CIAIAC

COMISIÓN DE
INVESTIGACIÓN
DE ACCIDENTES
E INCIDENTES DE
AVIACIÓN CIVIL

Report A-011/2017

Accident involving a Eurocopter AS 350 B3 aircraft, registration F-HETH, operated by Sky Helicópteros, in Garrovillas de Alconétar (Cáceres, Spain) on 17 June 2017

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MINISTERIO DE FOMENTO

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Foreword

This report is a technical document that reflects the point of view of the Civil Aviation Accident and Incident Investigation Commission (CIAIAC) regarding the circumstances of the accident object of the investigation, and its probable causes and consequences.

In accordance with the provisions in Article 5.4.1 of Annex 13 of the International Civil Aviation Convention; and with articles 5.5 of Regulation (UE) nº 996/2010, of the European Parliament and the Council, of 20 October 2010; Article 15 of Law 21/2003 on Air Safety and articles 1., 4. and 21.2 of Regulation 389/1998, this investigation is exclusively of a technical nature, and its objective is the prevention of future civil aviation accidents and incidents by issuing, if necessary, safety recommendations to prevent from their reoccurrence. The investigation is not pointed to establish blame or liability whatsoever, and it's not prejudging the possible decision taken by the judicial authorities. Therefore, and according to above norms and regulations, the investigation was carried out using procedures not necessarily subject to the guarantees and rights usually used for the evidences in a judicial process.

Consequently, any use of this report for purposes other than that of preventing future accidents may lead to erroneous conclusions or interpretations.

This report was originally issued in Spanish. This English translation is provided for information purposes only.

Contents

Abbreviations

° ' "	Sexagesimal degrees, minutes and seconds
° C	Degrees centigrade
AEMET	National Weather Service
AESA	National Aviation Safety Agency
AMM	Aircraft maintenance manual
CPL(H)	Commercial pilot license (helicopter)
CRM	Crew resource management
DECU	Digital engine control unit
EASA	European Aviation Safety Agency
EHEST	Europe Helicopter Safety Team
EGPWS	Enhanced Ground Proximity Warning System
FAA	Federal Aviation Administration (USA)
FF/SAR	Firefighting/Search and rescue
GOV	Governor
GPS	Global positioning system
h	Hours
HTAWS	Helicopter Terrain Awareness Warning System
Kg	Kilograms
IHST	International Helicopter Safety Team
Km/h	Kilometers/hour
m	Meters
MCTOM	Maximum Certified Take-off Mass
Min	Minutes
Mm^2	Square millimeters
MOPSC	Maximum Operational Passenger Seating Configuration
N/A	Not affected
OCAS	Obstacle Collision Avoidance System
PPT	*Pliego de Prescripciones Técnicas* (Tender of Technical Specifications)
RPM	Revolutions per minute
s	Seconds
SP	Single Pilot
STC	Supplemental type certificate
STR	Switching Transformer Substation
UE	European Union
UTC	Coordinated universal time
TAWS	Terrain Awareness Warning System

VEMD	Vehicle and engine multifunction display
VFR	Visual flight rules
WSPS	Wire strike protection system

Synopsis

Owner:	H2i[1]
Operator:	Sky Helicópteros
Aircraft:	Eurocopter AS 350 B3, registration F-HETH
Date and time of accident:	17 June 2017 at 21:29[2]
Site of accident:	Garrovillas de Alconétar (Cáceres, Spain)
Persons onboard:	1, not injured
Type of flight:	Aerial work– Commercial - Firefighting
Phase of flight:	Maneuvering – Low flight
Type of operation:	VFR
Date of approval:	7 June 2018

Summary of event:

On Saturday, 17 June 2017, a Eurocopter AS350 B3+, registration F-HETH, took off from the helicopter base of Hoyos, in Cáceres, at approximately 20:30 to take part in fighting a fire in the town of Garrovillas de Alconétar (Cáceres), 30 miles south of the helicopter base.

Earlier, the Regional Operations Center for the Infoex Plan in Cáceres had contacted the pilot, who was on a rest period after having taken part in fighting another fire. After finishing his rest period, he was mobilized to participate in the efforts to combat the new fire.

While flying to the fire in Garrovillas de Alconétar, the pilot's area of operations was changed several times, as a result of which he calculated that he would only have time to make two water drops by the time he reached the area of activity, which he reported.

1 The operator, Sky Helicópteros, had rented the helicopter involved in the accident from the owner, H2i, under a wet lease (no crew) agreement.

2 All times in this report are local. To obtain UTC, subtract 2 hours.

Once in the area of operations, he dropped off the firefighting squad at 21:25 and flew to a nearby reservoir to pick up water. After making an initial drop without problems, he returned to the reservoir to pick up more water, but while doing so, the pilot suddenly saw power lines in front of him. He made an evasive maneuver in an unsuccessful effort to avoid striking the power lines. The impact took place at around 21:29.

After hitting the power line, the pilot made an emergency landing to check the damage to the helicopter.

Unsure of the potential damage that may have been caused to the helicopter, it was decided not to board the firefighting squad, which returned to the base on a land vehicle.

The next day, following a check by the company's mechanic, the helicopter was flown from the accident site to the Serradilla helicopter base, which was the closest one, for a more thorough check.

Later, on 20 June, after having operated normally since the day of the accident, the company's mechanic saw some marks on one blade (the blue blade) that seemed to have been caused by the impact with the lines. These impact marks had not been detected earlier. The maintenance mechanic concluded that the blade had to be replaced, and the helicopter was grounded.

The pilot was not injured, but the aircraft sustained heavy damage.

The investigation has concluded that this accident was caused by the execution of a water loading maneuver in an area that had not been previously reconnoitered.

The following are deemed to have contributed to this accident:

1. The low visibility at the accident site.
2. The failure to reconnoiter the water loading area.
3. The absence of lights on the power lines in the reservoir, which was likely to be used in water loading operations.

1. FACTUAL INFORMATION

1.1. History of the flight

On Saturday, 17 June 2017, a Eurocopter AS350 B3+, registration F-HETH, took off from the helicopter base of Hoyos, in Cáceres, at approximately 20:30 to take part in fighting a fire in the town of Garrovillas de Alconétar (Cáceres), 30 miles south of the helicopter base.

