BEA
Bureau d'Enquêtes et d'Analyses
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SAFETY INVESTIGATION REPORT

Accident to the Issoire Aviation APM 30 registered F-HFIK on Saturday 17 June 2023 at Pignans

Time	Around 13:00[1]
Operator	Aéroclub du Var
Type of flight	Local
Persons on board	Pilot and two passengers
Consequences and damage	Pilot and passengers fatally injured, aeroplane destroyed
This is a courtesy translation by the BEA of the Final Report on the Safety Investigation. As accurate as the translation may be, the original text in French is the work of reference.	

Asymmetric stall, spin, post-impact fire

1 HISTORY OF THE FLIGHT

Note: the following information is principally based on statements, radio-communication recordings, radar data and a video from a surveillance system.

The pilot, accompanied by two passengers, carried out a local flight from Cuers - Pierrefeu aerodrome. At 12:12, the pilot took off from runway 11, headed south-east, passed close to the reporting point VC (Valcros, see **Figure 1**) and continued his route towards the Mediterranean coast. He then followed the coast to Fréjus, passing abeam Saint-Tropez and Sainte-Maxime before returning inland to Cuers, passing close to Luc aerodrome. At 12:54, he indicated on the Luc tower frequency that he was at an altitude of 2,000 ft for a QNH of 1015 and that he was going to fly north of the zones. At 12:58, he reported that he was crossing the Luc runway axes at an altitude of 2,200 ft heading towards reporting point SW[2] and that he had sight of skydiving traffic. After a few exchanges on the frequency with the pilot of the skydiving aeroplane, he passed close to reporting point SW and turned westward towards the Cuers entry point CN. No other radio exchange from the pilot of F-HFIK would be recorded.

[1] Except where otherwise indicated, the times in this report are given in local time.
[2] SW is the Luc aerodrome reporting point represented by a motorway bridge at Gonfaron.

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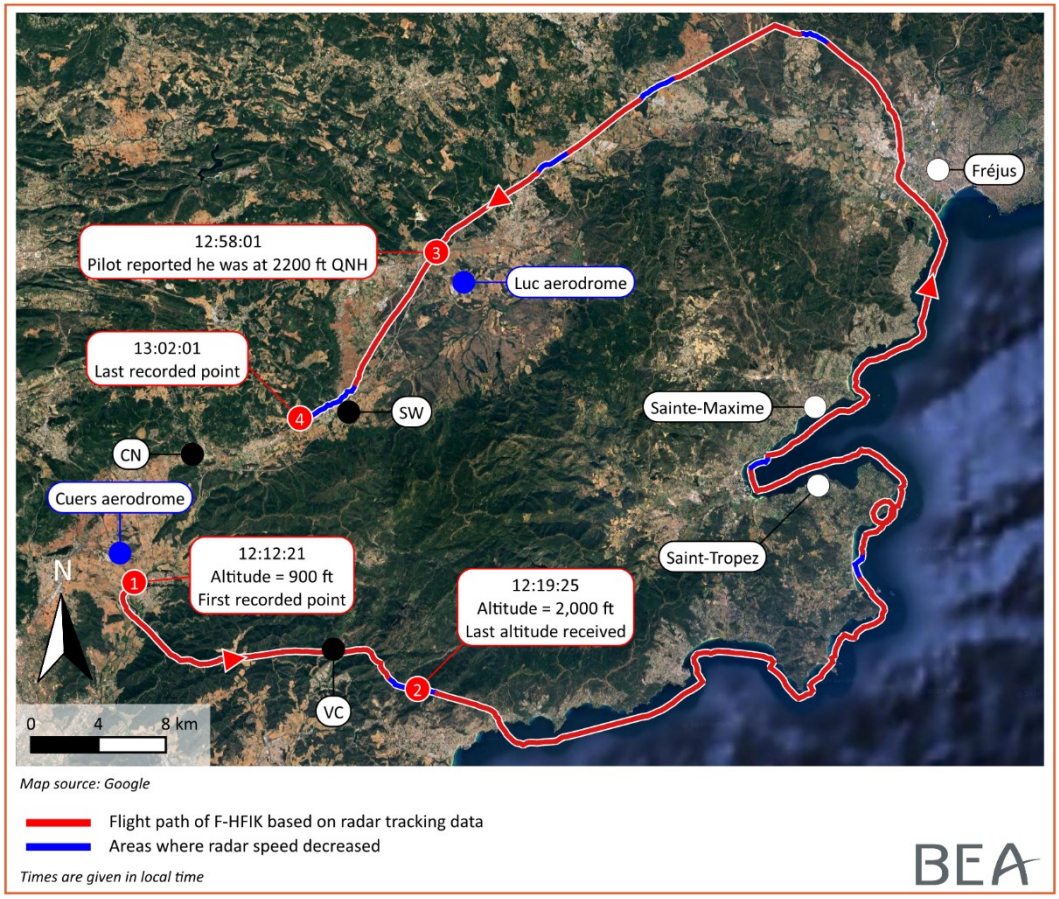


