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

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INVESTIGATION REPORT

Accident to a paraglider involving the Airbus - EC135 - T2 PLUS registered F-HTIN

on 11 May 2019

at Le Conquet (Finistère)

Time	Around 15:20[1]
Operators	Helicopter: Babcock for the SAMU 29 at Brest Paraglider: Private
Type of flights	Helicopter: Emergency medical service Paraglider: Local
Persons on board	Helicopter: Captain (PF), technical crew member, doctor, nurse Paraglider: Pilot
Consequences and damage	Paraglider: Pilot fatally injured
This is a courtesy translation by the BEA of the Final Report on the Safety Investigation published in August 2021. 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.

Fall of a paraglider pilot during slope soaring flight on crossing a helicopter on final, collision with ground

1 - HISTORY OF THE FLIGHT

Note: The following information is principally based on maintenance recorder data and statements.

Several paraglider pilots had been slope soaring over the Blancs Sablons beach from the beginning of the afternoon. At around 15:00, only one of them was still flying on this same site.

At 15:10, the crew of a helicopter for the Brest SAMU[2] received a mission to take charge of an injured person on the beach who was then to be taken to an ambulance.

At 15:13, the captain in the right seat, took off with a TCM[3] to assist him, an emergency doctor and a nurse from the SAMU.

At 15:21, the helicopter arrived from the south-east of the beach, along the Ria du Conquet.

[2] French emergency medical service.

[3] Technical Crew Member.

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

During the approach, the pilot quickly analysed the landing site, his intention being to land on the beach as close as possible to the injured person. On passing south abeam the beach, he observed the carpark above the beach and saw the ambulance and other vehicles parked there. At the same time, both he and the TCM saw the kites of the kitesurfers. The pilot turned north and lined up on final for the beach. He crossed the last high ground and then saw a paraglider in flight. He saw him on his right side on a parallel flight path and estimated that he was lower than the helicopter and coming towards him. The pilot decided not to carry out a go-around so as not to disturb the air around the paraglider. He asked the TCM to monitor the kites of the kitesurfers on the left side of the approach path and he took responsibility for visually monitoring the paraglider to maintain separation. The pilot then asked the doctor and nurse sat in the rear to continue this monitoring until they lost sight of him.

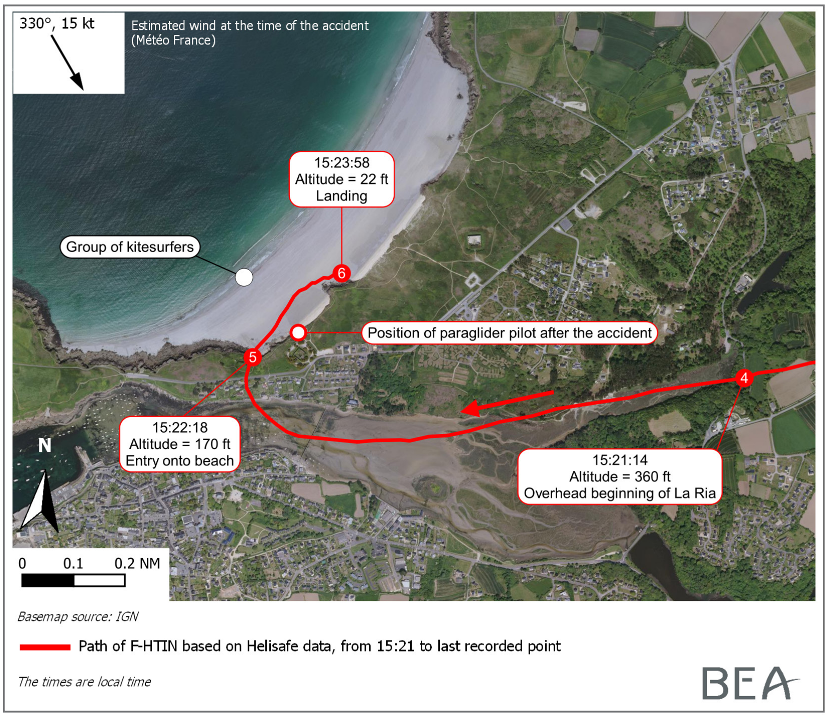


Figure 1: helicopter's arrival path on beach

Witnesses on the ground indicated that they saw the helicopter arriving at low height and on approach to the beach while the paraglider pilot was manoeuvring facing the helicopter on a path parallel to the cliff. A few seconds after the helicopter and paraglider had gone past each other, these witnesses saw the wing of the paraglider close "like a book" and the paraglider fall to the ground.

The pilot landed on the beach and shut down the engines. Witnesses approached the pilot and informed him that the paraglider had just fallen.

2 - ADDITIONAL INFORMATION

2.1 Environment of site at time of accident

2.1.1 Accident site

Basemap source: Google

Image of accident site showing the position of the various witnesses and the height of the sea at the time that the paraglider fell

Figure 2: configuration of beach

The accident site, frequently used by paraglider pilots, is a rectangular beach around 1,300 m long and 180 m wide. The cliff is parallel to the beach, running north-south and of an average height of between 15 and 20 m.

2.1.2 Meteorological information

The accident site is located around 27 km south-west of Brest airport, 26 km north-east of Lanvéoc and 49 km south-west of Landivisiau.

Reported conditions in the region

METARs available at Brest (LFRB) between 13:30 and 14:30 UTC (corresponding to 15:30 and 16:30 local time):

- ❒ LFRB 111330Z AUTO 32009KT 290V010 9999 FEW035 15/07 Q1025 NOSIG=
- ❒ LFRB 111400Z AUTO 33010KT 290V010 9999 SCT034 15/07 Q1026 NOSIG=

METARS available at Lanvéoc (LFRL) between 13:30 and 14:30 UTC

- ❒ LFRL 111330Z AUTO 33009KT 300V360 CAVOK 15/07 Q1025=
- ❒ LFRL 111400Z AUTO 33009KT CAVOK 15/05 Q1026=

METARS available at Landivisiau (LFRJ) between 13:30 and 14:30 UTC:
- METAR LFRJ 111330Z AUTO 33010KT 300V360 9999 SCT029 14/07 Q1025=
- METAR LFRJ 111400Z AUTO 33009KT 300V010 9999 SCT030 SCT038 14/07 Q1026=

Forecast conditions
Brest (LFRB) TAF:
- TAF AMD LFRB 110818Z 1108/1212 32008KT 9999 SCT018 SCT030 TEMPO 1108/1110 BKN012=
- TAF LFRB 111100Z 1112/1218 34008KT 9999 SCT018 SCT030 PROB30 TEMPO 1203/1208 1200 BCFG BKN003=

Estimated conditions in Conquet at the time of the occurrence
The additional reports available and in particular the satellite images, show that at the time of the accident there were very few clouds, and at the most scattered clouds at 3,000 ft.

The wind on the coast was slightly stronger than the values given in the METAR messages: the surface wind, as in the low levels up to FL050 was north-westerly at around 15 kt. Horizontal visibility on the ground was greater than 10 km.