Earlier, the Regional Operations Center for the Infoex Plan in Cáceres had contacted the pilot, who was on a rest period after having taken part in fighting another fire. After finishing his rest period, he was mobilized to participate in the efforts to combat the new fire.

During the call to dispatch the aerial resource, the Regional Operations Center in Cáceres, gave the following information to the pilot:

- Location of the fire.
- Grid of the fire.
- Operations channel.
- Firefighting Director (Forest Agent or Area Coordinator).
- Information on other aerial resources working in the area.
- Approximate idea of the type of fuel that was burning.

While flying to the fire in Garrovillas de Alconétar, the pilot's area of operations was changed several times, as a result of which he calculated that he would only have time to make two water drops by the time he reached the area of activity, which he reported.

Once in the area of operations, he dropped off the firefighting squad at 21:25 and flew to a nearby reservoir to pick up water. After making an initial drop without problems, he returned to the reservoir to pick up more water, but while doing so, the pilot suddenly saw power lines in front of him. He made an evasive maneuver in an unsuccessful effort to avoid striking the power lines. The impact took place at around 21:29.

After hitting the power line, the pilot made an emergency landing to check the damage to the helicopter.

Unsure of the potential damage that may have been caused to the helicopter, it was decided not to board the firefighting squad, which returned to the base on a land vehicle.

The next day, following a check by the company's mechanic, the helicopter was flown from the accident site to the Serradilla helicopter base, which was the closest one, for a more thorough check.

Later, on 20 June, after having operated normally since the day of the accident, the company's mechanic saw some marks on one blade (the blue blade) that seemed to have been caused by the impact with the lines. These impact marks had not been detected earlier. The maintenance mechanic concluded that the blade had to be replaced, and the helicopter was grounded.

The pilot was not injured, but the aircraft sustained heavy damage.

1.2. Injuries to persons

Injuries	Crew	Passengers	Total in the aircraft	Other
Fatal				
Serious				
None				N/A
None	1		1	N/A
TOTAL	**1**		**1**	

1.3. Damage to aircraft

While the cable cutter installed on the aircraft helped lessen the damage to the aircraft, the following problems were identified:

1 – On the day after the impact, the company's mechanic did a general visual inspection of both the blades and the rest and the helicopter, noticing:

- bits of the cable in the lower cable cutter,
- a crack on one of the aircraft's two mirrors,
- a scrape on the structure that holds the mirrors,

Illustration 1.
Close-up of damage caused by impacting the cable

- several scrapes on the nose and lower cowling, and
- a small dent at the tip of the yellow blade.

The previous image shows the damage to the tip of the blade (yellow blade):

2 – Later, on 20 June, the same mechanic, during the end-of-day daily inspection, saw some marks on another blade (the blue blade) that seemed to have been caused by the impact with the cables. These impact marks had not been detected earlier. The following image shows the marks on the blue blade:

Illustration 2. Close-up of the helicopter's blue blade

1.4. Other damage

The electric company stated that the accident took place on the line called "STR GARROVILLAS – GARROVILLAS". Specifically, the impact was on the span between supports 1987-2.11 and 1987-2.12, consisting of a bare conductor made of aluminum-steel, type LA 110, with a 116.2 mm^2 total cross-section. The span length is about 455 m. The span is held up by two supports consisting of CL-type metal structures, which are 11-m tall metal towers with a unit stress of 1800 kg at the tip and joined by a 7-m long metal crossarm. As required by the topography of the terrain and the tension in the line, the sag in the catenary in the affected span is about 14 m, resulting in a height above the maximum water level of about 29 m.

The impact broke the three conductors, which led to the tripping of the automatic breaker at the Garrovillas STR, which left all of the clients supplied by the line without electricity. These clients are mainly located in the town of Garrovillas de Alconétar. A further four transformer stations outside the town were also affected.

The accident took place at about 21;29, and after the initial efforts in the field, electricity was restored to Garrovillas de Alconétar through an alternate line at about 22:00. The other stations remained without power. Later, on 18 June, at about 1:30, the segment affected by the accident was isolated and power was restored to the remaining clients through the alternate line used to supply the town of Garrovillas de Alconétar.

1.5. Personnel information

1.5.1. Information on the pilot

The pilot, a 47-year old Spanish national, had had a commercial helicopter pilot license (CPL(H)) since 18 April 2005. It was issued by Spain's National Aviation Safety Agency, AESA, and it had the following type ratings:

- AS350/EC130/SP, valid until 30 April 2018
- CABRI G2/SP, valid until 31 March 2018
- R22/SP, valid until 30 September 2017

He also had a helicopter flight instructor rating, which was valid until 30 September 2018.

Likewise, he had a class-1 medical certificate, which was valid until 17 March 2018. The certificate contained the following entry: "must wear corrective lenses for near-sightedness and carry a spare set".

He also had a FF/SAR certificate of proficiency, issued by Sky Helicópteros on 29 April 2017, which certified the pilot's proficiency to take part in the following activities as part of firefighting operations: observation and patrol, coordination, helicopter water drops and transfer of additional specialized personnel.

During the investigation, the pilot also stated that the operator had trained him on how to avoid hitting power lines.

On the day of the accident he had a total of 2,754 flight hours, of which 700 had been on the helicopter type involved in the accident. He had also taken part in four firefighting campaigns in Extremadura, two of them from the same base.

As for his activity prior to the accident, he had flown 1:16 h on 9 June and 2:00 h on 13 June.

1.5.2. Information on the mechanic

The mechanic, a 41-year old Spanish national, had a B1 maintenance license for turbine helicopters issued by AESA, which included a B1.3 type rating for Eurocopter AS350 (Turbomeca Arriel 2) aircraft. This rating was valid at the time of the accident.

1.6. Aircraft information

The Eurocopter AS 350 B3 aircraft, registration F-HETH and serial number 7108, was registered in the French Civil Aviation Registry on 20 May 2011. It was outfitted with a Safran Turbomeca Arriel 2B1 engine, serial number 51073.

It had a Certificate of Airworthiness issued in May 2011 by the French Civil Aviation Authority. Its Airworthiness Review Certificate was valid until 21 May 2018.

There was a cable cutter installed on the aircraft, manufactured by Apical Industries, STC EASA.IM:R.S.01534.