Figure 1: flight path of F-HFIK based on radar tracking data

At around 13:00, according to several eyewitnesses on the ground, the aeroplane banked to the RH side, levelled its wings and then banked to the LH side before suddenly tipping forward. The aeroplane followed a nearly vertical path up to impact with the ground. A fire broke out in the seconds following the accident.

2 ADDITIONAL INFORMATION

2.1 Site and wreckage information

The wreckage was situated in a forest on a hillside in the Pignans district close to the village of Gonfaron. The aeroplane was complete when it struck the trees. A fire broke out following the accident. Marks found in the vegetation indicated that the final flight path was on a steep slope. The flaps were retracted.

Due to the numerous ruptures and damage resulting from the post-impact fire, it was not possible to conclude whether the roll and elevator control channels or the flap control channel were continuous. The observations on site and the examinations of the ruptured cables of the yaw control channel found that the latter was very probably continuous at the time of the accident.

The flap lever screws, the subject of an airworthiness directive (see paragraph 0) were found in one piece on the wreckage of F-HFIK. No damage prior to the accident was observed on the attaching screws in the examination in the BEA's laboratory.

The engine was not the subject of a detailed examination due to the substantial damage that it sustained in the fire.

Likewise, it was not possible to read out any data from the computers and telephones found burnt.

In short, the examination of the wreckage was very limited due to the fire damage. The elements that could be examined did not show any anomaly likely to explain the accident.

2.2 Pilot experience

The pilot's logbook was not found. It was probably destroyed in the fire which followed the accident. The pilot's experience was estimated based on the information collected from the Var flying club, the EALAT[3] based at Luc and Berck-sur-Mer flying club where he had flown previously.

The 26-year-old pilot held a PPL(A). He had logged around 160 aeroplane flight hours including more than 150 hours on the APM 20 and 1 h 20 min on the APM 30. He had flown for 3 h 14 min in the previous three months including two flights on the APM 30 for a total time of 1 h 20 min. He was approved for supervised solo flight on the APM 30 on 9 June 2023 following a 22-min flight on F-HFIK with an instructor. He then carried out another 58-min flight on 11 June 2023 on F-HFIK as pilot-in-command. The instructor indicated that during the solo supervised flight on F-HFIK, the pilot had carried out stall exercises and the reaction of the aeroplane had seemed normal to him.

The pilot also held a helicopter pilot certificate obtained at the EALAT at Dax. He had logged a total of 186 flight hours on the Fennec, Colibri and Gazelle.

Lastly, in 2014, he took part in an aerobatics light instruction day organised by Berck-sur-Mer flying club. During this light instruction flight on a CR100, one or two spin recoveries and spiral dives were carried out.

2.3 Passenger in RH seat experience

The passenger in the RH seat did not have any aeroplane flight experience. He held a helicopter pilot certificate obtained during his training with the EALAT.

2.4 Meteorological information

Météo-France estimated that the meteorological conditions were an easterly to southeasterly wind at 5 to 10 kt, light surface turbulence, visibility greater than 10 km, cloud cover clear to few clouds, a few thin fractional clouds at 3,000 ft in the valley between Pignans and Gonfaron, temperature 28°C, dew point temperature 17°C, QNH 1014.

The eyewitnesses to the accident stated that that there were no clouds where the aeroplane stalled. A surveillance camera recorded the aeroplane's last spin turn before the accident. The sky was blue with no visible clouds.

[3] *École de l'Aviation Légère de l'Armée de Terre* (French Army Light Aviation School)

2.5 Aircraft information

The examination of the aeroplane's maintenance documentation did not reveal any anomaly which could explain the accident.

F-HFIK was purchased by the Cuers flying club in May 2023. At this time it had logged around 2,182 flight hours, and its engine around 915 hours. Prior to this acquisition, the maintenance and management of the continuing airworthiness of the aeroplane were carried out by Aéro Pyrénées Maintenance. Subsequently, these services were provided by Alpes Aero Maintenance.

