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COMISIÓN DE
INVESTIGACIÓN
DE ACCIDENTES
E INCIDENTES DE
AVIACIÓN CIVIL

Report A-045/2018

Accident involving a Eurocopter AS-350-B2 aircraft, registration EC-MVV, in the vicinity of Montan de Tost on 20 November 2018

GOBIERNO DE ESPAÑA

MINISTERIO DE TRANSPORTES, MOVILIDAD Y AGENDA URBANA

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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

°C	Degrees centigrade
%	Percent
AEMET	Spain's National Weather Agency
AESA	Spain's National Aviation Safety Agency
cm	Centimeters
CPL(H)	Commercial pilot license (helicopter)
ft	Feet
h	Hours
HESLO	Helicopter sling operation
LP	Low pressure
LT	Local time
Kg	Kilograms
Km	Kilometers
Km/h	Kilometers per hour
Kv	Kilovolts
m	Meters
m^3	Cubic meters
MV	Medium voltage
OAT	Outside air temperature
OC	Operating Circular
OGE	Out of ground effect
PA	Pressure altitude
SLU	Single shareholder company
SOP	Standard operating procedure
TRI(H)	Type rating instructor (helicopter)
UTC	Coordinated universal time
VFR	Visual flight rules
Z	Zulu time

Synopsis

Owner and operator:	Helitrans Pyrinees
Aircraft:	Eurocopter AS-350-B2
Date and time of accident:	20 November 2018 at 16:53 LT([1])
Site of accident:	Montan de Tost (Lleida)
Persons on board:	1
Type of flight:	Aerial Work-Commercial-Construction/Sling load
Phase of flight:	Maneuvering-Hovering out of ground effect
Flight rules:	VFR
Date of approval:	26 February 2020

Summary of event

On Tuesday, 20 November 2018, a Eurocopter AS 350 B2, registration EC-MVV, was transporting a suspended bucket of concrete for the foundation of a transmission tower in the vicinity of the town of Ribera de Urgellet (Lleida).

Once it was hovering over the area of the foundation, the two operators who were on the ground handling the bucket of concrete received an electrical shock that resulted in serious injuries.

Following the electrical discharge, the pilot flew to the staging area where the concrete was being loaded in order to release the bucket and pick up company personnel who could assist the injured workers.

The pilot was not injured and the aircraft was undamaged.

[1] Unless specified otherwise, all times in this report are local. On the date of the accident, local time was equal to UTC + 1 hour.

1. FACTUAL INFORMATION

1.1. History of the flight

On 20 November 2018, a Eurocopter AS 350 BE, registration EC-MVV, was preparing to conduct work with external loads involving the transport of concrete as part of the work to "Upgrade the 'ADRALL' 25-kV overhead line between existing supports 93 and 103," in the municipality of Ribera d'Urgellet (Lleida), which the developer, Endesa Distribución Eléctrica SLU, had contracted to Sistem Melesur Energía, S.A.

The helicopter took off at 09:55 from the airport of La Seu d'Urgell en route to the material staging point, where a sling with a hook had been set up in order to transport the concrete, suspended in a bucket, to the worksite.

