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INVESTIGATION REPORT

Accident to the ROTORWAY - EXEC (162 HDF/A600) registered F-WSPM

on 5 November 2018
at Saint-Pierre (Saint Pierre and Miquelon)

Time	Around 14:35[1]
Operator	Private
Type of flight	Local
Persons on board	Pilot and passenger
Consequences and damage	Pilot fatally injured, passenger injured, helicopter destroyed

This is a courtesy translation by the BEA of the Final Report on the Safety Investigation published in December 2020. As accurate as the translation may be, the original text in French is the work of reference.

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

Loss of control during take-off, collision with ground

1 - HISTORY OF THE FLIGHT

Note: The following information is principally based on statements and the data recorded by the iEFIS[2].

The purpose of the accident flight, as for the previous flights[3], was to perform the number of flight hours and landings required to obtain the Special Airworthiness Certificate for kit-built aircraft (cf. paragraph 2.8.2).

At a private helipad, the pilot, accompanied by a passenger, both co-owners of F-WSPM, brought the helicopter into hover and then flew forward in a north-westerly direction towards a photographer. He hovered for around 30 s in ground effect. He then started gently climbing in a left-hand turn with a slow forward speed.

While in its initial climb, facing south-east, at height of around ten metres, the helicopter suddenly banked to the left and started side slipping. It lost height and the forward left section of the airframe collided with the ground. The helicopter bounced, turned over and came to rest on the right side a few metres from the initial point of impact.

[2] iEFIS: system composed of a screen used, in particular, to display flight parameters such as the altitude, position and navigation parameters, as well as engine and fuel parameters.

[3] The morning of the day of the accident, the pilot had carried out a flight of 1 h 10 min with the passenger.

2 - ADDITIONAL INFORMATION

2.1 Examination of site

The accident site is private property composed of a flat field bordered by fences and vegetation. It is located to the south of a hill whose altitude varies between 400 and 500 ft. The helicopter was kept under cover in a hangar located in the north part of the flat field.

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South of the hangar, a slightly raised path has been built in order to move the helicopter to a prepared circular surface acting as a helipad. The latter is very slightly higher than the terrain by around 1.3 m. It is situated 2 km north of Saint-Pierre Pointe-Blanche airport.

The immediate periphery of the helipad is clear of obstacles. However, there are trees 5 to 8 m tall at a distance of around 35 m to the west, a fence at around 50 m to the south and another fence at approximately 35 m to the east. There is a windsock in the south-east corner of the field.