According to the operator, the helicopter was airworthy on the day of the accident. It was up to date in terms of its scheduled maintenance tasks, airworthiness limitations, limited-lifetime components and airworthiness directives. On 4 May 2017, when the aircraft had 1097:04 flight hours, it underwent its last 600-h/24-month base check, and its last 100-h/12-month line check. At the time of the accident, the helicopter had no deferred items.

On the day of the accident, both the aircraft and the engine had a total of 1109:12 hours. The aircraft had 4708 cycles, and the engine had 917:25 N1 cycles and 727:40 N2 cycles.

After the event, the pilot informed the operator's maintenance mechanic that he had struck some power lines and that the cable cutter or a blade might have cut a cable.

The day after impacting the cable, the mechanic did a general visual inspection of both the blades and the rest of the helicopter. Specifically, he checked the blades from the ground, and then climbed on the helicopter to inspect them from the height of the leading edge. The mechanic was not looking for a small defect, but rather for a potential mark left by a cable cut by the blade. He therefore thought that the distance from which he did the visual check was adequate for this task. As a result, he did not inspect the blades from a short distance. He identified some damage, including a slight dent to the tip of one blade (yellow blade), which he

considered minor[3], he did the tasks in the AMM for the cable cutter and the yellow blade and he issued a Return to Service Certificate.

The pilot flew by himself from the site of the accident to the base in Serradilla, noting nothing unusual during the flight.

Once at the base in Serradilla, the same maintenance mechanic again did a general visual check of the aircraft, and specifically of the blades, using the same procedure as at the accident site. He did not find any further problems.

On 19 June, the pilot involved in the accident flew this helicopter twice, and at the end of the day the pilot conducted the daily inspection, finding no additional damage.

On 20 June, the same pilot flew the same helicopter again. At the end of the day, during the daily check, the mechanic saw marks on another blade (blue blade) that seemed to have been caused by the impact with the cables. These impact marks had not been detected earlier. The maintenance mechanic carried out other tasks in the AMM for the blue blade, reaching the conclusion that it had to be replaced[4]. The helicopter was grounded.

On 27 June 2017, the blue blade was replaced and the aircraft was returned to service, after which it operated normally.

1.7. Meteorological information

1.7.1. General meteorological situation

At medium and high levels, the geopotential over the Spanish mainland and Balearic Islands was relatively high, with weak flow and primarily high pressure. The temperature at medium levels ranged from -8º C in the north and -10º C in the south of the peninsula. At low levels, there was a high-pressure area over southwest England that extended over the Atlantic and western Mediterranean. There were relative low-pressure areas over the southwest of the peninsula, and a thermal ridge from west Africa entering the peninsula from the southwest. Initially there were clear skies over the peninsula and Balearic Islands, with clouds developing especially inland

3 Although the Airbus Helicopters Manual, and specifically the procedure after a main rotor blade strike, does not specify if damage to the tracking finger installed on the end blank of a blade is minor or major, during the investigation the manufacturer was asked about the damage to the edge of the blade, and it confirmed that it was minor.

4 According to the aforementioned procedure from Airbus Helicopters, any impact to the leading edge with the rotor turning is major damage.

in the southern half of the peninsula, where the instability was higher, with a significant amount of moisture and convergence zones.

1.7.2. Meteorological situation in the area of the accident

In Extremadura, there was considerable convective activity, though the associated precipitation did not affect the area of the accident. There was lightning in the area and considerable clouds, as shown in the satellite images:

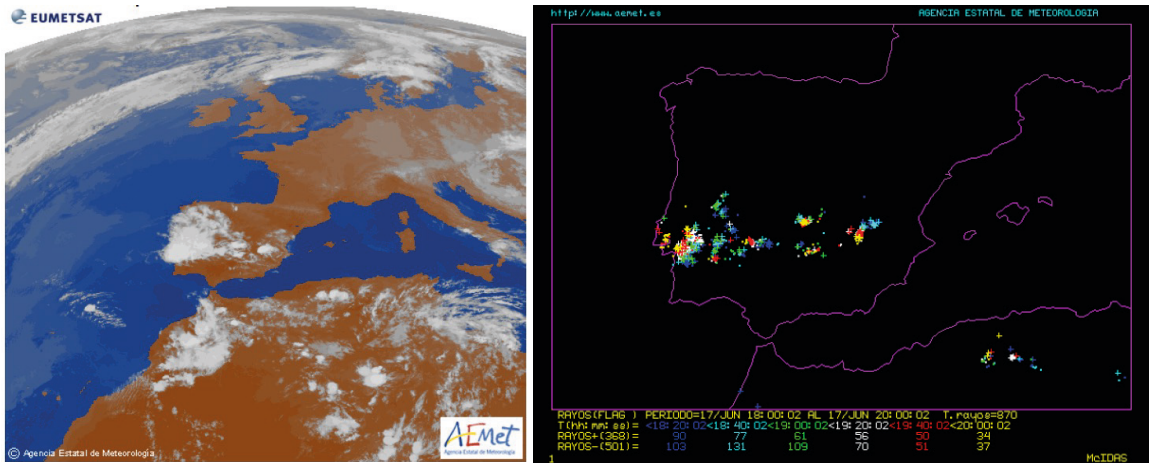

Illustration 3. Satellite images

At the AEMET station in Hoyos, near the helicopter base, there was significant wind from the west with average speeds above 30 km/h, with gusts in excess of 50 km/h. The temperature was about 29° C and the humidity was 34%.

At the closest station to the accident site, located in Cañaveral, within 20 km, the wind was from the northwest at an average speed of 20 km/h at 21:00 and a little over 40 km/h at 21:40, and maximum speeds near 60 km/h. The temperature was around 33° C and the humidity 25%.

In conclusion, the weather situation was complex, with convective activity in the area and strong winds, which could have hampered the helicopter's maneuvers.

The pilot confirmed that there was a very active storm front with heavy lightning activity, which caused some simultaneous fires. The visibility conditions were reduced by the smoke dispersed by the storm itself, which was moving to the west, and by the thick cloud cover, which was blocking out the sun.

1.8. Aids to navigation

Not applicable.

1.9. Communications

Not applicable.

