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

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INVESTIGATION REPORT

Accident involving Airbus Helicopters EC130 B4 registered F-GOLH on 24 October 2015 at Megève (74)

Time	At 11:45[1]
Operator	Mont-Blanc Hélicoptère MBH
Type of flight	Commercial air transport
Persons on board	Pilot and six passengers
Consequences and damage	Two passengers injured, the pilot and four passengers slightly injured, helicopter destroyed

[1]Unless otherwise specified, the times in this report are expressed in local time.

Loss of control in yaw during take-off, collision with the ground, in sightseeing flight

1 - HISTORY OF THE FLIGHT

During the morning, the pilot made several "*Mont Blanc*" sightseeing flights with the same helicopter from Megève altiport. During take-off for the fourth flight and as for the previous flights, he stabilized the helicopter in hover in the ground effect and then began to rotate it to the left around its yaw axis in order to face the climb-out path.

During this manoeuvre, the pilot lost the yaw control of the aircraft, which turned several times on itself before crashing below a slope adjacent to the take-off area.

2 - ADDITIONAL INFORMATION

2.1 Examination of the accident site and wreckage

The wreckage is located 25 meters to the north-north/west below the take-off area.

Observations indicate that the engine was providing power and that the rotor struck the ground with energy. The cyclic pitch and collective pitch controls are continuous. The fenestron tail rotor is complete and not damaged. It turns freely.

The tail rotor drive shafts (short shaft on engine side and long shaft on fenestron side) are complete, in position and undamaged. They are no longer connected as a result of the forward travel of the engine on impact with the ground.

The connection between the yaw anticipator and the yaw control is not damaged. The pitch control of the tail rotor is a ball control. It is continuous and functional. An action on the pedals causes a consistent movement of the blades of the tail rotor.

Examination of the wreckage did not bring to light any damage prior to the accident.

The setting of the pitch travel values of the tail rotor blades was checked and is in accordance with the factory settings.

2.2 Technical examinations

2.2.1 VEMD (Vehicle Engine Maintenance Unit)

Two failures and two limit violations were recorded in the VEMD. These recordings are representative of the consequences of the collision of the rotor with the ground.

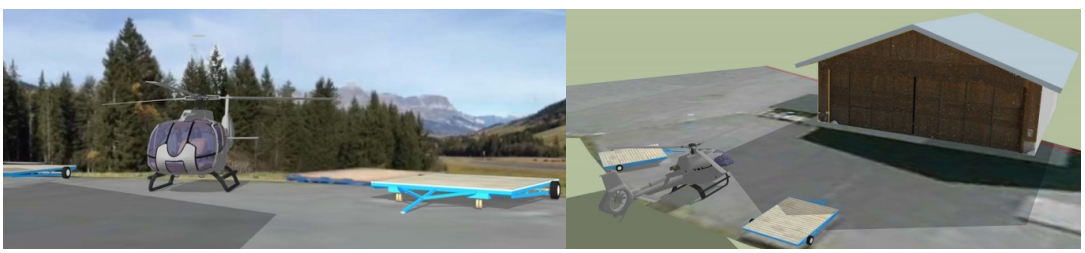
2.2.2 Helicom recorder

The aircraft was equipped with a Helicom data recorder. No parameter relating to the tail rotor is recorded. The recorded data do not bring to light any technical problem from starting the engine until the rotor came into contact with the ground.