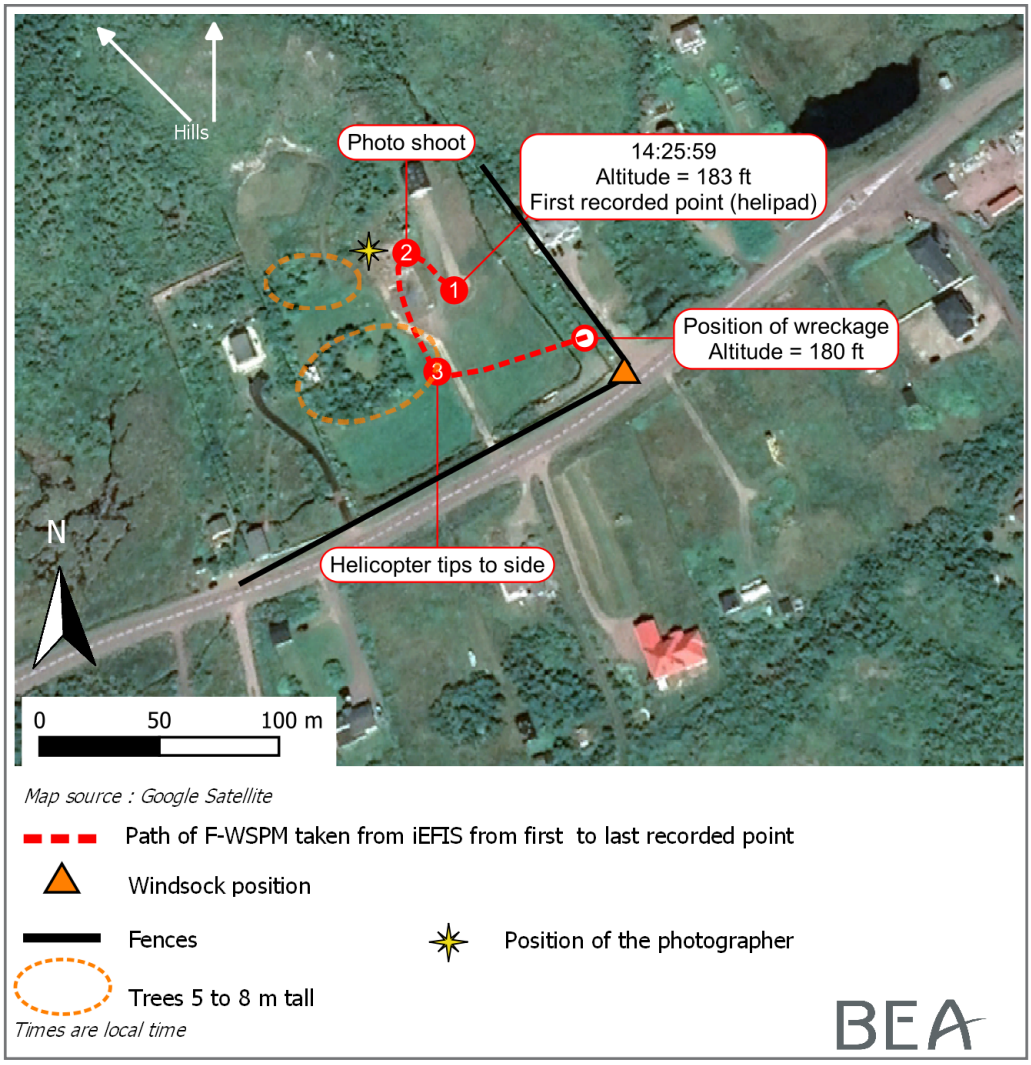


Figure 1: Path and position of wreckage

2.2 Examination of wreckage

The wreckage was examined after it had been moved to a hangar at Saint-Pierre airport.

The wreckage was complete. No anomaly was observed on the flight controls.

The helicopter was equipped with a flat-four engine providing power to the main rotor and tail rotor via a belt reduction gear.

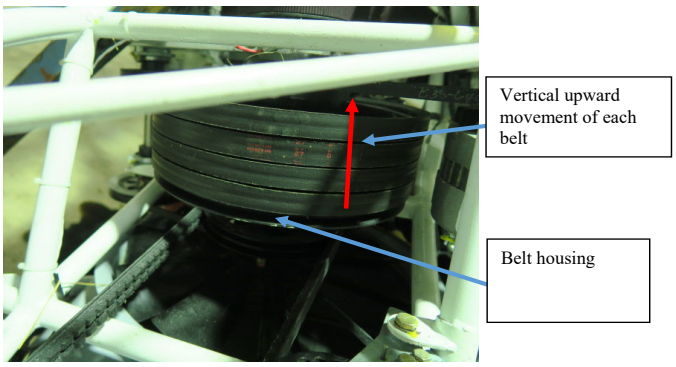


Figure 2: Drive belts outside their respective housings

Each of the four belts was displaced to the next highest housing (cf. Figure 2). The belts were taut and in good condition.

The main rotor blades were substantially damaged on the lead-lag axis.

The complete examination of the system transmitting power to the main and tail rotors did not show any anomalies.

These findings indicate that the engine was operating at the time of impact and was supplying power to the rotors. The latter were suddenly blocked on coming into contact with the ground, generating an overtorque resulting in the belt jumping.