The paraglider pilots present at the site at the time of the accident reported that there were good flight conditions with an established north-westerly wind off the sea of around 25 km/h (13 kt) with some gusts.

2.2 Helicopter's flight path

The helicopter was equipped with a Hélisafe system recording the flight path, attitudes and some engine parameters.

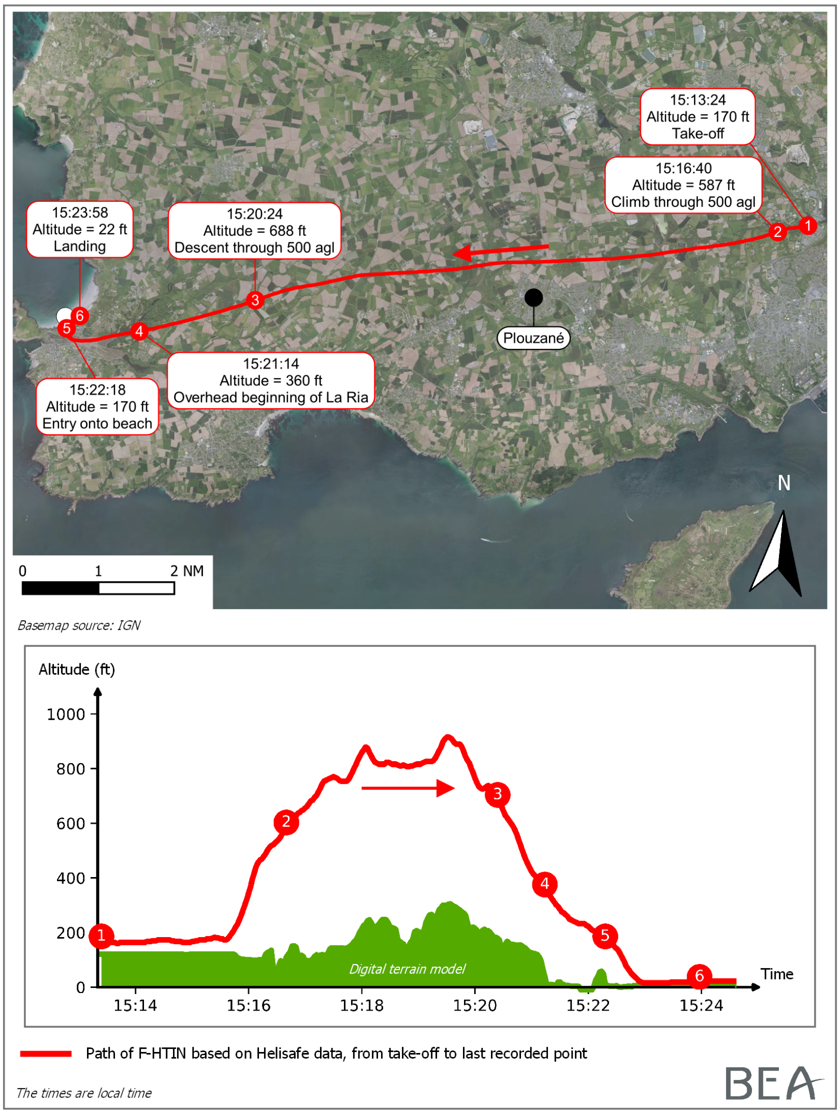


Figure 3: helicopter's overall flight path and vertical profile

The examination of the flight path shows that the pilot took a track to make a south-easterly approach to the beach and line up semi-direct for the final.

The pilot started his descent more than four minutes before arriving at the beach and descended through 500 ft agl around 5 km before the beach.

On final, after carrying out the last turn and flying over the terrain at a height of 125 ft, the pilot maintained level flight over the beach at around 130 ft agl before resuming the descent and landing. The aiming point of the helicopter pilot, close to the person that needed care, was around 430 m ahead of the path. The landing point was a zone of sand without a slope or surrounding obstacles.

During the final approach, kitesurfers were present on the accident site, on the ground, on the west side of the beach, at the edge of the sea.

The paraglider was practically overhead the cliff at a height of around 30 ft from it. Its parallel path, in the opposite direction to the helicopter's path was offset by around 70 m to the east.

2.3 Crew and paraglider pilot information

2.3.1 Helicopter crew

Captain

Male, 48 years old.

- CPL (H) obtained on 29 June 2011.
- EC135 rating valid until 30 November 2019.
- Last line check on 19 September 2018.

Experience

- Total: 4,783 flight hours, of which 3,282 hours as captain.
- On type: 247 flight hours, of which 230 hours as captain.
- In the previous three months: 28 flight hours.
- In the previous 7 days: 2 flight hours.

The pilot had carried out around 230 HEMS[4] missions for the SAMU 29.

[4] Helicopter Emergency Medical Service.

He was under contract with Babcock, employed as a SAMU pilot-in-command for 73 standby days a year and as a sales manager for the EMA (European Military Aviation) market for the France sector.

He thus worked seven days per month on the Brest SAMU base and the rest of the month on his sales files.

Technical Crew Member (TCM)

According to paragraph SPA.HEMS.130 of regulation (EU) No 965/2012 (or "Air-OPS"), the tasks of a technical crew member of a helicopter emergency medical service (HEMS) is to assist the pilot in:

- Avoiding collisions with other aircraft or obstacles, by reporting the presence of an aircraft on a converging track and obstacles that may interfere with the helicopter's flight path.
- Selecting landing sites by looking for the most suitable landing zones with respect to the operational needs and safety.
- Detecting obstacles during the approach and take-off phases, and giving the pilot the earliest warning possible.

The TCM on board the helicopter was employed by the Saint Brieuc SAMU 22. He held the Technical Crew Member rating issued by Babcock, he had been present at Brest since 9 May 2019 for augmentation purposes.

He had logged around 520 h as technical crew member on the EC135 and a total of 586 helicopter hours in this role. He did not have a helicopter pilot qualification.

2.3.2 Paraglider pilot

The pilot belonged to the French Federation of Free Flight (FFVL). He regularly soared[5] with a paraglider and was familiar with the Conquet beach site.

[5] To ride the air. The pilot stays just in front of the high ground (cliff) without moving away from it, constantly turning to the left and right.

The FFVL indicated that it did not have information regarding the pilot's training and experience and the BEA was not able to ascertain the latter points. It specified, however, that soaring required at least an elementary level.

2.4 Statements

2.4.1 Crew

On accepting the mission, the crew were not informed of any danger on the intervention site. From experience, they knew a certain number of paraglider sites, including the Conquet beach site.

When the helicopter approached the beach, only the paraglider pilot was in flight.

The crew member reports agreed with each other and confirmed that the kitesurfer kites, on the left, over the sea, were monitored by the TCM and the paraglider, on the right, by the pilot, in order to maintain separation. When the pilot lost sight of the paraglider pilot then on his rear right side, he asked the person sat in the rear right seat to continue monitoring the paraglider for as long as they could. The latter did not see the paraglider pilot fall.