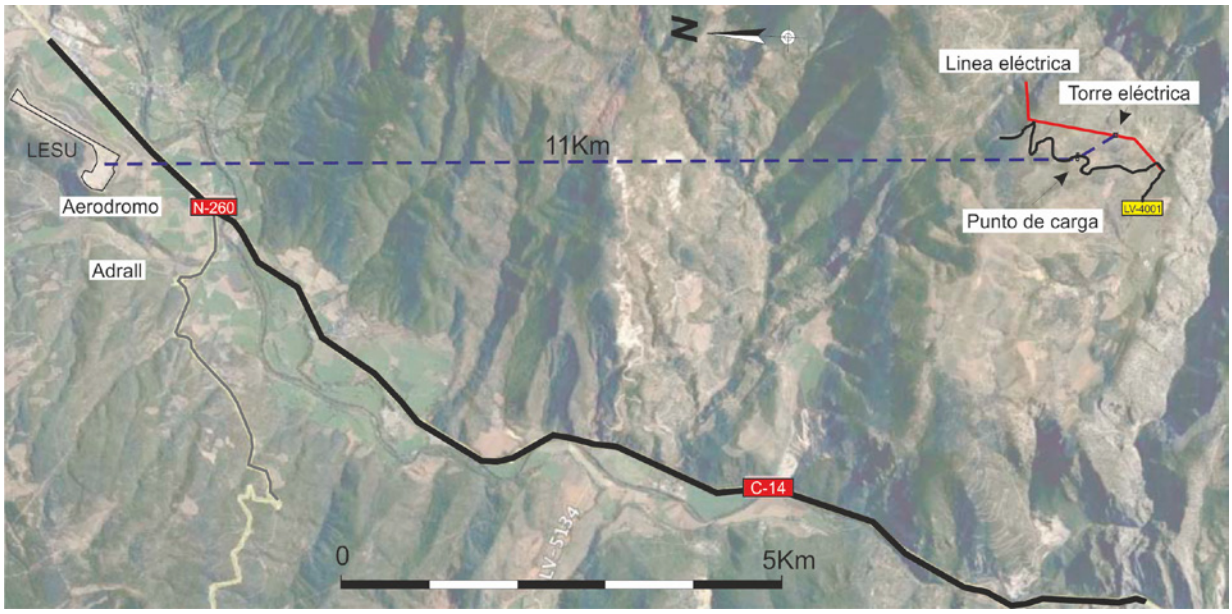

Fig. 1 – Diagram of the locations of the airport in La Seu d'Urgell, the staging area and the accident site

The concrete truck was at the staging site, and so the concrete was reloaded there and transported to the area where it was to be used (located no more than 500 m away). The helicopter lifted the bucket at the staging site and then proceeded to the work site. Once it was past the existing power line, it descended while turning left to reach the unloading point, making the final approach while hovering.

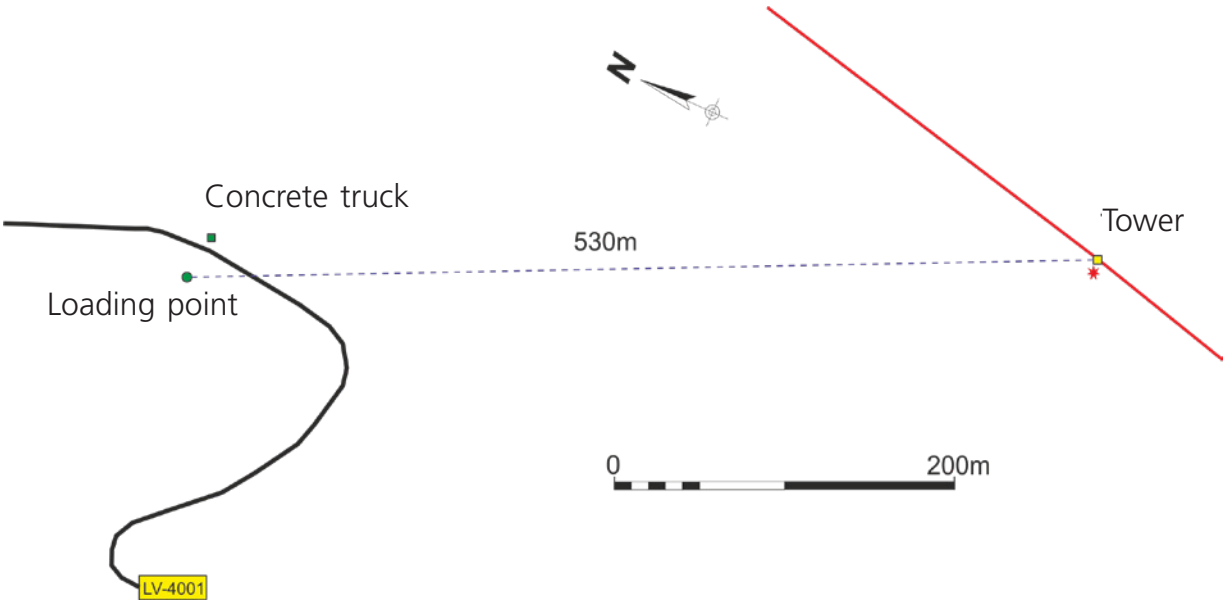

Fig. 2 – Close-up of staging area and accident site

The helicopter hovered perpendicular to the power line, some 12 meters above it, leaving a safety buffer between the sling and the power line to keep the sling from breaching the danger zone of the power line. Once the bucket was close to the ground, two operators on the ground unloaded the concrete by actuating the associated mechanism. The concrete was then poured in the foundation for the new tower. Once the concrete was unloaded, the helicopter climbed again and moved backward to gain enough altitude to clear the existing line, and then proceeded to the staging area.