2.3 Meteorological information

The meteorological conditions were characterized by westerly to north-westerly winds of around 15 to 20 kt.

At the time of the accident, the weather station based at Saint-Pierre Pointe-Blanche airport, situated at around two kilometres south of the helipad, measured a westerly to north-westerly wind of 12 to 25 kt. However, more marked variations in the wind direction between 270° and 360°, between 14:00 and 15:00, were observed. According to the Saint-Pierre Météo-France weather expert, even if they do not appear significant compared to what can be found at the airport, the risk of a small vortex phenomenon[4] or a small becalming phenomenon[5] linked to the proximity of high ground, trees or buildings may have existed very locally on the accident site.

When the BEA investigators went to the site, witnesses stated that the weather conditions were similar to those prevailing the day of the accident. The windsock on the field indicated large wind variations both in terms of direction and strength, underlining the presence of strong turbulence and a very local vortex phenomenon.

[4] Rolling waves of air which can give rise to extremely violent turbulence.

[5] Zone of wind disturbance on lee side of terrain where there is no or very little wind. It is considered that the effect is felt over a distance corresponding to ten times the height of the obstacle.

14:00 and 15:00 Saint-Pierre airport METAR messages on 5 November 2018:
LFVP 051700Z 30012KT 270V330 9999 SCT032 06/M01 Q1035 NOSIG
LFVP 051800Z 32010KT 270V360 9999 SCT033 07/M00 Q1034 NOSIG

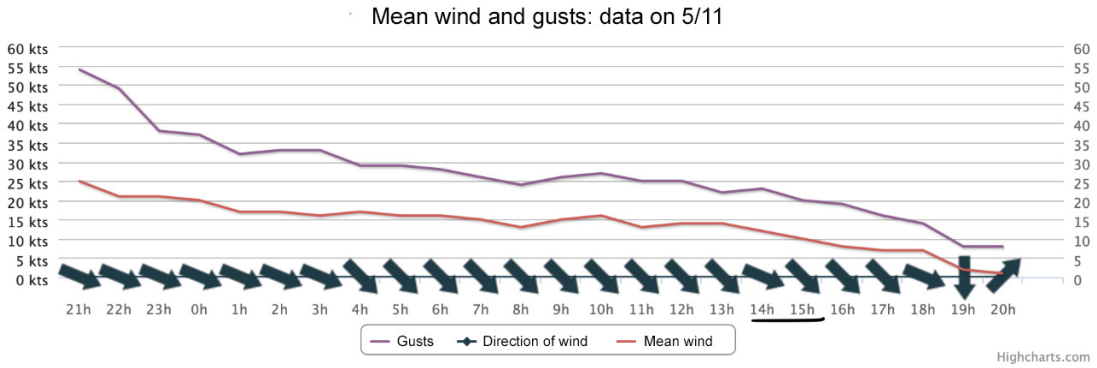


Figure 3: Wind measurements at Saint-Pierre Pointe-Blanche airport (LFVP)

2.4 Pilot information

The 60-year-old pilot held a private pilot license for helicopters (PPL(H)) obtained in June 2017. He had carried out his training solely on the RotorWay Exec 162 and had logged around 80 flight hours the day of the occurrence, of which 57 dual flight hours. Following completion of the build of F-WSPM, he had flown around 10 hours, all carried out locally from the helipad.

A former airline pilot, he had logged around 25,000 flight hours on different types of aeroplane (including the PA31, ATR42 and B737).

He was an island native and had good knowledge of the local meteorological conditions.

He had bought the Exec162, on a co-ownership basis, in kit form and had built it with his friends, one of whom was the passenger.

2.5 Passenger information

The 65-year-old passenger did not hold an aeronautical licence.

He had started training for a PPL(H) in metropolitan France. He had logged around 60 dual flight hours on the Exec 162.