1.10. Aerodrome information

The helicopter took off from the Hoyos helicopter base, in Cáceres, to take part in fighting a fire in the town of Garrovillas de Alconétar. The day after it ran into power lines, it returned to the helicopter base in Serradilla, also in Cáceres, as it was the nearest base.

Below is an aerial view of the Hoyos and Serradilla helicopter bases, and the site of the fire:

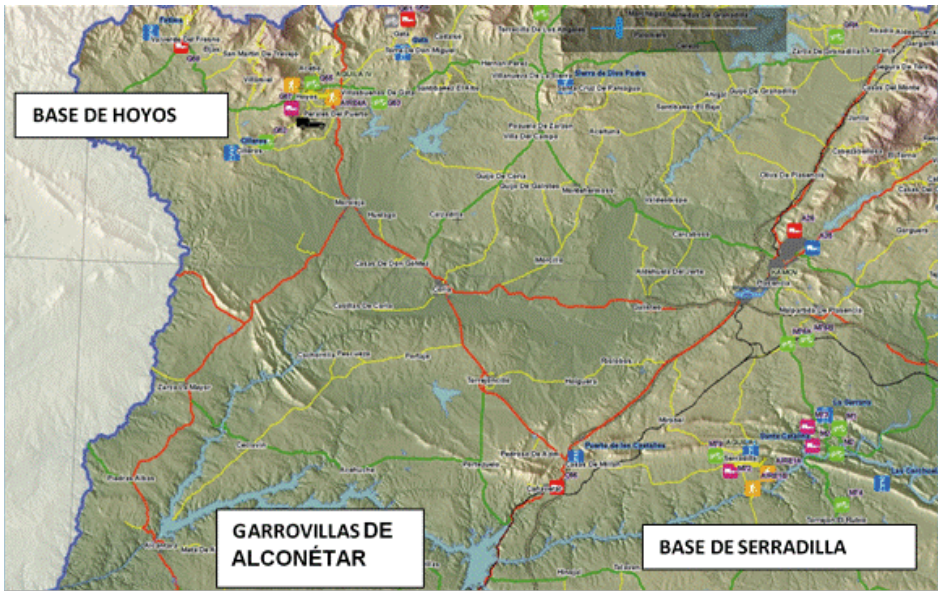

Illustration 4. Aerial view of the helicopter bases and the site of the accident

To prepare for flights, the helicopter base in Hoyos has access to the AEMET website, according to the pilot. There is also a weather station near the base.

1.11. Flight recorders

There was a GPS unit installed in the helicopter, as well as a fleet tracking unit,

which allowed investigators to access the track of the accident helicopter.

According to the recordings, the helicopter took off from the helicopter base in Hoyos at 20:30 and landed, after the accident, at 21:31.

As the figure below shows, after it was dispatched, its area of operations was changed on several occasions.

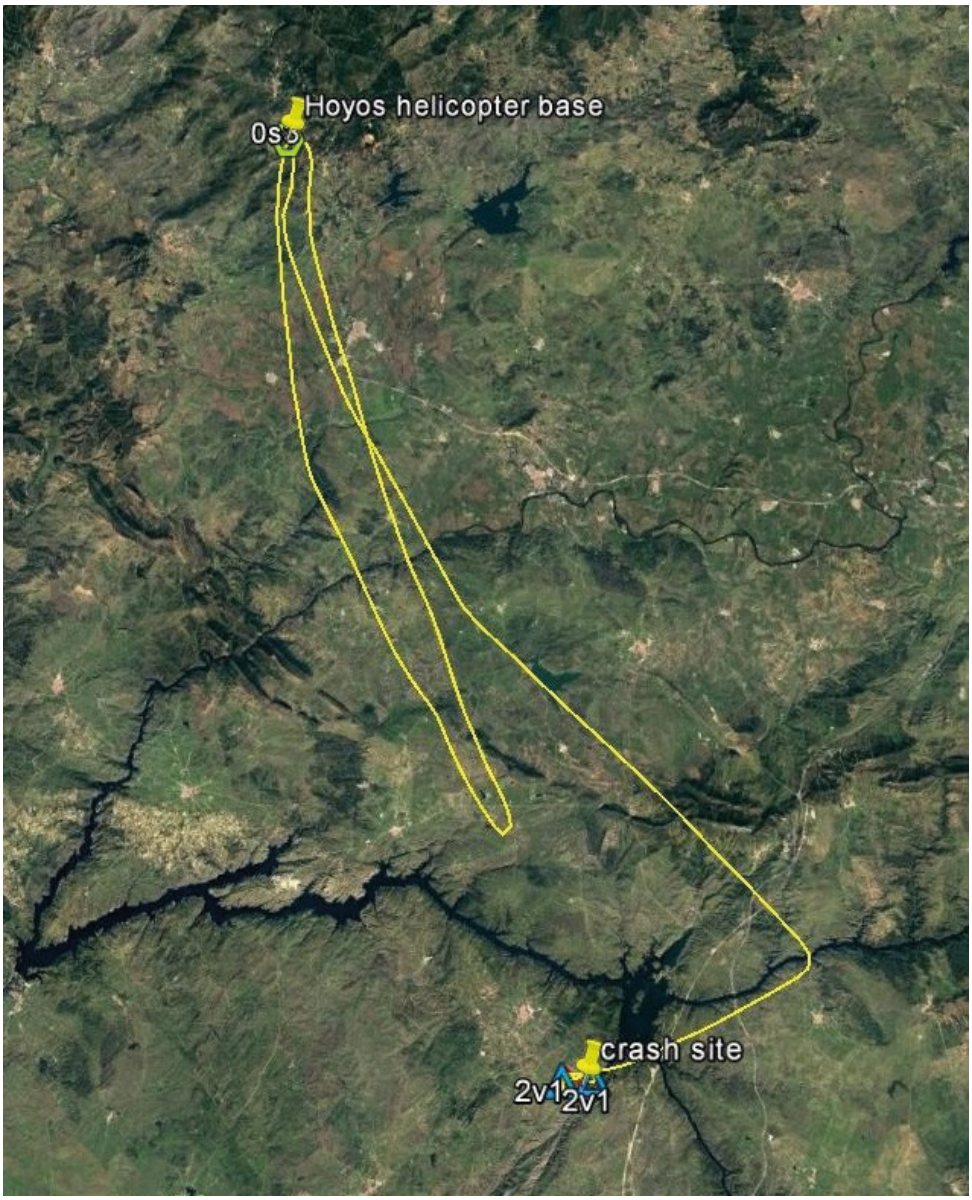

Illustration 5. Helicopter flight path

Before running into the power lines, the helicopter was only able to make one water drop in the area of the fire. The graph below shows the helicopter's activity at the site of the fire:

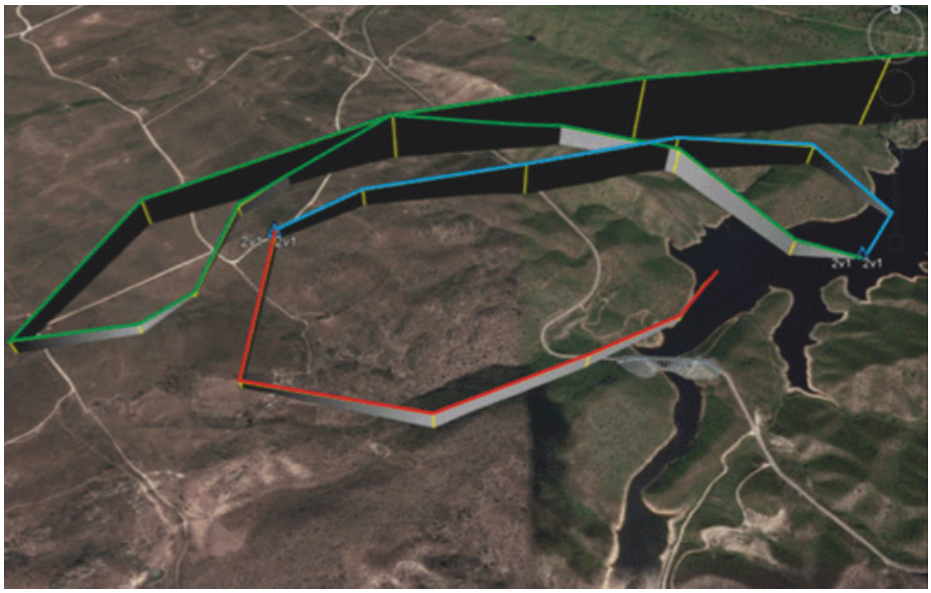

Illustration 6. Final instants of helicopter's flight

1 – Upon reaching the area of operations, the helicopter flies one counter-clockwise circle to reconnoiter the area before disembarking the firefighting squad. (Flight path in green color)

2 – Firefighting squad disembarks.

3 – Helicopter flies to the reservoir along route similar to that taken to reach the area of operations. (Flight path in green color)

4 – Water picked up.

5 – Returns to area of operations also along similar route to ones taken before. (Flight path in blue color)

6 – First water drop made at the site of the fire, and

7 – Returns to reservoir along different route from before and runs into power lines. (Flight path in red color)

1.12. Wreckage and impact information

The helicopter had a cable cutter, which helped reduce the damage to the aircraft.

The figure below shows the cable cutter, along with the remains of the power lines that it impacted.

Illustration 7. Close-up of cable cutter

Despite the cable cutter, the helicopter sustained some damage, namely:

- a crack in of the aircraft's two mirrors,
- a scrape in the structure holding the mirrors,
- several scrapes in the nose and lower cowling,
- a minor dent on one blade tip (yellow blade), and
- several marks in another blade (blue blade).

As indicated earlier, the impact cut the power lines, which left all of the clients who are supplied by this line, located mainly in the municipality of Garrovillas de Alconétar, without power. Four other transformer stations outside this town were also affected.

1.13. Medical and pathological information

There is no indication that physiological factors or impairments affected the pilot's actions.

1.14. Fire

There was no fire.

1.15. Survival aspects

The aircraft was outfitted with a cable cutter, which contributed to the pilot's survival.

1.16. Tests and research

1.16.1. Pilot's statement

On Saturday, 17 June, he was asked to take part in fighting a fire in the municipality of Garrovillas de Alconétar. He had previously been on duty for 1 h 40 min at another fire and he was resting at the time. He was dispatched once his rest period was over.

His area of operations was changed several times. First he was directed to one point of the fire that was already under control. This involved flying 30 miles there and another 30 miles back. He was then instructed to proceed to another point of the fire that was also already under the control of another aerial unit by the time he arrived. He was then informed that the first fire point had been activated, so he flew to that point, which required another 30-mile flight.

Having lost so much time before his area of operations was defined, by the time he arrived, it was a half hour before sunset. He figured he would only have time to make two water drops, which he reported.

The day was heavily overcast, with stormy areas and highly variable winds that were scattering the smoke. As a result, visibility was not very good.

Upon reaching the area of operations, he reconnoitered the area and disembarked the squad. He stated that the squad disembarked at approximately 21:20.

He had problems going back to the reservoir because the wind was very strong. He picked up water and made the first drop. When he returned to the reservoir for more water, he must have gone by a different route than the one he flew during the reconnaissance flight, since when he descended to take on water, he suddenly saw the power lines. He sharply banked 45º or more to try to avoid the power lines and applied full collective, but to no avail.

After impacting the lines, the pilot thought the helicopter's electronics might have failed. He felt the engine RPM drop, so he began an auto-rotation maneuver. However, the turbine was still running although not giving 100% power. After a few seconds, the turbine RPM recovered and all of the helicopter's components worked normally again. He stated that he did not lose control of the helicopter at any point.

After the accident, he left the helicopter in place. The next day, a mechanic checked the condition of the helicopter. After this maintenance mechanic's initial check, he flew to the helicopter base in Serradilla for a more thorough inspection.