2.4.2 Observers on the beach and in the paraglider take-off zone

The statements from several people with or without knowledge of paragliding, positioned at different places on the beach, agreed. They indicated that the paraglider pilot, who was familiar with Conquet beach and was in the habit of using his Spiruline wing, was slope soaring. The witnesses indicated that they had seen the helicopter suddenly appear on the beach and that the paraglider pilot had in all likelihood also been surprised by its arrival. Some of them tried to warn the paraglider pilot of the danger represented by the arriving helicopter by waving their arms and shouting. The witnesses did not report any specific manoeuvre made by the paraglider pilot who continued to fly in the opposite direction to the helicopter after the latter had appeared at the end of the beach, until the wing closed. Some witnesses added that in their opinion, the paraglider pilot did not have any other alternative than to continue on this flight path parallel to the beach after the helicopter had appeared.

The witnesses, on the beach and on the high ground, did not feel the helicopter's downwash or wake vortex.

2.4.3 Rescue team on ground

The injured person on the beach had been attended to by the first-aid personnel from the local rescue centre. The first-aid team on site had requested a helicopter to move the injured person from the beach to a nearby car park where an emergency care vehicle was parked ready to take the injured person to hospital.

During pre-flight exchanges between the emergency care vehicle leader, the SAMU coordinator and the helicopter pilot, the latter indicated that he knew the intervention zone.

None of the personnel present on the accident site thought to check with the kitesurfers and paraglider pilot, or the helicopter pilot himself, that each party was aware of the presence of the others.

The vehicle leader indicated that he had had a quick look at the paraglider but without paying particular attention as it did not seem to him that the latter presented a danger for his operation. He also indicated that there had been no radio contact with the pilot despite his attempts using his hand radio. He thought that this may have been due to the distance between his position and the emergency care vehicle.

The emergency care vehicle which had stayed in the car park above the beach had a mobile/hand-held radio to communicate with the pilot or with the departmental fire and rescue operational centre (CODIS).

The safety investigation found recurrent radio-communication difficulties between the pilots and emergency services on the ground. Although radio-communication equipment is available in nearly all emergency care vehicles, emergency service personnel on the ground are not all specifically trained in radio exchanges with a helicopter. In addition, they may hesitate to use the radio because they know it is the pilot's responsibility to choose the landing site and that he/she will adapt his/her manoeuvre accordingly. The noise from the helicopter when it is near the intervention site may also impair exchanges. It is for this reason that sometimes pilots themselves do not contact the ground teams.

2.5 Aircraft information

2.5.1 Airbus EC135

The EC135 is a multi-mission twin-engine helicopter. Babcock only uses the HEMS version, i.e. four seats with a stretcher. The captain (PF) sits in the front right seat and the TCM in the front left seat.

With a maximum take-off weight of 2,835 kg, the EC135 is classed as a "light"[(6)] aircraft in the wake vortex category.

[(6)] The light category includes aircraft with a certified maximum take-off weight of 7,000 kg or less (ICAO doc 4444 – Procedures for Air Navigation Services).

With a weight of 2,724 kg at take-off, the helicopter was in the weight and balance envelope for all of the flight.

2.5.2 Paraglider

The paraglider wing was a category B[(7)] Spiruline EZ 24. This is a flexible wing made of strong, lightweight fabric. It is composed of numerous "cells". Air surges into these cells mainly under the negative pressure on the upper surface and gives the wing its shape (inflation). Thus, the pressure in the wing determines its rigidity.

[(7)] Standard wing according to the European Norm (EN), which puts the wings into categories, from the school/beginner wing (A) to the competition wing (D).

According to the manufacturer, the Spiruline EZ 24 wing is suitable for all pilots including those in the learning phase and is considered as having tolerant flight characteristics. Moreover, it provides average resistance outside the normal flight envelope.

The designer indicated, however, that the majority of paraglider wings, like the majority of flexible wings, are sensitive to variations in airspeed. The presence of thermal uplifts, which generate changes in airspeed, can lead to wings closing, even for airspeed variations of 5 to 10 m/s. A sudden change in the direction of the airspeed can disrupt the air entering the cells and thus the interior pressure of the wing, and as a consequence, its rigidity; the wing's lift will then be modified or even cancelled, either in part on a half wing (tuck), or totally, up to a collapse, described by the witnesses as a the closing of a book.

The FFVL indicated that during their training, the paraglider pilots are informed of the dangers of rotor downwash. The FFVL recommends to paraglider pilots that they put up to 500 m between themselves and the environment in which the helicopter is manoeuvring, or even to land as soon as they hear or see a helicopter. This vigilance is particularly applicable in the mountains as helihoisting operations to rescue pilots caught on rock faces are quite frequent.

During pilot training, wake vortex is covered and for all types of aircraft, including that of paragliders and helicopters. The theoretical aspects are dealt with in a brief analysis of the aerodynamic vortex at the tip of the wing illustrated by videos.

Pilots often encounter wake vortex when flying in a cluster (several paragliders flying very close to each other) or when crossing paths while slope soaring.

2.6 Helicopter operator

Babcock holds an Air Operator Certificate (AOC) in compliance with regulation (EU) No. 2018/1139 on common rules in the field of civil aviation.

The company operates twin-engine helicopters certified for single-pilot day and night flights under VFR.

The company's pilots must prove substantial aeronautical experience when they are recruited. They must, among other flight skills, show an ability to adapt as the types of rescue operation are never the same. The operations, according to the contracts, may be carried out by day or night, in zones with different geographical characteristics including plains, mountainous regions, stretches of water or built-up areas.

2.7 Rescue mission

2.7.1 Definition

HEMS operations can only be carried out in the scope of an approval issued by the competent authority (SPA.HEMS approval). The purpose of these HEMS flights is to facilitate the emergency medical care, when it is essential to transport the patient immediately and quickly. Medical personnel, medical supplies, ill or injured people and other people directly concerned can also be transported. The minimum crew for HEMS flights is composed of a pilot and a member of the HEMS crew.

There are two types of HEMS (and more generally Mobile Emergency and Resuscitation Service) operations:

- The primary operations correspond to taking charge of a patient, who has not already been admitted into a hospital, at any location (e.g. place of residence or work, public road, etc.).

- The secondary operations (or hospital transfers) correspond to the transfer of a patient from one hospital to another.

2.7.2 Site reconnaissance

For a rescue mission, it is possible to land and take off from a HEMS operating site without the prior authorization of the owner and without a declaration to the competent authority (civil aviation code, article D 132-6-1).

The choice of HEMS operating site is rarely left to the captain's initiative. It often depends on where the person to be rescued is located or the position of the first-aid team. Nevertheless, the captain, on arriving in the zone, is responsible for carrying out a landing site reconnaissance to check for its accessibility and if applicable, to refuse this site and suggest another with a safety level compatible with helicopter operation.

To this end, each helicopter is equipped with an Antares radio operating on the 150 MHz or 80 MHz frequencies. It allows the pilot to communicate with the rescue team on the ground, to warn them of the imminent landing and to obtain information about any dangers such as specific obstacles, before landing.

The Babcock operations manual indicates that the landing site reconnaissance enables the captain to take into account all the aerological and environmental factors in order to determine the best landing and take-off paths, the associated vertical profiles and the touchdown point.

