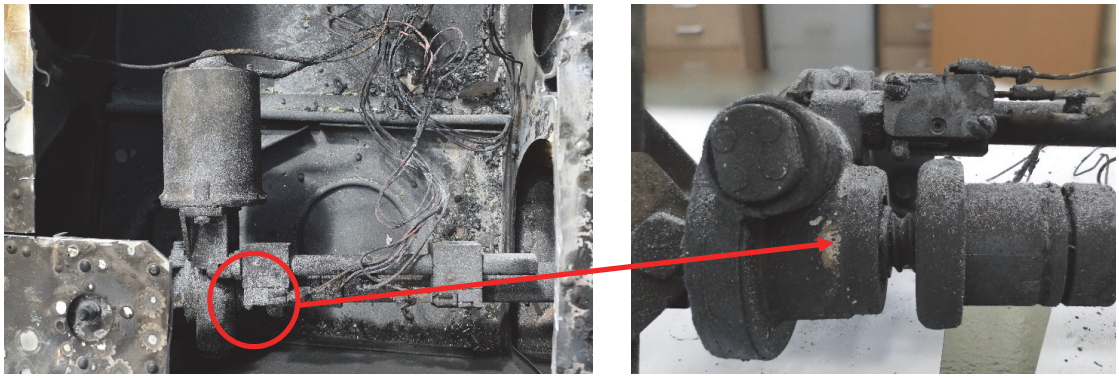

Figure 9
Flap actuator

According to the manufacturer's documentation, the actuator is extended by 4 mm at flaps UP. On the accident site, the left flap was found to be at an angle of 5°, which was calculated to require an actuator extension of 38 mm. It is therefore probable that the flap had moved due to the loss of tension in the control cables as a result of the post-crash fire. Discussion with the manufacturer confirmed that 9.2 mm of actuator extension could be accounted for in the flap rigging tolerances and it is therefore considered that the flaps were set to the UP position at the time of the accident.

Prior report of flap behaviour

On 13 November 2017 an entry was made in the aircraft technical log reporting *'flap oscillation 2-3° noted at flap 20° and flap 10°'*. On 20 November 2017 a note was added, '*fixed*', countersigned by a club instructor. After the accident the AAIB were provided with a video recording of unusual flap retraction behaviour on the aircraft. The video had been recorded several days before the accident. It showed that when the flaps were retracted from the 30° position to the UP position, at both the 20° and 10° positions they would pause, oscillate two to three times, before continuing to retract. This behaviour was only observed when the aircraft was on the ground.

Fire damage prevented any examination or testing of the flap actuation and position indicating system. The aircraft maintenance records showed that the flap position microswitches were last adjusted in September 2016. The flap oscillation was discussed with the aircraft manufacturer. It was suggested by the manufacturer that the oscillation could be caused by slight movement of the control microswitches when the flaps were moving. As there is no evidence that the flaps were moved during the accident sequence there is nothing to suggest this behaviour contributed to the accident.

Stall warning system

The stall warning system was destroyed in the post-crash fire, so it was not possible to verify if the system was operating normally.

Recorded information

Sources of recorded information

A digital camera and two mobile phones were recovered from the wreckage of the cockpit, however damage sustained during the post-crash fire meant that no data could be recovered from these devices.

Recorded radar information (primary and secondary Mode A and C[3]) was available from ground-based sites located at Belfast City and Belfast International Airport. This provided an almost complete recording[4] of the accident flight. The data started at 1049 hrs and ended at 1119:03 hrs, which was shortly before the aircraft struck the ground. RTF ground recordings of the pilot's communications with ATC at Belfast City and Belfast International Airport were also available. (Figures 1, 2 and 3)

Figure 10 is a plot of the estimated TAS and bank angle during the latter stages of the flight. The bank angle is derived from the aircrafts rate of turn and its TAS measured between each radar point, which were five seconds apart.

Interpretation of recorded data

The estimated TAS, derived from radar recordings, show that the aircraft was flying at below normal cruise speed during the latter stages of the flight when it was operating between Nutts Corner and Loanends. The average TAS between the last two data points was calculated to have been about 45 kt[5]. This was the lowest calculated during the flight. The final radar point was 60 m north-east of the accident site (Figure 3).