2.2.3 Video recordings

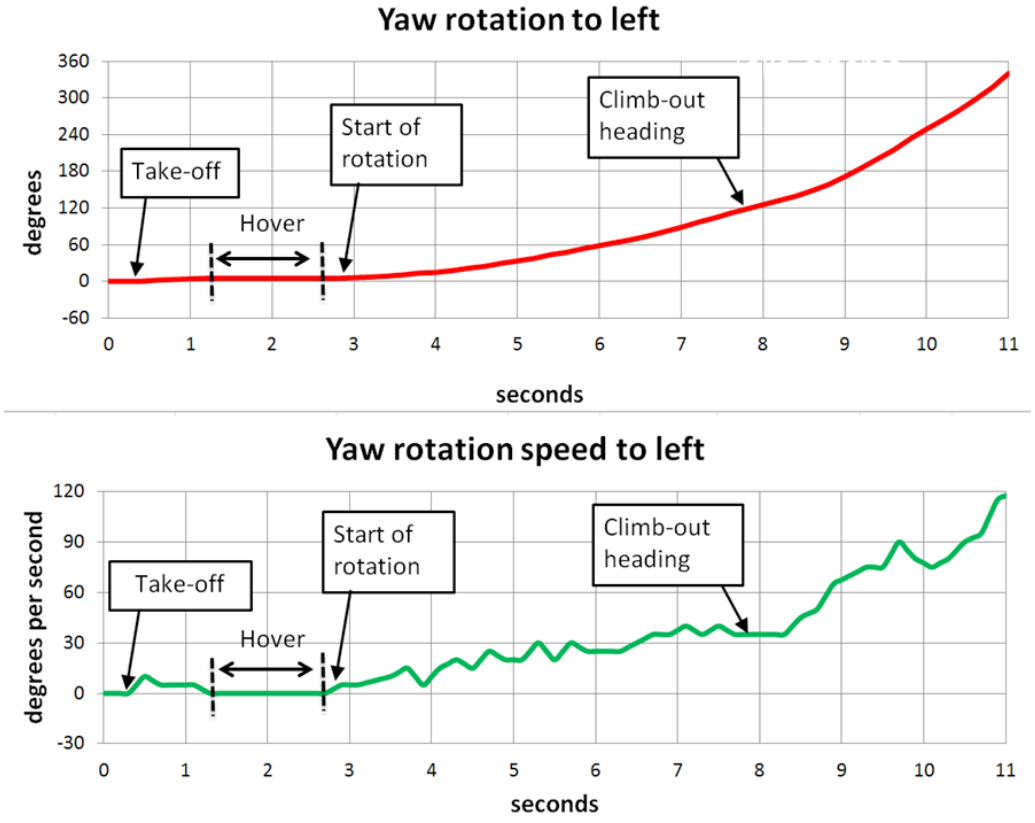
The video recording of the accident flight by a witness on the ground was compared with records of previous flights. The take-offs all take place in the same way with similar yaw rotation speeds: stabilized hover, left-hand rotation of about 120 degrees around the yaw axis and then an increase in speed towards the runway for climb-out. For the fourth flight, the rotation to the left continued beyond 120 degrees and increased until the accident.

In order to be able to estimate the yaw rate from the video recording, the helicopter and its environment were modelled.



Modelling of aircraft and its environment (front and top views)

By superimposing this modelling with images extracted from the film, it was possible to precisely determine the angle of rotation of the helicopter relative to its initial position. By derivative, we deduced an approximate value of its rotation speed.



Note: Based on the recorded data, the pilot lowered the collective pitch control eight to ten seconds after take-off.

It was observed that the helicopter yaw rotation increased in speed when passing the climb-out heading.

A flight on a helicopter of the same type under similar conditions but at an altitude[2] of 500 ft was used to evaluate the effect of the fenestron tail rotor on the yaw rate. At an angular rate to the left of 100 degrees per second (when the pilot begins to decrease the collective pitch to land the aircraft), pushing the right rudder pedal to 70% of its travel stops the yaw rotation of the aircraft in three seconds.

[2] Altitude of the accident site = 4800 ft.

