BEA
Bureau d'Enquêtes et d'Analyses
pour la sécurité de l'aviation civile
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SAFETY INVESTIGATION REPORT

Accident to the ROBINSON - R22 registered F-GFHA on 17 August 2021 at Fleurey-sur-Ouche (Côte-d'Or)

Time	Around 15:15[1]
Operator	Aéro Club de la Côte D'Or
Type of flight	Local
Persons on board	Pilot, passenger
Consequences and damage	Pilot and passenger severely injured, helicopter 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.	

Loss of yaw control, collision with ground

1 HISTORY OF THE FLIGHT

Note: the following information is principally based on statements as well as radar data.

The pilot, accompanied by a friend, took off from Dijon-Darois aerodrome[2] (Côte-d'Or) at around 14:30 for a first local flight lasting approximately 30 min, during which he flew over Montculot château in Urcy and the Roche d'Anse rocky spur. Accompanied by another friend, he took off again from this aerodrome at around 15:00 to perform a similar flight (see *Figure 1*).

Fifteen minutes after take-off and close to the Roche d'Anse spur, the pilot lost yaw control of the helicopter. A witness on the ground saw the helicopter spin several times while falling towards the forest and then disappear into the vegetation.

According to the radar recordings, the helicopter seems to have turned to the north-west, with a decreasing ground speed in the last seconds of flight. However, it was not possible to determine if the loss of control occurred before or after this path change.

[1] Except where otherwise indicated, the times in this report are in local time.

[2] Altitude = 1,586 ft.