He was the second co-owner of the helicopter and owner of the land on which the helipad and hangar were based.

2.6 Statements

2.6.1 Passenger's statement

After engine start-up, the pilot had hovered, staying in the ground effect at around 50 cm in height. He then flew forward at low speed to position the helicopter in hover close to a friend who was taking photos (point ❷ of Figure 1).

The helicopter remained hovering for around 30 s. The pilot then took off from hover by carrying out a forward climb to a height of around 15 to 20 m. The engine was at high speed. Immediately, the wind pushed the helicopter sideways (point ❸ of Figure 1). The latter tilted steeply to its left side. The helicopter fell.

He neither saw nor heard a warning and did not hear any unusual noise. The engine was operating nominally.

2.6.2 Other witnesses on ground

After taking off in straight flight overhead the path in a south-easterly direction, the helicopter suddenly tipped to the left side (point ❸ of Figure 1). It stayed tilted to the left up to its collision with the ground. They considered that the engine was operating normally up to the collision with the ground.

The witnesses said that there were very local, strong gusts of wind at the time of the accident at different points on the island. One of the witnesses, situated at one and a half kilometres west of the private helipad mentioned having observed strong gusts at the time of the accident.

2.6.3 Instructors' statements

Four instructors were met during the investigation. They all agreed that this helicopter had quick reactions and was very sensitive to a tailwind[(6)].

Some instructors recommend, for experienced helicopter pilots on other types, carrying out 20 dual flight hours in order to correctly understand the flight characteristics of the Exec 162.

One of the instructors was the importer of the helicopter. He had carried out the first on-site flights with the pilot. After observing the environment and the weather conditions, he had considered that it was not possible to carry out a climbing take-off with this helicopter facing the north-west hill. In his opinion, the Rotorway Exec 162 did not have the necessary performance to carry out this type of take-off and climb at maximum weight. He also specified that he carried out conventional take-offs from the helipad.

[(6)] On the weight and centre of gravity diagram in the flight manual, a maximum tailwind of 8 kt in hover flight is indicated when the centre of gravity is in the left-hand shaded part of the diagram (cf. Figure 4).

2.7 Helicopter take-off technique

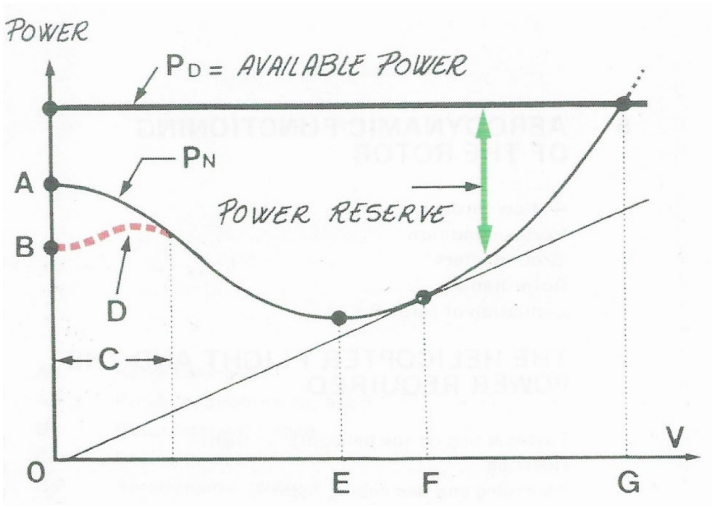
When the helicopter is in hover, in immediate proximity to the ground, the airflow around the rotor is modified by being near to the ground. The result of this is that the power necessary to develop the lift required for the flight decreases. The helicopter is said to be "*in ground effect*".

It is considered that this ground effect is negligible beyond a height equivalent to a rotor diameter. It is then said that the helicopter is "*out of ground effect*".

The pilot can choose between three types of take-off according to the obstacles. Each type of take-off has its advantages and drawbacks.