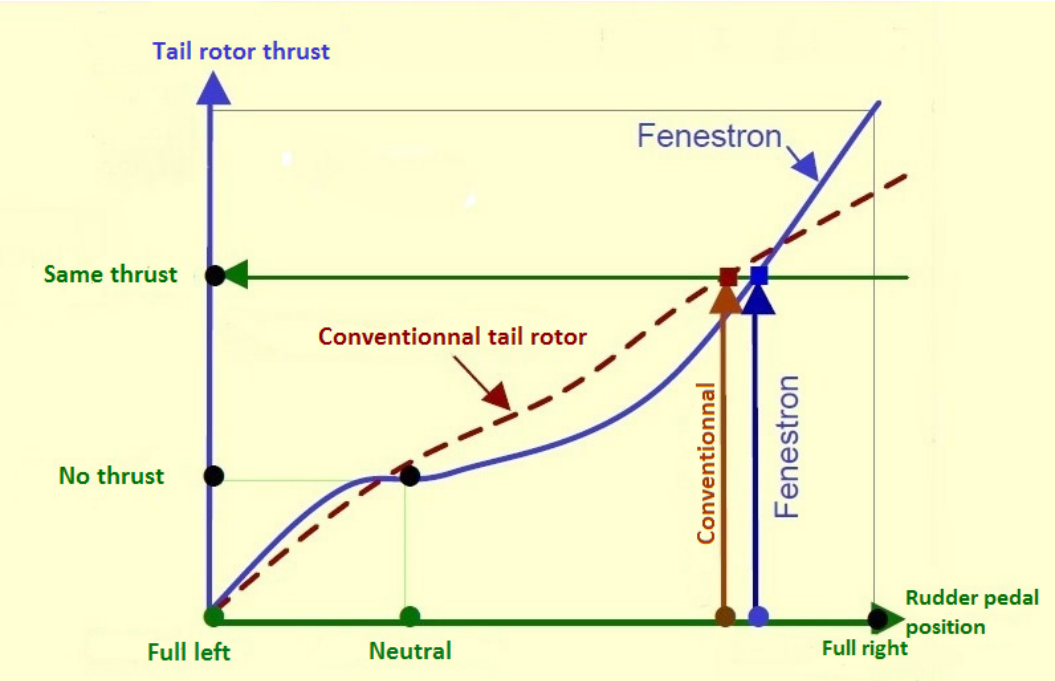
2.3 Implementation of fenestron[3]

The effect of the travel of the rudder pedals on the yaw control is different depending on whether the helicopters are fitted with a conventional tail rotor or a fenestron. The shrouded tail rotor of the EC130 is of the fenestron type.

When hovering, full travel on the right rudder pedal has more effect on helicopters equipped with a fenestron than on those equipped with a conventional tail rotor.

To counteract a fast left yaw rotation with a fenestron, it is necessary to apply a sharp input to the right rudder pedal and maintain the movement until the rotation stops.

[3] The Eurocopter service letter No. 1673-67-04 of 4 February 2005 reminds pilots of the yaw control techniques on helicopters whose main rotor rotates clockwise (including the AS350 and the EC130).



Curve of the force provided by the tail rotor according to the position of the rudder pedals
(from Airbus Helicopters documentation)

2.4 Pilot's testimony

For the first flight with a planned duration of 50 minutes, the pilot completed the pre-flight inspection and added the necessary fuel. Meanwhile, an agent of the company took care of placing the passengers in the helicopter. The meteorology was very good, no wind, very good visibility and sun. A maximum wind speed was expected of 30 km/h at 4,000 meters, the altitude at which the pilot carried out "*Mont Blanc*" sightseeing flights. Back in Megève, he added the fuel needed for the next two sightseeing flights, each with an expected duration of 30 minutes. Passenger embarkation for the third flight was done with the rotor rotating.

Before the fourth flight, the pilot added the necessary fuel for the flight. He states that he shortened the foot-to-rudder pedal distance to ensure that full pedal travel was possible (in particular, by using integrated adjustable shims). He then verified that the engine parameters were normal, that no alarm was activated and made the helicopter hover in the ground effect. He then started a rotation to the left. After a quarter turn, the pilot felt that the speed at which the aircraft was turning to the left suddenly started to increase. He found himself "*centrifuged*", i.e. held in his seat by the straps of his harness. The pilot "*[pushed his] foot hard on the right pedal*" and moved "*the cyclic pitch stick to the right*" to keep the aircraft horizontal. Seeing that the yaw rate was not decreasing and, in order to avoid hitting the trees north of the take-off area, he decided to lower the collective pitch control in order to land the aircraft.

Finally, the pilot explained that he was accustomed to doing six to seven sightseeing flights a day. He did not feel tired when he began his fourth flight. He also works in the ski lift sector and is used to spending eight hours a day at an altitude of between 2,000 and 3,000 meters. He is in good physical shape and his body is accustomed to altitude.

2.5 Pilot experience and qualifications

The pilot, CPL (H), had 300 hours of flight time including 74 hours on the AS350 and 9 hours 30 minutes on the EC130. The other flying hours were logged on the Robinson R22s and R44s[4].