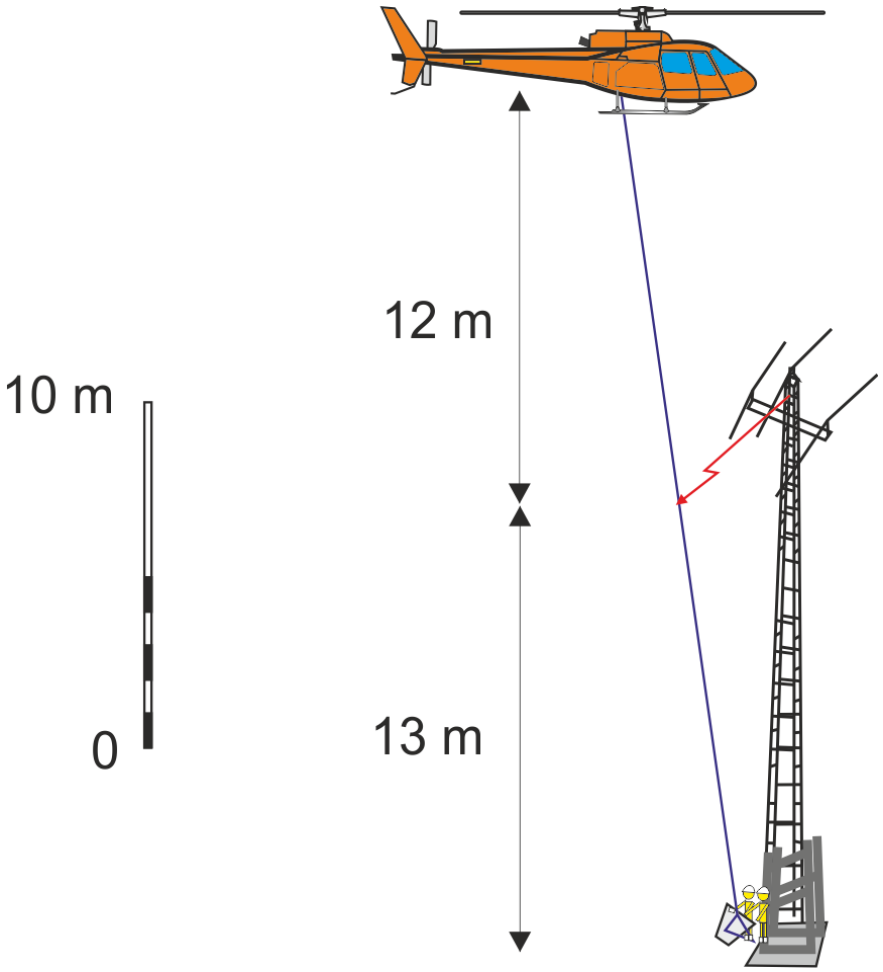

Fig. 3 – Diagram of the aircraft's position

After pouring the initial batch of concrete, which lasted until about 11:05, the activity was stopped for a break and also to refuel the helicopter.

At around 11:40, the aircraft took off once more to resume the activity.

After several rotations, all of them to the same concrete unloading point, and with the aircraft in place to unload a new batch, the pilot noticed a spark and a flashover. At the same time, he saw that the two operators who were handling the concrete bucket on the ground, near the base of the transmission tower into whose foundation they were pouring the concrete, fell to the ground.

The pilot immediately flew to the staging area where, after placing down the concrete bucket and unhooking the sling, he picked up company personnel who could help the two operators on the ground.

The first injured worker was flown to the fire station in La Seu d'Urgell, where he was treated by emergency medical personnel. He was later transported to the Vall d'Hebron Hospital in Barcelona.

Later, aided by the firefighters, the second injured worker was evacuated to the airport of La Seu d'Urgell, where he was transferred to an air ambulance and transported to the Vall d'Hebron Hospital in Barcelona.

1.2. Injuries to persons

Injuries	Crew	Passengers	Total in the aircraft	Other
Fatal				
Serious				2
Minor				
None	1			
TOTAL	1			2

1.3. Damage to aircraft

The helicopter was not damaged.

1.4. Other damage

The sling used to transport the external loads of concrete was burned.

1.5. Personnel information

Information on the pilot:

The pilot, a 46 year old Spanish national, had a commercial pilot license (CPL(H)) issued by Spain's National Aviation Safety Agency (EASA) on 18 August 1995, which was valid until 23 August 2019. He had valid type ratings for the following helicopter models:

Model	Valid until
AS350/EC130/SP	31 March 2019
AS355/SP	30 April 2019
EC135/635/SP	30 April 2019

He was also a type rating instructor (TRI(H)) for the AS350 and EC130 helicopters. This rating was valid until 28 February 2020.