He also added that:

- The lines were close to the ground. Normally power lines are higher up. He could not see the power line towers during the reconnaissance flight of the area due to the low light and to the large amount of smoke that was being dispersed by the swirling wind. He thought he would have been able to make out the power lines if it had been earlier in the day.
- He was flying alone. Having a copilot could have helped in that situation, since these are high-workload operations. He stated that in regions like Catalonia, a copilot is always on board, regardless of the helicopter's weight.
- In the CRM courses, pilots are told about operational safety and controlling self-pressure. He admitted that he could have placed pressure on himself in this case, although the regional government did not pressure him to go out or to make a certain number of water drops at any point. He acknowledged that regional officials are increasingly aware that aerial resources cannot always operate.
- He stated that other regions, like Asturias, have prepared maps with information on power lines, windmills, etc. Specifically, he noted that Asturian officials are very mindful of identifying obstacles that can affect aerial assets.
- He is a flight instructor, thanks to which he considered himself ready to respond to emergencies. He did not release the water bucket, as is taught in emergency training, since he focused on flying the helicopter. He thinks that the actions he took saved his life.

1.17. Organizational and management information

The Board of Extremadura contracted seven helicopters from the Sky Helicópteros company to transport personnel and make water drops, and another one to coordinate the aerial assets fighting one fire at the same time.

Pursuant to Decree 52/2010 of 5 March, which approved the Plan to Fight Forest Fires in the Region of Extremadura (INFOEX Plan), eleven coordination areas exist during the times of most danger. The Hoyos helicopter base is in "Zone 1. Sierra de Gata", and the municipality of Garrovillas de Alconétar is in "Zone 7. Center of Cáceres". There is no helicopter base inside "Zone 7. Center of Cáceres", meaning that if aerial resources are needed to fight a forest fire, they must be requested from the other coordination zones.

The operator, Sky Helicópteros, had a special operator's certificate, EC.COE.002, issued by AESA on 9 June 2017. According to this certificate, the accident aircraft was authorized to conduct the following activities when involved in firefighting operations: observation and patrol, coordination, helicopter water drops and transfer of additional specialized personnel, limited to daytime visual (VFR) flights.

1.18. Additional information

Sky Helicópteros Operations Manual

Section 1 of the Sky Helicópteros Operations Manual for aerial work, on "Scope and complexity of the operation", includes the considerations to take into account if there is low visibility in some areas due to smoke. These considerations include scouting the terrain to identify potential obstacles, such as cables.

Moreover, in Section 5, "Normal procedures", it states that once in the area, before commencing firefighting operations, the area where the drops are going to be made and where the water is going to be picked up must be reconnoitered. The Manual specifies that once the loading zone is sighted, to fly over it for as long as necessary to search for possible obstacles along the approach and takeoff paths, and to consider potential exit routes from the area in the event of an emergency.

Consultation with engine manufacturer on potential loss of power after impacting the power lines

During the investigation, the manufacturer of the helicopter's engine, Safran Helicopter Engines, was asked if power could have been lost after the helicopter hit the power lines, as the pilot described.

The manufacturer replied that it was not aware of events in which a loss of power occurred after a minor impact with power lines.

Furthermore:

- There were no visible signs of an electrical discharge on the helicopter blades. Electrical marks could also have been an indication of an electromagnetic voltage in the helicopter and its equipment (including the engine and DECU)
- No messages were recorded in the VEMD. A discrepancy in the DECU or a communications fault with the VEMD should have been recorded
- The pilot did not report any GOV lights (amber or red)
- The pilot reported that the engine worked correctly after the contact with the cable

According to the manufacturer, the loss of power most likely resulted from the pilot's strong input to the collective control.

Analysis of the visibility of the power lines

The investigators analyzed the visibility of the power lines at the time that the helicopter ran into them.

The graph below shows that when the pilot first picked up water from the reservoir, the power lines where at his back, meaning the pilot did not notice them. A yellow triangle is used to show on the figure the location of the initial water pick-up. The red line shows the power lines.

The pilot returned to the reservoir to pick up water again, but approached it from a different direction, which was in the shadows at the time. The contour line beyond which the area was already in the shadows, considering the position of the sun, is bolded in black. On the day of the accident, the sun set at 21:55.

Illustration 8. Visibility in the accident area

This would have hampered the pilot's visibility of the power lines in that direction.

Measures to offset the risk of impacting power lines

Currently, the Flight Manuals of aerial work companies usually instruct to do a preliminary check of the aviation charts and/or to do a high-altitude reconnaissance flight of the area of operations.

Neither European[5] nor Spanish[6] law have any requirements that force aircraft doing aerial work to have a device that reduces the likelihood of impacting power lines or that reduces the consequences of such an impact. European and Spanish laws only require that airplanes with a MCTOM of more than 5700 kg or a MOPSC of more than nine be equipped with a TAWS.

However, nowadays there are various means for reducing the likelihood or consequences of impacting power lines:

- In 2008, the FAA published the document "Safety Study of Wire Strike Devices Installed on Civil and Military Helicopters", which analyzed various systems for protecting against wire strikes.
- In August 2011, the IHST published its Compendium Report, which recommended pilot training and the installation of equipment such as: proximity detection systems, cable detection systems and systems to protect against cables (or cable cutters).
- Subsequently, in 2014, the EHEST group wrote a study on "The Potential of Technologies to Mitigate Helicopter Accident Factors". This study acknowledged that collisions with cables are a great concern to civil and military helicopters. In addition to cable cutters, devices to warn the pilot of the proximity of cables were identified, such as:

  1 - Enhanced Ground Proximity Warning System (EGPWS)/ Helicopter Terrain Awareness and Warning System (HTAWS)

  These systems can provide warning on obstacles on the ground such as towers.

  2 - Laser radar obstacle and terrain avoidance system

  This system user an eye-safe laser mounted on the helicopter fuselage. It provides information to the pilot on the surrounding environment using both an optical display and aural warning. By using a laser, the system can sense objects as thin as wires.

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5 Regulation (EU) No 965/2012 of the Commission requires the following airplanes to have a terrain awareness warning system (TAWS):

- Turbine-powered airplanes having a maximum certified takeoff mass (MCTOM) of more than 5700 kg or a maximum operational passenger seating configuration (MOPSC) of more than nine.
- Reciprocating-engine-powered airplanes with a MCTOM of more than 5700 kg or a MOPSC of more than nine.

6 Royal Decree 750/2014 of 5 September, which regulates aerial firefighting and search and rescue activities and lays out requirements involving airworthiness and licensing for other aviation activities, only specifies that turbine-powered airplanes with a MCTOM of more than 5700 kg must be equipped with an altitude warning system (TAWS).