- The conventional or normal take-off, also called in-ground-effect take-off, is used the most often. The helicopter accelerates in level flight in-ground-effect to reach the climb speed. This is maintained during the initial climb. This type of take-off guarantees a safety margin in the event of an engine failure and requires less power.
- The vertical take-off, also called the out-of-ground-effect take-off is generally used when the surrounding obstacles do not permit a forward take-off. The pilot must have a substantial power reserve to carry out vertical flight. When the safety height above the obstacles has been reached, the aircraft is put into horizontal flight. If the pilot cannot clear the obstacles during this exercise, he aborts the take-off.
- The yaw take-off is used to fly over obstacles situated in the climb-out area. As the helicopter is no longer in ground effect and has a low flight speed, a sufficient power reserve is required to maintain a constant safety height during the take-off. This type of take-off requires good knowledge and experience of the performance of the helicopter being flown.

The day of the accident, the pilot carried out a take-off which resembled a yaw take-off. He could have equally carried out a conventional take-off as he was not limited by any obstacle.



Source: Roger Raletz, Théorie élémentaire de l'hélicoptère, Cépadués 2009 2ème éd

Figure 4: Simplified diagram of power vs velocity

A - power required for out-of-ground-effect hover
B - power required for in-ground-effect hover
C - transition zone
D - power required to counter sink when gaining speed
E - velocity minimum power
F - velocity minimum drag
G - maximum speed

This led the manufacturer to publish maximum weight values out of and in ground effect according to the altitude and temperature.

2.8 RotorWay Exec 162 HDF information

The RotorWay Exec 162 HDF is an amateur-build, two-seat, single-engine helicopter provided in kit form by RotorWay International[7]. It is equipped with a twin-blade teetering rotor.

[7] The DGAC sent a Letter of Eligibility concerning the EXEC 162 HDF class 2 kit on 5 June 2001.

The maximum engine speed of 4,420 rpm is close to the engine's rated operating speed of 4,250 rpm. The data from the iEFIS shows that during the accident flight, the engine speed was around 4,400 rpm from the start of the forward climb.

The flight manual indicates that the neutral position of the cyclic control depends on the weight and balance. When the centre of gravity is at the edge of the flight envelope, the travel of the controls is limited in certain sectors.

2.8.1 Weight and balance

The flight manual states that a counterweight[8] must be attached to the rear of the airframe under the tailboom for a flight with two persons on board. The photos taken during the accident flight show that the helicopter was not equipped with a counterweight.

[8] The counterweight weighs 12 kg.

After the first flights, the pilot had replaced the original battery which weighs 12 kg with a lighter battery weighing 2.5 kg. In this configuration, with the two co-owners on board, no counterweight and a full tank, the helicopter was within the weight limits but at the edge of the centre of gravity envelope. The aircraft had a forward left centre of gravity (cf. Figure 5 below).

In the flight conditions, the centre of gravity was located in the shaded area. In this area of the diagram, the helicopter will require very quick, large-amplitude reactions from the pilot to keep control of it during hover. In this area of the diagram, gusts can amplify this phenomenon.

The investigation was not able to determine if the pilot had calculated the weight and balance for this flight.