He flew 8 hours and 22 minutes in the previous three months, including 7 hours 28 minutes on type. The morning of the accident he had made three sightseeing flights corresponding to one hour and 48 minutes of flight on type.

The pilot obtained his initial AS350 B/BA/B2 type rating on 28 October 2013 and then extended it twice: on 1 January 2015 to the AS350 B3 after having followed theoretical and practical training on the differences between the AS350 B2 and the AS350 B3 Arriel 2B/2B1 then on 3 July 2015 to the EC130 B4 after having followed theoretical and practical differentiation training between the AS350 B3 2B1 and EC130 B4 types.

The day before the accident, he had renewed his AS350/EC130 type rating on an AS350 type of helicopter[5].

Since 1 January 2015, he was employed under contract by the operator. Given his recent type rating, the pilot performed simple navigation and passenger transport missions.

[4] The main rotor of the R22 and R44 turns in the opposite direction to that of the AS350 and EC130 helicopters.

[5] The AS350 is equipped with a conventional tail rotor.

2.6 Meteorological conditions

The meteorological conditions estimated at the accident site were as follows:

- average wind from south, 5 to 10 kt with a risk of 18 kt gusts;
- partly cloudy sky with Cirrus formations around 7,000 meters;
- visibility greater than 10 km;
- temperature 15°C.

The pilot stated that there was no wind on the Megève altiport at the time of the accident. This was confirmed by the position of the windsock on a photograph taken at the time of take-off.

2.7 Cabin equipment

The pilot was seated in the left seat, in accordance with the configuration of this type of helicopter.

At this time of the year, the helicopter was used for sightseeing flights. Consequently, in order to avoid any risk of untimely action by a passenger, the cyclic pitch, collective pitch and rudder pedal controls had been removed from the front right seat.

2.8 Occupant survival

The pilot's and passengers' seats were equipped with four-point harnesses, which probably helped limit the injuries to the occupants of the aircraft.

The pilot was not wearing a helmet. Despite an injury to his head and hand, he remained lucid enough to cut off the electrical power, pull the fuel shut-off lever and help evacuate the passengers some of whom still had their belts attached.

Witnesses from the nearby skydiving club came to help with the evacuation. Given the appearance of thick smoke in the cabin bottom, a witness emptied the contents of a powder extinguisher into the helicopter's turbine.

2.8.1 Safety aspects of wearing a protective helmet by the pilot

The BEA conducted a search for similar events on the ECCAIRS[6] and SRIS[7] databases as well as using an Internet search engine. The search was based on key words related to wearing a protective helmet in helicopters.

Thirteen events, the details of which follow, were the subject of a safety investigation report highlighting the importance of wearing a protective helmet by the pilot[8]. In half of the cases, investigative agencies showed that wearing a helmet limited the severity of the pilot's injuries. In particular, it is mentioned in two reports that wearing the helmet meant that the pilot remained conscious after the impact, preserving his ability to provide assistance to passengers during the evacuation. Finally, in other cases, it was established that the pilot's injuries were aggravated by the fact that he was not wearing a helmet.

[6] European Coordination Centre for Accident and Incident Reporting Systems.

[7] European Central Repository for Safety Recommendations.

[8] This list is not exhaustive.

- **Accident on 12 May 2016 in Australia involving a R22 helicopter registered VH-WGB[9]**
  Wearing a protective helmet limited the severity of the pilot's injuries. The ATSB, the Australian investigative body, says in the report that this accident highlighted the value of wearing a helmet.

[9] https://www.atsb.gov.au/publications/investigation_reports/2016/aair/ao-2016-047/

- **Accident on 12 November 2015 in Australia involving a R22 helicopter registered VH-HWJ[10]**
  The protective helmet played a role in mitigating the injuries to the pilot. Following a previous accident, the operator had made the use of the helmet mandatory for its pilots. The report emphasizes the benefits of wearing a protective helmet in terms of reducing the risk of head injury.

[10] https://www.atsb.gov.au/publications/investigation_reports/2015/aair/ao-2015-134/

- **Accident on 24 June 2014 in Norway involving an AS 350 B3e helicopter registered LN-OSY[11]**
  The pilot was not wearing a protective helmet. According to the report of the Norwegian Investigation Body (SHT), this increases the risk of loss of consciousness on impact and therefore compromises the pilot's ability to assist passengers during evacuation.