At a distance corresponding to a high-angle approach, the pilot flies 360° around the landing area at a height of between 300 ft and 500 ft. According to the wind and the features of the landing site, the 360° circuit can be reduced to 180°.

During the reconnaissance phase, the pilot must ensure "air" safety, by taking into account, in particular:

- the presence of other aircraft in the manoeuvring volume;
- the presence of birds.

He must also ensure "ground" safety, and notably:

- check that there is no equipment, vehicles or persons in the immediate vicinity of the rotor downwash;
- determine the wind direction;
- determine the approach and take-off path according to the wind and obstacles.

On completing the site reconnaissance, the pilot decides whether to land or not. If he chooses to land, the pilot announces his decision to the TCM, indicating the approach path and the type of approach, and asks him if he has any questions about the action plan.

All the while the safety factors are not clearly identified, the pilot cannot safely land. If there are any doubts, it is recommended to carry out another reconnaissance on another approach path, even to choose another landing site.

In practice, the operator expects the crew to decide to accept or refuse to land or even to find another landing site quickly and in a safe manner. The crew must thus carry out the emergency service mission as quickly as possible, while ensuring a high safety level.

2.8 Wake vortex

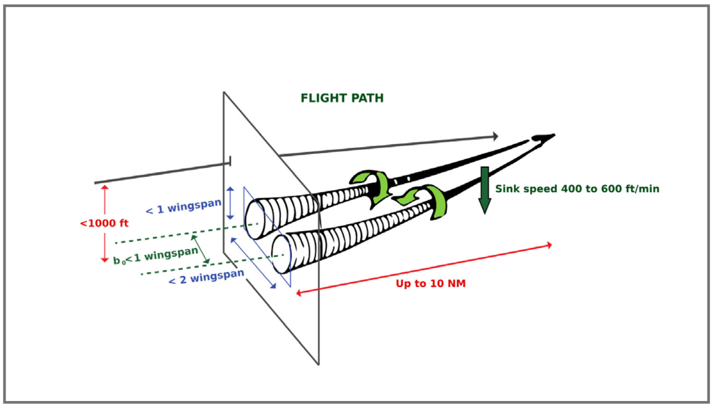
2.8.1 Description of phenomenon

Aircraft lift generates a parasite phenomenon called wake vortex. It starts at the tips of the airfoil. In these zones, air flows from the lower surface (highest pressure) to the upper surface (lowest pressure) generating two wing tip vortices.

The vortices have the following characteristics:

- They only exist when the aircraft is lifted by the air.
- They are well organized at low aircraft speeds (take-off, approach and landing phase).
- They are greater if the wing or disc loading is high (high weight, small wing/disc surface).
- They are greater if the aspect ratio is small (relatively small span with respect to the chord line, e.g. fighter plane).

The behaviour of the vortices is influenced by certain atmospheric conditions, notably atmospheric turbulence and ambient temperature (in particular its vertical gradient). Calm atmospheric conditions contribute to the persistence of the vortices while atmospheric turbulence accelerates their disintegration. In a calm atmosphere, wing tip vortices can persist several minutes after an aircraft's passage, sinking under its path. The vortices are pushed by the wind and are not visible to the naked eye (except in very particular atmospheric conditions).



Source: STAC, 2016

Figure 4: wake vortices

2.8.2 Aeroplane and helicopter wake vortex

All aircraft in flight generate wake vortex.

The three main hazards caused by a wake vortex encounter are the roll induced by the vortex speeds, altitude variations and stresses on the structure.

In the same way as an aeroplane, a helicopter generates wake vortex in forward flight. The main rotor blades, ensuring the lift and propulsion, are the moving equivalent of an aeroplane's fixed wings. The rotating rotor blades, because of their profile and their angle of attack, modify the air pressure locally and generate vortices.

A distinction is generally made between the aerological modifications made by a helicopter in hover, called downwash (in this case a descending air flow is generated by the main rotor) and the aerological modifications made by a helicopter in forward flight called wake vortex (in this case the modified air flow behind the helicopter is similar to the wake vortex of an aeroplane with two main vortices).

The hazard associated with downwash is well known to pilots as when the helicopter passes through it, there is a risk of the blades stalling and of losing control of the aircraft (VORTEX).

Source: STAC, 2016

Figure 5: helicopter wake vortex

2.8.3 Knowledge and awareness of helicopter wake vortices

While the helicopter community is aware of downwash, as testified by the information in flight manuals, the hazard caused by wake vortex seems to be little known and little taken into account. The BEA took the initiative during a meeting with professional pilots and French rotorcraft operators, organized after the accident, to question the participants to find out who, within this community, took into account wake vortex. It appeared from this consultation that 90% of them did not take it into account. Some of them considered that it was not to be taken into account by those who were going to create the wake vortex but by those who had to avoid it.

Few studies have been carried out about the wake vortices generated by helicopters in comparison with the number of studies concerning aeroplane wake vortices. However, from 1979, a few studies have endeavoured to measure or estimate the characteristics of helicopter wake vortices:

1. 1979, Air Force Flight Dynamics Laboratory, A method for assessing the impact of the wake vortices on USAF operations: an estimation of the direction and strength of the wake vortex of helicopters in order to assess the operating procedures at aerodromes used both by aeroplanes and helicopters.
2. 1996, Basset, Modeling of the dynamic inflow on the main rotor and the tail components in helicopter flight mechanics: modelling of the velocities induced by the main rotor and the vortex effect on the main rotor and tail structure.
3. 1999, Köpp, Wake-vortex characteristics of military-type aircraft measured at Airport Oberpfaffenhofen using the DLR laser doppler anemometer: an experimental study of the characteristics of aeroplane and helicopter wake vortices using LIDAR measurements.
4. 2007, Matayoshi and all, Flight-test evaluation of a helicopter airborne LIDAR: comparison between the LIDAR and anemometer measurements of helicopter downwash when in hover close to the ground, simulating atmospheric turbulence for the validation phase of the reliability of the LIDAR measurements.
5. 2017, Jimenez-Garcia and all, Helicopter wake encounters in the context of RECAT-EU: application of the wake vortex categorization methodology of aeroplanes to helicopters.

Studies 1 and 3 indicate that the maximum speeds resulting from the wake turbulence of a Boeing 707 type aeroplane in the landing configuration are 30% greater than those of an AS330-Puma type helicopter. A Boeing 707-300 weighs around 140 t and a Puma around 7 t.

It is also mentioned in study 1 that:

- *"The turbulence level in the vortices trailed behind a rotor, should be larger than that in the vortices trailed behind airplanes even in the landing approach configuration."*
- *"The vertical wake strength trailed behind a HH-53 flying at 60 knots is similar to that trailed behind a KC-135 or Boeing 707 in landing approach."*
- *"The HH-53 helicopter at 38,000 pounds is not a "heavy" configuration according to the FAA separation criteria; the strength of the vertical wake it trails while flying at 60 knots is similar to that behind a KC-135 or Boeing 707 in landing approach."*

Study 5 indicates that according to the distance, the decay of the wake vortex circulation of a CH-53 type helicopter is equivalent to that of a Boeing 737-500. The maximum weight of a CH-53 is around 20 t, while a Boeing 737-500 is around 60 t.