Descent rate following final radar return

The last radar return was at 1119:03 hrs when the aircraft was at a height of approximately 260 ft agl. Analysis of the Belfast International radar coverage[6] indicates that the radar floor extended to ground level near the area of the accident site. This indicates that the aircraft struck the ground prior to 1119:08 hrs which is when the next radar scan of the area occurred. The average descent rate of the aircraft proceeding the last radar point would have needed to be greater than 3,120 ft/min for the aircraft not to have been recorded on radar at 1119:08 hrs.

Footnote

[3] Mode A refers to the four-digit 'squawk' code set on the transponder and Mode C refers to the aircraft's pressure altitude which is transmitted in 100 ft increments.
[4] The position of the aircraft was recorded once every five seconds by radar.
[5] Based on level flight.
[6] The lowest altitude at which an aircraft may be detected by radar when the aircraft is at a specific location relative to the radar site.

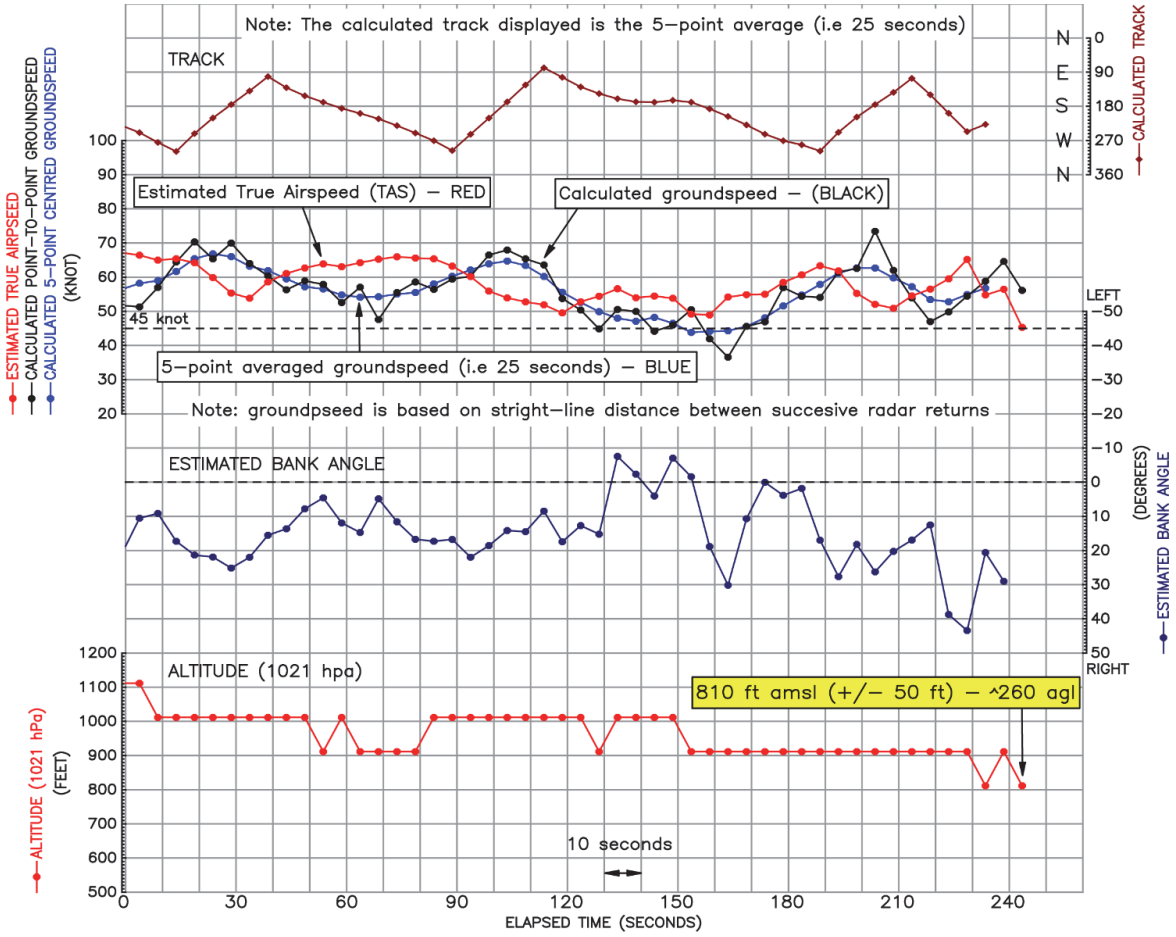

Figure 10

Estimated airspeed and bank angle during latter stages of the flight

Previous flight flown by pilot of G-UFCO

Radar data was analysed for a flight on 5 April 2018 flown by the pilot of G-UFCO and accompanied by the same passenger; this was flown in another Cessna C152 registration G-UFCN.