3 - Digital Map

Accurate navigation systems that also provide elevation and obstacle information to the pilot.

4 - Passive tower-based Obstacle Collision Avoidance System (OCAS)

These are units located on utility and power line towers that detect air traffic entering a predefined warning zone and activate warning lights to illuminate the tower. This system does not require any installations in the helicopter.

5 - Wire Strike Protection System (WSPS), also called wire cutters

The system consists of cutters placed on the roof and bottom of the helicopter that can cut the cables in case of collision and thus prevent an accident.

This system is already installed in some, but not all, civil helicopters. Its usefulness was already demonstrated in a study by the United States Army that concluded that the fatalities associated with wire strikes decreased by nearly half after helicopters were equipped with a Wire Strike Protection System.

Marking of aviation obstacles as a measure for mitigating the risk of colliding with power lines

Report A-025/2016 was recently published, which investigated the accident involving a Robinson R-22-BETA aircraft, registration EC-IGG, at the reservoir in Valmayor (Valdemorillo, Madrid) on 16 July 2016. This report makes a recommendation to the National Aviation Safety Agency to conduct studies in those reservoirs likely to be used in firefighting activities where there is a risk to operational safety due to the presence of power lines. In those cases where the study deems that power lines may pose a hazard to aircraft, it should require that they be marked or lit.

This safety recommendation arose after analyzing the "Guía sobre señalamiento e iluminación de obstáculos, Rev. 1.0" [Guide to marking and lighting obstacles], published by the National Aviation Safety Agency in December 2016, which states:

"*Elevated power lines, suspended cables, etc., that cross a river, navigable waterway, valley or road should be marked and their support towers marked or illuminated if an aviation study indicates that the power lines or cables could pose a hazard to aircraft*.

Recommendation: Type-B, high-intensity obstacle lights should be installed on support towers when an elevated power line, suspended cable, etc., has to be marked and it is not feasible to install lights on the wires, cables, etc., or when an aviation study indicates that they are essential in order to identify them.

This safety recommendation is also in agreement with the non-legislative motion to improve the safety of activities involving aerial work, approved on 28 June 2017 and whose text is as follows:

"*The Spanish Congress urges the Government to require the marking or lighting of obstacles more than 30 meters tall, as well as of power line cables, and the use of paints that help identify high-voltage towers that cross valleys and high-traffic areas or those located in potential forest maintenance or firefighting areas, and in areas of special environmental value, and that might jeopardize the safety of aerial work operations.*"

The reason behind this proposal was described in the document:

"*Of all aerial work activities, it is firefighting that has the highest accident rate. The main risk to professionals involved in these types of operations comes from high-voltage power lines, which are difficult to identify either due to the distance between the towers, or to their height, or because the towers are obscured by trees or painted in camouflage to reduce their visual impact. Because of this, measures have to be taken that specifically enhance the safety of these operations.*"

Cable cutters in the Tender of Technical Specifications in the different Autonomous Regions of Spain (CCAAs)

The different Autonomous Regions (CCAAs) produce Tender of Technical Specifications (PPTs) in which it is detailed how the firefighting operation service provided by aerial operators must be carried out.

A survey was made among the CCAAs in order to establish which ones required in their tender of technical specifications that helicopters should have installed a cable cutter. The result of the survey is as follows:

Autonomous Region	Is it required in the Tender of Technical Specifications PPTs that the helicopters taking part in firefighting operations campaign had installed a cable cutter?
Andalucía	Yes
Aragón	Yes
Principado de Asturias	No, although all the existing operating helicopters in Asturias have already installed it.
Islas Baleares	Yes

Canarias	No, although all the existing helicopters of the operating company have already installed it.
Cantabria	The helicopter does have a cable cutter.
Castilla-La Mancha	Yes
Castilla y León	No, although almost all of the existing helicopters of the different operating companies have already installed it.
Cataluña	No, although they had the intention to require it in the following PPT.
Comunidad Valenciana	No
Extremadura	Yes
Galicia	No
La Rioja	Yes
Comunidad de Madrid	No.
Región de Murcia	No, although all the existing hired helicopters have already one cable cutter.
Comunidad Foral de Navarra	No, although all the existing hired helicopters have already one cable cutter.

País Vasco region informed that they do not hire aircraft for firefighting operation purposes.

Therefore, of the 16 CCAA using aerial aircraft for firefighting operations:

- 6 of them do actually require in their Tender of Technical Specifications that the helicopters participating in firefighting operations have a cable cutter, and one more region has the intention to require it in the following campaign.
- 6 of them informed that, although they do not require it in the Tender of the Technical Specifications, the helicopters operating in their territories do have a cable cutter installed.
- 3 of them do no require it in their Tender of Technical Specifications.

Producing maps with information of possible obstacles for aviation.

Also Autonomous Regions (CCAAs) were asked if they have updated maps with the possible obstacles such as power lines, particularly in zones close to water intaking points.

The result of the survey is as follows:

Autonomous Region	Are there available updated maps with information of the posible obstacles for aviation, particularly in those points next to water intaking?
Andalucía	Yes, for identified and catalogued water intaking points. Furthermore: - They have the ones belonging to the State Network of Power Lines (Red Eléctrica Española, REE) and those of Endesa. They are high and medium tension. - When each helicopter is automatically dispatched, the pilot performs surveillance flights when entering the zone and collects information on obtacles, including power lines.
Aragón	They have the ones belonging to the State Network of Power Lines (Red Eléctrica Española, REE) and those of Endesa They have identified possible difficult points and they have communicated them to all aerial operators.
Principado de Asturias	They have maps and a manual for the aircraft operations, where the potentionally dangerous cables are indicated.
Islas Baleares	They have the ones belonging to the State Network of Power Lines (Red Eléctrica Española, REE) and those of Endesa.
Canarias	No
Cantabria	They have maps of the most representative power lines.
Castilla-La Mancha	Yes
Castilla y León	They have the ones belonging to the State Network of Power Lines (Red Eléctrica Española, REE).
Cataluña	They have available maps of the high and medium tension power lines, the latter ones provided by Endesa.
Comunidad Valenciana	No
Extremadura	They prepared a manual including "Zones with limitations for water intaking", in which it is enclosed a list and maps of zones where they are aware of possible obstacles for aircraft during water intaking operations.
Galicia	They have maps of the different power lines.
La Rioja	They have maps of the main power lines.
Comunidad de Madrid	Yes
Región de Murcia	They have maps with some power lines.
Comunidad Foral de Navarra	They have maps with possible obstacles for firefighting operations aircraft, mainly the big power lines.