He had Spanish and English language proficiency certificates issued by AESA, the latter of which was valid until 31 July 2022.

He also had a class 1 medical certificate that was valid until 23 February 2019.

He had a total of 10650:03 flight hours, of which over 9000 had been on the type.

1.6. Aircraft information

The Eurocopter AS-350-B2 helicopter has a maximum takeoff weight of 2250 kg. It is outfitted with a Turbomeca ARRIEL 1D1 engine, serial number 9147, with 4418:29 flight hours.

The accident aircraft has serial number 2456. It was manufactured in 1991 and had a temporary registration, EC-MVV, that was valid until 29 November 2018.

It had a certificate of airworthiness, issued on 27 April 2018 by the National Aviation Safety Agency, and an airworthiness review certificate that was valid until 13 September 2019.

The aircraft had an insurance policy that was valid until 10 May 2019.

At the time of the accident, it had 4786:45 flight hours, and it had undergone its last 100 h inspection in September 2018 with 4739 flight hours.

Based on the aircraft's cargo manifest and performance data, the center of gravity was within the operating limits, and it was able to hover OGE with a weight of 2442 kg, an OAT of 5º C and a PA of 5000 ft.

1.7. Meteorological information

According to information provided by Spain's National Weather Agency (AEMET), at the time of the accident, the skies were practically overcast, with occasional precipitation and a variable breeze. There was no lightning in the vicinity.

The stations closest to the accident site were in La Seu d'Urgell (9 km Northeast), Nargó (16 km Southwest) and Martinet (24 km east-Northeast).

The data recorded at these stations were as follows:

La Seu d'Urgell: temperature 6º C, relative humidity 91%, light rain. Average wind 1 km/h from the Southeast, gusting to 3 km/h, also from the Southeast.

Nargó: temperature 6º C, relative humidity 100%, it had just stopped raining. Average wind 3 km/h from the Northwest, gusting to 5 km/h, also from the Northwest

Martinet: temperature 4º C, relative humidity 95%, light rain. Average wind 3 km/h from the Northwest, gusting to 8 km/h, from the West

According to statements from various eyewitnesses, the visibility and weather were good at the start of the activity and worsened over the course of the second rotation, from 11:40. It was drizzling at the time of the accident.

1.8. Aids to navigation

Not applicable.

1.9. Communications

The pilot was in contact with the load coordinator of Helitrans Pyrinnes on an ICOM A6-E air-band radio to maintain the ground-air link and coordinate the concrete loading and unloading operations.

The operators on the ground communicated with the pilot using hand signals to instruct him to bring the load closer.

1.10. Aerodrome information

Not applicable.

1.11. Flight recorders

Not applicable.

1.12. Wreckage and impact information

The aircraft was unloading concrete for the foundations of a newly built transmission tower that was slated to replace existing tower nº 94, which was part of a medium-voltage power line that was in service.

It did so by hovering above and perpendicular to the power line while trying to keep a horizontal safety distance between the sling and the power line.

The accident occurred in a mountainous region with a considerable slope. The tower under construction was located a short distance away from the existing tower, which was in service. The two towers were 64 cm apart at the closest point and 125 cm apart at the most distant point.

Fig. 4 – General and close-up view of the position of the towers

The perpendicular distance between the power line of the existing tower and the last area where concrete was poured is 3 m.

The base of the tower is made of concrete, which was dry and not leveled, with footprints.

There was nothing around the tower that could have caused the accident.

There were various metal tower segments in the area where the concrete was mixed and loaded, which was some 500 m away from the accident site. Next to them was a plastic, tube-shaped structure 343 cm long with a 119 cm hole at one end used to unload the contents of the bucket on the ground.

The helicopter and the sling were housed in a hangar at the La Seu d'Urgell Airport.

The sling had three distinct points: one where it attached to the bucket, another where it attached to the helicopter and parts with burn marks. The sling measured a total of 22.20 m. The segment between the point where the bucket was attached and the burned part measured 10.10 m. The burned area, 28 cm long, had three punctures, with the punctures on either end being separated from the central puncture by 15 and 13 cm.

The layers that cover the internal core of the sling were uncut and undamaged, but the burn marks on the surface polyester layer revealed that there had been a short circuit.

Fig. 5 - Close-up of burn marks on the sling

The bucket used to transport the concrete was outside the hangar. There were burn marks on one side. The bucket is 145 cm long, and on top of the bucket is a triangular metal structure measuring 20 cm that is used to fasten the anchors. The chain that goes between the triangular piece and the hook on the sling is 1 m long.