The engine was replaced with a new one in 2018. Power losses and vibrations were subsequently observed during climb phases. In 2020, the vent hoses were lengthened, resolving the problem.

The last routine inspection before the accident took place in February 2023 (VP100), at 2,173 flight hours.

In April 2023, when the aircraft had flown 2,176 hours, the carburettor diaphragm, fuel pump and rubber pipes in the engine area (fuel, air, oil and water) were replaced, as their five-year service life had expired.

An airworthiness directive AD 2023-0096E relating to service bulletin SB No 63, issued on 9 May 2023, recommended the inspection and, if necessary, replacement of the flap lever screws. The reason for this AD was the fatigue failure of a flap lever screw that had occurred on an aircraft of the same type in 2020. On 12 May 2023, at 2,182 flight hours, this airworthiness directive had been complied with on F-HFIK. No play was observed on the flap lever screws, and the aeroplane was returned to service the same day.

The weight and centre of gravity during the accident flight, calculated using the information gathered by the BEA, were within the envelope recommended by the manufacturer.

The instructor indicated that, during the flight to approve the pilot for supervised solo flight on F-HFIK on 9 June 2023, the stall warning system was operational and triggered before the aeroplane actually stalled.

2.6 Altitude encoder information

F-HFIK was equipped with a GARMIN GTX 330 transponder associated with an ACK A30 altitude encoder.

In "mode A" operation, the transponder, in response to an interrogation from a secondary radar, enables air traffic control services to retrieve aircraft identification information and estimate its geographical position. In "mode C" operation, it also transmits altitude information from the altitude encoder. A selection button allows the pilot to decide whether or not the transponder transmits altitude information.

The analysis of the radar data from flights carried out by F-HFIK prior to the accident revealed the following:

- flights on 1, 2 and 6 June 2023: the altitude information was received by the radar processing system throughout the duration of the flights;

- flight on 11 June 2023: the altitude information was received by the radar processing system for the first thirty-three minutes of the flight, the altitude information was then no longer received for the fourteen minutes up to the end of the flight;
- accident flight on 17 June 2023: the altitude information was received by the radar processing system for the first seven minutes of the flight, the altitude information was then no longer received for the forty-three minutes leading up to the accident (see **Figure 1**).

According to the flying club's flight log, on 11 June 2023, the pilot was pilot-in-command on F-HFIK, as was the case on 17 June 2023, the day of the accident.

It is clear from the above information that altitude information was transmitted by F-HFIK's transponder throughout the duration of previous flights during the month of June, except when the pilot of the accident flight was pilot-in-command. During these flights, the altitude was not available in the radar recordings for part of the flight. It is therefore likely that the altitude encoder was operating normally, and that the pilot deliberately deselected the transmission of altitude information.

Under the regulations, when the aircraft is equipped with mode C equipment in working order, the pilot must use this mode at all times, unless otherwise instructed by the ATC. The transmission of the aircraft's pressure altitude, when available, is an important factor in flight safety. This information is essential for the operation of the TCAS in-flight collision-avoidance system fitted to certain aircraft, and more generally to enable air traffic control services to ensure the provision of information and separation of aircraft in flight.

2.7 Reconstruction of end of flight path

Radar data, information gathered from a number of eyewitnesses and the recording of a surveillance camera located close to the accident site made it possible to reconstruct the last moments of the flight up until the collision with the ground.

Based on the data recordings from the Luc primary radar, it was possible to estimate the various geographical positions and radar speed of F-HFIK in the seconds before the accident. The radar speed is calculated based on the time and geographical position of the radar blips. It is therefore an estimation of the aeroplane's ground speed. This data cannot be used to estimate the aeroplane's altitude.