The BEA is not aware of a specific study concerning the wake vortices of the EC135.

2.8.4 Separation rules

To minimize dangerous proximity during the take-off and landing phases, separation rules between aircraft have been defined. Today, both at international and national level, aircraft are classified by category according to their maximum take-off weight and not by type of aircraft.

At European level, the separation rules are defined in the paragraph, ATS TR.220 Application of wake turbulence separation in annex 4 of regulation (EU) No 2017/373. Aircraft are put into four categories defined in the AMCs. Certain airports, with capacity constraints, apply reduced separations based on a different aircraft classification. However, in France there are no regulations regarding the separation between an aircraft and a helicopter, whether it be hovering or in forward flight.

The UK regulations[8] recommend a safety zone around a helicopter in hover, based on operational experience, of three rotor diameters of the generating helicopter. This figure is consistent with the findings of studies previously carried out by the STAC and should be published in the near future by ICAO in the revision of the document, Procedures for Air Navigation Services (Doc 4444).

[8] CAA, 2014, Aeronautical information Circular AiC P 3/2014 Wake Turbulence, Civil Aviation Administration.

According to the United Kingdom Civil Aviation Authority (CAA), air traffic controllers and pilots should take into consideration the wake vortex of helicopters manoeuvring close to the ground on a runway in use and apply the appropriate wake turbulence separation minima. The American regulations also mention that in forward flight, helicopters generate strong wake vortex (2014, FAA, Advisory Circular on Aircraft wake turbulence[9]), without specifying a separation in terms of distance or time between light aeroplanes and helicopters, while suggesting that there is an effect within a distance of three rotor diameters of the helicopter.

[9] https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_90-23G.pdf

In compliance with the regulations currently in force in France, the pilot using VFR (or IFR on a visual approach) is responsible for ensuring that he avoids wake vortex and thus for maintaining a sufficient separation with the aircraft preceding him. The pilot can receive traffic information by radio concerning aircraft taking off or on approach which might generate wake vortex.

2.8.5 Accidentology linked to helicopter wake vortices

Wake vortex encounters must, according to European regulations, be notified to the oversight authorities. These occurrences are then monitored and the most notable incidents or recurrent events are the subject of in-depth analyses in order to modify the regulations as required.

A document search revealed accidents and incidents where the helicopter wake vortex was considered as a contributory factor (refer to Appendix 1). The analysis of these occurrences shows that they all occurred in the immediate vicinity of the aerodrome circuit or even on the runway itself, between light aeroplanes and light helicopters.

Some of these reports carried recommendations but always in connection with air traffic control and air traffic.

2.9 Simulation of F-HTIN wake vortex

2.9.1 Modelling helicopter wake vortex

The concomitance of the passing of the helicopter and the fall of the paraglider pilot led the BEA to question whether the helicopter had potentially contributed to the accident and on the hazard associated with its presence.

The BEA contacted Airbus Helicopters Deutschland in order to model the helicopter's wake vortex. The BEA also contacted a modelling support company (Iwiation) along with the various witnesses to the accident and the helicopter crew (pilot and TCM) in order to estimate the paraglider's path as the latter was not equipped with a position recording system.

A complete simulation was produced by combining the results obtained. It confirmed that the helicopter's wake vortex had reached the paraglider pilot.

The helicopter's flight path recorded by the Hélisafe computer was used for this work. The helicopter's weight and balance sheet was also available. The weather reports at the time of the accident, produced by Météo-France, corroborated the statements made by the paraglider pilots in the area.

Simulation tools

Broadly speaking, there are few tools available to model helicopter wake vortex. Manufacturers use digital simulation means during the design and aerodynamic optimization, but their applications are generally limited to turbulence propagation around the helicopter (roughly a few rotor diameters) to study, notably, the effects of the helicopter's turbulence on the helicopter itself. The Airbus aerodynamic modelling tools which existed at the time of the accident did not fully permit the air flow to be modelled in a larger helicopter environment. A newly industrialised simulation tool thus had to be adapted in order to study the generation and propagation of wake vortices.

As the wake vortex is mainly generated by the main rotor, only the latter was modelled and studied. This work was carried out in two steps:

1. Use of the available EC135 general model to determine the attitudes and main rotor speeds based on the helicopter's recorded flight path.
2. Use of rotor attitudes and speeds in the wake turbulence simulation tool to determine the propagation of the latter.

These two steps permitted the calculation of the pressure and airspeed distribution behind the helicopter's path.

Several methodologies are possible to calculate air pressure and speed variations. To represent the rotor, Airbus selected the Freewake methodology which permits the best modelling of the interactions of the local airflows and the incorporation of calculations, while limiting the numerical dissipation for a longer time period. This methodology had been validated by Airbus during simulations for another helicopter type and also during the comparison with experimental trials in a wind tunnel.

Application to event

For the modelling, the length of the wave vortex was limited to 230 m, as considered negligible beyond this distance, and the simulation was started for a period of 28 s.

The wind taken was based on the Météo-France estimations and the statements of those present at the accident site, i.e. a 15 kt wind from 330°. The weight taken for the simulations was between 2,300 kg and 2,750 kg, which permitted the lift force to be determined.

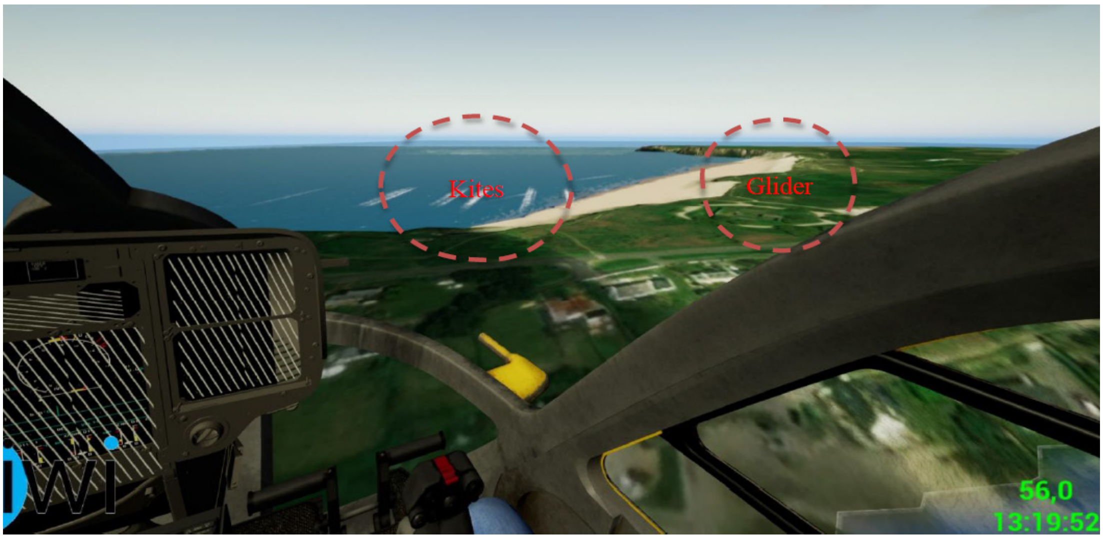
The image of the wake vortex behind the main rotor shows that the wind pushed the generated turbulence towards the cliff, and notably toward the point where the paraglider pilot fell.