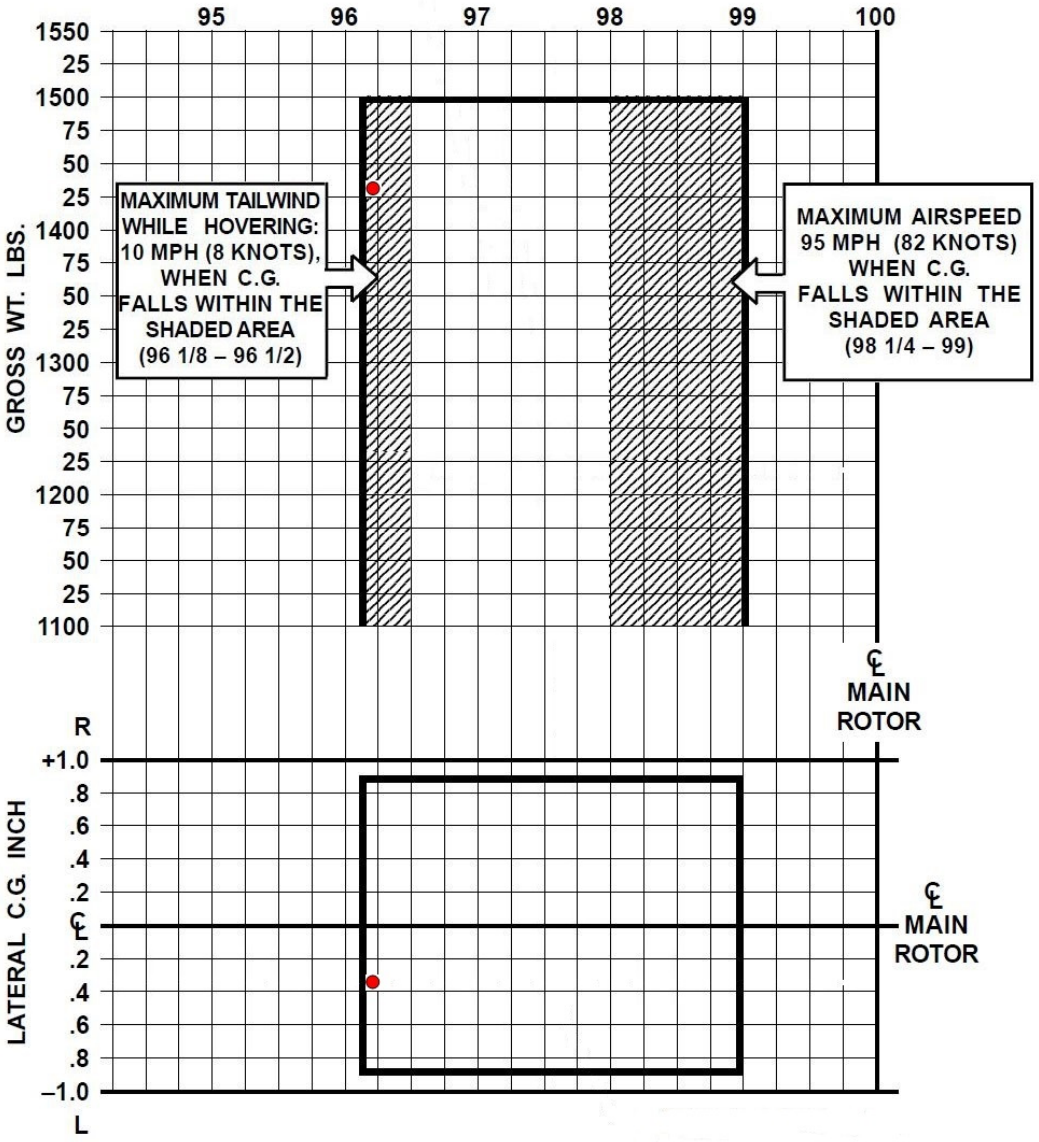


Figure 5: Weight and centre of gravity on day of accident ●, diagram taken from flight manual

In the case of a flight where the pilot is accompanied by a passenger, with the counterweight attached to the tail boom and with a full fuel load, the centre of gravity is situated between the two restrictive shaded areas.

2.8.2 Temporary flight authorization and Special Airworthiness Certificate for kit-built aircraft

The helicopter held a temporary flight authorization issued on 7 August 2018 by the French civil aviation safety organization (OSAC). In order to obtain its Special Airworthiness Certificate for kit-built aircraft, the helicopter must have logged 15 flight hours, including a test flight programme and 50 landings.

The names of the pilots responsible for the tests are specified in the temporary flight authorization. Only the latter are allowed on board the helicopter before the Special Airworthiness Certificate is issued.