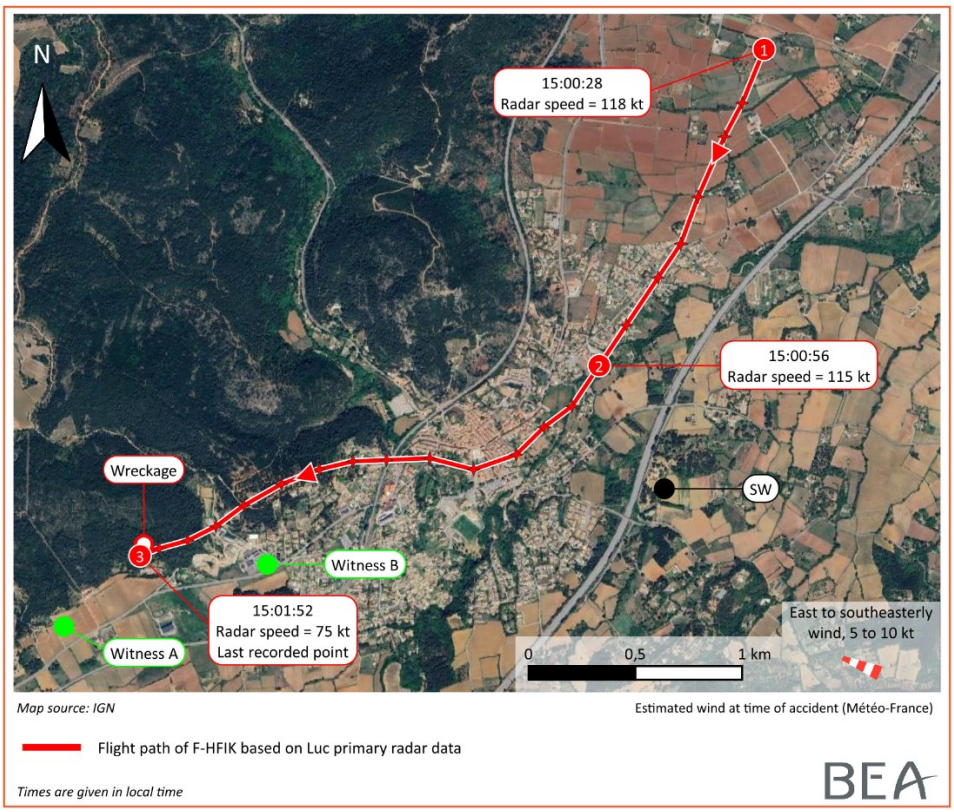


Figure 2: flight path of F-HFIK

Only the value of the horizontal component of the airspeed in the seconds leading up to the accident could be estimated based on the wind information provided by Météo-France and the speed provided by the Luc radar.

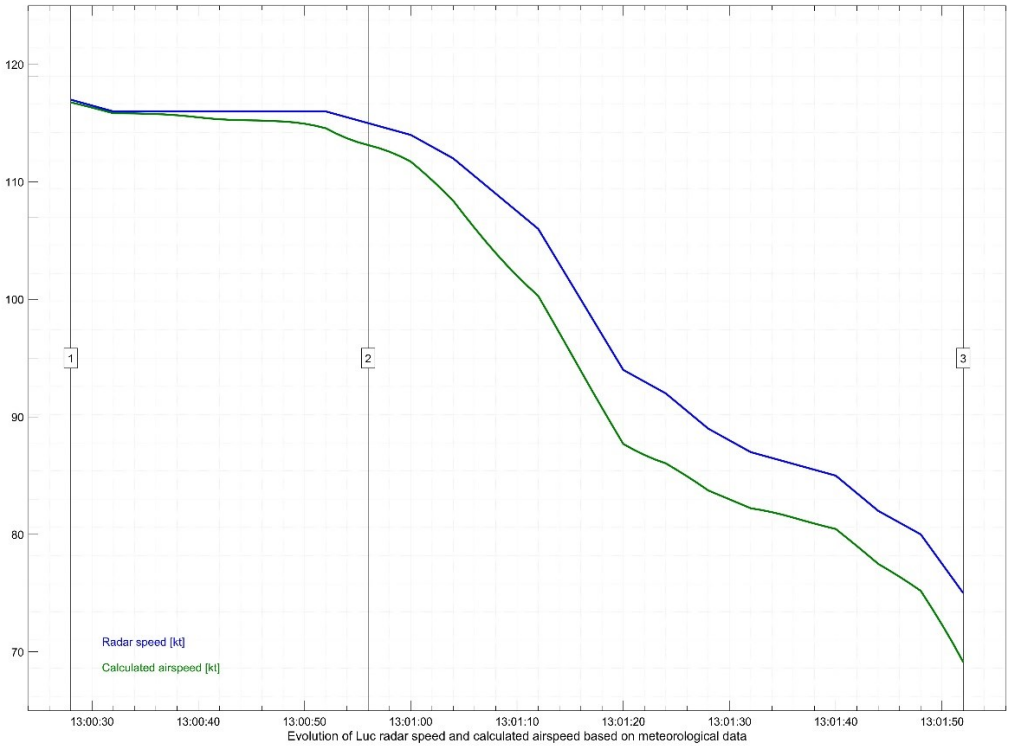
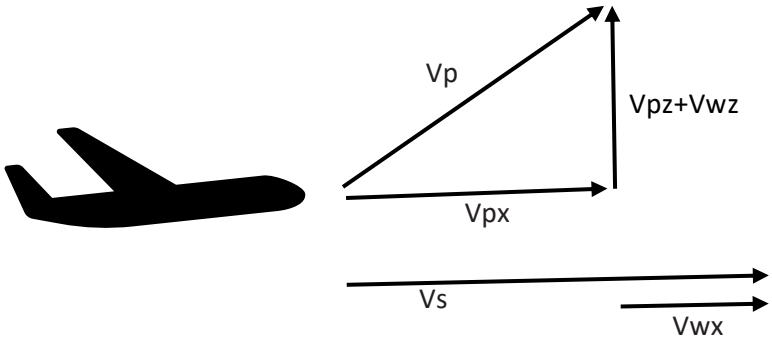