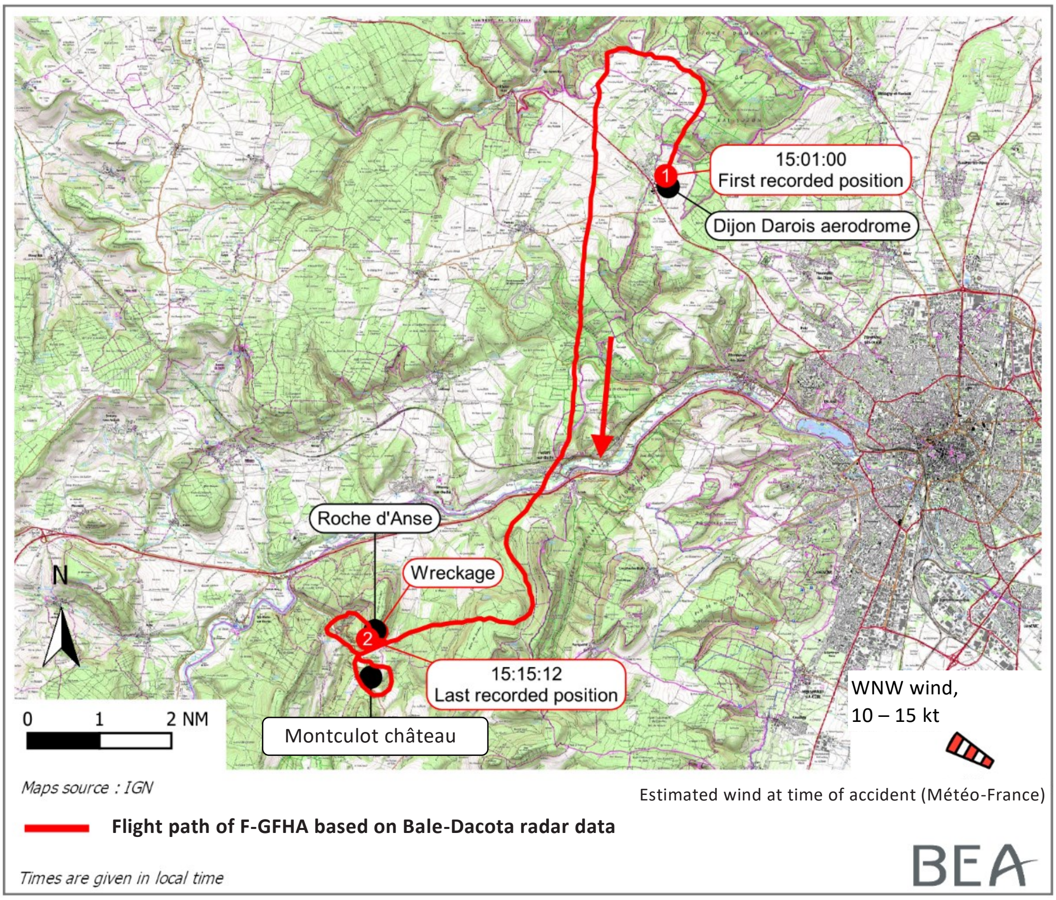

Figure 1: helicopter's flight path[3]

[3] For an undetermined reason, the helicopter's altitude information received by air traffic control radars was invalid. As a consequence, it was not possible to establish the vertical profile of the helicopter's path. The accuracy and sampling rate of the radar data meant that an accurate analysis of the horizontal profile of the helicopter's path was not possible.

2 ADDITIONAL INFORMATION

2.1 Site and wreckage information

Figure 2: site and wreckage (source BEA)

The wreckage was located at an altitude of 1,608 ft (490 m) on the side of a wooded hill, 70 m from the Roche d'Anse spur (altitude: 1,745 ft / 532 m). It was resting on its damaged skids. The tail boom was engaged between two trees which were holding it in place (see *Figure 2*).

The small hole in the vegetation, the various impacts in the trees and the damage to the main rotor blades indicated that the helicopter had fallen flat through the tree canopy with almost zero horizontal speed (see *Figure 3*).

Figure 3: hole in vegetation (source BEA drone)

The rear part of the helicopter was substantially damaged. The two tail rotor blades had failed near their attachment points. One of the blade tips was not found.

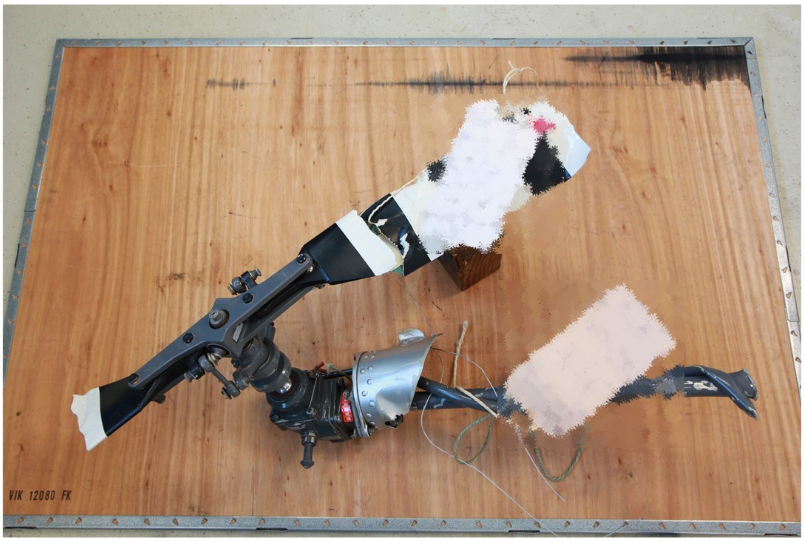

Figure 4: tail rotor (source BEA)

The tailplane, consisting of a horizontal stabiliser and a vertical stabiliser, was found ruptured near the wreckage.

The examinations of the distortions and impacts observed on the tail rotor blades, as well as of the tail rotor and tailplane fracture faces, revealed that the ruptures were caused by the collision with the vegetation and/or the ground.

The findings did not reveal any technical failure that may have contributed to the accident.

2.2 Pilot information

2.2.1 Experience and licences

The 75-year-old pilot held a Private Pilot Licence - Helicopters (PPL(H)) issued in 2000. He had logged 200 flight hours in the Robinson R22 and R44 and in the Bell 206, 135 h of which as pilot-in-command. Of late, he had only flown the R22.