Fig. 6 - Bucket

1.13. Medical and pathological information

The two workers on the ground who were handling the concrete bucket were seriously injured.

1.14. Fire

There was no fire.

1.15. Survival aspects

Immediately after the accident, the injured workers were treated and evacuated. To aid in this, the pilot flew to the staging area, where he released the sling and the concrete bucket and boarded the Helitrans load coordinator and a Melesur employee who was at a nearby tower.

After an initial assessment of the injured workers, one of them, who was unconscious, was reanimated, while the helicopter evacuated the other one to the fire station in La Seu d'Urgell. There, he was treated by emergency medical personnel and later transported to the Vall d'Hebron Hospital in Barcelona.

Subsequently, with assistance from the firefighters, the second injured worker, who had regained consciousness, was evacuated to the La Seu d'Urgell Airport, where he was transferred to an air ambulance and taken to the Vall d'Hebron Hospital in Barcelona.

1.16. Tests and research

1.16.1. Interview of the pilot

In his statement, the pilot said:

"I made the first round of concrete deliveries from 08:55 Z until 10:05 Z, at which time I landed to refuel and rest.

Visibility was good (over 10 km), with scattered clouds and a high cloud ceiling.

I resumed flying at 10:35 Z. The weather had worsened, but it was still good.

After several rotations (all to the same accident site), at the concrete unloading point I saw a spark and a flashover that caused the two ground workers who were handling the bucket to fall to the ground.

At that point I did not see any abnormal readings or warning lights or any effects on the helicopter.

The aircraft was perpendicular to the power line, some twelve meters above it, approximately three and half meters away from it horizontally.

It had started to drizzle and the visibility was still good.

After the flashover I headed to the landing area to put the bucket down, unhook the sling and pick up personnel from the company and Melesur to go assist the two workers.

We were able to evacuate the first one to the fire station in La Seu d'Urgell, where he was treated by emergency medical personnel, and then the second one, with help from the firefighters, was also evacuated to the airport of La Seu and flown by air ambulance to the hospital.

We later noticed that the sling had been affected by the flashover and that the discharge had been routed through the sling to the workers who were on the ground unloading the concrete. The helicopter was not at risk, but the operation of the helicopter did lead to the discharge that caused the accident."

He also confirmed that he had not been present at the briefing before work started, and that he had been briefed by telephone.

1.16.2. Statement from work personnel

Several other workers, including one of the injured employees, also provided a statement. They said that to cordon off the safety zone, "a line was drawn a certain distance away from the power line and marked with tape, which was not to be crossed."

They were unsure of the distance to mark off, although some mentioned 3 m. The injured worker stated that the distance may have been 1.5 to 2 m, and that in this case, they themselves had measured it.

He also noted that they "did not want to push the bucket, but rather activate the lever to unload it, attributing the event to a gust of wind."

1.17. Organizational and management information

The company Helitrans Pyrinnés is authorized by AESA to do aerial work with helicopters. It is based at the La Seu d'Urgell Airport.

Its main activity takes place in mountainous areas and relies on helicopters, which are used to transport construction material on external load operations and to install structures in places that are hard to reach.

It had been subcontracted by the company Sistem Melesur Energía, which had been awarded the work to "Upgrade the 'ADRALL' 25-kV overhead line between existing supports 93 and 103" in the municipality of Ribera d'Urgellet, in the province of Lleida.

The company responsible for the work was ENDESA DISTRIBUCIÓN ELÉCTRICA S.L.U.

1.18. Additional information

1.18.1. Information about the sling

The sling consists of a high-tenacity inner polyester core covered by a braided layer, also made of high-tenacity polyester, for protection. Atop this layer is a second layer of the same material with four braided copper wires individually covered with Nomex insulator, which has fireproof and dielectric properties, and an insulating capacity of up to 30,000 volts. Rounding out the protection are a third and fourth layer of high-tenacity polyester, the latter of which is twisted to provide abrasion protection for the sling. This fourth layer is orange to make it easy to see the sling.

The company representative in Europe stated that, according to laboratory tests, if the product is sufficiently close to an alternating current power line, arcing can occur at a distance of 50 cm.

The surface polyester layer melts at 240º C.