During the tests, the owner can ask for additional persons to be added to the temporary flight authorization, substantiating this request by indicating their aviation experience and the necessity of their role to correctly carry out these test flights.

Article 11 of the modified order of 22 September 1998 concerning the Special Airworthiness Certificate for kit-built aircraft[8] specifies that the flight tests and endurance flights are carried out by a sole pilot on board whose name is shown on the permit. If necessary, s/he can be accompanied by a sole technician whose role on board is considered necessary for the correct performance of the flight and whose name is shown on the permit. Each pilot declares that they hold the flight crew member licences required to carry out the test and endurance flights. The minister in charge of civil aviation can refuse to issue, or suspend a permit for any cause likely to compromise safety or when the ratings or experience of the pilot carrying out the flight tests do not guarantee flight safety or the successful completion of the flight tests.

For F-WSPM, two pilots were indicated on the temporary flight authorization, one being the pilot flying but not the passenger. The pilot had asked OSAC, on 24 September 2018, to add other people, including this passenger, to the temporary flight authorization. At the date of the accident, OSAC had not yet replied to this request.

The pilot had logged a flight time of 11 hours 30 minutes and 45 landings towards obtaining the Special Airworthiness Certificate for kit-built aircraft.

2.9 Reaction to a right tailwind gust

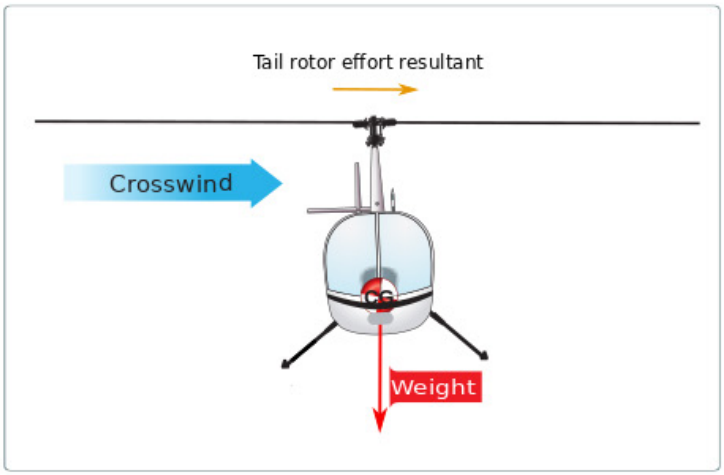
The tail rotor on the EXEC 162, situated on the right end of the tailboom, counters the yaw caused by the main rotor turning in a clockwise direction (viewed from above).

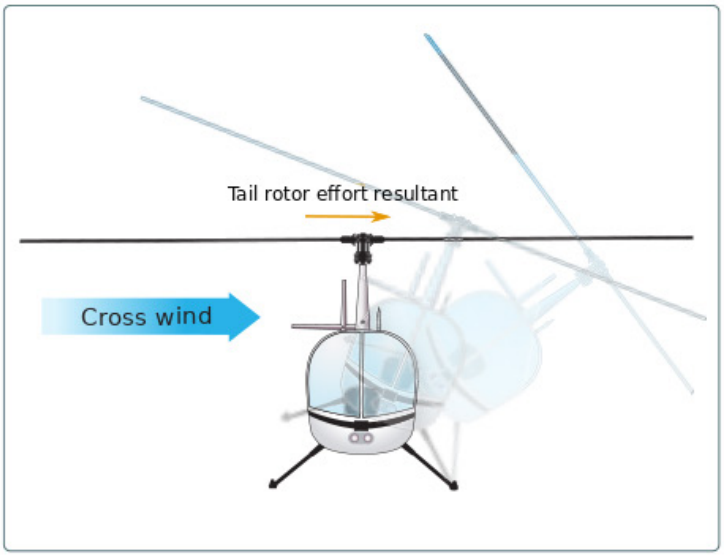
With a right tailwind, the relative speed of the retreating blade of the main rotor (right side of helicopter) increases and the relative speed of the advancing blade of the main rotor (left side of helicopter) decreases. This leads to greater lift on the right side of the helicopter and less lift on the left side. The main rotor disk plane then tilts to the left causing the helicopter to enter a left roll.