Figure 3: estimation of horizontal component of airspeed based on Luc primary radar data

At 13:00:28 (see **Figure 2** and **Figure 3**, point 1), the aeroplane was flying in a straight line at a constant horizontal speed of 118 kt. At 13:00:56 (point 2), the aeroplane's track started to veer right and the horizontal speed decreased[4] to around 88 kt. At 13:01:20, the track heading in a westerly direction started to veer left and the horizontal speed continued to decrease. At 13:01:52, (point 3), the last recorded radar point was situated close to where the wreckage was found, the horizontal speed was around 70 kt.

In the clean configuration, at maximum weight and a temperature of 15°C, the stall speed (airspeed) is 58 kt at zero bank and 69 kt with a bank of 45° (see paragraph 2.10).

In a straight climb, the airspeed of the aeroplane (Vp) is a combination of the radar speed (radar speed and ground speed Vs are assumed to be identical), the vertical speed (Vpz) and the wind (Vw).



Only knowing the horizontal component of the airspeed (Vpx) does not give a precise idea of the airspeed of the aeroplane (Vp).

According to the flight manual, at a speed of 76 kt (best rate-of-climb speed), with the engine full throttle and the flaps retracted, a weight of 750 kg, and an aeroplane free of rain and insect contamination, in the conditions prevailing on the day of the accident (pressure altitude of 1,500 ft and temperature difference of +14°C from standard), the rate-of-climb of the APM30 is theoretically 700 ft/min. With this best rate of climb, the airspeed corresponds to the horizontal component, with a margin of error of less than 0.3 kt.

On the other hand, in descent, vertical speeds can reach much higher values and have a much greater impact on the aeroplane's airspeed (Vp). By way of example, at a vertical speed of 5,000 ft/min in descent (an unusual, very high value, chosen arbitrarily to illustrate the influence of the vertical speed in the calculation), we have:

Horizontal component of airspeed (kt)	Vertical speed in descent (ft/min)	Maximum airspeed (kt)
90 kt	5,000 ft/min	103 kt
80 kt	5,000 ft/min	94 kt
70 kt	5,000 ft/min	86 kt

[4] The reduction in the horizontal speed may correspond to a reduction in the airspeed of the aeroplane following a reduction in power, but may also be the result of manoeuvres in the vertical profile, or a combination of the two.

Thus, a reduction in the horizontal speed may correspond to a reduction in the airspeed of the aeroplane following a reduction in power, but may also be the result of movements in the vertical profile, or a combination of the two.

2.8 Analysis of speed reductions during accident flight

The analysis of the flight data from the south-east ACC secondary radar found that a similar decrease in the radar speed of F-HFIK (assimilated with the ground speed) observed in the seconds preceding the accident occurred six times during the flight (see **Figure 1**).

The following table lists the values observed during the similar sequences:

Time	**Place**	**Max and min radar speed (kt), amplitude of reduction in speed (kt)**	**Duration of deceleration and mean value of deceleration**
12:19[5]	Bormes-les-Mimosas, North of Col de Caguo-Ven pass	Max = 116 kt Min = 67 kt Amplitude = 49 kt	68 s 0.37 m/s²
12:32	Off the coast of Pampelonne beach	Max = 121 kt Min = 88 kt Amplitude = 33 kt	32 s 0.53 m/s²
12:38	Off the coast of Mûres campsite beach, Grimaud	Max = 116 kt Min = 81 kt Amplitude = 35 kt	28 s 0.64 m/s²
12:49	North of Roquebrune-sur-Argens	Max = 116 kt Min = 90 kt Amplitude = 26 kt	32 s 0.42 m/s²
12:53	La Motte	Max = 110 kt Min = 90 kt Amplitude = 20 kt	48 s 0.22 m/s²
12:55	Escroy, Les Arcs	Max = 116 kt Min = 96 kt Amplitude = 20 kt	40 s 0.26 m/s²
Accident	Pignans	Max = 116 kt Min = 81 kt Amplitude = 35 kt	68 s 0.26 m/s²

2.9 Eyewitnesses and video

Several people were eyewitnesses to the last seconds of the aeroplane's flight before the accident.