[11] https://www.aibn.no/Luftfart/Avgitte-rapporter/2015-08-eng

- **Accident on 13 May 2014 in Canada involving an AS 350 BA helicopter registered C-FHPC[12]**
  The pilot was wearing a protective helmet which meant that he was conscious after impact, and was able to shut down the engine and help his colleague who was seriously injured. The pilot's helmet suffered a significant impact: it prevented serious injuries to his head and face. The TSB, the Canadian investigative body, says in the report that not wearing a protective helmet increases the risk of head injury and the loss of consciousness of the pilot after a crash or ditching. This type of injury compromises the pilot's ability to assist passengers during the evacuation. As a result of this accident, the operator set up a safety programme providing financial compensation to pilots for the purchase of protective helmets.

[12] http://www.bst-tsb.gc.ca/fra/rapports-reports/aviation/2014/a14q0060/a14q0060.pdf

- **Accident on 27 March 2014 in Australia involving an R22 helicopter registered VH-HRX[13]**
  The pilot, who was injured in the neck and head, was not wearing a protective helmet. The ATSB recommended that pilots and operators consider the benefits of wearing a protective helmet in terms of reducing the risk of head injury.

- **Accident on 21 July 2009 in Champagne (51) involving a Bell 47 G2 helicopter registered F-BTGR[14]**
  The protective helmet played a role in mitigating the injuries to the pilot during the emergency landing.

- **Accident on 27 May 2009 in the municipality of Montferrier (09) involving an AS 350 B3 helicopter registered F-GVCE[15]**
  The fact the pilot was not wearing a protective helmet contributed to the severity of the injuries to the pilot's head. The BEA recommended to the EASA that helicopter crews be required to wear protective helmets, at least for certain activities.

- **Accident on 17 August 2008 in the mountain range of Argentière (74) involving an AS350 helicopter registered F-GTTB[16]**
  The wearing of a protective helmet played a key role in the pilot's survival during the emergency landing.

- **Accident on 20 May 2014 in Canada involving the Bell 212 helicopter registered C-FJUR[17]**
  The pilot was not wearing a protective helmet, which contributed to the aggravation of his head injuries since his upper trunk was not restrained by the shoulder straps of the safety harness. The lack of a regulation or policy requiring helicopter pilots to wear a helmet exposes them to increased risks of disability caused by head injuries during ditching or hitting the ground. The investigation report refers to a study concluding that the head is the second most frequently injured part of the body in a helicopter accident[18] and to the results of research done by US military forces[19] : "*Helicopter occupants who do not wear a protective helmet face a risk up to six times higher of fatal head injuries. The effects of non-fatal head injuries range from confusion and the inability to focus momentarily to complete loss of consciousness. These debilitating effects can hinder a pilot's ability to quickly leave the helicopter and assist passengers in evacuating the aircraft or to ensure the survival of its occupants in an emergency*".

- **Accident on 12 March 2009 in Canada involving the Sikorsky S-92A helicopter registered C-GZCH[20]**
  The pilots were not wearing protective helmets. They were seriously injured especially by the impact of their heads and faces on the instrument panels. The TSB recommended that Canadian authorities and the Helicopter Association of Canada implement a pilot awareness programme on the importance of the protective helmet. As a result of this accident, the operator set up a safety programme providing financial compensation to pilots for the purchase of protective helmets.

[13] https://www.atsb.gov.au/publications/investigation_reports/2014/aair/ao-2014-058/

[14] https://www.bea.aero/fr/les-enquetes/les-evenements-notifies/detail/event/collision-avec-le-sol-lors-dun-vol-depandage-agricole-1/

[15] https://www.bea.aero/fr/les-enquetes/les-evenements-notifies/detail/event/perte-de-controle-lors-du-levage-dun-pylone-heurt-avec-la-vegetation-collision-avec-le-sol-1/

[16] https://www.bea.aero/fr/les-enquetes/les-evenements-notifies/detail/event/diminution-du-regime-du-rotor-atterrissage-durgence-en-campagne/

[17] http://www.bst-tsb.gc.ca/fra/rapports-reports/aviation/2011/a11w0070/a11w0070.pdf

[18] Shanahan, D., Shanahan, M., «*Injury in U.S. Army Helicopter Crashes October 1979 - September 1985*», The Journal of Trauma, vol. 29, no. 4, p. 415-423, 1989.