He had logged approximately seven flight hours in the last three months, all from and to Dijon-Darois, including one flight with an instructor to renew his R22 type rating.

He held a Private Pilot Licence - Aeroplanes (PPL(A)) and had logged just under 700 aeroplane flight hours, including parachute dropping and aerobatic flights. He also held a fixed-wing and flex-wing microlight licence. For the last several years, he had only flown the R22.

2.2.2 Pilot's statement

The pilot stated that he did not remember the circumstances of the accident clearly.

He indicated that during the accident flight and after taking off from Dijon-Darois aerodrome, he flew at an altitude of approximately 2,200 ft heading south-west towards Montculot château in Urcy.

While climbing on the path to the château, he thought that he experienced a gust of wind or severe turbulence, which caused him to lose yaw control of the helicopter and that he associated with a sudden loss of tail rotor effectiveness. He was unable to remember the direction of rotation. He tried (without success) to regain control of the helicopter, in particular with left and right rudder pedal inputs and by lowering the collective pitch control, as he had been taught in the loss of tail rotor effectiveness procedure. He tried to keep the helicopter level while it continued to turn about its yaw axis. According to him, the fall lasted less than 30 s before the collision with the ground. He and his passenger were able to get out of the wreckage and alert the emergency services.

He stated that the engine had been operating normally, that it had not been at its power limit, that no lights or warnings had triggered and that he did not think that there had been any mechanical problem with the helicopter.

He specified that he had been flying looking outside and that he could not remember what his precise flight parameters were at the time of the loss of control, or the orientation of the helicopter. He thought that he had been in a wide turn, at an estimated height of between 150 and 250 m, moving forward and at a speed possibly below 60 kt. He was showing his friend the landscape and the terrain.

He added that this was his first visit to the Roche d'Anse tourist spot near the accident site. According to him, there had been a westerly wind on departure from Dijon of around 15 kt.

Lastly, he specified that he was unfamiliar with the unanticipated yaw phenomenon.

2.3 Passenger's statement

The passenger, who was training to be a private aeroplane pilot, said that he and the pilot had first flown to a château. Having flown around it, they had headed to a spur. They were at a height of approximately 200 m, flying around the rocky spur, when the helicopter starting rotating. According to him, it was a right-hand rotation, but he could not be sure. He saw the pilot making a lot of inputs on the cyclic stick and the helicopter swung up and down in addition to spinning.

He said that his feet were under his seat, away from the rudder pedals, and that he had not interfered with the flight controls.

2.4 Meteorological information

According to the information transmitted by Météo-France, the estimated wind at the time of the accident was west-northwest at 10 to 15 kt and was relatively laminar. Only convective turbulence was generated by cumulus clouds based at an altitude of 5,000 ft.
The local aerology could have been different due to the hills and the variety of vegetation under the helicopter's path.

The temperature was approximately 21 °C.

2.5 Helicopter information

The helicopter registered F-GFHA was a Robinson R22 Beta powered by a Lycoming O-320-B2C engine.

According to the information in the flight manual, the helicopter had not reached the power limit for hovering out of ground effect (the most penalising situation) in the conditions of the day.
Like other major American-designed helicopters, the main rotor rotates counterclockwise. The tail rotor is conventional.

The R22's flight manual includes two emergency procedures in the event of a loss of tail rotor power, one for forward flight, and one for hovering. In both cases, it is indicated that the failure usually starts with a yaw movement to the right that cannot be corrected by pressing the left rudder pedal:

- If the failure occurs during hover, the pilot must lower the collective pitch control as quickly as possible with the helicopter level.
- If the failure occurs during forward flight, the pilot must immediately enter autorotation and maintain a speed of 70 kt. However, it states that it is also possible to keep the aircraft flying over 70 kt in order to carry out an autorotative landing as soon as possible.