Eyewitness A (see **Figure 2**), close to the accident site, saw the aeroplane make a RH turn and then track from left to right[6]. The aeroplane than banked to the LH side and entered into what seemed to be a LH spin. Its flight path was nearly vertical, nose down in a LH rotation. Eyewitness A indicated that the aeroplane made at least one complete spin turn.

[5] Time at which Mode C of the transponder was switched off.

[6] Given the position of the eyewitness, it can be deduced that the aeroplane was no longer heading towards Cuers.

Eyewitness B (see **Figure 2**) observed the aeroplane tracking from right to left. He believed that he saw the aeroplane make a LH banked turn, its nose slightly tip down, the canopy facing the ground, then its nose completely tip down. He then saw the aeroplane turn around itself once on the longitudinal axis before disappearing behind a building. During the descent, he heard a noise similar to what the engine would make if the pilot applied a lot of throttle.

The eyewitnesses reported that the noise generated by the rotation of the engine propeller was perceptible until they lost sight of the aeroplane.

Based on the eyewitness accounts, it was estimated that the aeroplane's altitude when it entered the spin was around 1,500 ft, or a height of around 700 ft.

From 13:01:55 to 13:02, a surveillance camera filmed the last complete turn which was akin to a spin up to the disappearance of the aeroplane behind the trees (see **Figure 4**).

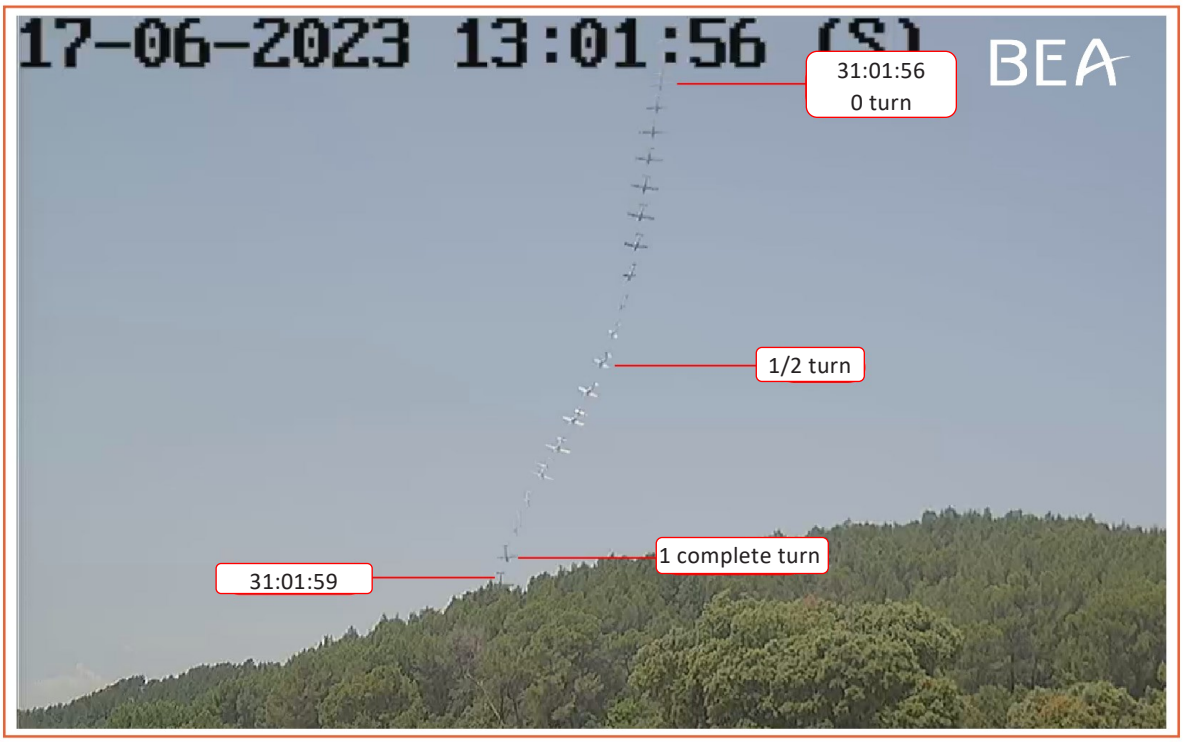


Figure 4: photo-sequence using surveillance camera video (source: BEA)

The average rotation rate calculated using the photo-sequence was one turn in three seconds. It increased at the end of the sequence to reach one turn in two seconds.