1.18.2. Information in the Operations Manual

The operator's *Operations Manual* has a section on "Standard Operating Procedures for assembly and construction activities" that mentions the following aspects:

Coordination with work personnel: *It is very important to coordinate and communicate properly with the individuals in charge of specialized tasks on the ground at each work site, as well as with those responsible for coordinating the work and the ground personnel of Helitrans Pyrinees.*

The section on "Normal Procedures/Normal In-Flight Procedures/Concreting Operations/ Unloading Phase" states:

The unloading phase includes the maneuvers from the final approach to the unload point until the helicopter departs for the staging area. It includes:

Approach:

The pilot will stop the helicopter smoothly and gradually to achieve a zero translational speed at an altitude that is high enough to clear obstacles and not drag the load on the ground.

Arrival at unloading point:

From the previous situation, the load will be slowly brought closer (while hovering, with no translational speed or letting the load swing) until the bucket is over the unloading point.

Stay in position without placing the bucket on the ground.

Emptying the bucket:

Ground personnel will approach the bucket and can help guide it into position.

They will activate the manual lever on the bucket to empty its contents out the lower door.

Once empty, or when the required amount has been poured, the door will be closed and the signal will be given to the pilot to raise it.

Lifting:

The operator will move away so the pilot can safely lift the bucket.

The helicopter will then climb and return to the staging area.

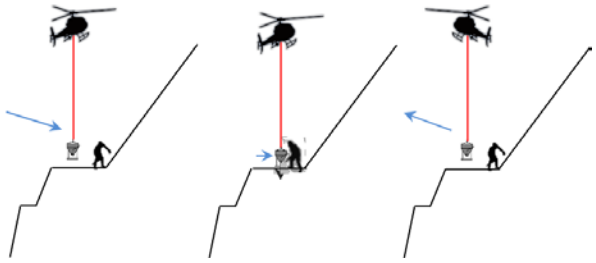

Fig. 7 – Sequence of the unloading phase

Variations

When personnel cannot be present at the unloading point, the operation can be carried out using remote opening devices (pneumatic actuation).

When concreting delicate elements (e.g. initial support for the base of a tower), it is preferable to stand the bucket on a flat area alongside the unloading zone and unload the concrete there for personnel to later shovel where needed.

1.18.3. Information on the Safety and Health Plan

The Safety and Health Plan, Annex V, "Upgrading Medium-Voltage Overhead Lines with a helicopter", mentions the following aspects:

These resources will only be used as an exception. Even so, and considering the need to use this work item, its usage limitations will be observed in terms of adverse weather conditions and of the presence of obstacles that make it impossible to do the work safely. In any case, safety distances to overhead power lines are to be observed that take into account the material being transported on the sling.

Elements involved:

Helicopter: *On board will be the pilot and a pilot's assistant, both employees of the company that owns the helicopter.*

Work area: *There will be a Melesur employee in the various work areas, located beneath the support, who will act as the safety technician and communicate with the pilot's assistant using visual signals to inform him when the load is properly positioned so that the sling holding the materials being transported by the helicopter can be removed. There will be a minimum of two Melesur employees on the support to receive the different parts of the supports.*

Before starting, the pilot will ensure that both the weather conditions and the situation in the work areas are conducive to the safe conduct of the work that is to be done. A sheet will be filled out at the briefing that will specify the work supervisor(s) and the safety technician(s).

During concreting operations, the buckets will not be filled to the top. A space of 20-30 cm will be left unfilled to keep particles from falling during perpendicular movements when lowering the bucket.

Two operators are required to guide and open the concrete bucket (both employed by the lead contractor). The sling used will be long enough to ensure that the helicopter is clear of obstacles both at the barrel and support. Approximately three trips will be made for each m^3 of concrete.

Flights will not take place in bad weather (fog, rain, storm, strong and/or turbulent wind). The evaluation criteria will be set by the pilot.

Point 7 lays out the following sequence of operations for doing the work:

1. *Transport materials to staging area by ground.*
2. *Excavation.*

3. *Work planning: all the Helitrans and Melesur workers will meet before work begins to have a briefing and determine if both the weather and working conditions are suitable for the work to be performed safely. At the start of the work, the operations will be determined and coordinated, and based on the existing and forecast weather conditions, the captain of the aircraft will decide whether the work can be done. Work cannot be performed…*
4. *Deenergizing the medium-voltage overhead lines: as indicated in the deenergizing documents of Endesa Distribución Eléctrica S.L.U., on the date and time specified, the necessary work will be done to satisfy the five golden rules[2] and leave the line(s) to be worked on deenergized, as well as any others that are needed to safely complete the work. Endesa procedure NNM003 (Deenergizing MV lines) and/or NNM004 (Deenergizing LV lines) and/or NNM005 (Deenergizing Remote Control or communications) will be carried out. Both a protected area and a work area will be created.*
5. *Work boundary: there is no mention of setting up a boundary for reasons of electrical shock.*
6. *Removing the existing span.*
7. *Setting up supports: involves placing the support bases, concreting, setting up the head and body of the support.*
8. *Spanning the lines.*
9. *Disassembly and removal of wooden supports.*
10. *Setting up support under the line: not applicable in this case, since the structure is placed alongside the line.*