Source: IWIATION

Figure 6: calculation of propagation of wake vortex (in blue)

Initially, the position of the paraglider was estimated by correlating the statements of those present on site and the statements of the helicopter crew. A playback was carried out several months later with the Iwiation application in the same tidal conditions. The witnesses, located in the actual environment and at the same spot as at the time of the event, had the possibility of indicating, on a tablet, the estimated positions of the helicopter and paraglider. The pilot and TCM were able to play back the event flight from the cockpit using augmented reality technology while commenting on the different moments of the flight. The combination of the Iwiation playbacks was used to confirm the paraglider's flight path.

A supplementary photogrammetric analysis of the two photos taken by a witness on the beach (see Figure 2 photographer witness) was used to more accurately determine the paraglider's path and to synchronize it with the helicopter's path. This was only possible during the last 13 s (time between the two photos), based on the supposition that the last position of the paraglider in flight was overhead the point where he fell. These photos were also used to estimate the orientation of the paraglider with respect to the helicopter.



Source: BEA

Figure 7: illustration in Iwiation of point of view of helicopter pilot

After cross-checking the various statements, Iwiation estimated that the uncertainty with respect to the paraglider's position was three metres vertically and five metres horizontally.

2.9.3 Conclusion with respect to simulation

The simulation of the helicopter's wake vortices carried out by the manufacturer showed that the latter, transported by the north-westerly wind, were propagated from the middle of the beach up to the cliffs during the helicopter's final approach.

The simulation showed that the helicopter's wake vortex crossed the path of the paraglider. The airspeeds resulting from the turbulence in the immediate environment of the paraglider pilot before and at the time of his fall reached values exceeding the variations which could be withstood by the wing, while being of varying directions and amplitudes. The continuation of the flight in these conditions was in all likelihood impossible.

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 helicopter had been called out for a rescue mission to take charge of an injured person on Conquet beach.

3.1 Quick site reconnaissance

3.1.1 Approach to beach

The experienced pilot had carried out numerous flights and approaches to sites outside aerodromes and he was familiar with the environment between Brest and Le Conquet. The execution of the day's mission seemed straightforward. During the flight preparation, he had obtained the information (weather reports, airspaces) permitting him to take the decision to take off. He had not received any specific information about hazards at the intervention site. Immediately after take-off, he followed a direct track to the area where the injured person was to be taken on board and opted to land on the beach as close as possible to this area.

Due to the short flight time, the pilot chose to fly at a low height to allow him to quickly reach the site. For this same reason, the pilot chose to carry out a semi-direct approach, with a constant descent angle which led to a start of descent at 2 Nm east abeam the site. This path thus restricted his field of vision of the beach, concealed by the high ground which bordered it, a few tall trees and houses.

The pilot and TCM then noted the presence of kitesurfers on the left while the pilot continued his approach. When he had passed the last of the high ground and was aligned on final, the pilot saw the paraglider ahead of him and on his right. The pilot assigned a task to each person on board in order to ensure that collision with the kites and paraglider was avoided.

The helicopter was 170 ft above the beach, the paraglider was ahead of him at around 300 m to his right.

3.1.2 Final approach to beach

The pilot's choice to make a semi-direct approach with a constant angle, without carrying out a reconnaissance by flying overhead the site, left him with a limited choice of manoeuvres from when he observed the kitesurfers and paraglider.

He had two options: to carry out a go-around to line up for the beach again with a new action plan or to continue his final approach and land. He rejected the go-around thinking that the turbulence from the helicopter's downwash might affect the paraglider's flight. He considered that the risk for the paraglider pilot was less if he continued the landing on the identified site as he had him in sight, on the right and slightly below the helicopter.

Arriving overhead or indeed with a high-angle approach as recommended by the operator's manual would in all likelihood have alerted the paraglider pilot to the arrival of the helicopter and the associated risks. Such an arrival would have also given the helicopter pilot the possibility of taking another flight path to maintain separation with the paraglider pilot. It is likely that the pilot thought that he controlled the situation, due to his experience, and that this overshadowed the need to take the time to analyse the obstacles by a complete reconnaissance of the landing area.

The mission to the beach had not presented any major difficulties for the pilot. On arriving at the beach, he discovered, almost all of a sudden, a new situation with associated difficulties. This short-term risk management put the crew in a relative impasse with the only possible solutions being a go-around or continuing the flight path and landing but in unfavourable conditions (downwash, restricted manoeuvring space).

3.1.3 Paraglider pilot's manoeuvres

The paraglider pilot was slope soaring, flying back and forth along the beach close to the cliff. It is probable that he only saw the helicopter when he was flying south, the helicopter at that time being higher than him, on his right side. Although witnesses tried to warn him of the presence of the helicopter, it was only possible to see it when flying south. His field of manoeuvre was then limited.

In this configuration, the paraglider pilot could neither turn left as he would then be slightly below and facing the cliff with a tailwind nor turn right because of the presence of the helicopter. Moreover, it is probable that the paraglider pilot, who was flying at a low height did not want to quickly descend by closing his wing because of the risk of injuring himself. A descent to land with a tailwind only provided a degree of safety.

Consequently and assuming that the paraglider pilot had identified the presence of the helicopter coming towards him and had taken into account the associated risk, it is likely that he wanted to continue on his path, this being the less risky solution.

The fact that the paraglider pilot did not make any manoeuvre may also indicate that he was not aware of the danger that the wake vortex represented at that moment which, given the wind, would be pushed towards the cliff.

3.2 Wake vortices not taken into account

Like air traffic controllers and other pilots, the helicopter pilot had received, during his initial training, information about the wake vortex of an aircraft, mainly with respect to the restricted environment represented by an aerodrome. This information focuses notably on the separation distances between aircraft.

Moreover, the aeronautic community often associate the strength of the wake vortex with the size of the aircraft whereas in reality, a helicopter will generate more wake vortex than an aeroplane of the same weight[10]. Thus, pilots do not generally think about the consequences associated with wake vortex. They mainly concentrate their attention on the downwash risks, taking care not to subject objects or indeed people to this downwash.

[10] This concept is adopted in GM1 to AMC7 ATS.TR.220 Application of wake turbulence separation.

The helicopter's downwash is generally expressed as air deflected downwards by the rotor in the helicopter's immediate environment. In contrast to this, wake vortex is propagated behind the helicopter and has a tendency to sink. The pilot, who had considered that he had ensured that there would be no collision when he had seen the paraglider pilot below him and on his right, did not realise that the wake vortex generated by his helicopter would be transported towards the paraglider by the wind.