2.10 APM 30 during stall and spin information

2.10.1 Spiral dive and spin

The aeroplane pilot manual describes complicated situations such as the spiral dive and spin.

Spiral dive
During a high-bank turn, the aeroplane may enter a spiral dive. This has the following characteristics:

- substantial increase in bank and nose-down attitude;
- increase in G-force;
- rapid increase in speed with the risk of rapidly exiting the flight envelope.

The procedure for exiting this situation is to completely reduce power, put the wings in zero bank and carry out a gentle pull-out so as not to run the risk of a dynamic stall or even the start of a spin if the symmetry of the aeroplane is not ensured.

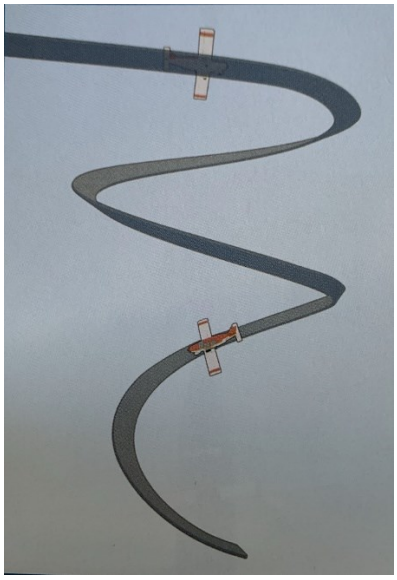


Figure 5: spiral dive
(Source: aeroplane pilot manual)

Spin (coded aerobatic figure)
The spin is characterised by:

- a high-bank asymmetric stall;
- an increase in the bank and wing drag which decreases and a decrease in the bank and the wing drag which increases which will amplify the roll-yaw movement;
- the aeroplane falling on a helicoidal path with a high rate of fall.

To stop the autorotation, the pilot must scrupulously follow the instructions in the flight manual (see paragraph 2.10.2). The stress associated with this situation, poor knowledge of the actions to be taken, combined with a significant loss of altitude, leave a very short reaction time.

Typical situations associated with entering a spin include a tight turn at low speed with the symmetry inadequately controlled.

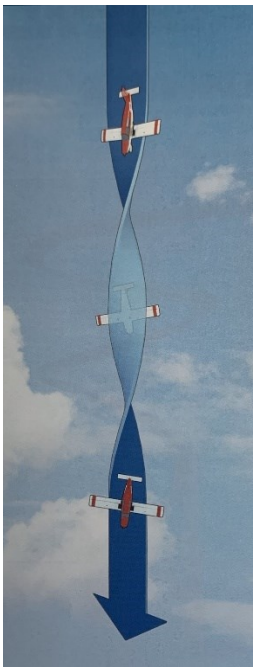


Figure 6: spin
(Source: aeroplane pilot manual)

2.10.2 Information contained in the APM 30 flight manual

The aeroplane flight manual provides the following table giving the stall speeds at the maximum weight of 750 kg, with a forward centre of gravity, at sea level in a standard atmosphere (1013 hPa, 15°C), with the aeroplane free of rain and insect contamination, and power cut off.

Position des volets	Inclinaison 0°	Inclinaison 30°	Inclinaison 45°	Inclinaison 60°
Lisse	58	62	69	82
1er cran	52	56	62	74
2ème cran	45	48	54	64
	kts	*kts*	*kts*	*kts*

The flight manual also states that in all cases of flap deflection:

- the aural stall warning sounds at least 5 kt approximately before the stall;
- at zero bank, buffeting[7] occurs 3 kt before the stall;
- the stall takes the form of pitch and roll excursions of increasing amplitude for all the time that the elevator is kept at full nose-up deflection;
- roll control remains possible with the ailerons as they receive sufficient airflow to remain effective;
- stall recovery is achieved by easing forward the control stick (altitude loss of around 20 m, bank less than 15°).