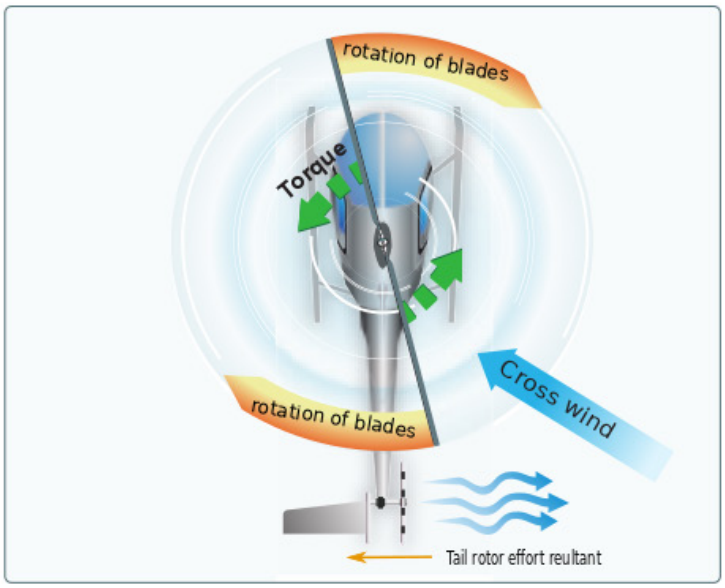
In the event of a strong gust, it is possible that the lift generated by the advancing blade significantly decreases. The start of roll may be very sudden.

To manage such a situation, the pilot must counter the start of left roll by a quick right input on the cyclic control of sufficient amplitude.

[8] https://www.legifrance.gouv.fr/loda/id/JORFTEXT000000207727/2018-11-05







Source: FAA, Helicopter Flying Handbook, Chap. 11

Figure 6: Reaction of a helicopter to a right tailwind gust

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

The day of the accident, the pilot, accompanied by a passenger, performed a flight as part of the programme to obtain the helicopter's Special Airworthiness Certificate for kit-built aircraft.

Several witnesses situated at varying distances to the accident site indicated that there were strong gusts of wind at the time of the accident. The helipad was situated at the foot of a hill with vegetation nearby. The direction of the wind that day in all likelihood generated strong local turbulence.

After entering hover flight into the wind, the pilot flew forward to position himself close to a photographer. He held the helicopter in hover while photos were taken. He started the take-off by carrying out a left turn and forward climb. He then had a tailwind.

It is probable that due to a gust of wind, the plane of the helicopter's main rotor tilted to the left. This may have created a left-hand roll moment, which was made all the greater by the helicopter's extreme forward left centre of gravity.

The low height at which the helicopter was flying and its slow forward speed at the time of the roll meant that the pilot could not avoid the collision with the ground.

Contributing factors

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

- The use of a "yaw" take-off technique in turbulent tailwind conditions although the site does not require such a manoeuvre.
- Positioning the helicopter for it to be photographed which limited the take-off path possibilities.

The following factors may have contributed to the control of the helicopter not being recovered:

- The pilot's late reaction to counter the sudden left roll movement which required swift inputs of significant amplitude.
- The helicopter's forward left centre of gravity linked to the absence of the counterweight, which may have limited control travel in certain sectors.
- The high weight linked to the full fuel load and the carrying of a passenger meaning that there was a small engine power reserve.

It is possible that the pilot's small amount of helicopter experience contributed to insufficiently accurate piloting to safely manoeuvre in a marginal part of the EXEC162's flight envelope.