This flight was operated in an area just to the south-west of Newtownards Airport and was similar to the accident flight with multiple clockwise turns flown at between about 550 ft and 1,250 ft agl (Figure 11).

Meteorology

The 1120 hrs meteorological report from Belfast International Airport, 4 nm north-west of the accident site, was: surface wind from 220° at 11kt, visibility 10 km or more, scattered cloud at 1,900 ft with a temperature of 16°C, a dewpoint of 11°C and a barometric pressure of 1021 hPa.

CCTV footage was obtained from a property near to the accident site which showed scattered cumulus cloud, estimated to be at a height of around 1,500 ft.

Figure 11

Flight flown by pilot of G-UFCO on 5 April 2018

Organisational information

The operator of the aircraft is a flying club with aircraft available for training and private hire, it did not hold an Air Operator's Certificate (AOC) for commercial work. The club stated that they were not aware that their aircraft were being used for photographic flights.

Pilot information

The pilot held a valid Class 2 medical certificate. The pilot's most recent logbook was available for the investigation. The Certificate of Experience lapsed on 30 September 2017 and thus he was required to undertake a flight test with an examiner to re-validate his licence. The test was carried out on 31 March 2018 but was not completed then, at the pilot's request. The examiner recorded that the pilot had been required to repeat one test item on 31 March, steep turns, which were noted as having been flown out of balance. The test was completed subsequently on 5 April 2018.

The pilot recorded photographic flights in his logbook. He had flown with two different photographers since 2003, on flights which varied in duration from 30 minutes to 4 hours. The flights were flown from Newtownards and most of the aircraft used were hired from the flying club which owned G-UFCO.

Other information

Regulations around the conduct of flights

EASA Air Operations Regulation (EU) No 965/2012 Part-SPO (Specialised Operations) applies to any aircraft operation, other than Commercial Air Transport, where the aircraft is used for specialised activities such as agriculture, construction, photography, surveying, observation, patrol and aerial advertisement. EASA Part-SPO became applicable in the UK from 21 April 2017. Specialised Operations may be commercial or non-commercial; where operators are engaged in commercial Specialised Operations in the UK they are required to submit a declaration to the CAA about their operation confirming compliance with relevant aspects of Annex III 9 (Part-ORO) and Annex VIII (Part-SPO) of the EASA Air Operations Regulations. A declaration had not been submitted for this, or previous photographic flights.

For non-commercial Specialised Operations in non-complex aircraft a pilot is required to operate in accordance with Annex VII (Part-NCO) and Subpart-E NCO.SPEC. The regulation includes a requirement for a risk assessment and provides an associated activity checklist which includes, as one item, a consideration of '*the nature of the flight and the risk exposure, e.g. low height*;'

At the time of the accident the definition of 'commercial operation' according to Regulation (EC) No 216/2008[7] Article 3 (Definitions) (i) was:

> *'any operation of an aircraft, in return for remuneration or other valuable consideration, which is available to the public or, when not made available to the public, which is performed under a contract between an operator and a customer, where the latter has no control over the operator.'*

A similar definition is provided for the UK in The Air Navigation Order 2016.

European Regulation (EU) 923/2012, The *Standardised European Rules of the Air* (SERA), stipulates the minimum VFR flight altitude in daylight**:**

> ***'SERA.5005 Visual flight rules***
>
> *(f) Except when necessary for take-off or landing, or except by permission from the competent authority, a VFR flight shall not be flown:*
>
> *..'at a height less than 150 m (500 ft) above the ground or water, or 150 m (500 ft) above the highest obstacle within a radius of 150 m (500 ft) from the aircraft.'*

Footnote

[7] Superseded by Regulation (EU) 2018/1139, 22 August 2018.

The CAA has established an exception to this 150 m (500 ft) requirement, provided the aircraft is not flown closer than 150 m (500 ft) to any person, vessel, vehicle or structure, except with the permission of the CAA. No such permission had been obtained

Analysis

Accident site

The location of the separated portion of the right wing in trees adjacent to the aircraft's final resting place and the presence of all of the aircraft's remaining structure on site confirmed that there had been no in-flight structural failure. Correct operation and continuity of all flying control surfaces was verified.