Therefore, the vast majority of the different Autonomous Regions have not prepared maps detailling the possible obstacles for aviation, specially at water intaking points. Some of them have pointed out the difficulty in preparing and updating such complicated maps.

1.19. Useful or effective investigation techniques

Not applicable.

2. ANALYSIS

The Regional Operations Center for the Infoex Plan in Cáceres contacted the pilot during his rest period, after he had taken part in fighting another fire. At the conclusion of said rest period (which was observed), he was dispatched to take part in fighting a new fire. He took off from the helicopter base in Hoyos at approximately 20:30. While flying to the fire, his area of operations was changed several times, which resulted in the pilot taking nearly one hour to reach the area of operations. In fact, according to GPS information, he disembarked the firefighting squad at 21:25. Because sunset was approaching[7], the pilot figured he would barely have time to make two water drops, which he reported. It is true that at no point was he requested to make a certain number of water drops at the fire site.

The information taken from the GPS indicates that the pilot did make a reconnaissance flight prior to disembarking the firefighting squad, but he did not reconnoiter the water loading area in an effort to locate potential obstacles along the approach and takeoff paths, as recommended in the Sky Helicópteros Operations Manual.

In the area of the fire, visibility was reduced not only by the approaching sunset, but by the weather conditions, since the wind in the area was dispersing the smoke from the fire. This complicated the task of identifying potential obstacles, like the power lines, in the water loading area.

Once the firefighting squad was disembarked, the pilot flew to a nearby reservoir to take on water. During the first water loading activity he was unable to see the power lines, which were behind him. He returned to the reservoir to reload the water bucket, but he followed a different flight path. The sun was almost setting at that time and the flight path taken by the pilot was in a shaded area. This, combined with the smoke dispersed by the wind, prevented him from seeing the power lines sufficiently far in advance. By the time he saw them, they were directly in front of him. He made an evasive maneuver to avoid the impact but to no avail.

One of the three power lines was cut by the cable cutter installed on the helicopter. The other two lines were severed by the helicopter's rotor blades. The cable cutter is deemed to have aided in the pilot's survival and in reducing the damage to the aircraft.

After impacting the power lines, the pilot felt a loss of power that the manufacturer attributed to the pilot's sudden input to the collective control.

7 Sunset on that day was at 21:55 local time.

The pilot stated that because he is a flight instructor, he was able to control the helicopter and make an emergency landing. He did not activate the emergency release of the bucket, although it is true that the Sky Helicópteros Operations Manual does not indicate what steps to take in this situation.

During the investigation, a survey was carried out among the CCAAs that hire aerial means to find out how many of them request in their Tender of Technical Specifications that the helicopters that participate in the firefighting campaign have an installed cable cutter. Most of them indicated that the helicopters are equipped with these devices either because they are requested in the Technical Specifications or because the operator has deemed it convenient. It is considered that the installation of a cable cutter in helicopters involved in firefighting tasks is an adequate measure to reduce the risk associated with an impact with cable and therefore, safety recommendations are proposed for the CCAAs to request in their Tender of Technical Specifications that the helicopters that participate in the firefighting campaign have an installed cable cutter.

3. CONCLUSIONS

3.1. Findings

- The pilot had a valid and in force license and medical certificate.
- The maintenance mechanic had a valid and in force license.
- The aircraft's documentation was valid and in force, and it was airworthy.
- The pilot did not reconnoiter the water loading area, as required by the Sky Helicópteros Operations Manual.
- The helicopter's cable cutter and blades impacted the power lines.

3.2. Causes/Contributing factors

The investigation has concluded that this accident was caused by the execution of a water loading maneuver in an area that had not been previously reconnoitered.

The following are deemed to have contributed to this accident:

1. The low visibility at the accident site.
2. The failure to reconnoiter the water loading area.
3. The absence of lights on the power lines in the reservoir, which was likely to be used in water loading operations.

4. SAFETY RECOMMENDATIONS

The installation of a cable cutter in helicopters involved in firefighting tasks is considered an adequate measure to reduce the risk associated with an impact with cable. From the survey carried out to the Autonomous Regions (CCAA) it appears that most of the helicopters are equipped with these devices either because they are requested in the Technical Prescriptions of the Autonomous Regions or because the operator has deemed it convenient. Therefore, the next safety recommendations are proposed:

REC 16/18. It is recommended that the Principado de Asturias government requests in its Tender of Technical Specifications that the helicopters that participate in the firefighting campaign have an installed cable cutter.

REC 17/18. It is recommended that the Canarias government requests in its Tender of Technical Specifications that the helicopters that participate in the firefighting campaign have an installed cable cutter.

REC 18/18. It is recommended that the Cantabria government requests in its Tender of Technical Specifications that the helicopters that participate in the firefighting campaign have an installed cable cutter.

REC 19/18. It is recommended that the Castilla y León government requests in its Tender of Technical Specifications that the helicopters that participate in the firefighting campaign have an installed cable cutter.

REC 20/18. It is recommended that the Cataluña government requests in its Tender of Technical Specifications that the helicopters that participate in the firefighting campaign have an installed cable cutter.

REC 21/18. It is recommended that the Comunidad Valenciana government requests in its Tender of Technical Specifications that the helicopters that participate in the firefighting campaign have an installed cable cutter.

REC 22/18. It is recommended that the Galicia government requests in its Tender of Technical Specifications that the helicopters that participate in the firefighting campaign have an installed cable cutter.

REC 23/18. It is recommended that the Comunidad de Madrid government requests in its Tender of Technical Specifications that the helicopters that participate in the firefighting campaign have an installed cable cutter.

REC 24/18. It is recommended that the Regíón de Murcia government requests in its Tender of Technical Specifications that the helicopters that participate in the firefighting campaign have an installed cable cutter.

REC 25/18. It is recommended that the Comunidad Foral Navarra government requests in its Tender of Technical Specifications that the helicopters that participate in the firefighting campaign have an installed cable cutter.