1.18.4. Applicable laws

According to Royal Decree 617/1997 of 8 June, on the minimum requirements for protecting the health and safety of workers against the risk of electrical shock, for a 25-kv line, the minimum distance for the work area is 3 meters if the work area cannot be closed off (distance to the outer limit of the proximity zone when it is not possible to accurately close off the work area and ensure that it is not breached during the performance of the work), and 1.27 meters when it is impossible to close off the work area (distance to the outer limit of the proximity zone when it is possible to accurately close off the work area and ensure that it is not breached during the performance of the work).

[2] Golden rule:
1st G.R. Disconnect. Cut off supply.
2nd G.R. Prevent potential reenergization. Lock and tag.
3rd G.R. Verify zero voltage.
4th G.R. Ground and short circuit.
5th G.R. Mark the work area.

1.18.5. Information from the preliminary investigation conducted by the regional police.

As concerns the briefing before starting the work, the planning and procedure log for the 20th only contains the signatures of the six Melesur employees. Point 2 of said log, on the risks identified, does not mention any type of electrical risk.

During his statement, the pilot noted that when the work began, the weather conditions were good, and that they worsened over the course of the day. In fact, they had discussed stopping, but since there were buckets full of concrete, and they had never before been left full, they decided to continue.

There was also photographic information available for the work site from that day which shows that the process of unloading the concrete was done by bringing the bucket directly to the support base.

1.19. Useful or effective investigation techniques

Not applicable.

2. ANALYSIS

2.1. General

Based on the documentation provided, the aircraft pilot had the license and medical certificate required for the flight. The aircraft also had the documentation needed for the flight.

The information on the pilot's duty period shows that the requirements for both working hours and days in OC 16B and Annex I were satisfied.

The takeoff weight during the initial rotations was 2349.1 kg, which is within the operating limits in the AS250B2 flight manual and in the company's SOP for HESLO.

2.2. Of the weather conditions

According to information provided by the National Weather Agency (AEMET), in the area of the accident, the skies were practically overcast with occasional precipitation and weak, variable winds.

The pilot himself stated that the conditions had worsened, since it had started to drizzle, although the visibility remained good.

Therefore, the prevailing humidity conditions throughout the morning, and, of course, the appearance of drizzle, caused so much moisture to build up on the sling that it lost its dielectric qualities.

The presence of moisture on the surface of the sling is conducive to the appearance of flashover in the vicinity of a voltage source, and since the sling was grounded, it caused the current to flow to an area of lower voltage.

Therefore, even though conditions were not limiting for flying, they were for an activity that was being carried out in the presence of an energized power line.

2.3. Of the operation

The line was in a mountainous area that was hard to access, which is why the concrete had to be transported using a helicopter.

The work being done involved concreting the foundation of a transmission tower so it could replace the existing tower that supported the power lines. The towers were separated by 64 cm at their closest points.

Based on the burn marks on the sling, the helicopter was some 12 m above the line but away from it horizontally as it placed the bucket near the unloading point.

As noted in the police report, the pilot stated that in light of the worsening conditions, they had decided to stop work once the buckets full of concrete had been emptied.

It thus seems that the possibility of not using, or even wasting, the concrete that had already been loaded into some of the buckets prompted the decision to keep working until they were fully unloaded, despite the worsening atmospheric conditions.

An inspection of the site revealed a plastic, tube-shaped structure 343 cm long with a 119 cm orifice at one end that was used to unload the contents of the bucket on the ground. However, the structure used to unload the concrete was not seen at any of the towers that were visited.

The photographs available in the report, which were taken at the work site on the day of the accident, show that the concrete was unloaded by bringing the bucket directly to the support base, without using the structure mentioned earlier.

This course of action entails bringing the sling close to the power line, with the ensuing increased risk of breaching the proximity zone of the power line and of having the sling come into contact with the line, either directly or through flashover.

As concerns the sling used in the operation, burn marks were found 10.10 m away from the attachment point for the bucket. This is consistent with the formation of flashover at the height of the power line. Also, considering the total length of the sling of 22.20 m, this indicates that the helicopter was about 12 m above the line, which is appropriate.