Finally, the flight manual recalls that deliberate spins are forbidden, and describes the procedure for recovering from unintentional spins.

[7] Buffeting is a vibration, an aeroelastic oscillation due to the appearance of a vortex flow over the wing. It is a warning sign that a stall is approaching.

➢ Recovery from a spin flaps retracted (clean configuration)

Simultaneously:

- completely reduce power
- comply with the following procedure:
  - ailerons neutral
  - rudder input opposite to the direction of spin
  - elevator in forward sector (nose down)

After the rotation has stopped (load factor n < 3.8; speed < VNE, i.e. 143 kt), perform a normal pull-out, wings horizontal, rudder pedals neutral, engine in idle. After this, restore the parameters required to continue the desired flight.

As a guide, the manual indicates that recovery from a spin (with flaps retracted, maximum weight and the centre of gravity at the aft limit) is achieved in half a turn when complying with the above instructions after one spin turn (about three seconds).

Finally, the aeroplane manufacturer indicates that, although the APM30 is not certified for deliberate spins, the height required to recover from a spin is around 700 ft. This height depends on a number of factors, including the nature and configuration of the start of the spin[8], as well as the pilot's training and familiarity with this type of situation.

2.11 Medical and pathological information

The autopsy, along with the anatomopathological and toxicological examinations carried out on the pilot and passengers did not reveal any signs of smoke inhalation. Nor was there any evidence of pilot or front-seat passenger incapacitation.

3 CONCLUSIONS

The conclusions are solely based on the information which came to the knowledge of the BEA during the investigation.

Scenario

Returning from a local flight, close to a navigation turning point, the aeroplane's horizontal speed gradually decreased. The investigation did not find any particular point of interest at this location. The reduction in the horizontal speed may correspond to a reduction in the airspeed of the aeroplane following a reduction in power, but may also be the result of manoeuvres in the vertical profile, or a combination of the two.

The eyewitnesses saw the aeroplane almost one minute after the horizontal speed had started decreasing. The different angles of view and positions of the witnesses made it possible to determine that its altitude was of the order of 1,500 ft, i.e. a height of 700 ft, and that the aeroplane had changed course in the final moments of the flight. It is therefore probable that the aeroplane was being piloted until the witnesses saw it tip to the left and then downwards, which appears to

[8] Whether the start of the spin is accidental or intentional, the standard adopts a deterministic approach, i.e. it sets precise and constant criteria to be met, rather than a probabilistic approach, which would involve an analysis based on the probability of events occurring.

correspond to a LH asymmetric stall. The aeroplane then continued on a near-vertical downward path with an attitude similar to that of a spin, until it collided with the ground. A fire then broke out.

The examination of the wreckage, limited by the fire damage, was not able to rule out the possibility of a technical failure that might have occurred shortly before the accident. Neither was the investigation able to rule out a sudden incapacitation of the pilot[9].

The investigation was not able to determine whether the reduction in the aeroplane's horizontal speed in the seconds leading up to the accident was deliberate or not. Nevertheless, similar speed decreases were observed six times during the flight before the crew of F-HFIK had radio exchanges with the pilot who was carrying out skydiving drops near Le Luc. No problems were reported during the radio exchanges. These horizontal speed decreases were therefore very probably deliberate. They could have been linked to reductions in speed, for example to observe a point of interest, or to manoeuvres in the vertical profile.

Furthermore, altitude information from the transponder (altitude encoder) was no longer available a few minutes after the aeroplane took off. The information collected during the investigation suggests that the altitude encoder was operating normally, and that the pilot deliberately deselected the transmission of altitude information to the radar system. The fact that a pilot deliberately switches off the altitude encoder during the flight may suggest his intention to carry out particular manoeuvres in the vertical profile, and that he has made sure that the control services are not able to detect this.

The height of around 700 ft estimated by the eyewitnesses, at which the loss of control occurred was theoretically just sufficient for a trained pilot to recover from a spin, reacting correctly and very quickly to the situation. The pilot had performed one or two spin and spiral dive recoveries on a CR100 during an aerobatics light instruction day at his previous flying club in 2014. The standard training program for a PPL license does not include recovery from a spin.

[9] As an example of sudden incapacitation, the BEA report concerning the accident to the AS 350 registered F-HLBT on 26 August 2017 at Guérande concluded that the pilot had experienced Benign Paroxysmal Positional Vertigo (BPPV), leading to the in-flight loss of control of the helicopter.