The helicopter manufacturer states that at speeds above 60/70 kt, the vertical stabiliser provides yaw stabilisation with little assistance from the tail rotor. In forward flight at cruise speed, in the event of a complete tail rotor failure or in the event of an extreme input on the rudder pedals, the helicopter will continue to fly without entering a rotation, with the heading changing by probably no more than 10° to 15°.

2.6 Unanticipated yaw

Unanticipated yaw is a flight characteristic that all types of single-rotor helicopter (regardless of the anti-torque system) are likely to encounter, especially at low speeds and/or when high power is required. It usually depends on the wind speed and its direction in relation to the helicopter (tailwind or wind from the left for a Robinson).

This phenomenon most often occurs in the opposite direction to the rotation of the main rotor blades (i.e. to the right for helicopters with rotors rotating counterclockwise like the R22).

This unanticipated yaw phenomenon has been the subject of numerous publications following accidents and incidents, including the following:

- Safety Notice 42 published by Robinson, which also published an educational video;
- Advisory Circular AC 90-95 published by the Federal Aviation Agency (FAA);
- Safety Alert 062 published by the National Transportation Safety Board (NTSB);
- Safety Information Notice No. 3298-S-00 published by Airbus, for helicopters whose main rotor rotates counterclockwise;
- Safety Information Notice No. 3297-S-00 published by Airbus, for helicopters whose main rotor rotates clockwise.

If a helicopter enters an unanticipated yaw, the pilot must act rapidly and appropriately to prevent loss of control. An input on the pedals to counter the yaw rotation will not stop the rotation immediately. This delay may lead the pilot to think that their corrective action is either incorrect or ineffective due to a tail rotor failure.
While this input on the pedals will result in reducing the yaw rate (°/s), zeroing this rate and therefore stopping the rotation will only occur if the pilot keeps the pedals pressed down.

2.7 Losses of yaw control

Incidents and accidents resulting from a loss of yaw control are generally referred to as "LTE[4]". However, there may be different causes for these losses of effectiveness. According to the manufacturers and publications, there are three main subgroups:

- LTEs related to a loss of tail rotor operation due to damage or blockage of the tail rotor or its controls. Examples include the collision of the tail rotor with an object, a bird or an obstacle, or a malfunction in the control linkage, a blockage of the controls, etc.
- LTEs related to unanticipated yaw. In this case, the tail rotor is turning correctly and the power control is operative, but the tail rotor is subject to an aerodynamic change (such as a gust of wind or helicopter rotation), which requires the pilot to find a new balance on the rudder pedals.
- LTEs related to insufficient available power given the conditions of the day (weight, temperature, altitude, wind direction and speed) to implement the pilot's inputs.

3 CONCLUSIONS

The conclusions are solely based on the information which came to the knowledge of the BEA during the investigation. They are not intended to apportion blame or liability.

Scenario

During a local flight near a tourist site, the pilot probably lost yaw control of the helicopter which turned to the right during a low-speed turn. He associated the yaw movement with a loss of tail rotor effectiveness and lowered the collective pitch control. His inputs on the left and right rudder pedals did not allow him to regain control of the helicopter. After several spins, the aircraft collided with the vegetation and then the ground with almost zero horizontal speed.

The fact that the vegetation cushioned the helicopter's fall, that the helicopter fell flat, and that the pilot lowered the collective pitch control, may have mitigated the consequences of the accident and contributed to the survival of the helicopter's occupants.

No technical failure was identified on the helicopter.

Contributing factors

The following factors may have contributed to the yaw movement and the loss of control:

- a slow forward speed and a turn during which the pilot probably encountered wind from the left or a tailwind, such conditions being conducive to a yaw movement to the right;
- the pilot's lack of understanding as to why there was a sudden yaw movement, as well as ill-adapted inputs on the rudder pedals in both directions and of insufficient amplitude and duration to regain control of the helicopter;
- a lack of knowledge of the unanticipated yaw phenomenon (see paragraph 2.6).

The BEA investigations are conducted with the sole objective of improving aviation safety and are not intended to apportion blame or liabilities.

[4] Loss of Tail rotor Effectiveness.