In the international regulations and standards, the wake vortex categories of aircraft only apply to aeroplanes and depend on their weight. Studies were initiated, but few were taken into account, to try and classify helicopters according to the strength of their wake vortex instead of their weight. Pilots who only associate turbulence categories with the weight of the aircraft thus have a tendency to assimilate a helicopter with a plane of equivalent size, overshadowing the dangers of wake vortex.

Safety investigation reports have shown wake vortex as being a contributory factor to and even the cause of accidents. Subsequent to some of these reports, certain authorities informed pilots of the dangers of wake vortex, promoted this information and at times envisaged wake vortex studies being carried out to better classify helicopters.

3.3 Contributing factors

On arriving at the intervention site, when the pilot identified the paraglider on his right and the kites of the kitesurfers on his left, the range of manoeuvre choices for the helicopter and paraglider became limited. The paraglider pilot, even if informed of the danger of the helicopter's wake vortex, could neither avoid crossing this vortex nor land.

When the paraglider crossed the wake vortex generated by the helicopter, this led to the wing closing and the paraglider falling to the ground. Flying at a low height, the paraglider pilot was not able to recover the situation.

The following factors contributed to the small separation between the helicopter and the paraglider:

- The inadequate site reconnaissance, prior to landing, which meant that the helicopter pilot did not see the paraglider pilot sufficiently early and the latter was not given possible warning of the presence of the helicopter.
- The pilot's decision to carry out a semi-direct approach at low height which restricted the paraglider's manoeuvring zone.

3.4 Safety lessons

Knowledge of wake vortex phenomenon

Even if in this present case the pilot's better knowledge of the wake vortex phenomenon would have probably not changed his intentions as to the choice of his path, the investigation has, however, shown that there is a shortage of specific studies and an absence of general information about this phenomenon within the rotorcraft community resulting in:

- Ignorance about the risk associated with helicopter wake vortices on the surrounding aircraft in restricted manoeuvring areas.
- Absence of specific instructions aimed at pilots with respect to the dangerous nature of wake vortices of helicopters frequently manoeuvring close to other aircraft.

Awareness actions regarding the risk associated with helicopter wake vortices would be more effective if information about the order of magnitude of this turbulence in comparison with that of aeroplanes of comparable weight was provided. This topic is the subject of a safety recommendation (see §4).

In order to share information with the aeronautic community about taking into account the risk associated with helicopter wake vortices, a video made by the BEA is available on its website.

Safety instructions in presence of a helicopter

The RSVF (the French flight safety network) set up by the DSAC (the French civil aviation safety directorate) and headed by the MEAS (the safety assessment and improvement mission) groups all the entities responsible for French operator safety (airline companies, helicopter operators, maintenance workshops, airports, air navigation services, etc.). It permits direct exchanges between these entities during both regular meetings and in the scope of a private "social" network.

In the specific "helicopter operator" network, a checklist was created giving instructions to ground personnel in order to safely work with a helicopter on an intervention site (see Appendix 2).

It mentions, among other points:

- To continuously monitor the air/ground frequency before the helicopter's arrival in the area, when radio equipment is available and if possible, never break off radio contact with a helicopter without the pilot's acceptance.
- Inform the pilot of the presence of any danger close to the landing area (cables, antennas, other aircraft, paragliders, etc.).

The DSAC informed the BEA that this checklist had been shared and distributed within the emergency services and that it would soon be available on the DGAC's website. The DSAC indicated to the BEA that discussions were being held with the European Aviation Safety Agency (EASA) with respect to a wider distribution of this sheet.

Measures taken by the operator after this accident

Following the accident, Babcock carried out specific safety promotion actions to supplement the teaching which had already been in place for several years with respect to the TEM[11] principles and reconnaissance instructions, in particular during missions on an operation site. This involves implementing a flight management method which enhances the detection/anticipation of threats, and adapting the action plan.

(11) Threat and Error Management.

During the recurrent training and check sessions for flight crews (pilots and MET), the following points were also developed to better prepare and raise awareness of the crews:

- helicopter wake vortices;
- site reconnaissance;
- lessons learned from the F-HTIN accident.

Babcock revised its operations manual with respect to the site reconnaissance and more particularly, the air reconnaissance and the taking into account of the possible presence of paraglider pilots.

4 - RECOMMENDATIONS

Note: in accordance with the provisions of Article 17.3 of Regulation No 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation, a safety recommendation in no case creates a presumption of fault or liability in an accident, serious incident or incident. The recipients of safety recommendations report to the issuing authority in charge of safety investigations, on the measures taken or being studied for their implementation, as provided for in Article 18 of the aforementioned regulation.

4.1 Helicopter wake vortex

During the investigation into this accident, several documents were studied, notably the regulatory texts, instruction manuals and studies carried out about wake vortex.

Although few studies have endeavoured to specifically compare the characteristics of aeroplane and helicopter wake vortices, the studies identified by the BEA suggest that helicopter wake vortices are equivalent to those of aeroplanes of a much greater weight.

What is more, the manuals intended for microlight and aeroplane private pilot instruction mention the danger arising from the wake vortex generated by transport category aeroplanes or, in general, by fixed-wing aircraft. They do not specify the amplitude and the dangers of wake vortex generated by helicopters although this can be of a relatively greater amplitude than that generated by an aeroplane of comparable weight.

Safety investigation reports mention wake vortex as being a contributory factor to and even the cause of accidents. Subsequent to some of these reports, certain authorities issued information about the dangers of wake vortex, promoted this information and at times envisaged wake vortex studies being carried out to better classify helicopters.

Consequently, the BEA recommends that:

- **whereas the danger associated with wake vortex generated by the movement of even light helicopters;**
- **whereas the lack of knowledge of the aeronautic community (operators, pilots and certification authorities) concerning the wake vortex associated with helicopter movement;**

EASA, in coordination with the main European helicopter manufacturers, assess the orders of magnitude of the wake vortices generated by a helicopter in comparison with an aeroplane of equivalent weight and share this information to raise awareness in the aeronautic community.
[Recommendation FRAN 2021-007]