The inspection of the sling also revealed that the layers that cover the central core were not cut or damaged, but the burns on the surface polyester layer had caused a short circuit, which is consistent with a spark propagating to the ground through the wet surface on the sling.

As concerns the safety distances, according to Royal Decree 614/1997 of 8 June, on the *minimum requirements for protecting the health and safety of workers against the risk of electrical shock*, for a 25-kv line, the minimum distance for the work area is 3 meters if the work area cannot be closed off (distance to the outer limit of the proximity zone when it is not possible to accurately close off the work area and ensure that it is not breached during the performance of the work), and 1.27 meters when it is impossible to close off the work area (distance to the outer limit of the proximity zone when it is possible to accurately close off the work area and ensure that it is not breached during the performance of the work). In the case at hand, since the work area could not be accurately closed off and monitored, the limit distance for the work area was three meters.

Breaching the proximity zone poses an obvious risk of accidentally encroaching on the danger zone.

Based on this, both the information from the company and in the Safety and Health Plan indicated that a safety distance in excess of three meters from the high-voltage line had to be set up. Once this distance was measured, it would be marked on the ground with white tape with an orange strip to ensure its visibility. The purpose of this line would be to keep individuals from breaching the proximity zone for the power line.

As is apparent from the information provided by one of the injured workers, the actual distance was between 1.5 and 2 m, and not 3 m, as others may have stated. He also mentioned that it was he and the other injured worker who measured the distance and placed the white tape with red stripes.

Therefore, the safety area was not marked as required by the regulation.

Continuing with the contents of the Safety and Health Plan, Annex V therein makes reference to working with a helicopter and specifies:

There will be a Melesur employee in the various work areas, located at the support, who will act as the safety technician and communicate with the pilot's assistant using visual signals to inform him when the load is properly positioned so that the sling can be removed. There will also be a minimum of two Melesur employees to receive the load. It is understood that in each work area, next to the post or support, there will be a safety technician to communicate with the flight assistant, who cannot be the pilot.

However, in the accident area, there were only two Melesur Energía employees near the tower, and only the pilot was in the helicopter. The work supervisor, who was the safety technician, was in the area but he was at other towers at the site and not in visual contact with this group of workers.

Independently of the above, point 7 in Annex V specifies the following as part of the sequence of work operations:

4. *Deenergizing the medium-voltage overhead power lines: As specified in the deenergizing documents of Endesa Distribución Eléctrica S.L.U., on the date and time specified, the necessary work will be done to satisfy the five golden rules and leave the line(s) to be worked on deenergized, as well as any others that are needed to safely complete the work. Endesa procedure NNM003 (Deenergizing MV lines) and/or NNM004 (Deenergizing LV lines) and/or NNM005 (Deenergizing Remote Control or communications) will be carried out. Both a protected area and a work area will be created.*
5. *Work boundary: there is no mention of setting up a boundary for reasons of electrical shock.*

Therefore, based on this sequence of operations, the line should have been deenergized before proceeding with the concreting work, which did not consider the electrical risk. The only measures considered in this regard were generic measures involving maintaining safety distances and the visual signals of the safety technician with the line deenergized.

3. CONCLUSION

3.1. Findings

The pilot of the aircraft had the license and medical certificate required for the flight.

The aircraft had the documentation required for the flight.

The aircraft's weight was within its maximum takeoff weight limits.

The weather conditions were not limiting for the flight, but they were for the activity that was being conducted, a short distance away from an energized power line.

The briefing was held without the pilot and did not consider the electrical risks.

The helicopter was some 12 m above and away from the power line as it placed the bucket near the unloading point.

The work was being done in very close proximity to an energized power line.

Due to the worsening weather conditions, it was decided to stop the work once the buckets that were full of concrete were unloaded.

The concrete was unloaded by bringing the bucket directly to the support base, without using the structure provided for this purpose that was located at the staging site.

The spark propagated to the ground through the wet surface of the sling.

The tape used to mark the safety zone was set up 1.5 m to 2 m away, which was not in keeping with the legal requirements.

In the accident area, there were only two workers near the tower and the pilot in the helicopter.

At the time of the accident, there was no safety technician present and there was no pilot's assistant.

The medium-voltage power line had not been deenergized.

3.2. Causes/contributing factors

The accident occurred when the safety zone for the medium-voltage power line was breached due to the incorrect execution of the concrete unloading operation as a result of failing to adhere to the operating procedures.

The weather conditions were conducive to the propagation of the spark.

4. SAFETY RECOMMENDATIONS

None.

5. APPENDICES