[19] Crowley, J.S., «*Should Helicopter Frequent Flyers Wear Head Protection? A Study of Helmet Effectiveness*», Journal of Occupational and Environmental Medicine, vol. 33, no. 7, p. 766-769, 1991.

[20] http://www.bst-tsb.gc.ca/fra/rapports-reports/aviation/2009/a09a0016/a09a0016.pdf

- **Accident on 10 August 2006 in Norway involving the AS 350 B3 helicopter registered LN-ODK**[21]
  None of the occupants were equipped with a protective helmet. The SHT recommended that the operator equip its personnel with protective helmets.

- **Accident on 5 March 2006 in the Swiss Alps involving the AS 365 Dauphin helicopter registered HB-XQS**[22]
  The investigation found that the co-pilot, who had suffered a mild traumatic brain injury, lost consciousness and suffocated due to large-scale inhalation of vomit into the lungs. His life would have been saved if he had worn a protective helmet. SESE, the Swiss investigative body, recommended that the Federal Office of Civil Aviation impose the wearing of helmets on all persons in the cockpit of a helicopter, given that the helmet offers protection against injury.

- **Accident on 10 July 2004 in Switzerland involving the SA 315B Lama helicopter registered HB-XFX**[23]
  The pilot was wearing a helmet that protected him from more serious injuries to his head.

2.8.2 Regulatory and operational aspects relating to the wearing of protective helmets

The excerpts from Regulation (EU) No. 965/2012 on explicit air operations concerning the wearing of protective helmets are located exclusively in the annexes concerning "*specialized operation*"[24]:

- SPO.IDE.H.205 Individual protective equipment: Each person on board shall wear individual protective equipment that is adequate for the type of operation being undertaken.
- GM1 SPO.IDE.H.205 Individual protective equipment: Personal protective equipment should include, but is not limited to: flying suits, gloves, helmets, protective shoes, etc.

This regulation recommends but does not make it mandatory for helicopter pilots to wear protective helmets when carrying out specialized operations.

In the context of a public passenger transport operation, the regulations do not make any protective equipment compulsory in an explicit manner. However, the operator is required to implement a safety management system capable of identifying and managing the risks associated with the types of operations performed. It can thus choose the wearing of protective equipment, in particular protective helmets.

The operator for which the pilot was conducting sightseeing flights advocated the wearing of protective helmets for pilots during aerial work and medical evacuation activities. Each pilot therefore had a helmet that was worn according to the nature of the flight. The operator did not request the use of a protective helmet for pilots conducting sightseeing flights because it considered that the risk of an accident was lower and that the wearing of such equipment by the pilots could worry passengers who did not have one.

[21] https://www.aibn.no/Aviation/Reports/2007-13

[22] www2.sust.admin.ch/pdfs/AV-berichte//2001_f.pdf

[23] https://www2.sust.admin.ch/pdfs/AV-berichte/1960_f.pdf

[24] Can be considered as largely corresponding to the notion of aerial work.

3 - SAFETY LESSONS

Occupant survival aspects

Current regulations explicitly require companies doing aerial work by helicopter to equip their pilots with individual protection suitable for the type of operation. No similar regulations apply to pilots engaged in the public transport of passengers, particularly in the context of sightseeing flights, and even more so, no regulation recommends that pilots be equipped with a protective helmet.

The investigation showed that the pilot, who was held by a four-point harness and was not wearing a protective helmet, suffered head injuries. Many other accidents have highlighted the benefit of wearing a helmet. After an accident, the pilot is the only person who can carry out the emergency actions in order to limit a possible aggravation of the situation. In addition, s/he plays a decisive role in the organization of the evacuation of passengers and the coordination with the emergency services.

4 - CONCLUSION

After stabilizing the helicopter in hover in the ground effect, the pilot was unable to stop or slow down the left rotation he had initiated to orient the aircraft towards its climb-out path.

The investigation did not bring to light any technical element that might explain it.

The investigation showed that the intervention of the pilot, who remained lucid and agile despite his injuries to the head and hands because he was wearing no protective equipment, was crucial in limiting the consequences of the collision with the terrain.