APPENDIX 1

Reports concerning events in connection with wake vortex

- Accident to a paraglider involving the AW109SP registered HB-ZRW on 23 June 2016 in Switzerland: fall of a paraglider pilot, lack of knowledge about helicopter wake vortex and associated dangers. A document concerning good practices between helicopters and paragliders was drawn up to raise the awareness of helicopter and paraglider pilots.
- Serious incident to the Aero AT-3 registered HB-SRC and the Robinson R66 registered HB-ZOK on 12 August 2016 in Switzerland: loss of control on landing. The wake vortex of a helicopter was probably the cause of the accident. The investigation authority recommended that the Swiss Federal Office of Civil Aviation (FOCA) guarantee that the pilots and other people involved in flight operations are informed and aware of the wake vortices of helicopters and the dangers that they generate.
- Accident to a paraglider involving the EC 120 B registered HB-ZFM on 28 December 2016 in Switzerland: fall of a paraglider, the wake vortex of the helicopter may be a contributing factor.
- Accident to the Piper PA-28 registered G-BRWO on 26 August 2016 in UK: uncommanded roll of aeroplane during landing probably due to the wake vortex of a Sikorsky S76 which had just landed in front of the plane. A recommendation was addressed to the Civil Aviation Authority to provide clear advice regarding the potential hazards to fixed wing aircraft when following a helicopter.
- Accident to the Air Création Racer 503 SL identified 83-IA on 8 January 1998 in France:
  - The loss of control which led to the accident was caused by the microlight entering the wake vortex generated by the preceding AS332 Super Puma.
  - During the investigation into this accident, several documents were studied, notably the regulatory texts and instruction manuals. The Air Traffic Regulation (RCA 3, paragraph 5.6.6.2. concerning greater spacing due to wake vortex) provides for the separation of aircraft when landing and taking off according to their weight. The illustrations accompanying the text present the wake vortices generated by aeroplanes without mentioning helicopters. The manuals intended for microlight and aeroplane private pilot instruction mention the danger arising from the wake vortex generated by transport category aeroplanes or, in general, by aircraft. The amplitude and dangers of the wake vortex generated by helicopters is not specified. The BEA recommended that the DGAC ensure that in the regulatory texts and training material, helicopters are explicitly designated as aircraft which can cause wake vortices in the same way as aeroplanes and that the amplitude of this turbulence is specified.
  - In compliance with the order of 13 March 1992 regarding the procedures for completing and transmitting filed flight plans (FPL), the wake vortex category of an aircraft is indicated in this document by means of the letters L, M or H. According to this text, the aircraft belongs to one of these categories according to its weight. However, it seems that helicopters produce significantly greater wake vortex than that of an aeroplane of equivalent weight. Thus, the aircraft's weight alone is not a sufficient criteria for quantifying the amplitude of the wake vortex generated. Consequently, the BEA recommended that the DGAC, and if applicable in consultation with the JAAs, study the definition of new criteria to classify helicopters into wake vortex categories according to the amplitude of the wake vortex actually produced.

BEA

APPENDIX 2

MINISTÈRE CHARGÉ DES TRANSPORTS

Consignes de sécurité en présence d'un hélicoptère

La présence sur intervention d'un ou plusieurs hélicoptères nécessite une vigilance accrue au regard de la sécurité du personnel et de la zone d'intervention.

1 Procédure radio et protection individuelle

- Veiller en permanence la fréquence air/sol avant l'arrivée sur zone de l'hélicoptère. Si possible, ne jamais interrompre une liaison radio avec un hélicoptère sans son accord !
- Protéger vos yeux des débris volants et de la poussière.
- Protéger vos oreilles du bruit.
- Être visible, mettre un gilet haute visibilité.
- Ne pas fumer aux abords de l'appareil.

2 Choix d'une zone de poser

- Dimensions minimales de la zone de poser : **30 x 30 mètres**.
- Éviter les sols poussiéreux, sablonneux ou caillouteux, les surfaces meubles.
- Surface dure et à peu près plane, sans obstacle au sol de plus de 30 cm.
- Vérifier sur l'aire de poser retenue et sur ses abords, qu'aucun objet ne pourra s'envoler en présence du souffle ou être arraché (ex. : fenêtres partiellement ouvertes ou mal verrouillées, auvents, etc.).
- Si possible un axe dégagé, face au vent.

De nuit :

- Respecter les mêmes consignes que de jour.
- Dimensions minimales de la zone de poser : **100 x 50 mètres**.
- Ne pas éclairer l'hélicoptère à l'approche, comme au décollage.
- De nuit les perceptions visuelles et sonores sont différentes, ne pas se faire surprendre.

3 Approche de l'hélicoptère

- Le personnel qui guide l'hélicoptère doit porter ses EPI (Gilet Haute Visibilité, casque, lunette).
- Un personnel compétent doit être en contact (VHF, FM, ANTARES, réseau GSM , etc.) avec l'hélicoptère lorsqu'il arrive sur la zone.
- Il doit se tenir dos au vent, les bras en l'air, en laissant la plus grande partie de la zone de poser libre devant lui.
- Signaler sa position au pilote via le cadran horaire.
- Signaler au pilote toute présence de danger à proximité de l'aire de poser (câbles, antennes, autres aéronefs, drones, parapentes, etc.)
- Durant l'approche finale, mettre un genou à terre, garder les bras levés en V, ne pas bouger et garder un contact visuel permanent avec le pilote.
- Aucune autre personne, objet ou véhicule ne doit se trouver sur l'aire d'atterrissage.

Réseau Sécurité des Vols France

4 Poser de l'hélicoptère

Garder l'aire d'atterrissage propre

Le déplacement d'air produit par l'hélicoptère soulèvera et déplacera une étonnante variété d'objets. Le souffle peut projeter des graviers ou cailloux sur plus de 40 mètres ; ne garer aucun véhicule proche de la trajectoire et du point de poser.

- Vérifier que sur l'aire de poser retenue, et sur ses abords, aucun objet ne pourra s'envoler en présence du souffle.
- Le personnel se trouvant à proximité de l'aire de poser doit avoir sa veste boutonnée, ses poches fermées et ne pas porter de vêtements risquant de s'envoler, tels que casquette, écharpe...
- Il lui est conseillé de porter des lunettes pour éviter les projections dues au souffle du rotor.

5 Aux abords de l'hélicoptère

- Lorsque le rotor tourne :
  - Attendre que les patins (ou le câble si treuillage) aient touché le sol afin de décharger l'électricité statique accumulée par la machine.
  - Attendre l'**AUTORISATION** explicite du mécanicien ou du pilote (par le geste du pouce levé) pour approcher.
- En toute circonstance, l'abord est toujours réalisé par le secteur **AVANT** de l'hélicoptère pour :
  - **Rester en visuel de l'équipage.**
  - Ne s'approcher de l'hélicoptère rotors tournants uniquement sur accord de l'équipage.
  - Il faut attendre environ deux minutes après l'atterrissage pour que les rotors s'arrêtent. Durant ce temps, les personnes et les véhicules doivent rester à une distance sûre.
  - **Il convient dans tous les cas de suivre les instructions de l'équipage.**
  - Ne jamais aborder un hélicoptère par son secteur arrière.
  - Dans cette zone **DANGEREUSE** l'équipage ne peut vous voir.

Baissez-vous et ne courrez pas en approchant.
Si vous transportez des objets assez longs, toujours les positionner à l'horizontale pour ne pas percuter les pales.

Attention aux dévers et aux talus.
Ils réduisent la garde entre le sol et les pales du rotor.
Toujours aborder l'hélicoptère par le côté aval.

Ne jetez jamais rien au voisinage d'un hélicoptère.
Les objets les plus innocents deviennent des projectiles mortels.
Il convient avant tout **d'ÉVITER TOUTE PRÉCIPITATION !!!**
Au départ de l'appareil, ne pas bouger jusqu'au décollage complet de l'hélicoptère (sauf ordres contraires).

6 À la mise en route

- Rester en vue du pilote afin de lui faire un signe d'urgence si besoin.
- Surveiller les alentours de la zone de poser.
- Interdire tout mouvement de personnel(s) ou de véhicule(s) tant que l'hélicoptère n'a pas décollé.

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Safety instructions in the presence of a helicopter (source: RSVF)