The damage to the trees and the ground marks suggest that the aircraft was descending steeply whilst turning to the right which increased as the right wing contacted the trees. Both wings showed uniform leading edge compression from ground impact. This, together with the ground markings showed that both wings stuck the ground at the same time.

Engine examination

No evidence was found of any problems that would have prevented normal operation of the engine. The position of the carburettor throttle valve suggested that the engine had been operating at approximately 35% of its maximum power at the time of the accident. This was supported by the damage observed to the aircraft's propeller which was consistent with an engine operating at low power at impact. If the engine's performance had been affected by carburettor icing, it would be expected that the pilot would have increased engine power and operated the carburettor heat system. The position of both the throttle valve and carburettor heat valve suggest that it was unlikely that carburettor icing was present immediately before the aircraft's final manoeuvre.

Flying controls

Due to the intense post-crash fire it was not possible to verify any of the positions or settings of the flight controls.

Conduct of the flight

The flight was carried out for the purpose of taking aerial photographs. The pilot and passenger had flown together on many similar flights over the last 14 years, thus, they were both familiar with the operation. Information was not available concerning any financial arrangement between them, either for this, or for previous similar flights. Were any '*remuneration or other valuable consideration'* accepted by the pilot then the flight should have been conducted in accordance with the requirements for commercial Specialised Operations. Otherwise it should have been conducted as a non-commercial Specialised Operation in a non-complex aircraft. In either case the pilot would have been required to conduct a risk assessment and to specify how any risk would be mitigated; for example a declaration of a minimum height for aerial photography to address the risks associated with flying at low level.

During the flight the aircraft flew a series of sustained turns, all in a clockwise direction, facilitating the taking of photographs from the passenger (right hand) seat. The orbits were being flown at an average speed of 60 kt TAS and at a height varying between 500 ft and 300 ft agl.

The CAA exception to SERA.5005 (f) allows flight below 500 ft agl in the United Kingdom, but the aircraft must remain 500 ft away from persons, vessels, vehicles and structures. As the aircraft was flown at a height of less than 500 ft agl and in the vicinity of houses for extended periods, it is improbable that the required separation was maintained throughout.

Stall speed

Calibrated (CAS) and True (TAS) airspeed have approximately equivalent values at the speed and altitude at which the aircraft was operating. During the later stages of the flight, the aircraft was flying at around 60 kt TAS and at bank angles of up to about 30°. The effect of a turn is to increase the stall speed.

A speed of 60 kt TAS is about 12 kt above the stall speed for straight and level flight, but at 30° angle of bank, this reduces to an approximate 8 kt to 10 kt margin, and only a 3 kt to 5 kt margin at 45° angle of bank. The stall warner would have activated at between 5 kt to 10 kt before the stall speed is reached. It is likely therefore that for periods during the latter stages of the flight the stall warner would have been sounding. This may have resulted in the pilot and passenger becoming accustomed to the sound of the stall warner, thereby reducing the value of its warning.

With the aircraft in a turn, additional engine power is required to maintain altitude and airspeed, but the evidence shows that the engine was operating at a low power setting. About 20 seconds before the final radar point the bank angle was estimated to have increased to about 45° as the aircraft turned through 180°. The altitude was maintained but the airspeed reduced to below 60 kt. The rate of turn was reduced for a short time and then the bank angle increased again to about 30°. The airspeed reduced below 50 kt TAS and the aircraft would have stalled, resulting in a loss of control with insufficient height to recover.

Conclusion

The aircraft was engaged in aerial photography and thus the flight came within the scope of Specialised Operations. This required a strategy for the evaluation and mitigation of risks, such as those associated with flying at low level. There was no evidence of the required risk assessment having been carried out or for the checklist associated with the mitigations for the particular activity being in place.

The aircraft was flying at low level and low airspeed when, for an undetermined reason, there was a critical reduction in airspeed and a loss of control. There is an increased level of risk associated with flying close to the stalling speed without sufficient height to recover from a stall, particularly when focussed on a task such as taking aerial photographs.

Safety action

Since the accident the flying club has issued instructions to their pilot members to remind them of their responsibility to understand and comply with the privileges of their licences and ratings. The club flying instructors have been reminded not to authorise any rental flight where there may be any doubt as to its purpose. The club is also re-drafting the flying order book and aircraft hire/rental agreements to make it clearer as to what can and cannot be undertaken in a hired aircraft. Additionally, the club intends to provide warning signage/posters to remind pilots and passengers of the restrictions and implications of travelling for any kind of payment in light aircraft.